Designated Office Evaluation Report

for

Type A Water Licence and Quartz Mining Licence Applications - Bellekeno Mine Development

Project Number: 2009-0030

Proponent: Alexco Keno Hill Mining Corp.

Assessment Start Date: March 17, 2009

Mayo Designated Office

P.O. Box 297
Mayo, YT
Y0B 1M0
Tel: (867) 996-4040
Fax: (867) 996-4049

www.yesab.ca

SUMMARY

Alexco Keno Hill Mining Corp. has proposed to take their advanced underground exploration project at the historic Bellekeno mine into production. The proposal includes details on principal mine development activities involving continued underground development and operations at Bellekeno and construction and operation of a conventional flotation mill at the Flame and Moth site 1.2km southeast of Keno City for the processing and production of minerals from Bellekeno mine. Views and information on the project were submitted by Keno City Advisory Board, Keno City residents, Yukon Government, Environment Canada, Transport Canada, Village of Mayo, Mayo residents, Wilderness Tourism Association, TIA Yukon, Nacho Nyak Dun First Nation, Mayo Renewable Resource Council, Workers Compensation Board and other members of the public. As a result of views and information received during the public comment period, the proponent proposed an alternative Mill Site for the project. The alternative was proposed to mitigate some of the concerns raised. Seven valued components were identified by the assessor:, environmental quality, aquatic resources, wildlife and wildlife habitat, health and safety, economy, quality of life, and heritage resources. The assessor determined that the project will have significant adverse effects on environmental quality, aquatic resources and health and safety. Mitigations proposed by the proponent in addition to those recommended by the assessor are considered adequate to eliminate, reduce or control the significant adverse effects of the project.

OUTCOME

The Mayo Designated Office, pursuant to section 56(1)(b) of the *Yukon Environmental and Socio-economic Assessment Act,* recommends to the decision bodies that the project be allowed to proceed, subject to specified terms and conditions, as the Designated Office has determined that the project will have significant adverse environmental or socio-economic effects in or outside of Yukon that can be mitigated by those terms and conditions.

The terms and conditions of the recommendation are as follows:

Aquatic Resources

1. All road construction and upgrades that utilize non-AML waste rock shall be done in accordance with project-specific developed quality assurance and quality control practices (*i.e.* periodic screening and sampling of waste rock used for road material) that govern the project's waste rock management plan and in a manner conducive to monitoring run-off as per the Adaptive Management Plan.
    - Run-of in areas utilizing non-AML waste rock shall be monitored.
    - Monitoring of these areas must be added to the Adaptive Management Plan

2. The key Best Management Practices ("BMP") that will be implemented to protect fish and fish habitat when constructing the Lightening Creek clear span bridge include:
    - Minimize the riparian area temporarily disturbed by access activities along the adjacent upland property. Use existing trails, roads, or cut lines wherever possible to

avoid disturbance to the riparian vegetation.

- Avoid building on meander bends, braided streams, alluvial fans, active flood plains, or any other area that is inherently unstable and may result in the alteration of natural steam functions or erosion and scouring of the bridge structure
- Removal of select plants within the road right-of-way (ROW) may be required to meet operational and/or safety concerns for the crossing structure and the approaches. This removal should be kept to a minimum and within the road right-of-way. When practicable, prune or top the vegetation instead of uprooting.
  - Trees will be felled away from watercourses to reduce damage to stream banks and beds. To maintain bank stability, trees within 10 m of watercourses will be close cut and stumps left in place except along the trench line.
- Ensure that the clear span bridge is properly designed to address river and channel processes at flows above the ordinary high water mark.
- Design and construct approaches so that they are perpendicular to the watercourse to minimize loss or disturbance to riparian vegetation.
- Design the bridge so that stormwater runoff from the bridge deck, side slopes and approaches is directed into a retention pond or vegetated area to remove suspended solids, dissipate velocity and prevent sediment and other deleterious substances from entering the watercourse.
- Generally there are no restrictions on timing for the construction of clear-span structures as they do not involve in-water work. However, if there are any activities with the potential to disrupt sensitive fish life stages (*e.g.* crossing of watercourse by machinery), these shall adhere to the timing window outlined above.
  - Machinery fording the watercourse to bring equipment required for construction to the opposite side is limited to a one-time event (over and back) and should occur only if an existing crossing at another location is not available or practical to use.
  - To exercise this option, the stream bed at the fording site must be comprised of stable gravel or bedrock and the stream banks must be low and stable.
  - If minor rutting is likely to occur, stream bank and bed protection methods (*e.g.* swamp mats, pads) shall be used provided they do not constrict flows or block fish passage.
  - Grading of the stream banks for the approaches shall not occur.
  - If the stream bed and banks are steep and highly erodible (*e.g.* dominated by organic materials and silts) and erosion and degradation are likely to occur as a result of equipment fording, then a temporary crossing structure or other practice shall be used to protect these areas.
  - Time the one-time fording to prevent disruption to sensitive fish life stages by

adhering to appropriate fisheries timing window.

- Fording shall occur under low flow conditions and not when flows are elevated due to local rain events or seasonal flooding.

3. Install effective sediment and erosion control measures, such as silt fencing, temporary diversion berms, clear crush check dams or straw bales, before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.
    - Work that will disturb soils shall be stopped during periods of high precipitation if it is likely to lead to sediment deposition into Lightening Creek.
4. Operate machinery on land (above the ordinary high water mark) and in a manner that minimizes disturbance to the banks of the watercourse.
    - Minimize grading on steep watercourse approach slopes. Use approved access where available to limit equipment and vehicle traffic on steep approaches.
    - Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks, invasive species and noxious weeds.
    - Wash, refuel and service machinery and store fuel and other materials for the machinery at least 15m away from top-of-bank to prevent any deleterious substance from entering the water.
    - Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
    - Restore banks to original condition if any disturbance occurs.
5. Use measures to prevent deleterious substances such as new concrete (*i.e.* it is pre-cast, cured and dried before use near the watercourse), grout, paint, ditch sediment and preservatives from entering the watercourse.
6. No debris shall remain within the high-water mark or placed into a stream.
7. Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps, berms or planting them with preferably native grass or shrubs.
8. Vegetate any disturbed areas by planting and seeding with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. All seeding and/or planting trees shall follow the DFO guidance on Riparian Revegetation. If there is insufficient time remaining in the growing season, the site shall be stabilized (*e.g.* cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring.
    - Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved.
9. Instream turbidity levels and sediment control measures shall be monitored during

construction and following major storm events.

Christal Creek

10. Baseline data must be collected from a site at Christal Creek pre-project.
11. Sample sediment and benthic invertebrates to characterize annual variation and the summer season during time of maximum biological activity.
12. Methods shall follow the protocol used in the Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007 (Laberge 2008) and the BC Field Sampling Manual 2003.
13. The Christal Creeksite shall be added to the monitoring program and the Adaptive Management Plan.

Christal Lake

14. Conduct water quality monitoring including dissolved oxygen and temperature profiles , and toxaphene, sampled at spring overturn, mid-summer and fall.
15. Conduct sediment sampling to characterize annual variation and the summer season during times of maximum biological activity (to be consistent with sediment sampling times at other stations).
16. Sample phytoplankton (at spring overturn, mid-summer and fall) and zooplankton (one time in late summer).
17. Methods must follow the protocol used in the Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007 where possible (Laberge 2008) and the BC Field Sampling Manual 2003.
18. Sites shall be added to the monitoring program and the Adaptive Management Plan.

19. Conduct benthic invertebrate and fisheries sampling/monitoring of populations in Christal Creek, Flat Creek, South McQuesten River and Lightning Creek to confirm species presence and diversity over time throughout the liof project (annual sampling).
20. The proponent shall continue to develop and modify sampling and analysis procedures to characterize contaminant levels in treated effluent as part of the Adaptive Management Plan.
21. Quarterly sampling shall continue at KV-37 (Lightning Creek u/s of Hope Gulch), KV-39 (Hope Gulch u/s of Lightning Creek) and KV-40 (Charity Gulch u/s of Lightning Creek) for flow, conductivity, pH, temperature, total and dissolved metals. These sites are relevant to

activities at the mine.

22. Water samples from treatment facilities at a minimum shall be collected end-of-pipe in addition to any additional sampling points required as per the Adaptive Management Plan. Record and provide to the appropriate regulator the following information:
    - Water flow rate measurements from mill pad and DSTF at Flame and Moth Mill;
    - Water flow rate measurements from treatment pond at Flame and Moth Mill;
    - Water flow rate measurements from Bellekeno East adit during underground development;
    - Water flow rate measurements of discharge from Bellekeno East settling pond either directly to Thunder Gulch or Bellekeno 625 treatment pond;
    - Water flow rate measurements from Bellekeno 625 adit;
    - Water flow rate measurements from Bellekeno 625 treatment pond; and
    - Water flow rate measurements of water extracted from upper Christal Creek to the Flame and Moth Mill Site.
23. The location for achieving the site specific water quality shall be determined by the appropriate regulator and based in part on consideration of:
    - Point in receiving waters where significant fish habitat values exist as defined by the Department of Fisheries and Oceans; and
    - Initial dilution and mixing zones as defined by the appropriate regulator.
24. Construct and/or maintain water treatment and retention infrastructure so that non-compliant water is not released into the environment.
25. Settling ponds shall have a freeboard of no less than 0.4 m to prevent risk of overtopping.
26. Settling ponds shall have a high level discharge (i.e. spillway) to prevent destructive overtopping in the event of high water volumes.
27. Ensure that all settling ponds are lined and monitored to prevent release of non-compliant water through ground.
28. Sludge from settling ponds at the Flame and Moth Mill and Bellekeno 625 and sediment collected in Bellekeno East settling ponds shall be removed and transported to Valley Tailings Area at the existing sludge storage area. Sludge resulting from Bellekeno mine operations will be stored in a separate paddy cell located in the valley tailings in order to keep liabilities separate.
29. Groundwater information is needed to quantitatively assess the available groundwater resources (*e.g.* quantity and quality) at the site, to identify flow directions and rates, and to identify any existing contaminant levels of groundwater resources. Monitoring wells shall be established at the site near the DSTF at Flame and Moth site, near the potential AML storage facility, and at the Christal Lake site.

30. It will be necessary to begin, as soon as feasible (but prior to project construction and operation), baseline characterization of any groundwater resources that will be affected by the project site. This must include an evaluation of:
    - Groundwater quality and quantity in the area,
    - Groundwater flow rates and directions
31. Additional on-going monitoring during operations will be required to determine:
    - The effects of operations on groundwater resources in the area

    Since historical baseline groundwater data are limited, establishing an on-going groundwater monitoring strategy, which is scoped with on-going surface water monitoring programs, is required to assess overall project effects on local groundwater resources. This detailed information on current groundwater conditions will inform the final decisions on post-closure remediation activities at the site's adits.
32. Design criteria and flow capacity for a channelized drainage system are required. Additionally, a flow control structure and monitoring program are required to demonstrate discharges from the pond are effectively managed, both during operations and post-closure.
33. Design and installation of a channelized drainage system (*e.g.* pipe or stream channel) to drain the pond is required. Plans for the pond drainage system proposed at Christal Lake may be used to guide the implementation of a new system at the Flame and Moth site, however consideration for the differences in slope and distance to Upper Christal Lake must be included in the plan. The plan must be approved by a geotechnical engineer.
34. Complete water balance for the site must be developed and be continued throughout operations.
35. Minimum and maximum flows for both wet and dry years must be annually re-assessed to assist planning the water extraction adaptive measures.
36. Characterize the local climate conditions and climate variability with locally derived and recent climate data.
37. Climate station monitoring must be maintained throughout mine operations. This information must be input to the water balance calculations for the site.
38. Prepare a detailed quality assurance/quality control plan as part of the overall Waste Rock Management Plan that stipulates regular and frequent checks (including lab and field screening techniques) that will yield a high confidence for waste rock classifications. This might include the recording of information for all work related to:
    - Categorization of rock types from blast rounds including the results of field screens and geochemical characterizations;
    - Subsequent rock management:
        – Determination of non-AML, AML or mineralized rock;

– Segregation, temporary storage location and relative volumes of rock types;

– Long-term storage location and relative volumes of rock types (i.e. transport of bulk mineralized sample off property; location and volume of non-AML rock used for roads and AML rock brought to the Bellekeno Pit).Detailed field tracking procedures that describe origin (*i.e.* blast unit, mineable unit), transportation, destination and AML classification of all waste rock

39. Provide all recorded information to the appropriate regulator.
40. Test and establish a more conservative approach for categorizing and segregating rock that is focused on determining non-reactivity.
41. Upon initiating this project, the relationship between field observations (i.e. tests and geochemical characterization) and the proposed calcium, sulphur, lead and zinc thresholds shall be continuously confirmed by sampling and laboratory analysis of rock. The results of laboratory analysis shall either confirm thresholds and the rock categorization and segregation approach or require adjustment.
42. The Temporary Conditional Waste Rock Classification Platform area shall have lined pads that are sloped in order to facilitate gravity drainage and collection of runoff water. Drainage that is collected shall either be:
    - Contained until analysis shows that it is within an acceptable standard for release; or
    - Sent to the Bellekeno 625 water treatment facility.
43. Bulk sample material must be covered to the extent practical to reduce contact with precipitation.
44. Bulk sample shall not be stored at the temporary facility for more than 6 months following removal from the excavation, unless a complete characterization and classification that demonstrates it to be non-AML rock is conducted.
45. Prior to any excavation of Bellekeno East, an engineered design with sufficient details of the waste rock cover is to be submitted by the proponent to the appropriate regulator for approval.
46. Place all potentially AML waste rock from underground exploration activities into Bellekeno Pit.
47. Create berms to divert surface run-off around Pit to minimize exposure to water, potential ARD and the requirement for frequent removal of accumulated effluent.
48. AML waste rock to be stored in a manner that eliminates exposure to air and water during placement, before capping and after capping.
49. Store AML waste rock on impermeable liner with collection system to ensure that any non-compliant water draining from the waste rock may be properly treated prior to release to the receiving environment.
50. Install a low permeable cover overtop AML waste rock at end of project to reduce/

eliminate water infiltration.

51. Drainage from the waste rock placed in the Bellekeno Pit shall be contained until analysis shows that it is within an acceptable standard for release.
52. Effluent from Bellekeno Pit shall be monitored to document any potential changes to water quality resulting from AML waste rock storage in the Bellekeno pit.
53. Location of the Bellekeno Pit to be approved by a qualified geotechnical engineer.
54. Berms must be constructed to divert surface run-off generated outside the waste rock storage area around the facility and to contain surface run-off generated within the storage area.
55. Surface water inside the berm will be collected in a sump, monitored and treated as necessary to meet water quality guidelines. Options for treating the effluent include the use of treatment ponds similar to the ones proposed for the Flame and Moth Mill Site and Bellekeno Mine Site or pumping the effluent to the nearby Bellekeno Mine site for treatment there. Management of the pond, including monitoring of untreated and treated water quality, flow rates and sediment removal will be as discussed above for the Flame and Moth Mill Site and Bellekeno Mine treatment ponds. Due to the level of uncertainty in the proposed waste rock storage plan, these measures are necessary to avoid a significant adverse effect on water quality in Lightning Creek.
56. Measures that are addressed in the Water Use/Management section.
57. Groundwater conditions downgradient of the DSTF must be characterized to help demonstrate that the liner has not failed. This might include the use of monitoring wells to measure changes in water levels, sample water quality and run recovery tests to help evaluate flow directions and velocities.
58. Hydrostatic pressure of the underground adits used for waste backfill must be monitored for as long as possible to demonstrate complete saturation of the tailings backfill.
59. Incorporate monitoring results into ongoing adaptive management of the mine operations and monitoring programs.
60. A groundwater monitoring program must be initiated by the start of the mine operations. Information gained from this program will establish contemporary baseline conditions at the site and will assist with planning for post-closure groundwater quality monitoring. The Maintenance and Monitoring program proposed for surface water at the site must incorporate flow monitoring (for quantity and quality) at all treatment ponds.
61. This plan must include maintenance of water diversion structures at all tailings stacks.
62. Water quality triggers should either be closer to baseline levels (perhaps 50% above baseline but still substantially under criteria) or monitoring must be done more often to detect trends sooner
63. Water discharge thresholds must be developed from seasonal baseline data with prescribed

thresholds based on effects rather than using arbitrary 24 month averages.

64. Results will be reported to the regulators.

Health and Safety

65. Conduct a noise impact study prior to project implementation. The study must aim to achieve the following:
    - Analyze baseline conditions during conditions of low ambient noise.
    - Calculate the potential noise emissions from all activities that generate significant noise.
    - Calculate the noise emission level that the closest receiver may experience due to those activities. Consideration must be given to local environmental conditions (*e.g.* terrain, temperature inversions, and downwind conditions relative to sensitive receivers) and proposed mitigations.
    - Calculate the cumulative noise emission of this project in combination with existing and proposed activities (*e.g.* care and maintenance, Keno City).
66. Develop a noise abatement and management plan based on the results of the noise impact study. The plan must aim to achieve the following.
    - Identify appropriate measures to reduce noise emissions.
    - Incorporate these measures into project design and implementation.
67. Upon commencement of each block of operations (*e.g.* crusher; bypass construction; ore traffic), a verification study will be conducted. This will consist of continuous monitoring over a two week period. Monitoring will aim to capture the ambient noise levels at sensitive receivers, inclusive of what the project is contributing. If unacceptable noise levels are identified further measures to reduce the noise levels are required.
68. Best management practices for the industry indicate that dust releases must be minimized through the application of a number of preventative measures, including the following.
    - If excess dust is produced in the crusher, the proponent must be prepared to use air filtration/dust collection equipment to collect the indoor crusher air and removal of particulate from the exhaust
    - Enclosure of the primary crusher and the use of air filtration/dust collection equipment to collect the indoor crusher air and removal of particulate from the exhaust.
    - Covering ore haul truck beds to reduce the loss of dust from the truck during transport.
    - Use of dust suppression techniques, such as the application of water as necessary, to the Dry Stack Tailing Facility, non-AML rock storage and the haul road, if and when

dusting conditions occur. Other dust suppression products and chemicals are available on the market at higher cost and potentially uncertain efficacy. Under no circumstances shall waste oil or other hydrocarbon product be used for dust suppression.

- Reduce the area of dust producing surfaces through timely reclamation (covering). The proponent has indicated only a small percentage of the DSTF will be exposed at any given time in order to accomplish this dust suppression goal.
- Haul road surfacing – frequently used roads near Keno shall be hard surfaced to the extent possible.
- Vehicle wheel and chassis wash to the extent possible.
- Site layouts – Design operational areas to minimize pollution from dust. For example, take account of prevailing wind conditions, use buildings as screens or enclosures, and use natural topography and vegetation as screening.

69. Monitoring dust conditions is an important step in controlling dust impacts. Simple TSP (dustfall) monitoring is a simple and inexpensive way to determine dust deposition at the sampling locations. This test can be done at the site by the proponent with little cost or training necessary.
70. If warranted by initial dustfall measurements indicating TSP concentrations in excess of 150 micrograms per cubic metre (the BC Air Quality Objectives and Standards Level A criteria) at the fence line, the proponent shall conduct more sophisticated monitoring with high volume samplers and re-evaluate and improve dust suppression techniques to achieve the TSP objective.
71. Potential dispersal of contaminants from Dry Stack Tailings Facility to Keno must be qualified based on wind dispersion models and local meteorological conditions and provided to appropriate regulator.
72. The proponent shall ensure that the bridge is capable of supporting the weights that will be crossing it and provide documentation to that effect to the regulator.
73. The proponent shall submit the bypass road plans to the regulator for review and approval.
74. Proponent shall ensure the following is achieved with respect to the health and safety of workers.
    - Comprehensive safety program is in place with ongoing updates.
    - Compliance with the OHS Act and Regulations.
    - Emergency plan in place with ongoing updates.
    - Mine Rescue Training and Equipment in place.
    - Back up plan for mine rescue assistance; (agreement in place with other U/G mines

for assistance in event of an emergency).

- Contractor Safety Management Plan in place; (especially during plant construction phase).
- Return to Work Program for Injured Workers.

75. Complete details of all other camps to be used need to be provided to Environmental Health Services. The details must include total population, accommodation, food service, potable water supply and sewage disposal.
76. Camps must comply with the requirements of the *Public Health and Safety Act*, Camp Sanitation Regulations.
77. Use an alternate Yukon Government regulated site for waste disposal as per guidance from Yukon Government.

Environmental Quality

78. Prior to constructing the new access road to the Flame and Moth Mill site and the Keno City bypass, the proponent must demonstrate that soil conditions beneath and in proximity to the proposed right-of-way are stable to support the intended construction and use.
79. New road construction shall not cause degradation of permafrost.
80. All potential roadway design and construction must be signed off by a qualified geotechnical engineer.
81. From borehole drilling throughout the various sites surrounding the Keno City region, evidence of permafrost was generally not encountered. It is acknowledged that the non-AML waste rock site is situated on a north facing slope more prone to permafrost, however the consequences of intermittent permafrost or altering the permafrost regime with the placement of the non-AML waste rock could be severe given the design assumptions for the slope stability assessment. Additional boreholes must be drilled throughout the areas of placement of the waste rock, especially throughout the lower toe area and extending westward along Lightning Creek. All boreholes must be extended to bedrock and several should be fitted with temperature reading devices to confirm the location and depth of permafrost. It would be expected that temperature monitoring would occur over several seasons. Several peizometers must also be installed to monitor supra-permafrost groundwater level conditions.
82. The detailed slope stability assessment discussed in Appendix E of the Project Proposal must be revised to include the additional geotechnical information. A discussion on the permafrost layer depth and how this may be altered by the placement of the waste rock must be given to document how the permafrost is to be protected and how the shear strength parameters could change with the degradation of the permafrost. A discussion of the rock placement protocol must be given, and should include a placement scenario from

the bottom of the slope upwards so as not to create slope stability issues during fill placement. The detailed slope stability assessment must be presented in a comprehensive report signed off by a qualified geotechnical engineer.

83. The shear strength of the foundation soils as outlined in Appendix E of the Project Proposal must be clarified. Based upon the drilling program, the foundation soils in this area consist of silty, gravelly sand. The assumed shear strength parameter of an undrained shear strength of 10kPa refer to a cohesive material (*i.e.* a material containing clay sized particles). Materials such as sand are non-cohesive and generally have a corresponding cohesion of 0kPa. These shear strength parameter assumptions may have a significant impact on the slope stability assessment, especially for very shallow potential slip surfaces (as likely in this case) with very low normal stresses.

84. The reports state "there is a terrace of mined placer tailings between the slope and Lightning Creek…. (which) could lead to long term stability issues." Relative to this concern, the non-AML waste rock storage area should be designed such that it does not cause degradation of the underlying warm permafrost, and that design must be signed off by a Geotechnical engineer.

85. The geotechnical investigation and final design must therefore be of sufficient detail to identify permafrost (i.e. temperature readings in both disturbed and non disturbed areas), identify the groundwater levels (piezometers), and characterize the native soils (both within the non-disturbed and disturbed areas) so that a detailed stability assessment can be performed.

86. The stability assessment must include potential settlements of the native soil caused by the tailings placement, site preparation required prior to tailing placement, stability assessment during tailings placement, and the long term stability under design loading conditions.

87. Detailed design of the mill building so as not to disturb permafrost.

88. All placement methodologies must be signed off by a qualified geotechnical engineer.

89. To evaluate the potential risks associated with this site as a AML storage facility and the potential effects this may have on the environment, detailed design information will need to be supplied outlining existing site conditions (native soils, permafrost, groundwater conditions, etc.), and rock placement methodology and geometry. The generic waste containment documentation can then be tied to the placement methodology on the slope.

90. All placement methodologies must be signed off by a qualified geotechnical engineer.

The following are suggested Best Management Practices as noted in the report. They are not part of the formal recommendation under section 56 of YESAA.

Noise Source Controls

- Time constraints – prohibiting work during sensitive hours.
- Scheduling – performing noisy work during less sensitive time periods or staggering the period of operation for different activities.
- Equipment Restrictions – restricting the type of equipment used.
- Emission Restrictions – specifying stringent noise emission limits.
- Substitute Methods – using quieter methods/equipment when possible.
- Exhaust Mufflers – ensuring equipment have quality mufflers installed.
- Lubrication and Maintenance – well maintained equipment is quieter.
- Reduced Power Operation – use only necessary size and power.
- Limit Equipment On-Site – only have necessary equipment operating on-site.
- Noise Compliance Monitoring – technician on site to ensure compliance.
- Quieter Backup Alarms – manually-adjustable or ambient-sensitive types.

Noise Path Controls:

- Noise Barriers – semi-permanent or portable wooden or concrete barriers.
- Noise Curtains – flexible intervening curtain systems hung from supports.
- Enclosures – encasing localized and stationary noise sources.
- Increased Distance – perform noisy activities farther away from receptors.

Noise Receptor Controls:

- Window Treatments – reinforcing the building's noise reduction ability.
- Community Participation – open dialog to involve affected residents.
- Noise Complaint Process – ability to log and respond to noise complaints.
- Temporary Relocation – in extreme otherwise un-mitigatable cases.

Issued by the Mayo Designated Office this 11th day of June, 2009.

For more information please contact:

Loralee Johnstone
Manager, Designated Office

Mayo Designated Office
P.O. Box 297
Mayo, YT
Y0B 1M0
Tel: (867) 996-4040
Fax: (867) 996-4049

TABLE OF CONTENTS

Summary ..... **i**

Outcome ..... **i**

1.0 Project Description **1**

1.1 Proponent Information 1

1.2 Introduction/Background 1

1.3 History 1

1.4 Project Scope 4

1.5 Project Location 5

2.0 Environmental and Socio-Economic Setting **8**

2.1 Physical Environment 8

2.1.1 Climate 8

2.1.2 General Geology 8

2.1.3 Bellekeno Mineralization Occurrences 9

2.1.4 Bellekeno Geoenvironmental Characterization 10

2.1.5 Physiography and Surficial Geology 10

2.2 Biological Environment 13

2.2.1 Water Resources 13

2.2.2 Surface Water Quality 13

2.2.3 Benthic invertebrates 16

2.2.4 Wildlife 17

2.2.5 Vegetation 19

2.3 Socio-economic Environment 20

2.3.1 Keno City 21

2.3.2 Mayo 22

2.3.3 NNDFN Exploration Cooperation Agreement 24

3.0 Requirement for an Assessment **25**

4.0 Scope of the Assessment **26**

5.0 Aquatic Resources **29**

5.1 Overview 29

5.2 Background Information 31

5.2.1 Effect Pathways 31

5.2.2 Contaminants of Concern 33

5.3 Effects Characterization and Significance Determination 36
5.3.1 Construction/Use of Surface Infrastructure 36
5.3.2 Construction of Lightning Creek Bridge 37
5.3.3 Water Use/Management 41
5.3.4 Underground Quartz Exploration 53
5.3.5 Waste Rock Management 54
5.3.6 Tailings Management 60
5.3.7 Reclamation and Closure 61
5.3.8 Adaptive Management Plan 62
5.4 Cumulative Effects Assessment 63
5.4.1 Historical Context 63
5.4.2 Overview 64
5.4.3 Proposals Submitted 64
5.4.4 Existing or Proposed Activities 64
5.4.5 Residual Effect Characterization, Interaction and Determination of Significance 65
6.0 Health and Safety 65
6.1 Noise 65
6.1.1 Overview 65
6.1.2 Background Information 67
6.1.3 Effects Characterization and Significance Determination 70
6.2 Public Safety 78
6.2.1 Overview 78
6.2.2 Effects Characterization and Significance Determination 78
6.3 Worker Safety 83
6.3.1 Overview 83
6.3.2 Effects Characterization and Significance Determination 84
6.4 Camp 90
6.4.1 Overview 90
6.4.2 Effects Characterization and Significance Determination 90
7.0 Environmental Quality 91
7.1 Overview 91
7.2 Effects Characterization and Significance Determination 92

7.2.1 Erosion and Sedimentation 92
7.2.2 Permafrost 92
7.2.3 Geotechnical Conditions and Permafrost- General 92
7.2.4 Road Construction and Use – Implications for Erosion and Permafrost Degradation 93
7.2.5 Waste Rock Storage 94
7.3 Cumulative Effects Assessment 100
7.3.1 Historical Context 100
7.3.2 Overview 100
7.3.3 Proposals Submitted 100
7.3.4 Existing or Proposed Activities 100
7.3.5 Residual Effect Characterization, Interaction and Determination of Significance 100
8.0 Wildlife 101
8.1 Overview 101
8.1.1 Relevant research 101
8.1.2 Bear, human conflict and nuisance wildlife 102
8.1.3 Avoidance 102
8.1.4 Contaminants – water quality, dust suppression 102
8.1.5 Hunting success 103
8.2 Cumulative effects assessment 105
9.0 Heritage Resources 105
9.1 Overview 105
9.1.1 Clearing land and movement of earth 106
9.2 Cumulative Effects assessment 107
10.0 Economy 107
10.1 Overview 107
10.1.1 Tourism 108
10.1.2 Business 111
10.2 Cumulative Effects Assessment 113
11.0 Quality of Life 113
11.1 Soundscape 114
11.1.1 Overview 114
11.1.2 Effects Characterization and Significance Determination 114

11.1.3 Cumulative Effects 117
11.2 Viewscape 118
11.2.1 Overview 118
11.2.2 Effects Characterization and Significance Determination 118
12.0 Acknowledgements 119

Appendix 1 – List of Key Proposed Mitigations 120

Appendix 2 – List of Relevant Non-Discretionary Legislation Applicable to the Project 127

Appendix 3 – List of Submissions Made By Interested Persons During the Assessment 128

Appendix 4 – Projects Assessed by YESAB in the Keno Region 131

Appendix 5 – Predictions of Potential Noise Levels 133

Appendix 6 – References 143

1.0 PROJECT DESCRIPTION

1.1 PROPONENT INFORMATION

The proponent for the proposed project is Alexco Keno Hill Mining Corp. Access Consulting Group acted as the agent to the proponent during the assessment process. The contact information for the proponent is as follows:

#3 Calcite Business Centre, 151 Industrial Road

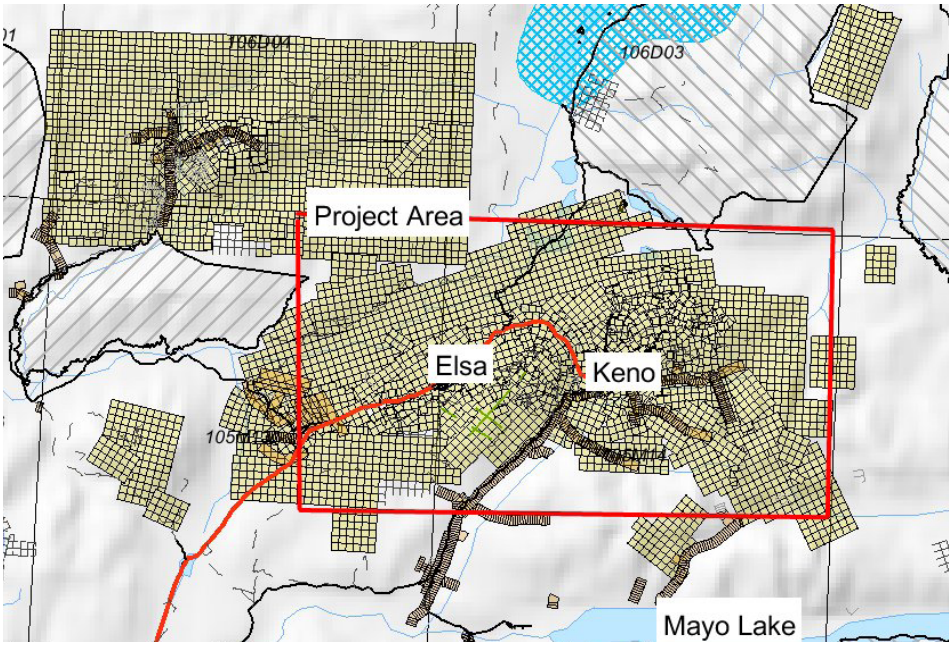
Whitehorse, Yukon

Y1A 2V3

Chief Operating Officer, Brad Thrall

1.2 INTRODUCTION/BACKGROUND

The United Keno Hill property is located near the community of Keno City, 85 km northeast of Mayo and 452 km north of Whitehorse, Yukon. Numerous old mine workings are located throughout the 26 km by 8 km site which consists of three mountains (Keno, Sourdough and Galena Hills). The property is located within the Nacho Nyak Dun First Nation's traditional territory.



1.3 HISTORY

From 1914 to 1989, there was near continuous mining and milling at the Keno Hill property. In 1989, United Keno Hill Mines Ltd. (UKHM), the last mining operator, suspended production.

Non-compliance issues with respect to the Water Use Licence resulted in convictions and financial difficulties that lead to the company halting the water treatment operations near the end of 2000. In early 2001, the Minister of the Department of Indian Affairs and Northern Development (DIAND) identified the property as abandoned and contracted Access Consulting Group (Access) to undertake care and maintenance of the existing treatment facilities and tailings ponds. By late 2001, as directed by the Devolution Transfer Agreement, the Government of Yukon (YG) took over the property but the Government of Canada retained financial responsibility. The site was closed and the property placed under care and maintenance.

In June 2003, after two failed attempts by creditors to take over the care and maintenance of the UKHM property, the site was again declared abandoned but this time by YG who took over interim care and maintenance of the mine site. The Assessment and Abandoned Mines branch of Energy, Mines and Resources became responsible for environmental management of the site.

In April 2004, at the request of DIAND and YG, the Supreme Court of the Yukon Territory appointed PricewaterhouseCoopers Inc. as the interim receiver for UKHM under the Bankruptcy and Insolvency Act.

When it closed, UKHM had known ore reserves left in the ground and high potential for further discoveries. In order to make the mine site viable for the private sector, the federal government agreed to limit the liability to any potential purchaser. Financial responsibility for the existing historical liability would remain with the Federal Government. A marketing plan was launched and in July 2005, Alexco Resource Corporation (Alexco) was chosen as the preferred purchaser. The Supreme Court of the Yukon approved the sale of the mine to Alexco in April 2006.

The actual sale was a two phased process. Upon court approval in April 2006 known as “Initial Closing” Alexco was granted access to the site for the purposes of exploration and undertaking of the day to day care and maintenance under contract with the Government of Yukon. Once Alexco had obtained a water licence for the site, in November 2007, final conveyance of assets was granted to the company. Alexco now has sole ownership of the site while the federal government retains financial liability for the environmental impacts resulting from work done on the site prior to devolution. Any new liabilities arising from the issuance of licences or permits for new work at the site will not be added to the federal government's liability but will be the responsibility of Alexco.

In July 2006, 650399 BC Ltd, a subsidiary company of Alexco Resource Corp., received a five year Class III Mining Land Use Approval (LQ00186) to conduct a diamond drilling program. Activities associated with that approval included the construction of a trailer camp for 36 people,

helicopter geophysical survey, construction of sumps, road upgrades, construction of new roads and trails on claims, fuel storage, and partial seasonal closure. In October of 2008 Alexco received a Class IV Mining Land Use Approval (LQ00204) and in June 2008 a Type B Water Licence (QZ07-078), both for ten years including the continuation of the above-mentioned activities for the duration of the new approval. On February 16, 2009, Alexco Keno Hill Mining Corp. submitted a project proposal to the YESAB Mayo Designated Office for the Bellekeno mine development, YESAB project #2009-0030.

History of development at the Bellekeno mine

Various mineralized zones within the Bellekeno ore deposit have seen commercial production from different operators over the years. Access to early production was from adits at the 100 and 200 levels, and later from the 625 adit. Operators have included Bellekeno Mines Ltd., Mayo Mines Ltd., and United Keno Hill Mines Ltd. Much of the ore from early mining was shipped out to smelters as direct-shipping ore, and in 1953 Mackeno Mines Ltd. constructed a flotation mill at Christal Lake to further concentrate the ore prior to shipping to smelters, including over 10,000 tons of ore produced from the Bellekeno mine between 1953 to 1954.

The Bellekeno deposits' modern mining era began in 1984 with the development of the adit at the 625 level, which was collared and driven to cross-cut approximately 200 meters to the "48" vein. Over the years, the 625 level workings were connected to the 400 level and the 500 level. This was used to mine ore from the 500, 625, 700, 750 and 800 levels from 1984 through to 1989. Dewatering and rehabilitation of the 700 through 800 levels, from the 625 adit, began in 1994. Internal mechanized ramps were developed to reach the 700 and 800 levels and a mechanized ramp was driven towards but stopped short of the 500 level. The property was maintained until 2001, when it was declared abandoned. The lower Bellekeno workings were allowed to flood in 2003.

In 2006, Alexco initiated a broad surface exploration program (YESAB Project 2006-0157 and Class III Mining Land Use Approval LQ00186) in the historic Keno Hill silver district with surface diamond drilling focused primarily toward systematic testing of numerous targets, validating and expanding historic mineral resources and acquiring a better understanding of the local geology and ore controls. Based on broadly successful 2006 results, Alexco in 2007 expanded its exploration to a two phase district exploration program; the first phase focused on following up prior results in the area of the historic Bellekeno mine and the second phase continuing the broad information gathering drill program elsewhere across the district. In 2008 Alexco conducted surface exploration at a number of targets throughout the district and proceeded with advanced underground exploration and development at Bellekeno. On July 9, 2008, Alexco released a Preliminary Economic Assessment (PEA) of Bellekeno prepared by SRK Consulting (SRK, 2008). The positive economics suggested by the PEA have led Alexco to pursue a Quartz Mining Licence and a Type A Water Licence in anticipation of a positive development plan and ultimately a production decision.

1.4 PROJECT SCOPE

The scope of the project for this assessment has been determined to be as follows.

The principal project involves mine development at Bellekeno. This includes continued underground development and operations. It will also involve construction of a conventional flotation mill at the Flame and Moth Mill Site. This site is within the Christal Creek drainage upstream of Christal Lake and will be used for the processing and production of minerals. The project timeline is 10 years and includes mine construction, production, reclamation and closure. The project area includes: the Bellekeno Mine site; Bellekeno waste rock storage facility; the Flame and Moth Mill Site; the Flat Creek camp; the Thunder Gulch/Lightning Creek drainage to where it joins with Duncan Creek; and the Christal Creek drainage to where it meets South McQuesten River.

Principal Activities

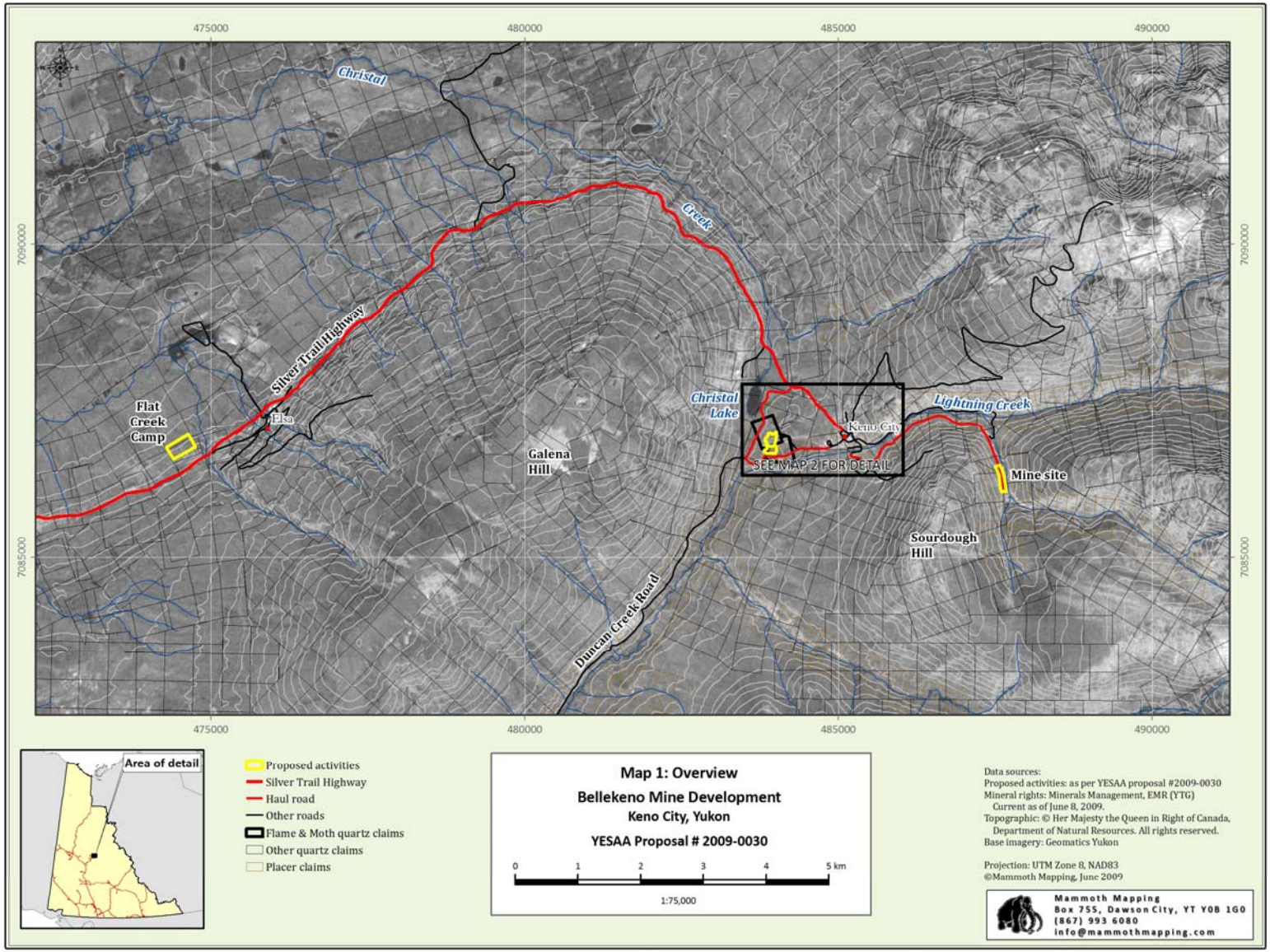
- Underground development and mining involving the movement of approximately 500,000 tonnes of waste rock and 600,000 tonnes of ore to the surface.
- Construction of a series of narrow, elongated waste rock disposal areas near the Bellekeno 625 adit for non-AML waste rock.
- Construction of a conventional flotation mill at the Flame and Moth site upstream from Christal Lake for processing ore and producing concentrate. Processing will occur at a rate of approximately 250 tonnes per day and produce 25,500 tonnes of mill concentrate per year for years one and two. This will ramp up to 400 tonnes per day and 48,500 tonnes of concentrate per year for years three to five.
- Use of mill chemicals.
- Temporary storage of mill tailings and mineralized rock in stock piles.
- Storage and disposal of mill tailings in a dry-stack tailings facility.
- Placement of pyritic tailings below water level in the Bellekeno Mine.
- Haulage of ore to the mill and haulage of potentially-AML waste rock to the Bellekeno Waste Rock Storage Facility. Dry tailings will be hauled to a dry stack tailings facility and also back to the Bellekeno Mine for use underground.
- Construction of surface infrastructure to support the mill including: coarse ore stockpile; plant services; fuel storage area; portal; and settling ponds.

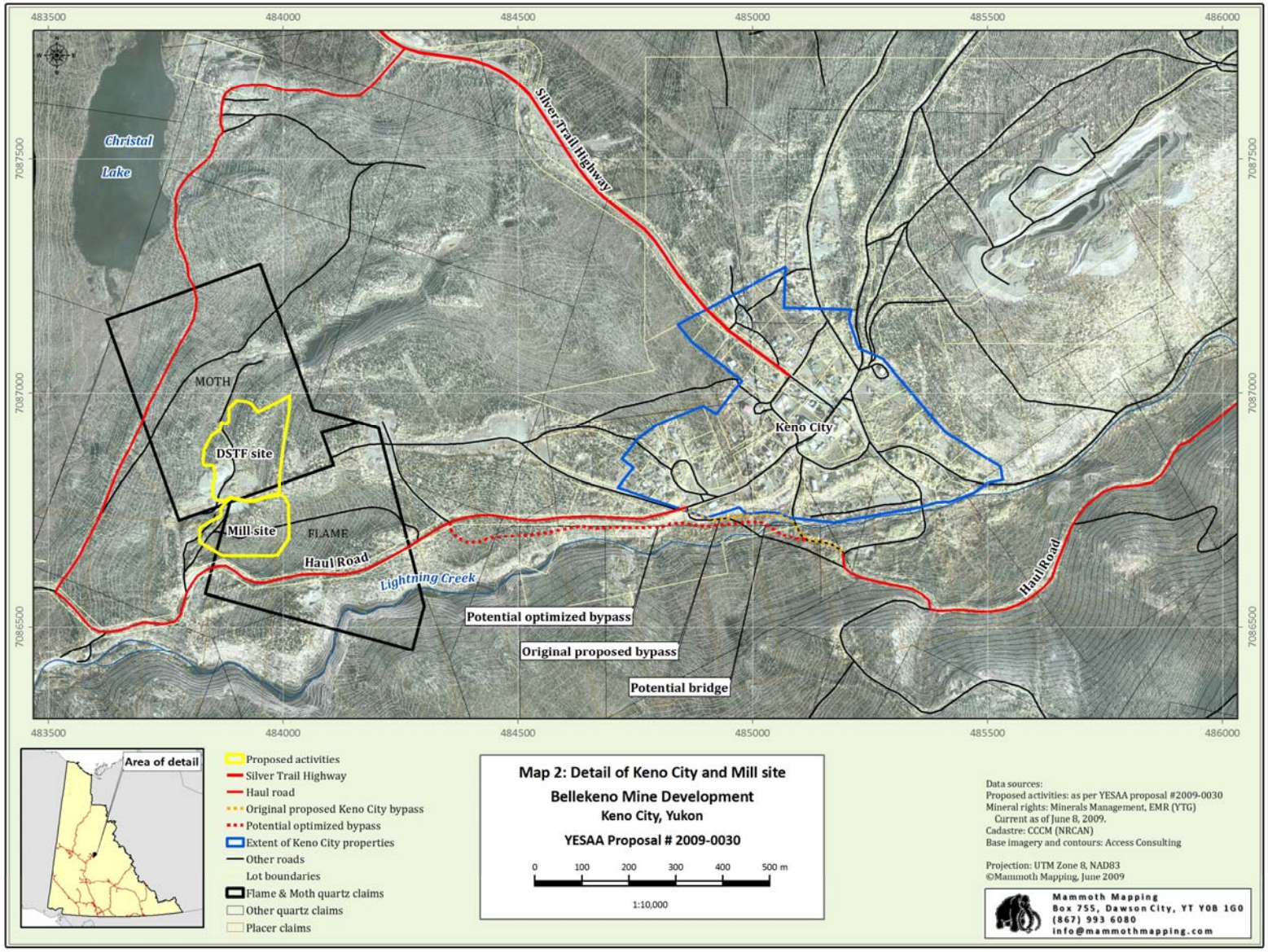
Accessory Activities

- Expansion of the Flat Creek Camp from a capacity of 100 to approximately 150 personnel.
- Reconstruction/upgrading of the existing Bellekeno Mine power line haul road and the existing Christal Lake haul road from Duncan Creek road to the Mill Site.
- Construction of a segment of new haul road around Keno City, including a new bridge across Lightning Creek for hauling ore and filtered tailings between the mine and mill.
- Installation of electrical power distribution system (i.e. power poles, transformers) to service the mill and ancillary buildings.
- Construction of water treatment facility to treat mill waste water.
- Use of water for mill operations from three potential sources: Dry Stack Tailings Facility/Mill pad runoff collection pond, Christal Lake, and local groundwater wells. Use of water for dust suppression, cooling and dry tailings rehydration from Lightning Creek or Thunder Gulch.
- Depositing Bellekeno mine waste water using existing water treatment facilities at Bellekeno 625. Treated wastewater from Flame and Moth mill will be deposited to Christal Creek.
- Inspection and maintenance of water treatment infrastructure to ensure discharge standards are achieved.
- Shipping mill concentrate to various smelters.
- Environmental monitoring and sampling programs.

1.5 PROJECT LOCATION

The following maps provide a visual as to the location of this project in relation to the surrounding region. Map 1 is an overview of the region and Map 2 a detailed view of project activities in proximity to Keno City.


475000
480000
485000
490000
7090000
7085000
Christal
Creek
Silver Trail Highway
Flat Creek Camp
Elsa
Galena Hill
Christal Lake
Keno City
SEE MAP 2 FOR DETAIL
Lightning Creek
Mine site
Sourdough Hill
Duncan Creek Road
Area of detail
Proposed activities
Silver Trail Highway
Haul road
Other roads
Flame & Moth quartz claims
Other quartz claims
Placer claims
Map 1: Overview
Bellekeno Mine Development
Keno City, Yukon
YESAA Proposal # 2009-0030
0 1 2 3 4 5 km
1:75,000
Data sources:
Proposed activities: as per YESAA proposal #2009-0030
Mineral rights: Minerals Management, EMR (YTG)
Current as of June 8, 2009.
Topographic: © Her Majesty the Queen in Right of Canada, Department of Natural Resources. All rights reserved.
Base imagery: Geomatics Yukon
Projection: UTM Zone 8, NAD83
©Mammoth Mapping, June 2009
Mammoth Mapping
Box 755, Dawson City, YT Y0B 1G0
(867) 993 6080
info@mammothmapping.com


483500
484000
484500
485000
485500
486000
7087500
7087000
7086500
Christal Lake
Silver Trail Highway
MOTH
DSTF site
Mill site
FLAME
Haul Road
Lightning Creek
Keno City
Haul Road
Potential optimized bypass
Original proposed bypass
Potential bridge
Area of detail
Proposed activities
Silver Trail Highway
Haul road
Original proposed Keno City bypass
Potential optimized bypass
Extent of Keno City properties
Other roads
Lot boundaries
Flame & Moth quartz claims
Other quartz claims
Placer claims
Map 2: Detail of Keno City and Mill site
Bellekeno Mine Development
Keno City, Yukon
YESAA Proposal # 2009-0030
0 100 200 300 400 500 m
1:10,000
Data sources:
Proposed activities: as per YESAA proposal #2009-0030
Mineral rights: Minerals Management, EMR (YTG)
Current as of June 8, 2009.
Cadastre: CCCM (NRCAN)
Base imagery and contours: Access Consulting
Projection: UTM Zone 8, NAD83
©Mammoth Mapping, June 2009
Mammoth Mapping
Box 755, Dawson City, YT Y0B 1G0
(867) 993 6080
info@mammothmapping.com

2.0 ENVIRONMENTAL AND SOCIO-ECONOMIC SETTING

Note – Much of the information presented in this section is taken from the project proposal.

2.1 PHYSICAL ENVIRONMENT

2.1.1 Climate

The project area falls completely within the Yukon Plateau-North ecoregions 176 according to (Ecoregions of the Yukon Territory produced by Agriculture and Agri-Foods Canada Research Branch 2004. This ecoregion consists of relatively rolling highlands with an east-west orientation. Mean annual temperatures in this ecoregion are near -5ºC, but there is a strong seasonal variability accentuated by difference of elevation. Mean January temperatures range from below -30ºC in the lower valleys to above -20ºC over the higher terrain. This gradient is dramatically reversed by July as mean temperatures in the lower valley floors of 15ºC drop to near 8ºC over the higher terrain. Extreme temperatures in the lower valley floors have ranged from -62 to 36ºC. Over higher terrain the extremes are more moderate. Frost can occur at any time of the year but is less likely from mid-June to late July.

Precipitation is relatively moderate showing an increase over eastern sections as a result of upslope conditions over the higher terrain of the east. Annual amounts range from near 300 mm in a minor rain shadow along the Tintina Trench, especially near Ross River, to near 600 mm over the higher terrain of the eastern sections. Amounts are fairly low from December through May, being only 2- to 30 mm per month. The wettest period is during July and August, with monthly amounts of 40 to 80 mm from rainshowers and thrunderstorms. Winds are generally light, and only moderate to strong in association with thunderstorms or unusually active weather systems.

Mayo and Ross River are representative climate stations in the lower valley floors. Elsa and Sheldon Lake (Twin Creeks) are good indicators for the valley floors in the higher terrain (Yukon Ecoregions Working Group, 2004).

2.1.2 General Geology

The Keno Silver District lies within the Yukon Plateau, just south of the rugged Wernecke Mountains. The terrain consists of concordant, rolling, upland areas separated by wide valleys. Alpine mountain peaks extend above the uplands locally. The area has been influenced by the latest glaciation but shows more subtle evidence of an earlier event as well. The Keno Hill Silver District is located in the western part of the Selwyn Basin in an area dominated by deformed and metamorphosed Upper Proterozoic to Mississippian sedimentary rocks formed at the edge of a continental margin. During the Jurassic and Cretaceous, the area was subjected to compressional tectonic forces producing two major thrust sheets (Robert Service and Tombstone) and

widespread folding. Early large scale deformation produced recumbent folds, resulting in local structural thickening of strata. A second (and possibly third) deformational event produced gentle south westerly plunging syn- and antiform pairs.

In addition to where polymetallic veins were exploited, the area hosts a number of occurrences, and showings of tungsten, copper, gold, lead, zinc, antimony and barite. Tin, tungsten, and molybdenite occurrences are possibly related to the suite of Cretaceous intrusion, whereas lead, zinc, and barite occur in stratiform calcareous sedimentary rocks of early to mid-Paleozoic age typical of sediment-hosted deposits.

2.1.3 Bellekeno Mineralization Occurrences

Sourdough Hill is capped by Upper Schist rocks which effectively mask the mineralized vein zones developed in the more favorable Central Quartzite beneath. Near the schist-quartzite contact greenstone sills have been emplaced, with a particularly large body occupying the section about 250 m below the schist contact.

The most important of the Bellekeno veins is the "48" Vein which contains all of the mineral resources thus far defined. Other veins such as the Ram, Eureka, Tundra and "50" have seen very limited exploration but continue to have reasonable potential for the discovery of new ore deposits.

The "48" vein traverses both the quartzite and greenstone but appears to rapidly die out in the Upper Schist. Dips are consistently to the southeast but at varying angles possibly due to changes in lithology i.e. quartzite to greenstone to schist. The vein itself occupies a fault zone which appears to have normal movement on the order of about 20 m. In quartzite the vein-fault is typically a zone of fracturing and local brecciation with or without significant fault gouge. Evidence of fluid movement is usually present either in the form of deposited ore and gangue minerals or as a subtle "bleached" appearance. From historic mapping, the vein, when crossing greenstone, appears to narrow drastically and possibly show the effects of weak argillization. Likewise upon entering schist, the vein becomes less well defined and eventually dissipates.

Mineral deposition within the vein is sporadic, but definitely occurs in shoots which show a decided pitch to the SW. Three shoots of potentially ore grade mineralization have been outlined by underground openings and drill holes and have been designated the East Zone, 99 Zone and the SW Zone. All show similar characteristics which include: gentle pitch to SW mimicking the attitude of lithologic units such as the greenstone and Upper Schist; mineralogy consisting of crudely banded coarse grained galena, sphalerite and siderite; subsidiary vein splits along strike and dip are fairly common although most die out rapidly.

A more detailed description of the ore shoots is as follows:

East Zone – A major cross fault appears to offset the "48" vein forming the eastern boundary of the East Zone. Wide spaced drilling suggests that the mineralized zone pitches at an angle of about 25° to the SW maintaining an offset of about 80 m from the footwall of the main greenstone sill. It is not clear whether the mineralization abruptly stops at the bounds of the ore shoot or undergoes a more gradual reduction. Beyond the ore shoot the structure continues with only small amounts of vein minerals present. Sphalerite is the dominant mineral within the vein followed by siderite and sporadic galena. One vein split has been identified and given the name "49" vein.

99 Zone – Ore has been developed immediately above the main greenstone sill, a possible control being a vein split at this location. Ore grade mineralization does not appear to extent into the greenstone. Galena is much more abundant in the "99" zone compared to the East Zone.

SW Zone – An abrupt change in vein strike separates the SW Zone from the "99" Zone where the flexure apparently produced a short segment of tight, barren vein. The upper limit on the ore shoot is the contact of the overlying Upper Schist which also tends to impart an apparent pitch to the southwest. Splits occur in the vein, possibly accounting for areas of particularly high grade and great width. Limited drilling suggests that at depth the vein splits into two distinct strands and the grade diminishes rapidly. Some sections of vein show evidence of post-mineral brecciation sub-parallel to the vein strike which could lead to doubling of the vein width or conversely gaps devoid of mineralization. Mineralogically the SW Zone shows relatively more galena than other zones, although thick bands of sphalerite often occur on the footwall.

2.1.4 Bellekeno Geoenvironmental Characterization

The geoenvironmental characteristics of the Keno Hill Silver District as a whole and in particular the Sourdough Hill/Bellekeno deposit. In addition to looking at historical analytical data including rock and water quality analyses, environmental studies on geoenvironmental characterization and the potential for Acid Rock Drainage (ARD)/Metal Leaching (ML) of the Bellekeno deposit have been carried out on behalf of Alexco by Altura Environmental Consulting (see Appendix B and Appendix C in Volume 2). Research on metal transport and attenuation in the Keno Hill District has also been consulted (MacGregor, D. 2002; Kwong, et al, 1994 and 1997). A number of insights have been gained from this work, which have enabled waste rock and tailings management programs to be designed.

2.1.5 Physiography and Surficial Geology

The Keno Hill Silver District lies within the northeastern part of the Yukon Plateau, and the terrain is mountainous with elevations ranging from 1,848 m (Summit of Keno Hill) to 610 m

(McQuesten River valley). The area has been profoundly influenced by the latest glaciation but shows more subtle evidence of an earlier event as well.

The lower slopes of Galena Hill show clear evidence of ice marginal deposits such as kame terraces related to the glacial lobes occupying the major valley. The retreat of the Cordilleran ice sheet has had a major impact on the south McQuesten valley. Till blankets much of the valley and glacio-fluvial deposits are widespread. Glacio-lacustrine deposits formed in ice marginal lakes occur in the deeper part of the valley. Large meltwater streams have left huge meander scars. Boyle (1965) provides the following additional description of the physiography and glacial deposits in the area.

Galena Hill trends northeast between Duncan Creek and the McQuesten River valley. It has an elevation of 4,740 feet, a moderately steep southwestern slope, and steeper north, northwestern, and southeastern slopes. The terrain above 4,300 feet is relatively flat and rolling, and marked by several level grassy meadows. The north, northwestern, and southeastern slopes of the hill are crossed by several streams that have cut steep gulches into the rock strata. The principal streams responsible for these gulches are Galena, Flat, Brefalt, and Sandy Creeks and Porcupine Gulch on the northwestern slope and Hinton and Fisher Creeks on the eastern and southeastern slopes.

Keno Hill and Sourdough Hill are adjacent hills separated by Lightning Creek. Keno Hill trends northeast and lies between the Keno Ladue-McQuesten River valley and Allen, Faith, Lightning, and Christal Creeks. The hill has relatively gentle southern and southeastern slopes and a precipitous northern slope, marked by two cirques, Faro Gulch and Silver Basin Gulch. The terrain above 4,500 feet is relatively flat and rolling with five prominent rocky knolls known as Keno, Minto, Monument (the highest point on Keno Hill, elevation 6,065 feet), Caribou, and Beauvette. On the slopes of the hill several streams follow steep gulches in the rock strata, the principal ones being Gambler, Faro, McKay, and Silver Basin on the northern slope, Faith, Hope, and Charity on the northeastern and southern slopes, and Erickson on the western slope.

Sourdough Hill lies southwest of Keno Hill and trends north between Thunder, Lightning, and Duncan Creeks. The part of the hill described in this report is on the northern and northwestern slopes, which are gentle up to 4,200 feet and from there rise abruptly to a steep rocky hogsback that trends southwest for some 6,000 feet.

Extensive rock outcrops are uncommon on Galena, Keno, and Sourdough Hills, and with the exception of the gulches and cirques where relatively good geological sections are present, detailed mapping can only be done by observing float. Below an elevation of 4,400 feet rock outcrops are sparse, and the slopes are covered with till, soil, rock debris, much, and muskeg, in

which conifers, birch, aspen, Arctic black-birch, and other vegetation grow abundantly. Above this elevation the soil is thin, outcrops are more numerous, the ground is covered with local rock float, the terrain is treeless, and the vegetation is limited to alpine species and grassy meadows.

The lower slopes of the hills were severely glaciated during Pleistocene time by ice-sheets that spread, from the east, over the entire area. Glacial till, gravel, and other debris lie in a series of benches on the slopes of the hills and floor the valleys. The deposits are generally 5 feet to 20 feet thick, but in some areas as on the southern slope of Keno Hill facing Lightning Creek and north of Christal Lake, they are 30 feet to 50 feet thick or more.

The Keno Hill-Galena Hill area is in the region of permanently frozen ground. The permafrost is irregularly distributed and its occurrence is dependent upon the elevation, hillside exposure, depth of overburden, amount of vegetative cover, and presence of flowing underground and surface water. At high elevations and on slopes with a northern exposure it is generally present. Thus, on Keno Hill, the mine workings on the top of the hill and on the northern slope encountered permafrost some 400 feet below the surface. On the northern slopes of Sourdough Hill and Galena Hill a similar situation prevails, and frost and ice lenses have been encountered at depths of 250 feet or more in the mine workings. On the lower southern slope of Keno Hill, however, the workings of the Onek and Mount Keno mines show little evidence of permafrost. In places where surface and underground water are flowing the permafrost has been thawed out and frost free windows and strips are present. These provide access and egress for waters that are oxidizing the lodes.

The effects of frost action, soil creep, and slope wash are marked on the hills, particularly at the higher elevations. Frost action is responsible for features such as stone rings and stripes, and produces a general ‘boiling action’ that brings rock float, mineralized float, and soil from deeper layers to the surface, thus facilitating the mapping of both the underlying bedrock and the tracing of vein faults. On steep slopes, however, frost action and land creep have transported float downhill, in some places, 100 feet or more, making the accurate mapping of contacts and vein faults difficult.

Except for a few localized areas, the soils are not strongly weathered or deeply leaching. They also exhibit a poor profile development, particularly those underlain by permafrost. The soils in the area can be conveniently classified into two general types: (1) residual, and (2) muck peat, and half-bog. Residual soils were formed principally from the weathering of the various types of bedrocks, or as is evident in some places, particularly in the vicinity of Dublin Gulch, from the decomposition of a till that predates the last glaciation.

2.2 BIOLOGICAL ENVIRONMENT

2.2.1 Water Resources

The South McQuesten and North McQuesten rivers are major tributaries to the Stewart River. From its headwaters near Keno City in west central Yukon, the South McQuesten River flows some 150 km to its confluence with the Stewart River, which eventually discharges into the Yukon River. The major tributaries to the South McQuesten River include Christal Creek, Flat Creek Haldane Creek, and Galena Creek.

There is a long history of mineral exploration and mine development in the McQuesten River watershed. Silver-lead-zinc mineralization was first discovered in the vicinity of Galena Creek in 1906. Since that time, many small silver deposits have been mined. In addition, a number of larger mining operations have been established in the area. Collectively, these historic mining activities have resulted in a diversity of pits, adits, tailings piles, and wasterock dumps throughout the basin. The available water quality data indicate that surface run-off from abandoned mine sites and/or discharges of leachate from abandoned tailings piles are releasing contaminants into surface waters within the South McQuesten River basin, including Christal Creek, Flat Creek, Galena Creek, and the South McQuesten River mainstream. In particular, the levels of zinc in receiving water systems represent a potential concern for the fish and aquatic organisms that utilize or potentially utilize habitats within the watershed.

In 1997, a proposal to re-open a mine in the watershed led to the development of site specific water quality objectives for zinc in South McQuesten River and its tributaries.

According to Environment Canada, little is currently known about the ground water regime in the area.

2.2.2 Surface Water Quality

The Bellekeno mine site is near the confluence of Thunder Gulch with Lightning Creek, a stream flowing from the north side of Sourdough Hill. Lightning Creek eventually flows into Duncan Creek, which drains into the Mayo River. All of these basins have undergone extensive placer mining activities both now and in the past. The Flame and Moth Mill Site is on Christal Creek upstream of Christal Lake. Christal Lake drains into Christal Creek, which is fed by Erikson Gulch and eventually drains into the South McQuesten River.

2.2.2.1 Christal Lake

Christal Lake is a small, shallow sub-alpine lake with a silt bottom covered with vegetation. Beaver activity at the lake outlet controls water levels in the lake. An old tailings pile (Mackeno tailings) is located on the north east corner of the lake with some tailings submerged in the lake.

During three investigations undertaken by the proponent, slimy sculpin was the only fish species observed in Christal Lake.

2.2.2.2 Christal Creek

In 2008 three locations along Christal Creek were investigated including at the Keno Road Crossing (KV6), the Hanson Lake Road Crossing (KV7) and at a walk-in site accessed via a gravel pit off the Hanson Lake Road (C4). These sites were also investigated in 1995 and 2006 as well as an additional site at the mouth of Christal Creek where it joins with the South McQuesten River. This site was not revisited in 2008.

Slimy sculpin was the only fish species recorded in Christal Creek at the Keno Road Crossing (KV6) in 1995 and 2006 and were observed in relative abundance. In 2008 no fish were captured at this location. The proponent noted that this was due to an extended period of precipitation where all streams in September 2008 were experiencing high, fast flow with increased turbidity during the investigation, which had some impact on the effectiveness of sampling at the time.

Investigations at site KV7 in Christal Creek at the Hanson Lake Road crossing resulted in no fish observed in 2006 and 2008. A single Arctic grayling juvenile was recorded at this site in 1995.

Site C4, accessed off the Hanson Lake Road is located approximately 4.7 km downstream of Christal Lake. A number of fish barriers were observed upstream of this site, three of which remain and appear to completely block upstream fish movement. No fish were captured at this location in 2008 while Arctic grayling were observed below the barriers in 2006.

Christal Creek at the mouth (site KV8) was investigated in 1995 and 2006. In 1995 and 2006, slimy sculpin, Arctic grayling, and burbot were recorded in this area, although no fish were recorded during spring investigations, the reason as indicated by the proponent, being high water levels.

2.2.2.3 Flat Creek

Fish utilization in Flat Creek (KV9) has been reported as being low subsequent to assessments performed in 1974 and 1995. In 1995, Arctic grayling, burbot, and slimy sculpin were recorded during summer and fall investigations with no fish observed during spring investigations.

During 2006 no fish were captured in the spring with a few slimy sculpin caught during August. During the summer months the lower reach of the creek had been colonized by slimy sculpin,

burbot, Arctic grayling and northern pike. Juvenile Arctic grayling were more common in 1995 than in 2006. By September very few sculpin remained and no other species were present. Adult sculpin were recorded near the Shangai Road during all 2006 sample periods indicating the presence of some over-winter habitat further from the South McQuesten River confluence. During 2008 a single northern pike was captured.

2.2.2.4 Lightning Creek

Lightning Creek continues to undergo significant channel changes as a result of placer mining. For this reason the sample location used in 1995 could not be revisited in 2006 and two new locations were selected to allow more representative sampling of Lightning Creek. These sites were revisited in 2008.

In 1995 the reach of Lightning Creek surveyed extended from just downstream of Keno City to approximately 200 m above the influence of Thunder Gulch, which was being placer mined. Adult Arctic grayling were found upstream of turbid water from Thunder Gulch and sub-adult Arctic grayling were observed in the turbid waters downstream of Thunder Gulch.

In 2006, two new stations were situated adjacent to the Keno City campground (LgT K) and just upstream of the confluence with Duncan Creek (LgT D). Both sites had been placer mined in the past and have man made channels. The fast flowing waters of LgT K contained Arctic grayling while the slower waters of LgT D had greater species diversity with slimy sculpin, round whitefish, and Arctic grayling common in August and September.

In 2008 no fish were observed in Lightning Creek adjacent to the Keno City campground while slimy sculpin and Arctic grayling were observed upstream of the confluence with Duncan Creek.

2.2.2.5 South McQuesten River

Fisheries investigations were conducted on the South McQuesten River in 1995 and 2006. In 2006, five sites along the river were sampled between McQuesten Lake and downstream of Haggart Creek and covered strategic locations such as downstream of the confluences with Flat and Christal Creeks.

Arctic grayling captured near the Haggart Creek confluence in June were assessed for maturity and spawn timing, which was determined to be around May 27. On July 31, Chinook salmon were also observed near the confluence with Haggart Creek. Fish utilization of the South McQuesten River was found to generally be higher downstream of the confluence of Haggart Creek both in terms of number of fish and species diversity. Other fish species observed in 2006 include slimy sculpin, round whitefish, northern pike, Arctic lamprey and burbot.

2.2.3 Benthic invertebrates

Benthic invertebrate sampling has taken place sporadically over the years, dating back to 1975. Environmental Protection Services carried out biological monitoring in the area in 1975, 1985 and 1990. In compliance with past water licences, various consultants carried out benthic sampling annually between 1986 and 1990 at four locations. As part of a biological monitoring survey conducted in 1994 by LES, benthic invertebrate sampling was also conducted. LES also conducted stream sediment and benthic invertebrate monitoring in 2007. All study methodologies used artificial substrate samplers with a colonization period of five to six weeks with triplicate samples collected at each site. As the same methodologies were employed for the various sample events, legitimate comparisons can be made. LES has conducted this comparison within the report entitled *"Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007"* prepared in March 2008 (LES, 2008).

There is a data gap for several years for the upstream sites, KV-1 and KV-6. Only KV-1 (South McQuesten River u/s of Christal Creek) represents a true background site. Populations were very low here in the first years of sampling but were far greater in recent years. It is not known why populations were so depressed in 1975 and 1985. Populations at Flat Creek (KV-9) and South McQuesten River downstream (d/s) of Flat Creek (KV-4) were depressed during the latter years of operation of the mine (operations ceased in 1989). Populations at both sites appear to have recovered somewhat in 1994 and 2005. Populations fluctuated at South McQuesten River upstream (u/s) of Flat Creek (KV-3) over time with higher populations documented during the recent surveys. Populations increased significantly in Christal Creek near the Keno highway (KV-6) in recent studies as well.

Diversity has fluctuated at the sites. The communities on the South McQuesten River generally are more diverse than those on Christal and Flat Creeks. The diversity of the communities at KV-3 and KV-4 has been relatively uniform in recent years.

Diptera has usually been the dominant order at all of the sites over time. Plecoptera shared dominance at KV-3, South McQuesten River u/s Flat Creek, on several occasions. There has been a shift in recent studies at KV-1 where Ephemeroptera has also been dominant. The community at Flat Creek at the mouth, KV-9, saw the greatest shift in dominance over the years. Homoptera (true bugs) and Oligochaeta (aquatic earthworms) have shared dominance here during some of the surveys. Based on the numbers, diversity and the composition of the community, Flat Creek is the most impacted site of those examined in Table 3-3.

In summary with the limited data available, it appears that benthic populations were negatively affected during the years of mine operation, and have significantly recovered since. Without corresponding data from the background site (KV-1) during this time period it can not be stated

definitively if this was a result of mining, or if natural regional conditions caused the depressed populations.

LES (2008) offers the following summary of benthic invertebrate sampling in 2007:

> *Benthic invertebrate populations were robust and healthy in the South McQuesten River and Lightning Creek drainages. There was good representation from the groups of insects that are known to be sensitive to chemical pollution, indicating healthy environments in these areas. There was a very high population at Christal Creek u/s of Keno Hwy, KV-6; however, the community was the least diverse of those studied. Populations at the other two sites on Christal Creek and at Flat Creek, KV-9, were depressed. It appears that the high concentrations of metals in the stream sediments at Flat and Christal Creeks are negatively impacting the health of the benthos communities located on these drainages.*

2.2.4 Wildlife

The project area is home to numerous species of mammals including shrews, bats, wolves, wolverine, coyotes, foxes, black and grizzly bears, weasels, lynx, moose, woodland caribou, mule deer, elk, cougar, rabbits, pikas, and numerous rodents. Different species utilize the project area at different times of the year, some year round and others seasonally.

Seasonally this area is home to numerous migratory birds during migration and breeding seasons. Several species – tundra swans, greater white-fronted geese, snow geese, and brant- pass through the area on their way further north to Arctic breeding grounds. They only sometimes touch down, and then only in small numbers. Two other species, the Canada goose and trumpeter swan, are much more abundant in the area and stay to breed locally. Twelve species of birds of prey have been observed in the surrounding area, for example the peregrine falcon. Also numerous species of shore and other birds all recorded in a 2006 published book: The Heart of the Yukon- a natural and cultural history of the Mayo area. This book was written in part by the local regional biologist and Ducks Unlimited Canada.

2.2.4.1 Moose

Within the whole Mayo-Elsa-Keno area, the mountains near Keno are some of the best moose habitat, with highest densities of moose, in the early winter when surveys are conducted. In early winter moose move up into the sub-alpine shrub habitats where there is abundant food after their rut. In mid-winter, once snow gets deep at high altitudes, moose move down into lower creek and river valleys and old burned areas. In winters with low snow depths, moose tend to congregate in old burned areas during the late winter, but when there is deeper snow, they prefer

dense forested areas along the major rivers and creeks. The area immediately around Keno and Elsa provides good late-winter habitat based on late-winter surveys.

Results from winter survey work done in the project area shows that Mount Hinton, to the east of Keno City and Mount Cameron to the north show high moose density during winter. Late winter after rut is when moose, particularly bulls are recovering from the rut and require high quality forage. Moose have been recorded at the Valley Tailings Area and throughout the project area year round. Willow is present throughout the project area and a main food source for moose.

2.2.4.2 Caribou

Little is known about caribou in the Keno area other than they are woodland caribou belonging to the Northern Mountain Population, which are listed as Special Concern under the Species at Risk Act. Since the Forty-mile herd stopped coming into this area 40-50 years ago, there have not been large numbers of caribou in the Mayo-Keno area. There have, however, been regular reports of smaller groups of caribou in the general Keno area, including winter observations around Tiny Island Lake and along the Keno-Ladue River in the 1980s and more recent summer observations on Rambler Hill, Bunker Hill, Mount Hinton, and a few on surrounding mountain blocks. Most of these are of small (<10 animals) groups. Caribou were observed on Bunker Hill in the summer a few years ago, but no sign of them in a quick search of those same mountains during the rutting season. Observations by Keno residents and miners are reported in that area pretty much every year during the summer. These caribou are a long way from the ranges of any known herds—the closest are the Ethel Lake herd to the south, which does not range north of the Stewart River, and the Bonnet Plume herd to the north, which does not range south of the Werneckes. It is unknown whether these caribou are wanderers from known herds or if they are part of a small undocumented herd in the area. Work has been ongoing to collate all sightings and, at some point, Department of Environment Yukon may decide that they have enough information to put a few collars on and see where these animals go in the winter time. At this time any reported sightings boost the current database and increase the knowledge of these animals.

2.2.4.3 Species at Risk

A review of the species at risk in Yukon was considered in accordance with the *Species at Risk Act* (2002) and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (2004). Species at risk in the Yukon and all of Canada, as listed on the YG, Department of Environment web site:

- http://environmentyukon.gov.yk.ca/wildlifebiodiversity/speciesrisk.php

and whose ranges could conceivably overlap within the study area include:

- peregrine falcon Anatum subspecies (Threatened);
- grizzly bear, wolverine, short-eared owl, woodland caribou (Special Concern); and
- mule deer, elk, cougar (At risk in Yukon but not elsewhere).

The proponent has indicated that no wildlife species at risk have been observed within the area nor were any key habitats for these species at risk encountered.

2.2.5 Vegetation

The Keno Hill Silver District is located within the Yukon Plateau-North ecoregion. The region is characterized by discontinuous widespread permafrost, with much of the area poorly drained and underlain by perennially frozen ground. Many valleys include peatlands, palsas, fens and meadows of sedge tussocks. Upper slopes may be covered with scree material, with treeline occurring at 1,350 to 1,500 meters.

Predominant tree cover in the area consists of white spruce (*Picea glauca*), black spruce (*Picea mariana*) and willows (*Salix spp*.). Less commonly occurring trees are trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), and white birch (*Betula papyrifera*). Alpine fir (*Abies lasiocarpa*) is common at higher elevations and alder (*Alnus crispa*) occurs along creek banks and in disturbed areas. Isolated pockets of lodgepole pine (*Pinus contorta*) can also be found.

Most south-facing slopes are covered with white spruce along with aspen, balsam poplar and willows, while north-facing slopes are underlain by permafrost and covered with stunted black spruce. Much of the drier south-facing slopes have been burned at some point.

The shrub layer on the north facing slopes and peatbog areas consists of dwarf birch (*Betula glandulosa*), willows (*Salix spp*.), shrubby cinquefoil (*Potentilla fruticosa*), crowberrry (*Empetrum nigrum*), cloudberry (*Rubus chamaemorous*) and dwarf raspberry (*Rubus acaulis*), as well as ericaceous shrubs such as Labrador tea (*Ledum decumbens*), bearberry (*Arctostaphylos rubra*), blueberry (*Vaccinium uliginosum*), cranberry (*Vaccinium vitis-idaea*) and bog cranberry (*Oxycoccus microcarpus*). The drier south-facing slopes have a shrub layer which includes rose (*Rosa acicularis*), twinflower (*Linnaea borealis*), and gooseberry (*Ribes oxyacanthoides*).

Alpine areas support a variety of plant communities. The low ground vegetation mainly consists of mat forming plants such as moss campion (*Silene acaulis*) and ericaceous shrubs such as

heather (*Cassiope spp*.). A variety of alpine flowering forb species are also found. Dry areas, particularly well-drained rocky alpine sites, have extensive lichen development.

Wetland species are mostly graminoids, including sedges such as Carex aquatilus and Carex lugens, cotton-grass sedges (*Eriophorum augustifolium, Eriophorum russeolum and Eriophorum vaginatum*), and grasses such as reed-bentgrass (*Calamagrostis canadensis*). Forb species such as Sudeten lousewort (*Pedicularis sudetica*), wintergreen (*Pyrola spp*.) and coltsfoot (*Petasites spp*.) are also scattered throughout wetland areas.

Aquatic plants commonly found in the area include water-milfoil (*Myriophyllum exalbescens*), pondweed (*Potamogeton richardsonii*), mare's-tail (*Hippuris vulgaris*) and bur-reed (*Sparganium spp*.).

Common horsetail (*Equisetum arvense*) is the predominant species of vegetation occurring on the unsubmerged portion of the Elsa tailings impoundment. Squirrel-tail grass (*Hordeum jubatum*) is found in large patches in the higher, drier areas. Hairgrass (*Deschampsia caespitosa*) and willows (*Salix spp*.) are scattered throughout. Sedge (*Carex aquatilus*) is the predominant plant in the wetter tailings and shallow water, along with occasional occurrences of willow, water horsetail (*Euisetum arvense*) and sloughgrass (*Beckmannia syzigachne*).

2.3 SOCIO-ECONOMIC ENVIRONMENT

The project area has been the focus of intensive and wide spread mining and mining related activities that have affected the Nacho Nyak Dun First Nation ("NNDFN") for the past eighty or so years. Consequently, the intervening years can be characterized as a time when mining and related activities have replaced virtually all other activities in the area. Currently, the land use is primarily for mining, trapping and hunting by members of the local community.

With the shutdown of the mining operations in the 1980's, there was an evacuation of the population of the Hamlet of Elsa, its housing stock, and much of the domestic infrastructure that was in place when the community flourished. Road access to Keno City has not changed, nor has the power and other services to Keno City. Road access to the workings on Galena Hill, Sourdough Hill and Keno Hill is currently maintained as required for care and maintenance. Access for potential users of other resources in the area such as forestry, recreation, and the like, is available since access through the property to Keno City and beyond, or to the Hanson Lakes and beyond, is mostly on public roads. Access to some areas may or may not be restricted depending on interest requirements. Present Mining Land Use Permit for Bellekeno exploration required an access management plan which Alexco is currently working on with the local community and NNDFN.

Alexco's activities on the Keno Hill property in the future are expected to bring about an economic upswing in the local area. Increased expenditures for exploration, development and production, as well as reclamation work are expected to be significant in the future (next 1-25 years). In addition, continued care and maintenance expenditures will benefit the local economy. Currently six employees work on a rotational full time basis for the care and maintenance program. All of these full time care and maintenance employees reside in Whitehorse, Dawson City, Keno City, or Mayo. The number of employees has increased to forty-five during the exploration season and will increase to approximately 150 during production/exploration.

Public awareness and transparency of the proposed mine development in the Keno district has been stated as integral to the proponent's operations. The office in Elsa is open to local visitors and general inquiries.

2.3.1 Keno City

The following socio-economic information for Keno City has been summarized from a number of websites:

- www.kenocity.info/about_keno.htm
- http://yukon.canada-travel.ca/keno-city
- www.yukonweb.com/community/mayo/
- http://travelyukon.com/thingstodo/yukonscenicdrives/silvertrail/)

Also brochures (Exploring Keno Hill Stories of a Silver Deposit, Keno City Historical Buildings Walking tour, Keno City Mining Museum and Keno City – Yukon Keno Cabins) and submissions from the public and local knowledge.

Keno City is a small community that lies nestled in the mountains at the end of the Silver Trail Highway. From its beginnings in 1919 as a stopping point on a haul road, Keno City quickly grew into a center for supplies and recreation. The population of the community has fluctuated with the fortunes of mining activity.

Today Keno City has a population of about 20, mostly artists and outdoor enthusiasts. It continues to serve as a base for local exploration, placer activity and recreation. Keno has developed a tourism industry and become a destination for visitors both local and abroad. Keno's attractions include a top-notch mining museum, hiking trails, an alpine interpretive centre and artist studios. The Keno City community maintains a campground and a number of residents run tourist businesses.

Some of the services of Keno City include:

- Alpine Interpretive Center
- Keno City Snack Bar
- Keno Mining Museum
- Keno Cabins B&B
- Blue Roof Studio
- Keno City Campground

2.3.2 Mayo

The following socio-economic information for Mayo has been summarized from the "Yukon Community Profiles" website, which was produced by Human Resources Development Canada in partnership with the Yukon Chamber of Commerce:

- http://www.yukoncommunities.yk.ca

The community of Mayo is located at the confluence of the Mayo and Stewart Rivers, about 400 km north of Whitehorse and serves as a distribution and service centre for the surrounding area. Mayo is also the administrative centre for the NNDFN. In addition to being a tourist destination, the community is a base for wilderness and mining tourism, canoeing, hiking, big-game hunting and fly-in fishing.

In 2003, the average population of Mayo was 409, which is down from an average of 504 in 1997. The Nacho Nyak Dun First Nation comprise 60 % – 70% of the community population. In Mayo more people are over the age of 65 (11%), compared to the Yukon average of 7%. There are fewer people proportionally in the 25 to 44 age group, which reflects some movement out of the area by people looking for work elsewhere.

In cooperation with industry (developers/companies), the Nacho Nyak Dun Development Corporation (NDDC) is establishing a number of training, work, and apprenticeship programs in the community. The First Nation works toward participation in land developments in their traditional territory and employs approximately 60 people.

The economy of Mayo is linked to the provision of services to the people of Mayo and the surrounding areas. One third of the jobs in the community are related to government services,

including First Nation and territorial administration. Placer mining and mineral exploration also provide an economic base for the community. Construction is a variable sector, and provided a significant share of employment in 2001. Tourism in the Mayo area is a growing industry. Accommodation, food services, recreation services (i.e. guiding and outfitting) and retail (catering to tourists) provide work for local residents. Tourist attractions in the area have to do with the history of mining around Mayo and Keno City including a mining museum and interpretive centre. Camping and hiking, hunting and fishing, and other outdoor pursuits comprise the activities undertaken by tourists in the area.

Some of the community services in Mayo include:

- NNDFN main administrative offices including NNDFN lands/environment office;
- J.V. Clark elementary level to post secondary level school with Yukon College Mayo Campus;
- Mayo Nursing Station;
- RCMP detachment;
- Community social services (YG Health and Social Services, Yukon Housing Corporation, Yukon Family Services (Dawson City), NNDFN social services);
- Village of Mayo community and municipal services (volunteer firefighting services, recreation and leisure services, etc.);
- Ambulance services (provided by community volunteers in partnership with YG);
- YEC supplies electric power from the Mayo hydroelectric dam;
- Mayo airport with weather station;
- YG Department of Environment office, Energy, Mines and Resources office, and a Mining Recorder's office;
- YESAB Designated Office;
- Post office;
- Internet services;
- Banking services;
- Tourist services (two motels, three campgrounds, one bed and breakfast, two seasonal businesses offering accomodation, one restaurant; two service stations, a store, Laundromat, showers businesses catering to wilderness tours and fishing);
- Helicopter, float-plane and taxi services; and

- The Silver Trail Area, including Keno, offers a lodge, cabins and eating facilities for tourists.

2.3.3 NNDFN Exploration Cooperation Agreement

The NNDFN is a self governing First Nation that signed their Final Agreement in May of 1993. The project proposal is entirely within the traditional territory of NNDFN.

On September 25, 2007 Alexco and the NNDFN announced that they had entered into a Negotiation Agreement relating to the activities of Alexco's wholly owned subsidiary, Elsa Reclamation and Development Company Ltd. ("ERDC") on and around the former United Keno Hill Mine property. The Negotiation Agreement provided for the negotiation and settlement of two further agreements between Alexco and the NNDFN (an Exploration Cooperative Agreement and an Impact Benefit Agreement).

The Negotiation Agreement provides for collaboration by Alexco and the NNDFN as well as support in principle by the NNDFN in relation to current activities at the property. It contemplates that Alexco and the NNDFN will work collaboratively in good faith with one another in order to facilitate and ensure the meaningful participation of the NNDFN in site activities and regulatory processes concerning the Keno Hill Project. Under the Negotiation Agreement, Alexco has provided funding to the NNDFN to cover their costs of negotiation expenses.

An Exploration Cooperation Agreement concerning the care and maintenance and exploration activities currently undertaken by Alexco has been negotiated and was signed May 22, 2008.

The second agreement between Alexco and NNDFN is an Impact Benefit Agreement to be concluded if as a result of exploration activities, any portion of Alexco's property is developed into a mine operation. Contingent on a positive production decision by Alexco for the Bellekeno Mine, the negotiation of this agreement between Alexco and NNDFN will commence in early 2009.

On June 6th 2008, NNDFN released an engagement process and a set of best practices codes for industry within the Traditional Territory of the NNDFN. The Cooperative Engagement Process for Economic Activities Proposed in the Traditional Territory of the NNDFN outlines the relationship between industry in the Traditional Territory of NNDFN and the Chief and Council of NNDFN. Guiding Principles towards Best Practices Codes for Mineral Interested within NNDFN Traditional Territory has been prepared for mineral exploration and mining companies who are planning activities on lands within the Traditional Territory of NNDFN.

3.0 REQUIREMENT FOR AN ASSESSMENT

An assessment by the Designated Office is required under the following circumstances:

1. An activity is proposed to be undertaken that is listed in Schedule 1 of the Assessable Activities, Exceptions and Executive Committee Projects Regulations (Activity Regulations) and not excepted;

   The proponent proposes to undertake activities listed in part *1* item *3* and part *9* item *1, 3 & 12* of the Activity Regulations, specifically:

   "Construction, operation, decommissioning of a quartz mine"

   "Drilling & operating a well for the extraction of ground water; direct use of water; deposit of treated waste water:

Decision bodies and authorizations have been identified based on information in the project proposal and information submitted to the Designated Office during the assessment.

Decision Body	Authorization(s) Required	Act or Regulation
YG, EMR – Mineral Resources Branch	Quartz Mining License	*Quartz Mining Act*
	Type A Water Use License	*Yukon Waters Act* Waters Regulation

Table 1: Decision Body(s) and Authorizations Required

4.0 SCOPE OF THE ASSESSMENT

This assessment garnered a high degree of participation from interested persons. This resulted in the receipt of numerous comments during Seeking Views and Information (”comment period”) as noted in Appendix 3. The majority of these comments have been addressed in the effects assessment. However there were a number of comments that require specific consideration. This is detailed as follows.

Consideration of Business Opportunity Costs

Concerns were raised about how implementation of this project would change business plans for tourism ventures. It was noted that these plans were still in the idea stage but with this project in place it was likely they would not be pursued.

It is difficult to consider these types of potential activities in an assessment. When conducting cumulative effects for example, we consider existing or proposed activities, or proposals submitted to YESAB. The outer limit for future projects is in relation to what is formally proposed. This is in contrast to considering anything that could possibly happen since that would be very difficult to rationally predict and assess. Because of this rationale, activities not formally proposed in some manner have been deemed outside the scope of this assessment.

Consideration of Community Infrastructure Capacity

A comment provided information on the current power supply available in Keno and questioned whether there would be enough to support this project. It is our understanding that the proponent is in a power purchase agreement with Yukon Energy. Further, the proposed generators are intended as a backup to this agreement. Therefore this project should not affect the current power supply to Keno.

Consideration of the Lack of Community Consultation

A number of concerns were raised about the lack of consultation by the proponent with the community of Keno. People felt that a greater level of effort to speak to locals could have helped to avoid many of the issues brought forward during this assessment. While community consultation is a positive practice that can lead to better understanding between the community and the proponent, this is not a requirement for projects being assessed by a Designated Office.

Consideration of Future Use/Expansion of Project Infrastructure

A few comments spoke to the potential for mill infrastructure to be used for increased production levels and throughput ore from other claim areas. The concern was that increased production levels are not assessed with this assessment. More importantly is the sense that this assessment

is not considering the ramifications of this infrastructure running at full potential at some future period of time.

As related elsewhere in this section, we are only authorized by the Act to assess what has been proposed. It is true that this assessment won't benefit from understanding the full picture of potential development but this is also the reality of project planning since there are practical limits to how far projects can be forecast. If this project expands further in the future, an assessment will occur if that expansion requires it.

Consideration of Economic Benefits

There were some comments that questioned the proponent's overall beneficial contribution to the economy of Keno. While this may be of interest it is not central to our outcome. We are tasked with determining if a project will result in significant adverse effects and to mitigate those effects to the extent possible so that they are no longer significant. There is a much more limited role for positive effects than the cost-benefit analysis that is often assumed with our assessment practice. We are not empowered by the Act to weigh the pro's and con's of a project. Our process is focused on understanding the adverse effects. Since the economic effects of this project were not determined to be significant and adverse there was no need to consider them any further.

Consideration of Alternatives

A number of comments spoke to the preference of having the mill located at an alternate location other than Christal Lake or as now proposed at the Flame and Moth site. Elsa and Hanson Lakes were the prominent preferences and reasons were cited. It is important to relate why these locations were not considered further in the assessment.

In the assessment of a project submitted to YESAB we are tasked primarily with considering the activities that are proposed. Christal Lake was the original proposed location for the mill. It was selected from an initial group of 9 possible sites. During the comment period concerns were raised that led the proponent to change the location. They chose the Flame and Moth site in an attempt to alleviate some of the concerns attributed to the Christal Lake location. With the new location our task remained the same – to determine if there are significant adverse effects associated with the project as proposed, and if any significant adverse effects could be mitigated sufficiently.

In completing this assessment we were able to understand the potential effects, determine their significance and where required recommend mitigation. Consideration of alternatives or alternative ways of undertaking an activity, as noted in section 42 of the Act, usually begins when mitigation is not available or is not viewed as feasible or likely to succeed. Since this was not the case with project effects associated with the Flame and Moth site, there was no need to further pursue consideration of alternatives.

We are not in a position to consider a number of potential sites and choose the 'best' one based on our effects assessment. The Act is clear that we assess only proposed activities.

Consideration of Questions Asked During Seeking Views and Information

The comment period is an opportunity for the public and others to raise issues and concerns, to input into the assessment and to provide information to the assessor. It is not intended to be a 'blog' for questions and answers between the public and the proponent, or others. Based on the information and questions received, the assessor will determine what is relevant to the assessment, what requires clarification or investigation and may issue a formal information request to the proponent if appropriate.

Consideration of Changes to the Project Scope

A number of comments questioned changing the location of the Mill and Dry Stack Tailing Facility during the comment period. It should be noted that the project scope issued with the public notice is in draft until the final recommendation is issued by the Designated Office. The comments further questioned the lack of time to contemplate this change in scope. In general the baseline conditions and activities proposed were similar enough to allow this change. Information related to use of the Flame and Moth site was provided to the assessment in early May and well before the end of the comment period. It is acknowledged that the actual change in location was formalized towards the end of the comment period. But given the similarities of the two sites, the fact that the activities proposed were the same and information for Flame and Moth was available during the comment period, and that this change was made in order to alleviate effects, this change of scope was deemed reasonable.

Consideration of Assessment Timelines

Comments raised concern with the length of time available to review and provide comments to the assessment of this project. Generally there was a sense that more time was needed. In completing this report the Mayo Designated Office is confident that this is the right outcome for this project and that all significant adverse effects have been appropriately mitigated. In order to achieve this outcome most of the time available under our operating rules was utilized in order to provide interested persons the time needed to provide comment.

Determination of Valued Environmental and Socio-economic Components

After taking into account the matters referred to in section 42 of the Act, the Designated Office has identified the valued environmental and socio-economic components (VESEC) for consideration in this assessment:

1. Aquatic Resources
2. Health and Safety
3. Environmental Quality
4. Wildlife
5. Heritage Resources
6. Economy
7. Quality of Life

5.0 AQUATIC RESOURCES

5.1 OVERVIEW

The Flame and Moth Mill Site, including Dry Stack Tailing Facility ("DSTF"), and the Bellekeno 600 adit will release treated waste water into Christal Creek and Thunder Gulch, respectively. Both are within the Stewart River watershed which is part of the Yukon River Basin. Mill drainage is to the north through Christal Creek which drains to the South McQuesten River and flows south-west to its confluence with the Stewart River [Burns (2008)]. Mine drainage flows through Thunder Gulch to Lightning Creek, south-west into Duncan Creek and then to the Mayo River which discharges into the Stewart River.

Aquatic resources can be characterized for the purposes of this assessment as all living organisms within the aquatic environment of this drainage area. Information provided during this assessment indicates an important and diverse array of aquatic resources within the footprint of this project. Aquatic plants, invertebrates and fish are interdependent with water and sediments that make up their habitat; all are part of the aquatic ecosystem.

The Canadian Council of Ministers of the Environment (CCME) – Canadian Water Quality Guidelines for the protection of Freshwater Aquatic Life are comprehensive national guidelines to support aquatic resources. They were developed with the approach that the "guideline values are meant to protect all forms of aquatic life and all aspects of the aquatic life cycles".

Canadian water quality guidelines are intended to provide protection of freshwater and marine life from anthropogenic stressors such as chemical inputs or changes to physical components (*e.g.* pH, temperature, and debris). Guidelines are numerical limits or narrative statements based on the most current, scientifically defensible toxicological data available for the parameter of interest. Site specific water quality objectives for zinc have been developed by CCME for the South McQuesten River system. The species identified in that guidance mimic those found in the Mayo River drainage as identified below. This guidance was developed on the premise that the Keno mine was going to re-open.

Minnow Environmental Inc. (2009) summarized, evaluated and compared data from benthic studies conducted in 2007 (Burns 2008), 1994 (Burns 1996) and 1989 (Davidge and Mackenzie-Grieve 1989) within Lightning Creek and the larger Mayo River drainage. Species of benthic invertebrates found within these waters include, but are not limited to, the order of Ephemeroptera (Mayflies), Plecoptera (Stoneflies), Trichoptera (Caddisflies), Diptera (flies), Oligochaeta (aquatic worms) Cladocera (water fleas), Arachnida (water mites), Copepoda (copepods), Ostracoda (ostracods), Gastropoda (snails) and Pelecypoda (bivalves).

Minnow Environmental Inc. (2009) also summarized, evaluated and compared fish and fish habitat data, including community composition, fish health and fish tissue metal concentrations, collected in 2006 (Sparling 2006) and 1994-1995 (Sparling and Connor 1996) from waters influenced or affected by UKHM operations. These studies also evaluated habitat availability and utilization by fish. The study areas included Christal, Flat and Lightning Creeks. The following 11 species of fish were identified: arctic grayling, slimy sculpin, round whitefish, northern pike, arctic lamprey, chinook salmon, burbot, longnose sucker, least cisco and lake chub.

Project components and sub-components which potentially overlap with existing aquatic resources include:

- Construction/Use of Surface Infrastructure
- Water Use/Management
- Underground Quartz Exploration
- Waste Rock Management
- Tailings Management
- Reclamation and Closure

5.2 BACKGROUND INFORMATION

This section will discuss the effects pathways to be considered (i.e. manner in which project activities may cause an effect) and contaminants of concern.

5.2.1 Effect Pathways

There are four effect pathways to be considered in relation to aquatic resources as follows:

- Water Quantity
- Water Quality/Turbidity
- Sediment Contamination
- Aquatic Life

1) Water Quantity

The project area lies within both the Christal Creek and Lightning Creek watersheds, both of which eventually drain to the Stewart River. Water quantity of the project area includes the volume of all available surface water and groundwater sources in these two watersheds. The annual hydrologic character of the site is largely defined by relatively high peak flows associated with spring snow melt (*e.g.* spring freshet), followed by relatively lower peak flows associated with summer rainfall events, with attenuating base flows that extend through autumn to freeze-up.

The total inflows and outflows of the site are represented by a water balance which includes total water input to the site (*e.g.* from precipitation), channelized flow and surface water and groundwater connectivity, and total water output (*e.g.* watercourses leaving the site area, evaporation, water use). Natural variability of annual precipitation in the watershed causes fluctuations in the annual water balance (*e.g.* dry or wet years). As such, characterizing the water quantity of a watershed needs to consider long-term mean flows, minimum and maximum flows, climatic variability, as well as dry and wet year cycles.

Water use plans for the project must account for total water extraction from both surface water and groundwater sources within both watersheds, while considering natural variations in stream, lake or groundwater levels. The duration and frequency of total water use ultimately affects aquatic habitat, water quality, surface water and groundwater supplies, and the overall ecological integrity of the watershed.

2) Water Quality and Turbidity

Effluent discharges containing elevated concentrations of contaminants have the potential to elevate concentrations of metals, nutirents and other compounds in receiving waters (either surface watercourses/bodies or groundwater).

The project area encompasses several watersheds in mountainous terrain. The various historical mine workings located along the mountainsides are subject to site-specific hydrological processes that can mobilize deleterious elements and compounds from natural terrain and project facilities into down-gradient water bodies. Greater volumes of effluent and/or higher concentrations of contaminants that reach receiving waters may lead to increased contaminant loading and potential significant adverse effects to water quality. Snow pack and spring melt conditions present natural environmental influences that have resulted in challenges to effluent management and adherence to water quality standards as evident with the spring freshet described in 2005 and 2006 . Accidents or malfunctions leading to failure of treatment infrastructure or improper storage of acid/metal leaching ("AML") waste rock could lead to discharge water that has elevated concentrations of certain metals.

Turbidity is a measure of lack of clarity or transparency of water caused by biotic and abiotic suspended or dissolved substances. The effects of increased turbidity may include increased water temperatures, reduced oxygen levels, abraded gills and ultimately, impaired habitat for benthic invertebrates and fish. Increased sediment loads (turbidity) are associated with unusually heavy precipitation and snow melt (spring freshet). A dam breach or settling pond failure could also result in the release of treated sludge to the receiving watercourse as fine particulate matter. In general, the deposition of fine sediment in stream ecosystems is detrimental to aquatic organisms.

3) Sediment Contamination

Sediment contamination can occur when untreated or non-compliant adit flows containing high contaminant concentrations enter watercourses and contaminants subsequently precipitate out of solution and into the sediments. Increased streamflows are sometimes associated with increased concentrations of total suspended solids and metal contaminants which can be transported substantial distances downstream. Suspended solids eventually resettle into the sediments based on particle size, water velocity and water quality parameters, such as pH, at the point of deposition.

4) Aquatic Life

Aquatic vegetation living in contaminated water and acquiring nutrients from stream sediment with elevated metals and other contaminants could absorb and accumulate metals. Aquatic vegetation has varying tolerance levels for contaminants depending on individual species. High

metal concentrations may harm or kill species that are more sensitive leading to local elimination and reduced ecosystem diversity. Species diversity is the basis for ecosystem function. The local elimination of particular species may ultimately result in decreased ecosystem diversity, which would be an adverse and significant effect.

Additionally, microscopic organisms that are living amongst the benthic sediments ingest inorganic matter (i.e. metals) and assimilate it to organic compounds. This bio-accumulation of metals in biota continues as each species is ingested by the next. Benthic organisms make an excellent indicator of stream health because of their relative immobility (compared to fish) which can provide accurate site data. In extreme circumstances benthic organisms will not be present because they cannot survive in an environment with high metal concentrations. Factors classically characterizing a healthy benthic community include a high taxonomic richness; an even distribution of numbers of each species; and the presence of species typically sensitive to habitat disturbances (e.g Ephemeroptera, Plecoptera and Tricoptera).

5.2.2 Contaminants of Concern

Aquatic communities are affected by both in-stream habitat characteristics and pollution. Failure to complete periodic bio-monitoring of benthic invertebrates could result in the inability to detect irreversible bio-accumulation of metals or conversely the stripping of essential nutrients in receiving waters. CCME provides freshwater aquatic guidelines that reference various water quality parameters. Upstream water quality not meeting these guidelines may result in bio-accumulations of adverse metal concentrations within body tissues of aquatic organisms. Evaluation of data reviewed by Environment Canada indicates that most of the aquatic health issues in this situation relate to cadmium and zinc.

Five metals (zinc, cadmium, arsenic, copper and lead) are characterized below in terms of their potential effects to aquatic resources. The five metals were selected based upon the former water licensing water quality discharge standards that are identified as elevated within the project area and are intended to provide the context for the more detailed effects characterization for specific activities in the next section. It is important to note that although they are representative of deleterious elements they do not constitute the complete list of water quality parameters that may be elevated and potentially affect aquatic resources. In terms of what these contaminants may be of concern to, consideration has been given to: Salmonids and Arctic Grayling since they are generally identified as indicator species for fish; and the benthic invertebrates that these fish species rely upon.

Zinc

Zinc can be present in water in dissolved or solid form. Only dissolved zinc tends to be bio-available, and bioavailability depends on the physical and chemical characteristics of the

environment and biological processes. Consequently, the management of zinc must be conducted on a site-specific basis. Environment Canada indicated that a site specific water quality objective, as per the CCME guidelines for zinc is "modified by hardness in the water, and that hardness is reduced during freshet which is the time where maximum load and minimum protection of aquatic life is occurring". Zinc bioavailability is affected by biotic and abiotic factors, for instance: organism age and size, prior history of exposure, water hardness, pH, dissolved organic carbon and temperature.

Potential Effects: Zinc concentrations of > 20 µg/litre have been shown to have adverse effects on aquatic organisms.[8] Zinc has been shown to exert adverse reproductive, biochemical, physiological and behavioral effects on a variety of aquatic organisms.[8] Yukon Government, Department of Environment (YG) also identified that the toxic effects of zinc on fish can vary from damaging the gill surface to accumulation in tissues. Fish can produce mucus to isolate zinc for short periods.

Scientific studies suggest that zinc contamination can profoundly affect the nature of the benthic community. Zinc is the most prevalent contaminant in the drainage waters from the project site and in documented concentrations is known to be toxic to fish as well as other aquatic life. The presence of zinc also increases the toxicity of cadmium in benthic invertebrates.

Cadmium

Cadmium mobility and bioavailability in aquatic environments are enhanced by low pH, low hardness, low suspended matter levels, high redox potential and low salinity.

Potential Effects: Cadmium interacts with the calcium metabolism of animals. In fish it causes hypocalcaemia, probably by inhibiting calcium uptake from the water. However, high calcium concentrations in the water protect fish from cadmium uptake by competing at uptake sites. Zinc increases the toxicity of cadmium to aquatic invertebrates, for example, sub-lethal effects have been reported on the growth and reproduction of aquatic invertebrates; there are structural effects on invertebrate gills. The toxicity is variable in fish, salmonids being particularly susceptible to cadmium. Sub-lethal effects in fish, notably malformation of the spine, have been reported. The most susceptible life-stages are the embryo and early larva, while eggs are the least susceptible. There is no consistent interaction between cadmium and zinc in fish. More generally, cadmium can be toxic to aquatic life.

Arsenic

Jones *et al*. (1997) found that increased mobility of arsenic after liming appears to be consistent with the pH dependence of sorption reactions of arsenic on iron oxide metals rather than dissolution–precipitation reactions of solid metal arsenates.

Potential Effects: The degree and rate of uptake depends on phosphorus, which interacts with arsenic and competes for sorption sites. Arsenic compounds cause acute and chronic effects in individuals, populations and communities at concentrations ranging from a few micrograms to milligrams per litre, depending on species, time of exposure and end-points measured. These effects include: lethality; inhibition of growth, photosynthesis and reproduction; and behavioural effects. Arsenic-contaminated environments are characterized by limited species abundance and diversity. If levels of arsenate are high enough, only species which exhibit resistance may be present.

Copper

In the aquatic environment the concentration of copper and its bioavailability depend on factors such as water hardness and alkalinity, ionic strength, pH and redox potential, complexing ligands, suspended particulate matter and carbon, and the interaction between sediments and water. Bioaccumulation of copper from the environment occurs if the copper is biologically available. A critical factor in assessing the hazard of copper is its bioavailability. Adsorption of copper to particles and complexation by organic matter can greatly limit the degree to which copper will be accumulated and elicit effects. Other cations and pH can also significantly affect bioavailability. Tolerance to copper has been demonstrated in the environment for phytoplankton, aquatic and terrestrial invertebrates, fish and terrestrial plants. Because copper is an essential element, procedures to prevent toxic levels of copper should not incorporate safety factors that result in recommended concentrations being below natural levels.

Potential Effects: Copper has been shown to exert adverse reproductive, biochemical, physiological and behavioural effects on a variety of aquatic organisms. Copper concentrations as low as 1-2 μg/litre have been shown to have adverse effects on aquatic organisms; however, large variations due to species sensitivity and bioavailability must be considered in the interpretation and application of this information.

Lead

Galena is by far the most important source of primary lead. It occurs mostly in deposits associated with other minerals, particularly those containing zinc. The uptake and accumulation of lead by aquatic organisms from water and sediment are influenced by various environmental factors such as temperature, salinity, and pH, as well as humic and alginic acid content. In

contaminated aquatic systems, almost all of the lead is tightly bound to sediment. The lead uptake by fish reaches equilibrium only after a number of weeks of exposure. Lead is accumulated mostly in gill, liver, kidney, and bone. Fish eggs show increasing lead levels with increased exposure concentration, and there are indications that lead is present on the egg surface but not accumulated in the embryo.

Potential Effects: Young stages of fish are more susceptible to lead than adults or eggs. Typical symptoms of lead toxicity include spinal deformity and blackening of the caudal region. The feeding ability of fish was affected with severe spinal curvature.16 Avoidance behavior of fish occur at lead concentrations of 10-100 mg/litre. Juvenile stages are generally more sensitive than adults, but eggs are often less sensitive because lead is adsorbed onto the egg surface and excluded from the embryo.

5.3 EFFECTS CHARACTERIZATION AND SIGNIFICANCE DETERMINATION

5.3.1 Construction/Use of Surface Infrastructure

5.3.1.1 Use of Waste Rock in the Construction of Keno City Bypass Haul Road, Flame and Moth Mill Site Access Road and Other Road Upgrades; the Use of Waste Rock

Waste rock will be classified by a project geologist prior to each blast while advancing underground. The rock will be segregated based on the classification it receives and then stored in one of three piles (see Waste Rock Management). The waste rock that is determined to be net neutral or non-acid/metal leaching ("non-AML") rock will then be used for road construction. There is a potential for anomalies to occur despite the extent of planning in place related to waste rock management. Waste rock removed from underground and used for road construction will be exposed to weathering. Any AML waste rock that inadvertently gets used for road construction has the potential to leach metals into the aquatic environment and add to metal loading in the Lightning Creek/Christal Creek watersheds. Metal leaching into the aquatic environment as a result of road construction would be considered significant and adverse.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Waste Rock Management Plan
- DFO Operational Statements Adhered to (*i.e.* Culvert maintenance)
- Use of existing roads, trails and disturbed areas where practical. Non-AML rock type for road use

After consideration of the proponent's mitigations and existing legislation I feel that there are significant adverse residual effects. I have determined that further mitigation is required to ensure that the project does not result in significant adverse effects as it relates to the use of waste rock for the construction of mine infrastructure:

Recommended Mitigation

All road construction and upgrades that utilize non-AML waste rock shall be done in accordance with project-specific developed quality assurance and quality control practices (*i.e.* periodic screening and sampling of waste rock used for road material) that govern the project's waste rock management plan and in a manner conducive to monitoring run-off as per the Adaptive Management Plan.

- Run-off in areas utilizing non-AML waste rock shall be monitored.
- Monitoring of these areas must be added to the Adaptive Management Plan

Rationale: While non-AML waste rock may be used for construction purposes it ultimately represents long-term if not permanent waste rock dumps. Construction and resulting placement of this material may not provide effective monitoring efforts to ensure that the material is in fact non-AML waste rock. Design options to help contain this waste, promote effective QA/QC practices and improve monitoring include: installation of a geotechnical liner, where appropriate, prior to waste rock being place ; and construction of drainage ditches along either side of new roadways to collect run-off.

With the implementation of these additional mitigations, residual effects related to the construction and upgrade of surface infrastructures are considered to be not significant.

5.3.2 Construction of Lightning Creek Bridge

Fisheries investigations were conducted in 1994/1995 (Sparling and Connor 1996), 2006 (Sparling 2006) and in 2008 by Access Consulting Group in waters influenced by mining near the Keno Hill property. These investigations confirmed the presence of slimy sculpins (Cottus cognatus), Arctic grayling (Thymallus arcticus), and round whitefish (*Propopium cylindraceum*) in Lightning Creek. Arctic grayling are spring spawners and are identified as species of importance for First Nations and sport fisheries.

Section 32 of the *Fisheries Act* prohibits the destruction of fish by means other than fishing (unless authorized by the minister). Under the *Fisheries Act*, adult and juvenile fish, embryos, and eggs are all protected. Although Section 32 of the Act applies to all fish species, the mortality of individuals of a managed stock (*i.e.* a stock that has a fishery) or species of conservation concern are of highest priority.

Construction and decommissioning of the Lightning Creek bridge can potentially cause fish mortalities, degradation of water quality, and the loss or alteration of instream habitat quality and quantity. The temporary disruption of stream flow during the construction and decommissioning of the bridge has the greatest potential to cause fish mortality. Water flow can be disrupted during the isolation of an instream work area by the installation of dams without provision for bypassing and maintaining continuous water flow. Flows may also be disrupted by the dewatering of stream portions that may occur during pumping or fluming. Even the short-term disruption of stream flows can strand fish, isolate fish in pools, increase downstream water temperatures, stress developing fish eggs and/or macroinvertebrates (food organisms available to fish), and inhibit fish migration.

Potential effects of reduced water quality on fish may include decreased feeding success, reduced ability to see and avoid predators, slower growth rates, lowered resistance to disease, impaired development of embryos, or direct mortality. Degraded water quality may also interfere with development of macroinvertebrates and other aquatic organisms that fish are dependent upon for food.

Clearing of riparian vegetation during bridge installation and operation phases can also adversely affect fish by reducing available cover from predators, temperature regulating shade and allochthonous nutrient inputs to the stream that come from insect and litter drop. The destabilized stream banks can result in increased erosion and the potential introduction of suspended sediments into the watercourse. In addition, erosion in cleared upland areas can also lead to instream sediment deposition and modify both the availability and suitability of habitat by altering stream morphology. This may affect the benthic community and/or developing fish embryos, as well as reduce the habitat available for juvenile, overwintering fish and other aquatic organisms.

In consideration of the earlier sections on effects pathways and contaminants of concern, the potential effects to aquatic resources, following the proponent's proposed mitigations, are considered to be significant and adverse.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Freshwater intakes will be screened as per DFO "*Freshwater Intake End-of-Pipe Fish Screen Guideline"* (DFO, 1995);
- Riparian area along watercourses will not be disturbed
- No drilling will be undertaken within 30 meters of a fish-bearing stream. DFO will be consulted on a case-by-case basis if questions arise regarding exploration activity near a stream

- Hazardous materials stored away from watercourses in a controlled area

Recommended Mitigation

The key Best Management Practices ("BMP") that will be implemented to protect fish and fish habitat when constructing the Lightening Creek clear span bridge include:

- Minimize the riparian area temporarily disturbed by access activities along the adjacent upland property. Use existing trails, roads, or cut lines wherever possible to avoid disturbance to the riparian vegetation.
- Avoid building on meander bends, braided streams, alluvial fans, active flood plains, or any other area that is inherently unstable and may result in the alteration of natural steam functions or erosion and scouring of the bridge structure
- Removal of select plants within the road right-of-way (ROW) may be required to meet operational and/or safety concerns for the crossing structure and the approaches. This removal should be kept to a minimum and within the road right-of-way. When practicable, prune or top the vegetation instead of uprooting.
    - Trees will be felled away from watercourses to reduce damage to stream banks and beds. To maintain bank stability, trees within 10 m of watercourses will be close cut and stumps left in place except along the trench line.
- Ensure that the clear span bridge is properly designed to address river and channel processes at flows above the ordinary high water mark.
- Design and construct approaches so that they are perpendicular to the watercourse to minimize loss or disturbance to riparian vegetation.
- Design the bridge so that stormwater runoff from the bridge deck, side slopes and approaches is directed into a retention pond or vegetated area to remove suspended solids, dissipate velocity and prevent sediment and other deleterious substances from entering the watercourse.
- Generally there are no restrictions on timing for the construction of clear-span structures as they do not involve in-water work. However, if there are any activities with the potential to disrupt sensitive fish life stages (*e.g.* crossing of watercourse by machinery), these shall adhere to the timing window outlined above.
    - Machinery fording the watercourse to bring equipment required for construction to the opposite side is limited to a one-time event (over and back) and should occur only if an existing crossing at another location is not available or practical to use.
    - To exercise this option, the stream bed at the fording site must be comprised of stable gravel or bedrock and the stream banks must be low and stable.

- If minor rutting is likely to occur, stream bank and bed protection methods (*e.g.* swamp mats, pads) shall be used provided they do not constrict flows or block fish passage.
- Grading of the stream banks for the approaches shall not occur.
- If the stream bed and banks are steep and highly erodible (*e.g.* dominated by organic materials and silts) and erosion and degradation are likely to occur as a result of equipment fording, then a temporary crossing structure or other practice shall be used to protect these areas.
- Time the one-time fording to prevent disruption to sensitive fish life stages by adhering to appropriate fisheries timing window.
- Fording shall occur under low flow conditions and not when flows are elevated due to local rain events or seasonal flooding.

- Install effective sediment and erosion control measures, such as silt fencing, temporary diversion berms, clear crush check dams or straw bales, before starting work to prevent the entry of sediment into the watercourse. Inspect them regularly during the course of construction and make all necessary repairs if any damage occurs.
  - Work that will disturb soils shall be stopped during periods of high precipitation if it is likely to lead to sediment deposition into Lightening Creek.
- Operate machinery on land (above the ordinary high water mark) and in a manner that minimizes disturbance to the banks of the watercourse.
  - Minimize grading on steep watercourse approach slopes. Use approved access where available to limit equipment and vehicle traffic on steep approaches.
  - Machinery is to arrive on site in a clean condition and is to be maintained free of fluid leaks, invasive species and noxious weeds.
  - Wash, refuel and service machinery and store fuel and other materials for the machinery at least 15m away from top-of-bank to prevent any deleterious substance from entering the water.
  - Keep an emergency spill kit on site in case of fluid leaks or spills from machinery.
  - Restore banks to original condition if any disturbance occurs.
- Use measures to prevent deleterious substances such as new concrete (*i.e.* it is pre-cast, cured and dried before use near the watercourse), grout, paint, ditch sediment and preservatives from entering the watercourse.
- No debris shall remain within the high-water mark or placed into a stream.
- Stabilize any waste materials removed from the work site to prevent them from entering the watercourse. This could include covering spoil piles with biodegradable mats or tarps, berms or planting them with preferably native grass or shrubs.

- Vegetate any disturbed areas by planting and seeding with native trees, shrubs or grasses and cover such areas with mulch to prevent erosion and to help seeds germinate. All seeding and/or planting trees shall follow the DFO guidance on Riparian Revegetation. If there is insufficient time remaining in the growing season, the site shall be stabilized (*e.g.* cover exposed areas with erosion control blankets to keep the soil in place and prevent erosion) and vegetated the following spring.
    - Maintain effective sediment and erosion control measures until re-vegetation of disturbed areas is achieved.
- Instream turbidity levels and sediment control measures shall be monitored during construction and following major storm events.

Rationale: These are standard measures used to mitigate the effects of direct fish mortalities, elevated turbidity and sedimentation resulting from construction and decommissioning of vehicle crossings.

With the implementation of these additional mitigations, residual effects of constructing and operating the Lightning Creek bridge on aquatic resources are considered to be not significant.

5.3.3 Water Use/Management

5.3.3.1 Direct Use of Water

The physical act of removing water from a waterbody via pump, as in the case for water withdrawals associated with drilling, underground exploration and water treatment, has the potential to cause death or injury to fish if they come into contact with an operating pump. Individual fish may become entrained or entrapped. Also the removal of water may result in a reduction in suitable habitat.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- All water withdrawals from stream reaches designated as fish streams must be screened to prevent the entrainment and/or entrapment of fish.

Rationale: This is a standard measure that effectively deals with this effect. It is intended to complement the more specific recommendation made by the Department of Fisheries and Oceans.

Implementation of the mitigation measures proposed by the proponent will prevent the entrainment and stranding of fish during construction and operation of the project, thus reducing the likelihood of the project resulting in significant adverse effects.

5.3.3.2 Operation of Flame and Moth Mill and Bellekeno Mine Site Waste Water Treatment Facilities and Related Infrastructure; Further Baseline Information Required in Upper Christal Creek and Christal Lake

The Flame and Moth Mill treatment pond will discharge into Christal Creek and baseline information is necessary at sites upstream and downstream of the effluent discharge point to evaluate potential effects from the project. Monitoring stations KV-50 and KV-51 are currently being monitored under the Water Licence QZ06-074. A new monitoring station is required, depending on the location of the effluent discharge point, to ensure that locations both upstream and downstream of the discharge are monitored. It will be important to begin baseline characterization of this new monitoring location as soon as possible and prior to effluent discharge into the creek.

Christal Lake is the receiving water for a number of potential contaminant sources associated with the project, including the Flame and Moth Mill Site, but the lake it is not currently being sampled under a Water Licence. A sampling program must be initiated on the lake to monitor water and sediment quality. Two monitoring stations, one at each end of the lake must be sampled. This will address the issue, raised throughout the comment period that the Flame and Moth mill will be discharging to a previously affected water body. Information submitted during the assessment indicates that Christal Lake may have been poisoned with toxaphene in the 1960's.. The establishment of baseline (pre-mill) water, sediment, phytoplankton and zooplankton data will enable potential effects from the mill to be separated from pre-existing contamination (*e.g.* concentrations of zinc, cadmium, lead in Christal Creek and Lake). In addition, site water quality modeling and a site water balance can then be performed to predict Christal Creek and Christal Lake receiving water quality from the resulting discharges. The effect of discharging Mill/DSTF effluent into the receiving waters of Christal Creek, without first predicting and understanding water quality conditions, could be significant and adverse.

Recommended Mitigation

Christal Creek

- Baseline data must be collected from a site at Christal Creek pre-project.
- Sample sediment and benthic invertebrates to characterize annual variation and the summer season during time of maximum biological activity.
- Methods shall follow the protocol used in the Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007 (Laberge 2008) and the BC Field Sampling Manual 2003.
- The Christal Creeksite shall be added to the monitoring program and the Adaptive Management Plan.

Christal Lake

- Conduct water quality monitoring including dissolved oxygen and temperature profiles , and toxaphene, sampled at spring overturn, mid-summer and fall.
- Conduct sediment sampling to characterize annual variation and the summer season during times of maximum biological activity (to be consistent with sediment sampling times at other stations).
- Sample phytoplankton (at spring overturn, mid-summer and fall) and zooplankton (one time in late summer).
- Methods must follow the protocol used in the Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007 where possible (Laberge 2008) and the BC Field Sampling Manual 2003.
- Sites shall be added to the monitoring program and the Adaptive Management Plan.

Rationale: Baseline and project-related data collection of these parameters are critical for understanding if water treatment infrastructure is successfully mitigating effects to aquatic resources. It may also aid in the monitoring of other project activities that could pose issues to these resources. The addition of the new monitoring site on Christal Creek will allow for the evaluation of potential effects due to the effluent discharge from the Flame and Moth Mill Site. Sampling on Christal Lake will allow for the evaluation of potential effects on the receiving environment due to effluents from a number of sources in the region, including the Flame and Moth Mill Site, historic tailings from the Mackeno Mill Site, and the Galkeno adit.

These additional mitigations are necessary to establish baseline conditions, provide ongoing monitoring, detect changes and adjust operations as required. Residual effects of the project on surface waters are considered not significant or adverse.

5.3.3.3 Operation of Flame and Moth Mill and Bellekeno Mine Site Waste Water Treatment Facilities and Related Infrastructure; Deposit of Waste Water into Receiving Environment

Effective waste water treatment infrastructure is essential to maintain water quality and discharge levels. Periodic slumping of dams in combination with being near maximum volume capacity has the potential to induce stress fractures along the borders. Based on successional placement of dams in a treatment system, a single breach in a dam could result in a chain reaction of dam failures. Any such breach could result in a surge of untreated water into Thunder Gulch/Lightning Creek or Christal Creek Drainage posing issues of erosion, sedimentation and contamination (*i.e.* TSS, metals, ammonia, etc.) downstream. Failure to operate and/or maintain the facility properly may lead to accidents and/or infrastructure malfunctions which could potentially release high sediment loads (*e.g.* clay, sand, silt, and organic and inorganic matter) and associated contaminants. Sediment loading activities such as a dam breach can impact benthic invertebrate and fish by:

a) altering water chemistry (*e.g.* increased turbidity can increase temperature and reduce oxygen content)
b) altering productivity (*e.g.* changes to types and numbers of invertebrate life, a food source for many kinds of fish);
c) causing effects to fish reproduction through:
    i. alterations to oxygen levels which are important to viability of eggs and young fish; and,
    ii. creating a physical barrier (*e.g.* silt layer) that removes spawning or rearing habitat availability.

The project proposes to discharge treated waste water from the mill pad, DSTF at the Flame and Moth Mill Site and from underground at Bellekeno East and the existing Bellekeno 625 adit to surface waters. Effluent facilities has the potential to degrade downstream water quality to a level that may have acute or chronic negative effects on aquatic life. Increased flow, during periods of high surface runoff, may reduce optimization of the system. Non-compliant discharge from the Flame and Moth Mill or the Bellekeno treatment facilities, regardless of operation procedures, maintenance, accidents and or malfunction will result in the alteration to receiving watercourses. Duration of exceedance and exceedance concentrations are key factors. Mobility and bioavailability of minerals and metals in aquatic environments (*e.g.* water, sediment) can be enhanced or conversely eliminated based upon parameter concentrations in existing upstream or downstream waters. These parameters include, but are not limited to, pH, temperature, total particulate matter, and water hardness. In the case of a dam breaching there would be a sudden and drastic increase of total particulate matter, consisting of metal, ammonia and contaminant-laden sediment entering the watercourse.

Dewatering of the existing mine workings is complete and the mine is currently being pumped out at a constant rate equivalent to the Bellekeno 625 adit flow. Environment Canada reports that

- Adit water use activities will be controlled to ensure capacity of water treatment facilities and discharge requirements are met.

A site visit by John Miller EPOD on May 21, 2009 to the Bellekeno water treatment pond revealed that there were difficulties treating the settling pond decant (*i.e.* via use of hay bales to control the settling pond discharges). Alexco has indicated that it has been having difficulties meeting total suspended solids ("TSS") standards and will be mitigating this issue through the use of strategic placement of sumps and pumping stations within the mine, to allow some settling of drill mud prior to pumping, and the installation of a clarifier, similar to the one added at Galkeno 300, at the treatment pond.

In consideration of the earlier sections on effects pathways and contaminants of concern, the effects to aquatic resources are considered to be significant and adverse.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Implementation of the Water and Wastewater Management Plans (Section 6.1 of the project proposal).
- Maintain and use existing water treatment system at Bellekeno 625. Construct new water treatment and retention infrastructure at Mill site in order to not release non compliant water. Settlement ponds will be used to settle out metals and sediment.
- Adit water use activities will be controlled to ensure capacity of water treatment facilities and discharge requirements are met.
- Adit water will be reused and recycled.
- Ensure physical and chemical stability of waste rock storage facilities by adhering to the physical inspection plan as submitted under Water Licence QZ07-078; and (Section 6.2.4.17 of the project proposal).
- Routine monitoring and inspection of all surface expressions of Bellekeno underground workings for early detection of subsidence and drainage changes.
- Undertake periodic de-sludging of settling ponds and disposal in existing sludge storage areas.
- Conduct routine receiving water quality sampling in accordance with monitoring programs (Section 6 and 7 of the project proposal) to inform mitigation measures and control metal levels.
- Implementation of adaptive management plans and contingency measures for water treatment system operations as required ensuring continued system operations including for discharge water exceeding applicable criteria.
- Where possible, undertake clean up of old Mackeno tailings (planning developed under Existing State of Mine Closure Plan).
- Conduct routine physical inspections and water quality and flow monitoring at Bellekeno mine workings to ensure physical stability and chemical stability.
- In order to further increase the robustness of the Bellekeno 625 treatment system, a clarifier similar to the one added at Galkeno 300 will be implemented/used.
- Waste and water management plans will be implemented to mitigate environmental effects.
- An environmental monitoring plan will be implemented to monitor effectiveness of mitigation measures.
- An Adaptive Management Plan will be implemented to provide for contingency measures and responses.

Recommended Mitigation

- Conduct benthic invertebrate and fisheries sampling/monitoring of populations in Christal Creek, Flat Creek, South McQuesten River and Lightning Creek to confirm species presence and diversity over time throughout the liof project (annual sampling).
- The proponent shall continue to develop and modify sampling and analysis procedures to characterize contaminant levels in treated effluent as part of the Adaptive Management Plan.
- Quarterly sampling shall continue at KV-37 (Lightning Creek u/s of Hope Gulch), KV-39 (Hope Gulch u/s of Lightning Creek) and KV-40 (Charity Gulch u/s of Lightning Creek) for flow, conductivity, pH, temperature, total and dissolved metals. These sites are relevant to activities at the mine.
- Water samples from treatment facilities at a minimum shall be collected end-of-pipe in addition to any additional sampling points required as per the Adaptive Management Plan. Record and provide to the appropriate regulator the following information:
  - Water flow rate measurements from mill pad and DSTF at Flame and Moth Mill;
  - Water flow rate measurements from treatment pond at Flame and Moth Mill;
  - Water flow rate measurements from Bellekeno East adit during underground development;
  - Water flow rate measurements of discharge from Bellekeno East settling pond either directly to Thunder Gulch or Bellekeno 625 treatment pond;
  - Water flow rate measurements from Bellekeno 625 adit;
  - Water flow rate measurements from Bellekeno 625 treatment pond; and
  - Water flow rate measurements of water extracted from upper Christal Creek to the Flame and Moth Mill Site.

Rationale: Project-related data collection of these parameters is critical to understand if water treatment infrastructure is successfully mitigating effects to aquatic resources. Flow measurements will allow mass balance determinations of contaminant contributions to Lightning Creek and Christal Creek. It may also aid in the monitoring of other project activities that could pose issues to these resources. Keeping KV-37, KV-39 and KV-40 will allow for the evaluation of additional sources of contamination to Lightning Creek (i.e. Keno Adit) and assess the relative effect from Bellekeno.

The location for achieving the site specific water quality shall be determined by the appropriate regulator and based in part on consideration of:

- Point in receiving waters where significant fish habitat values exist as defined by the Department of Fisheries and Oceans; and

- Initial dilution and mixing zones as defined by the appropriate regulator.

Rationale: In addition to establishing an objective is the inherent task of defining where exactly that objective is to be met within the ecosystem. This requires an understanding of where significant fish habitat values exist in the system as well as the initial dilution and mixing zones.

- Construct and/or maintain water treatment and retention infrastructure so that non-compliant water is not released into the environment.
- Settling ponds shall have a freeboard of no less than 0.4 m to prevent risk of overtopping.
- Settling ponds shall have a high level discharge (i.e. spillway) to prevent destructive overtopping in the event of high water volumes.
- Ensure that all settling ponds are lined and monitored to prevent release of non-compliant water through ground.

Rationale: The purpose of settling ponds and the treatment facilities is to mitigate the effects of dewatering activities to aquatic resources in consideration of variable environmental conditions. Any oversights in the design and construction of this infrastructure could compromise this purpose. These measures ensure the use of appropriate design targets so that this infrastructure will fulfill its purpose.

- Sludge from settling ponds at the Flame and Moth Mill and Bellekeno 625 and sediment collected in Bellekeno East settling ponds shall be removed and transported to Valley Tailings Area at the existing sludge storage area. Sludge resulting from Bellekeno mine operations will be stored in a separate paddy cell located in the valley tailings in order to keep liabilities separate.

Rationale: This measure ensures that sludge, which may contain high concentrations of metals and ammonia, will be managed properly.

The additional mitigations outlined above enable the assessment of treatment pond effluent on aquatic resources in Thunder Gulch, Lightning Creek and Christal Creek, and the adjustment of operations as required to reduce the effects of the project on surface waters. The residual effects are considered not significant or adverse.

5.3.3.4 Operation of Flame and Moth Mill and Bellekeno Mine Site Waste Water Treatment Facilities and Related Infrastructure; Proposed Effluent Limits

The original proposed effluent limits cite the effluent discharge standards from the Metal Mining Effluent Regulations (MMER), which are much higher than CCME guidelines, and propose that these be reflected in the water licence for the Bellekeno Mine. The CCME represents the national

standard for water quality parameters with respect to the use of water and is intended to preserve the quality of the environment. Therefore, unless otherwise specified, it is reasonable to use it as the accepted water quality objective for this site. Concentrations of zinc, cadmium, lead, arsenic and ammonia associated with the Flame and Moth Mill water treatment facilities, Bellekeno East, and being discharged from the Bellekeno 625 water treatment facility shall endeavour to meet the CCME Canadian Water Quality Guidelines for the Protection of Aquatic Life, as the acceptable site-specific water quality objective.

In consideration of site-specific conditions, some of which may be naturally occurring and others which are historical, it is reasonable to assert that at a minimum, water quality should be no worse than what is already naturally occurring upstream of the site; this assumes that care and maintenance activities are being properly implemented as per the corresponding Water Licence (QZ06-074/QZ07-078).

The MMER standards allow for grab samples to have contaminant concentrations that are double those authorized in the current Water Licence for the Keno Hill property (QZ07-078) and are likely to result in greater effects on receiving aquatic environments (also raised in the SVI period). The proponent has now agreed to operate according to the current Water Licence conditions (QZ07-078) and the residual effects on aquatic resources are considered to be not significant.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Abide by current water quality discharge standards under existing water licenses (QZ06-074 and QZ07-078) rather than the limits under MMER.

Rationale: Given the purposes of this project it seems reasonable to utilize the standards outlined in the water licence with the ultimate goal being to achieve effluent water quality that approaches the CCME guidelines as opposed to a higher, perhaps more arbitrary objective.

5.3.3.5 Groundwater Resources

Groundwater resources are required for mine operations (*e.g.* water extraction) and groundwater resources may be affected by contaminant seepage from the DSTF or from seepage from contaminated surface water. Groundwater quality and quantity may be affected by the mine operations. Local concerns have been raised about the risk of contamination of the Keno City municipal well and the impact of water withdrawals on groundwater quantity available to the residents of Keno City. Issues raised in the comment period included:

- Contamination of Keno City groundwater source from project workings

- Source of Keno City groundwater and project groundwater
- Groundwater contamination/loading at the site
- Groundwater flow directions and quantity

Most of these issues have been addressed by the proponent and the major issues of cross-contamination and water supply were addressed by the proponent's submissions to YESAB as summarized below. Mitigation steps described below will help address remaining concerns regarding groundwater at the site.

The desktop analysis that has been completed and included in the project proposal documents provides a basic conceptual hydrogeologic model of groundwater distribution at the site relative to the Keno City well. Although there are no historical baseline groundwater data and there remain some uncertainties of the surface water – groundwater interactions in the area, the report indicates that the potential impact on water supply in the groundwater well in Keno City is negligible (<1.65% of annual flow leaving Christal Lake to Christal Creek).

Based on these findings, the effects on Keno City's groundwater resources is not significant both for contamination risk and on groundwater supply. However, groundwater conditions (quantity and quality) must be monitored during the operational phase of the project to support these predictions.

Consideration of Proponent's Mitigation

The proponent proposed the following measure to help mitigate effects:

- Groundwater monitoring wells will be installed within the vicinity of the Flame and Moth Mill Site.

However further mitigation related to groundwater is required, including qualifying what information is collected.

Recommended Mitigation

Groundwater information is needed to quantitatively assess the available groundwater resources (*e.g.* quantity and quality) at the site, to identify flow directions and rates, and to identify any existing contaminant levels of groundwater resources. Monitoring wells shall be established at the site near the DSTF at Flame and Moth site, near the potential AML storage facility, and at the Christal Lake site.

It will be necessary to begin, as soon as feasible (but prior to project construction and operation), baseline characterization of any groundwater resources that will be affected by the project site. This would include an evaluation of:

- Groundwater quality and quantity in the area,
- Groundwater flow rates and directions

Additional on-going monitoring during operations will be required to determine:

- The effects of operations on groundwater resources in the area

Since historical baseline groundwater data are limited, establishing an on-going groundwater monitoring strategy, which is scoped with on-going surface water monitoring programs, is required to assess overall project effects on local groundwater resources. This detailed information on current groundwater conditions will inform the final decisions on post-closure remediation activities at the site's adits. As a result of these mitigations, the residual effects of the project on groundwater water quality are considered not significant.

5.3.3.6 Flame and Moth Mill Treatment Pond

The location of the mill pond at Christal Lake, effluent drainage and contaminant loading into the Lightning Creek watershed was raised as a major issue, particularly for the First Nation of Nacho Nyak Dun (NND). The proponent changed the proposed location of the Treatment Pond in response to stakeholders' complaints regarding locating the pond at Christal Lake. Although a change in the pond location at a late date was raised as an issue (for proper adequacy review), the proponent indicated all guidelines and mitigations included in the original application for the Christal Lake site could be applied to the Flame and Moth site.

With respect to effluent discharge, the proponent provided information regarding the expected drainage distribution from the Treatment Pond, indicating drainage will be directed into the Christal Creek watershed.

Information was also provided on the flood frequency and volume expected for the drainage area of the pond site. This information is adequate to address expected flood flows at the site both during the operations phase and post-closure and is used as design criteria of the Treatment Pond.

Effluent drainage from the Flame and Moth treatment pond is expected to drain to Christal Lake, post treatment. The route and method used to drain the pond are important to the stability of the slope below the pond and for controlling the distribution of mine waste waters. Proper control of the pond effluent is important to the water quality of the Christal Creek watersheds.

With uncontrolled or non-mitigated drainage from the pond, the slope may fail, or hillslope erosion processes, accelerated by increased water erosion, may undermine the proposed pond infrastructure. Uncontrolled drainage may distribute contaminated discharge to unaffected areas. Currently there is no drainage plan for the pond at the Flame and Moth site.

Recommended Mitigation

- Design criteria and flow capacity for a channelized drainage system are required. Additionally, a flow control structure and monitoring program are required to demonstrate discharges from the pond are effectively managed, both during operations and post-closure.
- Design and installation of a channelized drainage system (*e.g.* pipe or stream channel) to drain the pond is required. Plans for the pond drainage system proposed at Christal Lake may be used to guide the implementation of a new system at the Flame and Moth site, however consideration for the differences in slope and distance to Upper Christal Lake must be included in the plan. The plan must be approved by a geotechnical engineer.

Rationale: Introducing uncontrolled flow to a hillslope may decrease the stability of the slope and promote chronic hillslope erosion of the slope. These processes will undermine the stability of the slope and therefore creates a potential risk of slope failure. Furthermore, controlled discharge of effluent is recommended.

Poorly designed infrastructure increases the risk of failure and therefore environmental damage. Design criteria must be clearly indicated such that mitigation measures can be effectively designed.

The additional mitigations outlined above will lower the risk of water erosion undermining the pond infrastructure. The residual effects are considered not significant.

5.3.3.7 Site Water Balance

Concerns raised in the comments period pertaining to the site water balance related to the lack of a complete water quantity balance for the site and a full characterization of the range of flow conditions at the site. The proponent has indicated the range of hydrologic conditions at the site (*e.g.* 'wet' and 'dry' year) will be reviewed in the Water License Application.

Total water uses, water sources, and discharges associated with the Bellenkeno Mine have been estimated by the proponent. However, there are high uncertainties with some of these estimates, some environmental baseline information specific to the site is lacking and a complete site water balance has not been provided in the application. Thus, there are still uncertainties regarding the performance of water management strategies during consecutive dry or wet years. Estimates of

water quantities at the site based on proxy data have provided rough estimates of surface water flow at the site. These estimates could be improved with site-specific data.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Continuous flow monitoring of all affected water courses at the site.

If the proposed water management strategies fail due to uncertainties in the water balance, effects could be significant and adverse.

Recommended Mitigation

- Complete water balance for the site must be developed and be continued throughout operations.
- Minimum and maximum flows for both wet and dry years must be annually re-assessed to assist planning the water extraction adaptive measures.

These additional mitigation measures will help complete an accurate and current water balance for the site and will provide a contextual understanding of the current hydrologic conditions at the site in light of concerns of the impacts of the mine and climate change raised by local stakeholders. The results of these additional mitigations will be considered in the overall project design for water management. As a result of the additional mitigations, the residual effects are considered not significant.

5.3.3.8 Climate Data

Concerns raised in the Comments period included the possible effects of climate change on site infrastructure and the proposed waste-rock disposal sites (*e.g.* melting of permafrost). The mitigations described below will help the proponent characterize climate variability at the site.

All climatic characterizations of the site have been based on regional climate data and trends that are as much as 20 years old. Climate data are important for the site water balance and to characterize the local working conditions. For instance, precipitation contributions to the area drive the site water balance and the periodicity of freezing temperatures during the year will impact the operations of the mine.

Consideration of Proponent's Mitigation

The proponent has not proposed additional climate data assessment. In light of the stakeholder's understanding and concerns of the potential effects of climate change and the potential effects of the mine operation, information is required to update the climate characterization for the site. As a result of changing climate conditions and the 20 year age of the data used in the assessment, the potential risks to the project and the environment are considered significant.

Recommended Mitigation

- Characterize the local climate conditions and climate variability with locally derived and recent climate data.
- Climate station monitoring must be maintained throughout mine operations. This information must be input to the water balance calculations for the site.

These measures will help complete an accurate and current water balance for the site and will provide a contextual understanding of the current climate conditions at the site in light of concerns of the impacts of the mine and climate change raised by local stakeholders. As a result of the additional mitigations, the residual effects are considered not significant.

5.3.4 Underground Quartz Exploration

5.3.4.1 Use of Explosives

Ammonia is a byproduct of using explosives to support underground exploration. This poses a potential for ammonia to become a contaminant of concern in water discharged from the site. According to the CCME: there is extensive "data available on the toxicity of ammonia to aquatic organisms, in particular acute, chronic and sub-lethal effects of ammonia in fish"; and the speciation of ammonia into ionized and un-ionized forms is influenced by pH and temperature and un-ionized ammonia is known to be more toxic due to the greater mobility of un-ionized ammonia through biological membranes. The correlation of these factors indicates that as pH and/or temperature increase, the percentage of un-ionized aqueous ammonia also increases. Considering the expected water temperature and pH (as per proposal Bellekeno 625 is "consistently alkaline… between 7 and 8") for receiving waters in proximity to the project, there is potential for concern related to contamination of water with un-ionized ammonia where extenuating conditions occur.

The CCME indicates that "aquatic community ecological risk criteria on the impact of ammonia at the community level of both invertebrates and fish indicated that 5% of the species in an aquatic community would exhibit a 20% reduction in growth, or reproduction at an un-ionized ammonia concentration of 0.041 mg/L-1. Based on this type of information the guideline for un-ionized ammonia for the protection of aquatic health has been set at 0.019 mg/L while the guideline for total ammonia is presented as a range of values dependent upon temperature and pH. The proponent has not estimated nitrogen concentrations in water discharged from

Bellekeno East. They are proposing an effluent limit of 5.0 mg/L for total ammonia as stipulated by WUL QZ07-078. This level, depending on the extent of un-ionized ammonia, has the potential to cause significance adverse effects to aquatic resources.

Recommended Mitigation

- Mitigations related to ammonia and its effects were outlined above in Water Use/Management.

Through the proper management of ammonia, as described above, the residual effects on aquatic resources are considered not significant.

5.3.5 Waste Rock Management

5.3.5.1 Categorizing and Segregation of Rock

The proponent proposes to use waste rock removed from Bellekeno East that has been determined to be non-AML for construction of the Flame and Mill Site access road, the Keno City bypass, general road upgrades and other locations where it is used as fill or construction material. Waste rock will be categorized and segregated for temporary storage as either mineralized, AML or non-AML rock. The proposal indicates that for every blast round of the adit excavation, the face material will be:

- Field screened using basic field tests (i.e. fizz test) and visual interpretations (i.e. estimating the percent face area of sphalerite, galena and pyrite); and
- Characterized geochemically using thresholds for calcium, sulphur, lead and zinc that identify reactive materials once per blast round.

The proposed approach is to determine if materials are reactive based on these field observations, inferences from past data sets, and predicted levels of zinc and lead concentrations and loading that may result from reactivity. Comments during this assessment indicated that there is a more conservative approach available that would focus instead on identifying thresholds that define non-reactive materials. Comments suggested: there is inherent subjectivity with the field screening and geochemical characterization; potential errors in the data set and inferences made; and categorizing rock only once every 3 m of excavation makes it possible for a high volume of AML material to not be categorized. These issues are relevant given the notion that roads using this material are essentially long-term, if not permanent, waste rock dumps.

In terms of acceptable practices, YG put forward a recommendation that "all potentially AML waste rock from underground exploration activities be placed into the Onek Pit". The proposed approach allows discretion to the extent that if "30% or more of the working face is deemed as AML, the geologist shall assign the given blast round as AML". This implies that anything lower could be categorized as non-AML. The proponent did note that this discretion could be dropped down to a 20% threshold. Either way, this field approach does not seem to correspond with the lower tolerance of the YG recommendation. The reliance on defining reactivity rather than non-reactivity increases the potential that waste rock used for road construction may contain AML material and cause significant adverse effects.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Specialized handling of potentially-AML rock in accordance with the Waste Rock Management Plan (Section 6.2)

As a result of the uncertainty of AML classification from the field screening tests, the risk of mis-classification and deposition of AML in a designated non-AML location is considered to be significant and adverse.

Recommended Mitigation

- Prepare a detailed quality assurance/quality control plan as part of the overall Waste Rock Management Plan that stipulates regular and frequent checks (including lab and field screening techniques) that will yield a high confidence for waste rock classifications. This might include the recording of information for all work related to:
  - Categorization of rock types from blast rounds including the results of field screens and geochemical characterizations;
  - Subsequent rock management:
    - Determination of non-AML, AML or mineralized rock;
    - Segregation, temporary storage location and relative volumes of rock types;
    - Long-term storage location and relative volumes of rock types (i.e. transport of bulk mineralized sample off property; location and volume of non-AML rock used for roads and AML rock brought to the Bellekeno Pit).Detailed field tracking procedures that describe origin (*i.e.* blast unit, mineable unit), transportation, destination and AML classification of all waste rock
- Provide all recorded information to the appropriate regulator.

Rationale: It is important for the regulator to understand how information was collected and used to inform decision-making related to rock management. It is also very important to

understand exactly what rock types, within the range of potential geochemical properties for this site, went where and in what volume. This information is intended to complement the adaptive management plan and allow for efficient responses to any issues.

- Test and establish a more conservative approach for categorizing and segregating rock that is focused on determining non-reactivity.

Rationale: The intention of this measure is to apply a pre-cautionary approach to categorizing rock so that there is greater confidence that waste rock used for road construction and upgrades is non-AML instead of waste rock that is potentially AML (i.e. up to 30% of the face having potential reactivity). Nacho Nyak Dun suggested the following thresholds for non-reactive material: "leachate extraction testing showing lead loading of 1mg/kg or less or zinc loading of 3mg/kg or less" and "metal leaching… from materials that have lead contents lower than 3000ppm." This approach, combined with the record keeping above, also alleviates concerns about the proponent making this determination in isolation rather than a 3rd party as has been suggested.

- Upon initiating this project, the relationship between field observations (i.e. tests and geochemical characterization) and the proposed calcium, sulphur, lead and zinc thresholds shall be continuously confirmed by sampling and laboratory analysis of rock. The results of laboratory analysis shall either confirm thresholds and the rock categorization and segregation approach or require adjustment.

Rationale: Given some of the inherent subjectivity and error associated with field testing and geochemical characterization, it is important to also conduct proper lab analysis to either confirm or adjust what is done in the field.

The additional mitigations, including a more detailed QA/QC control plan and a more conservative approach for categorizing and segregating rock, will reduce the potential for AML rock to be used in construction or stored in the non-AML waste rock storage area.

With the implementation of these additional AML classification and management procedures, the residual effects are considered not significant.

5.3.5.2 Temporary Conditional Waste Rock Classification Area

The proposed conditional waste rock classification platform is up-gradient of Thunder Gulch near the Bellekeno East portal location. All material from underground will be sorted and stored temporarily at the classification area. Temporary storage of exposed waste rock, some of which may be AML if not highly mineralized, in proximity to a water course may result in leaching of

metals into that watercourse. Any metal leaching into a watercourse at this site that compounds metal loading and is preventable would be considered significant and adverse.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Bulk sample material and AML waste rock shall not be stored within 30 m of any watercourse.

Recommended Mitigation

- The Temporary Conditional Waste Rock Classification Platform area shall have lined pads that are sloped in order to facilitate gravity drainage and collection of runoff water. Drainage that is collected shall either be:
  - Contained until analysis shows that it is within an acceptable standard for release; or
  - Sent to the Bellekeno 625 water treatment facility.
- Bulk sample material must be covered to the extent practical to reduce contact with precipitation.
- Bulk sample shall not be stored at the temporary facility for more than 6 months following removal from the excavation, unless a complete characterization and classification that demonstrates it to be non-AML rock is conducted.

These measures will reduce the potential that highly mineralized materials will pose a risk to aquatic resources. The residual effects are considered not significant.

5.3.5.3 AML Waste Rock Storage Area – Bellekeno East

Waste rock from Bellekeno East underground workings and upgrades to Bellekeno underground workings with the potential for acid/metal leaching (AML) can release metals into surface or groundwater unless properly stored and contained. The proponent has proposed constructing a new Potentially-AML waste rock facility near the Bellekeno East portal for permanent AML waste rock storage.

The key to the success of the storage of AML waste rock will be the isolation of this rock from ingress of precipitation, surface runoff and groundwater in addition to elimination of any hydraulic connections away from the pit. The potential exists for AML waste rock stored in the Bellekeno Pit to contribute metal loading effluent to Thunder Gulch. Currently, approximately 105,000 tonnes is anticipated to be stored permanently at this location with use of a fine-grained soil cover. The lack of design information for the cover and placing one-half metre of compacted

material having a permeability of 10^{-3} m/s is generally not sufficient to adequately reduce infiltration of precipitation. The proposal lacks sufficient detail with respect to the storage and capping of AML waste rock to give confidence that AML impacted leachate will not be generated nor enter the Thunder Gulch drainage. This is a concern both during placement of the AML material before capping and after installation of the cap on the waste rock pile. Additional untreated AML impacted runoff would have a significant adverse effect on the management of Thunder Gulch.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- specialized handling of potentially-AML rock in accordance with the Waste Rock management Plan (Section 6.2)
- typical waste facility design outlined in Volume 2 Appendix D

As a result of the proposed mitigations, there remains a risk of AML-related releases to the environment which are considered significant and adverse. Additional mitigation is required.

Recommended Mitigation

- Prior to any excavation of Bellekeno East, an engineered design with sufficient details of the waste rock cover is to be submitted by the proponent to the appropriate regulator for approval.

Rationale: Given the level of concern on this matter, this is a reasonable measure to ensure that an adequate cover is designed and approved prior to it being implemented.

- Place all potentially AML waste rock from underground exploration activities into Bellekeno Pit.
- Create berms to divert surface run-off around Pit to minimize exposure to water, potential ARD and the requirement for frequent removal of accumulated effluent.
- AML waste rock to be stored in a manner that eliminates exposure to air and water during placement, before capping and after capping.
- Store AML waste rock on impermeable liner with collection system to ensure that any non-compliant water draining from the waste rock may be properly treated prior to release to the receiving environment.
- Install a low permeable cover overtop AML waste rock at end of project to reduce/ eliminate water infiltration.

Rationale: This progression of measures will ensure that AML waste rock is appropriately isolated in relation to environmental factors that could accelerate AML issues (i.e. infiltration of water and air).

- Drainage from the waste rock placed in the Bellekeno Pit shall be contained until analysis shows that it is within an acceptable standard for release.
- Effluent from Bellekeno Pit shall be monitored to document any potential changes to water quality resulting from AML waste rock storage in the Bellekeno pit.

Rationale: With AML waste rock appropriately isolated as per the previous measures, these conditions ensure that drainage from the pile is also isolated and contained prior to release so that effects to downstream water quality may be managed.

- Location of the Bellekeno Pit to be approved by a qualified geotechnical engineer.

The additional mitigations outlined above will reduce the potential effects of the AML waste rock storage area on aquatic resources. With the implementation of these additional measures, the residual effects are considered not significant.

5.3.5.4 Non-AML Waste Rock Storage

The proponent modeled soluble zinc, cadmium and lead loads expected to enter Lightning Creek from the non-AML waste rock storage area through ground water on an annual basis. Estimates are based on assumptions of moisture content in the waste rock, annual precipitation, leachable metals in the samples with characteristics of the waste rock, loading calculations based on dissolved metals, mean flows versus high and low flow conditions, and attenuation through the subsoils. Concerns were also raised through the comment period about the assumptions made in modeling the metal loads expected to reach the creek and that other contaminants (*i.e.* arsenic) have not been modeled. The non-AML waste rock storage relies on natural attenuation of run-off to reduce contaminant concentrations to acceptable levels prior to entering Lightning Creek. In addition, errors in waste rock segregation could result in potential-AML waste rock being stored in the facility. There is still an undesireable uncertainty regarding the degree of attenuation, the concentration of contaminants in surface and ground water escaping the storage facility and the volume of these water sources entering Lightning Creek. The additional loading of suspended solids or metal contamination into Lightning Creek would be significant and adverse.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Implement Waste Rock Management Plan (Section 6.2)

There remains a potential significant and adverse risk to the environment from the placement of waste rock. Additional mitigation will reduce this risk.

Recommended Mitigation

- Berms must be constructed to divert surface run-off generated outside the waste rock storage area around the facility and to contain surface run-off generated within the storage area.
- Surface water inside the berm will be collected in a sump, monitored and treated as necessary to meet water quality guidelines. Options for treating the effluent include the use of treatment ponds similar to the ones proposed for the Flame and Moth Mill Site and Bellekeno Mine Site or pumping the effluent to the nearby Bellekeno Mine site for treatment there. Management of the pond, including monitoring of untreated and treated water quality, flow rates and sediment removal will be as discussed above for the Flame and Moth Mill Site and Bellekeno Mine treatment ponds. Due to the level of uncertainty in the proposed waste rock storage plan, these measures are necessary to avoid a significant adverse effect on water quality in Lightning Creek.

Isolation, monitoring and treatment, as necessary, of drainage from the waste rock storage facility reduces the uncertainty surrounding potential contamination of Lightning Creek, fish and fish habitat. With the implementation of these additional mitigations, the residual effects associated with non-AML waste rock storage area are considered not significant.

5.3.6 Tailings Management

Approximately 50% of final flotation tailings will be stored on surface by dry stacking and 50% will be stored underground as waste backfill. High pyrite-rich tailings tailings stored underground must be kept below the groundwater surface to minimize the development of acidic waters.

The ground below the DSTF will be lined and diversion berms will direct seepage and surface flows generated outside the DSTF footprint around the facility and flows generated inside the facility to two lined collection sumps. The successful construction and function of the DSTF will depend on adequate design specifications and implementation of construction techniques (*e.g.* proper ground preparation to eliminate liner failure). Potential effects from run-off at the Flame and Moth Mill Site and DSTF on surface water quality have been addressed in the Water Use/Management section.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Diversion berms, collection sumps, treatment pond to control water quality.

Recommended Mitigation

- Measures that are addressed in the Water Use/Management section.
- Groundwater conditions downgradient of the DSTF must be characterized to help demonstrate that the liner has not failed. This might include the use of monitoring wells to measure changes in water levels, sample water quality and run recovery tests to help evaluate flow directions and velocities.
- Hydrostatic pressure of the underground adits used for waste backfill must be monitored for as long as possible to demonstrate complete saturation of the tailings backfill.
- Incorporate monitoring results into ongoing adaptive management of the mine operations and monitoring programs.

The additional mitigations outlined above, including monitoring of groundwater conditions and adit hydrostatic pressures will reduce the effects of tailings management on aquatic resources. With the implementation of the additional mitigation, the residual effects are considered not significant.

5.3.7 Reclamation and Closure

Alexco has developed, reviewed and approved under Mining Land Use Approval LQ00240 some elements of the Conceptual Decommissioning and Reclamation Plan for the Bellekeno mine (portal reclamation, mine access road, waste rock storage area) and security has been provided to cover the anticipated costs. The mine closure measures will be individually costed during the mine licensing stage of the review and approval of the Bellekeno Mine so that security can be posted to cover the anticipated liability. The final Detailed Decommissioning and Reclamation Plan (DDRP) for the Bellekeno Mine will be developed within two years of mine start up.

Concerns raised during the Comments period pertained to measures that will be implemented post-closure to monitor surface water quality, groundwater quality, and seepage from the DSTF. As there is limited empirical groundwater information for the site, concerns of the fate of possible contaminants in groundwater were expressed in light of the perception that the Keno City municipal well could be at risk. The proponent has provided a preliminary assessment of the groundwater regime at the site and estimates the risk of contamination to be negligible. However, because of the limited amount of groundwater information at the site the understanding of the

groundwater could be improved by establishing a monitoring program as addressed above Water Use/Management (section 5.1.2.3).

Recommended Mitigation

- A groundwater monitoring program must be initiated by the start of the mine operations. Information gained from this program will establish contemporary baseline conditions at the site and will assist with planning for post-closure groundwater quality monitoring. The Maintenance and Monitoring program proposed for surface water at the site must incorporate flow monitoring (for quantity and quality) at all treatment ponds.
- This plan must include maintenance of water diversion structures at all tailings stacks.

The additional mitigations outlined above will reduce the potential for residual effects related to mine reclamation and closure. The effects are considered not significant.

5.3.8 Adaptive Management Plan

Adaptive management plans (AMP) are an effective way of identifying and responding to potentially significant adverse effects that may arise due to unpredictable changes in the environmental and/or socio-economic context of the project. An AMP is intended to complement specific mitigations such that both the predictable significant effects and those that are unpredictable are satisfactorily anticipated and mitigated.

5.3.8.1 Change in Water Quality or Quantity

Effluent Thresholds

Thresholds for adit discharges require comparison of total cadmium load, zinc load or conductivity to the averages of the previous 24 months. Thresholds for adit or treated effluent discharge flows (increases or decreases) require comparison to the average of the previous 24 months in addition to a water quality threshold. This system is difficult to manage and is unlikely to identify gradual problematic trends as has been noted in comments through the Seeking Views stage of the assessment. Flows may have to increase much more than 2X in seasons of low flow in order to exceed average flows over the previous 24 months. Identification of problems in the treatment system will be delayed and could result in elevated contaminant concentrations or loadings reaching Thunder Gulch or Christal Creek. The effects of a delayed response could be significant and adverse.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Adaptive Management Plan (Section 7) including the comparison of adit and treated effluent metal concentrations and flows to previous 24 month averages

Recommended Mitigation

- Water quality triggers should either be closer to baseline levels (perhaps 50% above baseline but still substantially under criteria) or monitoring must be done more often to detect trends sooner
- Water discharge thresholds must be developed from seasonal baseline data with prescribed thresholds based on effects rather than using arbitrary 24 month averages.
- Results will be reported to the regulators.

The best management of operation processes and surface water quality will occur with early notification of trends and non-conformance in the system. Residual effects associated with the Plan are considered not significant.

5.4 CUMULATIVE EFFECTS ASSESSMENT

As per section 42 of YESAA, an assessment of cumulative effects shall consider the interaction of residual effects of the proposed project on Aquatic Resources with the residual effects of: projects for which proposals have been submitted for assessment under YESAA; and existing, or proposed activities that are known to the Designated Office. Interactions between residual effects of these activities combined may produce significant adverse cumulative effects.

5.4.1 Historical Context

The purpose of the historical context is to provide an understanding of baseline conditions for the project area and vicinity. Mining activities have occurred in this region for over a period of 100+ years. It also supports a small community with a residential area and tourism ventures. The resulting landscape and affected environmental conditions are the context in which the proposed project and its effects are considered in a cumulative effects assessment.

Written accounts of prospecting on the McQuesten River date back to 1886. Much of the gold on the Stewart bars probably came from the Keno Hill district, but its source eluded men for decades. In 1886 Howard Franklin and Henry Madison prospected the McQuesten River. Probably the first hardrock prospector in the Keno Hill district was Alex MacDonald, a New Brunswick Scotsman, who prospected the hills and named Mayo Lake in 1887. On February 23, 1913, Harry McWhorter staked the Silver King claim on this outcropping in the canyon and Jack Alverson staked the Webfoot claim to the northeast along strike, naming for the label bestowed on coastal Oregoninans.

Silver, lead and zinc have been mined at the Keno Hill since the early 1890's. The Keno Hill camp was considered to be Canada's second largest producer of silver. From 1914 to 1989, there was near continuous mining and milling at the Keno Hill property. Approximately 6.8 million kg (218 million ounces) of silver were produced from over 34 mine sites. Care and maintenance activities have been ongoing since 1989. Alexco Resources has been conducting advanced exploration and drilling activities since summer 2008.

5.4.2 Overview

The temporal scope for considering the proposed project and other existing or proposed activities is the approximately ten-year duration of this project. The spatial scope includes the Mayo River watershed in relation to work directly associated with the Bellekeno East adit and the South McQueston watershed in relation specifically to the storage of AML rock at the Onek Open Pit and sludge at the Valley Tailings Area. This is due to the fact that the receiving environment for activities associated with Bellekeno East starts at Thunder Gulch and flows downstream to Lightning Creek, Duncan Creek and eventually the Mayo River. The receiving environment for activities associated with the Onek Pit and Valley Tailings starts at Christal Creek and flows downstream to the South McQueston.

5.4.3 Proposals Submitted

The assessor is aware of the projects listed in Appendix 4 that have been submitted and assessed. The appendix provides a list of projects in the Keno area and a corresponding map for the purposes of this particular discussion.

5.4.4 Existing or Proposed Activities

The assessor is aware of the following activities:

- Placer mining has occurred and continues to occur in some of the same drainages as the proposed project. For example, we are aware that active placer claims and mining activity exists on Lightning Creek and Thunder Gulch, as well as Duncan and Christal Creeks.

- The area is surrounded by numerous quartz claim blocks not associated with the proposed project. A drilling exploration project is permitted and underway within the project area by the proponent and proposed to continue for ten years under this proposal. A 50 person camp is located at Flat Creek which is proposed to be increased to 100 people as part of this proposal. A mine closure planning exercise is underway for the site by the proponent.

- The Village of Keno includes a number of standard activities that are associated with small towns. For example, extraction of well water; deposit of waste; garbage management; traffic; roadwork and construction.

- The region is also used for tourism, fishing, hunting, trapping, berry picking and other recreational activities.

5.4.5 Residual Effect Characterization, Interaction and Determination of Significance

Placer mining activities generally affect water quality by increasing turbidity as will access roads and associated forestry if adequate buffers are not maintained. Improper waste and sewage management by those living in Keno may contribute to effects to water quality, including nutrient loading and contamination.

Background levels of metals are high in the drainages and watercourses on the property. It is important to recognize that historic activities and natural mineralization contribute to current conditions. Care and maintenance activities were initiated in 1989 when the mine was put into care and maintenance status. Since that time efforts have been made and short term actions taken to deal with deposit of deleterious substances into fish bearing waters from mine adit discharges. In November 2007 a care and maintenance licence to obtain water, divert water, store water and to deposit a waste for the purpose of care and maintenance activities for the Keno Hill Mines Property was issued to the proponent. Based on the proposed project, some of the care and maintenance activities will now be incorporated into the project during construction, operation and closure stages, where they will continue to treat mine effluent and other produced waters that are high in contaminants/metals. This will continue to reduce potential metal loading to receiving waters and the environment utilized by people and wildlife. As long as mitigations recommended in this report are accepted and implemented, the deposit of waste water associated with this project and potential AML, ammonia and sedimentation issues should have little interaction with the residual effects of other projects. It is the opinion of the assessor that this project will not contribute to significant cumulative effects to aquatic resources.

6.0 HEALTH AND SAFETY

Consideration of comments revealed concerns with how this project may affect the health and safety of residents, visitors and workers. This concern will be examined through the following specific topics:

- Noise
- Public Safety
- Worker Safety
- Camp Operations

6.1 NOISE

6.1.1 Overview

The mine and mill developments, and associated activities have the potential to produce noise above natural ambient levels. Ambient sound refers to sound in the outdoors or at locations removed from a noise source. This is in contrast to occupational noise within or adjacent to a work place. For the purposes of exploring the health effects of noise, this assessment will consider the local 'soundscape'. This references the combination of the current natural ambient levels of Keno and the occupational noise introduced by this project. Specific activities that represent the most significant occupational noise sources for this project are as noted below.

Point Sources:

- Temporary construction during dayshift (7am – 7pm):
  - Mill Building, Crusher and Dry Stack Tailings Facility (*e.g.* clearing).
  - Optimized bypass route near Keno (*e.g.* clearing, use of heavy machinery).
  - Water treatment infrastructure on the Flame and Moth site (*e.g.* use of heavy machinery).
  - Lightning Creek Bridge.
- Crushing operations on the Flame and Moth site (*e.g.* primary jaw and secondary cone crushers; screen, hopper and conveyor; loader) during dayshift.
- Milling infrastructure housed within the mill building on the Flame and Moth site (*e.g.* ball mill, pumps, reagent tanks, agitator, pumps, auxillary power generator) operates 24/7.
- Dry stack management at the Dry Stack Tailings Facility on the Flame and Moth site (*e.g.* wheel loader, dozer and soil compactor) during dayshift.
- Mine site operations at Bellekeno East and 625 (*e.g.* use of explosives; underground excavation and drilling; haulage of rock to temporary conditional waste rock classification area operates 24/7 with the exception of explosives and hauling rock/ore between the mine and mill.

Non-point Sources:

- Transportation:
  - Mobilization of equipment and supplies. Most likely during dayshift.
  - Movement of staff between Elsa, infrastructure at Flame and Moth and the mine site at Bellekeno East. Occurs 24/7 but particularly at shift changes (6-8am and 6-8pm).
  - Road maintenance during dayshift.
  - Haulage of non-AML waste rock for use in road construction; AML waste rock to Waste Rock Storage Facility at Bellekeno 625; ore from mine site to crusher; and tailings from mill building to Dry Stack Tailings Facility during dayshift.

These activities and the resulting sources of occupational noise will generally occur throughout four phases – mobilization, construction, operation and decommissioning/reclamation. The four phases will occur over an anticipated 10 year period, 5 of which are dedicated to actual operations. It is the operational phase during dayshift hours that presents the greatest likelihood for prolonged noise emissions.

It is important to consider the temporal context within which activities will occur. Noise emissions from the identified point and non-point sources will not be continuous or necessarily occur at the same time. For example, based on discussion with the proponent, there is not enough capacity in the fine ore bin for the crushing plant to run continuously for the 7am to 7pm period. Instead there will be a 5-10 minute peak noise level occurring 9 times daily during years 1-2 and 14 times daily during years 3-5. Aside from core mill infrastructure which will be running all the time, most activities will occur over a smaller period of time in comparison to the period of time within which they could occur. This is due to the disparity between the boundaries of a 12 hour shift and what is feasible based on production levels from the mine, crusher and mill.

6.1.2 Background Information

Sound Level, Spectra and Character

The human ear interprets sound in terms of the intensity of how many times greater one sound is to another. It is commonly measured in terms of the sound pressure level, or what is better known as the decibel (dB) range. This is represented by a logarithmic scale. It goes from 0 to 140dBA in relation to what a human ear can register. The 'A' added to dB refers to a common filter that corresponds to a frequency range recognized by the human ear. A 10dBA increase in sound represents a doubling of the sound intensity; this highlights the logarithmic nature of the scale. In order to provide further context for sound, the following dBAs provides some reference points for various sound pressure levels:

- 0 – threshold of hearing
- 20 – whisper
- 40 – quiet residential neighbourhood
- 60 – normal speech
- 80 – busy office
- 90 – lawnmower
- 100 – heavy city traffic
- 120 – rock concert
- 140 – gunshot or firecracker
- 160 – medium jet engine

Another factor for understanding sound is how it acts across a spectrum of frequencies. This ranges from 50 – 20,000 Hz. For example, equipment may exhibit different sound pressure levels at different operating frequencies. For the most part high frequency noises cause greater health effects than low frequency noises (Singal, S.P., 2000). This is an important consideration for this project as it involves a diverse set of equipment likely operating at a variety of frequencies.

Sound pressure level and spectra help to define the sound character, or the 'acoustical signature'. The most common sound character in industry is a 'discrete frequency noise'. It is known for pure tones and is generated mostly from rotating machinery (*e.g.* pumps, gears, internal combustion engines). The second most common sound character in industry is 'broadband noise'. It is known by a rumble, roar or hiss – for example, exhaust from a jet engine. The third most common is 'impulse noise', or impact noise. These are transient events of a short duration such as a gunshot, or intense repeat machinery. This project is associated mostly with discrete frequency and broadband noise. In terms of tones, the human ear and mind discern pure tones more easily than random white noise. Since heavy machinery often results in pure tones this characteristic is important to consider when determining the likelihood of effects.

Sound Propagation

Sound travels as energy represented by sound waves. Theoretically these waves are ruled by the 'inverse square law', meaning the energy in sound waves (and thus the sound intensity) will drop with the square of the distance to the sound source. For example, if you move 200m away from a D6 Dozer, the sound level will generally be a ¼ of what it is 100m away. However there are a number of environmental factors that make it difficult to accurately predict how sound will propagate over specific distances. Key factors include the following.

- Ground impedance (*e.g.* surface roughness, ground elasticity).
- Outdoor noise barriers (*e.g.* diffraction of sound by barriers, gaps).
- Effects of vegetation, trees and turbulence.
- Effects of local meteorology (*e.g.* prevailing wind speed, character and direction; temperature; humidity).

These factors need to be considered when attempting to predict the potential effects of occupational noise on ambient sound levels.

Combining Sounds

Sounds rarely act in isolation. The soundscape is a result of numerous sources of sound combining to be discerned by the human ear. Again theoretically, two identical sounds in close proximity will produce a sound level that is 3dB higher. Therefore if two D6 Dozers are operating close to one another, and each of them is emitting 90dB of noise, the combined noise would be 93dB.

Of course it is more likely that noise sources are diverse and emitting different levels. There is a theory governing this as well. As noted, two identical sounds will result in an additional 3dB of noise. This addition decreases in proportion to the difference in decibels between the two levels being added. So if one piece of equipment is emitting 90dB and another nearby 80dB, only 0.4dB would be added to the higher level. This proportion effectively ends when the difference is greater than 16dB. Therefore if the ambient noise of a community is 50dB but new occupational noise is 70dB, there is no additive quality to these two sources combining. Instead the new ambient noise will be raised to the higher level which in this scenario is 70dB.

Ambient Sound Levels

Ambient noise limits are evolving and vary by jurisdiction. In general terms, where ambient noise limits are in place, they relate to the sound level from a source as measured at the nearest sensitive receiver. This can be a nearby residence, school or business, or even the fence line of the facility. Typically these limits are defined as the equivalent continuous sound pressure level (Leq) at a receiver location. Variations in noise levels between day and night are important because background noise levels drop at night and individuals are generally more sensitive to noise during the night.

It should be noted that there are a number of natural sound sources, such as the creeks flowing adjacent to Keno that are part of the ambient sound level. Depending on the season, sound produced by these creeks will range from negligible during winter conditions, to loud during freshet.

In Alberta, the legislated ambient sound level for an industrial activity located in a rural location is 40dB at the property line and 56dBA in a townsite. No specific limits exist in British Columbia or Yukon for ambient sound, though most municipalities address the issue through nuisance control bylaws.

In a cross-section of states and municipalities in the United States, "specified maximum daytime construction noise levels range from 50 – 90dBA in residential areas with about 75dBA as an average. Construction nighttime noise limits range from 45 – 75dBA with an average of about 55 dBA" (Schexnayder, D.J. and J.J. Ernzen., 1999).

Noise Pollution

The 'sounds' we hear on a daily basis generally become 'noise' when they are too loud, unexpected, uncontrollable, have annoying pure tones, occur at undesirable times of the day and/or interrupt people's activities (Schexnayder, D.J). Generally a 5dB change is required before there is a perceptible change in the ambient sound level (Bell, L.H. 1994). Noise pollution tends to occur when the change from natural ambient conditions becomes disruptive to normal functioning. A survey of the Department of Transportation for 50 U.S. states found that

the greatest cause for complaint, specific to nighttime construction, was with back-up alarms (41%) (Schexnayder, D.J. and J.J. Ernzen., 1999). Coincidentally this is a safety feature common to large vehicles. It purposely produces an impulse noise in the range of 82 – 107dBA at a distance of 4'. Slamming tailgates (27%), milling (24%), earthmoving equipment (14%) and crushers (6%) rounded out the top noise generators that were a cause for complaint and therefore source noise pollution (Schexnayder, D.J.)

6.1.3 Effects Characterization and Significance Determination

Activities that create point or non-point sources of noise may result in the following effects to the health and safety of residents, visitors and workers: (Singal, S.P. 2000)

- annoyance;
- sleep disturbance;
- disruption of normal functions (*e.g.* communication and interaction, activities);
- distraction and reduced task performance;
- anxiety and stress;
- startle reflex (*e.g.* reactions ranging from mild surprise to severe shock);
- physiological changes (*e.g.* blood pressure, heart beat, constriction of blood vessels); and
- physiological impacts (*e.g.* nausea, headache, insomnia, loss of appetite, hypertension, heart disease, tinnitus, hearing damage, noise-induced hearing loss).

These effects may be acute or chronic in how they affect people. Certainly workers who work with heavy equipment their entire career are most likely to develop chronic conditions. In contrast residents and visitors may experience quite strong acute effects if the sound is of an impulse nature. Such acute effects could develop into chronic effects if there is repeated incident.

The further contrast is to consider the effects of noise as being either temporary or permanent. This would be somewhat analogous to sub-lethal and lethal, two qualifiers for toxicity. Some effects to hearing caused by exposure to heavy equipment are temporary, with normal hearing returning after a period of time. However some effects are quite permanent; it may be a subtle loss, imperceptible at first, but a loss nonetheless. Over time repeated hearing losses may start to accumulate until finally the victim realizes that they have been overexposed to noise and now have permanent hearing loss. These effects are commonly viewed as the more extreme in relation to noise. But as noted there are a number of other effects that can be just as serious and lead to complications with other health factors. Ultimately these effects lead to a reduction in a person's quality of life. This will be discussed further in section 11.0.

Consideration of Proponent's Mitigation

It is important to consider these potential effects in the context of mitigation measures proposed by the proponent. These measures may help to alleviate, reduce or eliminate occupational noise emissions before they even occur. Specific mitigations proposed include:

- Mill location 950m from the center of the community.
- Insulate the mill building for noise reduction.
- Orientation of the mill doors away from the community and sound baffling.
- Ore haulage to/from Bellekeno and the mill will be conducted on day shift only (7 am – 7 pm).
- The crusher at the mill is estimated to operate only 6 hours per day during the day shift (7 am to 7 pm) only. The crusher will have sound abatement panels to reduce ambient noise.
- Activity at the Dry Stack Waste Facility will only occur during the day shift (7am – 7pm).
- Will seek variance from Yukon Workers Compensation Health and Safety Board to modify backup indicators with strobe light for night time operation.
- Limit employee/contractor interaction with Keno City.
- All highway regulations will be followed for speed limits and use of air brakes.
- Engine retarder brakes will not be used within town limits.
- Make a concerted and earnest attempt to develop a fair and valid sound monitoring program for Keno City.

Existing Legislation

Non-discretionary provisions from the following legislation speak to the requirements for noise safety equipment, maximum daily exposure time to steady state noise and public nuisance.

- *Occupational Health and Safety Act*
- Occupational Health and Safety Regulations
- *Public Health and Safety Act*

Significance Determination

Worker Exposure

Of the potentially affected parties, workers are at the greatest risk for significant health effects. This is due to the fact that they work in close proximity to the sources of noise for long periods of time. However the *Occupational Health and Safety Regulations* include non-discretionary provisions that will ensure that these effects do not become significant and adverse. Specifically sections 4 – 6 of the regulations (1986/164) and Part 1 – General, section 1.25.

Before discussing the other activities that produce noise it is important to note the difference between workers and residents in how they may perceive the health effects of noise. Some would argue that if a workplace is deemed safe for the 'hearing' health of workers, then people in surrounding areas should also be safe. There are however some flaws to this argument.

First, workers willingly enter a workplace for the purposes of employment and are aware of the risks. In contrast, local residents are not willing participants. The ambient levels they are used to do not include noise associated with this project and they are usually not informed of when noise risks are highest.

Second, workers are trained and provided with the means to avoid hearing risks. Again in contrast, residents are not provided with this same level of support. Despite the distances, one might argue that residents are at greater risk of health effects compared to workers.

Third, while workers likely have the highest exposure levels to noise and at source, they also are most prepared for that noise given the duration of exposure. Also, they do not work 24/7. Residents will be continuously exposed to varying levels of noise 24/7, depending on their lifestyle (*i.e.* amount of time spent in Keno). Though these levels will be proportionately much lower, they will still exist. The main point of this discussion is that even if workers are protected from the effects of noise, this does not mean that residents and visitors are equally protected. The sections below will demonstrate some of the effects that residents and visitors may experience.

Temporary Activities

There are a number of proposed activities that are temporary and thus pose short-term noise effects. This includes the initial mobilization of equipment and supplies to the operating sites; clearing and construction of the Mill and Dry Stack Tailing Facilities; and construction of the Lightning Creek bridge and optimized bypass. Also the water treatment infrastructure (*e.g.* ponds, berms) on the Flame and Moth site located 1000m southwest of Keno.

In order to better qualify whether potential effects are significant and adverse, I attempted a desktop exercise. The purpose of the exercise was to perform a quantitative analysis in order to estimate the potential noise emissions of project activities. Appendix 5 details the process utilized for this exercise. It provides a summary of the results as well as discussion of the limitations associated with performing a desktop analysis of a very complex dynamic system. The map on page 7 is also valuable for understanding the distances involved in the modelling exercise.

In terms of temporary activities, they will primarily involve the use of heavy machinery during dayshift hours of operation (7am – 7pm). It is likely that these activities will use an assortment of equipment such as a dozer, front end loader, dump truck, backhoe and chainsaw. An estimate of the dBA from the closest point of activities (*e.g.* construction of bridge) to the nearest property (approximately 50m) is 75.2dBA. At the furthest point (water treatment facility 900m away) this level drops to 50dBA. This range is acknowledged to be a coarse estimate. However given that the modelling does not account for the absorption of sound through natural barriers and surface roughness, it is viewed as being conservative.

The duration of these activities is likely to be short-term. The infrastructure being built is critical for the mine to go into full production. Therefore construction activities will be conducted with some urgency and noise effects will be confined to short periods of construction.

This type of construction is similar in nature to YG road maintenance and construction projects that Keno would experience seasonally (*e.g.* grading, realignments). However there is a distinction in that those are necessary for public infrastructure whereas this is a private enterprise. Therefore the comparison falls somewhat short and the proponent should be held to the standard that any other resident would be held to.

The estimated noise levels seem to fall within the middle of the range for what is socially acceptable for daytime construction. Consideration of the natural ambient levels for Keno indicates that sustained noise at this level, even if temporary in nature, could lead to some of the noted effects. It is not likely that these effects would lead to serious health effects. But some of the more minor health effects are likely (*e.g.* annoyance, anxiety) given the baseline residents are used to. These effects are considered significant and adverse in consideration that there are reasonable measures available that can help to alleviate these effects.

Nightshift (7pm – 7am)

Humans are most sensitive to noise when it occurs between the hours of 10pm and 7am. This is of course due to the fact that most people are trying to sleep. However the importance of this should not be understated. Sleep is a "restorative process during which the organs of the body

renew their supply of energy and nutritive elements. Exposure to noise may cause difficulty in falling asleep when retiring, disrupt sleep patterns (i.e,. the five stages of sleep) and awaken people who are asleep." (Singal, S.P., 2000)

The proponent recognized this inherent conflict by reducing their level of activity between the hours of 7pm and 7am. Originally they were aiming for operations 24/7. Instead, activities that pose major noise impact have been confined to the dayshift (*e.g.* use of explosives, crushing operation, hauling of ore and tailings). During the nightshift mining activities will be localized primarily to the mine site at Bellekeno East, 3km from Keno. Here underground work and rock hauling will continue. The core mill infrastructure located 800m from Keno will continue to operate. Work areas will also experience shift change traffic from 6am to 7am and 7pm to 8pm. Finally, a potential exist for incidental traffic throughout the nightshift to occur (*e.g.* emergencies).

Despite this reduced level of activity some effects may still occur (*e.g.* annoyance, sleep disturbance). The degree of sensitivity associated with noise at night increases the magnitude such effects may have on people. Magnitude is essentially a measure of the change from baseline that is experienced. This corresponds to the change from ambient sound levels due to the addition of occupational noise.

Numerous comments noted how quiet Keno is during the day. It is a fair assumption that this degree of quiet extends also into the night and perhaps to a greater degree. Certainly at night ambient sound levels tend to drop as the level of activity is reduced. Remaining sources of natural sound are the running creeks near town, most prominent in the summer; wind; weather; wildlife; and other biota (*e.g.* birds, insects).

In this situation it is difficult to predict an accurate decibel range that represents what Keno naturally experiences during the night. This is due to the lack of baseline information for this particular environmental condition. However based on the reference points noted above, it is likely that Keno naturally experiences ambient sound levels during the night generally as high as 40dB with an average likely lower than that. This corresponds to night-time sound levels noted in other rural areas. The occasional 'impulse' noise would cause sound above this anticipated range on a case-by-case basis (*e.g.* thunder, falling tree). As per the theory, any proposed activities that create sounds between 40dB and 57dB would be additive in nature, meaning the combined sound would be 57 plus an added amount. For proposed activities that result in sounds greater than 57dB the resulting combination of ambient plus occupational would simply be the higher number.

With regards to potential night-time noise emitted by this project the scenario (#2) in appendix 5 estimates 49.6dBA. This would seem to place it in additive position relative to the ambient sound of the community. However, as noted in the discussion of limitations, the model fails to qualify the effects of Sourdough Hill and also the fact that much of the activity is underground (up to 300m). This hill would provide a high level of buffering between the minesite and Keno City..

There is no other information available to further qualify this estimate. What is known is that the effects of noise at night can be significant since this is the most sensitive time for people. It is feasible that more significant health effects could be attributed to a lower noise emission at night than to the higher noise emissions anticipated for the daytime. Sharp impulse noises, shift change traffic and discrete frequency noise produced by the mill building introduce noises. These may prove disruptive to residents and visitors. Given the context of this town over the last 20 years as a quiet community, any potential for noise emissions that might disrupt the residents or visitors at night should be viewed as significant and adverse, or at least until proven otherwise.

Dayshift (7am – 7pm)

It was noted that people are most sensitive to noise effects that occur between 10pm and 7am. However this fact should not discount the potential effects of noise occurring during the day. Residents are likely familiar with a certain ambient sound level. For 20 years this soundscape has been driven largely by local activities. This gives residents a certain amount of ownership and responsibility over the ambient sound levels experienced in Keno. Visitors as well have noted they enjoy coming to Keno for its quiet setting. With the free time afforded by vacation visitors interact within Keno largely during the daytime when this project would exert its largest noise emissions. With the encroachment of new occupational noise it is natural for residents and previous visitors to be concerned. Based on the level of concern presented during seeking views and information it was important to attempt some quantification of the potential noise impact of this project during the dayshift. The predictive modelling conducted for the analysis of nighttime effects was carried out for the dayshift as well.

The dayshift is an important facet of the project to analyze. This is because it involves the crushing operation and transportation, the two activities with the loudest potential noise emissions that could be experienced by residents and visitors. As noted above this is also the time period within which temporary construction activities will occur.

According to the desktop study, scenario #1 estimates that noise emissions from activities on the Flame and Moth site could be 63dBA during the day. This figure is based on a distance of roughly 825m between the nearest infrastructure and the nearest property. To better understand this dynamic the model calculated the potential noise emissions experienced 375m away from the claim area. This worked out to 69dBA. If I assumed that all the equipment was running at

the same time from one spot, then the potential noise level at source would be 121dBA. However this is not specifically proposed for this project. Therefore for the purpose of assessing health effects to residents and visitors the 63dBA figure is the most relevant. People potentially affected by noise emissions will most likely experience them from within the boundary of residential and commercial lots of Keno.

This estimated noise level falls within the middle of the range for what is socially acceptable for daytime construction (as noted, 50 – 90 with an average of 75). Consideration of the natural ambient levels for Keno indicates that sustained noise at this level could lead to some of the noted effects. This is more notable than the finding for temporary construction given the likelihood for sustained noise of these activities or at least a greater duration. It is not likely that these effects would lead to serious health effects. At that distance and that level it is important to note that 60dB is the sound level for a normal conversation. Still, some of the more minor health effects are likely (*e.g.* annoyance, anxiety) given the relatively quiet ambient levels. These effects are considered significant and adverse considering that there are reasonable measures available that can help to alleviate the effects.

Suggested Practices

There are a number of reasonable measures the proponent may implement to reduce the likelihood for significant adverse effects. This includes the following best management practices: (Federal Highway Administration, 2006.)

Noise Source Controls

- Time constraints – prohibiting work during sensitive hours.
- Scheduling – performing noisy work during less sensitive time periods or staggering the period of operation for different activities.
- Equipment Restrictions – restricting the type of equipment used.
- Emission Restrictions – specifying stringent noise emission limits.
- Substitute Methods – using quieter methods/equipment when possible.
- Exhaust Mufflers – ensuring equipment have quality mufflers installed.
- Lubrication and Maintenance – well maintained equipment is quieter.
- Reduced Power Operation – use only necessary size and power.
- Limit Equipment On-Site – only have necessary equipment operating on-site.
- Noise Compliance Monitoring – technician on site to ensure compliance.
- Quieter Backup Alarms – manually-adjustable or ambient-sensitive types.

Noise Path Controls:

- Noise Barriers – semi-permanent or portable wooden or concrete barriers.
- Noise Curtains – flexible intervening curtain systems hung from supports.
- Enclosures – encasing localized and stationary noise sources.
- Increased Distance – perform noisy activities farther away from receptors.

Noise Receptor Controls:

- Window Treatments – reinforcing the building's noise reduction ability.
- Community Participation – open dialog to involve affected residents.
- Noise Complaint Process – ability to log and respond to noise complaints.
- Temporary Relocation – in extreme otherwise un-mitigatable cases.

An effective combination of these best management practices can help to alleviate the health effects of noise. Their application depends on developing a better understanding of how this project will cause noise emissions. As such the focus of mitigation is for the proponent to better qualify their contribution to noise pollution by conducting a pre-study, preparing a noise abatement plan, and monitoring for effectiveness. Depending on the results of the study the proponent may choose the most relevant practices for reducing noise emissions. This mitigation is detailed in the following section as a formal recommendation of this report.

Recommended Mitigation

This mitigation aims to minimize and alleviate effects so that they are no longer significant. To be clear the intention is to not completely remove the effect from occurring but rather to remove or reduce any significant adverse effects. While there will still be residual noise levels associated with this project, application of the following measures will ensure they are not significant.

- Conduct a noise impact study prior to project implementation. The study must aim to achieve the following:
  - Analyze baseline conditions during conditions of low ambient noise.
  - Calculate the potential noise emissions from all activities that generate significant noise.
  - Calculate the noise emission level that the closest receiver may experience due to those activities. Consideration must be given to local environmental conditions (*e.g.*

terrain, temperature inversions, and downwind conditions relative to sensitive receivers) and proposed mitigations.

  - Calculate the cumulative noise emission of this project in combination with existing and proposed activities (*e.g.* care and maintenance, Keno City).

- Develop a noise abatement and management plan based on the results of the noise impact study. The plan must aim to achieve the following.
  - Identify appropriate measures to reduce noise emissions.
  - Incorporate these measures into project design and implementation.
- Upon commencement of each block of operations (*e.g.* crusher; bypass construction; ore traffic), a verification study will be conducted. This will consist of continuous monitoring over a two week period. Monitoring will aim to capture the ambient noise levels at sensitive receivers, inclusive of what the project is contributing. If unacceptable noise levels are identified further measures to reduce the noise levels are required.

6.2 PUBLIC SAFETY

6.2.1 Overview

This project is quite integrated with Keno City in terms of proximity and the use of infrastructure (*e.g.* public roads). Most mining operations are remote and therefore interaction with the public is often limited. Safety issues that commonly arise when the public is able to interact with industrial development is usually avoided or reduced and safety management becomes more focused on workers. In contrast the proximity of this project to Keno City, its residents and visitors means that public safety needs to be fully accounted for in the project design and implementation. This is true also for the assessment of this project.

This section will consider the potential effects to public safety in relation to the following specific topics:

- Contaminants
- Site Access
- Lightning Creek Bridge and Bypass

6.2.2 Effects Characterization and Significance Determination

6.2.2.1 Contaminants

A variety of sources of dust generation are associated with the mine and mill activities. The key sources of dust that have the potential to impact the community and surrounding ecosystems include:

- primary crusher
- haul road
- DSTF and non-AML rock storage operation causing disturbance of surfaces
- mine ventilation (intermittent source, generally only after blasting)
- fugitive dust from disturbed areas not otherwise reclaimed

As this is an underground mine, the potential for dust impacts from mining activities is significantly reduced, when compared to an open pit operation.

Uncontrolled dust from the activities listed above have the potential to impact human health and the environment as a result of the mineralization present in the materials being mined, transported and processed. Specifically, metals such as copper, arsenic, molybdenum and zinc can be present in ore-grade concentrations in dust and can cause health and ecological impacts. Dust released from the rock trucks hauling from the mine to the mill will be deposited adjacent to the haul road and can cause a localized impact. In addition, the size of the dust is important. Larger dust particles will settle quickly adjacent to the source, while smaller particles have the ability to be transported greater distances by wind. Total Suspended Particulate (TSP) includes all sizes of particulate matter. Of specific concern to human health are the 10 micron and 2.5 micron size particles, identified as PM_{10} and $PM_{2.5}$, as these are more likely to be transported greater distances from source and are more easily respired (inhaled) by humans. Chronic exposure to dust by workers and residents can cause health impacts if not controlled.

The loss of metals to the atmosphere through evaporation of DSTF pore water will not occur. The dissolved metals contained in this water will remain in the DSTF on evaporation of the water. However, loss of trace metals through suspension and transport of dust is a possibility.

A number of concerns were noted in relation to the transport of mill reagents through evaporative processes. As noted in the proposal, though these chemicals are transported to the site in a concentrated form, they are used at a highly diluted concentration during operations. Further, these reagents are recycled back into process solution during dewatering and filtering to produce the dry stack tailings. The result is that the dry stack tailings are not likely to contain high concentrations of mill reagents. Finally, with the concentration that is resident to the tailings other processes such as decomposition (*e.g.* due to UV breakdown, contact with oxygen) may act to further reduce or remove reagents. The end result is that while reagents will be present in the dry tailings the concentrations will be low.

Proposed Mitigation

It is important to consider these potential effects in the context of mitigation measures proposed by the proponent. These measures may help to alleviate, reduce or eliminate occupational noise emissions before they even occur. Specific mitigations proposed include:

- Progressive development and reclamation of Dry Stack Tailings Facility including dust suppression will be undertaken.
- In final year, open areas in the Dry Stack Tailings Facility will be recovered with a natural evapotranspiration cover as per the previous four operational years.
- Revegetation with a native seed/fertilizer mixture will be undertaken.
- The entire affected footprint, including berms, ditches, ponds, and mill pad, will be revegetated with the seed mixture to prevent erosion.
- Water spraying or other use of dust suppressants as appropriate.

Significance Determination

A number of objectives and standards are available in Canada for the application to air quality impacts from industrial activities. For the purpose of this evaluation, the BC Air Quality Standards and Objectives Level A have been referenced for guidance for on TSP, PM_{10} and $PM_{2.5}$. In consideration of these standards it seems there are reasonable measures available to ensure that significant adverse effects do not occur. I am of the opinion that despite the mitigations proposed by the proponent, additional mitigation is required to ensure that the significant adverse effects related to air contamination do not occur.

Recommended Mitigations

In order to ensure dust does not become an issue from operations, the following additional mitigations are required:

- Best management practices for the industry indicate that dust releases must be minimized through the application of a number of preventative measures, including the following.
  - If excess dust is produced in the crusher, the proponent must be prepared to use air filtration/dust collection equipment to collect the indoor crusher air and removal of particulate from the exhaust
  - Enclosure of the primary crusher and the use of air filtration/dust collection equipment to collect the indoor crusher air and removal of particulate from the exhaust.
  - Covering ore haul truck beds to reduce the loss of dust from the truck during transport.

- Use of dust suppression techniques, such as the application of water as necessary, to the Dry Stack Tailing Facility, non-AML rock storage and the haul road, if and when dusting conditions occur. Other dust suppression products and chemicals are available on the market at higher cost and potentially uncertain efficacy. Under no circumstances shall waste oil or other hydrocarbon product be used for dust suppression.
- Reduce the area of dust producing surfaces through timely reclamation (covering). The proponent has indicated only a small percentage of the DSTF will be exposed at any given time in order to accomplish this dust suppression goal.
- Haul road surfacing – frequently used roads near Keno shall be hard surfaced to the extent possible.
- Vehicle wheel and chassis wash to the extent possible.
- Site layouts – Design operational areas to minimize pollution from dust. For example, take account of prevailing wind conditions, use buildings as screens or enclosures, and use natural topography and vegetation as screening.

- Monitoring dust conditions is an important step in controlling dust impacts. Simple TSP (dustfall) monitoring is a simple and inexpensive way to determine dust deposition at the sampling locations. This test can be done at the site by the proponent with little cost or training necessary.
- If warranted by initial dustfall measurements indicating TSP concentrations in excess of 150 micrograms per cubic metre (the BC Air Quality Objectives and Standards Level A criteria) at the fence line, the proponent shall conduct more sophisticated monitoring with high volume samplers and re-evaluate and improve dust suppression techniques to achieve the TSP objective.
- Potential dispersal of contaminants from Dry Stack Tailings Facility to Keno must be qualified based on wind dispersion models and local meteorological conditions and provided to appropriate regulator.

6.2.2.2 Site Access

Public access to the site is currently possible using existing roads. With new roads proposed and the potential level of industrial activity there is an inherent concern for public safety.

Driving up the Signpost Road is a highlight for Keno visitors. Several hundred visitors hike marked trails around Keno to view and learn about alpine wildlife and wildflowers. The Signpost Road closely parallels the non-AML haul road for about half a kilometer east of the Onek Pit access point. Given the proximity of the two roads, there is potential for conflict between visitors and haul trucks.

While most known visitor activity occurs outside of the proposed active mining area, there are accessible trails throughout the region and the potential for visitors to enter the project area. Visitors to the area may not be aware of the current activity at the site since it has been promoted as an abandoned mine site for years. Use of heavy equipment, explosives, hauling waste rock, travel between project areas and other related activities may overlap with visitor use of the area. The potential conflict between visitors to the site and project activities could lead to injury or death which would be considered significant and adverse.

Finally, a number of concerns were raised about increased traffic in town and the potential for direct effects to public safety.

Consideration of Proponent's Mitigation

These potential effects need to be considered in the context of mitigation measures proposed by the proponent. Specific mitigations proposed include the following.

- Site orientations for all employees and visitors.
- Traffic will be controlled on mine access road. Communication and notification of hazardous materials transport to the site.
- Mine and Mill Site access road is gate restricted and public access to the site is discouraged. Physical restriction and security monitoring will ensure that the public is not exposed to project site accidents or malfunctions.
- Mine workers will be transported using a company bus to reduce traffic.
- Mine traffic will be redirected around Keno City to ensure that direct haulage traffic is routed around the community and interference with the local community is minimized. Figure 1-3 shows the proposed routing of traffic around the community. There will be occasional light vehicle traffic within Keno City but all ore haul traffic will be redirected at the commencement of production.
- 30 km/hr speed limit within or near the town.
- Highway access, signage and sign placement will be reviewed with YG Highways.
- A representative from Keno City with road building experience will be invited to accompany our engineers during our final route planning for the Keno City Bypass in order to obtain valuable local knowledge and additional community input.
- Radio controlled areas will be available.
- All highway regulations will be followed for speed limits and use of air brakes.

Significance Determination

The mitigations proposed to address safety issues related to site access are comprehensive and relevant to the potential risks. They represent an appropriate level of effort in relation to the risk. As such this project, as proposed, will not result in significant adverse effects to health and safety due to site access.

6.2.2.3 Lightning Creek Bridge and Bypass

This project proposes the construction of a bridge over Lightning Creek and an optimized bypass south of Keno. It is unknown at this time what standard this bridge will be built to though it is likely focused on supporting project activities such as hauling rock between the mine and mill. Using the pre-cautionary principle it is reasonable to assert that in the absence of detailed design information there is a potential for significant adverse effects to the health and safety of the public and workers onsite. The effects of a partial or complete failure of the bridge due to too much weight crossing at one time or the compounded use of it over time include injury or death to those using it. Malfunctions of the bridge due to inadequate design and construction may be sudden and cause immediate effects or may take longer to result in effects. While the likelihood of the noted effects happening relies on a number of factors (*i.e.* presence of humans at time of failure; severity and circumstances of failure), should these effects occur they would be considered significant and adverse. This conclusion is the same for the bypass route.

Recommended Mitigation

- The proponent shall ensure that the bridge is capable of supporting the weights that will be crossing it and provide documentation to that effect to the regulator.
- The proponent shall submit the bypass road plans to the regulator for review and approval.

6.3 WORKER SAFETY

6.3.1 Overview

This section will consider the potential effects to worker safety in relation to the following specific topics:

- Air quality
- Working Underground and Adit Failure
- Explosives
- Chemicals
- Emergencies Accidents and Malfunctions

6.3.2 Effects Characterization and Significance Determination

6.3.2.1 Air Quality

Working underground may put workers into confined spaces that are quite remote from natural sources of oxygen such that they are completely reliant on ventilation equipment. Activities such as blasting, drilling and operation of machinery may lead to the accumulation of particulate matter (*i.e.* rock dust; diesel exhaust) and reduced air quality adversely affecting human health. Particulate matter may constitute inhalable and fine particles smaller than 10 micrometers in diameter that may generally pass through the throat and nose and enter the lungs (United States Environmental Protection Agency).

Effects include increased respiratory symptoms (*i.e.* irritation of airways, coughing or difficulty breathing); decreased lung function; development of lung and heart ailments (*i.e.* chronic bronchitis; lung cancer); and over time premature death in people who develop lung or heart disease from long term or intense exposure to particulates.[1] Given the likelihood of workers being exposed to particulate matter and the potential severity of effects, they are considered significant and adverse.

In addition to the effects of particulate matter, if ventilation equipment was to fail through improper operation, malfunction or accident, workers could potentially be working in an oxygen deficient environment or stranded without oxygen and have limited options for finding an alternative source. A reduction or absence of oxygen could lead to hypoxia oxygen deficiency, a shortage of oxygen in the body. This in turn may cause discomfort, reduced body function, unconsciousness and ultimately brain death if not recognized and resolved immediately. While the likelihood of this effect occurring requires some improper operation, malfunction or accident, if it were to occur it would be considered significant and adverse.

Air quality could also be compromised by gases that may accumulate over time in some the deeper recesses of the workings where air is not sufficiently recycled and could become stagnant. Carbon monoxide, which results from the incomplete combustion of organic carbon-based materials, may be emitted from generators, pumps and vehicles. Nitrogen dioxide is an extremely toxic gas to the human body and is produced from the detonation of explosives as is sulfur dioxide when blasting sulfide ores. Carbon dioxide (*e.g.* associated with rotting mine timbers), hydrogen (*e.g.* incomplete combustion in explosives), hydrogen sulfide (*e.g.* decomposition of sulfur compounds), methane (*e.g.* associated with coal seams) and nitrogen are also common gases that are of concern in underground workings, though less so in relation to this project (United States Mine Rescue Association). Effects of these gases to humans range from headaches, tiredness, irritation to nose and throat, dizziness and nausea, to convulsions and ultimately unconsciousness or in some cases pulmonary edema. If a situation resulting in such effects is not quickly identified and resolved it could lead to injury or death of workers. While

the effects of these gases require a number of variables to interact for them to become likely, if they were to occur they would be considered significant and adverse.

Existing Legislation

I have considered the requirements of non-discretionary legislation and specifically the Occupational Health and Safety Regulations and the *Occupational Health and Safety Act*. The following sections address the noted effects:

- Part 2 – Confined Spaces;
- Part 8 – Materials and Storage (*i.e.* rock dust);
- Part 14 – Blasting; Part 15 – Surface and Underground Mines or Projects (*i.e.* mine rescue); and
- Part 16 – Mine Shafts and Hoists (*i.e.* ventilation and heating; safety examinations and certificates).

For example, the regulations specify exposure limits for workers to dust that are not to be exceeded and what is to be done if there is a system failure in the ventilation system.

Significance Determination

I am satisfied that compliance with this legislation will adequately eliminate, reduce or control potential significant effects related to underground quartz exploration and air quality implications for health and safety.

6.3.2.2 Working Underground and Adit Failure

The practice of underground quartz exploration has inherent safety risks associated with it. Underground operations place workers initially into a controlled yet foreign environment. Over time this environment may become more familiar but it will still need to be strictly controlled to make it safe and comfortable to work within (*i.e.* ventilation, heat, lights, efficient access and exit). Part of this control is in relation to securing the excavation so that there is no risk of failure or collapse of the structure internally or blockage of the portal itself (*i.e.* with respect to the steep slopes, permafrost and avalanche potential). Such an event is one of the major risks to workers when working underground and effects could be serious. They include indirectly isolating workers from possible escape routes and supplies necessary for survival until a rescue can be implemented; production of particulate matter and related air quality effects over the short term; directly injuring workers with potential for long term disability; and death. Since underground mining requires a controlled environment to safely work within, it is particularly sensitive to unpredictable changes (*i.e.* earthquakes; avalanches blocking the adit) and cannot afford a high tolerance for improper practices, malfunctions or accidents.

Existing Legislation

I have considered the requirements of non-discretionary legislation and specifically the Occupational Health and Safety Regulations and the *Occupational Health and Safety Act*. The following addresses the noted effects:

- Part 2 – Confined Spaces
- Part 6 – Mobile Equipment
- Part 8 – Materials and Storage (*i.e.* unconsolidated and solid material, hazardous substances, battery charging, compressed gas containers, rock dust, rock crushing)
- Part 10 – Construction and Building Safety
- Part 14 – Blasting (*i.e.* transportation and storage of explosives aboveground and underground, blending, drilling, handling, loading holes, guarding, misfires, underwater blasting and avalanche control)
- Part 15 – Surface and Underground Mines or Projects (*i.e.* mine closure, fire protection, mine rescue, electrical, underground haulage)
- Part 16 – Mine Shafts and Hoists (*i.e.* raising, stoping, ventilation and heating, shaft-sinking, rope attachments, skips and cages, electric hoists, safety examinations and certificates, hoist operators and communication)

Significance Determination

I am satisfied that compliance with this legislation will adequately eliminate, reduce or control the potentially significant effects related to underground quartz exploration and the implications of adit failure on health and safety.

6.3.2.3 Explosives

The project involves the continued use of explosives to facilitate underground excavation. Explosives are stored in a magazine at Bellekeno East. Transporting, storing, handling and detonating explosives poses inherent safety risks to both workers and the public. Effects associated with poor operating practices, accidents or malfunctions may be quite serious and include injury and death. These effects are considered to be significant and adverse.

Existing Legislation

I have considered the requirements of non-discretionary legislation and specifically the *Explosives Act* and associated Explosives Regulations; *Transportation of Dangerous Goods Act*; Quartz Mining Land Use Regulations (Schedule 1, Part M); the *Occupational Health and Safety*

Act and the associated Occupational Health and Safety Regulations. Part 14 of these regulations in particular address the potential for effects:

- Part 14 – Blasting (*i.e.* transportation and storage of explosives aboveground and underground, blending, drilling, handling, loading holes, guarding, misfires, underwater blasting and avalanche control)

Significance Determination

I am satisfied that compliance with this legislation will adequately eliminate, reduce or control the potentially significant effects related to the use of explosives on health and safety.

6.3.2.4 Chemicals

Lime is used on site for the treatment of adit, mill and DSTF discharges. Lime acts to modify the pH (acid concentration) in order to precipitate (*i.e.* draw out/remove) excess metals from the mine discharges before they are released to the receiving environment. The lime is mixed with fresh water at a central mixing facility in the town of Elsa and delivered to the treatment sites (historic mine portals) via a lime slurry tanker truck. Lime slurry is stored and continuously mixed in lime holding tanks and then automatically added to the mine effluent.

Lime (calcium hydroxide) poses a risk to employees who handle and prepare slurry for treatment. Inadvertent contact or ingestion of lime may result in ulceration and burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhea. It can be a severe irritant to eyes upon contact with powder/dust forms. Over-exposure may result in pain, redness, corneal burns and ulceration with possible permanent injury. Prolonged and repeated skin contact with powder or wetted form may result in skin rash and dermatitis. Over exposure to powder (*i.e.* dust produced when mixing) may result in severe mucous membrane irritation of nose and throat, coughing and bronchitis at high levels. Any such health effects attributable to exposure to lime, without the proper occupational precautions, would be considered significant and adverse.

There is a potential for similar or worse health effects in relation to some of the other chemicals proposed to be used on site. Namely chemicals proposed to be used as reagents in the milling process. For example, solid reagents such as copper sulphate, zinc sulphate, sodium sulphite and SIPX. The transportation, storage and use of these chemicals at varying concentrations posses health risks to workers as detailed in the Material Safety Data Sheets (Appendix F of the proposal).

Consideration of Proponent's Mitigation

It is important to consider these potential effects in the context of measures proposed by the proponent to address effects. Specific measures include the following

- Occupational Health and Safety Act and Occupational Health and Safety Regulations will be enforced for all personnel on the site.

Significance Determination

Implementation of the mitigations proposed by the proponent in addition to compliance and enforcement of the legislation will ensure that significant adverse effects do not occur.

6.3.2.5 Emergencies, Accidents and Malfunctions

A concern submitted to this assessment noted that there are limited fire protection services available within Keno. The Keno City Fire Department ("KCFD") is volunteer based (approximately 11 people) and has at its disposal 1 pumper truck and 1 tank truck. The submission concluded that the KCFD lacked the "*equipment, training or financing to deal with chemical containment, massive release of toxins caused by an industrial fire or community evacuations*" and further that "*it will be impossible for this community to provide any emergency services for such a facility*". The concern is quite relevant since any industrial activity poses fire safety risk. This is even more pertinent when process chemicals are involved such as those used as reagents and for water treatment. The concern is not limited to fire risk; accidents and malfunctions could lead to a variety of health and safety risks. Given the limited resources available in town to manage such situations it is critical that the proponent is self-sufficient. Failure to have proper training, equipment and plans in place could lead to significant adverse effects to the health and safety of both the public and workers.

Consideration of Proponent's Mitigation

It is important to consider the above mentioned effects in the context of measures proposed by the proponent to address the effects. Specific measures include the following.

- *Occupational Health and Safety Act* and Occupational Health and Safety Regulations will be enforced for all personnel on the site.
- Employees will be educated on the potential risks associated with their position and be properly trained.
- Emergency Response Plan which includes the Spill Contingency Plan (see Appendix G in Volume 2) will be posted and implemented as necessary.
- Emergency Response Plan training will be provided.
- Training will be provided to all staff on general safety and safe vehicle operations.

- Supervisors and emergency personnel will be on site at all times to address accidents/malfunctions. A first aid attendant will be on site as all times.
- Weekly staff safety and education meetings.
- A Safety Committee will be established and maintained.
- Medical and emergency response equipment and trained personnel will be on site 24 hours a day during operations.
- Site and mobile communications will be provided.
- Radio controlled areas.
- Employees are covered by Workers Compensation.
- Vehicles will be equipped for winter travel and will carry emergency first aid kits.
- Treatment contingency measures and back-up systems to minimize accidents and malfunctions will be available
- Alcohol and drug screening as a pre-employment condition.
- Consumption of alcohol and 'recreational' drugs will not be allowed on site by employees.
- Monitoring and maintenance to ensure facility and worker safety and equipment integrity.

Existing Legislation

The following non-discretionary legislation has been considered:

- *Occupational Health and Safety Act*,
- Occupational Health and Safety Regulations,
- *Public Health and Safety Act.*

Significance Determination

Compliance with the above-mentioned legislation and implementation of the mitigation measures proposed by the proponent is expected to reduce to an extent the adverse effects of the project. However, further mitigation measures are required as recommended by the Yukon Workers Compensation Board to ensure that the project does not result in significant adverse effects.

Recommended Mitigation

- Proponent shall ensure the following is achieved with respect to the health and safety of workers.
    - Comprehensive safety program is in place with ongoing updates.

- Compliance with the OHS Act and Regulations.
- Emergency plan in place with ongoing updates.
- Mine Rescue Training and Equipment in place.
- Back up plan for mine rescue assistance; (agreement in place with other U/G mines for assistance in event of an emergency).
- Contractor Safety Management Plan in place; (especially during plant construction phase).
- Return to Work Program for Injured Workers.

6.4 CAMP

6.4.1 Overview

This section will consider the potential effects of camp operations to health and safety. Because the camp exists and is currently authorized this assessment is limited to speaking to issues related to the increase in camp size. As such topics such as food storage, handling and preparation and water consumption have been adequately addressed in the previous assessment. The following topics will be considered in further detail:

- General Sanitation
- Waste

6.4.2 Effects Characterization and Significance Determination

6.4.2.1 General Sanitation

The increase in camp capacity from 100 to 150 people may lead to conditions of overcrowding and potentially unsanitary conditions. This in turn may result in the spread of disease amoung the camp population. While the likelihood of this occurring is low, the consequences could have a considerable impact on the health of people residing in camp.

The assessor has considered the requirements of the Camp Sanitation Regulations as per the *Public Health and Safety Act*, and specifically sections 4, and 10-18. Given this consideration the assessor is satisfied that compliance with this legislation will adequately eliminate, reduce or control the potential effects noted above so that they are not significant and adverse.

It should be noted that YG – Environmental Health Services indicated that their records for Flat Creek camp do not match what is in the proposal. While this is seemingly more of an administrative manner it is important for the proponent to inform the regulator of their activities. This will help to ensure compliance with key legislative provisions. Failure to do so could lead to significant adverse effects.

Recommended Mitigation

- Complete details of all other camps to be used need to be provided to Environmental Health Services. The details must include total population, accommodation, food service, potable water supply and sewage disposal.
- Camps must comply with the requirements of the *Public Health and Safety Act*, Camp Sanitation Regulations.

6.4.2.2 Waste

Improper management of garbage and other waste produced by the camp and/or failure of a waste management system has the potential to contaminate water sources and lead to unsanitary conditions. Given the size of this camp there is potential for a large volume of waste to be generated. Further, YG – Environmental Health Services noted that this camp would cause a significant increase in the amount of solid waste to the local facility in Keno. Given the limited information on capacity for this facility it was indicated that an alternative site with greater capacity should be used. These effects are considered to be significant and adverse.

Recommended Mitigation

- Use an alternate Yukon Government regulated site for waste disposal as per guidance from Yukon Government.

7.0 ENVIRONMENTAL QUALITY

7.1 OVERVIEW

This Bellekeno Project is located approximately 45km north of Mayo. The project area covers several square kilometers and encompasses several hundred mineral claims including the abandoned mines of Keno and Elsa. The proposed project falls in a historically known world class silver mining area dating back to the 1900's.

The landscape and vegetation of the area is described by the proponent as being comprised of stunted black spruce set in spongy vegetative mat on north facing slopes and mixed poplar, birch, pine, white and black spruce on south facing slopes. Alpine reaches consist of low bush species, berries, moss and lichen. Disturbed areas are overgrown in thick stands of willow. The area is characteristic of continuous permafrost typically near surface layers and fragmented soil with little humus rich vegetation. An alpine environment can be expected throughout the project area.

7.2 EFFECTS CHARACTERIZATION AND SIGNIFICANCE DETERMINATION

7.2.1 Erosion and Sedimentation

Operation of Flame and Moth Mill and Bellekeno Mine Site Waste Water Treatment Facilities and Related Infrastructure; Deposit of Suspended Solids into Receiving Environment

Failure to operate and/or maintain the facility properly may lead to accidents and/or infrastructure malfunctions that have the potential to release high sediment loads (*e.g.* clay, sand, silt, and organic and inorganic matter) and associated contaminants. The potential effects of a dam breach have been addressed in Section 5.1.2.

7.2.2 Permafrost

The specific components of the project reviewed that are contained within this section include; road construction; non-AML waste rock storage; DSTF storage; and AML waste rock storage. Included within this section is a brief discussion on permafrost and general permafrost effects, along with the review of potential effects, mitigation and rationale for each of the subject areas.

7.2.3 Geotechnical Conditions and Permafrost- General

Permafrost in the Canadian North and the Yukon specifically ranges from continuous throughout northern Yukon; a discontinuous permafrost zone through mid Yukon; to sporadic permafrost in the southern Yukon. The ground temperatures in the continuous permafrost zone are below -5˚ C, between -5˚ and -1˚C in the discontinuous zone and above -1˚C in the sporadic zone. According to the Geologic Survey of Canada, Keno City lies in the northern limit of the discontinuous permafrost zone, very near the boundary with the continuous permafrost zone.

Generally speaking, permanently frozen ground has the following characteristics in a frozen state and consequences when thawed:

- For continuous permafrost zones, the upper (up to) several metres will thaw and refreeze on a yearly basis during seasonal temperature fluctuations.
- For discontinuous permafrost zones, the horizontal distance between a frozen zone and an unfrozen zone can be highly variable depending on terrain and aspect, and well within the distances between, for example, the proposed dry stacked tailings and waste rock stockpile areas at this site.
- Permanently frozen ground eliminates most groundwater movement, while the thawing of permafrost can have a substantial effect on groundwater flow processes.

- From a geotechnical perspective, thawing of permanent frost can have a significant negative impact on the shear strength and bearing capacity characteristics of soils, especially soils that are finer grained.

7.2.4 Road Construction and Use – Implications for Erosion and Permafrost Degradation

Construction and use of new roads, particularly on steep grades that are likely to have permafrost may lead to slope instability and subsequent slope failure. Travel on steep and potentially unstable roads with heavy equipment may lead to road failure as a result of erosion and/or inadequate characterization of ground conditions. Permafrost that is present in poorly or unconsolidated material may become damaged and lead to slumping and/or retrogressive thaw slides (*i.e.* thermal erosion). Given the steep slopes and likelihood of permafrost in the project area these effects are considered to be significant and adverse.

Proposed Mitigations

The following mitigation measures proposed by the proponent were considered:

- Minimal disturbance to the vegetative matt.

Residual effects are expected to be significant without additional mitigation.

Recommended Mitigation

Cuts and fills in hillsides or within frozen ground can have a dramatic negative impact on slope stability if detailed assessments and planning are not adequate and complete. In order to reduce the risk of impacts associated with road construction and use relating to permafrost, the Proponent is required to undertake the following additional mitigations:

- Prior to constructing the new access road to the Flame and Moth Mill site and the Keno City bypass, the proponent must demonstrate that soil conditions beneath and in proximity to the proposed right-of-way are stable to support the intended construction and use.

- New road construction shall not cause degradation of permafrost.

- All potential roadway design and construction must be signed off by a qualified geotechnical engineer.

With the above additional mitigations, there will not be any significant or adverse residual impact from these operations.

7.2.5 Waste Rock Storage

7.2.5.1 Non-AML Site

The proposed non-AML site is located approximately 2km east of Keno City on the south side of Lightning Creek. The natural ground topography slopes up to the north. A geotechnical investigation for this general area has been performed, as outlined in the EBA Engineering Consultants LTD report dated December 2008 and contained as Appendix I of the Project Proposal document dated February 2009. Additional documentation is also contained in Appendices D and E of the same report. From these reports, the following may be summarized.

- The non-AML waste rock storage area is labeled as the Bellekeno site in the EBA report, and the investigation was performed as part of the initial dry stack tailing facility and mill location evaluation. The selection of the tailing storage and mill location at the Flame and Moth site does not alter the validity of the geotechnical information gathered as part of that process.
- From the borehole drilling investigation, the soil conditions in this area consist of deep deposits of sand with varying amounts of gravel and silt. Groundwater was not observed during drilling.
- Temperature probe readings from one borehole to 8 m depth on Oct 31/08 and Nov 26/08 showed ground temperatures from approximately 0˚ to -1˚ C. The ground temperatures generally decreased with depth. It is anticipated these ground temperatures would decrease during the winter months.
- The EBA report (Appendix I of the Project Proposal) state the terrace of mined placer tailings between the slope and Lightning Creek could lead to long term stability issues, and that the DSTF (or presumably other fill material) should be designed such that it does not cause degradation of the underlying warm permafrost. These potential long term stability issues and the mitigation design is not mentioned anywhere else within the documentation.
- A series of assumptions are listed in Appendix E of the Project Proposal document relative to the design shear strength of native and fill soils, permafrost conditions and groundwater level conditions at this site. These assumptions include an active layer of permafrost 1 m below existing ground, with the groundwater table at 0.5 m above the

permafrost layer. All potential slip surfaces from the slope stability assessment performed would not penetrate through the permafrost. Shear strength of the foundation soils was assumed as an undrained shear strength of 10kPa and a friction angle of 28˚. Based on these assumptions, a waste rock placement geometry is given.

The stockpile of the non-AML waste rock as currently proposed has the following potential effects and consequences:

- *Insufficient understanding of the foundation soils and the location of permafrost* – Consequences could lead to overall slope failure blocking the haul road, impacting Lightning Creek with debris, and increased groundwater flow (issue raised in the seeking views period).
- *Ambiguous shear strength parameters* – Consequence could lead to overall slope failure.
- *Incomplete slope stability assessment* – Consequence could lead to slope movements during material placement and could affect the long term storage geometry. The will address comments from the seeking views period.
- *Non AML waste rock placement methodology* – material must be placed from the bottom of the slope proceeding upwards so as not to create slope stability issues.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Design of the waste rock pile to applicable guidelines
- Choosing a pile location that minimizes sediment from being transported into adjacent streams
- Conducting a review of liquefaction potential of foundation soils
- Operational procedures will be developed to minimize the incorporation of snow and ice in the waste rock piles

On the basis of the proposed mitigations, it is believed there remains a significant and potentially adverse impact relating to ground stability associated with the non-AML waste rock storage proposal.

Recommended Mitigation

The rationale for the potential effects and proposed mitigation is that there is currently insufficient characterization of site conditions to support the slope stability design assumptions, the material placement methodology, and the long term stability of the waste rock storage. Prior to proceeding to final design, the proponent will implement the following recommendations relative to the non-AML waste rock storage:

- From borehole drilling throughout the various sites surrounding the Keno City region, evidence of permafrost was generally not encountered. It is acknowledged that the non-AML waste rock site is situated on a north facing slope more prone to permafrost, however the consequences of intermittent permafrost or altering the permafrost regime with the placement of the non-AML waste rock could be severe given the design assumptions for the slope stability assessment. Additional boreholes must be drilled throughout the areas of placement of the waste rock, especially throughout the lower toe area and extending westward along Lightning Creek. All boreholes must be extended to bedrock and several should be fitted with temperature reading devices to confirm the location and depth of permafrost. It would be expected that temperature monitoring would occur over several seasons. Several peizometers must also be installed to monitor supra-permafrost groundwater level conditions.

- The detailed slope stability assessment discussed in Appendix E of the Project Proposal must be revised to include the additional geotechnical information. A discussion on the permafrost layer depth and how this may be altered by the placement of the waste rock must be given to document how the permafrost is to be protected and how the shear strength parameters could change with the degradation of the permafrost. A discussion of the rock placement protocol must be given, and should include a placement scenario from the bottom of the slope upwards so as not to create slope stability issues during fill placement. The detailed slope stability assessment must be presented in a comprehensive report signed off by a qualified geotechnical engineer.

- The shear strength of the foundation soils as outlined in Appendix E of the Project Proposal must be clarified. Based upon the drilling program, the foundation soils in this area consist of silty, gravelly sand. The assumed shear strength parameter of an undrained shear strength of 10kPa refer to a cohesive material (*i.e.* a material containing clay sized particles). Materials such as sand are non-cohesive and generally have a corresponding cohesion of 0kPa. These shear strength parameter assumptions may have a significant impact on the slope stability assessment, especially for very shallow potential slip surfaces (as likely in this case) with very low normal stresses.

- The reports state "there is a terrace of mined placer tailings between the slope and Lightning Creek…. (which) could lead to long term stability issues." Relative to this concern, the non-AML waste rock storage area should be designed such that it does not cause degradation of the underlying warm permafrost, and that design must be signed off by a Geotechnical engineer.

7.2.5.2 DSTF Site

Based on the documentation reviewed the DSTF and Mill Site immediately east of Cristal Lake has been moved south to the Flame and Moth site, and that a geotechnical investigation consisting of test pits for this site is currently underway.

This potential site is located approximately 1 km west of Keno City. The natural ground topography slopes up from the west to the east. Documentation for this area is contained in an EBA Engineering Consulting Ltd. letter dated April 29, 2009 and an Alexco letter dated May 6, 2009. From these reports, the following may be summarized.

- The DSTF would generally be placed in an undisturbed area, however the western limit of the tailings may extend onto a previously disturbed area. The tailings may be up to 10 m thick.
- The foundation soils have been assumed to be bedrock or shallow overburden.
- The EBA report outlines that permafrost is not anticipated in the area previously disturbed by mining activities, but it is possible that permafrost exists in the undisturbed areas. The May 6, 2009 Alexco report assumes there permafrost is not present at the DSTF site.
- The mill foundation would be on bedrock.

Given that detailed level investigation and design for this site is currently ongoing, the potential concerns relative to the development are conceptual and are as follows:

Slope failures caused by a disruption of a potential permafrost layer – Warm tailings placement may thaw permafrost, altering shear strength parameters and potentially causing slope movements. Slope movements may impact the lower diversion structure potentially allowing effluent into the general environment.

Slope failures caused by improper placement methodology – Depending on the native foundation soil, excess pore pressures may be generated within the native soils during tailing placement. Excess pore pressures have the tendency of reducing the effective strength of soil material thereby decreasing the stability. The mitigation discussed below will address several questions from the seeking views period.

Lack of understanding of previously disturbed areas – The shear strength parameters of disturbed soil can be significantly less than similar intact soils. This may have a significant impact on the stability assessment and if not characterized effectively could lead to slope stability issues.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- As outlined on Appendix E of Project Proposal – Conceptual Tailings and Waste Rock Management Plans.
- Detailed geotechnical investigation and design for this site is ongoing. Mitigations will be derived from this investigations and design.

On the basis of the proposed mitigations, it is believed there remains a significant and potentially adverse impact relating to ground stability associated with the DSTF proposal.

Recommended Mitigation

The rationale for the potential effects and proposed mitigation is that the geotechnical investigation and stability design is currently ongoing and must be completed as part of the detailed design:

- The geotechnical investigation and final design must therefore be of sufficient detail to identify permafrost (i.e. temperature readings in both disturbed and non disturbed areas), identify the groundwater levels (piezometers), and characterize the native soils (both within the non-disturbed and disturbed areas) so that a detailed stability assessment can be performed.
- The stability assessment must include potential settlements of the native soil caused by the tailings placement, site preparation required prior to tailing placement, stability assessment during tailings placement, and the long term stability under design loading conditions.
- Detailed design of the mill building so as not to disturb permafrost.
- All placement methodologies must be signed off by a qualified geotechnical engineer.

With the successful application of these mitigations, there will be no significant or adverse impact associated with these operations.

7.2.5.3 AML Waste Rock Disposal

This potential site is located approximately 500 m south of the non-AML disposal site, adjacent to the Bellekeno Mine. The natural ground topography at this location slopes up from the east to the west. Detailed geotechnical information relative to this potential site and the design considerations are not available beyond generic waste containment documentation.

The potential effects of the AML waste rock disposal include degradation of permafrost; slope movements caused by improper placement methodologies, and slope movements caused by improper final design geometry. All of these potential effects could impact haul roads, dramatically impact the local water quality by effluent migration from slope movements, and potential impact on local plant and wildlife.

Consideration of Proponent's Mitigation

The mitigation proposed for the AML waste rock disposal location are essentially the same as those indicated above for other disposal locations. On the basis of the proposed mitigations, it is believed there remains a significant and potentially adverse impact relating to ground stability associated with the AML disposal location proposal.

Recommended Mitigation

The rationale for the potential effects and proposed mitigation is that additional information is required. The native soil types, groundwater level conditions and the presence of permafrost is not known. All of these factors will have an influence on the final disposal geometry and the effectiveness of the containment strategy.

- To evaluate the potential risks associated with this site as a AML storage facility and the potential effects this may have on the environment, detailed design information will need to be supplied outlining existing site conditions (native soils, permafrost, groundwater conditions, etc.), and rock placement methodology and geometry. The generic waste containment documentation can then be tied to the placement methodology on the slope.
- All placement methodologies must be signed off by a qualified geotechnical engineer.

With the successful application of these mitigations, there will be no significant or adverse impact associated with these operations.

7.3 CUMULATIVE EFFECTS ASSESSMENT

As per section 42 of YESAA, an assessment of cumulative effects shall consider the interaction of residual effects of the proposed project on Environmental Quality with the residual effects of: projects for which proposals have been submitted for assessment under YESAA; and existing, or proposed activities that are known to the Designated Office. Interactions between residual effects of these activities combined may produce significant adverse cumulative effects.

7.3.1 Historical Context

The historical context is provided in Section 5.4.1.

7.3.2 Overview

The temporal and spatial overlap is described in Section 5.4.2.

7.3.3 Proposals Submitted

Proposals submitted are listed in 5.4.3.

7.3.4 Existing or Proposed Activities

Existing or proposed activities are described in 5.4.4.

7.3.5 Residual Effect Characterization, Interaction and Determination of Significance

Residual effects of noted activities potentially include contamination from fuel spills/leakages, erosion and permafrost degradation. The proponent is proposing to use existing access roads where possible, build new facilities (including a mill, a dry stack tailings facility and waste rock storage areas), construct new access roads to these facilities and to build a new segment of a haul road which includes a new bridge crossing over Lightning Creek. Further the proponent is planning on using or upgrading existing secondary containment for fuel storage and wastewater storage facilities, and they will also update current fuel spill contingency plans and training for staff to minimize potential effects. It is the opinion of the assessor that cumulative effects to environmental quality associated with this project after mitigations, including those proposed by the proponent, are not significant.

8.0 WILDLIFE

8.1 OVERVIEW

Project activities such as construction of waste rock disposal areas, construction of a mill at Flame and Moth and production of ore, use of mill reagents, temporary storage of tailings, haulage of ore, construction of surface infrastructure to support the mill, discharge of Bellekeno mine and Flame and Moth mill treated water, and shipping mill concentrate have the potential to affect wildlife in the area. Specific concerns that were raised regarding the effects to wildlife include:

- valuable wildlife research specifically woodland caribou observations not being reported,
- potential bear human conflict as a result of camps and waste management,
- habitat destruction at Christal Lake and avoidance of wildlife as a result of undertaking the project.
- effects of contaminants on wildlife

8.1.1 Relevant research

At this time little is known about caribou in the Keno area other than they are woodland caribou. Since the Forty-mile herd stopped coming into this area 40-50 years ago, there have not been large numbers of caribou in the Mayo-Keno area. There have, however, been regular reports of smaller groups of caribou in the general Keno area, including winter observations around Tiny Island Lake and along the Keno-Ladue River in the 1980s and more recent summer observations on Rambler Hill, Bunker Hill, Mount Hinton, and a few on surrounding mountain blocks. Most of these are of small (<10 animals) groups. Caribou were observed by the regional biologist on Bunker Hill in the summer a few years ago, but there was no sign of them in a quick search of those same mountains during the rutting season. They were frequently seen by Keno residents and miners in that every year during the summer. These caribou are a long way from the ranges of any known herds—the closest are the Ethel Lake herd to the south, which does not range north of the Stewart River, and the Bonnet Plume herd to the north, which does not range south of the Werneckes. There is some uncertainity as to whether these caribou are wanderers from known herds or if they are part of a small undocumented herd in the area.

The regional biologist in Mayo has been trying to collate all sightings. More information is required to justify radio collaring of the caribou will be done in the near future to determine where these animals go in the winter months. At this stage every sighting is a piece of the puzzle to understanding this population. Every sighting that is reported is valuable and helps to build a database that may eventually help resource managers to understand where these animals came from. The proponent has committed to reporting all sightings of caribou. The proponent will also encourage employees to keep a wildlife log which will add to the database in the region and therefore the effects on valuable research related to wildlife sightings is considered not significant.

8.1.2 Bear, human conflict and nuisance wildlife

Bears commonly utilize valley bottom and stream corridors as travel routes, as well as alpine and sub-alpine areas. Mining exploration activities, including the location of long term seasonal camps, usually are situated in similar settings. Such activities associated with noise from heavy equipment may cause disturbance and avoidance of wildlife to the area; however without threat or danger, wildlife can become accustomed to routine noise.

A longer-term mining camp has a higher likelihood of encountering a bear visitation than a short-term camp, regardless of waste management procedures. However, if bears are not adequately deterred from a camp, or if they receive food rewards, the likelihood of encountering bears in the camp increases further. Bears constantly assess risk and reward situations and when adequate deterrent (risk) is applied, bears usually will stay away from camps. Conversely, bears conditioned to seeking food at camps become increasingly bold and often are killed in protection of property or life, resulting in direct wildlife mortality.

The remoteness of a project does not diminish the likelihood of habituating bears to human presence. Bears can become accustomed to human activities in a remote area as easily as in a populated area, such as suburban neighborhoods in the City of Whitehorse. If human activities do not seem threatening, bears are not deterred by routine activities and noise.

8.1.3 Avoidance

Activities such as clearing land, removing habitat, human presence and noise from equipment are likely to deter wildlife from the surrounding area known as a zone of influence. Development of the mine related infrastructure may result in habitat loss, both direct and secondary. Direct habitat loss will be associated with the project footprint, including the new section of haul road and Mill Site development. Secondary habitat loss may result from avoidance of functional range as a result of noise and human disturbance. Locating the proposed project in the vicinity of an occupied community where human activity including noise and dust is already present is an effective mitigation for secondary habitat loss for wildlife. Locating a new disturbance in an area where there is little or no human activity would create a significantly greater avoidance area or zone of influence Noise and dust have been addressed in sections 6 and 7 of this report.

8.1.4 Contaminants – water quality, dust suppression

Willow is present throughout the project area and a main food source for moose. Information from the previous assessments discuss metal loading in the soils throughout the project area. Willow absorbs some of the metals present in the adits and potentially could bio-accumulate in moose utilizing the plants as a food source. Metals can also be consumed by moose that drink from affected water sources and eat aquatic vegetation from tailings ponds and untreated water sources.

Ongoing research by Gamberg Consulting on contaminants in Yukon caribou and moose provided the opportunity to compare contaminant results between the project area and the rest of the Yukon on a suite of 23 elements. Moose sampled in the five sub-zones overlapping with the project area were compared to those sampled throughout the rest of the Yukon. All elements were compared and most of them were not statistically different between the project area and the rest of the Yukon. Exceptions were arsenic and barium which are higher in moose in the project area. These concentrations were, however, well below levels of concern and therefore are not considered significant. The levels of arsenic in moose within the project area when compared to normal levels in beef fit for consumption were below normal range. Therefore the effects of contaminants on moose and caribou for this project are considered not significant.

8.1.5 Hunting success

Results from surveys conducted between 1993 and 2006 and the annual ground based monitoring program in the fall from 2001 – 2006 indicate that, in general, the density of moose in the Mayo-Elsa-Keno area is higher than the Yukon average (about 150 moose per 1000 sq km) at about 205 moose per 1000 sq km. Recruitment has varied from year to year, as is normal, and over the long term it has been adequate to sustain moose populations with normal levels of natural and harvest mortality.

Based on results from censuses, moose numbers increased in the Mayo area between 1993 and 1998, and stayed about the same between 1998 and 2006. The 2006 census showed good calf survival in that year, fairly low numbers of yearlings, and a low sex ratio. The number of bulls compared to cows is especially low in the Gustavus Range (the mountains southeast, east, and northeast of Keno), and this is likely due to the easy access provided by mining roads for hunters on 4-wheelers.

Numerous access roads and trails exist to wildlife habitat and wildlife and potentially increases hunter success and reduce survival success of wildlife. Increased harvest in areas nearing harvest thresholds can lead to significant adverse effects on moose and other species. This project proposal does not include any additional accesses in the area and therefore it is unlikely that there will be any significant adverse effects on moose population as a result of the creation of new access for hunters.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Adherence to provisions of Commercial Dump Permit No: 81-012. Camp will be kept clean and combustible waste will be incinerated completely on a daily basis to eliminate odors that may attract wildlife;
- Camp compound will be fenced and gated;

- If wildlife becomes and nuisance or problem a portable electric fence will be installed around the perimeter of the camp. All nuisances/problems with wildlife will be reported to the local conservation officer immediately for assistance in further effective means of reducing wildlife mortality;
- Where possible, existing facilities will be used to minimize new disturbance of lands
- Access to ponds (gates and/or fencing) and adits will be restricted;
- A no hunting policy for project employees will be implemented;
- Firearms will be banned from the mine site except as authorized for protection of employees in the field;
- The use of non company all-terrain vehicles by employees at the mine site will be prohibited;
- Employees will be required to follow posted speed limits;
- Employees are encouraged to fill out the Company's posted wildlife log;
- The Company will participate in education and awareness programs of wildlife through presentations by local residents, members of the Mayo Renewable Resource Council (MRRC), NNDFN, and regional Fish and Wildlife conservation personnel. For example in summer 2007 and 2008, all Elsa employees attended Bear Awareness Workshop presented by YG Fish and Wildlife Conservation Officer;
- The Company will participate in MRRC Big Game Management Planning;
- Caribou observations will be reported to the Regional Biologist in Mayo. This commitment will be added to the Wildlife Management Plan to be submitted to EMR Minerals Resources for approval

Existing Legislation

The following legislation is relevant to this project and its potential effects to wildlife:

- *Wildlife Act*,
- *Migratory Birds Convention Act*, Migratory Birds Convention Regulation *(sec6)*
- *Species at Risk Act*

I am satisfied that effects associated with avoidance of wildlife will be reduced by implementation of the mitigation proposed by the proponent as well as the footprint of the mill and bypass road being in close proximity to an area that is already inhabited effectively reducing the zone of influence of the project by virtue of overlap with existing zone of influence of Keno City. I am also satisfied that compliance with existing legislation will reduce the likelihood of significant and adverse effects to wildlife.

8.2 CUMULATIVE EFFECTS ASSESSMENT

The proposed project occurs in an area that has been exposed to mining and exploration activities historically. Currently there is active placer activity near Keno City which is home to approximately 20 people, the area is surrounded by active quartz claims and mining related activities. This office has assessed 22 projects within 20 km of the proposed project over the past 4 years including 9 placer and 7 quartz indicating the activity level in the area. The new footprint of the proposed project is in close proximity to Keno City and existing activities including human presence. Upon consideration of the proponent's mitigation, I am satisfied that the residual effects from the project will not be significant and adverse.

It is my conclusion that the project will not result in residual effects that in combination with the effects of other projects for which proposals have been submitted or existing/and proposed activities cause significant adverse cumulative (environmental or socio-economic) effects.

9.0 HERITAGE RESOURCES

9.1 OVERVIEW

The proposed project falls in a historically known world class silver mining area dating back to the 1900's. First Nations people are known to have traveled throughout the region for hundreds if not thousands of years. Heritage resources can be discovered at any time throughout the life of the operation. Historic resources include cabins, cache, graves, brush camps and other man-made structures, feathers or objects that have been abandoned and are of greater than 50 years antiquity. Archaeological and palaeontological resources are protected as historic resources as well.

Project activities such as the construction of waste rock disposal areas, construction of a mill at Flame and Moth, construction of surface infrastructure to support the mill, and construction of a water treatment facility have the potential to affect heritage resources in the area. Specific concerns that were raised regarding the effects to historic resources include damage/destruction to historic structures (museum and outbuildings).

I have determined that the proposed project will not result in significant adverse effects to heritage resources. I have provided a discussion on the characterization of potential effects associated with the above noted project activities specifically clearing of land and movement of earth.

9.1.1 Clearing land and movement of earth

First Nations people are known to have utilized the area historically and heritage resources can be discovered at any time. Activities associated with mining that may have an adverse effect on heritage resources by destroying or disrupting artifacts include use of heavy equipment, clearing of land, and earthworks related to mining. Once disturbed or removed, the value of these resources, from cultural or scientific perspectives, may be diminished. Damage to heritage resources is considered a significant and adverse effect. The area around the proposed project has also experienced over one hundred years of mining activity and historic resources related to mining are considered valuable to history of the area and particularly to the museum in Keno. Destruction of historic mining resources would be a significant adverse effect of the project

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186); See Document
- Adherence to the Heritage Resources Protection Plan (Section 4.1.1 of the project proposal)
- All discoveries of heritage resources will be reported to NNDFN government's heritage department and YG Heritage Branch;
- Consultation will be held with local community groups including the NNDFN and YG Heritage Branch prior to infrastructure removal (limited historic buildings in area);
- A detailed Heritage Resource Management Plan for the Bellekeno project area will be prepared as part of detailed planning during the Quartz Mining Licencing stage. In general this plan will address the following:
  - Protection of Historic, archaeological and Palaeontological resources;
  - Development of a protocol to be followed during the discovery of these resources to ensure proper resource protection and reporting; and
  - Heritage awareness training of employees.

Existing Legislation

The following legislation is relevant to this project and its potential effects to heritage resources:

- *Yukon Historic Resources Act*, specifically but not limited to Section 64, and Section 71,
- Archaeological Site Regulation (O.I.C. 2003-73) specifically but not limited to Section 4,
- Nacho Nyak Dun First Nation Final Agreement specifically but not limited to chapter 13, Section 13.3.0, Section 13.8.0 and Section 13.9.0.

Significance Determination

I have concluded that compliance with the above legislation and provisions in the Final Agreement, will eliminate, reduce or control the effect of the proposed project activities on heritage/historic resources. Therefore I have determined that the project will not result in significant adverse effects to heritage/historic resources.

9.2 CUMULATIVE EFFECTS ASSESSMENT

I am aware of proposed activities or other projects for which proposals have been submitted to the Designated Office. There has been extensive exploration and mining activity in the area historically, including full scale mining. The assessor is aware of 22 other projects over the past four years within 20 km of Keno City (see appendix). The proponent is proposing to use existing access where possible and ground truth new access prior to building in order to minimize effects. The foot print of this project is relatively small and most of the area has been previously disturbed. Given the site-specific nature of heritage resources it is the opinion of the assessor that cumulative effects associated with this project after mitigations are not significant.

Residual Effects Interaction and Significance Determination:

Residual effects of such activity potentially include increased access to remote or undiscovered heritage resources; and damage, destruction or removal of site-specific archaeological or heritage resources. Taking into consideration the proponent's compliance with existing legislation and implementation of *Recommended Mitigation* measures, I am of the opinion that the residual effects from the project will not be significant and adverse.

10.0 ECONOMY

10.1 OVERVIEW

In order to consider the potential effects of the proposed project on economy, the spatial scope will include the communities of Keno and Mayo. The economy of Keno City is based on tourism and mining. Residents in Keno City make or have made their living on mining related activities and tourism. Tourism is a much valued economy in Keno City and has been described as a small but growing economy. The economy of Mayo is linked to the provision of services to the people of Mayo and the surrounding areas. One third of the jobs in the community are related to government services, including First Nation and territorial administration. Placer mining and mineral exploration also provide an economic base for the community. Construction is a variable sector, and provided a significant share of employment in 2001. Tourism in the Mayo area is a growing industry. Accommodations, food services, recreation services (i.e. guiding and outfitting) and retail cater to tourists and provide work for local residents.

Project activities such as construction of waste rock disposal areas, construction of a mill at Flame and Moth and production of ore, use of mill reagents, temporary storage of tailings, haulage of ore, construction of surface infrastructure to support the mill, discharging of treated waste water from the Bellekeno mine and Flame and Moth mill, and shipping mill concentrate have the potential to affect tourist satisfaction and health in the area. Specific concerns that were raised regarding the effects to tourism include noise disturbance as a result of the mill being located close to the community and hauling of ore on the bypass road, visual esthetics related to dust, health effects associated with contaminants both in the air and water, and safety of travelers in relation to the hauling of ore and concentrate..

10.1.1 Tourism

Silver Trail Tourism Region

The Silver Trail Tourism Region includes the communities of Mayo, Elsa and Keno - linked by the Silver Trail Highway, as well as Stewart Crossing and remote wilderness rivers of the Peel Watershed. The information in this section focuses on the Silver Trail Highway and surrounding backcountry.

The Silver Trail is a popular side trip from the Klondike Highway and destination for visitors looking for beautiful scenery, interesting communities and a rich mining history, and accessible outdoor activities.

Numerous trails and rough roads support a variety of soft adventure opportunities, and visible historic artifacts and wildlife viewing opportunities make the area an interesting destination for hikers and mountain bikers. Other guided and self-guided activities include fishing, canoeing, boating, horseback riding and dog mushing.

Museums, interpretive centers and publications showcase the regions mining history and wildlife viewing opportunities and local communities offer a range of visitor services and facilities. The ‘Silver Trail Scenic Drive’ is featured in the Yukon Vacation Planner and visitor website.

In 2005-2006, Tourism and Culture undertook extensive research and analysis to better define who the potential markets/visitors are and how to market effectively to them. Part of that research involved finding out - from a potential visitors' perspective - what sets Yukon apart from other similar destinations. Potential visitors ranked beautiful scenery, natural phenomenon, a quiet place to relax and vast wilderness as Yukon's top four attributes. While similar destinations share these attributes, their level of quality here is what sets the Yukon apart. For visitors considering a Yukon vacation "a quiet place to relax" is important. Learning new things, experiencing different lifestyles and outdoor activities also ranked high for potential visitors.

Keno City

Keno has successfully marketed itself as a quiet, unique little town where visitors can relax for a few days, explore the outdoors, learn about local history and see how people live. 'Tranquil and quiet' are a key part of that appeal. Visitors who stay overnight spend considerably more in the town, the region and the Yukon as a whole. Attracting overnight visitors is critical to tourism growth in Keno and that's what local and new businesses have invested in. Visitors are drawn to Keno for its rich mining history, a variety of year round outdoor activities, a core of tourism attractions and services marketed by businesses, government and other partners. Residents and tourism business operators are concerned that activities associated with the proposed project will reduce visitor satisfaction and reduce the potential for tourism growth.

Keno City is a popular tourism destination and an important consideration for visitors choosing to visit the Silver Trail Region. Rustic interesting buildings, an impressive Mining Museum, Alpine Interpretive Centre, campground, restaurant, artist studios and a quiet, relaxed ambience make Keno is a popular stop on the Silver Trail Scenic Drive.

The Keno City Mining Museum is a major tourist draw for Keno and the Silver Trail Region and is an important place to share information about the area. Since it opened in 1982, over 48,800 people have visited the Museum. Over the past five years, between 1300 and 2000 people visited the Museum each summer.

Specific issues raised include:

- Clean air, water and a safe environment
- Noise, dust and visual esthetics associated with the close proximity of the mill
- Access to a variety of year round activities

Mayo

Visitors are drawn to Mayo for its rich mining history, the Mayo Midnight Marathon, wilderness tourism, canoeing, hiking, big-game hunting and fly-in fishing. The Binet House in Mayo is also a popular regional attraction. No concerns were raised by residents or business operators in Mayo regarding the proposed project.

The potential effects associated with the above mentioned specific issues have been addressed in previous sections of this report.

Noise from Crushing Plant

Noise and visual esthetics were raised as issues associated with the Mill Site and infrastructure. Noise effects have been addressed in sections 6, 7 and 11 of this report. The visual aesthetics has been addressed under viewscapes in section 11.

Visitor Health and Safety

Dust and potential air and local water supply contamination were raised as concerns for both visitor health and the health of residents. Health concerns related to dust have been addressed under section 6 of this report. Health concerns related to water supply have been addressed under section 5 of this report.

Negative Economic Effects

Tourism development requires a consistent and sustained investment of time and money in product development and marketing in order to be successful. Over the past 5 years Keno business have developed new products and worked with other businesses, organizations and governments to raise the profile of Keno as a tourism destination. Businesses are seeing a return on their investment and new businesses are being planned and developed.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

- Employee/contractor interaction with Keno City will be limited;
- An Access Management Plan will be developed for the local area as part of Existing State of Mine Closure Plan;
- The Company will work with local community to establish potential mining heritage tourism potential opportunities;
- The Company will conduct mine tours to facilitate public education of the mining industry; and
- Provide financial contribution to establish mining heritage tourism opportunities or facilities.

As stated by Yukon Government Department of Tourism, unless adverse effects are adequately mitigated there is significant potential for reduced visitation with direct economic impacts to existing and developing tourism businesses in Keno and reduce the potential for tourism growth in the area.

Previous sections of this report have addressed the potential adverse effects of the project on the community including, drinking water quality, viewscapes, noise and health and safety. The project does not propose to restrict access to existing trails/roads/areas or to existing activities enjoyed by visitors. In fact the proponent has committed to working with the local community to establish mining heritage tourism potential opportunities. I am satisfied that effects associated with reduced visitation related to tourism have been adequately addressed and the project will not result in significant adverse effects to tourism.

10.1.2 Business

Business owners in Keno City are concerned about the potential effects of the mill location on their businesses. Concerns were raised regarding the project affecting businesses and the market value of infrastructure. Business in Keno City is closely related to tourism and visitation.

Specific issues raised include:

- Decrease in property values
- Decrease in accommodation rental as a result of decreased tourism satisfaction.

Decreased Property Values

Property values are dynamic though arguably currently in a decline in Canada. The Canadian real estate market has experienced steep declines in sales and property values. Sales dropped 17.1 percent in 2008 and the Canadian Real Estate Association is predicting a further drop of 16.9 percent in 2009. It is realized that the Yukon market does not follow that of Canada, real estate agents have confirmed that at least in Whitehorse the trend has been downward in the past year.

> *"Residential property prices are continuing to fall and now there are fears that increases in mortgage rates could put off a lot of investors, especially first time buyers.*
>
> *Canadian home prices fell 5.8% in March from the same month a year earlier, a faster pace of decline than in February, according to the latest published figures from the Teranet-National Bank National Composite House Price Index. It also shows that prices were down 8.5% nationally from the peak in August last year."* (Quote from prpoertywire.com June 9, 2009)
>
> *"Many of British Columbia's lumber mills sit idle. Coal exports are down 40 per cent. The price of natural gas, one of its key commodities, has collapsed.*
>
> *And now, economists say, an industry that had helped fuel the province's economic growth, residential home and condominium construction, is suffering the "nastiest" downturn among the provinces - though there is hope among builders this is the low ebb for the business. Still, B.C.'s building*

*boom has gone bust, even as most of the rest of Canada sees some improvement in the sector." (*Quote from The Globe and Mail, June 9, 2009)

Mining is usually seen as a boom and bust industry. Property values or housing represents more of a long term investment. It should also be noted that this project is proposed for 10 years with a 5 year mine life. The project proposal includes a camp as the primary residence for employees that are not residents of Keno City and Mayo and therefore does not require additional housing in the communities. There are some spin off benefits to businesses that provide lodging and accommodation with the increased activity potentially increasing the clientele in the area (mine visitors such as consultants, regulators, contractors, etc.). The project has the potential to create more jobs for residents of Keno City and the surrounding area which in turn may send property values up. The project will also afford some enhanced infrastructure in the community.

Concerns regarding decreased value of homes and businesses are directly related to tourism, health and safety, water quality, environmental quality and quality of life which have all been addressed previously in this report.

Yukon Government, Department of Economic Development has stated that while Bellekeno is a smaller mining project in terms of production, it will provide employment and business opportunities to residents of Keno City and Mayo and the economic impacts of the project will benefit the Yukon economy as a whole.

Consideration of Proponent's Mitigation

The following mitigation measures proposed by the proponent were considered:

Keno City Socio-economic Mitigation Plan

This mitigation plan has been specifically developed to address the community concerns that have been brought forward by the Keno City Community Advisory Committee and local residents. The plan is intended to address and mitigate potential effects as identified by the community and to maintain the quality of life presently experienced by the community.

1. Communication Protocol

- Implementation of a communication protocol for events, both planned and unplanned. This protocol will ensure that direct communications with the local community continues and provides a mechanism where the community can be apprised of company activities and present issues for identification and resolution. Senior company management will

meet with the Advisory Committee as required and provide activity updates and information sharing as determined by the protocol.

2. Access Management and Traffic

- Mine traffic will be redirected around Keno City to ensure that direct haulage traffic is routed around the community and interference with the local community is minimized. Figure 1-3 shows the proposed routing of traffic around the community. There will be occasional light vehicle traffic within Keno City but all ore haul traffic will be redirected at the commencement of production;
- 20 km/hr speed limit within or near the town;
- No use of engine retarder brakes in town limits; and
- Review of highway access, signage and sign placement with YG Highways.

After consideration of proponent's mitigations and mitigations stated in other sections of this report, I have determined that the effects on economy as a result of this project are not significant.

10.2 CUMULATIVE EFFECTS ASSESSMENT

The proposed project occurs in an area that has a rich mining history, one of the main attractions for tourism. Keno City has experienced the boom and bust cycles of past mining projects. This office has assessed 22 projects within 20 km of the proposed project over the past 4 years, 9 placer and 7 quartz indicating the activity level in the area. Most of these are seasonal projects and/or projects that house staff in camps. The area has been heavily impacted by mining activity historically. After considering proposed and r*ecommended mitigations*, it is my opinion that this project in combination with other known and proposed projects will not have a significant adverse effect on economy related to tourism and business.

11.0 QUALITY OF LIFE

Consideration of comments received revealed concerns with how this project may affect the quality of life. This is related primarily to residents who live permanently in the area. This concern was specific first to what we'll call the "soundscape" and second to the "viewscape". Inherent to discussion of these values is the sense of place that residents have developed with their surroundings.

11.1 SOUNDSCAPE

11.1.1 Overview

The report thus far has considered increased noise primarily as having effects to the health of residents, visitors and workers. Serious health effects are not likely due to the relatively short duration for the operational phase of this project (i.e. 5 years within a 10 year period) and the measures proposed to help alleviate effects. However this report has concluded that minor health effects are likely, such as annoyance, anxiety and sleep disruption. It went further by concluding that these effects, whether temporary, at night or during the day were potentially significant and adverse in consideration of baseline conditions.

The health effects of noise however are just one facet of the discussion. It is possible for residents to enjoy normal health despite the increased noise this project introduces. Yet they may still be affected by it in other, less tangible ways. Noise levels may change the patterns and behaviours of residents. They may not enjoy their sense of place as they once did. These effects are not distinctly health-related. Rather they speak to how a person's quality of life may be affected.

This section intends to further this discussion by considering how increased noise may impact the quality of life of residents of Keno. Since we've mitigated the significant noise levels effecting health, the noise we are speaking to in this section would be the remaining residual level.

11.1.2 Effects Characterization and Significance Determination

Numerous concerns were raised about how quiet Keno is and that "establishing a large industrial complex in close proximity to Keno" would ruin this quality and make it an industrial town. Comments questioned the "short-term gain for long-term cost" and noted that ultimately it is the residents that will have to live with the effects of this project. These concerns are relevant given the continuity of baseline conditions that have existed in Keno for the past 20 years. The potential effects include:

- Changes to normal patterns of living (*e.g.* less time spent outside; less time recreating in areas with mining activity).
- Increased time away from the community to avoid subtle noise effects.
- Changes to emotional constitution (*e.g.* resentment, anger).
- Decreased enjoyment of living in the area.
- Changes to personal sense of place.
- Opportunity costs and perceived economic loss.
- Moving away from the community to recapture an individuals preferred sense of place.

These can be viewed as indirect effects that are associated with the direct health effects discussed above. For example, a build-up of anxiety due to perceived noise increases over time may lead to avoidance of that effect, such as staying indoors more often. One of the things this assessment has achieved then is to ensure that the significant adverse health effects of noise are mitigated. If the direct effects are lessoned substantially so that they are no longer significant, then the likelihood of indirect effects noted above should also be decreased.

Some may argue that there is no health effect needed in order to experience significant effects to their quality of life. This is based on a number of comments that suggested any amount of noise coming from this project would negatively impact life in Keno. However this very perspective makes it difficult for anything to ever change in Keno. It implies that Keno should continue to exist in a static state, its ambient soundscape remaining the same into perpetuity. The reality of course is that Keno, like any other town, is by necessity very dynamic. Its soundscape is continually being adjusted by new noises, whether from seasonal activities such as snow clearing, or isolated incidents such as new construction.

In order to consider this perspective further it needs proper context. When viewing Map 1 – Overview (page 6) what is most striking is the degree to which this region is staked with placer and quartz claims. It speaks volumes about the historical relevance of this area for mining activities. Earlier sections of the report go into further detail. The main point is that mining plays a very important role in the history of Keno and in many ways it is also the reason it even exists today.

A comment attempted to discount this history, observing that for the past 20 years mining has been secondary to the tourist ventures taking place. There is a sense from residents that this is no longer a town wishing to be known only for its mining. The difficulty with this perspective is that mining is traditionally a boom-and-bust economy. A 20 year span of low activity is quite common given fluctuations in world demand, prices for metals and the dynamics of free-market business. While mining has been limited and replaced by other activities, the mining claims and associated rights have remained in good standing. These claims afford their owners certain rights of access under law. The debate about whether mining should occur in close proximity to the commercial and residential areas of Keno was decided a long time ago by whatever government agency of the day granted those rights. Further, those who over time have decided to make Keno their home most likely were aware of the history of this area. More importantly it would be difficult to believe that they were not aware of the prevalence of claims close to town and in the surrounding hills. Since the purpose of mining is ultimately to produce metals, the potential for these claims to be used for mining activity is certain to the extent practicable as long as the subsurface rights remain.

Now despite the legitimacy of these rights, it is acknowledged that in certain circumstances there is potential for conflict to occur between subsurface and surface activities. There are mechanisms in place that have anticipated this dynamic and exist to resolve it as needed and where possible. For example, this is a primary function of the Surface Rights Board. However in this case there is no direct interaction between subsurface and surface rights. The central conflict is how noise produced by the claim holder, as per their proposal, may be transmitted and potentially affect the quality of life of residents nearby. Fortunately there are other mechanisms in place, namely legislation, to help resolve such potential conflict.

Existing Legislation

The following provision from the *Public Health and Safety Act* is pertinent to this discussion.

> *"(1) No person shall create, establish or maintain a condition injurious to health or which is or is likely to become a public nuisance in or on any*
>
> *(a) premises or part thereof,*
>
> *(b) Highway, lane, path, pool, ditch, gutter, water course, well, sink, water or earth closet, toilet, privy, urinal, septic tank, cesspool, drain, dung pit, or soakage pit,*
>
> *(c) stable or other building where birds or animals are kept,*
>
> *(d) building or land used for any work, manufactory trade or business*
>
> *(e) school house, theatre, factory, church, shop, public building, or other building to which the public ordinarily has the right of access."*

This provision ensures that, aside from what has been concluded in this report, the proponent may not establish or maintain conditions likely to become a public nuisance. The *Act* defines public nuisance as follows.

> *"Public Nuisance" includes everything noxious or offensive which affects the property or the health, comfort or convenience of the general public, or of all persons who happen to come within its operation."*

It follows then that, subject to interpretation by those who regulate this *Act*, increased noise beyond a socially acceptable level or at an inappropriate time could be viewed as a public nuisance. Compliance and enforcement of this provision will ensure that in addition to the measures recommended under health, noise introduced by this project will not pose significant adverse effects to the quality of life of residents.

11.1.3 Cumulative Effects

11.1.3.1 *Overview*

The temporal scope for considering the proposed project and other existing or proposed activities is the approximately ten-year duration of this project. The spatial scope includes Keno City and the surrounding area. It is difficult to place a physical boundary to the subject of cumulative noise. The focus is still on potentially affected receivers that live for the most part in Keno City. Therefore the boundary for this discussion will be to the extent that noise from different sources can be heard and potentially be additive to one another.

11.1.3.2 *Proposals Submitted*

The assessor is aware of projects listed in Appendix 4 as being submitted and assessed for this region.

11.1.3.3 *Existing or Proposed Activities*

The assessor is aware of the following activities:

- Placer mining has occurred and continues to occur in some of the same drainages as the proposed project. For example, we are aware that active placer claims and mining activity exists on Lightning Creek and Thunder Gulch, as well as Duncan and Christal Creeks.

- The area is surrounded by numerous quartz claim blocks not associated with the proposed project. A drilling exploration project is permitted and underway within the project area by the proponent and proposed to continue for ten years under this proposal. A mine closure planning exercise is underway for the site by the proponent.

- The Village of Keno includes a number of standard activities that are associated with small towns. For example, extraction of well water; deposit of waste; garbage management; traffic; roadwork and construction.

- The region is also used for fishing, hunting, trapping, berry picking and other recreational activities.

11.1.3.4 *Residual Effects Characterization, Interaction and Determination of Significance*

Despite the application of mitigation noted in this report noise will still be introduced as a result of this project but it won't be above a threshold for significant adverse effects. Therefore the residual effect is noise emissions of a lower pressure level (i.e. lower dBA). In relation to Keno

this residual effect should not cause any considerable health or quality of life effect. Of course outside of Keno as one gets closer to the mining activities the noise emissions will be louder. Residual effects could include annoyance and stress.

These residual effects would likely be the same for any other activities that cause noise emissions outside of normal ambient levels. The occasional gunshot heard through the course of hunting, or crash of equipment engaged in road work would of course cause a spike in noise emissions beyond the norm. These are likely less of a concern than prolonged noise emissions, say for example with local construction or drilling. Either way these activities could contribute to further annoyance and stress.

This report provided detail as to how noises from different sources can be additive to a certain degree. Given the distances that are likely to exist between noise sources of various activities, it is unlikely that there would be any large additive quality to these activities interacting in time or space. Where activities do interact with those of this project, the additive quality is likely to be minimal. This project probably introduces the highest noise levels in proximity to Keno in comparison to those listed. Therefore the resulting disparity in noise levels means there would be a limited addition of sound pressure to the higher noise.

It's the conclusion of this report that this project will not contribute to significant adverse cumulative effects.

11.2 VIEWSCAPE

11.2.1 Overview

The appearance of a town and its surroundings has an aesthetic quality often appreciated by residents and visitors alike. Keno is no different in this regard than any other town. Residents often have a sense of pride about their community and how it is presented both to themselves and the outside world. This section intends to review potential effects to the aesthetic qualities of the Keno area.

11.2.2 Effects Characterization and Significance Determination

As a mining endeavour this project will have an impact on local aesthetics. The clearing of land, movement of earth, placement of infrastructure and increased heavy truck traffic will affect the viewscape. Potential effects include:

- Light pollution from equipment and buildings operating at night. May affect the natural ambient light levels, especially in winter.
- Increased ground disturbance and clearings.
- Increased litter, off-trail traffic and rutting.

Consideration of Proponent's Mitigation

These effects need to be considered in the context of measures proposed by the proponent. Specific measures include the following.

- Incorporation of light pollution abatement measures.
- Limit employee/contractor interaction with Keno City.
- Reduce new disturbances and use previously disturbed area (i.e. Flame and Moth site) to minimize environmental effects.
- In conjunction with Existing State of Mine Closure Plan develop clean up plan for old Mackeno tailings.
- Environmental monitoring plan to monitor effectiveness of mitigation measures;
- Adaptive Management Plan to provide for contingency mitigative measures and responses.

Significance Determination

Implementation of the proposed mitigation should ensure that effects to the local aesthetic and viewscape are not significant and adverse.

12.0 ACKNOWLEDGEMENTS

It is important to acknowledge the project team that compiled this report. The volume of information presented in this proposal required an impressive effort from the entire team in order to successfully complete this report. The team consisted of the following individuals:

YESAB: Loralee Johnstone
Steve Caram
Kerri Bianic
Russell McDiarmid
Aliesha Narain
Wendy Randall

Stantec: Douglas M. Whiticar, M.Eng., P.Eng., CEA
Steve Wilbur, Ph.D, P.Geo
Neil MacLeod

APPENDIX 1 – LIST OF KEY PROPOSED MITIGATIONS

The following is a compilation of the key mitigations proposed by the proponent and noted in this report. These mitigations are important because they help to mitigate the potential for significant adverse effects. The conclusions of this report are based in part on the understanding that the proponent will undertake these mitigations. Further that the decision body and regulators will ensure, and if necessary, enforce that these activities are undertaken as proposed.

Aquatic Resources

- Implementation of the Water and Wastewater Management Plans (Section 6.1 of the project proposal).
- Implementation of the Waste Rock Management Plan (Section 6.2 of the project proposal).
- Implementation of the Tailings Management Plan (Section 6.3 of the project proposal).
- Adherence to the current water quality discharge standards under existing Water Licenses (QZ06-074 and QZ07-078) rather than the limits under MMER.
- Installation of groundwater monitoring wells in the vicinity of the Flame and Moth Mill Site.
- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186).
- Maintain and use existing water treatment system at Bellekeno 625. Construct new water treatment and retention infrastructure at Mill Site in order to not release non compliant water. Settlement ponds will be used to settle out metals and sediment.
- Depyritize tailings to be placed in dry stack tailings facility to insure long term geochemical stability.
- Collect and recycle water runoff from dry stack tailings facility and mill pad to reduce discharge and freshwater makeup needs.
- Store pyritic tailings underground in Bellekeno 625 below water static level to prevent oxidation.
- Adit water use activities will be controlled to ensure capacity of water treatment facilities and discharge requirements are met.
- Adit water will be reused and recycled.
- Freshwater intakes will be screened as per DFO "*Freshwater Intake End-of-Pipe Fish Screen Guideline"* (DFO, 1995).
- Adherence to applicable DFO Operational Statements (i.e. Culvert Maintenance).
- Ensure physical and chemical stability of waste rock storage facilities by adhering to the physical inspection plan as submitted under Water Licence QZ07-078; and (Section 6.2.4.17 of the project proposal).
- Undertake routine inspections, monitoring and maintenance of treatment facilities.
- Undertake periodic de-sludging of settling ponds and disposal in existing sludge storage areas.
- Conduct routine receiving water quality sampling in accordance with monitoring programs (Section 6 and 7 of the project proposal) to inform mitigation measures and control metal levels.

- Implementation of adaptive management plans and contingency measures for water treatment system operations as required ensuring continued system operations including for discharge water exceeding applicable criteria.
- Use of existing roads, trails and disturbed areas where practical.
- Non-AML rock type will be used in road construction.
- Specialized handling of potentially-AML rock in accordance with the Waste Rock Management Plan (Section 6.2 of the project proposal).
- Routine monitoring and inspection of all surface expressions of Bellekeno underground workings for early detection of subsidence and drainage changes.
- Where possible, undertake clean up of old Mackeno tailings (planning developed under Existing State of Mine Closure Plan).
- Riparian area along watercourses will not be disturbed.
- No drilling will be undertaken within 30 meters of a fish-bearing stream. DFO will be consulted on a case-by-case basis if questions arise regarding exploration activity near a stream.
- Conduct routine physical inspections and water quality and flow monitoring at Bellekeno mine workings to ensure physical stability and chemical stability.
- Ensure proper transport, storage, handling and disposal of all chemicals, reagents, and fuels. A response team will be identified for implementing the Emergency Response Plan (see Appendix G in Volume 2 of the project proposal).
- Hazardous materials will be stored away from watercourses in a controlled area.
- Waste materials will be handled and stored properly.
- Solid waste will be disposed within an existing dump No 81-012 permitted by the proponent.
- In order to further increase the robustness of the Bellekeno 625 treatment system, a clarifier similar to the one added at Galkeno 300 will be implemented/used.
- Install groundwater monitoring wells in the vicinity of the Flame and Moth Mill Site.
- Abide by current water quality discharge standards under existing water licenses (QZ06-074 and QZ07-078) rather than the limits under MMER.
- Waste and water management plans will be implemented to mitigate environmental effects.
- An environmental monitoring plan will be implemented to monitor effectiveness of mitigation measures.
- An Adaptive Management Plan will be implemented to provide for contingency measures and responses.
- In conjunction with Existing State of Mine Closure Plan develop clean up plan for old Mackeno tailings.
- New disturbances will be reduced; previously disturbed areas will be used.
- Groundwater monitoring wells will be installed within the vicinity of the Flame and Moth Mill Site.

Health and Safety

Noise

- Ensure that the mill location is greater than 1.0km from the center of the community.
- Ore haulage to/from Bellekeno and the Flame and Moth Mill will be conducted on day shift only (7 am – 7 pm).
- Mill doors will be oriented away from the community and sound baffling will be installed.
- The crushing facility will only be operated during the day shift (7 am – 7 pm).
- The mill building will be insulated for noise reduction.
- Sound abatement panels or walls will be constructed around the crushing facility to reduce noise.
- Engine retarder brakes will not be used within town limits.
- Employee/contractor interaction with Keno City will be limited.
- Concerted and earnest attempts will be made to develop a fair and valid sound monitoring program for Keno City;

Public Safety - Contaminants

- Dust suppressants including, but not limited to, water spraying will be used as appropriate.
- Progressive development and reclamation of Dry Stack Tailings Facility including dust suppression will be undertaken.
- In the final year, open area will be recovered with a natural evapotranspiration cover as per the previous four operational years.
- Revegetation with a native seed/fertilizer mixture will be undertaken.

Public Safety – Site Access

- Site orientations will be given to all employees and visitors.
- Traffic will be controlled on mine access road. Communication and notification of hazardous materials transport to the site will be undertaken.
- Mine and Mill Site access road will be gate restricted and public access to the site discouraged. Physical restriction and security monitoring will ensure that the public is not exposed to project site accidents or malfunctions.
- Mine workers will be transported using a company bus to reduce traffic.
- Mine traffic will be redirected around Keno City to ensure that direct haulage traffic is routed around the community and interference with the local community is minimized. Figure 1-3 shows the proposed routing of traffic around the community. There will be occasional light vehicle traffic within Keno City but all ore haul traffic will be redirected at the commencement of

production.

- 30 km/hr speed limit will be maintained within or near the town.
- Highway access, signage and sign placement will be reviewed with YG Highways.
- A representative from Keno City with road building experience will be invited to accompany our engineers during final route planning for the Keno City Bypass in order to obtain valuable local knowledge and additional community input.
- Radio controlled areas will be available.
- All highway regulations will be followed for speed limits and use of air brakes.

Worker Safety – Chemicals, Emergencies, Accidents and Malfunctions

- Occupational Health and Safety Act and Occupational Health and Safety Regulations will be enforced for all personnel on the site.
- Employees will be educated on the potential risks associated with their position and be properly trained.
- The Emergency Response Plan which includes the Spill Contingency Plan (see Appendix G in Volume 2 of the project proposal) will be posted and implemented as necessary.
- Emergency Response Plan training will be provided.
- Training will be provided to all staff on general safety and safe vehicle operations.
- Supervisors and emergency personnel will be on site at all times to address accidents/malfunctions. A first aid attendant will be on site at all times
- Weekly staff safety and education meetings will be held.
- A Safety Committee will be established and maintained.
- Medical and emergency response equipment and trained personnel will be on site 24 hours a day during operations.
- Site and mobile communications will be provided.
- Radio controlled areas.
- Employees are covered by Workers Compensation;
- Vehicles will be equipped for winter travel and will carry emergency first aid kits;
- Treatment contingency measures and back-up systems will be available to minimize accidents and malfunctions;
- Alcohol and drug screening as a pre-employment condition;
- Consumption of alcohol and ‘recreational’ drugs will not be allowed on site by employees;
- Monitoring and maintenance to ensure facility and worker safety and equipment integrity;
- Treatment contingency measures and back-up systems will be available to minimize accidents and malfunctions.

Environmental Quality

- Settling facilities freeboard will be maintained and decant structures are to be routinely inspected.
- When necessary, diversion ditches will be used for overflow.
- Regulated engineered systems will be used.
- The mill dry stack structures and underground workings will be engineered for stability (i.e. seismic events such as earthquakes).
- Redundant systems will be in place to ensure wastewater treatment systems remain operational during extreme events.
- Spare parts and equipment will be available to ensure equipment failures are replaced/repaired and to ensure continued treatment system operations.
- On site personnel will be trained to maintain redundant systems during emergency situations.
- Climatic conditions will be monitored at existing station to forecast storage requirements.
- Snow clearing equipment will be available on site to maintain mine access road.
- Radio telephone or satellite phones will be on site to ensure communication links.
- Trained first aid staff will be on site at all times during operations.

Wildlife

- Adherence to provisions of Commercial Dump Permit No: 81-012. Camp will be kept clean and combustible waste will be incinerated completely on a daily basis to eliminate odors that may attract wildlife.
- Camp compound will be fenced and gated.
- If wildlife becomes and nuisance or problem a portable electric fence will be installed around the perimeter of the camp. All nuisances/problems with wildlife will be reported to the local conservation officer immediately for assistance in further effective means of reducing wildlife mortality.
- Where possible, existing facilities will be used to minimize new disturbance of lands.
- Access to ponds (gates and/or fencing) and adits will be restricted.
- A no hunting policy for project employees will be implemented.
- Firearms will be banned from the mine site except as authorized for protection of employees in the field.
- The use of non company all-terrain vehicles by employees at the mine site will be prohibited.
- Employees will be required to follow posted speed limits.
- Employees are encouraged to fill out the Company's posted wildlife log.
- The Company will participate in education and awareness programs of wildlife through presentations by local residents, members of the Mayo Renewable Resource Council (MRRC), NNDFN, and regional Fish and Wildlife conservation personnel. For example

in summer 2007 and 2008, all Elsa employees attended Bear Awareness Workshop presented by YG Fish and Wildlife Conservation Officer.

- The Company will participate in MRRC Big Game Management Planning.
- Caribou observations will be reported to the Regional Biologist in Mayo. This commitment will be added to the Wildlife Management Plan to be submitted to EMR Minerals Resources for approval.

Heritage Resources

- Adhere to provisions of the *Quartz Mining Land Use Regulations* Schedule 1 Operating Conditions (MLUA Class 3 LQ00186).
- Adherence to the Heritage Resources Protection Plan (Section 4.1.1 of the project proposal).
- All discoveries of heritage resources will be reported to NNDFN government's heritage department and YG Heritage Branch.
- Consultation will be held with local community groups including the NNDFN and YG Heritage Branch prior to infrastructure removal (limited historic buildings in area).
- A detailed Heritage Resource Management Plan for the Bellekeno project area will be prepared as part of detailed planning during the Quartz Mining Licencing stage. In general this plan will address the following:
  - Protection of Historic, archaeological and Palaeontological resources;
  - Development of a protocol to be followed during the discovery of these resources to ensure proper resource protection and reporting; and
  - Heritage awareness training of employees.

Economy

Tourism

- Employee/contractor interaction with Keno City will be limited;
- An Access Management Plan will be developed for the local area as part of Existing State of Mine Closure Plan;
- The Company will work with local community to establish mining heritage tourism potential opportunities;
- The Company will conduct mine tours to facilitate public education of the mining industry; and
- Provide financial contribution to establish mining heritage tourism opportunities or facilities.

Business

Keno City Socio-economic Mitigation Plan

This mitigation plan has been specifically developed to address the community concerns that have been brought forward by the Keno City Community Advisory Committee and local residents. The plan is intended to address and mitigate potential effects as identified by the community and to maintain the quality of life presently experienced by the community.

1. Communication Protocol

Implementation of a communication protocol for events, both planned and unplanned. This protocol will ensure that direct communications with the local community continues and provides a mechanism where the community can be apprised of company activities and present issues for identification and resolution. Senior company management will meet with the Advisory Committee as required and provide activity updates and information sharing as determined by the protocol.

2. Access Management and Traffic

Mine traffic will be redirected around Keno City to ensure that direct haulage traffic is routed around the community and interference with the local community is minimized. Figure 1-3 shows the proposed routing of traffic around the community. There will be occasional light vehicle traffic within Keno City but all ore haul traffic will be redirected at the commencement of production.

Quality of Life

- Light pollution abatement measures will be incorporated into the mill/mine operation.
- Will seek variance from Yukon Workers Compensation Health and Safety Board to modify backup indicators with strobe light for night time operation.
- Clearing around Mill Site will be minimized to limit mill view.
- Previously disturbed areas will be used to minimize environmental effects.
- In conjunction with Existing State of Mine Closure Plan develop clean up plan for old Mackeno tailings.
- Environmental monitoring plan to monitor effectiveness of mitigation measures.
- Adaptive Management Plan to provide for contingency mitigative measures and responses.
- The entire affected footprint, including berms, ditches, ponds, and mill pad, will be revegetated with seed mixture to prevent erosion.

APPENDIX 2 – LIST OF RELEVANT NON-DISCRETIONARY LEGISLATION APPLICABLE TO THE PROJECT

The following is a notation of the key legislation and associated sections that I believe are relevant for this project. These provisions help to ensure that potential significant adverse effects will not occur. Note that this list is not intended to be a comprehensive list of all the relevant legislation that applies to this project. Rather it is a reflection of the legislation that was discussed in this report. I have confidence that the proponent will adhere to this legislation. Further I expect that the decision body and regulators will enforce this legislation.

Yukon Waters Act, Waters Regulation

Quartz Mining Act, Quartz Mining Land Use Regulations

Navigable Waters Protection Act

Occupational Health and Safety Act, Yukon Occupational Health and Safety Regulations

Environment Act, Spill Regulations *(2-4 respecting spills of substances)*

Fisheries Act

Wildlife Act

Migratory Birds Convention Act, Migratory Birds Convention Regulation *(sec6)*

Public Health and Safety Act

Species at Risk Act

APPENDIX 3 – LIST OF SUBMISSIONS MADE BY INTERESTED PERSONS DURING THE ASSESSMENT

Name of Person or Party	YOR Document Number	Date Submitted
Yukon Government: Energy, Mines and Resources – Minerals Resources Branch	**2009-0001-01-1**	**January 9, 2009**
Keno City Advisory Board	**2009-0030-027-1**	**March 24, 2009**
Keno City Advisory Board	**2009-0030-028-1**	**March 24, 2009**
Keno City Advisory Board	**2009-0030-029-1**	**March 24, 009**
L. Fowler	**2009-0030-030-1**	**March 25, 2009**
C. Hartley	**2009-0030-031-1**	**March 25, 2009**
Klondike Visitor's Association	**2009-0030-032-1**	**March 31, 2009**
V. Priest	**2009-0030-033-1**	**April 1, 2009**
P. Davis	**2009-0030-034-1**	**April 2, 2009**
T. De La Barre **D. Rentmeister**	**2009-0030-035-1**	**April 2, 2009**
I. Schultenkotter	**2009-0030-036-1**	**April 2, 2009**
B. Wagner	**2009-0030-038-1**	**April 3, 2009**
I. Shultenkotter	**2009-0030-039-1**	**April 3, 2009**
T. Casten	**2009-0030-040-1**	**April 6, 2009**
Keno City Advisory Board	**2009-0030-041-1**	**April 6, 2009**
Keno City Advisory Board	**2009-0030-042-1**	**April 6, 2009**
G. Berg	**2009-0030-043-1**	**April 6, 2009**
C. Hartley	**2009-0030-044-1**	**April 6, 2009**
E. &. P. Mueller	**2009-0030-045-1**	**April 6, 2009**
A. Steele	**2009-0030-046-1**	**April 7, 2009**
J. Kelly	**2009-0030-047-1**	**April 7, 2009**
R. Elliot	**2009-0030-048-1**	**April 7, 2009**
G. Keitel	**2009-0030-049-1**	**April 7, 2009**
L. Blackburn	**2009-0030-050-1**	**April 8, 2009**
R. Layman	**2009-0030-051-1**	**April 8, 2009**
N. Hartley	**2009-0030-052-1**	**April 14, 2009**
B. Hartley	**2009-0030-053-1**	**April 14, 2009**
G. Steyrer	**2009-0030-054-1**	**April 14, 2009**

Name of Person or Party	YOR Document Number	Date Submitted
E. Steyrer	2009-0030-055-1	April 14, 2007
L. Swinton	2009-0030-056-1	April 14, 2009
J. & G. Hartley	2009-0030-057-1	April 14, 2009
YG Tourism	2009-0030-058-1	April 15, 2009
Keno City Advisory Board	2009-0030-059-1	April 16, 2009
B. Wagner	2009-0030-060-1	April 21, 2009
Village of Mayo	2009-0030-061-1	April 21, 2009
Y. Bessette	2009-0030-062-1	April 21, 2009
Transport Canada	2009-0030-064-1	April 21, 2009
Yukon Conservation Society	2009-0030-067-1	April 21, 2009
T. Russell	2009-0030-068-1	April 21, 2009
Fisheries and Oceans Canada	2009-0030-069-1	April 22, 2009
B. Wagner	2009-0030-070-1	April 22, 2009
Environment Canada	2009-0030-071-1	April 22, 2009
YG – Economic Development	2009-0030-074-1	April 22, 2009
YG – Assessment & Abandoned Mines	2009-0030-074-1	April 22, 2009
YG – Client Services & Inspections	2009-0030-074-1	April 22, 2009
YG – Minerals Resources	2009-0030-074-1	April 22, 2009
YG – Environment	2009-0030-074-1	April 22, 2009
YG – Heritage Resources	2009-0030-074-1	April 22, 2009
YG - Tourism	2009-0030-074	April 22, 2009
Y Bessette	2009-0030-075-1	April 23, 2009
J. Milley	2009-0030-076-1	April 23, 2009
T. Stad	2009-0030-077-1	April 23, 2009
Y. Bessette	2009-0030-078-1	April 23, 2009
I. Schultenkotter	2009-0030-079-1	April 23, 2009
W. Greinwald	2009-0030-080-1	April 27, 2009
L. Roy	2009-0030-081-1	April 27, 2009
Wilderness Tourism Association	2009-0030-082-1	April 27, 2009
K. Pavlovich	2009-0030-087-1	May 11, 2009
B. Wagner	2009-0030-089-1	May 19, 2009
I. Schultenkotter	2009-0030-090-1	May 19, 2009
N. Nicholson	2009-0030-091-1	May 19, 2009

Name of Person or Party	YOR Document Number	Date Submitted
B. Gilbert	2009-0030-092-1	May 19, 2009
Tourism Industry Association of the Yukon	2009-0030-094-1	May 22, 2009
Y. Bessette	2009-0030-096-1	May 22, 2009
C. Hartley	2009-0030-099-1	May 25, 2009
S. Stange	2009-0030-100-1	May 25, 2009
Yukon Conservation Society	2009-0030-101-1	May 26, 2009
B. Wagner	2009-0030-102-1	May 26, 2009
I. Schultenkotter	2009-0030-103-1	May 26, 2009
S. Stange	2009-0030-104-1	May 26, 2009
Y. Bessette	2009-0030-105-1	May 26, 2009
C. Hartley	2009-0030-106-1	May 26, 2009
YG – Community Services	2009-0030-107-1	May 26, 2009
YG – Economic Development	2009-0030-107-1	May 26, 2009
YG – Assessment & Abandoned Mines	2009-0030-107-1	May 26, 2009
YG – Client Services & Inspections	2009-0030-107-1	May 26, 2009
YG – Minerals Resources	2009-0030-107-1	May 26, 2009
YG – Environment	2009-0030-107-1	May 26, 2009
YG – Health & Social Services	2009-0030-107-1	May 26, 2009
YG – Heritage Resources	2009-0030-107-1	May 26, 2009
YG - Tourism	2009-0030-107-1	May 26, 2009
I. Schultenkotter	2009-0030-108-1	May 27, 2009
J. Milley	2009-0030-109-1	May 27, 2009
J. Milley	2009-0030-110-1	May 27, 2009
First Nation of Na Cho Nyak Dun	2009-0030-111-1	May 27, 2009
I. Schultenkotter	2009-0030-112-1	May 27, 2009
Worker's Compensation Board	2009-0030-113-1	May 27, 2009
Mayo District RRC	2009-0030-114-1	May 27, 2009
J. Milley	2009-0030-115-1	May 27, 2009
J. Milley	2009-0030-116-1	May 27, 2009
Environment Canada	2009-0030-117-1	May 27, 2009

APPENDIX 4 – PROJECTS ASSESSED BY YESAB IN THE KENO REGION

The following projects correspond to the points notated on the accompanying map. The map that follows corresponds to map sheet 105/M.

Projects:

2006-0033 – Marg Property (Land Use - winter access road)

2006-0070 – McNeil Gulch (Placer)

2006-0157 – Keno Hill (Quartz)

2006-0233 – Lightning Creek (Placer)

2006-0293 – Keno Hill Care & Maintenance (Water Board)

2007-0013 – Placer Water License (Placer)

2007-0068 – Placer Mine on Duncan Creek (Placer)

2007-0143 – Keno-Lightning Creek exploration (Quartz)

2007-0186 – Hope Gulch (Placer)

2007-0198 – Duncan Creek Access Road (Highways)

2007-0205 – Wernecke Winter Road (Land Use – Wind River Trail)

2007-0227 – Curly Creek (Placer)

2008-0039 – Bellkeno Advanced Exploration (Quartz/Water board)

2008-0129 – Mount Hinton (Quartz)

2008-0156 – Rip Rap Removal (highways)

2008-0171 – Duncan Creek, Lightning Creek & 40 Pup (Placer)

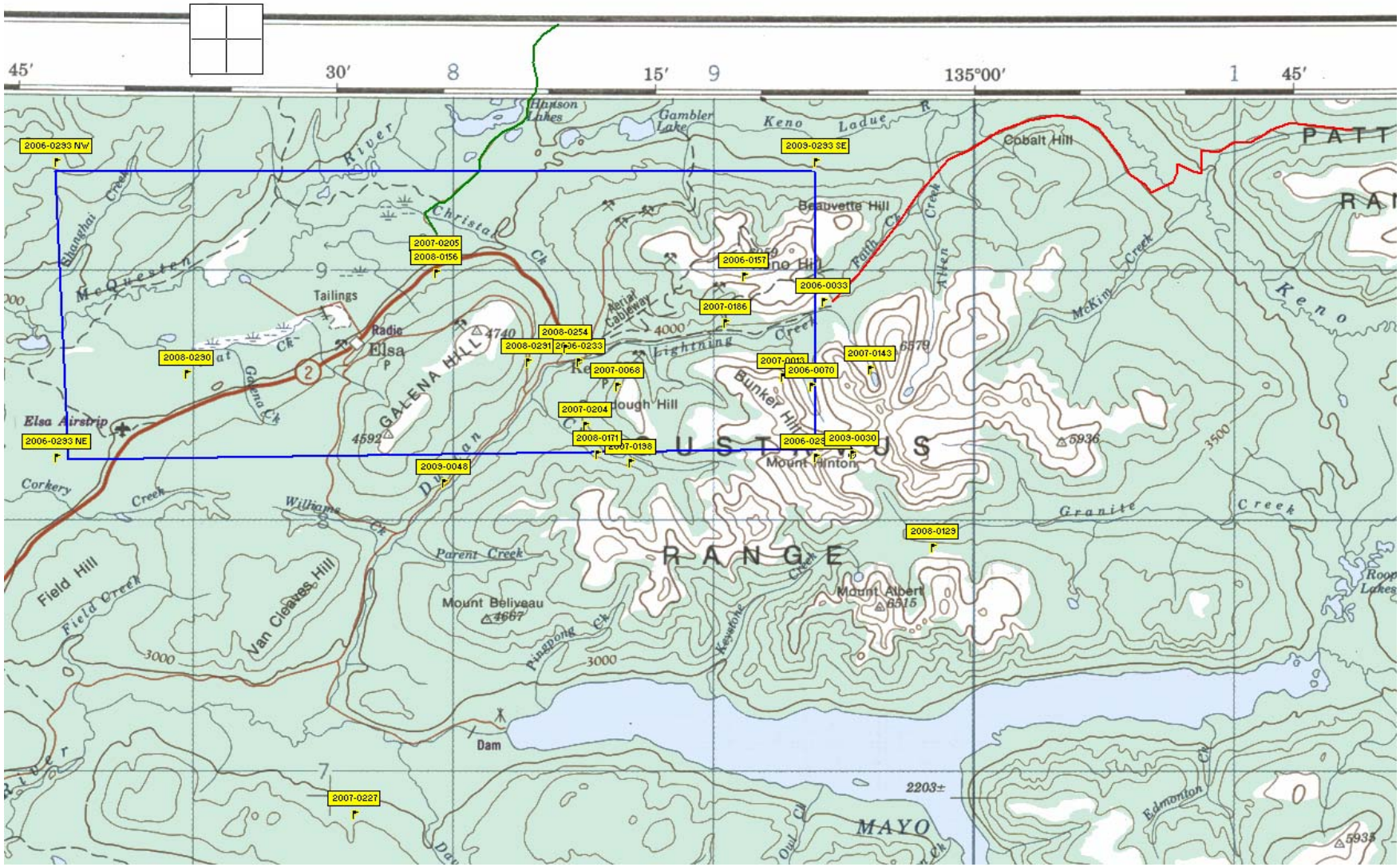
2008-0254 – Keno Solid Waste Facility (Solid Waste)

2008-0290 – Placer Lease (Placer)

2008-0291 – Aurex (Quartz)

2009-0030 – Bellkeno Mine Development (Quartz/Water Board)

2009-0048 – Eagle (Quartz)


45′
30′
8
15′
9
135°00′
1
45′
2006-0293 NW
2006-0293 NE
2003-0293 SE
2007-0205
2008-0156
2008-0230
2008-0254
2008-0231
2006-0233
2007-0068
2007-0204
2008-0171
2007-0138
2003-0048
2006-0157
2006-0033
2007-0186
2007-0013
2006-0070
2007-0143
2006-023
2003-0030
2008-0123
2007-0227
Hanson Lakes
Gambler Lake
Keno Ladue R
Cobalt Hill
Beauvette Hill
Christal Ck
Shanghai Creek
McQuesten River
Tailings
Radio
Elsa
GALENA HILL
4740
Aerial Cableway
4000
Lightning Creek
Bunker Hill
Mount Hinton
5936
Elsa Airstrip
Galena Ck
Corkery Creek
Williams Ck
Parent Creek
Field Hill
Field Creek
Van Cleaves Hill
Mount Beliveau
4667
Pinepong Ck
3000
Dam
RANGE
Mount Albert
6515
Granite Creek
Keweenaw Creek
Edmonton Ck
Owl Ck
2203±
MAYO
5935
3500
Keno
McKim Creek
Faith Ck
Aitken Creek

APPENDIX 5 – PREDICTIONS OF POTENTIAL NOISE LEVELS

Process:

The Roadway Construction Noise Model ("RCNM") is the United States Federal Highway Administration's national model for the prediction of construction noise (US Department of Transportation, 2008**)**. This model is available free from the internet as a downloadable program. It allows for the input of numerous receptors (*e.g.* residence that could be affected by noise) and equipment. Equipment is detailed in terms of

- being an impact device (*e.g.* jackhammer vs dozer);
- % usage factor (i.e. how many hours its used out of a period of time);
- Lmax in positive dBA (i.e. specified or actual noise emission);
- distance to receptor; and
- estimated shielding in negative dBA (*e.g.* enclosed insulated barrier = -10dBA).

Based on input it can produce a summary of the calculated Lmax and Leq for each piece of equipment. More importantly it provides the total combined noise level as experienced at the receptor location. Lmax corresponds to the maximum noise level for a particular piece of equipment in consideration of other equipment. Leq is a more realistic output that considers the % usage factor and other variables.

In order to accurately reflect this project, Table 1 below was created to provide a summary of the key equipment proposed for use. It was divided by the major project components and corresponds to the list of point and non-point sources. The construction of the bypass, Lightning Creek Bridge and water treatment infrastructure have not been included due to the temporary nature of these activities. However they are discussed in the report and utilize some of this information to provide an estimate of potential noise levels.

Estimates for the 'Lmax' sound emission levels were taken from two sources. First, the Central Artery / Tunnel ("CA/T") project in Boston, Massachusetts which helped to develop the "Construction Noise Control Specification" and corresponding noise prediction spreadsheet. This information provides specified and actual Lmax figures for numerous pieces of construction equipment. Second, a

noise impact study that provided some of the more obscure noise levels for the crushing infrastructure.

The RCNM User's Guide provides best practices for calculating estimated shielding levels. Namely the reduction in noise level based on a variety of construction techniques (*e.g.* completely enclosed buildings reduce noise to the outside by 8dBA). These were included based on some of the proposed mitigations.

The model was used to create three scenarios by calculating the potential estimated noise levels from:

- Crushing Operations, Mill Infrastructure and Dry Stack Tailing Facilities
- Mine Site
- Transportation

Each scenario includes a discussion of the specific limitations and things that need to be considered when using the data produced. In general this data simply provides some sort of quantitative reference from which to better discuss the potential for significant adverse effects to the health and safety of residents, visitors and workers.

General Limitations:

- The input data is not comprehensive. For example, crushing and DSTF activities were given a usage factor of 50% which represents them at their highest possible production level. However the real usage level is likely much lower.

- Noise emission levels are not catered specifically to the equipment the company is using. This introduces error in the level of prediction.

- Noise emission levels taken from the Nelson Quarry Extension Noise Impact Study are quite high and the only available reference related to crushing equipment that was found (Rimrott, 2004). While they do nearly match the equipment proposed to be used these numbers may or may not be accurate. As a high number they are at least conservative.

- In some ways the model assumes that all equipment will operate all the time from one location. The % usage factor attempts to remedy the operation time. However the reality is that there will be periods when the project produces very little noise as few of the equipment pieces may be running. And in terms of location, the DSTF and millsite are as close as 60m from one another, making it easy to consider their respective noises as additive. However they are also as far as 300m meaning the specific activities associate with each would not necessarily be additive. Running three scenario's was an attempt to remedy this situation.

- The actual amount of shielding that various construction techniques enable is an estimate provided by the guide. The reality may prove to be more or less.

- This particular model does not allow environmental factors to be accounted for. In general it makes the assumption that noise reflection balances out any possible noise absorption. The reality for this project is of course much different as will be discussed in each scenario. Due to this fact, the numbers presented are viewed as conservative. The reality is likely to be lower once environmental conditions are accounted for and balanced out.

Table 1 – Proposed Activities, Equipment and Noise Emission Level

Activity and Equipment	Equipment Detail	Noise Level (dB) from CA/T Project Study (1994) measured 15m from source	Other Noise Level (dB) from other references measured at source	Proposed Noise Mitigations
1. Crushing Operations – Occurs during dayshift (7am – 7pm) – Point source: located 850m from nearest lot; 50m from Mill Infrastructure				
- Primary Jaw and Secondary Cone	- Trio 20" x 36" jaw crusher, 75 kw. - Simons 4 ¼ shorthead cone crusher, 149 kw		115	-18 (-3 for perimeter barrier; -15 for building barrier)
- Screen, Hopper and Conveyor	Unknown		115	-18 (-3 for perimeter barrier; -15 for building barrier)
- Loader Feed	Primary direct haul dump into hopper, secondary feed with Cat 938 loader	86		-18 (-3 for perimeter barrier; -15 for building barrier)
2. Mill Infrastructure – Occurs during dayshift (7am – 7pm) – Point Source: located 800m from nearest lot; 50m from Crushing Operations				
- Insulated Mill building	Internal equipment including tire-type ball mill, pumps, reagent tanks, agitators, filter press, and auxillary power generator (350kva Cat to operate internal mixers, lights, heat trace and pumps)		90 – 105 = average of 98	-10 (-10 for insulated enclosed building and doors facing away from Keno)
3. Dry Stack Tailings Facility – Occurs during dayshift (7am – 7pm) – Point source: located 775m from nearest lot; 60-250m from Mill Infrastructure and Crushing Operations				
- Tailings management	Cat 938 wheel loader	86		

- Dry Stack management/packing	Cat 815f Soil Compactor	82		
- Dry Stack management/spreading	Cat D6 dozer	85		
4. Mine Site – Occurs 24/7. Specific activities (*e.g.* explosives, ore haul to mill) only occur during dayshift. – Point source: located at Bellekeno East 3km from Keno				
- Surface and underground operations*	D8K Dozer	85		
	Cat 235 Excavator	85		
	Cat 16H grader	85		
	988B Loader	80		
	Tractor Trailer	84		
	30 tonne Crane	85		
	Cat 950 Loader	80		
5. Transportation – Occurs 24/7. Specific activities (*e.g.* haulage of material between mine and mill) only occur during dayshift – Non-point source				
- Road maintenance	Cat 14 H motor grader	85		
- Ore/tails haul	Volvo A30E articulated trucks	88		
	Volvo A30E articulated trucks	88		
- Concentrate haulage	Highway tractor-trailer	88		
	Highway tractor-trailer	88		
	Highway tractor-trailer	88		
- Staff Transit between Elsa, Mine Site and Millsite/DSTF	Van		80	

Scenario #1: Calculation of Potential Noise Levels from Crushing Operations, Mill Infrastructure and Dry Stack Tailing Facilities

Receptor: Keno – using the location of the western-most piece of private property

Equipment:

Description	(%)	Actual Lmax (dBA)	Receptor Distance (meters)	Estimated Shielding (dBA)
Crusher - Feed with Cat 938 Loader	50	86.0	850.0	18.0
Crusher - Conveyor, Screen and Hopper	50	115.0	850.0	18.0
Crusher - Primary Jaw and Secondary Cone	50	115.0	850.0	18.0
Mill Building - Ball Mill, Pumps, Tanks, Agitator, Press	100	97.5	800.0	10.0
DSTF - Cat 938 Wheel Loader	50	86.0	775.0	0.0
DSTF - Cat 815f Soil Compactor	50	82.0	775.0	0.0
DSTF - Dozer	50	85.0	775.0	0.0

Results:

	Calculated (dBA)	
Equipment	Lmax	Leq
Crusher - Feed with Cat 938 Loader	33.1	30.1
Crusher - Conveyor, Screen and Hopper	62.1	59.1
Crusher - Primary Jaw and Secondary Cone	62.1	59.1
Mill Building - Ball Mill, Pumps, Tanks, Agitator, Press	53.1	53.1
DSTF - Cat 938 Wheel Loader	51.9	48.9
DSTF - Cat 815f Soil Compactor	47.9	44.9
DSTF - Dozer	50.9	47.9
Total	**62.1**	**63.0**

Note – This model was also used to calculate the noise level at a closer distance in order to contrast these results. The receptor location used was where the Duncan Creek road and Landfill road meet, roughly 375m away. The Lmax was 68.1 and the Leq 69.1

Specific Limitations:

- The crushing operations, mill building and DSTF are all located downgradient of Keno. The two areas are separated by a narrow valley that is vegetated and treed. The DSTF in particular is located along the bottom slope of a 50m hill. This topography would seem to create a natural barrier to sound. The fact that there is a valley directly connecting the two areas would make it compelling that this barrier may also act to funnel noise into town. However when adding in the vegetation, surface roughness and nearby creek it is more likely that these natural features have a reducing or shielding effect on noise levels produced at Moth and Flame. The amount of reduction if unknown at this time and therefore the only shielding figures included were those attributed to the proposal.

- The model does not account for seasonality. A number of concerns were raised about the transmission of noise during winter. They noted that colder temperatures transmit noise to a greater extent. As with most natural dynamics there are contrasting arguments available. For example, the snow cover present in winter would have an insulating effect on noise emissions. This is due to the greater porosity of snow (approximately 60%) in comparison to hard ground (5-15%). Further the impact of these emissions is likely less in winter than in summer. This is due to the fact that in winter people spend more time indoors. As noted insulated, enclosed spaces tend to reduce dBA emissions by about 15.

- The model does not account for 'bounce-back' noise. Concerns were raised with the Christal Lake millsite that the nearby face of Galena Hill would act to reflect noise back to town. It is difficult to discern the dynamic of reflection, especially in light of other factors such as surface roughness and vegetation which may act to absorb the noise. What is known however is that the further noise travels the weaker the signal. Given this location the assumption is that any noise traveling west and being reflected off of Galena Hill, or south off of the Lightning Creek valley walls, is likely quite depleted by the time it could affect Keno. However this is not known absolutely.

Scenario #2: Calculation of Potential Noise Levels from Mine Site

Receptor: Keno – using the location of the eastern-most piece of private property

Equipment:

Description	(%)	Actual Lmax (dBA)	Receptor Distance (meters)	Estimated Shielding (dBA)
Dozer	40	81.7	3000	0
Excavator	40	80.7	3000	0
Front End Loader	40	79.1	3000	0
Grader	40	85.0	3000	0
Flat Bed Truck	40	74.3	3000	0
Crane	16	80.6	3000	0
Front End Loader	40	79.1	3000	0

Results:

	Calculated (dBA)	
Equipment	Lmax	Leq
Dozer	46.1	42.1
Excavator	45.1	41.2
Front End Loader	43.5	39.6
Grader	49.4	45.5
Flat Bed Truck	38.7	34.7
Crane	45.0	37.0
Front End Loader	43.5	39.6
Total	**49.4**	**49.6**

Specific Limitations:

- This scenario relies upon equipment listed in the Bellekeno exploration project that was assessed last year (2008-0039). It was created simply so that mine operations were not completely discounted as a source of noise that could affect Keno. Running the figures for a basic set of equipment reveals what at first seems a relatively high number given the distance of 3km. However much of this equipment is likely underground, as far as 300m, which will reduce these numbers substantially. More importantly, activities that do occur outside the portal are not actually in site of Keno. They are nearly 1km south of the Lightning Creek valley at which point it is still 2km to Keno. The portal area and Keno are essentially separated by Sourdough Hill. The RCNM guide notes that if a building stands between a noise source and receptor and completely shields the noise source there is a reduction of 15dBA. It is very likely that a mountain the height of Sourdough would go even further towards shielding activity at the portal.

Scenario #3: Calculation of Potential Noise Levels from Transportation

Receptor: Keno – using the location of the southern-most private property

Equipment:

Cat 14 H motor grader	85
Volvo A30E articulated trucks	88
Volvo A30E articulated trucks	88
Highway tractor-trailer	88
Highway tractor-trailer	88
Highway tractor-trailer	88
Van	80

Specific Limitations:

- This scenario is difficult since it is a compilation of equipment that produces non-point sources of noise. It is safe to assume that not all this equipment will be running at any given time or in close proximity to one another. This equipment will likely act true-to-form as non-point sources of noise. However this scenario is important because this equipment will get the closest to Keno, notably at Lightning Creek bridge and where the bypass skirts the southern extents of the community. This means that the dBA indicated for any single piece of equipment could be experienced in close proximity by residents and visitors. This appears to be a maximum of 88dBA.

APPENDIX 6 – REFERENCES

A. Gomez-Caminero, P. Howe, M. Hughes, E. Kenyon, D.R. Lewis, M. Moore, J. Ng, A. Aitio and G. Becking, Arsenic and Arsenic Compounds -Environmental Health Criteria 224. 2nd ed. International Programme on Chemical Safety (2001). 22 Jan 2007 Available from: http://www.inchem.org/documents/ehc/ehc/ehc224.htm

Access Consulting Group, 2008. Fisheries Reconnaissance Field Studies. Unpublished Data, 2008.

Access Mining Consultants Ltd., *United Keno Hill Mines Limited, Report No.UKH/96/01, Site Characterization*. June 3 1996.

Bell, L.H. 1994. *Industrial Noise Control*. CRC Press.

Burns, B., 1996. Biological Monitoring Survey at United Keno Hill Mine Area, 1994. Laberge Environmental Services, Whitehorse, YT, 1996.

Burns, B., 2008. Keno Valley Stream Sediment and Benthic Invertebrate Monitoring Programs, 2007. Laberge Environmental Services, Whitehorse, YT. March 2008.

Canadian Council of Ministers of the Environment. 1999. Canadian water quality guidelines for the protection of aquatic life: Temperature (marine). In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment. 2001. Canadian water quality guidelines for the protection of aquatic life: Arsenic. Updated. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Canadian Council of Ministers of the Environment. 2003. Canadian water quality guidelines for the protection of aquatic life: Guidance on the Site-Specific Application of Water Quality Guidelines in Canada: Procedures for Deriving Numerical Water Quality Objectives. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Davidge, D. and G. Mackenzie-Grieve, 1989. Environmental Quality of Receiving Waters at United Keno Hill Mines Ltd., Elsa Yukon. Regional Program Report No. 89-04. Department of Environment, Environmental Protection, Pacific Region, Yukon Branch. September 1989.

DFO's Intake End-of-Pipe Fish Screen Guidelines (DFO 1995)

Dobson. S., Cadmium- Environmental Effects – Environmental Health Criteria 135, International Programme on Chemical Safety (1992). 22 Jan 2007. Available from: http://www.inchem.org/documents/ehc/ehc/ehc135.htm

Dr C. Dameron and colleagues, and Mr. P.D. Howe, Copper -ENVIRONMENTAL HEALTH CRITERIA 200,International Programme on Chemical Safety (1998) 22 Jan 2007. Available from: http://www.inchem.org/documents/ehc/ehc/ehc200.htm

Drs B. Simon-Hettich, A. Wibbertmann, Mr D. Wagner, Dr L. Tomaska, and Mr H. Malcolm, Zinc-Environmental Health Criteria 221, International Programme on Chemical Safety (2001) 22 Jan 2007. Available from: http://www.inchem.org/documents/ehc/ehc/ehc221.htm

Federal Highway Administration. 2006. *FHWA Highway Construction Noise Handbook*. U.S. Department of Transportation

Health Canada, Cadmium and its compounds - PSL1, Health Canada (1994). 22 Jan 2007. Available from: http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/cadmium_comp/cadmium_comp_2_e.html Page 59 of 61

K.A. Morin and N.M. Hutt. 2000. Prediction of Water Chemistry in Mine Lakes: The Minewall Technique. Minesite Drainage Assessment Group.

Minnow Environmental Inc, 2009. Aquatic Resource Assessment Report for United Keno Hill Mines. Prepared for Elsa Reclamation and Development Company Ltd., Whitehorse, YT, March 2009.

Morth et al. 1972. Pyrite Systems: A Mathematical Model, Contract Report for the U.S. Environmental Protection Agency, EPA-R2-72-002.

Schexnayder, D.J. Effective *Noise Control During Nighttime Construction.* Presentation for U.S. Department of Transportation – Federal Highway Administration.

Schexnayder, D.J. and J.J. Ernzen. 1999. *Mitigation of Nighttime Construction Noise, Vibration and Other Nuisances*. Transportation Research Board. Page 12.

Schexnayder, D.J. and J.J. Ernzen. 1999. *Mitigation of Nighttime Construction Noise, Vibration and Other Nuisances*. Transportation Research Board. Page 9.

Singal, S.P. 2000. *Noise Pollution and Control*. Alpha Science Int'l Ltd. Page 68 - 103.

Singal, S.P. 2000. *Noise Pollution and Control*. Alpha Science Int'l Ltd. Page 68.

Smith, C. Meikle, J. Roots, C.(editors), 2004. *Ecoregions of the Yukon Territory: Biophysical properties of Yukon landscapes*. Agriculture an Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Columbia.

Sparling, P. and M. Connor, 1996. Fish and Fish Habitat Assessment Conducted Near Elsa, Yukon for United Keno Hill Mines August 1994 - Septernber 1995. White Mountain Environmental Consulting, Whitehorse, YT, December 1995.

Sparling, P., 2006. Fisheries Assessments Conducted in the Keno Hill Mining Area, Including Metals Analysis of Fish Tissue Samples, 2006. White Mountain Environmental Consulting, Whitehorse, YT. January 2006.

Trefor B. Reynoldson, Craig Logan, Tim Pascoe and Sherri .P. Thompson, Canadian Aquatic Biomonitoring Network Invertebrate Biomonitoring Field and Laboratory Manual, Environment Canada. Available from: http://cabin.cciw.ca/Application/Downloads/cabin_protocol.doc

United Keno Hill Mines Ltd., *Mine Re-opening Operating Plan, Report No. UKH/96/03*. August 15, 1996.

United States Environmental Protection Agency. Particulate Matter. Available from: http://www.epa.gov/particles/

United States Mine Rescue Association. Mine Gases. Available from: http://www.usmra.com/download/minegases.htm

World Health Organization, Lead – Environmental Effects –Environmental Health Criteria 85, International Programme on Chemical Safety (1989) 22 Jan 2007. Available from: http://www.inchem.org/documents/ehc/ehc/ehc85.htm

World Health Organization, Lead – Environmental Health Criteria 3, International Programme on Chemical Safety (1977). 22 Jan 2007. Available from: http://www.inchem.org/documents/ehc/ehc/ehc003.htm

Wright and Hopky, 1998.

YESAB Online Registry. Document Reference #2006-0157-004-1 and #2006-0157-006-1

YESAB Online Registry. Document Reference #2006-0157-032-2

YESAB Online Registry. Document reference #2006-0293-045

YESAB Online Registry. Document reference #2006-0293-045-1

YESAB Online Registry. Document reference #2006-0293-045-1

YESAB Online Registry. Document Reference #2006-0293-045-1

YESAB Online Registry. Document reference #2008-0039-022-1

YESAB Online Registry. Document reference #2008-0039-041-1

YESAB Online Registry. Document reference #2008-0039-048-1

Yukon Ecoregions Working Group, 2004. Yukon Southern Lakes In: Ecoregions of the Yukon Territory: Biophysical Properties of Yukon Landscapes**,** C.A.S. Smith, J.C.Meikle and C.F. Roots(eds.), Agriculture and Agri-Food Canada, PARC Technical Bulletin No. 04-01, Summerland, British Colombia, p.197-206.

[Book]

Turner, S.A., Roozenburg, A.P. and Francis, T. 2006. *Predicting Accident Rates for Cyclists and Pedestrians.* Ministry of Land Transport, New Zealand.

[Correspondence]

Nelson, I. Personal Communication. Department of Fisheries and Oceans. June 9, 2009.

[Journal]

Keefer, M.L., et al. 2005. *Route Selection in a Large River During the Homing Migration of Chinook Salmon*. Canadian Journal of Fisheries and Aquatic Sciences 63 (8): 1752-1762