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ALEXCO KENO HILL MINING CORP.

ADAPTIVE MANAGEMENT PLAN

KENO HILL SILVER DISTRICT MINING OPERATIONS

July 2018

KENO HILL SILVER DISTRICT MINING OPERATIONS

Prepared by:

ALEXCO ENVIRONMENTAL GROUP

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1 INTRODUCTION

This version of the Adaptive Management Plan has been prepared to include the proposed Bermingham Mine in addition to meeting the requirements under QML-0009 and Water Licence (WL) QZ09-092-2 for the previously outlined project activities. WL QZ09-092 currently specifies the following Licence conditions:

#115.Within 90 days of the effective date of amendment #2 of this licence, the Licensee shall submit to the Board an updated AMP and shall implement that plan. The updated AMP should be based on the contents of the AMP submitted as exhibit 1.12 of Application QZ09-092-2 and shall include, but not be limited to, adaptive management triggers and responses for the following:

- *a) update of AMP Event 2 to include sulphate and alkalinity as indicator parameters;*
- *b) update of AMP Event 8 to identify and respond to erosion before significant erosion occurs and relocation/reorientation of discharge is required;*
- *c) update of AMP Event 12 to include:*
  - *i. KV-50 as an AMP station in Christal Creek;*
  - *ii. thresholds that will trigger the investigation of sources of contaminants that show increasing trends in contaminant concentrations prior to concentrations in the receiving environment exceeding the water quality objectives;*
  - *iii. thresholds based on an increasing trend outside of seasonal norms and compared to 3 years of historical data; and*
  - *iv. update of section 5.7.3 to include comparison of results to data from the preceding 3 years; and*
  - *v. incorporation of revised 95th percentile and UCLM water quality objectives for Christal and Lightning Creek where comparison to the UCLM value will be carried out based on a 12-month moving average:*
- *d) update of AMP Event 13 to include:*
  - *i. an assessment of baseline groundwater quality and groundwater characterization, based on the Yukon Contaminated Sites Regulation Protocol 10, and development of specific triggers for action;*
  - *ii. identification of groundwater quality impacts at the Flame and Moth mine site including the DSTF expansion area and the underground development; and*
  - *iii. thresholds that will trigger the investigation of sources of contaminants that show increasing trends in contaminant concentrations prior to concentrations in the receiving environment exceeding the water quality objectives;*
- *e) development of erosion and/or permafrost degradation at the Lightning Creek and Christal Creek discharge to ground areas at the Flame and Moth mine site;*
- *f) transport of sediment from the Flame and Moth mine site discharge areas into Christal Creek and/or Lightning Creek;*
- *g) change in the water quality of the Flame and Moth adit discharge (KV-105);*
- *h) mine inflow/adit discharge from the Flame and Moth adit (KV-105) greater than predicted;*
- *i) attenuation of the Flame and Moth discharge to Christal Creek does not perform as predicted;*
- *j) presence, water quality and confirmation of source of water observed in the DSTF monitoring wells BH-39 and KV-107; and*
- *k) radium-226 monitoring in the receiving environment as per the Schedule 5, Section 7 (Water Quality Monitoring) of the MMER.*

#116. At a minimum, the AMP shall include the addition of ammonia, zinc, cadmium, selenium and uranium to the parameters being used to establish thresholds and monitor trends for changes in water quality.

In addition, when mining activities resume in the Keno Hill Silver District, this AMP will be reviewed and updated as required to incorporate any modifications to the designs of the Bermingham, Flame and Moth, Onek and Lucky Queen Mines that haven't been constructed to date. Annual reviews and updates of the AMP will also occur to incorporate new monitoring data collected in the previous year and evaluation of monitoring locations, triggers and thresholds be completed.

2 ALEXCO ACTIVITIES IN THE KHSD

Alexco and its subsidiary companies are undertaking care and maintenance, exploration and development, active mining and mill processing activities, and closure studies in the Keno Hill Silver District which includes various activities:

Principal activities: Bermingham, Flame and Moth, Bellekeno, Onek 990 and Lucky Queen Deposits Production and District Mill:

- Mining ore and waste rock from Flame and Moth, Bellekeno, Onek 990 and Lucky Queen deposits;
- Placement of potentially acid metal leaching (P-AML) rock within engineered waste rock storage facilities;
- Placement of non acid metal leaching (N-AML) rock in waste rock disposal areas;
- Construction of earthworks and erosion control protection;
- Crushing, grinding, flotation, thickening, filtration, and production of a lead concentrate, zinc concentrate, and tailings streams related to the lead flotation circuit and the zinc flotation circuit;
- Placement of tailings in the engineered Dry Stack Tailings Facility;
- Placement of tailings and P-AML rock in a cemented rock backfill within the former vein areas;
- Water treatment of water from Bellekeno and Flame and Moth Mines, and potentially from the District Mill and Lucky Queen Mine;
- Use of water for camp purposes and quartz mining undertakings;
- Use of water and wastewater for lime mixing operations;
- Use of water for milling operations; and
- Environmental monitoring, including dust, noise, surface water, groundwater and treated mine water prior to discharge.

Principal activities Exploration, Development, Care and Maintenance and Closure:

- Surface drilling and advanced underground exploration with view to mine development;
- Direct use of water for camp purposes and quartz mining undertakings;
- Direct use of water and wastewater for lime mixing operations;
- Deposit of waste into water and receiving environment;
- Waste rock storage;
- Construction and upgrades to access roads;
- Operation and maintenance of four existing wastewater treatment facilities and associated settling ponds using lime treatment (Silver King 100, Galkeno 900, and Galkeno 300 and the Valley Tailings Area) and the proposed Onek 400 water treatment plant;
- Deposit of waste as lime treatment sludge;
- Construction of earthworks and erosion control protection;
- Storage of wastewater in the treatment settling ponds and Valley Tailings Area; and
- Maintenance of existing diversion channels (Porcupine Creek) and ditches.

Accessory activities:

- Maintenance and operation of site infrastructure related to water treatment systems and access roads;
- Site security and maintenance of site facilities and structures for public health and safety;
- Transport of milk of lime solutions to treatment sites;
- Periodic desludging of treatment settling ponds and transportation or pumping to sludge storage areas which are periodically decanted;
- Mine dewatering for care and maintenance purposes and to advance underground exploration or development;
- Water sampling (effluent and receiving waters);
- Waste rock analysis and classification;
- Environmental monitoring, inspections and sample programs, including monitoring and inspection of physical structures;
- Removal of blockages that have formed naturally or cofferdams that have been constructed as temporary structures to avoid uncontrolled discharge of mine pool water;
- Removal and clean up of infrastructure related to adits, adit structures and facilities;
- Wastewater treatment studies and test programs related to potential closure design options; and
- Operation, inspection and maintenance of the Valley Tailings Area.

2.1 PLANS IN PLACE

Alexco recognizes that the activities associated with the Bermingham, Flame and Moth, Bellekeno, Onek 990 and Lucky Queen deposits and the District Mill are being performed in a historic mining district which includes waters and physical workings at the Keno Hill Silver District that could potentially become an environmental risk or hazard that do not yet require immediate attention. The discharge of treated water, the future discharge of water from the District Mill area, and placement of water treatment sludge is being performed in watersheds that are impacted by historic mining operations. The development of a Keno Hill District Closure Plan is intended to address these water discharges and workings which require further intervention over the long term. As the closure work is implemented, it is expected that changes in the environmental status of the KHSD will be observed.

Several plans are currently in place pursuant to the existing licences and approvals and are referenced throughout this AMP. Table 2-1 lists these plans that have been updated as part of the amendment of Water Use Licence QZ09-092 and the Quartz Mining License QML-009 to guide the management of activities and monitoring associated with operation of the Bermingham, Flame and Moth, Bellekeno, Onek 990 and Lucky Queen deposits, and District Mill.

Table 2-1: Plans updated Under the Existing Mine Licences

QML-009 Plans	WL QZ09-092 Plans
Emergency Response Plan	Sludge Management Plan
Hazardous Materials Management Plan	Groundwater Monitoring Plan
Heritage Resources Protection Plan	Water Management Plan
Monitoring, Surveillance and Reporting Plan	Tailings Characterization Plan
Noise Monitoring and Management Plan	Physical Inspections and Reporting Plan
Traffic Management Plan	Monitoring, Surveillance and Reporting Plan
Wildlife Protection Plan	Spill Contingency Plan
Mine Development and Operation Plan	Waste Management Plan
Mill Development and Operation Plan	Reclamation and Closure Plan
Dry Stack Tailings Facility Construction and Operation Plan	Christal Creek Attenuation Study Plan
Waste Rock Management Plan	
Dust Abatement and Monitoring Plan	
Reclamation and Closure Plan	

This document builds on these plans and is intended to summarize and augment the adaptive management activities already contained in these plans.

3 ADAPTIVE MANAGEMENT PLAN OVERVIEW

3.1 ADAPTIVE MANAGEMENT PLAN OBJECTIVES

An adaptive management plan (AMP) is a management tool designed to guide responses to unforeseen or contingency events respecting for example, water quality and quantity and physical conditions of site workings and infrastructure. The adaptive management approach will provide for assessment of mitigation measures and their effectiveness, and guide the orderly implementation of responses. Since it is difficult to predict the specific environmental condition that may arise which requires a response from management, the AMP does not necessarily provide specific detailed descriptions of responses to a situation. The AMP provides a range of possible responses to use as a guide to respond to specific environmental conditions encountered. Management should use the information provided in the AMP and adapt the appropriate response from this guide, which is the sole purpose of an AMP.

The AMP framework encompassing Company management activities includes:

- routine inspection and environmental monitoring, maintenance and reclamation;
- routine assessment of monitoring and performance data;
- performance thresholds for implementation of appropriate levels of responses for planned contingency measures; and
- reporting of monitoring results and actions.

Results of the monitoring programs (Section 2.2 – Plans in Place) will be assessed on an ongoing basis to determine if any negative trends in water quality, quantity or other parameters are occurring. If the results indicate that there are no negative environmental impacts, then the frequency and length of monitoring and maintenance would continue as usual. Adaptive management will be implemented to respond to negative trends observed through the monitoring programs.

3.2 AMP EVENTS SUMMARY

The district-wide closure AMP identified a number of “events” which represent potential environmental conditions that would require a management response, if they were to occur; these are the first five “events” listed below. The Bellekeno WL clause 91 added nine additional “events” which are in addition to the ones previously identified in the District-wide closure AMP, identified as “events” 6 through 14 listed below. four additional “events” were identified in Water Use Licence QZ09-092, amendment 1, listed as “events” 15 and 16. The events 17 and 18 were developed for Flame & Moth and events 17 and 18. Additionally, the proposed Bermingham mine has been incorporated into the existing AMP events.

1) Change in Water Quality or Quantity:
    - Including, the identification and assessment of trends in water quality in discharges from the Keno Hill Silver District Mill or the Bermingham, Bellekeno, Lucky Queen, Onek 990 or Flame & Moth Mine sites for parameters with and without effluent discharge standards. Assessment of trends and changes in water quantity from the Keno Hill Silver District Mill or the Bermingham, Bellekeno, Lucky Queen, Onek 990 or Flame & Moth Mine sites
2) N-AML Waste Rock Disposal Area(s) Seepage Exhibits AML
    - Waste rock disposal area(s) (including where used for road and general construction) runoff trending to AML conditions
    - Identification of water quality changes from N-AML Waste Rock, including results from kinetic testing
    - Waste rock screening criteria or segregation protocols are ineffective
3) Sludge Storage Area Effectiveness Compromised:
    - Seepage observed near sludge storage area
    - Sludge storage area approaching capacity
4) Physical Instabilities:
    - Area of significant subsidence is observed
    - Rock fall or landslide occurs within a monitored area
    - Structure failure or portal collapse
5) Site Security Compromised:
    - Gate, Fence or Sign Damaged
6) Development of High Pore Pressures Underneath the DSTF
7) Development of Significant Erosion of Exposed DSTF Surfaces
8) Development of Erosion at the District Mill Site and Flame and Moth Discharge Areas
9) Transport of Sediment from the District Mill Site and Flame and Moth Discharge Areas
10) Development of Large Differential Settlements at the DSTF or Approved Waste Rock Storage Facilities
11) Development of Large Differential Settlements Along the Conveyance Flume from the DSTF to the District Mill Site collection and sediment pond
12) Exceedance of Water Quality Objectives in the Receiving Environment Occurring Irrespective of Compliance with Effluent Discharge Standards
13) Identification of Groundwater Quality Impacts at the Bermingham Flame and Moth, Bellekeno, Onek 990, and Lucky Queen Mines or the District Mill Site and Dry Stack Tailings Facility
14) Identification of Water Quality Impacts to Keno City Water Wells
15) Development of Erosion and/or Permafrost Degradation at the discharge areas at the Lucky Queen and Onek mine sites
16) Operation of the Contingency Lucky Queen Water Treatment Plant
17) Fugitive Dust Generated from the DSTF Results in the Exceedance of Yukon Ambient Air Quality Standards or TSP Metal Guidelines
18) Attenuation of the Flame and Moth Discharge to Christal Creek or Bermingham Discharge to No Cash Creek Does not Perform as Predicted

The AMP response for each of these events is described individually in subsequent sections while Table 3-1 at the end of this section provides a summary of the approach to AMP events. The table summarizes the narrative triggers, indicators and response thresholds, monitoring locations and parameters.

3.3 AMP APPROACH

For each AMP event a methodical approach is provided:

1) Description of the event and possible environmental consequences - Addresses issues or information that trigger the AMP;
2) Location of possible event occurrence – Identifies specific working site locations if applicable to event;
3) Monitoring requirements – Identifies the parameters to be monitored, frequency and means for monitoring each parameter;
4) Specific indicators and thresholds - Defines the conditions when management actions should be taken. There may be a series of indicators and staged thresholds for an individual event; and
5) Approach to responses – Description of the approach to responses including a simplified flow chart to guide the implementation process if any specific thresholds have been crossed.

Table 3-1: AMP Summary

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
1. CHANGE IN WATER QUALITY OR QUANTITY					
a. Significant change in water quality of Bellekeno water treatment plant discharge, District Mill decant pond, Onek settling pond decant, Lucky Queen settling pond decant, or Flame & Moth water treatment pond decant	Decline in discharge pH noted or effluent quality trending towards possible exceedance of standards or exceeds licenced standards.	All effluent quality standard parameters	Bellekeno, Onek, Lucky Queen and Mill discharge: Treated effluent: TSS>20 mg/L for three consecutive days; OR Total Zinc > 0.40 mg/L, or pH < 7.0 for three consecutive days; OR Ammonia > 4.0 mg/L and pH > 9.0 for three consecutive days; OR weekly samples exceeds Effluent quality standards. Flame& Moth or Bermingham Discharge: Treated effluent: TSS>20 mg/L for three consecutive days; or pH < 7.0 for three consecutive days; OR and pH > 9.0 for three consecutive days; OR weekly sample exceeds Effluent quality standards.	Bellekeno Water Treatment Facilities (KV-43), Mill Decant pond (KV-83), Lucky Queen settling pond decant (KV-97), Onek settling pond decant (KV-96), Flame & Moth settling pond decant (KV-104), Bermingham settling pond decant (KV-114)	Routine in-situ including ammonia and on-site total zinc, external multi-element ICP, hardness, pH, conductivity, TSS, ammonia
b. Significant change in water quality of adit discharge	Significant decline in field pH or increase in conductivity, zinc, cadmium or ammonia from mine adit discharge to treatment plant	Field pH and conductivity, zinc, cadmium, ammonia	Adit discharge field pH more than 1 pH standard unit lower than historical average or increasing trend towards historical maximum for ammonia, conductivity, cadmium, and zinc	Bellekeno adit (KV-42), Lucky Queen adit (KV-34), Onek 990 settling pond (KV-96), Flame & Moth adit (KV-105), Bermingham adit (KV-110)	Same as indicators
c. Bellekeno adit discharge quantity significantly increases	Observed or measured flows display a sustained and statistically significant increase over historical flow conditions	Flow	Increase of flow to greater than 95% upper confidence level when compared to the average for previous 24 months or 90% licence flow discharge criteria exceeded for seven consecutive days	Bellekeno Water Treatment Facilities (KV-43)	Same as indicators

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
d. Lucky Queen underground workings inflow rate significantly greater than expected resulting in greater discharge than predicted	Observed or measured flows display a sustained and statistically significant increase over predicted monthly inflow conditions	Flow	Increase of flow rate to within 10% of 172.8 m^3/day for seven consecutive days	Lucky Queen adit (KV-34)	Same as indicators
e. Onek 990 portal discharge	The Onek 990 settling pond discharges water after the decline is developed	Flow	Flow from the Onek 990 portal pad settling pond	Onek 990 Settling pond (KV-96)	Same as indicators
f. Flame and Moth or Bermingham underground workings inflow rate significantly greater than expected resulting in greater discharge than predicted	Observed or measured flows display a sustained and statistically significant increase over predicted monthly inflow conditions	Flow	Increase of flow rate to within 10% of 3,200 m^3/day for seven consecutive days for Flame and Moth or increase of flow rate to within 10% of 1,200 m^3/day for seven consecutive days for Bermingham	Flame and Moth adit (KV-105) and Bermingham adit (KV-110)	Same as indicators
g. Identification and assessment of trends in water quality in discharges from the District Mill or the Bermingham, Bellekeno, Lucky Queen, Onek or Flame & Moth Mine sites for parameters without effluent discharge standards	Effluent quality trending towards decreased water quality	Parameters without effluent discharge standards (i.e. aluminium, chromium, nitrate, iron, selenium, uranium, sulphate)	Increasing trend resulting in exceedance of water quality objectives in receiving environment	Bellekeno Water Treatment Facilities (KV-43), Mill Decant pond (KV-83), Lucky Queen settling pond decant (KV-97), Onek settling pond decant (KV-96), Flame & Moth pond decant (KV-104), Bermingham pond decant (KV-114)	Same as indicators
2. WASTE ROCK SEEPAGE EXHIBITS AML					
a. Waste rock seepage or runoff trending to AML conditions	Seepages from waste rock disposal areas or from works constructed or upgraded with non AML material show significant decline in pH or alkalinity and/or an increase in conductivity, sulphate, zinc or cadmium OR approaching	pH, conductivity, zinc, cadmium, sulphate, alkalinity	Significant decline in pH between measurements or pH <7.0 and/or conductivity, zinc, cadmium, or sulphate or showing a significant increasing trend or alkalinity shows a significant decreasing trend; OR indicators approaching licenced effluent quality standards	Waste rock disposal areas (Lucky Queen N-AML dump (KV-98), Bellekeno WRDA, Flame & Moth WRDA, Bermingham WRDA and works or features constructed from N-	pH, conductivity, alkalinity, sulphate, routine multi-element ICP

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
	licenced effluent quality standards			AML material including Bellekeno Haul road,	
b. Identification of water quality changes from N-AML Waste Rock or tailings, including results from kinetic testing	Kinetic testing of N-AML waste rock or tailings shows significant decline in pH or alkalinity and/or an increase in conductivity, sulphate, zinc or cadmium	pH, conductivity, zinc, cadmium, sulphate, alkalinity	Significant decline in pH between measurements or pH <6.0 and/ or conductivity, zinc, cadmium or sulphate showing a significant increasing trend or decreasing trend in alkalinity; OR indicators approaching licenced effluent quality standards	Field bins or humidity cells with N-AML waste rock or tailings, DSTF and waste rock disposal areas (KV-98)	pH, conductivity, alkalinity, sulphate, routine multi-element ICP
3. SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED					
a. Seepage observed near sludge storage areas	Routine inspection of sludge storage area shows seepage	Total zinc, cadmium, pH	pH >8.5, total zinc > 0.5 mg/L, total cadmium > 0.01 mg/L	Valley Tailings sludge storage cell	Same as indicator
b. Sludge storage area approaching capacity	Sludge storage area approaching minimum freeboard of 1.0 metre below the decant point	Visual observation of freeboard	Freeboard is at 1.5 metre below decant point	Valley Tailings sludge storage cell	Same as indicator
4. PHYSICAL INSTABILITIES					
a. Area of significant surface subsidence has occurred	An observed subsidence has exposed an opening to surface or resulted in slope failure	Visible slope failure, ground subsidence or opening on surface	Opening to underground workings or area of subsidence effects public safety or down gradient environment	Keno Hill Silver District Mining Operations	Same as indicators
b. Rock fall or landslide is observed that affects road right-of-way or intrudes into stream	An observed rock fall or landslide effects a road right-of-way, infrastructure or intrudes into stream	Mine source material movement	Source material effects road or stream	Keno Hill Silver District Mining Operations	Same as indicators
5. SITE SECURITY COMPROMISED					
a. Security gate, fence, sign damaged	Public health and wildlife safety measure damaged or removed	Sign, fence, gates, locks	Security feature damaged, removed, or compromised	Keno Hill Silver District Mining Operations	Same as indicators

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
6. DEVELOPMENT OF HIGH PORE PRESSURES UNDERNEATH OR WITHIN THE DSTF					
a. High porewater pressure within groundwater monitoring wells in the DSTF	Porewater pressure is observed in groundwater monitoring wells in the DSTF	Porewater pressure	Tip @1.0m or 1.7m depth – Porewater pressure parameter (Ru) exceeds 0.15	Groundwater monitoring wells in the DSTF	Same as indicators
7.0 DEVELOPMENT OF SIGNIFICANT EROSION OF EXPOSED DSTF SURFACES					
a. Area of significant erosion on exposed DSTF surface	An observed movement of tailings caused by erosion on surface	Visual inspection of tailings surface	Geotechnical engineer or operator inspection identifies adverse operating condition	DSTF	Same as indicators
8. DEVELOPMENT OF EROSION AT THE DISTRICT MILL OR FLAME & MOTH SITE DISCHARGE AREAS					
a. Erosion at the District Mill or Flame & Moth site discharge areas	Erosion and ground degradation is observed in area downgradient of the discharge locations	Visual inspection of area downgradient of discharge location	Geotechnical engineer or operator inspection identifies adverse operating condition	Visual inspection of area downgradient of discharge locations	Same as indicators
9. TRANSPORT OF SEDIMENT FROM THE DISTRICT MILL SITE OR FLAME & MOTH DISCHARGE AREAS INTO CHRISTAL CREEK					
a. Transport of sediment from the Mill site or Flame & Moth discharge areas to Christal Creek	An observation of significant erosion is observed in area downgradient of the discharge location resulting in high TSS discharge	TSS in discharge after final control point and visual inspection of area downgradient of discharge locations	TSS of 20 mg/L in daylighted discharge. TSS of 15 mg/L greater than monthly seasonal average calculated from existing conditions concentration at KV-50. TSS at KV-81 in Lightning Creek is 25 mg/L higher than upstream of Flame and Moth discharge area on Lightning Creek.	Area downgradient of Mill pond discharge (KV-83), and Flame & Moth pond decant (KV-104)	TSS
10. DEVELOPMENT OF LARGE DIFFERENTIAL SETTLEMENTS AT THE DSTF					
a. Significant differential settlements are observed in the DSTF	An observation of significant differential settlements is observed at the DSTF	Displacement of survey monitors and slope indicators	Displacements greater than 25 mm in any direction	Survey monuments and slope inclinometers	Same as indicators
11. DEVELOPMENT OF LARGE DIFFERENTIAL SETTLEMENTS ALONG THE CONVEYANCE FLUME FROM THE DSTF TO DISTRICT MILL SITE COLLECTION AND SEDIMENT POND					

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
a. Significant differential settlements are observed along the conveyance flume	An observation of significant differential settlements is observed in the conveyance flume	Displacement of survey monuments	Displacements greater than 25 mm in any direction	Survey monuments	Same as indicators
12. EXCEEDENCE OF WATER QUALITY OBJECTIVES IN THE RECEIVING ENVIRONMENT OCCURRING IRRESPECTIVE OF COMPLIANCE WITH EFFLUENT QUALITY STANDARDS					
a. A significant increasing trend is observed in receiving environment even though authorized licenced discharges are within effluent quality standards	Receiving environment water quality are trending towards exceeding the water quality objectives.	Arsenic, cadmium, copper, lead, nickel, selenium, silver, zinc, ammonia, nitrate, nitrite, sulphate	Trending towards or exceedance of water quality objective at a receiving environment monitoring station based on seasonal norms compared to preceding 3 years data.	Receiving environment monitoring stations (Christal Creek at KV-50, KV-6, and KV-7, Lightning Creek at KV-81, No Cash Creek at KV-21, and Star Creek at KV-56)	Same as indicators
13. IDENTIFICATION OF GROUNDWATER QUALITY IMPACTS WITHIN THE KENO HILL SILVER DISTRICT MINING OPERATIONS					
a. A significant increasing trend is observed in groundwater near the District Mill (including DSTF) or N-AML Waste Rock Disposal Areas	Total zinc, cadmium or ammonia significantly exceeds baseline measurements for a given monitoring well, and exceeds licenced effluent discharge standards	Total zinc, cadmium and ammonia	Exceedance of the 95th percentile for dissolved constituents that have a surface water quality objective. Statistically significant increasing trend compared to past three years of data	KV-85 to KV-94, LQ-MW-01, LQ-MW-02, KV-116, RB-MW-1, NC-MW-1	Same as indicators
b. Water level within groundwater monitoring wells in the DSTF	Water level is observed in monitoring wells within the DSTF	Water level, total zinc	More than 30 cm of water is in well and water quality trending towards KV-83 EQS	Groundwater monitoring wells in the DSTF (BH39, KV-107)	Same as indicators
14. IDENTIFICATION OF WATER QUALITY IMPACTS TO KENO CITY WATER WELLS					
a. A significant increasing trend is observed in groundwater near Keno City due to the Onek 990 mine	Total zinc, arsenic or cadmium significantly exceeds baseline measurements for a given monitoring well, or parameters listed in the Canadian Drinking Water quality guidelines are exceeded	Total zinc, arsenic, cadmium, and parameters listed in the Canadian Drinking Water Guidelines	Exceedance of the 95th percentile for total cadmium, and zinc Statistically significant increasing trend compared to past three years of data; or Sample result exceeds YCSR drinking water standards.	Groundwater monitoring wells (ON-MW-02, KC-MW-4, KV-84Nd)	Same as indicators

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
15. DEVELOPMENT OF EROSION AND/OR PERMAFROST DEGRADATION AT THE DISCHARGE TO GROUND AREAS AT THE BERMINGHAM, LUCKY QUEEN AND ONEK MINE SITES					
a. Erosion is observed at the discharge to ground areas at the Bermingham, Lucky Queen and Onek mine sites	An observation of erosion is made at the discharge to ground areas	Visual inspection of discharge to ground areas	Geotechnical engineer or operator inspection identifies adverse operating condition	Bermingham, Lucky Queen and Onek discharge to ground areas	Same as indicators
16. OPERATION OF THE CONTINGENCY LUCKY QUEEN WATER TREATMENT PLANT					
a. The use of the contingency Lucky Queen water treatment plant is required	The Lucky Queen water treatment plant is required for treatment and deposit of water as the adit discharge has degraded and the settling ponds are not effectively reducing the metal load in the discharge.	Effluent quality standard parameters and discharge rate	3 consecutive results above 3 standard deviations of the historical average	Lucky Queen adit, (KV-34), Lucky Queen Settling Pond (KV-102), Lucky Queen Settling Pond Decant (KV-97)	Same as indicators
17. FUGITIVE DUST GENERATED FROM THE DSTF RESULTS IN THE EXCEEDANCE OF YUKON AMBIENT AIR QUALITY STANDARDS					
a. Dust generated from the DSTF exceeds Yukon ambient air quality standards and metal guidelines	An increasing trend in fugitive dust from the DSTF and/or haul roads is observed	TSP, PM10, PM2.5 and metals	An increasing trend in TSP, PM10 or PM2.5 measurements or in metal concentrations towards Yukon Ambient Air Quality Standards or Ontario Ambient Air Quality Criteria for metals; An exceedance of the Yukon Ambient Air Quality Standards for particulate matter or the Ontario Ambient Air Quality Criteria for metals in TSP at AQ3.	AQ1, AQ2 and AQ3	Same as indicators

Event	Narrative Trigger	Indicators	Thresholds	Monitoring Locations	Monitoring Parameters
18. ATTENUATION OF THE FLAME AND MOTH OR BERMINGHAM DISCHARGE TO CHRISTAL CREEK AND NO CASH CREEK, RESPECTIVELY, DOES NOT PERFORM AS PREDICTED					
a. Natural attenuation does not remove metals to the degree expected from Flame and Moth or Bermingham Mine discharge and water quality in Christal Creek or No Cash Creek may be degraded and not meet the water quality objectives	The calculated natural attenuation at KV-50 or KV-21 is less than 50% for any of these elements and the WQOs in Table 4-8 are exceeded for KV-50 or KV-21	Cadmium, nickel and zinc for Christal Creek and silver, arsenic, copper, nickel, lead and ammonia For No Cash Creek	Calculated natural attenuation at KV-50 or KV-21 is less than 50% for any of these elements and the WQOs for KV-50 or KV-21 are not met	KV-6, KV-50, KV-104, KV-21, KV-111, KV-114	Same as indicators

4 KENO HILL SILVER DISTRICT MINING OPERATIONS AMP EVENTS

4.1 EVENT 1: CHANGE IN WATER QUALITY OR QUANTITY

Results of water quality and quantity monitoring are assessed on an ongoing basis to determine if significant changes are occurring and if an adaptive management response is required. The following sections describe what constitutes a significant change to water quality or quantity and associated responses that would be implemented.

4.1.1 Significant Change in Water Quality

4.1.1.1 Descriptions

All data for current water sample stations required in the WL QZ09-092 are stored in an EQWin database that allows water quality to be tracked at each site such that conditions can be identified at any point in the season. New sampling stations and their respective data collected for the Flame & Moth Mine are also being stored in the same database. In this way parameters can be tracked, and fluctuations from the normal to levels where management is required to respond can be monitored. Set point triggers can be placed in the database so that response parameters are flagged for notification and action.

4.1.1.2 Locations

Water quality is currently monitored from the Bellekeno water treatment facilities, the Lucky Queen adit and District Mill for potential effects to the receiving environment including loading of down gradient waters. In addition, once Onek is in production, the Onek settling pond and discharge will also be monitored. The Flame & Moth pond decant (KV-104) will also be monitored. These sites are listed below and shown in Figure 4-1.

Water Treatment Facilities:

- KV-43 - Bellekeno 625 Treatment Pond Decant;
- KV-83 - District Mill Treatment Decant;
- KV-104 – Flame & Moth settling pond decant; and
- KV-114 – Bermingham settling pond decant.

Settling Ponds:

- KV-102 - Lucky Queen settling pond;
- KV-97 – Lucky Queen settling pond decant; and
- KV-96 - Onek 990 Portal settling pond.

Adits:

- KV-42 - Bellekeno 625 Adit;

- KV-34 - Lucky Queen Adit;
- KV-105 – Flame & Moth Adit; and
- KV-110 – Bermingham Adit.

4.1.1.3 Monitoring Requirements

Specific parameters from the monitored areas will be compared to specific thresholds to determine if they have been exceeded. Monitoring requirements will change should one of the AMP thresholds be triggered. This could include more frequent monitoring of grab samples at the station location as well as more frequent monitoring of the receiving environment below the site where the trigger was initiated.

4.1.1.4 Specific Thresholds

Specific thresholds for the different categories of monitoring stations that will initiate a response are provided in the following sections.

4.1.1.4.1 Water Treatment Facilities/Licenced Effluent Discharges/Parameters with Effluent Quality Standards

Water quality data from treatment facilities and other potential effluent discharge from Bellekeno 625 decline, District Mill decant pond, Onek settling pond decant, and Lucky Queen settling pond will be assessed to determine if the following thresholds have been exceeded:

- Daily sampling result for pH less than 7.0 units at a water treatment facility decant for more than 3 consecutive days; or
- Daily sampling result for zinc or ammonia trending toward possible exceedance of effluent quality standard; or
- Total arsenic >0.075 mg/L and pH < 7.0 units for three consecutive days; or
- Total cadmium > 0.0075 mg/L and pH < 7.0 units for three consecutive days; or
- Total zinc > 0.40 mg/L and pH < 7.0 units for three consecutive days; or
- Ammonia > 4.0 mg/L and pH > 9.0 for three consecutive days;
- TSS > 20 mg/L for three consecutive days; and
- Sample result exceeds effluent quality standards (Table 4-1 and Table 4-2).

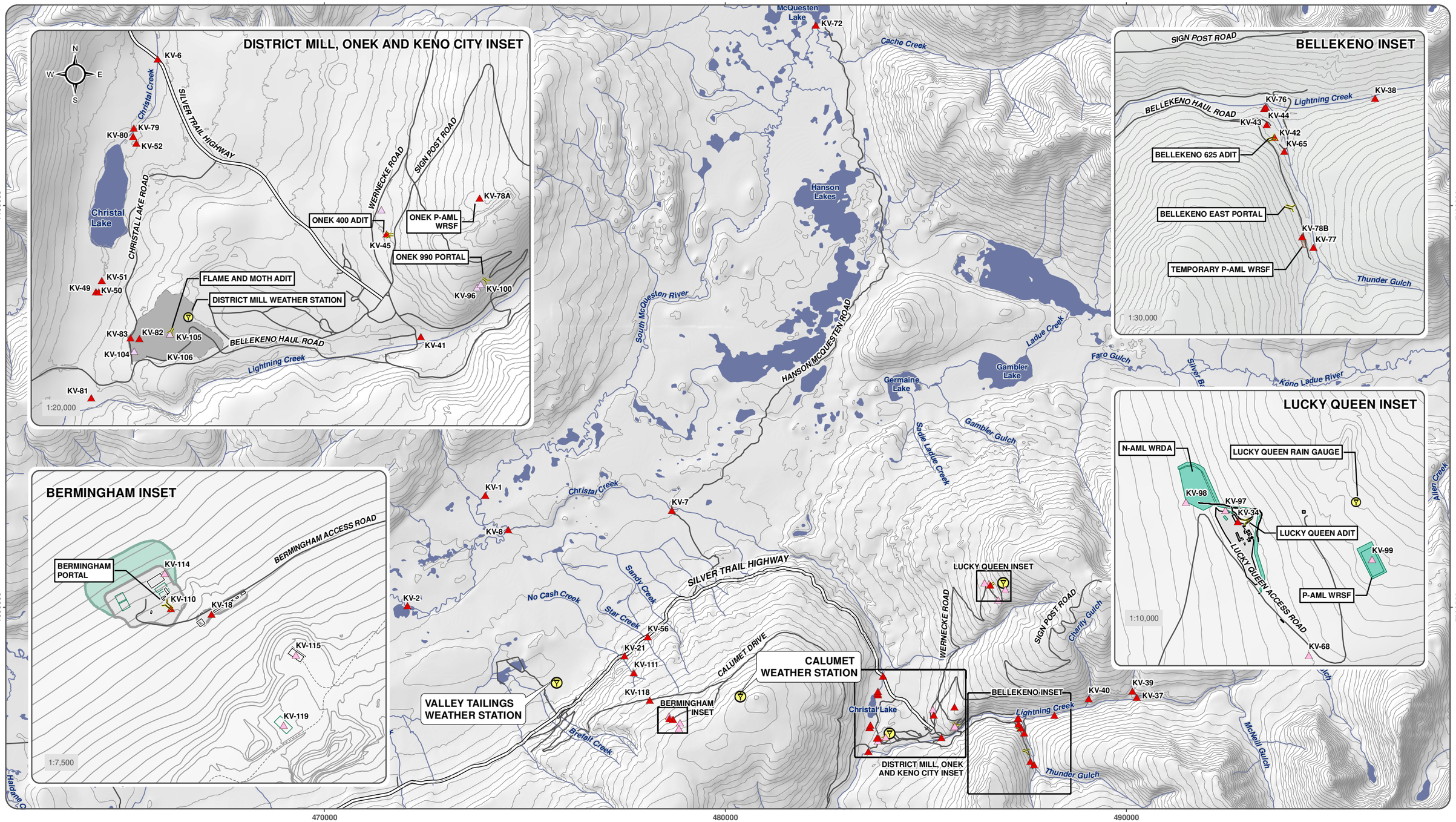
The water quality data from the Flame & Moth pond decant will be assessed to determine if the following thresholds have been exceeded:

- Daily sampling result for pH less than 7.0 units at a water treatment facility decant for more than 3 consecutive days;
- Daily sampling result for zinc or ammonia trending toward possible exceedance of effluent quality standard;

- Results from three consecutive events that exceed 80% of the effluent quality standards (EQS) listed in Table 4-3 and Table 4-4; and
- Sample result exceeds effluent quality standards (Table 4-3 and Table 4-4).

The water quality data from the Bermingham pond decant will be assessed to determine if the following thresholds have been exceeded:

- Daily sampling result for pH less than 7.0 units at a water treatment facility decant for more than 3 consecutive days;
- Daily sampling result for zinc or ammonia trending toward possible exceedance of effluent quality standard;
- Results from three consecutive events that exceed 80% of the effluent quality standards (to be determined through Water Licencing process and AMP updated accordingly); and
- Sample result exceeds effluent quality standards (to be determined through Water Licencing process and AMP updated accordingly).



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Datum: NAD 83; Map Projection: UTM Zone 8N

1:90,000 (when printed on 11 x17 inch paper)

0 1 2 3 4 5 Kilometers

- Monitored Water Quality Station
- Pending/Proposed Water Quality Station
- Weather Station
- Adit
- Mine Feature Footprint
- To Be Constructed Feature
- Silver Trail Highway
- Other Road
- Watercourse
- Waterbody

AKHM

AEG

ALEXCO KENO HILL MINING CORP.

FIGURE 4-1
SURFACE WATER QUALITY STATION LOCATIONS

AUGUST 2018

D:\Project\All\Projects\ALEX-05-01\gis\mxd\Overview_Maps\WQ\02-SURFACEWATER\Specific_Topic\Licenses\SWMonitoring_KenoHill_Qz09-092_20180730.mxd (*Last edited by: amatlashevska; 08/08/2018/15:44 PM*)

Table 4-1: Licenced Bellekeno 625 adit, Lucky Queen Mine, and Onek Settling Pond Effluent Quality Standards

Parameter	Maximum Concentration in a Grab Sample (mg/L)
pH	6.5 to 9.5 pH Units
Total suspended solids	25
Ammonia Nitrogen (as N)	5
Arsenic (Total)	0.1
Cadmium (Total)	0.01
Copper (Total)	0.1
Lead (Total)	0.2
Nickel (Total)	0.5
Radium 226	0.37 BQ/L
Silver (Total)	0.01
Zinc (Total)	0.5

Table 4-2: District Mill Licenced Effluent Quality Standards

Parameter	Maximum Concentration in a Grab Sample (mg/L)
pH	6.5 to 9.5 pH Units
Total suspended solids	25
Ammonia Nitrogen (as N)	5
Arsenic (Total)	0.1
Cadmium (Total)	0.01
Copper (Total)	0.1
Lead (Total)	0.2
Nickel (Total)	0.5
Radium 226	0.37 BQ/L
Silver (Total)	0.02
Zinc (Total)	0.5

Table 4-3: Flame & Moth Effluent Quality Standards for Discharge to Christal Creek

Parameter	Maximum Concentration in a Grab Sample	Maximum Concentration in a Grab Sample	Maximum Concentration in a Grab Sample	Maximum Concentration in a Grab Sample
Discharge rate	Up to 10 L/s	Up to 20 L/s	Up to 30 L/s	Up to 35 L/s
Total As	0.043	0.021	0.017	0.012
Total Cd	0.01	0.01	0.0094	0.0086
Total Cu	0.042	0.026	0.021	0.019
Total Pb	0.131	0.081	0.064	0.056
Total Ni	0.5	0.5	0.5	0.5
Total Ag	0.00089	0.00064	0.00053	0.00049
Total Zn	0.5	0.5	0.5	0.5
pH	6.5-9.5	6.5-9.5	6.5-9.5	6.5-9.5
TSS	15	15	15	15
Ammonia	6.5	3.7	2.7	2.4

Table 4-4: Flame & Moth Effluent Quality Standards for Discharge to Lightning Creek

Parameter	Maximum Concentration in a Grab Sample	Maximum Concentration in a Grab Sample	Maximum Concentration in a Grab Sample	Maximum Concentration in a Grab Sample
Discharge rate	Up to 10 L/s	Up to 20 L/s	Up to 30 L/s	Up to 35 L/s
Dissolved As	0.034	0.020	0.015	0.013
Dissolved Cd	0.0012	0.0007	0.00052	0.00048
Dissolved Cu	0.042	0.023	0.016	0.015
Dissolved Pb	0.035	0.019	0.014	0.012
Dissolved Ni	0.42	0.42	0.43	0.40
Dissolved Ag	0.0029	0.0016	0.0011	0.0010
Dissolved Zn	0.23	0.13	0.09	0.08
pH	6.5-9.5	6.5-9.5	6.5-9.5	6.5-9.5
TSS	15	15	15	15
Ammonia	10	10	9.0	8.1

The thresholds for Bermingham adit, Bellekeno 625 adit, Lucky Queen 500 adit, Onek 990 portal, and Flame & Moth adit discharges that would be applied in order to determine if mine water source quality had been significantly altered:

- A monitoring pH concentration trend, 1.0 standard pH unit below historic average. A trend would be established comparing the prior month average to the historic average.
- An increasing trend towards historical maximum in comparison to the previous 24 months of data for ammonia, cadmium, conductivity and zinc.
- Specific metals trends will be evaluated if a pH, conductivity, ammonia, zinc or cadmium trend has been triggered. Due to the nature of mining activities high concentration of suspended solids and metals found in the suspended solids are periodically expected as sumps are cleaned out or during dewatering changes; consequently, metals concentrations will not be a primary trigger.

The thresholds for the deification and assessment of trends in water quality in discharges from the District Mill, or the Bermingham, Bellekeno, Lucky Queen, Onek, or Flame & Moth mine sites for parameters without effluent discharge standards (i.e. aluminium, chromium, nitrate, iron, selenium, uranium, sulphate):

- An increasing trend whereby the water quality objectives in the receiving environment.

4.1.1.5 Responses to Changes in Water Quality

Responses to changes in water quality from treatment plants and changes in adits will be different to account for the level of control over the results of water quality, where treatment plants are actively managed, while a mine's water quality is dependent on the native groundwater associated with veins, host rock, recharge, and other factors not directly under the control of the mine operator.

4.1.1.6 Responses to changes in Treatment Plants

If an adaptive management trigger associated with the treatment plants is identified as being triggered, the following steps will be performed:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Investigation of the root cause of the exceedance.
- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.
- Water will be stored in underground sumps or the mill sediment pond to the extent practical to limit discharge until root causes have been identified and a solution implemented.

4.1.1.7 Responses to Changes in Mine Adit Chemistry

Monthly averages of pH, conductivity, ammonia, cadmium and zinc are considered good surrogate parameters to identify water quality changes that may affect the cost and feasibility of water treatment associated with the mine adits. If the trend analysis identifies specific changes then the following steps will be performed:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Investigation of the root cause of the exceedance:

  Due to the nature of underground mine workings, inflows to different areas of the mine may be different than other areas. A screening level water quality study will be implemented using field pH and conductivity equipment to identify mine areas that may be contributing to the change in water quality.

  A review of recent mining practices and a study of specific rock lithologies in the area of recent mining activity will be performed to assess if the change is associated with specific rock types or if a mining practice could be associated with the change.
- If a root cause can be identified, plans will be implemented to manage the water quality, which may include modification of the water treatment plant design or operating approach.

4.1.2 Significant Changes in Water Quantity

4.1.2.1 Significant Changes Water Quantity for Bellekeno Mine

The Bellekeno Hydrology Plan, and the Water Balance Report and Water Management Plans provide for a monitoring approach to identify water quantity and to determine if water quantity from the Bellekeno mine is showing long term trends that indicate sustained changes in water quantity. However, if sustained changes in water quantity are encountered from the development and mining activities show that the increase of water is greater than 95% Upper Confidence Level when compared to the average for the previous 24 months or 90% Licence flow discharge criteria exceeded an adaptive management response is required.

4.1.2.2 Change in Predicted Water Quantity for Bermingham, Flame and Moth, Onek and Lucky Queen Mines

The water management plan has been updated to include the Onek and Lucky Queen deposits. Short term temporary spikes in water quantity are to be expected as new mine areas with water transmissive features such as veins or fractures are encountered. The potential for even short term spikes in water quantity is not considered likely at either Onek or Lucky Queen, as the proposed mining areas are above the expected water table. However, if encountered, experience from the advanced development and initial mining activities show that the amount of water associated with these initial drainage episodes is not significant, and in a short timeframe the water drains from the vein or fracture and the net contribution compared to the ongoing flow is minimal. The triggers include an increase of flow rate within 10% of 172.8 m^3/day for 7 consecutive days for the Lucky Queen underground working and discharge from the Onek 990 portal pad settling pond following the completion of the Onek decline. The trigger for Flame and Moth is increasing of flow rate within 10% of 3,200 m^3/day for 7 consecutive days. The trigger for Bermingham Mine is increasing of flow rate within 10% of 1,200 m^3/day for 7 consecutive days.

4.1.2.3 Monitoring Requirements and Specific Thresholds

4.1.2.4 Monitoring Requirements for Significant Change in Water Quantity for Bellekeno Mine

The relevant flowmeter and totalizer that measures water quantity data from KV-42, the Bellekeno adit, is located just upstream of the rapid mix tank. The data from the flowmeter and totalizer will be downloaded on a frequent basis and analyzed monthly. The average daily totalized flow for each month will be compared with the trailing 24 months of water flow to establish trends and also to determine significant deviation from the trends.

Two thresholds for determining significantly increased water flow are:

- If average flow from the adit for the month is significantly higher than the previous 24 months of flow data. This will be determined by comparing the current month flow with the 95% upper confidence level (UCL).
- If the water discharge from KV-43, the water treatment plant discharge, is within 10% of 864 m^3/day, which is the licence condition in WL QZ09-092. KV-43 shows the net adit outflow, and will not be affected by changes in water recycle usage.

4.1.2.5 Monitoring Requirements for Change in Predicted Water quantity for Bermingham, Flame and Moth, Onek and Lucky Queen Mines

A totalizer flowmeter was installed at the Lucky Queen 500 adit in January 2012. The data from the flowmeter and totalizer will be downloaded on a frequent basis and analyzed monthly. At this time no discharge is anticipated at the Onek deposit as the underground workings will be developed above the groundwater table via a decline. The Onek 990 settling pond will be monitored daily for discharge following the completion of the decline. The Flame and Moth adit will be monitored continuously via a totalizer flow meter.

Thresholds for determining significantly increased water flow are:

- If the water discharge at Lucky Queen settling pond (KV-97) is within 10% of 172.8 m^3/day, predicted amount. KV-34 shows the net adit outflow, and will not be affected by changes in water recycle usage;
- Discharge from the Onek settling pond is required after the completion of the decline; and
- If the water discharge at Flame and Moth adit (KV-105) is within 10% of 3,200 m^3/day, predicted amount. KV-105 shows the net adit outflow and will not be affected by changes in water recycle usage.
- If the water discharge from the Flame and Moth adit (KV-105) increases from 0-10L/s to greater than 20 L/s in a period of less than two weeks.
- If the water discharge at the Bermingham adit (KV-110) is within 10% of 1,200 m^3/day, predicted amount. KV-110 shows the net adit outflow and will not be affected by changes in water recycle usage.

4.1.2.6 Responses to Changes in Water Quantity

If a significant increase in water quantity is determined by the statistical test or if 90% of the WL water quantity discharge is observed, the following response actions will be taken:

- Notification to the Water Inspector that the trigger has been triggered within 3 working days.
- Investigation of the root cause of the exceedance:

  Due to the nature of underground mine workings, inflows to different areas of the mine may be different than other areas. A screening level water quantity study will be implemented using portable flow meter equipment such as portable flumes or a standard time to fill the bucket test to identify mine areas that may be contributing to the change in water quantity.
- If a root cause can be identified, plans will be implemented to manage the change in water quantity, which may include modification of the water treatment plant design or changing the mine operating approach such as increasing water recycle usage.
- Investigation into limiting mine inflows into Bermingham, Flame and Moth, Lucky Queen and Onek including establishing additional surface water diversions or diversions around the vent raises.

4.2 EVENT 2: N-AML WASTE ROCK SEEPAGE OR TAILINGS EXHIBITS AML

As mentioned previously in Section 2.1 (Plans in Place) a number of plans are in currently in place with respect to waste rock management and monitoring. The efficacy of these plans has been demonstrated through advanced exploration, development and production at the Bellekeno Mine. Although Alexco has a high level of confidence in the ability of these plans to accurately predict drainage chemistry and accurately designate waste rock appropriately, the following sections pertain to the possibility for acidic or metal leachate (AML) to occur as a result of seepage or runoff though waste rock disposal areas or areas where waste rock designated as N-AML has been used as a construction material. In addition, seeps from historic (unsegregated) waste rock piles, and tailings are also considered.

4.2.1 Description

DSTF and N-AML waste rock seeps/runoff will be monitored to determine if water quality is trending to AML conditions and waste rock screening criteria or management is not adequately working resulting in an adaptive management response being required. Kinetic testing results will also be reviewed to determine if changes in water quality could be expected from N-AML waste rock or tailings.

4.2.2 Locations

- An observed seep has historically been monitored below Bellekeno 625 (KV-44);
- Any seepage from works constructed or upgraded with N-AML material, which currently includes Bellekeno East and Bellekeno powerline roads. Other Bellekeno East waste rock management areas as defined in the Waste Rock Management Plan are also monitored for drainage or seeps;
- Any seepage from works constructed or upgraded with N-AML material proposed at Bermingham, Onek, Lucky Queen and Flame & Moth which includes: the extension of the waste rock disposal area

(WRDA) at Lucky Queen, the extension of the advanced exploration waste rock disposal area (WRDA) at Bermingham, placement of the WRDA on the proposed rock dump at Bellekeno, placement of waste rock in a WRDA adjacent to the Flame & Moth site with the District Mill area, and the Keno City Bypass Road;

- Any other roads, facilities or structures built from N-AML material to be constructed under existing licenses;
- The DSTF; and
- Field bins or humidity cells with N-AML waste rock or tailings.

4.2.3 Monitoring Requirements

Specific monitoring requirements for the Bellekeno 625 seep (KV-44), and the Lucky Queen N-AML dump (KV-98) are outlined in QZ09-092. Similar monitoring requirements are outlined for the Bermingham and Flame & Moth N-AML waste rock. Monthly field measurements of pH, temperature, conductivity and zinc, and lab measurements of total zinc, cadmium, sulphate and alkalinity will be taken between May and October, and flow at KV-44 and KV-98 will also be estimated. Samples will also be collected on an annual basis for KV-44 and KV-98 for the full suite of water quality analyses. Seep monitoring stations will be established at the proposed Lucky Queen WRDA's, and the Keno City Bypass Road. These proposed N-AML constructed features will be monitored following the same frequency and parameters as mentioned above.

Kinetic testing of N-AML waste rock and tailings are being conducted using field bins and/or humidity cells. Field bins are typically monitored on a monthly basis during open water season, while humidity cells are conducted in a lab environment over a minimum 40-week period with testing weekly to bi-weekly thereafter, depending on parameters.

As per the Waste Rock Management Plan, any waste rock drainage or seeps observed between May and October will be monitored for estimated flow volume and basic field parameters of pH and conductivity. Evidence of sulphide oxidation such as snow melt areas or the presence of sulphide oxidations products will also be noted.

4.2.4 Specific Thresholds

Field measurements of pH, conductivity and zinc, and lab measurements of zinc and cadmium will be monitored to determine if the following specific thresholds have been breached due to AML:

- pH significantly declining between measurements or dropping below 7.0;
- Sulphate showing an increasing trend;
- Alkalinity showing an decreasing trend;
- Conductivity, zinc or cadmium showing a significant increasing trend;
- Sample results approaching licenced effluent quality standards; and
- Kinetic testing of N-AML waste rock shows a significant decline in pH/alkalinity, or increase in sulphate, conductivity, zinc, or cadmium.

4.2.5 Approach to Responses

Initial responses to an observed waste rock seep or runoff trending to AML conditions can include further inspection of the waste rock source material to ensure that the rock types used for construction are acceptable and mitigative measures such as ditching, berming, or pumping water, rock removal or whatever alternative is required to prevent degradation to the quality of water nearby. A full suite of water quality analysis will be performed by an external laboratory to verify the accuracy of field measurements. The location of seepage or runoff will be documented with photos and GPS.

Downstream or down gradient locations will be monitored to ensure that AML runoff does not eventually reach fish bearing waters. If water quality analyses indicate runoff does deposit metal loading into a fish bearing stream or creek, the initial response of ditching, berming, pumping or selective waste rock removal to prevent this would be implemented. Once the seepage/runoff is diverted or removed, measures would be taken to prevent the AML from occurring. This may include removing the material responsible for producing the AML runoff and transporting it to a P-AML Waste Rock Storage Facility, or installing a cover or water diversion system.

Weekly monitoring at the location trending to AML conditions would be implemented until seepage/runoff stops for two consecutive weeks or thresholds are not triggered for two consecutive months.

4.3 EVENT 3: SLUDGE STORAGE AREA EFFECTIVENESS COMPROMISED

As mentioned previously in Section 2.1 (Plans in Place) a Sludge Management Plan is currently in place. The following sections pertain to the potential for the effectiveness of the Valley Tailings sludge storage area (the specific sludge storage area dedicated to Bellekeno-related sludge) to become compromised. Sludge storage in the DSTF will be evaluated by DSTF monitoring programs. Sludge storage at the Bermingham Southwest (SW) will also be evaluated

4.3.1 Seepage Observed Near Sludge Storage Area

4.3.1.1 Description

Any seepage observed in the vicinity of the sludge storage areas will be monitored to determine if it is resulting from sludge deposition.

4.3.1.2 Locations

The DSTF, Valley Tailings and Bermingham SW sludge storage areas will be routinely monitored for seepage.

4.3.1.3 Monitoring Requirements

Visual inspections will be conducted at the DSTF, Bermingham SW pit and Valley Tailings Sludge Storage Cell when these facilities are in use. Any seepage will be documented and water quality assessed for alkalinity pH, sulphate, total zinc and cadmium.

4.3.1.4 Specific Thresholds

Any new identified seeps will be monitored and analyzed for the pH, alkalinity, sulphate, zinc, and cadmium thresholds:

- pH < 7.5, zinc > 0.5 mg/L, cadmium > 0.01 mg/L.

4.3.1.5 Approach to Responses

Seepage observed in the vicinity of the sludge storage areas will be documented with photos and monitored for flow, field pH, zinc and cadmium. A full suite of water quality analysis will be performed by an external laboratory to verify the accuracy of field measurements. The flow path will be documented and an assessment of the down gradient environment conducted to determine if flow is reaching surface waters and whether or not they are fish bearing. If seepage is depositing a load into a fish bearing stream or creek, ditching, berming or pumping may be implemented to prevent this. Alternative sludge storage area would be assessed and use of the current one would cease. The Sludge Management Plan would be revised to incorporate any new sludge storage areas and implemented.

4.3.2 Sludge Storage Area Approaching Capacity

4.3.2.1 Description

Sludge storage areas will be monitored daily during use to ensure sufficient capacity.

4.3.2.2 Locations

The DSTF, Bermingham SW pit and Valley Tailings Area Sludge Storage Cell.

4.3.2.3 Monitoring Requirements

Visual inspection of freeboard in Bermingham SW and Valley Tailings Sludge Storage Cell will be conducted when this facility is in use.

4.3.2.4 Specific Thresholds

Freeboard is approaching capacity: 1.5 m. A minimum freeboard of 1.0 m below the decant point will be maintained.

4.3.2.5 Approach to Responses

- Determine if there is seepage from the sludge storage area as per the visual inspection.
- An investigation would be conducted of the ability to increase the facility capacity by increasing berm height for example.

- Alternative sludge storage area would be assessed and use of the current one would cease.
- The Sludge Management Plan would be revised to incorporate any new sludge storage areas and implemented.

4.4 EVENT 4: PHYSICAL INSTABILITIES

The following sections pertain to potential physical instabilities that may be encountered in the Keno Hill Silver District Mining Operations, though specific DSTF triggers will be discussed separately.

4.4.1 Area of Significant Subsidence is Observed

Subsidence can be observed as a result of slope failure or erosion, which could potentially affect the down gradient environment, particularly surface water. Slope failure could eventually result in a rock fall or landslide or lead to structure failure or portal collapse. Additionally, areas where permafrost is encountered unexpectedly during construction activities for new mine facilities are also considered.

4.4.1.1 Locations

Throughout the Keno Hill Silver District Mining Operations based on routine inspection throughout the property and as outlined in the Physical Inspection and Reporting Plan. The Physical Inspection and Reporting Plan has been updated to include Bermingham, Onek, Lucky Queen, and Flame & Moth Mines.

4.4.1.2 Monitoring Requirements

Maintenance personnel will routinely observe subsidence, slope failure, or erosion in the course of their daily site activities. Routine inspections will be performed in accordance with the Physical Inspection and Reporting Plan.

4.4.1.3 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- A depression with defined edges is noted in the ground with the potential to create a public safety concern;
- A cave-in has occurred allowing access to the underground workings of a mine site;
- Unexpected encounter of permafrost for construction of new mine facilities;
- Break in soil/ slope creep/ sediment transport observed from physical structure with perceived potential to effect nearby structures or down gradient surface water.

4.4.1.4 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to an observed area of subsidence, slope failure or erosion will be implemented if the threshold is triggered.

The initial response to observing an area of subsidence, slope failure or erosion will be to prevent a hazard to public health and safety and minimize sediment transport to surface waters. This could include installation of barriers such as dykes or silt fencing or construction of diversion ditches or berms.

If necessary, physical removal or physical repair of the structure will be performed to remediate it to a safe status. Access to the area would be limited using fencing, barricades, or signage to alert the public and other maintenance personnel to the danger that may exist.

If there are no underground workings in the area, then it is possible that the subsidence, slope failure or erosion would be due to liquefaction of soil near the surface and may not be a cause for concern. The break or depression will be filled in with soil and monitored to see if the subsidence, slope failure or erosion continues. If the subsidence, slope failure or erosion continues to appear after repair, then further investigation by a mining engineer may be warranted, particularly if there is a risk to the stability of a nearby structure. Any physical repairs to slopes or embankments would involve an assessment in consultation with a mining engineer before implementation.

The final stage will be to implement the repair at the area of the subsidence, slope failure or erosion and to monitor the area to watch for signs of continued subsidence, slope failure or erosion at or around the previously identified area.

If permafrost is encountered unexpectedly during the construction of new mine facilities the design engineer will be notified to review the design and perform any modifications if required.

4.4.2 Rock Fall or Landslide Occurs Within Monitored Area

4.4.2.1 Description

The deposition of waste rock in the Keno Hill Silver District Mining Operations is being done in areas where engineering assessments were performed for suitability. However, it is possible that waste rock piles can possibly shift due to changes in foundation conditions. Even though it is remote or unlikely, a significant amount of material can potentially block access to a site.

4.4.2.2 Locations

Monitoring locations are throughout the area of the Keno Hill Silver District Mining Operations in accordance with the Physical Inspection and Reporting Plan.

4.4.2.3 Monitoring Requirements

At a minimum the locations identified in the Physical Inspection and Reporting Plan, and other areas as observed by site operators. Maintenance personnel will routinely observe soil or earth movement during their daily site activities.

4.4.2.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- A rock fall or landslide has blocked access to a previously monitored site;
- A rock fall or landslide has blocked access to a roadway previously used by the public;
- A rock fall or landslide has blocked or re-directed the flow of water of a documented stream or watercourse; and
- Liquefaction of a waste rock pile foundation has caused waste rock to migrate closer to a watercourse.

4.4.2.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to the presence of a rock fall or a landslide will be implemented if a threshold is breached.

The initial response to observing a rock fall or a landslide will be to determine if it impedes on a right-of-way or a water flow path. If the debris impedes on a right of way, access to the area will be limited using fencing, barricades, or signage to alert the public and other maintenance personnel to the debris' presence.

The next stage of the response will be to examine the area to assess the possibility of further erosion of the originating slope. This task may require the services of a registered engineer. If warranted, a plan will be developed to prevent future erosion in the area.

The final step in the response to debris from a rock fall or a landslide impeding on a right-of-way will be to remove the debris, likely with heavy machinery, and transport it to an isolated waste pile where the debris will not affect any watercourse or physical stability.

If the rock fall or landslide debris enters a watercourse, then water quality testing will be implemented. This will be done to determine if the presence of the rock in the water is contributing any metal loading to the water. If the loading in the water is found to be affected by the source material, then a mitigation plan will be developed and implemented in consultation with technical experts and regulatory agencies until such time as the debris can be removed from the watercourse, and water levels return to their historical norm.

If the metal loading is determined to be not affected by the source material, then no mitigation treatment plan will be necessary, and the debris can be removed from the watercourse. The final stage will be to continue monitoring water quality at that location for a period of time until it is determined that the rock fall or landslide had no lingering effects on the water quality.

4.5 EVENT 5: SITE SECURITY COMPROMISED

4.5.1 Gate, Fence or Sign Damaged

In the Keno Hill Silver District Mining Operations hazards to public safety exist. In order to alleviate these hazards, depending on the type of hazard and its accessibility, structures, gates, fences, or signs have been erected to prevent the public from entering these areas or draw their attention to the hazard.

Over the course of time, some of these deterrents may suffer damage or may degrade which impedes on their ability to perform as a safety deterrent. The most likely scenario is for the item to have fallen down, however, the item's performance may have been degraded by weather erosion or possibly at the hands of vandals.

4.5.2 Locations

Throughout the Keno Hill Silver District Mining Operations.

4.5.3 Monitoring Requirements

Since it is almost impossible to predict when or where a gate, fence, or sign will be damaged, there can be no specific monitoring requirements to observe these circumstances prior to their existence. The monitoring information required is observations of damage to any of these safety features throughout the Keno Hill Silver District Mining Operations. Maintenance personnel will be familiar with the placement of gates, signs, and fences around the property and thus, during their routine site activities will be able to observe when one of these features requires attention.

4.5.4 Specific Thresholds

The specific thresholds that will initiate the action plan will be as follows:

- A gate is found open outside of a scheduled visit by authorised site personnel.
- A gate post is found to be damaged such that the gate is sufficiently disabled to prevent access to the site by authorised site personnel.
- A gate post is found to be damaged such that the gate no longer prevents unauthorised access to a site of concern.
- A fence or structure is found to be damaged such that it no longer prevents unauthorised access to a site of concern.
- The placard of a sign has been damaged either by environmental conditions or by vandalism such that the sign is no longer effective in relaying the information intended.
- A sign post has been damaged to an extent where the sign is in a position which renders it ineffective in relaying the information intended.

4.5.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to any one of the above circumstances will be implemented if the threshold is triggered.

The initial response to a gate being found open or a fence being damaged and allowing access to the site will first trigger an examination of the area in question in order to ascertain whether trespassers are in the vicinity and may have initiated the condition of the gate or fence. If trespassers are found and do not appear to impose a risk to the site personnel, they will be cordially escorted off the property and the gate will be locked. If site personnel feel that there may be a risk in confronting the trespassers, then the appropriate authorities will be

contacted immediately and requested to attend to the situation. If the lock on the gate has been damaged or tampered with, it will be replaced in a timely fashion.

If the gate is found to be damaged such that in no longer prevents unauthorised personnel from accessing a site, then the same measures above will be implemented. Once the trespassers have been escorted off site or the area is deemed to not contain any trespassers, the gate will be repaired or replaced in a timely fashion to ensure it will prevent access to the site by unauthorised personnel.

If the placard of a sign has been damaged either by environmental conditions or by vandalism, or the sign post is broken such that the sign is no longer effective in relaying the information intended, then maintenance personnel should note this at the time of observation and this information should be passed on to the project manager.

4.6 EVENT 6: HIGH PORE PRESSURE UNDERNEATH DSTF

EBA Engineering Consultants (EBA) designed the Dry Stack Tailings Facility for Alexco. In September 2010, EBA developed the Operation, Maintenance, and Surveillance Manual (OMSM) for the Dry Stack Tailings Facility at the direction of Alexco for the Keno Hill District Mill. This manual will be referenced in response to some triggers.

Located beneath the DSTF is a Drainage Blanket. This feature provides drainage beneath the facility and will allow excess water, whether in the stack or freed from thawing permafrost, to drain away and not allow porewater pressures to build underneath and/or within the tailings.

According to the DSTF design, the drainage blanket was constructed with gravel material obtained from excavation near the toe of the DSTF. The drainage blanket was then covered with a properly bedded geosynthetic clay liner to act as a collection layer for any seepage leaving the tailings stack. This material will help prevent tailings and tailings porewater from infiltrating the coarser gravel material of the drainage blanket.

The OMSM contains an adaptive management plan which can be triggered if the tailings handling and disposition is not meeting critical performance objectives according to specific conditions. Close monitoring of the DSTF is critical in determining if and when action is required. Section 9.0 of the OMSM contains a surveillance plan that provides for adequate monitoring to determine if and when adaptive management is required.

Specific to the development of high pore pressures identified underneath the DSTF, the OMSM presents the following table that lists triggers as well as response actions:

Table 4-5: High Pore Pressure Event

Taken from Table 14 of EBA's OMSM			
Provision	**Monitored Item**	**Triggers/Threshold**	**Action**
EBA Design Report	Groundwater Monitoring Wells	Tip @ 1.0 m or 1.7 m depth - Porewater pressure parameter (Ru) exceeds 0.15	Facility designer will review well data. Monitoring and review will be increased to semiweekly until determined unnecessary.
		Tip @ 1.0 or 1.7 m depth - Porewater pressure parameter (Ru) exceeds 0.25	Facility designer will review existing well data Facility designer will conduct a site visit and determine if tailings placement and/or construction plan requires modification Monitoring and review will be increased to daily until determined unnecessary. Facility designer will determine if additional instrumentation is required. Facility designer will complete analysis of mitigative measures should exceedance continue.

In the event that the above triggers occur, the Alexco staff will perform one or all of the listed actions to address the identified issue.

4.7 EVENT 7: SIGNIFICANT EROSION OF EXPOSED DSTF SURFACES

The OMSM presents a management plan to ensure that the DSTF is managed to create compacted tailings, to limit run-on of surface water that could cause erosion, and also a plan to operate the DSTF in adverse conditions. The OMSM plan (pgs 22-23) states:

Potentially adverse conditions must be accounted for in the operation of the DSTF. These conditions, along with mitigative measures of dealing with them, are as follows.

- High Rainfall;
- Erosion control – grade control and compaction of tailings stack during construction to seal lifts and prevent pooling of water;
- High snow accumulation;
- Removal prior to lift placements;

- Snow dumps will be sited to minimize any erosional impacts during thaw conditions;
- Freezing temperatures;
- Location of placement – east portion of placement area away from the ultimate tailings slope as compaction prior to freezing problematic;
- Compaction – must be completed prior to the tailings freezing;
- Tailings Characteristics (higher moisture);
- Location of placement – south portion of placement area away from the ultimate tailings slope; and
- Compaction – may require drying out material prior to achieving compaction. At the discretion of the Geotechnical Engineer, material requiring additional compactive effort will be moved to less critical areas of the DSTF; i.e. south portion of the placement area away from the ultimate tailings slope, if required.

The OMSM surveillance plan includes key parameters to determine if failure modes are occurring. A visual observation list includes (Section 9.3, pages 27-28)

- Surface—cracking, bulging, depression, sinkholes;
- Seepage—new seepage areas, changes in seepage areas;
- Turbid water in the natural drainages around or downstream the facility;
- Water or tailings flowing down the stack indicating improper grading; and
- A failure or breach of a component of the facility.

Other routine monitoring required by the OMSM plan includes:

- Checking for settlement or holes in embankment crest or benches;
- Checking for holes on the surface of the tailings indicating possible piping of material to outside;
- Checking for dust;
- Measuring water levels in monitoring wells located in the foundation soils during operation;
- Measuring ground temperatures using cables in the foundation soils during operation;
- Surveying DSTF components—displacement of survey monuments;
- Measuring slope inclinometers located in the foundation soils;
- Water sampling of Christal Creek; and
- Recording Weather conditions.

Erosion is an adaptive management event which can be triggered if significant erosion of exposed DSTF surfaces occurs. Close monitoring of the DSTF is critical in determining if and when action is required.

Specific to these conditions, EBA has developed the following table that lists triggers as well as response actions:

Table 4-6: Significant Erosion

Taken from Table 13 of EBA's OMSM			
Provision	**Monitored Item**	**Triggers/Threshold**	**Action**
Water Licence Q209-092	Tailings Runoff	Visible turbidity in runoff and/or excessive erosion evidence	Address runoff at source; report to Water Board within 60 days Apply appropriate runoff, erosion or sediment control measures

In the event that the above triggers occur, the Alexco staff will perform one or all of the listed actions to address the identified issue.

4.8 EVENT 8: EROSION AT THE DISTRICT MILL OR FLAME & MOTH DISCHARGE SITES

4.8.1 Description

The Mill Pond will periodically discharge to ground and only occurred to date seasonally to date in 2015 and 2016. The Flame & Moth pond decant is will discharge to Lightning Creek and to ground toward Christal Creek. However, the development of erosion or permafrost degradation at the discharge to ground locations may compromise and affect the down gradient environment, particularly soils including permafrost.

4.8.2 Locations

The discharge to ground areas at Mill Pond (KV-83) to Christal Creek, and the discharge areas in Christal Creek and Lightning Creek from the Flame & Moth pond decant (KV-104).

4.8.3 Monitoring Requirements

Maintenance personnel will routinely inspect for subsidence, slope failure, or erosion during their daily site activities. Monitoring will aim to identify areas of erosion prior to any significant sediment loading, significant erosion or slope degradation and requirement to relocate the discharge area. Weekly inspections of the discharge to ground locations will be included in and carried out as part of the Physical Inspections and Reporting Plan.

4.8.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- A depression with defined edges is noted at the discharge to ground locations; and
- Break in soil/ slope creep/ sediment transport is observed at the discharge to ground locations with perceived potential to effect discharge or down gradient surface water.

4.8.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to the development of erosion and/or permafrost degradation will be implemented if the threshold is triggered.

The initial response to observing erosion or permafrost degradation at the discharge to ground location will be to prevent further degradation of the area through limiting the transport of waste to surface waters. This could include the installation of barriers such as dykes or berms.

If necessary, physical repair will be performed to ensure longer term stability of the area, such as general armouring of the discharge to ground location. Access to the area would be limited using fencing or signage to alert maintenance personnel to the concern.

The final stage will be to monitor the area to watch for signs of continued erosion or degradation.

4.9 EVENT 9: TRANSPORT OF SEDIMENTS FROM BERMINGHAM DISCHARGE, MILL POND DISCHARGE AREA OR FLAME & MOTH DISCHARGE AREAS

4.9.1 Description

The Mill Pond has periodically discharge to ground and only occurred seasonally in 2015 and 2016. The Flame & Moth pond decant will discharge to Lightening Creek and to ground toward Christal Creek. Additionally, the Bermingham Mine discharge will be to ground, but may develop a surface channel as mine discharge rates increase. However, the development of erosion or permafrost degradation at the discharge to ground locations may compromise and affect the down gradient environment, particularly surface water.

4.9.2 Locations

The area downgradient of the discharge to ground from the Mill Pond (KV-83) and Bermingham (KV-110), and the discharge area at the Flame & Moth pond decant (KV-104).

4.9.3 Monitoring Requirements

Maintenance personnel will routinely inspect for the daylighting of the mill pond discharge and any associated TSS. Weekly inspections of the discharge to ground locations will be included in and carried out as part of the Physical Inspection and Reporting Plan. Additionally, site KV-50 in Christal Creek will be monitored weekly when Flame and Moth is discharging and KV-81 in Lightning Creek.

4.9.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- TSS of 20 mg/L in daylighted discharge;
- TSS of 15 mg/L greater than monthly seasonal average calculated from existing conditions concentration at KV-50 and KV-21; and

- TSS at KV-81 in Lightning Creek is 25 mg/L higher than upstream of Flame and Moth discharge area on Lightning Creek.

4.9.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to the transport of sediments from discharge locations will be implemented if the threshold is triggered.

The initial response to observing erosion or permafrost degradation at the discharge to ground location will be to prevent the transport of waste to surface waters. This could include the installation of barriers such as dykes or berms with silt fencing.

If necessary, physical repair will be performed to ensure longer term stability of the area, such as general armouring of the discharge to ground location. Access to the area would be limited using fencing or signage to alert maintenance personnel to the concern.

The final stage will be to monitor the area to watch for signs of continued erosion or degradation.

4.10 EVENT 10: LARGE DIFFERENTIAL SETTLEMENTS AT DSTF

Included in EBA's OMSM is an adaptive management plan which can be triggered if differential settlements within the DSTF surfaces occur. Close monitoring of the DSTF as outlined in Section 4.7 will be implemented to determine if and when action is required.

Specific to these conditions, EBA has developed the following table that lists triggers as well as response actions:

Table 4-7: Large Differential Settlements

Taken from Table 14 of EBA's OMSM			
Provision	**Monitored Item**	**Triggers/Threshold**	**Action**
EBA Design Report	Survey Monuments and Slope Inclinometers	Displacements greater than 25 mm in any direction	Facility designer will review existing piezometer, temperature, and survey data. Facility designer will conduct a site visit and determine if tailings placement and/or construction plan requires modification. Monitoring and review will be increased to semiweekly until determined unnecessary. Alexco to complete survey of area of interest to monitor any future displacement, if any. Facility designer will determine if additional instrumentation is required. Facility designer will complete analysis of mitigative measures should exceedance continue.
Water Licence Q209-092	Toe runoff collection ditches, conveyance channel and water collection pond	Presence of abnormal cracking or failure	Report to general manager, take corrective action as required

In the event that the above triggers occur, the Alexco staff will perform one or all of the listed actions to address the identified issue.

4.11 EVENT 11: LARGE DIFFERENTIAL SETTLEMENTS FROM DSTF TO STORMWATER COLLECTION POND

The development of large differential settlements along the conveyance flume from the DSTF to the District Mill Site collection and sediment pond will be identified and addressed through the same actions listed in Table 4-7 above.

4.12 EVENT 12: EXCEEDANCE OF WATER QUALITY OBJECTIVES IN RECEIVING ENVIRONMENT

Sitewide monitoring of the entire KHSD, and specific monitoring of the Keno Hill Silver District Mining Operations is being performed in accordance with WL QZ09-092 and the plans referenced in Section 2.1.

In addition to the historic impacts of mining in the KHSD, the Bermingham mine, Bellekeno Mine, District Mill, Lucky Queen Mine, Onek 990 Mine, Flame and Moth Mine, placer mining on Lightning creek, deposition of waste

in the Keno City municipal dump facility, and other non-mining activities has the potential to impact the receiving environment.

4.12.1 Description

With respect to the Keno District Mining undertaking, it is imperative to identify the impact of the discharges authorized under this licence with the existing discharges occurring in the KHSD and other human activities in the area. Consequently, site-wide monitoring information must be compared with water quality information collected and compiled for the Keno Hill Silver District Mining Operations to assess the relative impacts of these various activities.

All data for current water sample stations required in WL QZ09-092 are stored in an EQWin database that allows water quality to be tracked at each site such that conditions can be identified at any point in the season. In this way, parameters can be tracked, and fluctuations from the normal to levels where management is required to respond can be monitored. Set point triggers can be placed in the database so that response parameters are flagged for notification and action.

Comparison of all water quality information is routinely done and a variance report is generated on at least a quarterly basis for sitewide information that could identify sitewide trends.

4.12.2 Locations

Water quality is monitored from the Bellekeno water treatment facilities, the Lucky Queen adit, and District Mill for potential effects to the receiving environment including loading of down gradient waters. In addition, once Bermingham, Onek and Flame and Moth are in production, the Onek and Flame and Moth settling ponds and settling pond decants will also be monitored. These sites are shown in Figure 4-1.

4.12.3 Monitoring Requirements

All water quality information in the KHSD and the Keno Hill Silver District Mining Operations is analyzed for exceedances of CCME criteria, as well as variances with the previous 12 months of data at that location, which can assist in the determination of causes of water quality changes over time. All exceedances of water quality for licenced parameters will be compared with historic exceedances. Monitoring of radium will occur in the receiving environment as required per Schedule 5 section 7 of the Metal Mining Effluent Regulations (Canada, 2017).

4.12.4 Specific Thresholds

Water quality objectives for No Cash Creek (KV-21), Star Creek (KV-56), Christal Creek (KV-50, KV-6 and KV-7) and Lightning Creek (KV-81) have been established using CCME, BCMoE or using the background concentration procedure. The water quality objectives for Christal and Lightning Creeks are presented in Table 4-8. If an increasing trend or an exceedance is detected in either the No Cash Creek, Star Creek, Lightning Creek or Christal Creek drainage, the two drainages where the Bermingham, Bellekeno, Lucky Queen, Onek and Flame & Moth undertakings deposit waste, then further responses will be undertaken.

The trend analysis threshold review will incorporate the three previous years of data relative to the WQOs, where as the comparison against the UCLM will be carried out monthly on a 12 month moving average.

Table 4-8: Water Quality Objectives for Christal Creek, Lightning Creek, No Cash Creek and Star Creek (mg/L)

	KV-50	KV-6	KV-7	KV-81[a]	KV-21[a]	KV-56
Ammonia-N	CCME	CCME	CCME	CCME	CCME	CCME
Nitrate-N	CCME	CCME	CCME	CCME	CCME	CCME
Nitrite-N	CCME	CCME	CCME	CCME	CCME	CCME
Arsenic	0.0451[b], 0.031[c]	0.0153[b], 0.0084[c]	0.010[b], 0.0040[c]	CCME	CCME	CCME
Cadmium	0.000927[b], 0.00055[c]	0.00276[b], 0.0015[c]	0.00244[b], 0.00097[c]	BCMoE	0.0341[d], 0.0156[e]	BCMoE
Copper	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE
Lead	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE
Nickel	CCME	CCME	CCME	CCME	CCME	CCME
Silver	CCME	0.00042[b], 0.00014[c]	CCME	CCME	CCME	CCME
Radium	MMER	MMER	MMER	MMER	MMER	MMER
Uranium	CCME	CCME	CCME	CCME	CCME	CCME
Zinc	0.305[b], 0.228[c]	0.338[b], 0.193[c]	0.219[b], 0.124[c]	CCME	3.66[d], 1.79[e]	0.049[d],0.023[e]
Sulphate	-	-	BCMoE	BCMoE	BCMoE	BCMoE
Selenium	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE	BCMoE

a) Objectives for KV-81 and KV-21 metals are dissolved
b) Upper 95th percentile from 2008 to June 2018 data set
c) Upper confidence level mean from 2008 to June 2018 data set
d) Upper 95th percentile from 2007 to June 2018 data set
e) Upper confidence level mean from 2007 to June 2018 data set

4.12.5 Responses to Changes in Receiving Environment Water Quality

Potential responses to exceedances include the following:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Increased sampling frequency may be required around the area of the exceedance and will be implemented to help determine potential causes.
- Investigation of the root cause of the exceedance including utilizing the Goldsim model to understand the loadings of the system of concern. Compare the monitoring results to the Goldsim predicted concentrations.
- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

4.13 EVENT 13: IDENTIFICATION OF GROUNDWATER QUALITY IMPACT WITHIN THE KENO HILL SILVER DISTRICT MINING OPERATION

The Groundwater Monitoring Plan provides data that can be utilized to assess groundwater quality impacts associated with mining and milling activities. The original Groundwater Monitoring Plan identified two areas of the Bellekeno undertaking where groundwater monitoring will be carried out. The updated Groundwater Monitoring Plan includes the Flame and Moth, Onek and Lucky Queen areas where additional groundwater monitoring has been proposed. Additionally, the proposed Bermingham Mine has outlined additional groundwater monitoring locations outlined in this section and in the YESAB project proposal.

4.13.1 Description

Groundwater in the vicinity of Onek, Keno City and the mill site flows in a north-westerly direction towards Christal Creek. A network of shallow and deep groundwater monitoring wells is specified for the District Mill site in order to determine if there are any impacts to groundwater as a result of deposition of waste authorized by the Licence and also to determine if upgradient users may be influencing groundwater which flows toward the site (i.e. the Keno City dump). The District Mill Site (including Flame & Moth) is located upgradient of Christal Creek, so understanding any impacts to groundwater as a result of the undertaking is important to help determine any risk to Christal Creek. Although groundwater flow direction has been demonstrated to flow away Keno City towards the northwest, KV-84Nd in Keno City is also being monitored (See Section 4.14). The Groundwater Monitoring Plan has been updated to include the additional monitoring locations in the Keno City area downgradient of the Onek deposit.

The second groundwater monitoring location specified by the Groundwater Monitoring Plan is downgradient of the proposed N-AML Waste Rock Disposal Area along the north flank of Sourdough Hill to the west of the Bellekeno 625 adit. It is assumed that groundwater flow in this area follows surface topography and flows down slope towards Lightning Creek. Groundwater wells located below the toe of the N-AML Waste Rock Disposal Area will be used to determine if seepage from N-AML waste rock is having any impacts to downgradient groundwater quality, which might in turn, impact water quality in Lightning Creek.

The Groundwater Monitoring Plan has been updated for a third area near the Lucky Queen deposit to include monitoring downgradient of the Lucky Queen N-AML Waste Rock Disposal Area. A groundwater monitoring well, LQ-MW-01, has been installed downgradient of the N-AML waste rock disposal area shown on Figure 4-2.

A fourth location is identified as part of the proposed Bermingham Mine and is on the North side of Galena Hill. This includes areas downgradient of the proposed mine, N-AML WRDA, Bermingham SW pit sludge disposal area and P-AML WRSF and these locations are shown on Figure 4-3.

4.13.2 Locations of Groundwater Monitoring Wells

Existing and proposed groundwater monitoring wells at the District Mill Site (including Flame and Moth) and DSTF area (KV-85 to KV-89, KV-107, KV-108, KV-109 and BH-39), Lucky Queen (LQ-MW-1 and LQ-MW-2), and Bellekeno (KV-91 to KV-94) are shown on Figure 4-2. Additionally, BH-39 is located within phase 1 of the DSTF and KV-107 will be installed in phase 2 of the DSTF. Additional proposed wells (KV-116, RB-MW-1 and NC-MW-1) for the Bermingham Mine are shown on Figure 4-3.

480,000 482,500 485,000 487,500

7,090,000

7,087,500

N W E S

HANSON MCQUESTEN ROAD

SILVER TRAIL HIGHWAY

Christal Creek

LUCKY QUEEN PORTAL

LQ-MW-1

LQ-MW-2

LUCKY QUEEN ACCESS ROAD

Sandy Creek

Star Creek

WERNECKE ROAD

NC-MW-1

No Cash Creek

RB-MW-1

CALUMET DRIVE

BERMINGHAM ACCESS ROAD

KV-116

BH-MW-1

BERMINGHAM 200 ADIT

BERMINGHAM PORTAL

GALENA HILL

DISTRICT MILL SITE

CHRISTAL LAKE ROAD

ON-MW-4

KC-MW-2

KC-MW-3

ON-MW-1

SIGN POST ROAD

ONEK 990 PORTAL

KV-88D/S

KC-MW-1B

KV-84

ON-MW-2

Lightning Creek

Thunder Gulch

BELLEKENO HAUL ROAD

KV-91

KV-92

KV-93

KV-94

KV-85D/S

BH-39

KV-84ND

ON-MW-3

KENO CITY

KV-89D/S

KV-87

KC-MW-4

KV-108

KV-103

DUNCAN CREEK ROAD

KV-86

FM-MW-02

FM-MW-01

FM-MW-03

KV-109

BELLEKENO 625 ADIT

FLAME AND MOTH PORTAL

BELLEKENO EAST PORTAL

1:25,000 (when printed on 11 x17 inch paper)

Kilometres

0 0.5 1 1.5 2

Datum: NAD 83; Map Projection: UTM Zone 8N

- Proposed Monitoring Well
- Monitoring Well
- Adit
- Alexco/ERDC Quartz Claims
- District Mill Footprint
- Silver Trail Highway
- Other Road

AKHM AEG

ALEXCO KENO HILL MINING CORP.

FIGURE 2
KHSD GROUNDWATER MONITORING LOCATIONS

JULY 2018

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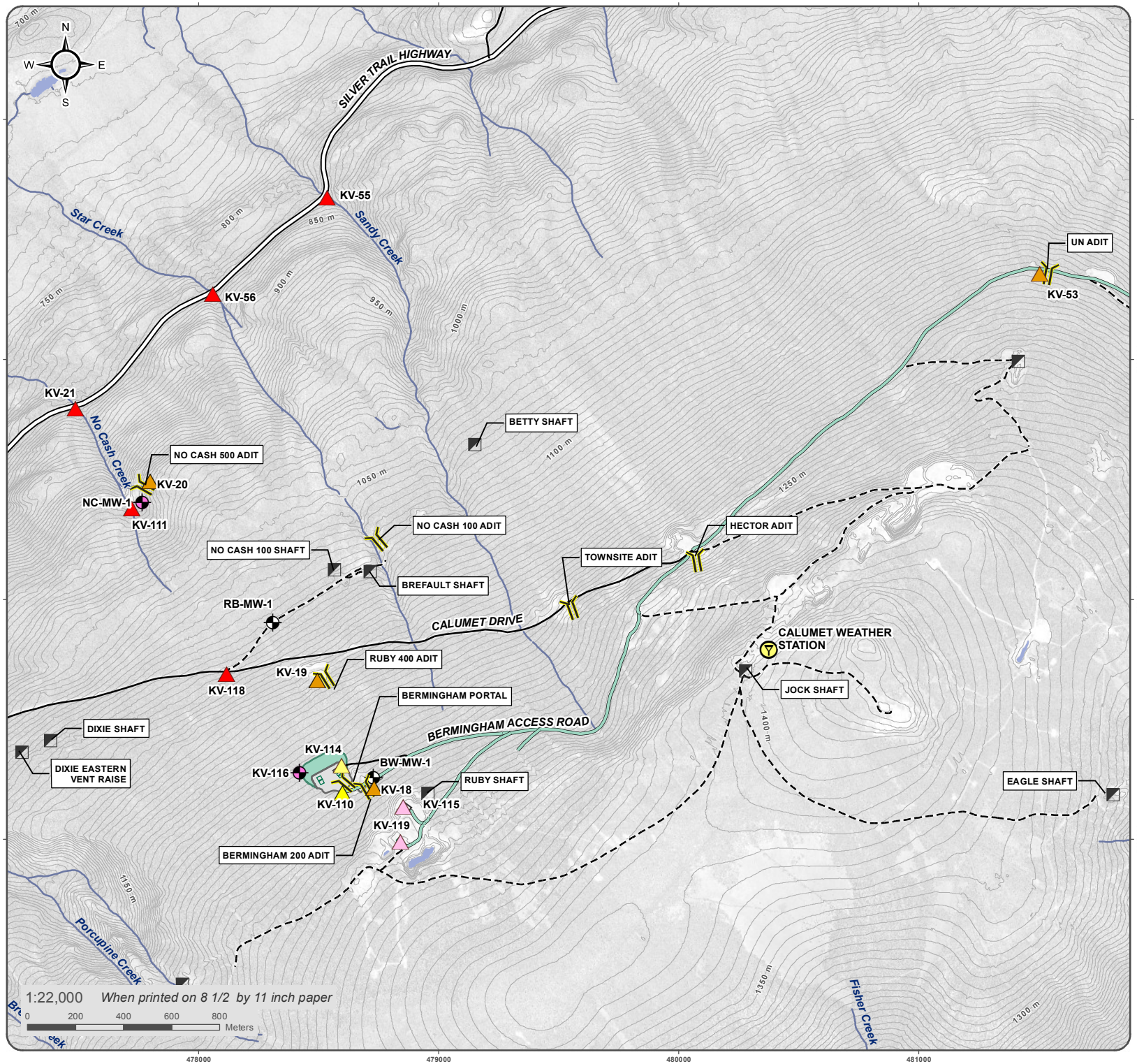

ALEXCO KENO HILL MINING CORP.
BERRMINGHAM

FIGURE 4-3

WATER QUALITY MONITORING LOCATIONS WITHIN BERMINGHAM AREA

JULY 2018

- Adit/Portal
- Shaft
- Weather Station
- Surface Water Quality Station, Existing
- Surface Water Quality Station, Proposed
- Adit Water Quality Station, Existing
- Adit Water Quality Station, Proposed
- Groundwater Quality Monitoring, Existing
- Groundwater Quality Monitoring, Proposed
- Permitted Mine Footprint
- Proposed Mine Footprint
- Proposed Road Upgrades
- Silver Trail Highway
- Road
- Limited-Use Road
- Contour (5m interval)

Datum: NAD 83; Map Projection: UTM Zone 8N

AKHM AEG

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4.13.3 Monitoring Requirements

Monitoring requirements for groundwater monitoring are described in detail in the Groundwater Monitoring Plan. Quarterly measurement field parameters including water level and measurement by an external laboratory of a suite of standard parameters including dissolved ICP metals, alkalinity, ammonia, phosphorous, sulphate, uranium, selenium DOC, and hardness is specified by the Licence.

4.13.4 Thresholds

Monthly sampling will be undertaken for each new monitoring well until a minimum of one year of data points are available to provide a baseline for each monitoring well. After these data points are collected, for each well, sampling will revert to quarterly sampling as per the groundwater monitoring plan. A trigger for adaptive management have been developed based on the Yukon Contaminated Sites Regulation Protocol No.10: Determining Background Groundwater quality. Additional thresholds have been established for increasing trends and water quality present in the monitoring wells for the phase 1 and 2 of the DSTF:

- Exceedance of the 95th percentile for dissolved constituents that have a surface water quality objective (Table 4-9);
- Statistically significant increasing trend compared to past three years of data; and
- Water depth is greater than 30 cm in DSTF monitoring wells and water quality is approaching EQS for KV-83 (BH-39 and KV-107).

4.13.5 Responses

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Increased sampling frequency may be required around the area of the exceedance and will be implemented to help determine potential causes.
- Investigation of the root cause of the exceedance.
- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

Table 4-9: 95th Percentile AMP Triggers for Dissolved Constituents in Groundwater Monitoring Wells

	Sulphate	Ammonia-N	Nitrite-N	Nitrate-N	Arsenic	Cadmium	Copper	Lead	Nickel	Selenium	Silver	Uranium	Zinc
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
KV-85D	880	0.63	nd [a]	nd [a]	0.16	0.00066	0.022	0.0014	0.011	0.00024	0.000036	0.032	0.085
KV-85S	370	0.042	0.0034	2.2	0.0023	0.0007	0.0016	0.0027	0.0018	0.0058	0.000011	0.0035	0.030
KV-86	320	0.067	0.0031	0.29	0.0011	0.00091	0.0029	0.023	0.0037	0.0013	0.000024	0.0045	0.064
KV-87	1300	0.52	0.01	0.05	0.05	0.001	0.00072	0.0032	0.011	0.00028	0.00004	0.034	0.10
KV-88D	1800	0.26	0.01	0.05	1.0	0.028	0.0019	0.003	0.12	0.00078	0.000015	0.018	0.41
KV-88S	44	0.064	nd [a]	nd [a]	0.0021	0.00012	0.0022	0.00016	0.0048	0.0011	2.5E-06	0.0026	0.0018
KV-89D	730	0.34	0.0063	0.031	0.041	0.00065	0.00047	0.00065	0.012	0.0001	0.000061	0.093	0.11
KV-89S	2200	0.61	0.031	8.3	0.028	0.029	0.0049	0.0013	0.42	0.0026	0.00013	0.013	110
RB-MW-1	139	1.3	<0.0010	<0.005	0.047	0.00010	<0.00020	0.0011	0.0031	0.000077	<0.000010	0.00054	0.016
LQ-MW-1	110	0.041	0.02	0.99	0.00041	0.00068	0.0023	0.00045	0.025	0.0011	0.000005	0.00046	0.025

[a] nd indicates no data available (parameter not monitored)

4.14 EVENT 14: WATER QUALITY IMPACT TO KENO CITY WATER WELLS

The Groundwater Monitoring Plan provides data that can be utilized to assess groundwater quality impacts associated with mining and milling activities. In addition to addressing groundwater monitoring in the immediate vicinity of the District Mill Site including Flame & Moth, the Bellekeno Waste Rock Disposal Area, the Lucky Queen Waste Rock Disposal area and the Onek Mines, the Groundwater Monitoring Plan identifies groundwater sampling which will be undertaken within the townsite area of Keno City.

4.14.1 Description

Groundwater in the vicinity of Onek, Keno City and the mill site flows in a north-westerly direction towards Christal Creek. Although groundwater flow direction has been demonstrated to flow away from Keno City towards the northwest, a well in Keno City is being monitored (KV-84Nd) through WL QZ09-092. Alexco, through part of the District Closure Planning, has installed several wells around Keno City for a groundwater study of the Keno City area (Figure 4-2) to better understand the potential impact of the Onek 400 adit discharge to the Keno City groundwater table. In 2013, well KV-84Nd was drilled in a more suitable location than previously monitored KV-84 and has replaced the monitoring location at KV-84.

Initial sampling as part of the Keno City Groundwater study has been reported in the Update: Keno City Groundwater Evaluation memo prepared by Interralogic, Inc. (2011). Ongoing monitoring will be undertaken to assess whether there are exceedances of baseline measurements, and/or if parameters listed in the Canadian Drinking Water quality guidelines are exceeded.

4.14.2 Location of Groundwater Monitoring Wells

Groundwater monitoring wells in the vicinity of Keno City are shown on Figure 4-2, including locations of the KV-84Nd, ON-MW-02, and KC-MW-4 in addition to the private wells within Keno City.

4.14.3 Monitoring Requirements

Monitoring requirements for groundwater monitoring are described in the Groundwater Monitoring Plan. Quarterly measurement field parameters including water level and measurement by an external laboratory of a suite of standard parameters including total ICP metals, dissolved ICP metals, ammonia, phosphorous, selenium, uranium, sulphate, DOC, and hardness is specified by the Licence.

4.14.4 Thresholds

A trend based approach for the Keno City monitoring well wills be used to determine thresholds and triggers for adaptive management. This approach is deemed to be necessary because of the high degree of local variability in local aquifers due to mineralization.

Monthly sampling has been undertaken for KV-84Nd, ON-MW-02, and KC-MW-4 until a minimum of one year of data points were collected to provide a baseline for each monitoring well. After these data points were

collected for each well, sampling has reverted to quarterly sampling as per the groundwater monitoring plan. The trigger for adaptive management would be:

- Exceedance of the 95th percentile for total cadmium, and zinc (Table 4-10);
- Statistically significant increasing trend compared to past three years of data; or
- Sample result exceeds YCSR drinking water standards.

Table 4-10: 95th Percentile AMP Triggers for Total Cadmium, and Zinc in Keno City Monitoring Wells

	Cadmium	Zinc
	mg/L	mg/L
KV-84ND	0.00044	0.74
ON-MW-2	0.00063	2.3
KC-MW-4	0.0047	0.073

4.14.5 Responses

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Increased sampling frequency may be required around the area of the exceedance and will be implemented to help determine potential causes.
- Quarterly results of the monitoring program will be communicated to the Yukon Government, Keno residents and the First Nation of Nacho Nyak Dun. Any mitigation measures identified through the meetings with the stakeholders will inform the responses.
- Investigation of the root cause of the exceedance.
- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, and the water inspector notified of the remedy implementation in a timely manner according to permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause.

4.15 EVENT 15: DEVELOPMENT OF EROSION AND/OR PERMAFROST DEGRADATION AT THE DISCHARGE TO GROUND AREAS AT THE LUCKY QUEEN AND ONEK MINE SITES

4.15.1 Description

The Lucky Queen and Onek discharges report to ground, with no evidence of the Lucky Queen discharge, in particular, reappearing at the surface. However, the development of erosion or permafrost degradation at the discharge to ground locations may compromise these flows, and affect the down gradient environment, particularly surface water.

4.15.2 Locations

The discharge to ground areas at Lucky Queen (KV-97) and Onek (KV-96).

4.15.3 Monitoring Requirements

Maintenance personnel will routinely observe subsidence, slope failure, or erosion in the course of their daily site activities. Quarterly inspections of the discharge to ground locations will include and be carried out as part of the Physical Inspection and Reporting Plan.

4.15.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- A depression with defined edges is noted at the discharge to ground locations;
- Break in soil/ slope creep/ sediment transport is observed at the discharge to ground locations with perceived potential to effect discharge or down gradient surface water.

4.15.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to the development of erosion and/or permafrost degradation will be implemented if the threshold is triggered.

The initial response to observing erosion or permafrost degradation at the discharge to ground location will be to prevent the transport of waste to surface waters. This could include the installation of barriers such as dykes or berms.

If necessary, physical repair will be performed to ensure longer term stability of the area, such as general armouring of the discharge to ground location. Access to the area would be limited using fencing or signage to alert maintenance personnel to the concern.

The final stage will be to monitor the area to watch for signs of continued erosion or degradation.

4.16 EVENT 16: OPERATION OF THE CONTINGENCY LUCKY QUEEN WATER TREATMENT PLANT

4.16.1 Description

The Lucky Queen contingency water treatment plant could be needed if the Lucky Queen adit discharge is degraded and the settling ponds are not effectively reducing the metal load in the discharge. In order to ensure that pond water quality does not exceed effluent discharge standards, the timely building and installation of the contingency water treatment system requires a trigger providing advance notice that water quality is degrading and the treatment system is proving inadequate.

All data for current water sample stations required in the WL QZ09-092 are stored in an EQWin database that allows water quality to be tracked at each site such that conditions can be identified at any point in the season.

New sampling stations and their respective data collected for the Lucky Queen Mine are also being stored in the same database. In this way, parameters can be tracked, and fluctuations from the normal to levels where management is required to respond can be monitored. Set point triggers can be placed in the database so that response parameters are flagged for notification and action.

4.16.2 Locations

Water quality is currently monitored at the Lucky Queen adit (KV-34), settling pond (KV-102) and settling pond decant (KV-97).

4.16.3 Monitoring Requirements

Specific parameters from the monitored areas will be compared to specific thresholds to determine if they have been exceeded. Monitoring requirements will change should one of the AMP thresholds for the Lucky Queen adit and settling pond be triggered. This could include more frequent monitoring of grab samples at the station location as well as more frequent monitoring of the receiving environment below the site where the trigger was initiated, to determine if the contingency water treatment plant should be commissioned.

4.16.4 Specific Thresholds

Water quality data from the Lucky Queen adit and settling pond will be assessed to determine if the thresholds presented in section 4.1.1.4.1 have been exceeded. Five consecutive results about three standard deviations of the historical average would trigger the construction of the Lucky Queen contingency water treatment plant.

4.16.5 Responses

If an adaptive management trigger associated with the Lucky Queen adit is identified as being triggered, the following steps will be performed:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Investigation of the root cause of the exceedance:

  Due to the nature of underground mine workings, inflows to different areas of the mine may be different than other areas. A screening level water quality study will be implemented using field pH and conductivity equipment to identify mine areas that may be contributing to the change in water quality.

  A review of recent mining practices and a study of specific rock lithologies in the area of recent mining activity will be performed to assess if the change is associated with specific rock types or if a mining practice could be associated with the change.
- If a root cause can be identified, plans will be implemented to manage the water quality, which may include the construction of the contingency water treatment plant.

If an adaptive management trigger associated with Lucky Queen settling pond is identified as being triggered, the following steps will be performed:

- Notification to the Water Inspector that the trigger has been triggered within three working days.
- Investigation of the root cause of the exceedance.

- If a root cause of exceedance can be readily identified and remedied, the remedy will be implemented in a timely manner, which may include the construction of the contingency water treatment plant, and the necessary notifications according to licence and permit requirements.
- If a root cause cannot be readily identified, a study plan will be outlined and communicated to involve qualified professionals to assist in the identification of the root cause, and the construction of the contingency water treatment plant may be implemented, including the necessary notifications according to licence and permit requirements.

4.17 EVENT 17: FUGITIVE DUST RESULTS IN THE EXCEEDANCE OF AMBIENT AIR QUALITY STANDARDS AND/OR METAL GUIDELINES

4.17.1 Description

The DSTF contains fine grained material that could be subject to wind blown transport. Given the presence of metals in the tailings contained in the DSTF, and the potential health and environmental effects from degraded air quality resulting from dust generation, an adaptive management strategy has been developed. Additional sources of fugitive dust may include mineral processing (primary and secondary crushing, wet grinding and various material transfers and handling) and unpaved roads.

4.17.2 Locations

Air quality monitoring stations AQ1, AQ2 and AQ3.

4.17.3 Monitoring Requirements

Air quality monitoring is undertaken 3 times per month at each air quality monitoring station. Results are analysed by an approved analytical laboratory for TSP, PM_{10}, $PM_{2.5}$ and metals.

4.17.4 Specific Thresholds

The specific thresholds that will initiate an adaptive management response include:

- An increasing trend in fugitive dust as shown by TSP, PM_{10} or $PM_{2.5}$ measurements or in metal concentrations towards Yukon Ambient Air Quality Standards or Ontario Ambient Air Quality Criteria for metals;
- An exceedance of the Yukon Ambient Air Quality Standards for particulate matter at AQ3; and
- An exceedance of the Ontario Ambient Air Quality Criteria for metals in TSP at AQ3.

4.17.5 Approaches to Responses

As per the general approach to the adaptive management plan, a staged response to the development of air quality degradation will be implemented if the threshold is triggered. The initial response to degraded air quality from fugitive dust, is to prevent conditions conducive to dust transport, including the initiation of dust suppression activities. If necessary, additional mitigative measures will be undertaken, including potential

acceleration of the progressive reclamation of the DSTF. The final stage will be to monitor the area to watch for signs of continued fugitive dust generation.

4.18 EVENT 18: ATTENUATION OF THE FLAME AND MOTH TO CHRISTAL CREEK OR BERMINGHAM DISCHARGE TO NO CASH CREEK DOES NOT PERFORM AS PREDICTED

4.18.1 Description

Natural attenuation of selected constituents of interest was incorporated in the modelling of the effects of the Flame and Moth water treatment plant (WTP) discharge on Christal Creek water quality. Attenuation of 50% was assumed as part of the water quality model for arsenic, cadmium, nickel, and zinc between the Flame and Moth WTP discharge and the existing monitoring station in Christal Creek (KV-6). Should natural attenuation not remove metals to the degree expected, water quality in Christal Creek may be degraded and not meet the water quality objectives (Event 12 - Section 4.12).

Additionally, the modelling for the proposed Bermingham Mine included natural attenuation of 50% for several parameters (ammonia, arsenic, copper, lead, nickel, and silver). This was based on the well documented natural attenuation that occurs year-round in No Cash Creek (Interralogic Inc., 2013). Although upstream water treatment is expected to minimize any reliance on natural attenuation, lower natural attenuation than predicted may result in degraded water quality in No Cash Creek such that water quality objectives may not be met.

4.18.2 Locations

The Flame and Moth WTP pond decant (KV-104) and downstream monitoring sites in Christal Creek (KV-50 and KV-6) are the principal monitoring locations to assess natural attenuation. The proposed Bermingham water treatment pond decant (KV-114) will discharge into the No Cash Creek catchment, which may go to ground or become part of the No Cash Creek at KV-111 seasonally or at KV-21 in No Cash Creek at the Silver Trail Highway.

4.18.3 Monitoring Requirements

Routine water quality monitoring will be conducted as part of the Monitoring, Surveillance and Reporting Plan and Christal Creek Attenuation Study which will be used to determine the extent of natural attenuation. During periods when the Flame and Moth WTP is discharging, water quality sampling and flow monitoring will occur weekly at sites KV-104, KV-50, and KV-6. Monitoring for the proposed discharge for Bermingham includes KV-114, KV-111 and KV-21.

4.18.4 Specific Thresholds

The degree of natural attenuation for those constituents that were modelled to experience 50% natural attenuation) between KV-104 and both KV-50 and KV-6 in Christal Creek and KV-114 and KV-21 in No Cash Creek; will be calculated monthly. An AMP response will be triggered if the calculated natural attenuation at

KV-50 or KV-21 is less than 50% for any of these elements and the WQOs in Table 4-8 are exceeded for KV-50 or KV-21.

Similarly, the natural attenuation for ammonia, arsenic, cadmium, copper, lead, nickel, selenium, silver, and zinc between KV-114 and both KV-111 and KV-21. An AMP response will be triggered if the calculated natural attenuation at KV-50 is less than 50% for any of these constituents and the WQOs in Table 4-8 are exceeded for KV-21.

4.18.5 Responses

If natural attenuation of arsenic, cadmium, nickel, or zinc falls below the 50% threshold and results in an exceedance of the KV-6 or KV-21 WQOs, the AMP responses for Event 12 (Exceedance of Water Quality Objectives in the Receiving Environment; Section 4.12) will be enacted.

If no WQO exceedance is noted, but the concentration of parameters of interest at KV-50, KV-6, or KV-21 have increased to within 10% of their WQO (95th percentile or BCMOE/CCME-based WQO), then the causes of the reduced natural attenuation will be investigated. This may include:

- Visual inspection of the WTP decant pond discharge flow path to Christal Creek or No Cash Creek for evidence of significant channel formation that may be limiting interaction with soil and vegetation substrate, potentially limiting natural attenuation;
- Evaluation of any water quality changes in WTP pond decant (KV-104 or KV-114) that may be limiting effectiveness of natural attenuation; and
- Additional water sampling to identify any sources of increased load. Such sampling may include:
    - End of the overland discharge from the WTP decant pond to check natural attenuation effectiveness there;
    - Upstream of KV-50 for any potential load sources that may be masking natural attenuation;
    - Christal Lake to check on lake processes that may be providing metal load; and
    - No Cash 500 adit discharge water quality.

Depending on the results of the investigation, corrective measures may be considered such as:

- Reduce Flame and Moth Pond decant discharge rate to Christal Creek or move all discharge to Lightning Creek until corrective actions are implemented;
- Relocating the WTP decant diffuser to an area that is not affected by flow path channelization;
- Replace with a larger diffuser to better spread the overland flow path of the discharge and enhance interaction with underlying soils;

- Water treatment improvements (e.g., upgrades to clarifier) to account for lack of natural attenuation capacity in Christal Creek and/or No Cash Creek discharge area.

5 REFERENCES

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