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Mount Nansen Water Quality and Quantity Adaptive Management Plan
Final

Prepared for: Assessment and Abandoned Mines
Department of Energy, Mines and Resources
Government of Yukon

May 25, 2015
SLR Project No.: 200.03027.00000

MOUNT NANSEN WATER QUALITY AND QUANTITY ADAPTIVE MANAGEMENT PLAN

FINAL

SLR Project No.: 200.03027.00000

Prepared by
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Whitehorse, Yukon Y1A 1N2

for

GOVERNMENT OF YUKON, DEPARTMENT OF ENERGY, MINES AND RESOURCES,
ASSESSMENT AND ABANDONED MINES

May 25, 2015

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1.0 INTRODUCTION

The Mount Nansen Mine Site is an abandoned former gold and silver mine located approximately 60 km west of the Village of Carmacks, Yukon and within the Traditional Territory of the Little Salmon/Carmacks First Nation. Water from the former mine site makes its way to Victoria Creek, the receiving environment downstream of the site, which also flows through LSCFN settlement land and has associated fish and fish habitat values and related Final Agreement matters.

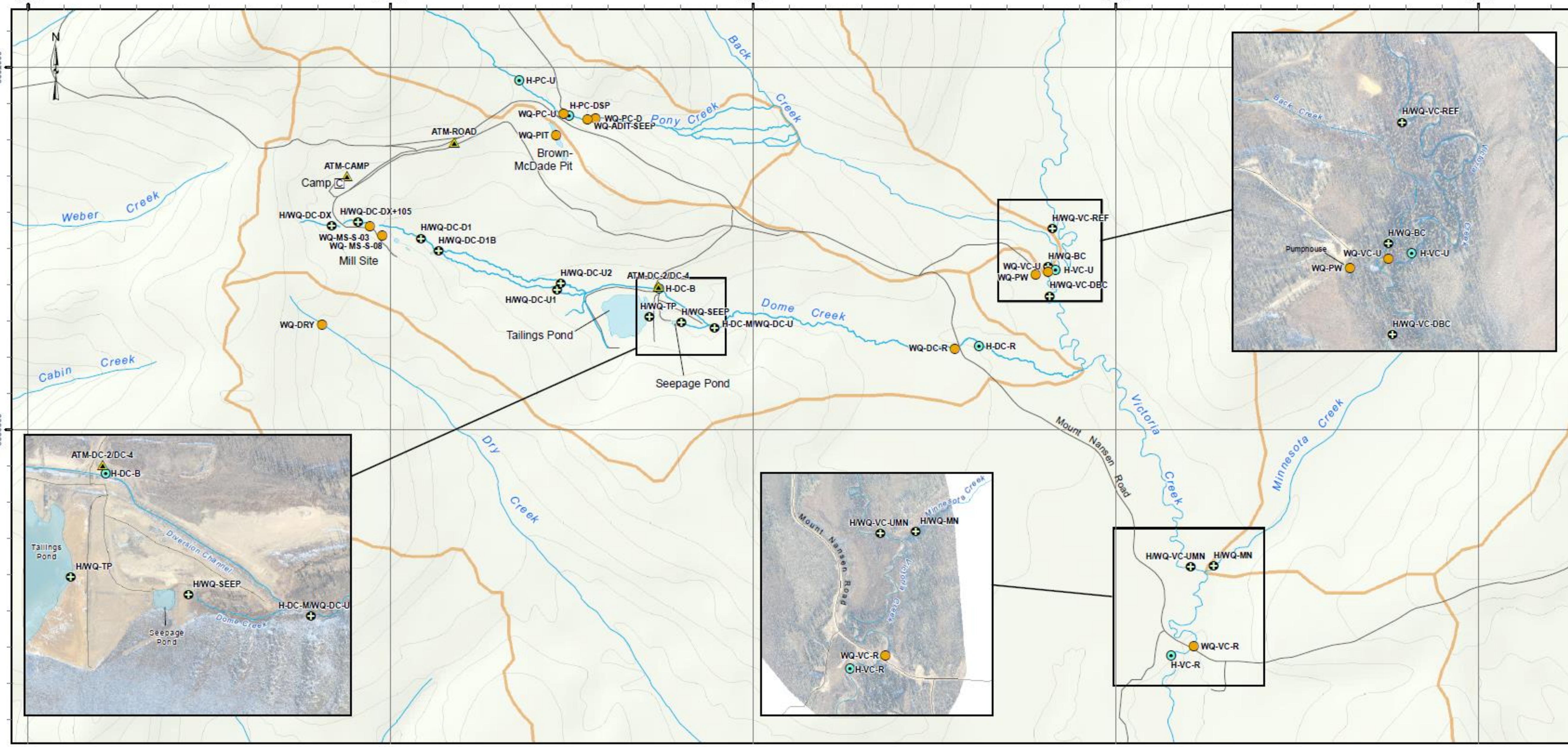
The Mount Nansen Mine Site consists of the following main components (See Figure 1 – Study Area Overview):

- underground workings (e.g. Huestis and Brown McDade);
- Brown McDade open pit from which 269,000 m^3 of ore and several hundred thousand cubic meters of waste rock were extracted;
- a tailings pond in the Dome Creek valley containing approximately 258,000 m^3 of tailings;
- a seepage collection dam and pump facilities immediately downstream of the main tailings dam;
- the former mill/generators/workshop complex;
- cookhouse and bunkhouse buildings;
- Victoria Creek wellhouse building and pump; and,
- various pipelines and power lines.

The former owners of the Site, BYG Natural Resources Inc., are currently under receivership. PricewaterhouseCoopers (PwC) was appointed Interim Receiver of the Site in April 2004 and Trustee in Bankruptcy in November 2006. Day-to-day operations on the Site are managed by Assessment and Abandoned Mines (AAM), Department of Energy, Mines and Resources of Yukon Government, and have been since 2003.

In 2011 an evaluation of remediation options for the Site was conducted and selection of an option followed in 2012. A design team has been procured and is developing and preparing a design for implementation. It is currently anticipated that remediation works will begin in 2018.

In the interim, a management plan is required to monitor for degradation of environmental conditions, particularly surface water, to ensure that mitigative measures can be put in place.



Mount Nansen Site: Hydrometric Stations and Water Quality Sites

Legend

- Atmospheric Station (label ex: ATM-DC-2)
- Hydrometric Station and Water Quality Site (label ex: H/WQ-VC-UMN)
- Hydrometric Station (label ex: H-VC-R)
- Water Quality Site (label ex: WQ-PC-U)
- Unpaved Road/Access
- Drainage Areas (Local)

1:50,000 and 1:250,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Digital Elevation Model provided by Geomatics - Yukon Government via online source (Corporate Spatial Warehouse) www.geomaticsyukon.ca.

Watercourse, drainage areas and Mount Nansen Road layers digitized / modified by EDI (2011) using orthophotos provided by Yukon Government, Energy, Mines and Resources (2011).

Project data displayed is site specific. Data collected by EDI Environmental Dynamics Inc. (2011) was obtained using Garmin GPS technology.

This document is not an official land survey and the spatial data presented is subject to change.

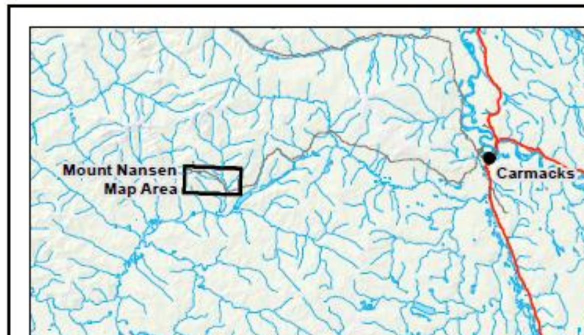
0 200 400 600 800 1,000

metres

Map Scale = 1:22,000 (printed on 11 x 17)

Map Projection: North American Datum 1983 UTM Zone 8N

Drawn: LG	Checked: MM	FIGURE 1	Date: 28/10/2013



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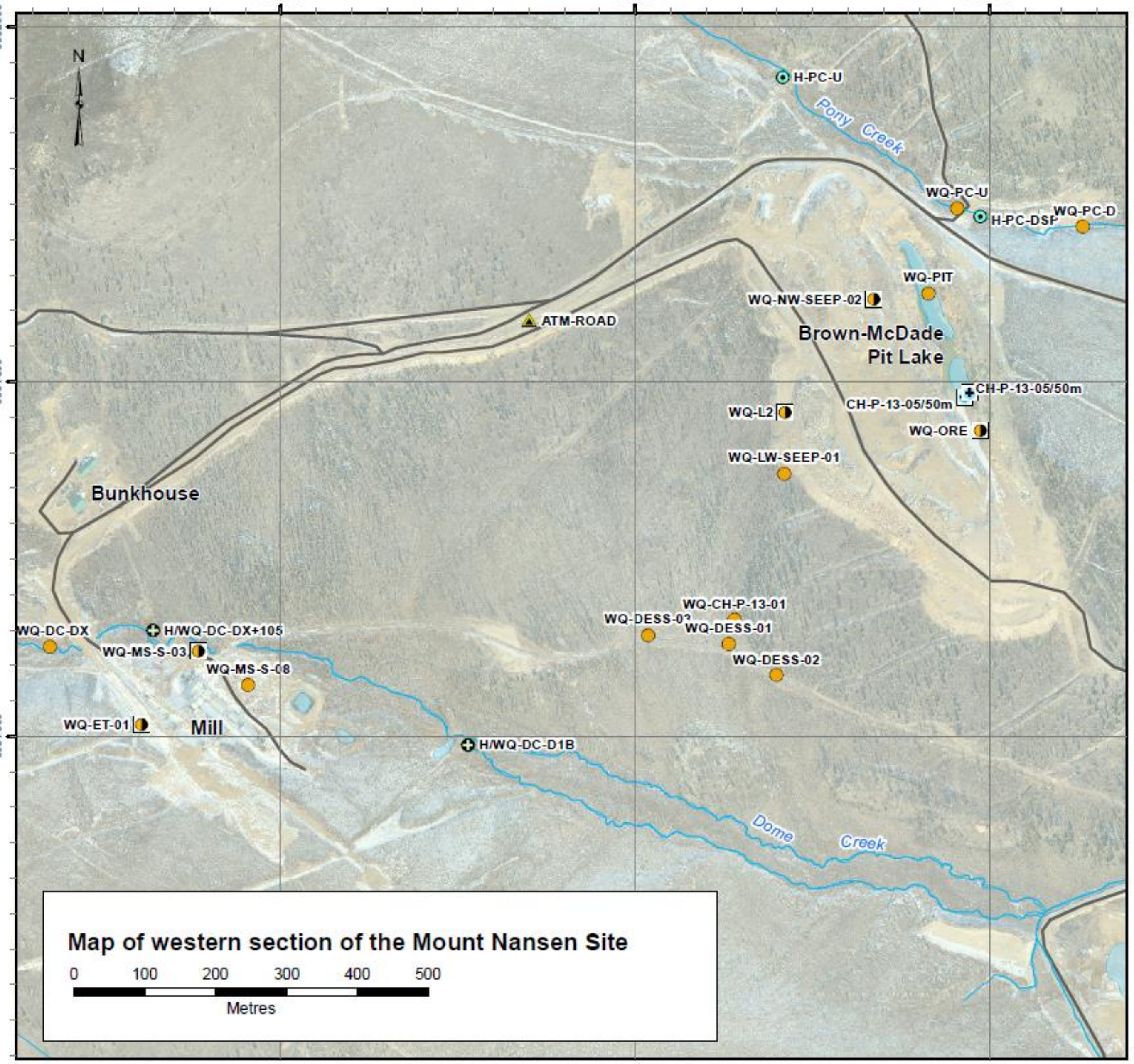

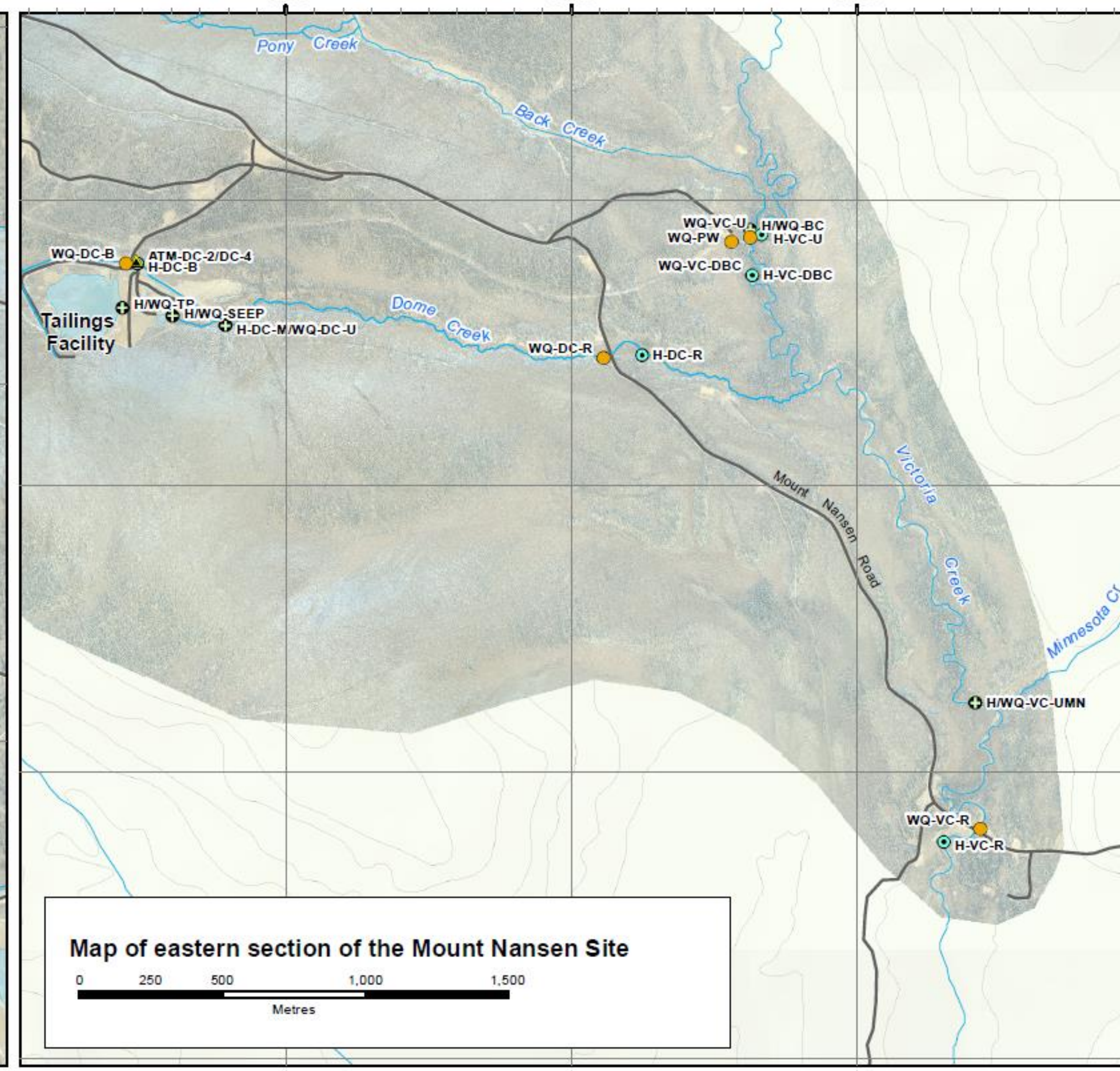

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- Hydrometric Station (label ex: H-VC-R)
- Water Quality Site (label ex: WQ-PC-U)
- Temporary Hydrometric Station
- Temporary Water Quality Site
- Unpaved Road/Access

Notes:

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Imagery provided by Yukon Government - Energy, Mines and Resources - Abandoned Mines Branch.

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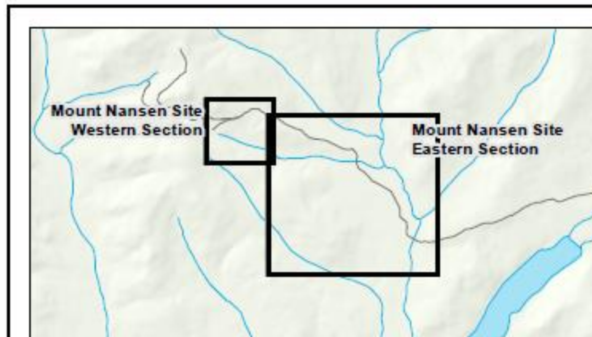
Map Projection: North American Datum 1983 UTM Zone 8N

Drawn: LG	Checked: MM	FIGURE 2	Date: 28/05/2014



Yukon EDI

2.0 APPROACH TO THE AMP

2.1 Objectives for the Adaptive Management Plan (AMP)

The AMP is a management tool that provides a consistent and predictable framework for identifying and responding to unforeseen deteriorating environmental conditions on site. The AMP provides the site operator, and AAM, with a pre-planned framework within which problems can be identified in a timely manner and decisions can be quickly and efficiently made. The AMP also provides regulators with the security of a consistent and predictable approach to unforeseen events.

The AMP takes the Precautionary Principle Approach: it provides a mechanism to identify potential environmental risks as they emerge and provides for a management response before an environmental impact occurs.

The AMP must be linked to the site operational plan and a comprehensive monitoring program that provides an indication of when management intervention is necessary. This assures that the necessary data and information for the assessment of environmental conditions are being collected, analysed and evaluated against predetermined “triggers” or “thresholds.”

Although some of the specific environmental conditions that may be encountered are, by definition, unknown, with the current understanding of the site conditions, many of the potential issues are generally understood. As such, the AMP should not provide detailed description of specific management responses but rather present a toolbox of possible management responses that range in level of intervention or mitigation. The level of intervention required is based on the assessment of the timing and impact on the receiving environment. The AMP therefore provides general descriptions of a range of possible responses that may be adapted or otherwise used to guide the design of an appropriate response that best suits the needs of the specific environmental conditions that are encountered. This approach is inherent to the fundamental purpose of the AMP.

Areas where there is uncertainty about site conditions, or where possible future conditions could lead to unacceptable environmental effects, have been identified, and the AMP provides a an approach that will be used to monitor, detect, and respond to changing conditions. Such an approach includes the following key components:

- Proactive monitoring to detect changing conditions in areas of expected uncertainty within a timeframe that allows for effective response;
- Clear and defensible triggers that will assure timely implementation of effective responses; and,
- Appropriate measures that can be undertaken to address unacceptable conditions and performance.

2.2 AMP Events

There are ten proposed events for the Mount Nansen AMP for Mount Nansen. These events represent anticipated environmental conditions that may significantly decline and therefore require a management response. These events specifically focus on locations on site where deteriorating conditions, including water quality, may affect receiving environments.

The following are the ten proposed events:

1. Degraded Water Quality in Dome Creek downstream of the Mill Area (D1b).
2. Changing Water Quality in the Seepage Pond.
3. Changes in Seepage Pond inflows/volume above normal range.
4. Degraded Water Quality in Dome Creek downstream of the seepage pond (DC-U and DC-R).
5. Degraded Water Quality in Victoria Creek at Road (VC-R).
6. Degraded Water Quality in Pony Creek downstream of the culvert.
7. Increases in Pit Water Level Elevation above normal range.
8. Changes in Groundwater Quality downgradient of the Brown-McDade Pit.
9. Degraded Water Quality in the Brown-McDade Pit.
10. Water Level in the Tailings Pond reaches Maximum Desired Water Level.

The AMPs for each of these events are described individually in subsequent sections.

2.3 Common Elements

To maintain consistency within the AMP, each of the AMP Events is described according to common elements. These common elements provide a structure that will ensure that a consistent approach is followed for each event and that the AMP will be proactive in detecting changes and implementing appropriate responses before any unacceptable environment effects occur. The following common elements form part of each specific AMP Event.

<u>Event</u> – This element describes the specific event that is addressed by the AMP.

<u>Possible Environmental Consequence</u> – This element describes the environmental consequences that could arise if the event was allowed to proceed without appropriate response.

<u>Narrative Trigger</u> – This is a description of the AMP trigger event and leads to the development of the specific indicators and thresholds. In general, the narrative trigger states that monitoring results indicate a specific type of environmental condition is deteriorating.

<u>Specific Indicators</u> – This element describes the environmental parameters to be monitored and assessed as part of the AMP. These indicators will be selected to provide early detection of relevant changes in environmental conditions or system performance. They should be representative of the issue being monitored and assessed, easily measured, and reproducible.

<u>Specific Thresholds</u> – This element defines thresholds, in terms of specific indicators, that would lead to actions being taken. They may be a series of staged thresholds or multiple thresholds for an individual AMP event, and where warranted, may include seasonally-based thresholds.

<u>Monitoring Requirements</u> – This element describes the monitoring that will be carried out to support implementation of the AMP. Parameters and general locations for sampling are discussed as part of the AMP framework. Physical inspections and visual monitoring can also form part of the monitoring requirements. Monitoring requirements may change at various stages of the AMP.

<u>Evaluation of Monitoring Results</u> – This element describes the methods and frequencies that will be used to evaluate the monitoring data and determine whether specific thresholds have been reached or exceeded.

Response Approach – This element describes the overall approach to responses to be implemented if thresholds have been reached or exceeded. In most cases, the responses will include a range of actions that may be taken to address the events. The selection of the appropriate responses would depend on changed site conditions or system performance and the associated impact on the receiving environment.

Within the context of implementing the AMP, there will be an ongoing need to understand the validity of monitoring results and confirm the circumstances of threshold or trigger activation. This validation and confirmation process will be conducted in a timely manner and is necessary to verify that response actions are applied in the appropriate circumstances. For each AMP element, if monitoring identifies conditions that are approaching or meeting triggers or thresholds, a stepped response will be implemented for validation and confirmation. Although presented in a sequential order, some steps may occur concurrently or be omitted, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to the trigger activation.

1. Notification & Validation
   The initial response to the trigger will be to notify AAM, followed by the verification of the monitoring information. The verification will involve a comprehensive analysis of the laboratory results or field data (e.g. in the case of water levels).

2. Preliminary Identification
   The second step will be a comprehensive analysis of the other related monitoring results from the locations including the monitoring data collected to directly support the AMP and other relevant site monitoring data, possibly including results collected for other associated AMP Events. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

   The third step will be an analysis of the timing and potential consequences of trigger activation on the receiving environment including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to prevent or mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Modelling may also be used to assess the effectiveness and impact of various mitigative options. Increased monitoring intensity may also be required (parameters, locations, and frequency) to verify and understand the cause/source of the trigger activation. This may entail detail site investigation work, such as seepage or groundwater investigations, to delineate the source of the trigger activation.

4. Response Plan

   A response plan will subsequently be developed based on the comprehensive analysis and investigation described above. Generally this plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of intervention required will, in part, be based on the assessment of the timing and impact of the trigger activation on the receiving environment.

2.4 Approach to Trend Analysis

Trend analysis plays a key part of the AMP protocol with several of the AMP Events having a statistically significant trend as one of the thresholds or triggers. To facilitate trend assessment a standardized approach was adopted using Microsoft Excel.

For the trend analysis and determination of a significant trend, the least squares method of linear regression is used to fit a trend line to the data. This can be done using the LINEST function in Excel. The F-statistic for this regression is calculated from the ratio of the variances. The F-statistic is used to test the null hypothesis that the data is a random scatter of points with a zero slope with non positive or negative trend. The calculated F-statistic is compared to critical values of F-statistic found in standard statistic tables. If the F-statistic is greater than the critical value, the null hypothesis fails and the linear model, and associated trend, is significant. Using a significance level of 0.05, if the calculated statistic is greater than the critical value, then we are 95% confident that the data is not a random scatter and the linear regression is justified.

2.5 Management Reviews, Annual Review and Reporting

An annual AMP review will be completed that assesses the adequacy and appropriateness of the elements of each Event such as trigger locations, specific indicators and thresholds, and monitoring requirements. Updates, amendments or other changes to the AMP will be recommended as part of this annual review.

Each AMP Event includes a management review by the AAM Environmental Monitoring Officer or contractor, of the relevant data to asses if a trigger has occurred. These reviews will occur monthly or annually, depending on the specific requirements of the AMP Event. The results of the monthly review, where a trigger occurs will be reported monthly. The results of these reviews will also be summarized as part of the annual review.

2.6 AMP Event Communication

Should an AMP Event occur the following communications will take place:

Party	Action	Timeline
AAM	Receives and reviews water quality data.	Monthly
AAM	If unusual, contractor returns to site for confirmatory sampling.	ASAP
AAM	If result is similar, AAM notified LSCFN and AANDC.	Immediately following results of confirmatory sampling.
AAM	Develops and circulates proposed mitigation plan.	ASAP – dependent on Event.

The type and frequency of communication following circulating the proposed mitigation plan will depend on the type and scale of the Event.

3.0 AMP EVENT 1 - DEGRADED WATER QUALITY IN DOME CREEK DOWNSTREAM OF MILL AREA

3.1 Description

The water quality in Dome Creek downstream of the mill area is currently affected by surface water runoff and seepage inflows from the mill area. The water quality in Dome Creek in this area is measured monthly, when flowing, at WQ-DC-D1-b with the exception of spring. At this time, samples are collected at a higher frequency (bi-weekly) in the period leading up to freshet, during freshet and following freshet. Historically, water quality in Dome Creek downstream of the mill area was measured further upstream at WQ-DC-D1. In 2012 it was identified, that due to migration of the channel, that WQ-DC-D1 no longer captured the majority of the flow. WQ-DC-D1-b was then established and in 2013, the use of Station D1 was discontinued. Monthly water quality samples are analyzed for a full suite of parameters including total suspended solids, cyanide species, nitrogen species, sulphate, total and dissolved metals. The flow in Dome Creek in this area is measured at HC-DC-D1-b.

The environmental consequence of degraded water quality in Dome Creek downstream of the mill is the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants. The mill area is a known source of contaminants to Dome Creek including sulphate, arsenic, cadmium, and zinc.

3.2 Specific Information or Issues

Water quality data in Dome Creek at WQ-DC-D1-b has only been collected since 2012. A comparison of data collected from both WQ-DC-D1 and WQ-DC-D1-b in 2012 and in May 2013 indicates that although similar parameters are elevated at each station, there were slight variations between the water quality data from these two stations. Specifically sulphate, ammonia, aluminum, antimony, arsenic, iron and manganese were present at higher concentrations at WQ-DC-D1-b than WQ-DC-D1. As such, the data from these two stations cannot be pooled to generate numerical thresholds based on the 2008 to 2011 reference period. A summary of the 2012 to 2013 water quality data for Dome Creek at WQ-DC-D1-b is presented in Table 3-1. Water quality results below detection limit are assumed to be at detection limit for the purposes of statistical and graphical analysis. For months where there was more than one sampling event, the weekly concentrations are averaged for the month. This average monthly value is then carried forward into the statistical assessment of the data.

3.3 Narrative Trigger

The trigger for the implementation of the AMP is “contaminant concentrations in Dome Creek downstream of the mill area as measured at WQ-DC-D1-b display a statistically significant increase”.

3.4 Specific Indicators

The specific indicators that should be monitored at Station WQ-DC-D1-b to provide the information necessary to assess whether the trigger has been achieved are:

- Sulphate (mg/L);
- Total and dissolved arsenic (mg/L);
- Total cadmium (mg/L) and total zinc.

Table 3-1 Summary of 2012 to 2013 Water Quality (mg/L) Data for Dome Creek at WQ-DC-D1-b.

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Cadmium	Total Zinc
Management Threshold			0.15	0.02	0.3
Minimum	437.0	0.015	0.008	0.00078	0.24
5^{th} Percentile	468.5	0.015	0.010	0.00085	0.25
Median	576.5	0.027	0.012	0.00203	0.44
95^{th} Percentile	665.3	0.072	0.021	0.00412	0.76
Maximum	720.0	0.116	0.025	0.00801	1.39
Number of Samples	16	16	16	16	16
Significant Trend (increasing or decreasing)	No	No	No	Decreasing	Decreasing

3.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- Monitoring results above the Management Threshold (Table 3-1) for dissolved arsenic, total cadmium and dissolved zinc; or
- A statistically significant (0.05) increasing trend in the monitoring results from WQ-DC-D1-b using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data for station D1-b from 2012 on will be used for the trend analysis.

3.6 Monitoring Requirements

The monitoring information required monthly (when available) is: sulphate, total and dissolved arsenic, total cadmium and total zinc concentrations measured at WQ-DC-D1-b. This data will be used to update the trend analysis for each parameter.

Additional monitoring information that is required for analysis should the AMP triggers be activated include surface and subsurface water quality and flow data from locations upstream of D1-b. Both water quality and flow data is essential as they enable not only the analysis of contaminant concentrations but loadings as well. The locations required are surface water quality stations upstream in the Dome Creek Drainage and from any surface, seepage and groundwater monitoring locations located in and downgradient of the mill area. The monitoring locations are outlined in Table 3-2.

Table 3-2 Summary of Water Quality Sites for Dome Creek at D1b AMP

Site Name	Description
WQ-DC-D1-b	Dome Creek at D1-b, downstream of mill area
WQ-DC-DX	Dome Creek at DX, upstream of mine site area
WQ-DX+105	Dome Creek at DX+105, 105 m downstream from DX
MS-S-03	Mill Site Seep 03
MS-S-08	Mill Site Seep 08
Groundwater Wells	Monitoring wells in and downgradient of mill area

3.7 Evaluation of Monitoring Results

The management review of the relevant water quality data (D1b) will be carried out on a monthly basis. This review will be completed when the QA/QC'd water quality data has been received from the contractor responsible for the routine site water quality monitoring program. For the assessment of triggers during periods with bi-weekly sample events, the bi-weekly concentrations will be averaged for the month. This average monthly value will then be carried forward and assessed as per the AMP Protocol.

3.8 Response Approach

As per the general approach to the AMP, a staged response to degraded water quality in Dome Creek downstream of the mill area will be implemented if one of the triggers is activated. Four major steps are identified below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results. The water quality at WQ-DC-D1-b may then require re-sampling if warranted (i.e. if QA/QC data or field notes indicates sampling issues/errors). This re-sampling should be done within approximately 1 to 4 weeks of the previous sampling time. Upon verification of the monitoring data that a threshold has been crossed and that the mill area is the likely cause, notification to AAM will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined in Table 3-2 will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require detailed site investigation work such as seepage, groundwater or surface water quality investigations.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Diversion of “clean” runoff water away from mill area to minimize the pathway to Dome Creek;
- Interception and collection of the identified source and routing to the Tailings Pond such as interception sumps and/or trenches or pumping wells; and
- Early implementation of components of the MNRP in targeted areas to minimize ongoing source loading to the receiving environment.

4.0 AMP EVENT 2 – CHANGES IN WATER QUALITY IN THE SEEPAGE POND

4.1 Description

The seepage pond at the toe of the tailings impoundment collects shallow groundwater seepage from the tailings area. The seepage collected in the pond is continuously pumped to Dome Creek. The water quality in the seepage pond is measured monthly, at the seepage pond outlet pipe, WQ-SEEP, with the exception of spring. In spring, samples are collected at a higher frequency (bi-weekly) in the period leading up to freshet, during freshet and following freshet. Water quality samples are analyzed for a full suite of parameters including total suspended solids, cyanide species, nitrogen species, sulphate, hardness, total and dissolved metals. The pond water levels are measured daily, during open water, via a staff gauge. The discharge pumping rate is measured daily via an inline flowmeter (H-SEEP) and routinely checked using timed volumetric measurements.

The environmental consequence of degraded water quality in Dome Creek downstream of the seepage pond discharge is the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants. The discharge from the seepage pond is a primary source of contaminants to Dome Creek including sulphate, arsenic, iron, manganese and cadmium. The seepage pond discharge also contains cyanide and nitrogen based species. Since 2009, only total iron and total manganese are present in the seepage pond discharge at concentrations above the EQS from the previous BYG water licence QZ94-004.

4.2 Specific Information or Issues

An analysis of the 2008 to 2013 water quality data for the seepage pond discharge (WQ-SEEP) was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Table 4-1. For reference, where applicable the reference EQS is also provided. Water quality results below detection limit are assumed to be at detection limit for the purposes of statistical and graphical analysis. For months where there was more than one sampling event, the weekly concentrations are averaged for the month. This average monthly value is then carried forward into the statistical assessment of the data

4.3 Narrative Trigger

The trigger for the implementation of the AMP is "contaminant concentrations in the seepage pond discharge as measured at Station WQ-SEEP display a sustained and statistically significant increase over the 2008 to 2013 reference period".

4.4 Specific Indicators

The specific indicators that should be monitored at WQ-SEEP to provide the information necessary to assess whether the trigger has been achieved are:

- Sulphate (mg/L);
- Total and dissolved arsenic (mg/L);
- Total cadmium (mg/L);
- Total and dissolved iron and manganese (mg/L);
- Total zinc (mg/L); and
- Total and WAD Cyanide (mg/L).

Table 4-1 Summary of 2008 to 2013 Water Quality Data (mg/L) for Seepage Pond Discharge (WQ-SEEP)

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Iron	Dissolved Iron	Total Cadmium
EQS			0.15	1.0		0.02
Minimum	289	0.008	0.002	3.17	0.01	0.00050
5th Percentile	465.4	0.022	0.002	6.65	0.045	0.00052
Median	623.0	0.035	0.005	11.7	3.20	0.00071
95th Percentile	822.6	0.057	0.035	20.8	9.67	0.00117
Maximum	931.5	0.066	0.043	24.8	11.40	0.00142
Number of Samples	69	69	69	69	68	69
Significant Trend	No	Increasing	Increasing	No	Increasing	Decreasing

Statistic	Total Manganese	Dis. Manganese	Total Zinc	Total Cyanide	WAD Cyanide
EQS	0.5		0.3	0.3	0.1
Minimum	4.1	3.3	0.005	0.019	0.005
5th Percentile	5.3	4.9	0.007	0.024	0.006
Median	6.4	6.3	0.012	0.046	0.012
95th Percentile	9.2	8.8	0.028	0.076	0.035
Maximum	11.8	10.0	0.039	0.077	0.091
Number of Samples	69	65	69	9	69
Significant Trend	Decreasing	Decreasing	Decreasing	No	Decreasing

4.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- Monitoring results at Seep above the reference EQS; or
- Three consecutive monitoring results at Seep greater than the upper 95th percentile of the reference period (2008 to 2013); or
- A statistically significant trend in the monitoring results from Seep as defined as statistically significant (0.05) increasing trend which, when extrapolated forward one year, would result in values greater than the 95th percentile. This trend assessment will be carried out using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data for Station Seep from 2008 and on will be used for the trend analysis.

4.6 Monitoring Requirements

The monitoring information required is monthly sulphate, total and dissolved arsenic, total cadmium, total and dissolved iron, total and dissolved manganese, total cyanide and WAD cyanide measured at the seepage discharge (WQ-SEEP). This data will be used for direct comparison to the specific thresholds and to enable an updated projected trend.

Additional monitoring information that is required for analysis should the AMP triggers be activated include surface and subsurface water quality and water level data from locations upstream of the seepage pond in the tailings impoundment area along with seepage pond pumping records. The monitoring locations are outlined in Table 4-2.

Table 4-2 Summary of Water Quality Stations for Seepage Pond Discharge AMP

Site Name	Description
WQ-SEEP	Seepage Pond Discharge
WQ-TP	Tailings Pond Water Quality
Seepage site	Seepage monitoring locations upgradient of the seepage pond
Groundwater Wells	Monitoring wells upgradient of the seepage pond in the Tailings Impoundment Area

4.7 Evaluation of Monitoring Results

The management review of the relevant water quality data from WQ-SEEP will be carried out on a monthly basis. This review will be completed when the QA/QC'd water quality data, has been received from the contractor responsible for the routine site water quality monitoring program. For the assessment of triggers during periods with bi-weekly sample events, the bi-weekly concentrations will be averaged for the month. This average monthly value will then be carried forward and assessed as per the AMP Protocol.

4.8 Response Approach

As per the general approach to the AMP, a staged response to changing water quality in the seepage pond discharge will be implemented if one of the triggers is activated. Four major steps are identified below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results. The water quality at WQ-SEEP may then require re-sampling if warranted (i.e. QA/QC data or field notes indicates sampling issues/errors). This re-sampling should be done within approximately 1 to 4 weeks of the previous sampling time. Upon verification of the monitoring data that a threshold has been crossed and that mine related facilities are the likely cause, notification to AAM will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined in Table 4-2 will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require detailed site investigation work such as seepage, groundwater or surface water quality investigations. Groundwater/seepage modelling may be used to provide an indication of the contaminant transport pathways and the rate and development of changes in contaminant loading to the seepage pond.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Pump back of seepage pond water to tailings pond;
- In-situ treatment in the seepage pond including aeration/flocculation to promote formation and settling of metal precipitates; and
- Design and implementation of treatment system for seepage pond discharge.

5.0 AMP EVENT 3 – CHANGES IN SEEPAGE POND INFLOWS/VOLUME OUTSIDE OF HISTORIC NORMS

5.1 Description

As discussed in Section 4.1 the seepage pond at the toe of the tailings impoundment collects shallow groundwater seepage from the tailings area. The seepage collected in the pond is continuously pumped to Dome Creek. The maximum design operating level of the seepage pond is 1078.1 masl. The pond water levels are measured daily, during open water, via a staff gauge. The discharge pumping rate is measured daily via a new inline flowmeter (H-SEEP) installed in 2012 and routinely checked using timed volumetric measurements.

The environmental consequence of changes in the seepage pond inflows/volumes above historic norms is the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants in the downstream receiving environment in Victoria Creek due to increased seepage from the tailings impoundment area. In addition, as a result of higher than normal seepage inflows, there is a concern related to the stability of the dam structure.

5.2 Specific Information or Issues

An analysis of the seepage pond daily pumping records (H-SEEP) from April 2012 to December 2013 and the open water season seepage pond water level data for 2012 and 2013 was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Table 5-1.

Table 5-1 Summary of Seepage Pond Discharge Rates and Water Level (2012 – 2013)

Statistic	Pumping Rate (L/min)	Water Level (masl)	Water Level Rate of Change (m/day)
Minimum	119.1	1077.02	-0.230
5^{th} Percentile	156	1077.10	-0.100
Median	198	1077.30	0.000
95^{th} Percentile	240.12	1077.50	0.092
Maximum	412	1077.78	0.260
Number of Samples	593	238	237

5.3 Narrative Trigger

The trigger for the implementation of the AMP is “seepage pond water levels and pumping rates display a sustained change from the 2012 to 2013 pumping rate, water level and rate of water level change.”

5.4 Specific Indicators

The specific indicators that should be monitored at the seepage pond to provide the information necessary to assess whether the trigger has been achieved are:

- Seepage pond pumping rate (L/s);
- Seepage pond water level (masl); and
- Seepage pond water level rate of change.

5.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any of the specific indicators will be as follows:

- Four consecutive average weekly results greater than the upper 95th percentile or lower than the lower 5th percentile of the 2012 to 2013 data record; or
- A statistically significant (0.05) increasing or decreasing trend in the monitoring results as defined as statistically significant using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data from 2012 on will be used for the trend analysis.

5.6 Monitoring Requirements

The monitoring information that is required is:

- Seepage Pond water elevation data; and
- Seepage Pond discharge data.

The daily water level and discharge data will be compiled monthly for assessment against the specified thresholds. Additional monitoring information that is required for analysis should the AMP triggers be activated include:

- Results of routine dam inspections (weekly) carried out by site personnel including identification of any new seeps;
- Local precipitation data from the site meteorological station;
- Water level data from groundwater monitoring wells upgradient of the seepage pond in the tailings impoundment area;
- Annual pond drawdown and refilling test to assess for any changes in the rate of inflow to the pond;
- Annual review of thermistor and piezometer data: and
- Spring and fall geotechnical inspections.

This additional data will be compiled to facilitate an annual review of the Seepage Pond AMP Event.

5.7 Evaluation of Monitoring Results

A management review of the Seepage Pond water elevations and pumping rates will be made on a monthly basis when updated data from the site is available. This will provide for an immediate assessment against the specific thresholds. Although the pond is actively managed to ensure the water level remains below the maximum target elevation, routine inspection of this data will enable the assessment of any changes in pumping rates required to keep the pond at its target elevation. A comprehensive annual review of this data will also be carried out as part of the annual AMP review.

5.8 Response Approach

As per the general approach to the AMP, a staged response to changing Seepage Pond water elevation and discharge rate will be implemented if one of the triggers is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will include assessment of the pond elevation and discharge data including comparison to manual measurements such as volume bucket test data and cross-checking with site operational records. This should be done within 2 weeks of the initial indication of trigger activation. Upon verification of the monitoring data that a threshold has been crossed and that there are no operational changes which resulted in the change, notification to AAM will be provided. Where substantial changes (increasing or decreasing) in seepage rates are noted immediate investigation of the cause should be carried out as it could relate to stability issues.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined previously will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation and will incorporate an assessment of pond water balance as well as recent results of routine site inspections and bi-annual geotechnical inspections.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require additional groundwater elevation and seepage inflow measurements. Groundwater/seepage modelling may be used to provide an indication of the inflow pathways to the pond and the rate and development of changes in inflows. This may also be required increasing the frequency and number of samples collected.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of the trigger activation in conjunction with the assessment of the timing and environmental consequence of the trigger activation. Given the linkages between this AMP Event and dam stability, where substantial increases or decreases in seepage rates are noted, immediate investigation of the cause should be carried. The following provides a list of the range of potential responses:

- Diversion/routing of non-impacted water away from the seepage pond;
- Increase pumping capacity for discharge to Dome Creek when downstream receiving environment conditions allow;
- Pump back to tailings to reduce water level in the seepage pond; and
- Engagement of engineer to address any physical stability issues of the tailings and seepage dams associated with changes in seepage rates and/or volumes.

6.0 AMP EVENT 4 - DEGRADED WATER QUALITY IN DOME CREEK DOWNSTREAM OF MINE FACILITIES

6.1 Description

Dome Creek, downstream of the tailing impoundment area, receives inputs from the mine site via direct discharge from the Seepage Pond, inflows from the mill area, and seepage and groundwater inflows from mine site facilities. The water quality in Dome Creek below the mine site facilities is measured at Stations WQ-DC-U and WQ-DC-R. Station WQ-DC-U is located downstream of the confluence of Dome Creek and the Seepage Pond discharge and Station WQ-DC-R is located in Dome Creek at the mine access road crossing. Water quality samples are collected monthly, with the exception of spring, where samples are collected at a higher frequency (bi-weekly) in the period leading up to freshet, during freshet and following freshet, and during frozen conditions. Water quality samples are analyzed for a full suite of parameters including total suspended solids, cyanide species, nitrogen species, sulphate, hardness, total and dissolved metals. Two corresponding hydrological monitoring stations are also established in Dome Creek: H-DC-U and H-DC-R.

The environmental consequence of degraded water quality in Dome Creek downstream of the mine facilities is the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants. The water quality in Dome Creek, below the mine site facilities, shows a clear mine-related influence with elevated concentrations of key contaminants of concern including sulphate, arsenic, iron, manganese, cadmium, and zinc. Total and WAD cyanide is also present in Dome Creek below the mine facilities, although at concentrations typically well below the CCME guidelines, at or near detection limits.

6.2 Specific Information or Issues

An analysis of the 2008 to 2013 water quality data for the Dome Creek (WQ-DC-U and WQ-DC-R) was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Tables 6-1 and 6.2. Water quality results below detection limit are assumed to be at detection limit for the purposes of statistical and graphical analysis. For months where there was more than one sampling event, the weekly concentrations are averaged for the month. This average monthly value is then carried forward into the statistical assessment of the data

6.3 Narrative Trigger

The trigger for the implementation of the AMP is “contaminant concentrations Dome Creek as measured at Stations WQ-DC-U and WQ-DC-R display a sustained and statistically significant increase over the 2008 to 2013 reference period”.

6.4 Specific Indicators

The specific indicators that should be monitored at WQ-DC-U and WQ-DC-R to provide the information necessary to assess whether the trigger has been achieved are:

- Sulphate (mg/L);
- Total and dissolved arsenic (mg/L);
- Total cadmium and total zinc (mg/L);
- Total and dissolved iron (mg/L);
- Total and dissolved manganese (mg/L).

Table 6-1 Summary of 2008 to 2013 Water Quality Data (mg/L) for Dome Creek (WQ-DC-U)

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Iron	Dissolved Iron
Minimum	130.0	0.009	0.003	1.1	0.01
5th Percentile	212.0	0.013	0.004	1.5	0.01
Median	460.7	0.024	0.009	4.1	0.43
95th Percentile	785.1	0.052	0.031	10.5	5.35
Maximum	904.0	0.083	0.038	16.4	7.36
Number of Samples	63	63	63	63	63
Significant Trend (increasing or decreasing)	Increasing	Increasing	Increasing	Increasing	Increasing
Statistic	**Total Cadmium**	**Total Manganese**	**Dis. Manganese**	**Total Zinc**	
Minimum	0.00009	0.53	0.11	0.004	
5th Percentile	0.00010	0.66	0.54	0.006	
Median	0.00032	1.72	1.73	0.018	
95th Percentile	0.00066	5.94	5.68	0.090	
Maximum	0.00122	7.58	7.90	0.154	
Number of Samples	63	63	58	63	
Significant Trend (increasing or decreasing)	No	No	No	No	

Table 6-2 Summary of 2008 to 2013 Water Quality Data (mg/L) for Dome Creek (WQ-DC-R)

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Iron	Dissolved Iron
Minimum	142.0	0.010	0.004	0.75	0.020
5th Percentile	160.7	0.019	0.005	1.55	0.023
Median	334.4	0.033	0.009	3.78	0.39
95th Percentile	490.8	0.055	0.018	6.09	1.58
Maximum	519.0	0.064	0.021	15.3	3.99
Number of Samples	38	39	39	38	39
Significant Trend (increasing or decreasing)	No	Increasing	Increasing	Increasing	Increasing

Statistic	Total Cadmium	Total Manganese	Dis. Manganese	Total Zinc
Minimum	0.00008	0.60	0.42	0.007
5th Percentile	0.00008	0.69	0.55	0.008
Median	0.00017	1.17	1.00	0.020
95th Percentile	0.00044	2.96	2.56	0.068
Maximum	0.00083	3.78	3.59	0.116
Number of Samples	39	39	36	39
Significant Trend (increasing or decreasing)	No	No	No	No

6.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- Three consecutive monitoring results at WQ-DC-U or WQ-DC-R greater than the upper 95th percentile of the reference period (2008 to 2013); or
- A statistically significant trend (0.05) in the monitoring results from WQ-DC-U or WQ-DC-R which, when extrapolated forward one year, would result in values greater than the 95th percentile. This trend assessment will be carried out using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data from 2008 and on will be used for the trend analysis.

In establishing the numeric threshold values at WQ-DC-U, the use of a back-calculated valued based on the relative flow between WQ-DC-U and Victoria Creek (WQ-VC-R) and the proposed guideline-based thresholds in Victoria Creek (AMP Event 5) was assessed. Using concurrent flow data for high and low flow conditions in 2013, the ratio of Victoria Creek flow to Dome Creek flow ranged from 7:1 to 37:1. Assuming the lower, more conservative, ratio of 7:1 resulted in back-calculated threshold values much higher than those based on the 95th percentile: the only exception being dissolved iron. Therefore, the use of the threshold based on the 95th percentile was adopted for the Dome Creek AMP Event.

6.6 Monitoring Requirements

The monitoring information required monthly is: sulphate, total and dissolved arsenic, total cadmium, total and dissolved iron, total and dissolved manganese, and total zinc concentrations. This data will be used for direct comparison to the specific thresholds and to enable an updated projected trend.

Additional monitoring information that is required for analysis should the AMP triggers be activated include surface and subsurface water quality and flow data from locations upstream of WQ-DC-U and WQ-DC-R. Both water quality and flow data is essential as they enable not only the analysis of contaminant concentrations but loadings as well. The locations required are surface water quality stations locations upstream in the Dome Creek drainage and from any surface, seepage and groundwater monitoring locations located downgradient of mine related facilities in the Dome Creek catchment. Monitoring data assessed as part of AMP Event 1 (Mill Area) and AMP Event 2 (Seepage Pond Discharge) will also provide important information should the Dome Creek AMP be activated. The monitoring locations are outlined in Table 6-3.

Table 6-3 Summary of Water Quality Stations for Dome Creek AMP

Site Name	Description
WQ-DC-U	Dome Creek, downstream of confluence with Seepage Discharge
WQ-DC-R	Dome Creek, at Mine Access Road
WQ-SEEP	Seepage Pond Discharge

Site Name	Description
	Monitoring location in Dome Creek Diversion
WQ-DC-D1-b	Dome Creek at D1-b, downstream of mill area
WQ-DC-DX	Dome Creek at DX, upstream of mine site area
WQ-DX+105	Dome Creek at DX+105, 105 m downstream from DX
Seepage site	Seepage monitoring locations downgradient of mine facilities
Groundwater Wells	Monitoring wells downgradient of mine facilities

6.7 Evaluation of Monitoring Results

The management review of the relevant water quality data from WQ-DC-U and WQ-DC-R will be carried out on a monthly basis. This review will be completed when the QA/QC'd water quality data, has been received from the contractor responsible for the routine site water quality monitoring program. For the assessment of triggers during periods with bi-weekly sample events, the bi-weekly concentrations will be averaged for the month. This average monthly value will then be carried forward and assessed as per the AMP Protocol.

6.8 Response Approach

As per the general approach to the AMP, a staged response to changing water quality in the seepage pond discharge will be implemented if one of the triggers is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results. The water quality at WQ-DC-U and WQ-DC-R may then require re-sampling if warranted (i.e. QA/QC data or field notes indicates sampling issues/errors). This re-sampling should be done within approximately 1 to 4 weeks of the previous sampling time. Upon verification of the monitoring data that a threshold has been crossed and that mine related facilities are the likely cause, notification will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined in Table 6-3 will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require detailed site investigation work such as seepage, groundwater or surface water quality investigations. Groundwater/seepage modelling may be used to provide an indication of the contaminant transport pathways and the rate and development of changes in contaminant loading to Dome Creek.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Pump back of seepage pond water to tailings pond;
- Design and implementation of treatment system for seepage pond discharge;
- Interception/collection and routing to tailings pond of seepage flows from other mine related facilities including mill area, pit or waste rock areas; and
- Aquatic risk assessment of impact in Victoria Creek of parameters with activated triggers in Dome Creek.
- Targeted remediation of Dome Creek downstream of seepage pond to remove non-point sources of loading.

7.0 AMP EVENT 5 - DEGRADED WATER QUALITY IN VICTORIA CREEK AT MINE ACCESS ROAD

7.1 Description

Victoria Creek, downstream of the mine site area, receives inputs from the mine site from surface water inflows and from groundwater inflows from mine site facilities. The receiving environment for the site is represented by sampling location WQ-VC-R. This location is downstream of inputs from both Dome and Back Creek, and includes all potential mine related inputs to the receiving environment. In contrast to Dome Creek, Victoria Creek is known to support fish and fish habitat. The water quality in Victoria Creek at WQ-VC-R is collected monthly, with the exception of spring, where samples are collected at a higher frequency in the period leading up to freshet, during freshet and following freshet. During winter, water quality in this area is sampled 100 m downstream at WQ-VC-R+100. Water quality samples are analyzed for a full suite of parameters including total suspended solids, cyanide species, nitrogen species, sulphate, hardness, total and dissolved metals. A corresponding hydrological monitoring station is also established in Victoria Creek: H-VC-R.

The environmental consequence of degraded water quality in Victoria Creek is the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants The water quality in Victoria Creek, below the mine site facilities, shows a clear mine-related influence with elevated concentrations of key contaminants of concern, compared to background, including sulphate, dissolved arsenic, dissolved iron, dissolved manganese, dissolved cadmium, and dissolved zinc.

7.2 Specific Information or Issues

The water quality in Victoria Creek at WQ-VC-R is significantly influenced by elevated levels of suspended solids from both natural and anthropogenic sources (including placer mining in the Back Creek watershed) with total suspended solids concentrations historically measured. Due to this influence of upstream sediment inputs, the development of the AMP Event for Victoria Creek is based on dissolved metals. Taking this approach enables the isolation of site-related influences and eliminates the interfering effects of elevated suspended solids contributed from upstream, in the Victoria Creek catchment.

An analysis of the 2008 to 2013 water quality data for the Victoria Creek (WQ-VC-R and WQ-VC-R +100) was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Tables 7-1. For reference purposes the applicable water quality guidelines are included. For arsenic, zinc and cadmium, the CCME Water Quality Guidelines for the Protection of Aquatic Life for the corresponding total metal are provided. For iron the more recent BC Guideline for dissolved iron is provided and for manganese the BC guideline for total manganese is presented. Water quality results below detection limit are assumed to be at detection limit for the purposes of statistical and graphical analysis. For months where there was more than one sampling event, the weekly concentrations are averaged for the month. This average monthly value is then carried forward into the statistical assessment of the data

7.3 Narrative Trigger

The trigger for the implementation of the AMP is “contaminant concentrations Victoria Creek as measured at Stations WQ-VC-R and WQ-VC-R +100 display a sustained and statistically significant increase over the 2008 to 2013 reference period”.

7.4 Specific Indicators

The specific indicators that should be monitored at WQ-VC-R/+100 to provide the information necessary to assess whether the trigger has been achieved are:

- Sulphate (mg/L);
- Dissolved arsenic (mg/L);
- Dissolved cadmium (mg/L);
- Dissolved iron (mg/L);
- Dissolved manganese (mg/L); and
- Dissolved zinc (mg/L).

7.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- Three consecutive monitoring results at WQ-VC-R/+100 greater than the upper 95th percentile of the reference period (2008 to 2013); or
- A statistically significant trend (0.05) in the monitoring results from WQ-VC-R/+100 which, when extrapolated forward one year, would result in values greater than the 95th percentile. This trend assessment will be carried out using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data from 2008 and on will be used for the trend analysis.

For dissolved arsenic, cadmium, iron, manganese and zinc the specific threshold values are below the associated total metal CCME (or BC for dissolved iron and manganese) guideline values for the protection of aquatic life.

Table 7-1 Summary of 2008 to 2013 Water Quality Data (mg/L) for Victoria Creek (WQ-VC-R/+100)

Statistic	Sulphate	Dissolved Arsenic	Dissolved Cadmium
Guideline		0.005	0.00012
Minimum	9.0	0.0003	0.00001
5th Percentile	11.7	0.0006	0.00001
Median	27.0	0.001	0.00002
95th Percentile	45.9	0.002	0.00009
Maximum	119.0	0.004	0.00011
Number of Samples	55	55	55
Significant Trend (increasing or decreasing)	No	No	No
Statistic	**Dissolved Iron**	**Dis. Manganese**	**Dissolved Zinc**
Guideline	0.35	1	0.03
Minimum	0.005	0.008	0.0005
5th Percentile	0.010	0.019	0.0009
Median	0.095	0.057	0.002
95th Percentile	0.270	0.120	0.0082
Maximum	0.456	0.294	0.016
Number of Samples	55	52	55
Significant Trend (increasing or decreasing)	Increasing	Increasing	No

7.6 Monitoring Requirements

The monitoring information required monthly is: sulphate and dissolved arsenic, cadmium, iron, manganese, and zinc concentrations. This data will be used for direct comparison to the specific thresholds and to enable an updated projected trend.

Additional monitoring information that is required for analysis, should the AMP triggers be activated include surface and subsurface water quality and flow data from locations upstream of WQ-VC-R/+100. Both water quality and flow data is essential as they enable not only the analysis of contaminant concentrations but loadings as well. The locations required are surface water quality sites upstream in the Dome Creek drainage and Victoria Creek drainage and from any surface, seepage and groundwater monitoring locations located downgradient of mine related facilities in the Dome Creek catchment. Monitoring data assessed as part of AMP Event 1 (Mill Area), AMP Event 2 (Seepage Pond Discharge) and AMP Event 4 (Dome Creek) will also provide important information should the Victoria Creek AMP be activated. The monitoring locations are outlined in Table 7-2.

Table 7-2 Summary of Water Quality Stations for Victoria Creek AMP

Site Name	Description
WQ-VC-R/+100	Victoria Creek, at Mine Access Road
WQ-VC-U	Victoria Creek, upstream of Back Creek Confluence
WQ-VC-DBC	Victoria Creek, downstream of Back Creek
WQ-DC-U	Dome Creek, downstream of confluence with Seepage Discharge
WQ-DC-R	Dome Creek, at Mine Access Road
WQ-SEEP	Seepage Pond Discharge
WQ-DC-D1-b	Dome Creek at D1-b, downstream of mill area
WQ-DC-DX	Dome Creek at DX, upstream of mine site area
WQ-DX+105	Dome Creek at DX+105, 105 m downstream from DX
Seepage site	Seepage monitoring locations downgradient of mine facilities
Groundwater Wells	Monitoring wells downgradient of mine facilities

7.7 Evaluation of Monitoring Results

The management review of the relevant water quality data from WQ-VC-R /+100 will be carried out on a monthly basis. This review will be completed when the QA/QC'd water quality data, has been received from the contractor responsible for the routine site water quality monitoring program. For the assessment of triggers during periods with bi-weekly sample events, the bi-weekly concentrations will be averaged for the month. This average monthly value will then be carried forward and assessed as per the AMP Protocol.

7.8 Response Approach

As per the general approach to the AMP, a staged response to changing water quality in the seepage pond discharge will be implemented if one of the triggers is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results. The water quality at WQ-VC-R/+100 may then require re-sampling if warranted (i.e. QA/QC data or field notes indicates sampling issues/errors). This re-sampling could be done within approximately 1 to 4 weeks of the previous sampling time. Upon verification of the monitoring data that a threshold has been crossed and that mine related facilities are the likely cause, notification to AAM will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined in Table 7-2 will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require detailed site investigation work such as seepage, groundwater or surface water quality investigations. Groundwater/seepage modelling and/or surface water quality load modelling may be used to provide an indication of the contaminant transport pathways and the rate and development of changes in contaminant loading to Victoria Creek.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Aquatic risk assessment of impact in Victoria Creek of parameters with activated triggers.
- Pump back of seepage pond water to tailings pond;
- Design and implementation of treatment system for seepage pond water prior to discharge;
- Interception/collection and routing to tailings pond of seepage flows from other mine related facilities including mill area, Pony Creek, pit or waste rock areas; and
- Targeted remediation of Dome Creek downstream of seepage pond to remove non-point sources of loading.

8.0 AMP EVENT 6 - DEGRADED WATER QUALITY IN PONY CREEK DOWNSTREAM OF MINE AREA

8.1 Description

The water quality in Pony Creek downgradient of the mine area (below the Brown-McDade Pit) is currently affected by the historic practice of depositing waste rock within the stream channel. The water quality in Pony Creek in this area is measured monthly, when flowing, at WQ-PC-D with the exception of spring. At this time, samples are collected at a higher frequency (bi-weekly) in the period leading up to freshet, during freshet and following freshet. The collected water quality samples are analyzed for a full suite of parameters including total suspended solids, cyanide species, nitrogen species, sulphate, total and dissolved metals. The flow in Pony Creek in this area is measured at H-PC-DSP, located in Pony Creek upstream of WQ-PC-D.

The environmental consequence of degraded water quality in Pony Creek is the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants. Water quality in Pony Creek in this area shows a clear site-related influence with elevated levels of total cadmium, copper and zinc in comparison to background water quality.

8.2 Specific Information or Issues

An analysis of the 2008 to 2013 water quality data for Pony Creek downstream of the mine area (WQ-PC-D) was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Table 8-1. Water quality results below detection limit are assumed to be at detection limit for the purposes of statistical and graphical analysis. For months where there was more than one sampling event, the weekly concentrations are averaged for the month. This average monthly value is then carried forward into the statistical assessment of the data

Table 8-1 Summary of 2008 to 2013 Water Quality Data (mg/L) for Pony Creek at WQ-PC-D.

Statistic	Total Cadmium	Total Copper	Total Zinc
Minimum	0.00030	0.005	0.032
5th Percentile	0.00043	0.006	0.046
Median	0.0012	0.011	0.12
95th Percentile	0.0044	0.040	0.42
Maximum	0.0059	0.072	0.56
Number of Samples	36	36	36
Significant Trend (increasing or decreasing)	Decreasing	Decreasing	Decreasing

8.3 Narrative Trigger

The trigger for the implementation of the AMP is "contaminant concentrations in Pony Creek as measured at Station WQ-PC-D display a sustained and statistically significant increase over the 2008 to 2013 reference period".

8.4 Specific Indicators

The specific indicators that should be monitored at WQ-PC-D to provide the information necessary to assess whether the trigger has been achieved are:

- Total cadmium (mg/L);
- Total copper (mg/L); and
- Total zinc (mg/L).

8.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- Three consecutive monitoring results at WQ-PC-D greater than the upper 95th percentile of the reference period (2008 to 2013); or
- A statistically significant trend in the monitoring results from WQ-PC-D as defined as statistically significant (0.05) increasing trend which, when extrapolated forward one year, would result in values greater than the 95th percentile. This trend assessment will be carried out using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data for Station Seep from 2008 and on will be used for the trend analysis.

8.6 Monitoring Requirements

The monitoring information required monthly (when available) is total cadmium, total copper and total zinc concentrations measured at WQ-PC-D. This data will be used for direct comparison to the specific thresholds and to enable an updated projected trend.

Additional monitoring information that is required for analysis should the AMP triggers be activated include surface and subsurface water quality and flow data from locations upstream of WQ-PC-D. Both water quality and flow data is essential as they enable not only the analysis of contaminant concentrations but loadings as well. The locations required are surface water quality stations locations upstream in the Dome Creek Drainage and from any surface, seepage and groundwater monitoring locations located downgradient of mine related facilities in the Pony Creek catchment. The monitoring locations are outlined in Table 9-2.

Table 8-2 Summary of Water Quality Stations for Pony Creek AMP

Site Name	Description
WQ-PC-D	Pony Creek, downstream of Pit
WQ-PC-U	Pony Creek, upstream of Pit and waste rock

Site Name	Description
WQ-ADIT-SEEP	Pony Creek Adit Seepage Monitoring Site
Groundwater Wells	Monitoring wells downgradient of mine facilities in Pony Creek catchment

8.7 Evaluation of Monitoring Results

The management review of the relevant water quality data from WQ-PC-D will be carried out on a monthly basis. This review will be completed when the QA/QC'd water quality data, has been received from the contractor responsible for the routine site water quality monitoring program. For the assessment of triggers during periods with bi-weekly sample events, the bi-weekly concentrations will be averaged for the month. This average monthly value will then be carried forward and assessed as per the AMP Protocol.

8.8 Response Approach

As per the general approach to the AMP, a staged response to degraded water quality in Pony Creek downstream of the mine area will be implemented if one of the triggers is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results. The water quality at WQ-PC-D may then require re-sampling if warranted (i.e. QA/QC data or field notes indicates sampling issues/errors). This re-sampling could be done within approximately 1 to 4 weeks of the previous sampling time. Upon verification of the monitoring data that a threshold has been crossed and that the mill area is the likely cause, notification to AAM will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined in Table 9-2 will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require detailed site investigation work such as seepage, groundwater or surface water quality investigations. Groundwater/seepage modelling and/or surface water quality load modelling may be used to provide an indication of the contaminant transport pathways and the rate and development of changes in contaminant loading to Pony Creek.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Identification of source material (i.e. waste rock) and removal into pit catchment;
- Interception/collection and routing to pit of identified seepage flows; and
- Targeted remediation of components in Pony Creek catchment.

9.0 AMP EVENT 7 – CHANGES IN PIT WATER LEVEL ELEVATION OUTSIDE OF HISTORIC NORMS

9.1 Description

The water quality in the Brown-McDade Pit is currently above the reference EQS for several parameters including iron, manganese and zinc. Water is not actively discharged from the pit and the water level in the Pit currently fluctuates between approximately 1181 masl and 1184 masl. The water balance of the pit is dominated by precipitation and runoff from its immediate catchment, although there is a continual discharge from the Pit via groundwater, estimated at approximately 0.5 L/s (AMEC 2014a). Annually the water level in the pit starts to rise in spring with the onset of freshet and steadily increases until the end of the open water season. During winter, the water level then drops in response to the continuous discharge via groundwater. Although there is no operational target for the Pit, the elevation of the Pony Creek Adit (1185 masl) provides a maximum water elevation limit. The pit water elevation level is measured continuously via a level logger which is downloaded routinely as part of the site routine monitoring program.

The environmental consequence of changes in the Pit water level outside of historic norms is the potential exposure of aquatic and terrestrial resources and human users to increased contaminant loading to the downstream receiving environment of Pony, Dome and Victoria Creeks.

9.2 Specific Information or Issues

An analysis of the pit water elevation data from August 2010 to June 2013 was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Table 9-1.

Table 9-1 Summary of Brown-McDade Pit Water Level (2010 – 2013)

Statistic	Water Level (masl)
Minimum	1181.2
5th Percentile	1181.79
Median	1183.21
95th Percentile	1184.09
Maximum	1184.12
Number of Samples	1040

9.3 Narrative Trigger

The trigger for the implementation of the AMP is “Brown-McDade Pit water levels display a sustained change from the 2010 to 2013 water levels”.

9.4 Specific Indicators

To assess whether the trigger has been reached, the specific indicator that should be monitored at the Brown-McDade Pit is the Pit water level elevation data (masl).

9.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, will be as follows:

- Four consecutive average weekly Pit water level results greater than the upper 95th percentile or lower than the lower 5th percentile of the 2010 to 2013 data record; or
- A deviation from the typical Pit annual water level pattern: increasing during open water and decreasing during winter.

9.6 Monitoring Requirements

The monitoring information that is required is Brown-McDade Pit water elevation data. The level logger water level data will be compiled monthly for assessment against the specified thresholds. Additional monitoring information that is required for analysis should the AMP triggers be activated include local precipitation data from the site meteorological station, water level data from groundwater monitoring wells downgradient of the Pit, and the results of routine site inspections identifying any new seeps or inflows to the pit or changes in existing inflows. This additional data will be compiled to facilitate an annual review of the Brown-McDade Pit AMP Event.

9.7 Evaluation of Monitoring Results

A management review of the Pit water elevations will be made on a monthly basis when updated data from the site is available. This will provide for an immediate assessment against the specific thresholds. A comprehensive annual review of this data will also be carried out as part of the annual AMP review.

9.8 Response Approach

As per the general approach to the AMP, a staged response to changing Pit water elevation will be implemented if one of the triggers is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will include assessment of the Pit elevation data and may include a physical survey of the pit water elevation. This should be done within 2 weeks of the initial indication of trigger activation. Upon verification of the monitoring data that a threshold has been crossed, notification to AAM will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined previously will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation and will include an assessment of the Pit water balance.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted using, if necessary, groundwater modelling. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require additional groundwater elevation and seepage inflow measurements, site investigation for additional seeps or inflows in the pit as well as down gradient of the pit. Groundwater/seepage modelling may be used to provide an indication of the rate and development of changes in Pit inflows and outflows. As part of this process, all recent pit water level and related data will be provided to the Project Design Team for consideration in the preparation of the MNRP.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Update of pit water balance and establishment of target elevations and trigger elevations for implementation of water management plan for the pit;
- For increasing water level, assessment of timing to reaching the maximum water elevation (1185 masl);
- Routing of onset pit runoff away from pit catchment; and
- Design and implementation of pit water management program, including possible treatment for discharge to the receiving environment.

10.0 AMP EVENT 8 – CHANGES IN GROUNDWATER QUALITY DOWNGRADIENT OF THE BROWN-MCDADE PIT.

The water quality in the Brown-McDade Pit is currently above the reference EQS for several parameters including iron, manganese and zinc. Water is not actively discharged from the pit and the water level in the Pit currently fluctuates between approximately 1181 masl and 1184 masl. As discussed in Section 9.0, the water balance of the pit is dominated by precipitation and runoff from its immediate catchment, although there is a continual discharge from the Pit via groundwater, estimated at approximately 0.5 L/s (AMEC 2014a). The discharge via groundwater from the Pit follows regional groundwater flow towards Dome and ultimately Victoria Creek. In 2013, as part of the site investigation program carried out by AMEC (AMEC 2014b), several new monitoring wells were installed downgradient of the Pit. Of the monitoring wells installed, one is located along or adjacent to the inferred regional groundwater flow pathway between the Pit and Dome Creek: CH-13-03 and CH-13-04. Water quality samples collected from these locations can be used to track potential changes in groundwater quality due to the ongoing seepage from the Pit.

The environmental consequence of changes in groundwater quality is the potential exposure of aquatic and terrestrial resources and human users to increased contaminant loading to the downstream receiving environment of Dome and Victoria Creeks.

10.1 Specific Information or Issues

Two new monitoring wells, CH-13-03 and CH-13-04, were installed in 2013 downgradient of the Pit, each completed with monitoring locations at two depths. To date only one set of groundwater samples has been collected from each with well and as such there is insufficient data to provide any statistical assessment of the available data. It is recommended that sufficient samples should be collected annually to adequately quantify the seasonal nature of the ground water quality. Given the linkage between this AMP Event and closure it is recommended that staged triggers be developed for this AMP once sufficient data has been collected to characterize the groundwater quality downgradient of the pit.

10.2 Narrative Trigger

The trigger for the implementation of the AMP is “changes in groundwater quality in groundwater downgradient of the Pit as measured at CH-13-03 and CH-13-04 display a statistically significant increasing trend”.

10.3 Specific Indicators

The specific indicators that should be monitored at CH-13-03 (10 m/50 m) and CH-13-04 (10 m/35 m) to provide the information necessary to assess whether the trigger has been achieved are:

- Sulphate
- Dissolved arsenic (mg/L);
- Dissolved cadmium (mg/L);
- Dissolved iron (mg/L);
- Dissolved manganese (mg/L); and
- Dissolved zinc (mg/L).

10.4 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- A statistically significant trend in the monitoring results from WQ-PC-D as defined as statistically significant (0.05) increasing trend. This trend assessment will be carried out using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, a minimum of four data points is required.

10.5 Monitoring Requirements

The monitoring information required is sulphate, dissolved arsenic, dissolved cadmium, dissolved iron, dissolved manganese and dissolved zinc concentrations measured at CH-13-03 and CH-13-04. This data will be collected as part of the routine groundwater monitoring program four a year: early spring, summer (2) and late fall. This data will be used to enable an updated trend assessment.

Additional monitoring information that is required for analysis should the AMP triggers be activated include pit water quality data and well water level data. Both water quality and water level data is essential as they enable not only the analysis of contaminant concentrations but changes in groundwater flow patterns.

10.6 Evaluation of Monitoring Results

The management review of the relevant groundwater quality data from CH-13-04 and CH-13-04 will be carried out four times per year following each sampling event. This review will be completed when the QA/QC'ed groundwater quality data, following routine QA/QC, has been received from the contractor responsible for the routine site water quality monitoring program.

10.7 Response Approach

As per the general approach to the AMP, a staged response to changing groundwater quality downgradient of the Pit will be implemented if one of the triggers is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will involve a comprehensive analysis of the laboratory results. This may include re-sampling if warranted (i.e. QA/QC data or field notes indicates sampling issues/errors). This re-sampling could be done within approximately 1 to 4 weeks of the previous sampling time. Upon verification of the monitoring data that a threshold has been crossed, notification to AAM will be provided.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined in Section 10.5. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation.

3. Analysis and Investigation

An analysis of the impacts of the trigger activation on the receiving environment will be conducted, including magnitude, spatial extent and reversibility of potential effects. The results of this analysis will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program. Following this analysis, increased monitoring intensity may be required (parameters, locations and frequency) to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require detailed site investigation work such as seepage, groundwater or surface water quality investigations. Groundwater/seepage modelling and/or surface water quality load modelling may be used to provide an indication of the contaminant transport pathways and the rate and development of changes in contaminant loading in groundwater downgradient of the Pit.

4. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation. The following provides a list of the range of potential responses:

- Detailed assessment of the impact of increasing concentrations in groundwater on the receiving environment in Dome and Victoria Creeks including timing, magnitude and reversibility;
- Installation of additional monitoring wells to delineate the migration of contaminants via groundwater downgradient of the pit;
- Investigation of the cause of the increases in groundwater concentrations including increased outflow from the pit or depletion of attenuation capacity along the flowpath;
- Establishment of stage triggers for the design and implementation of an appropriate remediation plan; and
- Design of an appropriate remediation plan which could include:
    - In-situ treatment; or
    - Groundwater interception, collection and/or treatment system.

11.0 AMP EVENT 9 – DEGRADED WATER QUALITY IN BROWN-MCDADE PIT

11.1 Description

The water quality in the Brown-McDade Pit is currently above the reference EQS for several parameters including iron, manganese and zinc. The water quality in the pit is variable with depth. In general concentrations of metals including total arsenic, cadmium, iron, manganese and zinc increase with depth along with sulphate and ammonia. Water is not actively discharged from the pit and it is understood that there will be no discharge from the pit prior to closure implementation. At that point, any discharge from the pit will be actively treated and managed as per the MNCRP. The water level in the pit has remained within the same general range for several years and is not anticipated to rise to an elevation that would require discharge from the pit. The pit water elevation level is measured continuously via a level logger which is downloaded routinely as part of the site routine monitoring program. Water quality in the Brown-McDade Pit is sampled monthly at the deepest part of the pit with samples typically collected at surface, middle and bottom of the pit lake.

The water in the Brown-McDade pit does not directly discharge to the receiving environment. The environmental consequence of changes in the Pit water quality is related to the potential exposure of aquatic and terrestrial resources and human users to potential increased loading of contaminants to Dome and Victoria Creek due to outflows from the Pit either via groundwater or seepage through the Pony Creek Adit.

11.2 Specific Information or Issues

An analysis of the 2008 to 2013 water quality data for the Brown-McDade Pit (WQ-Pit-1 (top), WQ-Pit-2 (middle) and WQ-Pit-3 (bottom)) was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Tables 11-1, 11-2 and 11-3. For reference, where applicable the reference EQS is also provided. Water quality results below detection limit are assumed to be at detection limit for the purposes of statistical and graphical analysis.

11.3 Narrative Trigger

The trigger for the implementation of the AMP is “contaminant concentrations in the Brown-McDade Pit as measured at Stations WQ-Pit-1 (top), WQ-Pit-2 (middle) and WQ-Pit-3 (bottom) display a statistically significant increase.

11.4 Specific Indicators

The specific indicators that should be monitored in the Brown-McDade Pit to provide the information necessary to assess whether the trigger has been achieved are:

- Sulphate (mg/L);
- Total and dissolved arsenic (mg/L);
- Total cadmium (mg/L);
- Total iron (mg/L);
- Total manganese (mg/L); and
- Total zinc (mg/L).

Table 11-1 Summary of 2008 to 2013 Water Quality Data (mg/L) for Brown-McDade Pit (Top)

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Iron
Minimum	10	0.0028	0.0022	0.02
5th Percentile	394	0.00414	0.00338	0.0206
Median	826	0.00892	0.0066	0.059
95th Percentile	1074	0.01202	0.008948	0.1266
Maximum	1190	0.013	0.00929	0.2
Number of Samples	53	53	53	53
Significant Trend (increasing or decreasing)	Increasing	No	No	No

Statistic	Total Cadmium	Total Manganese	Total Zinc
Minimum	0.00268	0.0253	0.29
5th Percentile	0.003272	0.05635	0.362
Median	0.00716	0.169	0.954
95th Percentile	0.0165	0.836	1.646
Maximum	0.0183	1	1.9
Number of Samples	53	51	53
Significant Trend (increasing or decreasing)	No	No	No

Table 11-2 Summary of 2008 to 2013 Water Quality Data (mg/L) for Brown-McDade Pit (Middle)

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Iron
Minimum	550	0.0047	0.0023	0.01
5th Percentile	619	0.00496	0.0027	0.0198
Median	884	0.0086	0.00656	0.058
95th Percentile	1160	0.01324	0.00894	0.204
Maximum	1420	0.0164	0.00923	0.365
Number of Samples	53	53	53	53
Significant Trend (increasing or decreasing)	Increasing	No	Increasing	Decreasing
Statistic	**Total Cadmium**	**Total Manganese**	**Total Zinc**	
Minimum	0.00261	0.027	0.279	
5th Percentile	0.003446	0.0553	0.3852	
Median	0.00819	0.179	1.07	
95th Percentile	0.0288	1.765	2.736	
Maximum	0.0353	5.08	3.09	
Number of Samples	53	51	53	
Significant Trend (increasing or decreasing)	Decreasing	Decreasing	Decreasing	

Table 11-3 Summary of 2008 to 2013 Water Quality Data (mg/L) for Brown-McDade Pit (Bottom)

Statistic	Sulphate	Total Arsenic	Dissolved Arsenic	Total Iron
Minimum	0.8	0.0051	0.0004	0.01
5th Percentile	824.8	0.00572	0.00224	0.0176
Median	1220	0.0102	0.0072	0.096
95th Percentile	1622	0.07616	0.03968	2.904
Maximum	1750	0.101	0.0998	5.18
Number of Samples	53	53	53	53
Significant Trend (increasing or decreasing)	No	Increasing	Increasing	No
Statistic	**Total Cadmium**	**Total Manganese**	**Total Zinc**	
Minimum	0.00307	0.0258	0.297	
5th Percentile	0.004812	0.11295	0.5196	
Median	0.0101	1.485	1.27	
95th Percentile	0.02946	7.1415	2.81	
Maximum	0.0339	9.77	2.96	
Number of Samples	53	52	53	
Significant Trend (increasing or decreasing)	Decreasing	No	Decreasing	

11.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan, for any one of the specific indicators, will be as follows:

- A statistically significant increasing trend (0.05) in the monitoring results from WQ-Pit-1, WQ-Pit-2 or WQ-Pit-3, as defined using the trend analysis technique outlined in Section 2.4. For the purposes of AMP trend line development, data from 2008 and on will be used for the trend analysis.

11.6 Monitoring Requirements

The monitoring information required is monthly sulphate, total and dissolved arsenic, total cadmium, total iron, total manganese, and total zinc measured in the pit at WQ-Pit-1 (top), WQ-Pit-2 (middle) and WQ-Pit-3 (bottom). This data will be used to enable an updated trend analysis.

Additional monitoring information that is required for analysis should the AMP triggers be activated include water level data for the pit as well as input from AMP Event 7. The monitoring locations are outlined in Table 11-4.

Table 11-4 Summary of Water Quality Stations for Pit Water Quality AMP

Site Name	Description
WQ-Pit-1	Brown-McDade Pit Water Quality - Top
WQ-Pit-2	Brown-McDade Pit Water Quality - Middle
WQ-Pit-3	Brown-McDade Pit Water Quality - Bottom

11.7 Evaluation of Monitoring Results

The management review of the relevant water quality data from the Brown-McDade Pit will be carried out on an annual basis. This review will be completed when the full year of QA/QC'ed water quality data has been received from the contractor responsible for the routine site water quality monitoring program.

11.8 Response Approach

Given that the water in the pit is internal to the site and does not directly discharge to the receiving environment, the approach to response for the Brown- McDade Pit AMP differs slightly from the general approach outlined in Section 2.3 as it is closely tied with AMP Event 7.

1. Notification & Validation

Upon identification that one of the triggers has been activated, following the annual data review, notification will be provided to AAM.

2. Analysis and Investigation

A comprehensive analysis of the water quality data from all sample depths in the Pit will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation. This will also incorporate the results of pit wall seepage data and routine inspection reports highlighting new or changing pit seeps. This will then be followed by an analysis of the impacts of the trigger activation on the receiving environment. This will incorporate the results from AMP Event 7, Pit water level, and results of this assessment will be used as a basis for the development of an appropriate response plan to mitigate any identified or predicted impacts and to highlight any required modifications to the monitoring program

Following analysis, the next step may be to increase monitoring intensity to verify the source that resulted in the trigger activation. Depending on the preliminary source identification, this may require additional pit water quality sampling or pit wall seepage sampling. Groundwater/seepage modelling may be used to provide an indication of the contaminant transport pathways and the rate and development of changes in contaminant loading from the Pit in response to the changing pit water quality.

3. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of contamination in conjunction with the assessment of the timing and environmental consequence of the trigger activation and is tied to AMP Event 7, specifically if increasing pit water levels required active intervention. If this AMP Event is triggered in isolation of increasing pit water levels the results of the annual pit water quality assessment will be provided to the Project Design Team for consideration in closure planning. If required and where possible, identified loading sources could isolated or removed to limit contribution to pit loadings (i.e. waste rock within pit catchment). Should water levels in the pit require active intervention, the response plan will include the design and implementation of a pit water management program, including possible treatment and discharge to the receiving environment.

12.0 AMP EVENT 10 – WATER LEVEL IN TAILINGS POND REACHES MAXIMUM DESIRED WATER LEVEL

Note: AMP Event 10 will be finalized post-March 31, 2015 upon completion of the assessment and development of updated operating levels for the Tailings Pond.

12.1 Description

The tailings impoundment area holds an estimated 240,000 m^3 of tailings along with residual mill process chemicals including copper sulphate, lime, cyanide and associated degradation compounds including cyanate, thiocyanate, ammonia, nitrite, and nitrate. Currently, there are minor exceedances in concentrations of dissolved arsenic, iron, manganese, and zinc above the EQS. Concentrations of total and WAD cyanide are present in tailings pond water near detection limit, well below the EQS. Water is not actively discharged from the tailings pond and it is understood that there will be no discharge from the pond prior to closure implementation. At that point, any discharge from the tailings pond will be actively treated and managed as per the MNRP. Tailings pond water levels are measured daily, during open water, via a staff gauge. Prior to 2014, the maximum operating water level elevation for the tailings pond is 1097.8 masl. In 2014 the emergency spillway was reconstructed and the maximum operating water level was lowered to XXXX (pending updated survey results).

The water quality in the tailings pond is significantly different than that in the seepage pond, particularly with respect to nitrogen species, cyanide species (including cyanate and thiocyanate) and some key metals species including arsenic, cadmium, copper, iron, lead, manganese and zinc. The tailings pond water quality has lower concentrations of nitrogen species, cyanide species (including cyanate and thiocyanate), manganese and iron while it has higher concentrations of total arsenic, dissolved arsenic, total cadmium, total copper, total lead and total zinc.

The environmental consequence of increasing water levels in the tailings ponds is the potential for release of pond water to Dome Creek via the emergency spillway under a high return period storm/runoff event as well as the potential for increased seepage through the tailings dam. In addition, increased water levels increase the potential for stability issues related to dam stability. This could result in the potential exposure of aquatic and terrestrial resources, and human users to increased levels of contaminants.

12.2 Specific Information or Issues

An analysis of the tailings pond open water elevation data for 2012 and 2013 was carried out in preparation of the AMP protocol. A summary of this analysis is presented in Table 12-1.

Table 12-1 Summary of Tailings Pond Water Level (2012 – 2013)

Statistic	Water Level (masl)
Minimum	1095.79
5^{th} Percentile	1095.81
Median	1095.91

Statistic	Water Level (masl)
95th Percentile	1096.28
Maximum	1096.33
Number of Samples	209

Once the updated maximum operating water level is available a detailed water balance will be carried for the tailings pond to determine the maximum desired water level to maintain adequate storage for unforeseen flood events (i.e. an "action level"). Then a threshold elevation will be established below the maximum desired water level elevation which will be used to initiate a management response such that there is sufficient time (TBD ~ 1 year) to put in place the necessary management systems prior to the pond water level reaching the target water level.

12.3 Narrative Trigger

The trigger for the implementation of the AMP is "the water elevation in the tailings pond reaches the AMP trigger elevation".

12.4 Specific Indicators

The specific indicators that should be monitored to provide the information necessary to assess whether the trigger has been activated are:

- Pit water elevation; and
- Projected timeframe to maximum desired water elevation.

Supplementary monitoring information regarding tailings pond water chemistry would be beneficial in the event that an action plan that includes the treatment of tailings pond water is required. However, this information is not essential to the AMP.

12.5 Specific Thresholds

The specific thresholds or triggers that will initiate an action plan will be as follows:

- Tailings pond water level elevation reaches the AMP trigger elevation; and
- The projected timeline for reaching the maximum desired water level elevation is projected to be one year or less (timing to be confirmed based on discussions with the parties).

12.6 Monitoring Requirements

The monitoring information that is required is:

- The tailings pond water elevation data; and
- Local precipitation data to enable an updated projection of the filling timeframe.

Information from site operational reports and the bi-annual geotechnical inspection reports will also be used.

12.7 Evaluation of Monitoring Results

The management review of the tailings pond water level data will be carried out on a monthly basis when updated data from the site is available. This will provide for an immediate assessment against the specific AMP trigger elevation. A comprehensive annual review will be carried out, including updating of the pond filling projection trend, will be carried out as part of the annual AMP review.

12.8 Response Approach

As per the general approach to the AMP, a staged response increasing water level in the tailings pond will be implemented if the trigger is activated. Four major steps are identified and summarized below. Although presented in a sequential order, some steps may occur concurrently or may be eliminated, depending on the individual circumstances of the trigger activation. In all cases, the approach to responses will be such that it expedites the process of responding to trigger activation.

1. Notification & Validation

The initial response to the trigger will be the verification of the monitoring information. This will include either a re-survey of the pond elevation or recalculation and cross-checking of the pond filling projection. This should be done immediately following initial trigger activation. Upon verification of the monitoring data that a threshold has been crossed and that there are no operational changes which resulted in the change, notification to AAM will be provided. Where substantial changes in pond water level are immediate investigation of the cause should be carried out as it could relate to stability issues.

2. Preliminary Identification

At this time a comprehensive analysis of the other related monitoring results from the locations outlined previously will be carried out. The goal of this analysis is to provide for a preliminary identification of the cause of the trigger activation and will incorporate an assessment of pond water balance as well as recent results of routine site inspections and bi-annual geotechnical inspections.

3. Response

A response plan will subsequently be developed based on the comprehensive trigger analysis described above. This plan will include short-term mitigation to be implemented as an interim measure prior to implementation of the MNRP. The level of response will depend on the identified source of the trigger activation in conjunction with the assessment of the timing and environmental consequence of the trigger activation. Given the linkages between this AMP Event and dam stability, where substantial increases in water level are noted, immediate investigation of the cause should be carried. The following is a list of potential responses:

- Design and implementation of pumping systems for transfer of excess water to pit for storage to reduce water level if not suitable for discharge; and
- Design and implementation of pond treatment system for discharge of pond water to receiving environment.

13.0 REFERENCES

AMEC (2014a). *Mount Nansen Remediation Project 30% Design Report*. Prepared for Assessment and Abandoned Mines Branch, Department of Energy, Mines and Resources, Government of Yukon. March 2014.

AMEC (2014b). *Mount Nansen Remediation Project 2013 Site Investigation Report*. Prepared for Assessment and Abandoned Mines Branch, Department of Energy, Mines and Resources, Government of Yukon. March 2014.

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