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Report

Deloitte & Touche Inc. (acting as the Court Appointed Interim Receiver for Anvil Range Mining Corporation)

Anvil Range Mine Adaptive Management Plan

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Prepared by:

AECOM Canada Ltd.
2251 2nd Avenue, Whitehorse, YT, Canada Y1A 5W1
T 867.633.6474 F 867.633.6321 www.aecom.com

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Signature Page

Report Prepared By:

Jay Cherian, M.Sc. (Candidate), B.Sc.
Environmental Scientist/ Hydrologist

AECOM

Leslie Gomm, P.Eng.
Environmental Engineer

GOMM ENVIRONMENTAL ENGINEERING CONSULTING

Executive Summary

The Water Licence for the Anvil Range Mine (QZ03-059) provides primarily for the continuation of environmental care and maintenance activities to the end of 2008, when a Final Closure and Reclamation Plan is scheduled to be in place. In addition to water and facilities that will receive active management, there are other waters and facilities on the mine site that are recognized as representing potential environmental risks but which do not require immediate intervention. Long term management of these waters and facilities will be addressed in the Final Closure and Reclamation Plan. However, a short term management strategy is required to monitor for potential degradation of conditions to the point where active intervention might be necessary prior to the end of February 2009 and to provide a framework for ensuring that appropriate management actions are implemented.

Such a strategy is provided for in the Water Licence through the Adaptive Management Plan (“AMP”). A conceptual AMP was developed and reviewed by parties to the Environmental Assessment and Water Licencing processes through 2002 and 2003. The Water Licence then required that a detailed AMP Implementation Protocol be developed that follows from the conceptual plan. The AMP Implementation Protocol was filed with the Water Board in June 2004. The Implementation Protocol also requires that an annual review of the AMP program be undertaken. The annual review provides a mechanism whereby any necessary or beneficial modifications to the AMP program can be identified and proposed to the Water Board on a regular basis.

Eight AMP “events” were developed through the Environmental Assessment and Water Licence Renewal processes. These events represent possible future environmental conditions that would require a management response, if they were to occur.

The eight events are as follows with a summary for 2008 activities:

1. Degraded Groundwater Quality in Rose Creek Valley Aquifer;
   One new trigger activated in 2008 for increasing concentrations of sulphate at X25A/B.
   New triggers at P03-09-2, P03-09-5 and P03-09-9 and p08-03-03 for increasing concentrations of sulphate.
2. Degraded Water Quality in Vangorda Creek Downstream of the Mine Facilities;
   One trigger activated in 2008 for sulphate. Data analysis demonstrated that this was due to the elevated sulphate concentrations during a period of discharge of compliant effluent.
3. Degraded Water Quality in Rose Creek Downstream of the Mine Facilities;
   One trigger activated in 2008 for sulphate. Data analysis demonstrated that this was due to the elevated sulphate concentrations during winter low flow period, consistent with historical trends, particularly during periods of discharge of compliant effluent during low flow conditions.
4. Degraded Seepage Quality from the Grum Rock Dump;
   No new triggers at V2 in 2008. The 2008 monitoring results suggest that zinc concentrations have stabilized around 1 mg/L. The transfer of water from station V15 to station V2A was implemented in 2007, via Grum Creek diversion as a proactive intervention and has been seen to be successful.

5. Degraded Water Quality in the North Fork of Rose Creek;
   No new triggers in 2008. Ongoing concern over increasing concentrations in this area, particularly zinc during the winter low flow period, prompted a detail site investigation, design and implementation of a remedial intervention system to collect and route contaminated shallow groundwater to Faro Pit.
6. Water level in Grum Pit Reaches Maximum Desired Elevation;
   No triggers activated in 2008.
7. Disruption of Fannin Sheep Migration Through the Mine Site; and
   No triggers activated in 2008.
8. Wind Dispersed Tailings Result in Adverse Effects in the Terrestrial Environment.
   No triggers activated in 2008. Ongoing concerns with respest to dusting from the tailings resulted in the development of a Tailings Dust Control Program using Soil Sement. Wet conditions on site resulted in this program being delayed until 2009.

Other than the specific recommendations listed above, the AMP program functioned in 2008 as intended and no other changes should be made.

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1. Introduction

1.1 Background

The Anvil Range Mine, inclusive of both the Faro and Vangorda Plateau mine sites, is located near the Town of Faro, Yukon. The mine produced lead and zinc mineral concentrates from 1969 to 1998 and was, at one time, the largest open pit, lead-zinc mines in the world. All mining and processing operations ceased permanently in early 1998 when the mine owner, Anvil Range Mining Corporation, entered into receivership. The mine has been under the management of a court appointed interim receiver, Deloitte & Touche Inc., since April 1998 and will be officially transferred to the Yukon Government February 28, 2009.

The Water Licence for the Anvil Range Mine (QZ03-059) provides primarily for the continuation of environmental care and maintenance activities to the end of February 2009, when a Final Closure and Reclamation Plan is scheduled to be submitted. The licenced care and maintenance activities address specifically water and facilities that require active management to ensure that adequate environmental protection is provided in the short term.

In addition to water and facilities that will receive active management, there are other waters and facilities on the mine site that are recognized as representing potential environmental risks but which do not require immediate intervention. Long term management of these waters and facilities will be addressed in the Final Closure and Reclamation Plan. However, a short term management strategy is required to monitor for potential degradation of conditions to the point where active intervention might be necessary prior to the end of 2008 and to provide a framework for ensuring that appropriate management actions are implemented.

Such a strategy is provided for in the Water Licence through the Adaptive Management Plan ("AMP"). A conceptual AMP was developed and reviewed by parties to the Environmental Assessment and Water Licencing processes through 2002 and 2003. The Water Licence then required that a detailed AMP Implementation Protocol be developed that follows from the conceptual plan. Part F, Item 54 of the Water Licence reads:

> *An Adaptive Management Plan for the facilities authorized by this licence shall be prepared and submitted to the Board by June 30, 2004. The plan shall identify the indicators and triggers for action, the measures of statistically significant changes to be tracked, the monitoring locations and parameters, the sampling frequencies, the methods to be used to analyze and evaluate the data, and the actions to be taken.*

The AMP Implementation Protocol was filed with the Water Board in June 2004. The Implementation Protocol provided all of the information that was required by the Water Licence for the eight AMP "events" that had been developed in the conceptual plan.

The Implementation Protocol also requires that an annual review of the AMP program be undertaken. The annual review provides a mechanism whereby any necessary or beneficial modifications to the AMP program can be identified and proposed to the Water Board on a regular basis. The annual review also ensures that all of the year's activities under the AMP program are compiled and documented.

1.2 AMP Events

Eight AMP "events" were developed through the Environmental Assessment and Water Licence Renewal processes. These events represent possible future environmental conditions that would require a management response, if they were to occur.

The eight events are as follows:

1. Degraded Groundwater Quality in Rose Creek Valley Aquifer;
2. Degraded Water Quality in Vangorda Creek Downstream of the Mine Facilities;
3. Degraded Water Quality in Rose Creek Downstream of the Mine Facilities;
4. Degraded Seepage Quality from the Grum Rock Dump;
5. Degraded Water Quality in the North Fork of Rose Creek;
6. Water level in Grum Pit Reaches Maximum Desired Elevation;
7. Disruption of Fannin Sheep Migration Through the Mine Site; and
8. Wind Dispersed Tailings Result in Adverse Effects in the Terrestrial Environment.

Each of the AMP events is described according to nine common elements. This ensures that a consistent approach is followed for each event that achieves the general objectives of the AMP Implementation Protocol. The common elements are as follows:

1. Description of the event and possible environmental consequences;
   As developed through the Environmental Assessment and Licence Renewal Processes.
   The possible environmental consequences will lead to the narrative trigger and specific thresholds.
2. Discussion of event-specific information or issues;
   Any unique issues or information that have a direct influence for applying the AMP.
3. Narrative response trigger;
   As developed through the Environmental Assessment and Licence Renewal Processes.
   The narrative trigger will lead to the specific indicators.
4. Specific indicators;
   The environmental parameters to be monitored and assessed.
5. Specific Thresholds;
   Defines the conditions, in terms of the specific indicators, when management actions should be taken.
   There may be a series of staged thresholds for an individual event.
6. Monitoring requirements;
   The frequency and means for monitoring of the specific indicators.
7. Evaluation of monitoring results;
   The means of evaluating whether any specific thresholds have been crossed.

8. General approach to responses; and
   As developed through the Environmental Assessment and Licence Renewal Processes.
   Describes the general approach to management responses, if necessary.
9. Specific thresholds and responses.
   Describes the specific responses to be implemented if any specific thresholds have been crossed.

The details of these AMP elements are not provided in this report. Readers are referred to the AMP Implementation Protocol for this level of detail (Gartner Lee Limited, now AECOM, on behalf of the Interim Receiver, June 2004).

1.3 Approach to the Annual Review

This report provides the annual review of the AMP for the year 2008, as described in the AMP Implementation Protocol. The prime purpose of the annual review is to assess 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 may be recommended based on the annual review.

Each AMP Event includes a routine management review of the monitoring data against the triggers and thresholds. The results of these reviews are reported to the Water Board as part of the Monthly Reports submitted under Part A, Item 15 of the Water Licence. The results of these reviews are summarized as part of the Annual Review. Where required for some of the AMP Events, the results of the annual review are also summarized.

Each AMP event is reviewed individually in the following sections of the report.

2. AMP Event 1, Degraded Groundwater Quality in Rose Creek Valley Aquifer

2.1 Description

Groundwater in the Rose Creek Valley aquifer collects seepage and contaminants released from the surface tailings impoundments and has the potential to become contaminated to the degree where discharge from the aquifer to Rose Creek may result in a sustained adverse effect in Rose Creek. The groundwater quality in the Rose Creek Valley aquifer is presently measured twice per year, in spring and fall, at various locations within the tailings facility and downstream of the tailings facility. Samples are analyzed for dissolved metals, pH, temperature, conductivity, total dissolved solids, sulphate, and alkalinity as per the Water Licence (YWB, 2004). Additional groundwater quality data is also provided for through a series of monitoring wells which were installed in 2003 as part of the ongoing hydrogeological and geochemical investigations of the Rose Creek Tailings Facility and the Rose Creek Valley Aquifer.

Since degradation of groundwater quality is anticipated to occur progressively from the source area (tailings deposit) in a downgradient direction (Cross Valley Dam and downstream), the trigger locations for the implementation of the AMP are designed to provide for the early detection of emerging trends or "plumes". The trigger locations include locations downgradient of the tailings deposit as well as locations directly underlying the tailings deposit as follows:

- groundwater quality downgradient of the Cross Valley Dam (location P03-09);
- groundwater quality at the Intermediate Dam, below the downstream extent of the tailings deposit (locations X24 and X25);
- groundwater quality (i.e., the aquifer underlying the tailings deposit) approximately mid-length of the Intermediate Impoundment (location P03-08); and
- groundwater quality at the Second Impoundment Dam, approximately mid-length of the tailings facility (location P03-04).

The environmental consequences of degraded water quality in the Rose Creek Valley aquifer are the potential exposure of aquatic resources, terrestrial resources and human resource users to increased levels of contaminants in Rose Creek, Anvil Creek and the Pelly River. Zinc is currently the primary contaminant of concern and zinc and sulphate are currently the primary indicators of acid rock drainage.

A substantial amount of work has been carried out to characterize the environmental conditions in the Rose Creek Valley aquifer. This work serves to provide information that is important to the Adaptive Management Plan as well as the long term needs of the Final Closure and Reclamation Plan that is currently being developed. The results of the ongoing studies of the Rose Creek Valley aquifer need to be continually incorporated into the AMP.

2.2 Summary of Implementation Protocol Information

The following is a summary of the AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
$Zn_{(D)}$, SO_4	X24, X25	• 3 consecutive results > 75th percentile of reference period; or • statistically significant trend projects >75th percentile of reference period within three years.	Quarterly
	P03-04, -08 and -09	• statistically significant trend.	Quarterly

Dissolved iron was initially identified as an indictor in the Rose Creek Valley Aquifer AMP but was removed after 2005 due to issues related to the sensitivity of dissolve iron concentrations on sampling methodology in samples collected during the reference period.

Note that there was insufficient data for monitoring wells P03-04, -08 and -09 to form a “reference period” because these wells were installed in 2003.

2.3 Background

2.3.1 X24 and X25

As documented in the 2004 Adaptive Management Plan Annual Report the following triggers were activated at the toe of the Intermediate Dam for zinc, sulphate and iron:

1. *Sulphate in monitoring wells X24-A, X24-C and X24-D;*
2. *Dissolved zinc in X24-D; and*
3. *Dissolved iron in monitoring wells X25-A and X25-B.*

In response to the activation of these triggers the procedures described in the Adaptive Management Plan Implementation Protocol (AMPIP) were initiated. The following four action steps are described in the AMPIP and, as stated in the AMPIP, were initiated in 2004:

1. *Verification of the monitoring information followed by notification to the YG Water Inspector (completed 2004);*
2. *Additional monitoring, if necessary (completed 2004);*
3. *Data analysis and predictive impact modeling, if necessary; and*

4. Mitigation (Response) plan, if necessary.

The first two steps outlined above were completed in 2004 and summarized in the 2004 Annual Adaptive Management Annual Report. In early 2005, a data analysis of the related monitoring results was carried out, incorporating new information that has been developed for development of the Final Closure and Reclamation Plan. The results of this analysis indicated that the increased concentrations being seen at the AMP trigger locations, specifically X24, may in part be due to contaminant loading to the aquifer from drainage in the Old Faro Creek Channel, including loading from the Faro rock dumps (location X23) and the Emergency Tailings Area.

Data analysis was then carried out in February 2005 using predictive modeling to assess the potential for contaminant loading to the receiving environment and any associated impacts. This was done using the aquifer loading balance model that has been developed by Robertson Geoconsultants as part of the closure planning studies. The fundamental outcome of this modeling exercise was to determine if the current groundwater conditions are having an effect on Rose Creek and, further, provide an indication of the rate and development of contaminant loading, if any, to the receiving environment. The following provides a summary of the results of predictive modeling. Details of the modeling were summarized in a letter to Government of Yukon, Water Resources Branch in May 2006 (Appendix A).

The predictive model was run based on the fall 2004 groundwater quality data for X24 (A, B and C) and X25 for sulphate and dissolved zinc. The following four scenarios were run using the calibrated Rose Creek Water and Load Balance Model to estimate the loading to Rose Creek from groundwater and subsequent sulphate and dissolved zinc concentrations in Rose Creek.

- "Base Case" using fall 2004 concentrations;
- Sensitivity Run 1 – 20% increase in sulphate and dissolved zinc concentrations at X24 and X25;
- Sensitivity Run 2 – 50% increase in sulphate and dissolved zinc concentrations at X24 and X25; and
- Sensitivity Run 3 – 100% increase in sulphate and dissolved zinc concentrations at X24 and X25.

The results of this predictive modeling exercise indicate that the present groundwater conditions (base case) are not predicted to have a detrimental effect on the water quality in Rose Creek in the near future. Predicted concentrations of dissolved zinc for the four scenarios (0.03 – 0.041 mg/L) are within the range of concentrations presently seen in Rose Creek downstream of the Cross Valley Dam (X14). Based on these results there is no need for the development of a short-term response plan, other than ongoing monitoring and assessment of all related water quality data. Furthermore the degradation of water quality in the Rose Creek Valley aquifer and subsequent impacts Rose Creek, Anvil Creek and the Pelly River continues to be a major area of investigation as part of the ongoing development of the Faro Closure and Reclamation Plan.

In September 2005, an additional trigger was activated at X24-A for dissolved iron. An assessment of the water quality data and sampling techniques was carried out which indicated that the elevated levels of iron may be due to slight variation in sampling methodology during the reference period. The sensitivity of dissolved iron concentrations to minor variations in sampling methodology introduces some uncertainty in the interpretation of the results prior to 2002. Furthermore, through the ongoing aquatic risk assessment work being carried out as part of closure planning, iron was not identified as a contaminant of concern in the receiving environment. Therefore, it was recommended that dissolved iron no longer be an indicator in the AMP Protocol for the Rose Creek Aquifer. This recommendation was subsequently adopted in 2006.

Therefore, at the end of 2005, the triggers for dissolved zinc and sulphate at X24 and X25 remained "activated" because concentrations were above the threshold values; however, the determination had been made that no immediate response was required pending the analysis of future monitoring results. The ongoing management review in 2006 of the relevant groundwater quality data from X24 and X25 indicated there were no new triggers above those already identified in 2005.

Due to ongoing sampling issues at location X24 (A/B/C) an investigation was conducted in August 2006 to assess the present conditions of the wells and determine the cause of the previous sampling difficulties. Problems at these wells were first encountered at X24-B where sand heaved within the well to above the water table. This problem continued to progress in the area, with issues now encountered at X24-A and X24-C. In 2007, X24 B and C could not be sampled due to the ongoing issues of the build up of sediment in the wells. The following is a summary of the recommendations after the 2007 monitoring program:

- X24A-96 – Well was suspected to have been compromised upon installation (RGC, 1996) and decommissioning should be considered based on the present condition. This conclusion is also supported by others (RGC, 2007).

- X24-96 B/C – Wells were not sampled in 2007 due to operational issues and recommendations outlined by Gartner Lee (2007). Based on field observations made by Gartner Lee in 2007, it is recommended that these wells be decommissioned (RGC, 2007).

- X24-D – Although there have not been any issues regarding sampling at X24-D, it is recommended that it be investigated in 2007. X24D-96 is the only well from the nested X24-96 series that is recommended to remain operational for continued groundwater monitoring (RGC, 2007).

In 2007, X24-B and C could not be sampled due to the ongoing issues of the build up of sediment in the wells. In addition, X24-A, although it could be sampled, is also suspect due to the accumulation of sediment due to it possibly being compromised during installation, and caution should be used when using data from this well. Based on the ongoing issues associated with these three wells it has been recommended by Gartner Lee Limited, and supported by others (Robertson GeoConsultants) that these wells be decommissioned. AMP trigger location X24-D has been determined to be adequate for routine monitoring and ongoing assessment of AMP Event 1. Therefore the following modifications were made for AMP Event 1, Degraded Groundwater Quality in Rose Creek Aquifer as part of the 2007 Annual AMP Review, specifically that X24-A, X24-B and X24-C be removed as AMP trigger monitoring stations at X24.

In 2007 there were no new triggers at location X24 and X25 above those already identified other than dissolved zinc at X24-A: specifically: three consecutive monitoring results greater than the upper 75th

percentile of the reference period (1998 – 2002). Given the issues outlined below associated with this well, ongoing assessment and follow-up on this trigger was discontinued.

2.3.2 P03 Multi-Level Wells

Review of the water quality data from three AMP multi-level wells installed in 2003 (P03-04, P03-08 and P03-09) included an assessment of the following specific threshold for dissolved zinc and sulphate:

- A statistically significant trend in the groundwater monitoring results with a requirement of a minimum of four results.

Previously, ongoing trends were limited by the number of data points (degrees of freedom). At the end of 2006, sufficient data points were provide for a statistically significant determination. Annual review of the 2006 multi-level data against the threshold indicated that the following thresholds for sulphate and dissolved zinc were reached:

- Increasing trend in zinc concentrations at P03-04-2 and P03-04-3; and
- Increasing trend in sulphate concentrations at P03-09-3 and P03-09-4.

Annual review of the 2007 multi-level data against the threshold indicated that the following new thresholds for sulphate and dissolved zinc were reached:

- Increasing trend in sulphate concentrations at P03-04-2 and P03-04-3; and
- Increasing trend in sulphate concentrations at P03-09-6 and P03-09-7.

Furthermore, review of the updated 2006 and 2007 relevant groundwater quality data from the three AMP multi-levels (P03-04, P03-08 and P03-09) indicates that the triggers identified in 2006 still remained in effect.

As outlined in the 2006 AMP Annual Review, the next step in response to activation of this trigger was verification and notification of the AMP Trigger to Government of Yukon, Water Resources Branch. This would be followed up by a detailed assessment of the trigger location including any associated water quality data. Given restrictions in the collection of groundwater samples in winter conditions, the earliest a verification sample could be collected in spring 2007. In the interim, it was planned to expedite the response to these trigger by initiating a detailed assessment of the multi-levels triggers prior to the spring sampling event. At the same time, during the 2007/2008 study planning meetings, it was identified that there was a need to provide an updated review of the groundwater quality monitoring data. This work was subsequently undertaken by Robertson GeoConsultants Inc. and a final report was issued in May 2008. Based on the findings of the RGC 2007 groundwater review, an additional study was recommended and initiated in January 2007: geochemical assessment of groundwater quality in Rose Creek aquifer including the determination of the hydraulic gradients and geochemical fingerprinting was recommended to determine the cause for the recent deterioration in groundwater quality in this portion of the Rose Creek.

Therefore, it was decided to hold off on the completion of the trigger assessment until such time that the results of the geochemical assessment could be incorporated. Results of the 2008 geochemical assessment are summarized below in Section 2.4.

2.4 Summary of 2008 Geochemical Assessment

To further the understanding of the recent deterioration of the groundwater quality in the Rose Creek aquifer, RGC carried out a geochemical assessment of the groundwater quality in the aquifer which included conservative and reactive mixing calculations (RGC 2009b). The main objective of this assessment was to determine if seepage from the Old Faro Creek Channel is the cause of the recent deterioration of the aquifer water quality and subsequently assess if the intervention implemented in the ETA area will have a positive effect on groundwater quality trends in the aquifer. The various sources of acid rock drainage (ARD) products were distinguished based on their distinct geochemical characteristics or "fingerprint". The relative contribution of each source to impacted groundwater was then evaluated at various locations in the aquifer.

The following provides a summary of the key findings of this assessment. Full details can be found in Geochemical Assessment of Groundwater Quality in the Rose Creek Aquifer (RGC, 2009b) that will be submitted to the Water Inspectors and other interested government agencies under separate cover.

- As discussed in Section 2.3.1, previous studies on the groundwater quality in the aquifer have concluded that the recent increase in ARD products such as zinc and sulphate in wells screened in the northern portion of the aquifer could be due to seepage from the Old Faro Creek channel. The results of the geochemical "fingerprinting" and mixing calculations support this conclusion. Furthermore the assessment indicates that the seepage from the Old Faro Creek channel may have contributed a significant contaminant load to this portion of the aquifer.

- The seepage interception system that was implemented in the ETA area in the fall of 2006 has been operating seasonally during the ice free period, typically from May to October. This system captures and conveys via pipeline approximately 78% of the flow into the Old Faro Creek Channel. The mixing calculations suggest that the continued operation of this system will result in significant improvement in the groundwater quality in the northern portion of the Rose Creek aquifer. At P03-06, the results of the mixing calculations indicate that full interception of the Old Faro Creek channel and elimination of seepage from this source could reduce sulphate and zinc concentrations by approximately 50%.

- The time required for the benefits of the interception system to be evident in the Rose Creek aquifer is dependent on groundwater transport parameters including velocity and distance. Conservative transport calculations indicate that improvement in groundwater quality at P03-06 can be expected to occur after 1 to 5 years. Improvements to groundwater quality farther downstream at the Intermediate Dam (X24), would occur later, in approximately 4 to 20 years.

- While the interception of seepage from the Old Faro Creek channel will reduce the contaminant load to the aquifer, the load from the tailings is predicted to gradually increase over time. This increase in loading may offset any improvement due to the seepage interception.

Based on the results of the geochemical assessment, it is recommended that the ongoing AMP assessment of key monitoring wells in the northern portion of the aquifer (P06-03, X21 and X24) should continue to assess whether the ongoing interception of the Old Faro Creek is resulting in improvements to groundwater quality. Although these locations are included in the routine tailings groundwater monitoring program, presently only X24 is identified as a trigger location in the AMPIP. Therefore, based on the recommendations stemming from the geochemical assessment it is recommended to add P06-03 and X21 as aquifer AMP trigger locations. This recommendation will be forward to Dennison Environmental for consideration for inclusion into 2009/10 Adaptive Management Program.

RGC (2009b) also recommends that a more comprehensive geochemical assessment be carried out to include mixing calculations for other wells that have shown recent increases in contaminant concentrations (X21 and X24). In addition the used of collected stable isotope data to further delineate contaminant sources to the aquifer should also be considered. This recommendation will be forwarded to the Faro Project Management Team for consideration in the 2009/10 study program.

2.5 2008 Review

2.5.1 Wells X24 and X25

The ongoing management review in 2008 of the relevant groundwater quality data from X24D and X25A/B at the toe of the Intermediate Dam was carried using data collected during four sampling events: May, August, September and November. This data review included assessment of the two following specific thresholds for dissolved zinc and sulphate:

- Three consecutive monitoring results greater than the upper 75th percentile of the reference period (1998 – 2002); or
- A statistically significant trend in the monitoring results (from 2003 and on) which, when extrapolated forward three years, would result in values greater than the upper 75th percentile of the reference period.

The results of the review are summarized in Table 2-1 and Table 2-2.. Based on the 2008 data there were no new triggers at location X24D and two new triggers at X25: specifically three consecutive monitoring results greater than the upper 75th percentile of the reference period (1998 – 2002) at both X25A and X25B.

Table 2-1. Sulphate and Zinc Data for Rose Creek Valley Aquifer - X24D (2008)

	X24D	
Date	**Sulphate (mg/L)**	**Zinc (mg/L)**
May 2008	Frozen	
August 2008	*2100*	*0.0829*
September 2008	*1900*	*0.0822*
November 2008	*2200*	*0.0846*
Threshold	**1057**	**0.03**

Table 2-2. Sulphate and Zinc Data for Rose Creek Valley Aquifer - X25 (2008)

	X25A		X25B	
Date	**Sulphate (mg/L)**	**Zinc (mg/L)**	**Sulphate (mg/L)**	**Zinc (mg/L)**
May 2008	*327*	<0.005	383	<0.005
August 2008	*369*	0.0019	*410*	0.0004
September 2008	*379*	0.0014	*430*	0.0004
November 2008	*410*	0.002	*420*	0.0002
Threshold	**294**	**0.055**	**395**	**0.02**

Based on the recent review of groundwater quality data carried out by Robertson Geoconsultants (RGC 2009) the water quality in the aquifer in the area of X25, beneath the southern portion of the Intermediate Dam, is characterized by significantly lower SO_4 concentrations than observed in the northern portion, in the area of X24. At X25 and other wells in the southern portion of the intermediate Dam, water quality has remained relatively unchanged. One exception was the concentration of SO_4, which increased in each of the wells in this area, including X25, except P01-04B. Although the levels of sulphate at X25 are increasing to levels above the threshold values, they remain significantly lower than those in the wells in northern portion (i.e. X24) and zinc concentrations at X25 have remained at or below the detection limit for the current monitoring period.

2.5.2 P03 Multi-Level Wells

A management review consisting of the relevant groundwater quality data from the three AMP multi-level wells installed in 2003 (P03-04, P03-08 and P03-09) was conducted in 2008. This data review included an assessment of the following specific threshold for dissolved zinc and sulphate:

- A statistically significant trend in the groundwater monitoring results with a requirement of a minimum of 4 results.

Annual review of the 2008 multi-level data against the threshold indicated that the following new thresholds for sulphate and dissolved zinc have been reached:

- Increasing trend in sulphate concentrations at P03-09-2, P03-09-5 and P03-09-9; and
- Increasing trend in sulphate concentrations at P03-08--03.

Although an increasing trend in sulphate has been found for P03-08-03, the sulphate concentrations at the trigger locations of P03-08-03 remain relatively low, peaking at 210 mg/L in November 2008.

Ongoing review of the groundwater quality data from the toe of the Cross Valley Dam, including P03-09, show a pattern of deteriorating water quality with time that is most evident from increases in the concentrations of oxidation products (i.e. SO_4) and key metals of interest (i.e. Zn) (RGC 2009). It is likely that the elevated levels of oxidation products and metals are related to the leading edge of the seepage "breakthrough" observed up-gradient at the Intermediate Dam (RGC, 2008). Although increases in sulphate concentrations are evident at the toe of the Cross Valley Dam at P03-09, water quality time trends in wells farther downstream of the toe of the Cross Valley Dam indicated that the groundwater quality remained unchanged during the current monitoring period.

Review of the 2008 relevant groundwater quality data from the three AMP multi-levels (P03-04, P03-08 and P03-09) indicates that the following triggers identified in 2006 and 2007 are no longer in effect:

- Increasing trend in zinc and sulphate concentrations at P03-04-2; and
- Increasing trend in zinc concentrations at P03-04-3.

Review of the time trends of selected water quality parameters for P03-04, located about 140m downgradient of the decommissioned wells P01-07A/B/C/D/E, was carried out as part of RGC's 2008 annual review of groundwater data. The results of this review indicate that contaminant concentrations in the deeper piezometers at this location (P03-04-01 to -05) all peaked around 2007 and started to decline in 2008. These observations would suggest that sealing of the leaky wells indeed reduced the contaminant loading and improved groundwater quality in the Rose Creek aquifer at P03-04.

3. AMP Event 2, Degraded Water Quality in Vangorda Creek Downstream of Mine Facilities

3.1 Description

The water quality in Vangorda Creek downstream of the Vangorda Plateau mine facilities could be negatively affected by surface water runoff from the mine facilities and groundwater seepage. The water quality in Vangorda Creek downstream of the mine facilities is measured monthly at Station V8 at the foot bridge in the Town of Faro for total metals, dissolved metals, pH, temperature, conductivity, total suspended solids, sulphate, ammonia and hardness (YWB 2004). Water quality in Vangorda Creek is also monitored monthly farther upstream in the main stem of Vangorda Creek at Station VGMAIN.

The environmental consequences of degraded water quality in Vangorda Creek is the potential exposure of aquatic resources, terrestrial resources and human resource users to increased levels of contaminants in Vangorda Creek and, possibly, the Pelly River. Zinc is currently the primary contaminant of concern and zinc and sulphate are currently the primary indicators of acid rock drainage. However, the consideration of degraded water quality should include other metals and contaminants which could source from the rock dumps, open pits and other mine facilities. Assessment of total copper and total suspended solids (TSS) also forms part of the AMPIP in this area.

3.2 Summary of Implementation Protocol Information

As part of the 2005 Annual AMP Review, an assessment was carried out to determine if there are any statistically significant seasonal differences in the sulphate concentrations at V8, and if necessary determine seasonally based threshold values for sulphate at V8 based on the reference period (1998 – 2002). Concentrations of sulphate during the reference period were found to exhibit seasonal variability. Using the Analysis of Variance and Multiple Comparisons (Least Significant Difference) at a 5 % significance level, statistically higher concentrations are observed in the winter months (November – April) compared to the open water months (May – October). Given this seasonal variability in the concentrations of sulphate in Vangorda Creek at V8, it was recommended that the AMP Protocol for V8 be modified for sulphate to include two seasonal components: open water season (May – October) and winter (November – April). The following is a summary of the modified AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
Zn(T), Cu(T), and TSS	V8	• 3 consecutive results > 75th percentile of reference period; or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly
SO_4	V8	• 3 consecutive results > 75th percentile of reference period (75 mg/L); or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly (May – October)
SO_4	V8	• 3 consecutive results > 75th percentile of reference period (171 mg/L); or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly (November – April)

3.3 Review

A management review of the relevant water quality data from V8 was carried out on a monthly basis in 2008. This data review included assessment of the two following specific thresholds for total copper, total zinc, total suspended solid (TSS) and sulphate:

- Three consecutive monitoring results greater than the upper 75th percentile of the reference period (1998 – 2002); or
- A statistically significant trend in the monitoring results (from 2003 and on) which, when extrapolated forward three years, would result in values greater than the upper 75th percentile of the reference period.

For sulphate, the data review included the assessment based on two seasonal components: open water season (May – October) and winter (November – April).

The results of the review are summarized in Table 3-1 and in Figure 3-1, Figure 3-2, and Figure 3-3.

In 2008, there was one trigger activated for sulphate at V8. Review of the August 2008 water quality data from V8 against the pre-defined thresholds indicated that the concentrations of sulphate were greater than the open water season Adaptive Management Plan (AMP) trigger level of 75 mg/L for three consecutive monthly samples: 86.7 mg/L on June 16, 78.7 mg/L on July 14 and 149 mg/L on August 11.

This was documented in the monthly data report to the Yukon Water Board dated September 30, 2008. The following short term management plan was outlined for this trigger event:

Upon receipt and analysis of the upcoming monthly samples for September, an assessment will be provided to the Water Inspector if the trigger continues (as per the AMP Protocol).

Review of the September water quality data from V8 for sulphate confirms that the sulphate concentrations at V8 in September dropped to 56.8 mg/L, below the threshold value of 75 mg/L and no further assessment was required. These elevated concentrations of sulphate were primarily due to the discharge of compliant effluent into Vangorda Creek from location V25BSP. Water quality atsite V8 continued to be monitored and assessed as part of regular AMP evaluations for the remainder of 2008.

Table 3-1. Summary of 2008 AMP Data for Vangorda Creek (V8)

Date	Total Zinc (mg/L)	Total Copper (mg/L)	Total Suspended Solids (mg/L)	Sulphate (mg/L)
01/7/08	0.015	<0.0010	1	137
02/18/08	0.015	0.0010	2	150
03/17/08	0.011	<0.0010	2	168
04/14/08	0.011	<0.0010	<1	165
05/14/08	0.022	0.0050	*54*	69.6
06/16/08	0.035	0.0010	4	*86.7*
07/14/08	0.025	0.0030	*30*	*78.7*
08/11/08	0.019	0.0010	8	*149*
09/15/08	0.020	0.0040	*49*	56.8
10/15/08	0.013	0.0010	4	*83.8*
11/03/08	0.019	0.0020	6	104
12/01/08	0.035	0.0010	2	134
Trigger	**0.042**	**0.023**	**8**	**75[a]/171[b]**

***Note**:*

Italics = Exceeds Trigger Value.

a. Open Water Trigger Value.

b. Winter Trigger Value.

Figure 3-1. Vangorda Creek (V8) Sulphate (2003 – 2008)

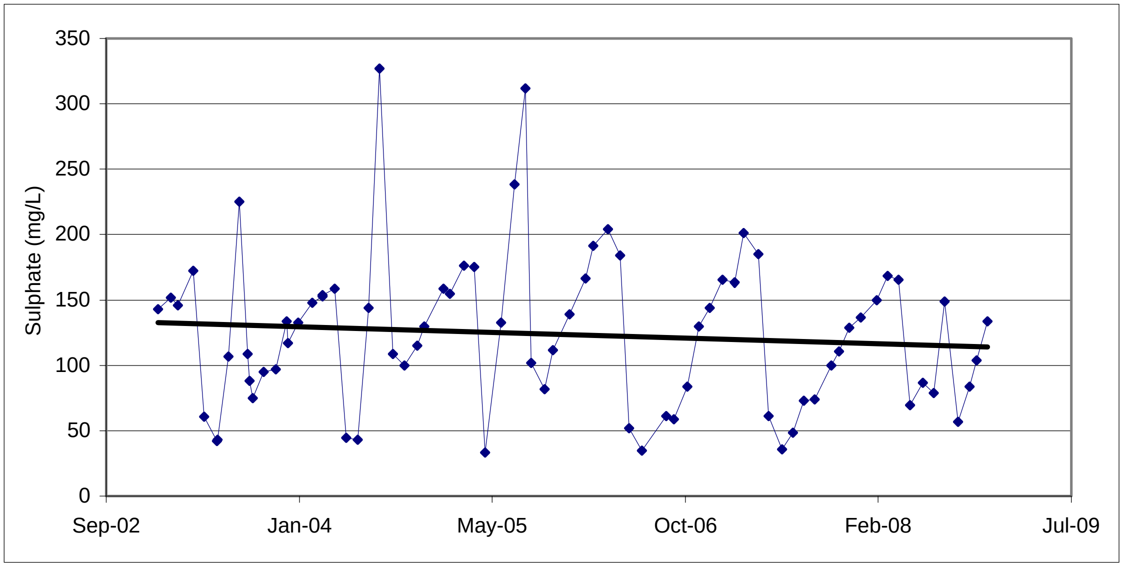


Figure 3-2. Vangorda Creek (V8) Total Suspended Solids (TSS) (2003 – 2008)

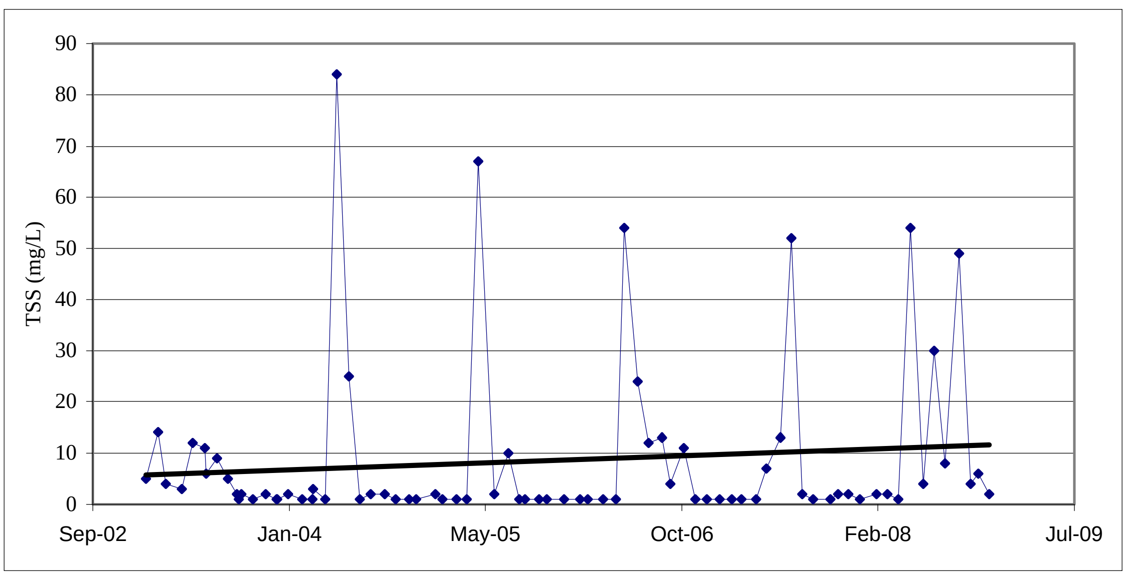
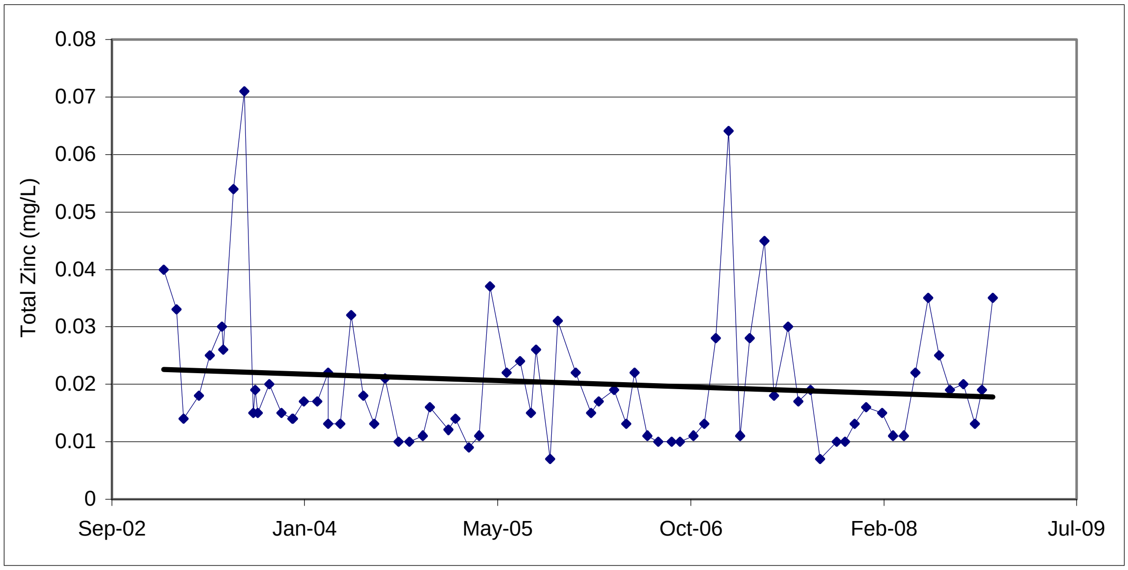


Figure 3-3. Vangorda Creek (V8) Total Zinc (2003 – 2008)



4. AMP Event 3, Degraded Water Quality in Rose Creek Downstream of Mine Facilities

4.1 Description

Water quality in Rose Creek downstream of the mine facilities could be negatively affected by surface runoff from the mine facilities and groundwater seepage from the Rose Creek Tailings Facility. The water quality in Rose Creek immediately downstream of the Mine Facilities is presently measured monthly at Station X14, and weekly during periods of effluent release (effluent is released upstream at location X5), for total metals, dissolved metals, pH, temperature, conductivity, total suspended solids, sulphate, ammonia and hardness (YWB 2004). Water quality in Rose Creek is also monitored twice per year, winter and summer, in the receiving environment farther downstream at R3, mid length of Rose Creek, and at R4, upstream of the confluence with Anvil Creek.

The environmental consequences of degraded water quality in Rose Creek is the potential exposure of aquatic resources, terrestrial resources and human resource users to increased levels of contaminants in Rose Creek, Anvil Creek and the Pelly River. Zinc is currently the primary contaminant of concern and zinc and sulphate are currently the primary indicators of acid rock drainage. However, the consideration of degraded water quality should include other metals and contaminants which could source from the rock dumps, open pits, tailings and other mine facilities.

4.2 Summary of Implementation Protocol Information

The following is a summary of the AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
$Zn_{(T)}$, $Cu_{(T)}$, and SO_4	X14	• three consecutive results > 75th percentile of reference period; or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly and Weekly during periods of discharge

Given the variations in sample frequency at X14 from monthly to weekly during periods of discharge, the AMP Protocol for X14 was modified to ensure consistency with the reference period sample frequency and the basis for the determination of the thresholds. When carrying out the assessment of consecutive weekly samples during periods of discharge, the weekly concentrations are averaged for the month. This subsequent monthly average value is then assessed as per the AMP Protocol.

4.3 Review

A management review of the relevant water quality data from X14 was carried out on a monthly basis in 2008. This data review included assessment of the two following specific thresholds for total copper, total zinc and sulphate:

- Three consecutive monitoring results greater than the upper 75th percentile of the reference period (1998 – 2002); or
- A statistically significant trend in the monitoring results (from 2003 and on) which, when extrapolated forward three years, would result in values greater than the upper 75th percentile of the reference period.

The results of the review are summarized in Table 4-1 and in Figure 4-1 and Figure 4-2.

In 2008, there was one trigger activated for sulphate. Similar to previous years, review of the March water quality data from X14 against the pre-defined threshold of 166 mg/L indicated that the concentrations of sulphate were greater than the trigger level for three consecutive monthly samples (225 mg/L in January, 255 mg/L in February and 275 mg/L in March).

This was documented in the monthly data report to the Yukon Water Board dated April 28, 2008. The following short term management plan was outlined for this trigger event:

> ***Upon receipt and analysis of the upcoming monthly samples for April and May at X14, an assessment will be provided to the Water Inspector (per the AMP Protocol). If appropriate, the assessment may propose a modification of the threshold values that provides recognition of the natural seasonal variation in sulphate.***

This trend in elevated sulphate concentrations during the winter low flow period is consistent with historical trends at this location where concentrations as high as 326 mg/L have been seen during winter low flow conditions. This seasonal variation in sulphate is known to occur during winter low flow conditions with higher concentrations in winter than in summer due to the predominance of groundwater "baseflow" (which naturally contains higher sulphate and hardness than surface runoff) and the influence of the discharge of compliant water from the toe of the Cross Valley Dam (X13) during the winter season. In this case, one would expect that the threshold might be exceeded again in April followed by a decrease in sulphate concentrations as surface runoff increases.

Review of the April data for X14 indicated that the concentrations of sulphate continued to exceed the threshold value (466 mg/L on April 14th, 467 mg/L on April 15th, 504 mg/L on April 22nd and 472 mg/L on April 29th) due to the presence of ongoing low flow conditions and further confounded by the discharge of compliant water to Rose Creek from the Cross Valley Pond at X5. This was documented in the monthly data report to the Yukon Water Board dated May 30, 2008.

Assessment of the May 2008 data showed that with the onset of spring freshet and higher flow volumes in Rose Creek, the sulphate concentrations dropped ranging from 19.5 mg/L to 108 mg/L, all well below the trigger value of 166 mg/L except the first weekly sample collected on May 6th due to ongoing low flow conditions.

Table 4-1. Summary of 2008 AMP Data for Rose Creek (X14)

Date	Total Zinc (mg/L)	Total Copper (mg/L)	Sulphate (mg/L)
1/8/08	0.049	<0.001	*172*
2/19/08	0.052	<0.001	*255*
3/18/08	0.058	0.001	*275*
4/14/08	*0.1*	0.002	*466*
4/15/08	*0.096*	0.002	*467*
4/22/08	*0.089*	0.001	*594*
4/29/08	0.13	0.002	*472*
5/6/08	0.12	0.003	*269*
5/13/08	0.071	0.003	97.2
5/15/08	0.059	0.003	108
5/20/08	0.034	0.003	39.5
5/27/08	0.025	0.003	19.5
6/3/08	0.015	0.001	45.9
6/10/08	0.025	0.002	47.6
6/16/08	0.021	0.001	56.1
6/17/08	0.018	<0.001	56.8
6/24/08	0.027	0.002	30.4
7/1/08	0.041	0.001	78.3
7/8/08	0.026	<0.001	59
7/14/08	0.022	0.001	40.7
7/16/08	0.031	0.003	33.6
7/22/08	0.022	0.001	48.2
7/31/08	0.027	0.001	76.6
8/5/08	0.033	0.001	93.8
8/11/08	0.028	0.001	86.3
8/12/08	0.032	0.001	82.8
8/19/08	0.031	0.001	75.9
8/28/08	0.018	0.002	34
9/2/08	0.023	0.001	60.1
9/9/08	0.016	0.002	49.8
9/15/08	0.025	<0.001	68
9/16/08	0.023	0.001	66.8
9/23/08	0.031	<0.001	84.3
9/30/08	0.036	<0.001	79.8
10/7/08	0.044	<0.001	79.7
10/14/08	0.059	<0.001	122
10/15/08	0.06	<0.001	111
10/21/08	0.076	0.001	130
11/4/08	0.062	<0.001	51.2
12/1/08	0.075	<0.001	79
Trigger	**0.08**	**0.022**	**166**

Note: Italics = Exceeds Trigger Value.

The contemplated assessment of natural seasonal variability was not completed. Such an assessment might result in recommending a two-part seasonal threshold value in the manner that was previously recommended for location V8. However, such an assessment for location X14 would be confounded by a number of complicating factors such as releases of (sulphate-rich) effluent. Therefore, this assessment has been deferred at this time.

Figure 4-1. Rose Creek (X14) Sulphate (2003 – 2008)

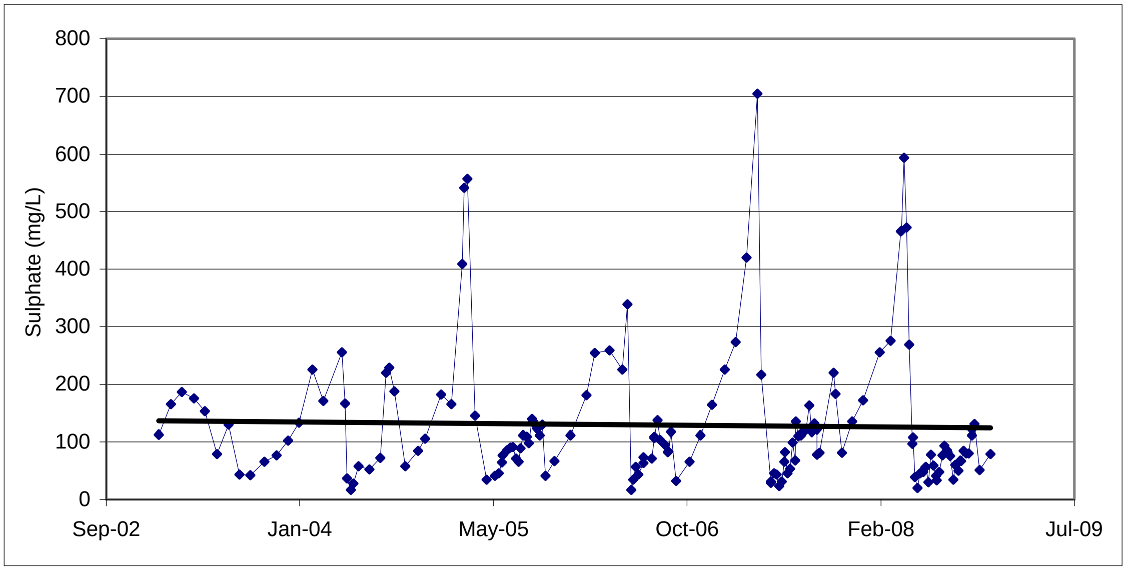
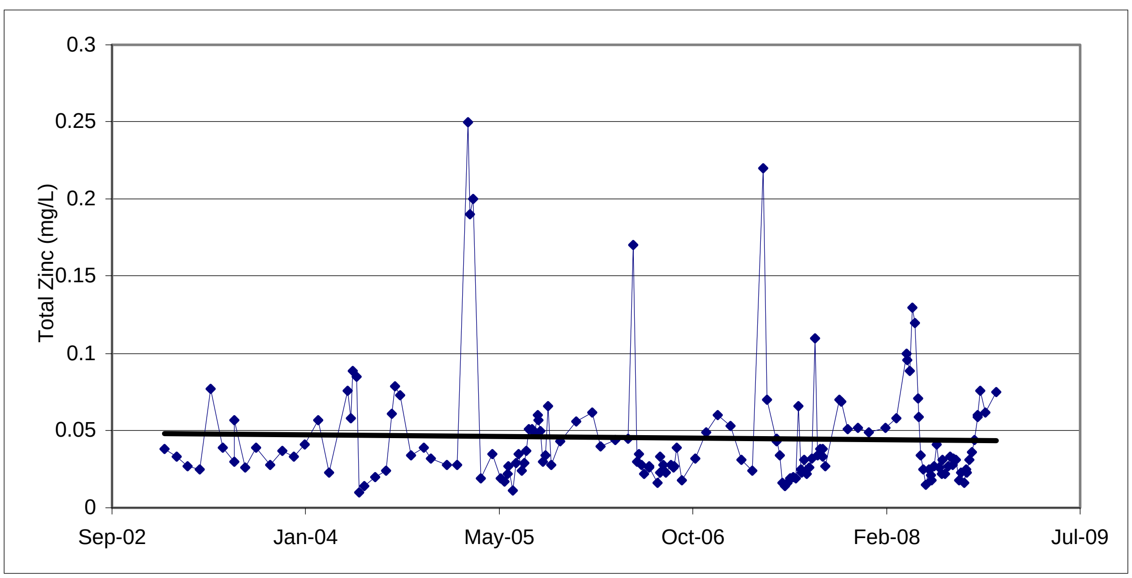


Figure 4-2. Rose Creek (X14) Total Zinc (2003 – 2008)



5. AMP Event 4, Degraded Seepage Quality from the Grum Rock Dump

5.1 Description

Surface and subsurface seepage from the Grum Rock Dump contains contaminants that are released from the waste rock dump. The water quality of Grum Dump seepage is measured monthly at V2 for total metals, dissolved metals, pH, temperature, conductivity, total suspended solids, sulphate, ammonia and hardness (YWB, 2004). This seepage water flows into Vangorda Creek and has the potential to become contaminated to the degree where the receiving environment in Vangorda Creek is adversely affected. The trigger for the implementation of contingency measures is proposed to be surface water quality in Grum Creek prior to discharging into Vangorda Creek.

5.2 Summary of Implementation Protocol Information

The following is a summary of the AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
$Zn_{(T)}$, $Cu_{(T)}$, and SO_4	V2	• 3 consecutive results > 75th percentile of reference period; or • statistically significant trend projects >75th percentile of reference period within three years.	Twice monthly

5.3 Background

Review of the reference period data (1998 to 2002) carried out as part of the development of the AMP Implementation Protocol indicated that both water quality thresholds had been exceeded for sulphate at Station V2 below the Grum Rock Dump. Since 2000, the concentrations of sulphate at V2 have remained elevated. This resulted in the immediate triggering of the AMP as of the date of implementation, July 1, 2004. A letter of notification was provided to the Government of Yukon, Water Resources Branch, on July 15, 2004 from SRK Consulting on behalf of the Interim Receiver.

On August 16, 2004 an additional notification was provided to the Government of Yukon from SRK Consulting, outlining the proposed response plan to address this issue. The response plan outlines a staged approach to investigating the increase sulphate concentrations at V2. The following outlines the key components of the response plan:

- Collection of Routine Water Quality Samples;
- Review of Existing Water Quality Record;
- Detailed Contaminant Pathway Survey;
- Installation of Flow Monitoring Station on Grum Creek;
- Groundwater Monitoring Well Installation; and
- Preparation of Status Report.

In May 2005, a status report was submitted to Government of Yukon, Water Resources Branch, Water Inspector from SRK Consulting on behalf of the Interim Receiver and the Water Board which address five of the six key components of the response plan. The main findings in the status report were as follows:

- sulphate and zinc concentrations at V2 and V2A have increased over a period of several years;
- flow from V2A infiltrates into the base of Moose Pond. Downgradient seepage at Moose Seep was noted to have elevated sulphate and low zinc concentrations, which indicated that zinc attenuation was occurring along the groundwater flow path;
- sampling at the toe of the Grum Dump indicates that dump is generating zinc loads on the order of 1,700 kg/year;
- sampling downgradient of the dump showed that zinc loading from Grum Dump into Vangorda Creek is about 5 kg/year. Significant attenuation was noted along of the potential surface and shallow subsurface flow paths that were monitored;
- monitoring of Vangorda Creek at V1, upstream of the mine site, has shown that background concentrations of zinc loads in Vangorda Creek are on the order of 140 kg/year; and
- monitoring of Vangorda Creek at V27, downstream of the mine site, has had variable concentrations of zinc and sulphate, with no discernable trends since the start of mining.

Based on the review of water quality and available discharge data for Grum Dump catchments and Vangorda Creek, the May 2005 status report recommended the following actions:

- Increase surface and groundwater monitoring downgradient of Grum Dump;
- Discuss options for collection and transfer or surface water with site management;
- Adopt a zinc concentration of 0.5 mg/L in three consecutive samples as an interim threshold for the implementation of water collection activities;
- Continue Spring/Fall monitoring of seepage and surface water locations downgradient of Grum Dump that are not sampled as part of routine or AMP monitoring programs;
- Install additional monitoring wells, including a well downgradient of Moose Pond; and
- Continue Grum Creek flow monitoring.

During 2005, all the actions listed above were implemented. Frequency of surface water monitoring at AMP reference water quality stations V15, V2, and V2A was increased to bi-weekly, and bi-weekly sampling of Moose Seep was initiated, in September 2005. Results of this sampling were screened as part of the monthly review of site-wide routine water quality data, to identify exceedances of thresholds for implementation of water collection. No thresholds were exceeded in 2005. A detailed summary of 2005 response activities was submitted to the Water Board and Government of Yukon, Water Resources Branch in October 2006.

In 2006, water quality at Station V2 continued to show that sulphate concentrations continued to exceed the initial trigger established in the AMP. There were no additional triggers beyond that identified for sulphate in 2004, and zinc concentrations did not show the same increasing trend observed for sulphate.

Results of 2006 dump toe seepage surveys indicated that zinc concentrations in dump seepage were stabilizing, with dissolved zinc concentrations at all toe seepage stations within the previously-observed ranges. In particular, zinc concentrations in Grum Creek (the largest discharge from Grum Dump) in 2006 were within the previously observed range.

Downgradient monitoring stations east of V2 below Moose Pond and west of V2 near Vangorda Creek showed similar elevated sulphate concentrations, but zinc concentrations were typically at or near detection levels (0.005 mg/L). The 2006 monitoring data thus showed that zinc loading from Grum Dump to Vangorda Creek continued to be minimal (~5 kg/yr, as estimated from the water and load balance) and that significant attenuation was occurring along surface and shallow subsurface flowpaths.

However, the dramatic and consistent rise in dissolved zinc concentration observed at V15 in 2006 was noteworthy. The data appeared to show a classic case of breakthrough of attenuated chemical species, and the results reviewed as of the end of 2006 did not suggest that the breakthrough process has run its course. Therefore at that time it was reasonable to expect to see some measure of continued increase in zinc concentrations at V15, and that increases at V15 would lead to an increase in zinc concentrations observed at V2. A detailed summary of 2006 response activities was submitted to the Water Board as part of the 2006 AMP Annual Report.

In response to the increasing concentrations of zinc observed at the outlet of the V15 sedimentation pond in 2006, an interim collections system was installed in January 2007 to divert this seepage into an existing ditch below the V-Notch weir on Grum Creek which routes water from Grum Creek to Moose Pond at Station V2A. This interim system consisted of a pump and pipeline to convey the water. In August 2007, this system was upgraded to a diversion ditch.

The ongoing management review of the relevant water quality data from the Grum Dump area was carried out monthly in 2007. Full details of the water quality data were presented in the AMP Event #4 Response: 2007 Status Report prepared by SRK Consulting and presented in the 2007 AMP Annual Report.

In 2007, water quality at Station V2 continued to show that sulphate concentrations continued to exceed the initial trigger established in the AMP. There were no additional triggers in 2007, beyond that identified for sulphate in 2004, and zinc concentrations did not show the same increasing trend observed for sulphate.

Results of the 2007 dump toe seepage surveys continued to indicate that the zinc concentrations in dump seepage may be stabilizing, with dissolved zinc concentrations at all stations within the previously observed ranges.

The consistent rise in dissolved zinc concentration observed at V15 remained noteworthy in 2007 with the data continuing to show a classic case of breakthrough of attenuated chemical species, and the results reviewed, as of the end of 2007, did not suggest that the breakthrough process had run its course. It was reasonable to expect to see some measure of continued increase in zinc concentrations at V15.

Despite the increases in zinc concentrations at V15 in 2007, zinc concentrations at V2 have remained very low throughout the 2007 monitoring period.

Overall, in 2007, it appeared that the partial diversion of water from Station V15 to Station V2A via Grum Creek diversion was successful in controlling the amount of zinc reporting to station V2, without having a noticeable effect on concentrations at Station V2A in Grum Creek. In 2007, as in 2006, downgradient monitoring stations east of V2 below Moose Pond and west of V2 near Vangorda Creek show elevated sulphate concentrations, but zinc concentrations were typically at or near detection levels (0.005 mg/L). The 2007 monitoring data, as in 2006, thus showed that zinc loading from Grum Dump to Vangorda Creek continued to be minimal (~5 kg/yr), as estimated from the water and load balance) and that significant attenuation was occurring along surface and shallow subsurface flowpaths.

5.4 2008 Review

The ongoing review of the relevant water quality data from the Grum Dump area was carried out monthly in 2008. Full details of the water quality data are presented in the AMP Event #4 Response: 2008 Status Report prepared by SRK Consulting and presented in Appendix A of this AMP Review.

In 2008, water quality at Station V2 showed that sulphate concentrations continued to exceed the initial trigger established in the AMP. There were no additional triggers beyond that identified for sulphate in 2004. Since mid-2007, sulphate concentrations at V2 decreased and have stabilized around 700 mg/L. In 2008, the range of zinc concentrations at V2 was similar to that observed in 2004 through 2007, between 0.05 and 0.06 mg/L, indicating that the partial diversion for flows from V15 to Moose Pond was successful in controlling zinc concentrations, in the downstream receiving environment.

Results of the 2008 dump toe seepage surveys indicate that the zinc concentrations in dump seepage have not stabilized, with the highest observed dissolved zinc concentrations occurring at several toe seepage stations in 2008.

The rise in dissolved zinc concentration observed at V15 in 2006 and 2007 remains noteworthy. The data continue to show a classic case of breakthrough of attenuated chemical species. Zinc concentrations reached a maximum in October 2007 (1.2 mg/L) before appearing to stabilize at approximately 1 mg/L throughout 2008.

Despite the increase in zinc concentrations at V15, zinc concentrations at V2 have remained very low throughout the 2008 monitoring period. The data suggests that the partial diversion of water from Station V15 to Station V2A via the Grum Creek diversion has been successful in controlling the amount of zinc reporting to station V2, however it appears as though concentrations at Station V2A in Grum Creek have increased as a result of this diversion. Since June 2008, dissolved zinc concentrations at V2A have increased from below 0.2 mg/L to between 1 and 2 mg/L.

Downgradient monitoring stations east of V2 below Moose Pond and west of V2 near Vangorda Creek show elevated sulphate concentrations, but zinc concentrations are typically at or near detection levels (0.005 mg/L). The 2008 monitoring data showed that zinc loading from Grum Dump to Vangorda Creek continued to be minimal (~5 kg/yr, as estimated from the water and load balance) and that significant attenuation was occurring along surface and shallow subsurface flowpaths.

The following summarizes recommendations for continued monitoring of water quality downgradient of Grum Dump, and for implementation of additional water management if zinc concentrations exceed acceptable levels. Details are provided in Appendix A.

1. Continue monitoring Reference Water Quality Stations, as required under the AMP, by site environmental staff on a twice-monthly basis.
2. Continue to divert seepage from station V15 (the sedimentation pond) to station V2A in 2008, via Grum Creek diversion, as a pro-active short-term mitigation strategy to minimize zinc concentrations at station V2 until a final closure plan can be implemented.
3. Implement collection and transfer of water to Vangorda Pit or Little Creek Pond if zinc concentrations exceed acceptable levels at station V2, at Moose Seep, or at Moose Well.

   a. In the absence of site specific water quality objectives, the discharge water quality criteria of 0.5 mg/L zinc will be used as an interim threshold for implementation of water collection activities. Surface water collection and transfer would be implemented if three consecutive samples either at Station V2, at Moose Seep, or at Moose Well 2 exceed 0.5 mg/L zinc.

   b. Once a site-specific water quality objective has been developed for Vangorda Creek, the threshold for implementation of contingency measures should be re-evaluated to ensure that loading from this flow pathway is within acceptable limits.

   c. In the event that the interim threshold is exceeded, notification will be sent to the Water Board within 30 days.
4. Continue Spring/ Fall downgradient pathway and dump toe seepage surveys.
5. Reinstall Grum Creek weir flow-monitoring instrumentation and continue monitoring.
6. Review monitoring data on an ongoing basis. Results of the Reference Water Quality Station monitoring data should continue to be included as part of the regular monthly report to the Water Board.
7. Summarize the 2009 monitoring results in an annual AMP Event #4 Status Report.

6. AMP Event 5, Degraded Water Quality in the North Fork of Rose Creek

6.1 Description

Water quality in the North Fork of Rose Creek could be negatively affected by rock dump seepage, seepage or overflow from the Zone 2 Pit, seepage from the disturbed area between the creek and the Zone 2 Pit and the rock drain at the haul road crossing, and contaminated groundwater from the Main/Intermediate waste rock dumps. The water quality in the North Fork of Rose Creek is measured monthly at Station X2 (YWB 2004) for total metals, dissolved metals, pH, temperature, conductivity, total suspended solids (TSS), sulphate, hardness and ammonia. The flow rate is also measured monthly at X2.

The environmental consequence of degraded water quality in the North Fork of Rose Creek is the potential exposure of aquatic resources, terrestrial resources and human resources to increased levels of contaminants in the North Fork, Rose Creek Diversion canal and, possibly, further downstream in Rose Creek, Anvil Creek and the Pelly River. Zinc is currently the primary contaminant of concern and zinc and sulphate are currently the primary indicators of acid rock drainage. However, the consideration of degraded water quality should include other metals and contaminants which could source from the rock dumps, open pits and other mine facilities.

6.2 Summary of Implementation Protocol Information

As part of the 2005 Annual Review, an assessment was carried out to determine if there were any statistically significant seasonal differences in the sulphate concentrations at X2, and if necessary determine seasonally based threshold values for sulphate at X2 based on the reference period (1998 – 2002). Concentrations of sulphate during the reference period were found to exhibit seasonal variations. Using the Analysis of Variance and Multiple Comparisons (Least Significant Difference) at a 5 % significance level, statistically higher concentrations are observed in the winter months (November – April) compared to the open water months (May – October). Given this seasonal variability, it was recommended that the AMP Protocol for X2 be modified for sulphate to include two seasonal components: open water season (May – October) and winter (November – April). The following is a summary of the modified AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
$Zn_{(T)}$, and $Cu_{(T)}$	X2	• three consecutive results > 75th percentile of reference period; or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly
SO_4	X2	• three consecutive results > 75th percentile of reference period (15 mg/L); or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly (May – October)
SO_4	X2	• three consecutive results > 75th percentile of reference period (30 mg/L); or • statistically significant trend projects >75th percentile of reference period within three years.	Monthly (November – April)

6.3 Background

Review of the April 2006 water quality data from X2 against the winter seasonal threshold indicated that the concentration of sulphate was greater than the trigger level for three consecutive monthly samples (January 23rd, February 14th and April 25th). No sample was collected in March due to the sample location being frozen. This was documented in the monthly data report to the Yukon Water Board dated May 29, 2006. This trend in elevated sulphate concentrations during the winter low flow months was consistent with historical trends due to influence of groundwater "baseflow" during the winter season. Although present at concentrations above the winter seasonal threshold value, the levels were within the range of those seen historically during the winter months at X2 (1998 – present).

The following short term management plan was outlined for this trigger event:

> ***Upon receipt and analysis of the upcoming monthly samples for May at location X2, an assessment will be provided to the Water Inspector if the trigger continues (per the AMP Protocol).***

As expected the sulphate concentration at X2 in May 2006 showed that with the onset of spring freshet the concentrations of sulphate dropped to 4.85 mg/L, well below the open water threshold value of 15 mg/L. Trend analysis carried out on the 2003 to 2006 winter low-flow sulphate data indicated that there is a statistically significant increasing trend in sulphate concentrations at X2. When carried forward, this trend indicated that winter sulphate concentrations will remain above the threshold of 30 mg/L. This same trend was not seen in the corresponding open water sulphate data (2003 to 2006).

In May 2006, another trigger was identified at X2 for zinc. This was documented in the monthly data report to the Yukon Water Board dated June 29, 2006. After incorporating the May 2006 data, there was a statistically significant increasing trend in the concentration of total zinc that estimated the concentration of total zinc would exceed the threshold concentration of 0.06 mg/L in April 2007. In response to this trigger the following short term management plan was outlined:

Upon receipt and analysis of the upcoming monthly samples for June at location X2, an assessment will be provided to the Water Inspector if the trigger continues (per the AMP Protocol).

Subsequent analysis of monthly samples for total zinc at location X2 confirmed the continuation of this trigger and in October 2006 concentration of total zinc reached the threshold value.

There were, therefore, two confirmed and outstanding triggers for location X2 in 2006, projected continued elevated winter sulphate concentrations and increasing zinc concentrations.

Review of the April 2007 data found that three consecutive monthly total zinc concentrations exceeded the threshold value of 0.06 mg/L (0.065 mg/L in October 2006, 0.064 mg/L in November 2006 and 0.18 mg/L in April 2007). Glaciation and ice conditions at this location limited sample collection between December 2006 and March 2007. This was documented in the monthly data report to the Yukon Water Board dated May 28, 2007. After incorporating the May 2007 data, there continued to be concentrations of total zinc that exceeded the threshold concentration of 0.06 mg/L. In response to this trigger the following management plan was outlined:

In response to this trigger, and as outlined in the 2007 AMP Annual Review, a comprehensive assessment is being carried out including analysis of water quality from related monitoring locations. The goal of this assessment is to provide for a preliminary identification of the dominant source of the increase concentrations. This analysis will incorporate new information that has been generated as part of the ongoing development of the Final Closure and Reclamation Plan, specifically the ongoing seepage investigation in the area below the Faro Waste Rock Dump. Based on this analysis, an appropriate response plan will be developed and filed with the Water Board, the timing of which is dependent on the closure planning process.

Preliminary assessment of the May 2007 data indicates that the total zinc concentration of 0.18 mg/L at X2 in April may be somewhat of an anomaly with the May monthly concentration being substantially lower at 0.068 mg/L and within the range of concentrations at this location in late 2006. It is thought that the reason for this substantially higher concentration in April is primarily associated with the conditions that were encountered at this location during sampling. The site was ice covered with minimal flow. Under these low flow conditions, there is minimal surface water contribution to the creek at this location and the flow is dominated by the influence of groundwater "baseflow".

Trend analysis carried out on the 2003 to 2007 winter low-flow sulphate data indicated that there was no longer a statistically significant increasing trend in sulphate concentrations at X2. Although, this was most likely confounded by the lack of winter data in 2007.

6.4 2008 Review

A management review of the relevant water quality data from X2 was carried out on a monthly basis in 2008. This data review included assessment of the two following specific thresholds for total copper, total zinc and sulphate:

- Three consecutive monitoring results greater than the upper 75th percentile of the reference period (1998 – 2002); or
- A statistically significant trend in the monitoring results (from 2003 and on) which, when extrapolated forward three years, would result in values greater than the upper 75th percentile of the reference period.

For sulphate, the data review included the assessment based on two seasonal components: open water season (May – October) and winter (November – April).

The results of the review are summarized in Table 6-1 and in Figure 6-1 and Figure 6-2. In 2008, although there were no new triggers, ongoing increased concentrations, particularly zinc during winter low flow conditions, continued to occur at X2.

Table 6-1. Summary of AMP Data at X2 (2008)

Date	Total Zinc (mg/L)	Total Copper (mg/L)	Sulphate (mg/L)
1/7/08	0.056	<0.0010	*30.9*
2/18/08	*0.099*	<0.0010	*36.4*
3/17/08	*0.094*	<0.0010	*38.2*
4/14/08	*0.097*	<0.0010	*36.3*
5/14/08	*0.076*	0.0030	6.12
6/16/08	0.037	0.0020	8.35
7/14/08	0.024	0.0010	7.3
8/11/08	0.03	<0.0010	11.7
9/15/08	0.024	0.0020	10.1
10/15/08	0.039	<0.0010	14.6
11/3/08	*0.1*	<0.0010	22.2
12/1/08	*0.092*	<0.0010	23.7
Trigger	**0.06**	**0.028**	**15[a]/30[b]**

Notes:
Italics = Exceeds Trigger Value.
a. Open Water Trigger Value.
b. Winter Trigger Value.

Figure 6-1. North Fork Rose Creek (X2) Sulphate (2003 – 2008)

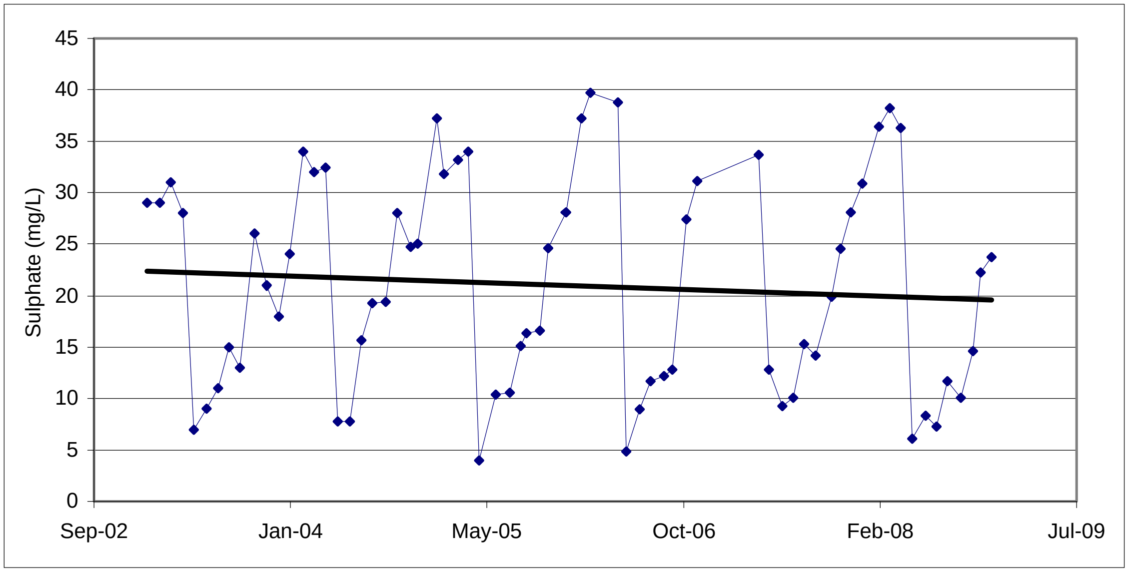
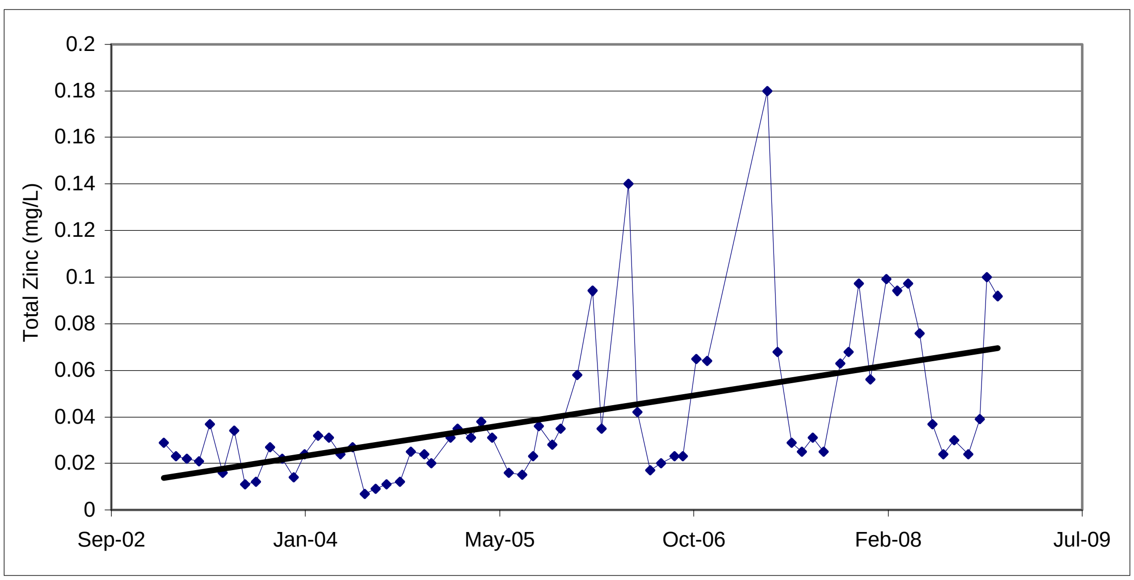


Figure 6-2. North Fork Rose Creek (X2) Zinc (2003 – 2008)



In response to the ongoing triggers at X2, a detailed assessment was carried out in 2008 incorporated the following:

- Water quality data from the key Reference Water Quality Stations outlined in the AMPIP, including X2;
- Flow data for the North Fork of Rose Creek upstream at R7 and at X2;
- Initial Review of Groundwater Quality Downstream of Faro, Grum and Vangorda WRD's Yukon Territory (Robertson GeoConsultants Inc. (RGC) 2004) as part of Task 14d Preliminary Seepage Collection Options Faro and Grum Waste Rock Dumps (SRK 2006a);
- Task 20e Anvil Range Mining Complex 2005 Seepage Investigation at the S-Cluster Area below the Faro Waste Rock Dump (SRK and RGC 2006);
- 2007 Groundwater Review Anvil Range Mining Complex, Yukon Territory (RGC 2008); and
- 2008 North Fork of Rose Creek June Surface Water Survey (Laberge 2008).

Full details of this assessment are in the Anvil Range AMP Event #5 Follow-Up Work Report prepared by Gartner Lee (now AECOM) and submitted to the Water Board on September 30, 2008. In summary, this assessment confirmed the presence of highly impacted groundwater in the S-Well area adjacent to the North Fork of Rose Creek and projected continued deterioration of the groundwater quality, particularly zinc concentrations. The likely source of the contaminant loading to this area is the Main and Intermediate Rock Dumps. The impact of this on the North Fork of Rose Creek is most evident during the winter, when flows in the creek are dominated by groundwater base flow.

There were also concerns noted in the May 2008 environmental report prepared by site management relating to elevated zinc levels in the S-wells area and the possibility of migration of contaminated water to the North Fork of Rose Creek. As a result of discussions with SRK in May 2008, it was noted that they were in the process of preparing a proposal for mitigating the risk of further contamination to the area. It was noted that in preparing a draft budget for the 2008 operating year, SRK had written the following relating to the S cluster groundwater. "Previous investigations found that concentrations of zinc and other metals (Fe, Mn) in the S-well area were highly elevated and likely contributing to loads within the North Fork of Rose Creek (NFRC)". Preliminary review of the data collected since completion of the 2005 S-well report indicated that zinc levels have continued to increase significantly over the last 2 years.

It was recommended by SRK that during the 2008 operating season further investigation of the S-wells subsurface bedrock topography and ground water quality should be carried out including significant drilling activity. In addition, engineering designs would be developed for the Seepage Interception System (SIS) in the S cluster area with focus on interim measures that target areas of high contaminate loading. Pump tests would be performed and assessed relating to the feasibility of active recovery by pumping of the contaminated water. Following several discussions between the Faro Technical Advisory Team (TAT) and the Faro Project Management Team (FPMT), during April and May, a revised project scope was recommended relating to an intervention system. Deloitte & Touche Inc. received a copy of this recommendation on June 6, 2008. On June 17, 2008, Deloitte & Touche Inc. received from SRK a proposal entitled "S-wells groundwater investigations and options for collection and treatment". The ultimate objective of the project was to determine an approach on collecting and treating contaminated groundwater in the S cluster area. Following further discussions between the TAT and SRK, a final proposal dated August 5, 2008 was received by Deloitte & Touche Inc. A portion of the delay was due to confirming availability of the required drilling rigs and scheduling them for the site. The FPMT approved the proposal on August 12, 2008 and the drilling rigs arrived mid August and the contractor completed the field work on September 17, 2008.

In late September water samples were collected from the S-wells area including surface water nearby and in close proximity to the North Fork of Rose Creek. The results of the laboratory analysis showed significant levels of zinc in both the ground water and the surface water. On October 3, 2008 Deloitte & Touche Inc. received notification by the FPMT relating to the elevated levels of zinc and a preliminary proposal prepared by the TAT relating to an intervention system in the S-well area to capture the contaminated water and send it by a pipeline to the Faro Pit as an interim measure. It was suggested that Deloitte & Touche Inc. consider setting up this intervention program this fall and winter rather than waiting until next spring, if practically possible.

Deloitte & Touche Inc. contacted the FPMT and SRK along with individuals from TAT to discuss the issues and difficulties relating to an intervention program that late in the season due to winter conditions. A conference call was arranged on October 9, 2008 with the following participants; representatives from Deloitte & Touche Inc., FPMT, SRK, and TAT. It was concluded during the conference call that an intervention should take place regarding the S-wells contaminated water and that a technical sub-committee made up of the members noted above hold a conference call following the meeting to begin the planning and initiation of the project. The technical sub-group had a conference call on the afternoon of October 9, 2008 and subsequent conference calls to formalize a planned intervention including system design, equipment requirements and all associated costs. The goal was to put in place a remedial intervention system to capture the contaminated waters at the S-wells and pump the water to the Faro Pit. It was intended to have the system operational prior to February 28, 2009. The system design and installation would be managed by SRK.

The recommendation was accepted by both Deloitte and Touche Inc. and the pertinent government agencies. A design and implementation program for the S-wells intervention was prepared by SRK with assistance from Hatch Engineering. Two Yukon contractors were asked to quote on the installation with Pelly Construction of Whitehorse receiving the contract. Installation activities were carried out in January and February 2009 under severe weather conditions, a portion of the time. The installation is on schedule with initial start-up planned, prior to February 28, 2009. Full details of this program are presented in the S-cluster Groundwater and Option Assessment Report prepared by SRK Consulting and presented in Appendix B of this report.

7. AMP Event 6, Water level in Grum Pit Reaches Maximum Desired Elevation

7.1 Description

Water quality in the Grum Pit is currently non compliant with the discharge criteria in Water Licence QZ03-059 for the Faro and Vangorda Plateau mine sites (YWB 2004) and can not, therefore, be directly released to the receiving environment. The water elevation in the Grum Pit has been rising since mine shut down in 1998 but remained safely below an overflow level at the end of 2006. Further, a report has been completed (GLL 2003a) that indicated that it is unlikely that the pit will fill to a level requiring active management before 2011, under a conservative long-term projection. Nonetheless, it remains possible that a series of extreme natural events could cause the in-pit water level to rise to a maximum desired operating range during the term of the current Water Licence and, therefore, an AMP is required to ensure that appropriate responses are implemented if necessary.

The environmental consequences of the water elevation in the Grum Pit reaching the maximum desired elevation could result in the absence of adequate emergency storage capacity for containment of a flood event and, ultimately, a release of non-compliant water to the receiving environment, Vangorda Creek. This could result in the exposure of aquatic resources, terrestrial resources and human resource users to increased levels of contaminants in Vangorda Creek and the Pelly River.

Zinc is currently the primary contaminant of concern and zinc and sulphate are currently the primary indicators of acid rock drainage. However, the consideration of degraded water quality should include other metals and contaminants that could source from the pit.

7.2 Summary of Implementation Protocol Information

The following is a summary of the AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
Pit water elevation and projected timeframe to maximum desired water elevation	Grum Pit	• Water level of 1,210.8 m asl; or • Projected timeframe of 1 year or less to maximum desired water level.	• Monthly; and • Annual.

7.3 Review

Water elevations were measured by mine personnel through 2008 and are illustrated on Figure 7-1. The maximum measured elevation was 1203.476 m asl, which is well below the threshold elevation of 1,210.8 m asl. Therefore, the first trigger for pit water elevation was not activated in 2008. The threshold elevation was previously determined as a “safe” elevation that is below the level where any surface or subsurface seepages would occur. As illustrated on Figure 7-1, the threshold elevation is 2.6 m below the maximum desired water level elevation (1213.4 m asl), based on the till contact elevation and allowance for emergency diversions into the pit during flooding, and is approximately 21.5 m below the elevation at which surface outflow would occur. This threshold, once reached, was established to provide preparatory time of approximately 1 to 1.5 years to develop plans for the management pit water prior to any water releases.

The timeframe for reaching the maximum desired elevation was projected using the observed rate of increase from 2003 through 2008. The measured rate of rise is illustrated on Figure 7-2, as are a best-fit power function and the projected rate of rise used for assessment of the AMP trigger. As illustrated in Figure 7-2, the rate of rise of Grum Pit increased dramatically in 2008, due in part, to the higher levels of rainfall at the site during 2008 (about 2 times normal summer precipitation). In addition, there was an increase in the amount of sloughing of till in the Grum Pit from the east pit wall. This sloughing could cause an increase in the pit lake as well as cause a possible narrowing or decrease in the surface area of the pit at the water surface area levels (SRK 2009). Therefore, with this decrease in surface area, the rate of rise from the same inflow would be higher.

The “incremental” line on Figure 7-2 indicates the rate of rise for each individual (primarily monthly measurement). The “cumulative” line on Figure 7-2 indicates the cumulative rate of rise for each measurement as compared to the initial survey in 2003. The “power” curve illustrated on Figure 7-2 is a best fit curve based on the cumulative rate of rise data, which shows the “best fit” rate of rise projected into the future. Finally, the “long term projection used” curve illustrated on Figure 7-2 shows the projected rate of rise that has been used to project future water levels (as illustrated on Figure 7-1). The power curve and the long-term projection curve both begin at the most recent water level measurement, December 2008. Figure 7-2 demonstrates that the projected rate of rise that was used for this assessment is more conservative (i.e., a greater rate of rise) than would be projected from the best-fit power curve.

The projection for the pit water level is illustrated on Figure 7-1 and demonstrates that the timeframe for reaching the AMP threshold elevation of 1,210.8 m asl is by January 2011. Therefore, the second trigger outlined in Table 7-1 was not reached in 2008. Once the trigger elevation is reached in 2011, another year is available to develop and implement appropriate systems for the management, including possible lime treatment, of Grum Pit Water. In summary, based on the projected water levels, it is anticipated that active management of the Grum Pit water will be required in 3 years time.

It has been suggested that prior to commencing conventional lime treatment, assuming this is part of the future required water management systems for Grum pit water, a time period of at least one year without biological treatment is required. If this is the case, and assuming the projected timing for active intervention is the start of 2012, then the ongoing biological treatment of Grum pit should be stopped at the end of the 2010 treatment season.

The projection presented in Figure 7-1 is considered to be conservative (i.e., overestimating the rate of rise). Additional information is being developed regarding the water balance for the Grum pit through the studies that are underway for development of the Final Closure and Reclamation Plan. However, the information is not available for reporting at this time. Regardless, the conservative projection provided here is considered to provide a lower "bound" for the timeframes required to reach the stated elevations.

Figure 7-1. Grum Pit Water Elevations and Projection

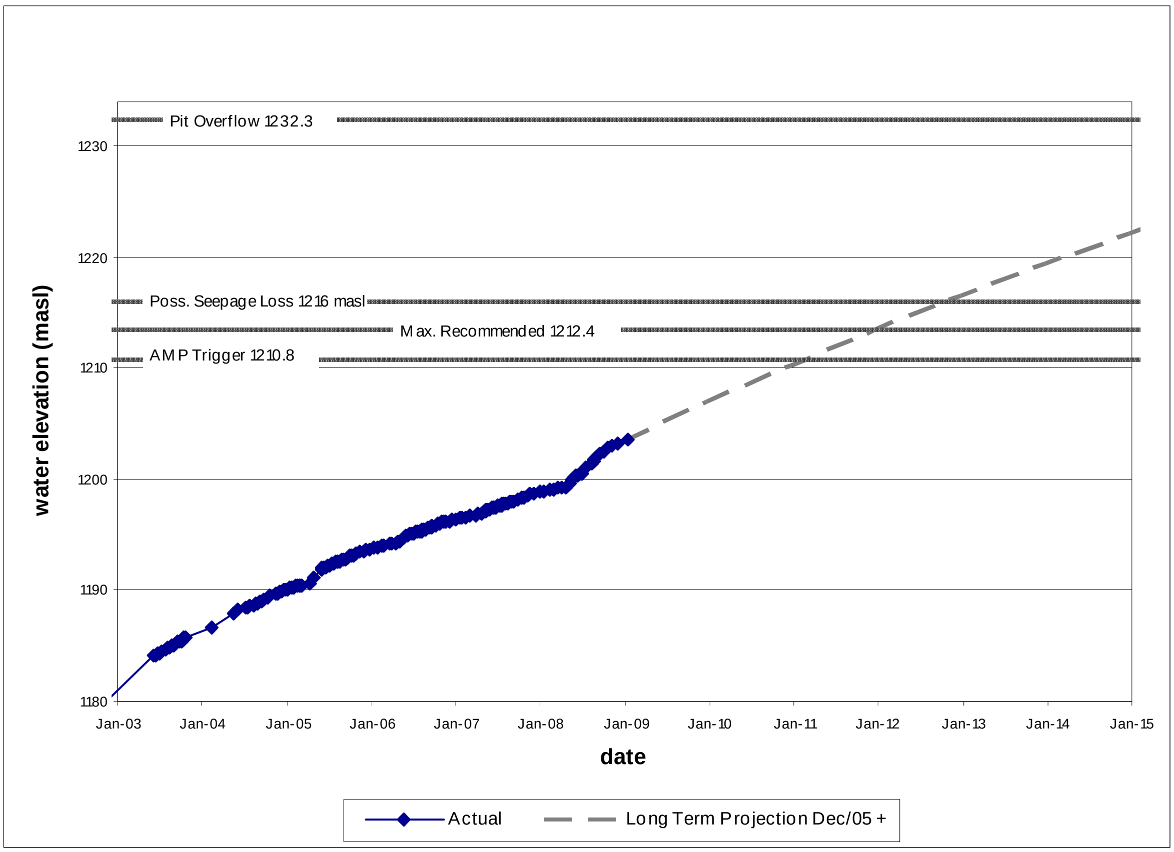
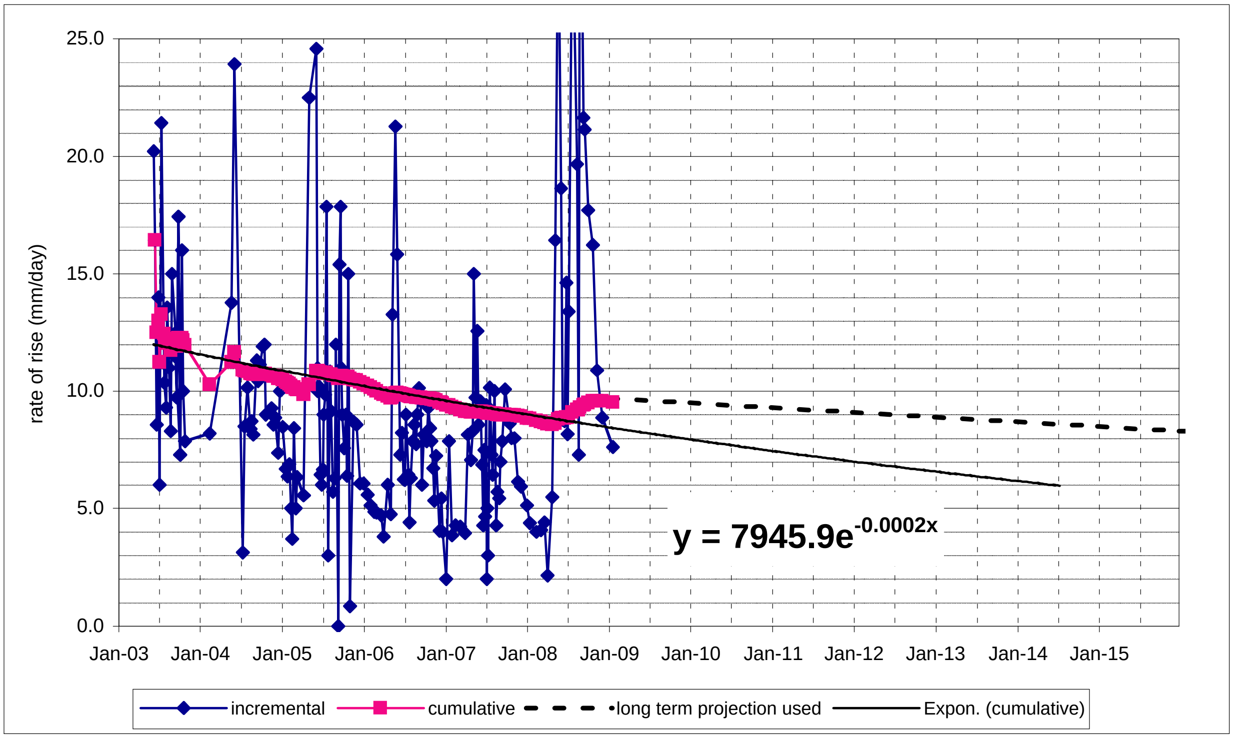


Figure 7-2. Grum Pit Water, Rate of Rise



8. AMP Event 7, Disruption of Fannin Sheep Migration Through the Mine Site

8.1 Description

It is well documented that the Fannin sheep seasonal migration route between winter and summer areas passes through the Vangorda Plateau mine site and that the sheep have continued their migration pattern through the period of mine operations and care and maintenance activities. Mine personnel routinely observe the sheep migration during the course of their activities on the mine site.

The experience gained during the 1998 to 2002 care and maintenance period indicates that the proposed continuation of care and maintenance activities should not disrupt the sheep migration patterns. The wide ranging land use by the Fannin sheep suggests that a disruption or irregularity in the migration pattern would more likely be caused by off-site effects.

However, regardless of the source, an irregularity or disruption in the migration pattern could negatively affect the health of the herd by delaying or preventing their established pattern of land use. Alternatively, an irregularity in the sheep migration could be an indicator of a previously unidentified affect on the health of the herd.

8.2 Summary of Implementation Protocol Information

The following is a summary of the AMP Implementation Protocol information for this event to serve as a quick reference for the review that follows.

Indicators	Locations	Thresholds	Monitoring
Locations, time and conditions of Fannin Sheep sightings, number and behaviour of animals	Vangorda Plateau	Determination of specific thresholds will be done by the licencee in conjunction with YG DOE	Ongoing

8.3 Review

Wildlife observations at the site are recorded in a “Wildlife Observations Logbook”. The information recorded was passed on the YG DOE Conservation Officer every three months, with no triggers being activated.

9. AMP Event 8, Wind Dispersed Tailings Result in Adverse Effects in the Terrestrial Environment

9.1 Description

At the time the AMP Implementation Protocol was originally developed, the available information demonstrated that wind dispersed contaminants (i.e., heavy metals) were present in the terrestrial environment near the mine site. This information is described in the Water Licence Renewal Environmental Assessment Report. However, at that time, this data did not clearly identify the source of the contaminants (i.e., tailings, waste rock, mining activities or emissions from the concentrator during operating periods, for example), the extent of their distribution, or whether the effects have increased, diminished or remained static through the care and maintenance timeframe (i.e., post-1998) in comparison to the operating period of the mine.

In response to concerns with respect to this issue, the Terrestrial Effects Study was initiated under the recommendation of the Environmental Assessment conducted for the Water Licence Renewal for ongoing care and maintenance activities at the Anvil Range Mine Complex (Deloitte & Touche Inc. and Gartner Lee Limited, 2003). The broad goal of the study is to answer two fundamental questions:

1. Are there any existing and ongoing impacts to the terrestrial environment (i.e., animals, vegetation and land users) that need to be addressed during the care-and-maintenance phase, while the Final Closure and Reclamation Plan is being prepared?
2. What are the impacts of the past mining operations on the terrestrial environment (animals, vegetation and land users) that should be addressed in the Final Closure and Reclamation Plan?

9.2 Summary of Implementation Protocol Information

The trigger for implementation of contingency measures under the AMP is “the 2005 Terrestrial Effects Study Report concludes that current and on-going wind dispersion of tailings is having a negative effect on the environment such that short term mitigation measures for a reduction in wind dispersion are recommended”.

9.3 Review

In September 2006, the two following reports were submitted to the Water Board as per Part F, Item 49 of Water Licence QZ03-059:

1. *Anvil Range Mine Complex – Terrestrial Effects Study: Investigation into Metal Concentration in Vegetation, Wildlife and Soils*, prepared by Gartner Lee Limited (now AECOM); and
2. *Summary Report Anvil Range Mine Tier 2 Risk Assessment of Current Conditions*, prepared by SENES Consultants Ltd.

The two combined reports fulfilled the requirements of the Water Licence. The first report presented the findings of a two-year study for gathering information on terrestrial resources (such as animals, soil, vegetation and air). The second report assessed that information for potential risks to people and wildlife. These reports, along with attached cover letter, provided a comprehensive summary of the results of the studies with respect to the requirements of the Water Licence. A copy of this was provided to the Water Board as part of the 2006 Annual Report. The key findings are presented below.

The specific objectives of the Terrestrial Effects Study were:

1. Definition of the spatial distribution of elevated metal concentrations in the terrestrial environment;
2. Determination of whether the elevated metal levels are related to historic mine activities and/or current care and maintenance activities;
3. Improvement of the characterization of natural background (reference) metal concentrations;
4. Investigation of metal levels in vegetation species of importance to humans and wildlife;
5. Investigation of metal levels in wildlife tissues, including species of importance to humans;
6. Determination of ambient air metal concentrations (required information for the Human Health and Ecological Risk Assessment (HHERA)); and
7. Identification of potential sources of ongoing metal deposition.

This work relied on the participation provided by the Ross River Dena, Selkirk First Nation, Town of Faro and scientific experts to guide the collection of information, including metal levels in small mammals, large animals, soil, vegetation, berries, and air quality.

The information collected in the terrestrial environment showed that past operations at the Anvil Range Mine have resulted in metal concentrations in the mine area that are greater than the reference/background levels. For example, lead concentrations near the mine are up to 450 times those at reference sites and the lead isotope analysis indicates that the majority of the lead deposited in the study area was from mine ores. The concentrations of metals that originated from the mine site are generally higher near the mine and decline with distance from the mine. Deposition of some metals from the mine site is still occurring in the immediate area, mostly during the snow-free period.

Metal concentrations that were greater than the reference/background levels were detected in plants, small mammals and other wildlife in the area. This information does not necessarily indicate a high risk to wildlife or people but reinforces the appropriateness of conducting a human health and ecological risk assessment, as described below.

The HHERA for the current conditions at the site was developed using the information collected at the Anvil Range mine as supplemented by other general information where necessary to complete the assessment.

The assessment was based on the current care and maintenance activities being carried out at the site, as is appropriate to the requirements of the Water Licence.

The results of the ecological risk assessment indicate that no adverse health effects are expected in fish and animals that are currently present on the site. The human health risk assessment indicates that humans who use the site for approximately 1.5 months per year to gather berries and trap animals and also hunt and eat animals from the site are not at risk from adverse health effects.

Although based on the results of the HHERA, there is no need for short-term mitigation to ensure animals and people are adequately protected from risks associated with on-going wind dispersion of tailings while the Final Closure and Reclamation Plan is being developed, due to the ongoing concerns related to dusting from the tailings area at the site, a Tailings Dust Control Project was initiated in 2008 (Appendix C). The main area of concern for wind erosion has been identified as the Original and Secondary tailings impoundments with smaller contributions from parts of the Intermediate impoundment. All together these areas cover approximately 196 hectares but due to parts of the impoundments being covered by water, the maximum potential area requiring dust control was found to be 136 hectares.

Despite the fact that the tailings areas are covered by snow for a portion of the year, the potential for dust generation during the summer months was considered to be significant enough to justify investigating potential remediation methods. A number of physical and chemical control options were considered as part of this project. Soil Sement, a water-soluble liquid polymer, was selected as it was expected to have the best results in the unique environment at Anvil Range. A test application was proposed to determine how effective Soil Sement will be and how long the service life for a single application is.

Sufficient Soil Sement was procured to conduct tests over approximately 16 hectares of the tailings and three areas on the various impoundments were identified as having the highest dust generation potential. A delivery system was developed on site based on the equipment used at the Giant mine site. All of the preparations for the test project were completed by the end of July. Due to the consistently wet conditions meaning minimal dust and to the limited window of time available for testing before cold weather and snow were expected the, actual testing has been postponed until the summer of 2009.

10. Recommendations

Based on the information assessed and described in this report, we feel that the AMP program is functioning as intended.

As outlined in Section 2 we recommend that the following modifications be implemented at this time, specifically:

- AMP Event 1– Degraded Groundwater Quality in Rose Creek Valley Aquifer – add P03-06 and X21 as trigger locations.

Other than these specific recommendations, the AMP program functioned as intended in 2008 and no other changes should be made.

Appendix A

AMP Event #4 Response: 2008 Status Report

Prepared by SRK Consulting

Appendix A AMP Event#4 Response: 2008 Status Report

Found in digital file AppxA_Event4_2008StatusReport_SRK

Appendix B

2008 S-cluster Groundwater Investigation and Option Assessment

Prepared by SRK Consulting

Appendix C

Tailings Dust Control Project

Appendix B 2008 S-cluster Groundwater Investigation and Option Assessment

Found in digital file AppxB_S-Cluster_2008_SRK

DELOITTE & TOUCHE INC.

ANVIL RANGE MINE SITE
TAILINGS DUST CONTROL
TEST PROJECT

FARO MINE, YT

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

The Anvil Range mine site is situated roughly 20 kilometers to the north of the town of Faro and the tailings impoundments are situated adjacent to the Rose Creek Diversion on the western end of the site. The main area of concern for wind erosion has been identified as the Original and Secondary tailings impoundments with smaller contributions from parts of the Intermediate impoundment. All together these areas cover approximately 196 hectares but due to parts of the impoundments being covered by water, the maximum potential area requiring dust control was found to be 136 hectares.

Despite the fact that the tailings areas are covered by snow for a portion of the year, the potential for dust generation during the summer months is considered to be significant enough to justify investigating potential remediation methods. A number of physical and chemical control options were considered with Soil Sement, a water-soluble liquid polymer, expected to have the best results in the unique environment at Anvil Range. A test application is required to determine how effective Soil Sement will be and how long the service life for a single application is.

Sufficient Soil Sement was procured to conduct tests over approximately 16 hectares worth of the tailings and three areas on the various impoundments were identified as having the highest dust generation potential. A delivery system was developed on site based on the equipment used at the Giant mine site. All of the preparations for the test project were completed by the end of July. Due to the consistently wet conditions meaning minimal dust and to the limited window of time available for testing before cold weather and snow were expected the, actual testing has been postponed until the summer of 2009.

2.0 PROJECT BACKGROUND

2.1 Alternatives Considered

The report prepared by Brodie Consulting outlined a number of dust control methods commonly used and assessed their suitability for the tailings at the Anvil Range mine. All of the methods presented were divided into two categories: physical or chemical control.

Physical dust control methods such as increasing surface roughness or tilling in mulch or straw are not recommended for use at the Faro site because of the potential for release of oxidation products that the soil disturbance would cause. The construction of wind breaks or installation of a rip rap cover are two other commonly used methods of dust control but both are generally better suited to smaller areas than what is at the Anvil Range site. Both of these two methods are also generally longer term than what is required currently at this site where it is anticipated that a long term plan for the tailings will be

2.0 PROJECT BACKGROUND (continued)

developed in the near future. The final physical approach discussed is the planting of grass to help bind the surface material. This is not feasible as the tailings are toxic to grass.

Chemical dust control strategies fall in to two categories: water based or glues and binders. Water based dust suppression requires some sort of system that can apply water to the target area on a continuous basis. There are several wetting agents, foams and humicants that can be added to enhance the effectiveness of plain water. It was observed that because of a wetter than average summer in 2008, the rainfall provided adequate dust control for more than half of the time that the tailings weren't covered by snow anyway. Glues and binding agents work by forming the surface particles into larger masses that are less likely to become airborne or by forming a crust over top of native soil. As most of the products available in this category can typically function for a period of months to years before requiring reapplication, this was considered to be the best method of dust control for the Anvil Range mine site.

Soil Sement is applied by mixing with water and then spraying over the target area. After the water evaporates, the polymer remains in place to bind the soil and prevent dust generation. The effective service life of this product typically varies from site to site so testing at the Faro location is required to determine its effectiveness and the required re-application period.

2.2 Application Requirements

A very light application rate of 1000 L/ha was chosen for the test project primarily since the areas being considered are relatively large and it would be very costly to apply a heavier coating. The equipment that was available on site, which will be discussed further in the following section, presented some additional constraints:

1) It was observed that a full tank of water can provide continuous spray out of four nozzles for roughly 30 minutes.
2) Based on the volume of the tank it was decided that adding two barrels of product to the tank and then filling it with water would give the desired mix.
3) The spray arms mounted on the back of the tank provide roughly 6.5 metres of effective coverage when spraying.

Using these conditions it was calculated that one full tank can cover an area of roughly 4200m^2 or one strip of tailings 6.5m wide and 640m in length. To ensure that the desired thickness is achieved, the tank should travel at 1.3km/h while spraying.

3.0 PROJECT PREPARATIONS

3.1 Overview

Preparations for the test project began the week of July 13th, 2008. Over a period of four days, preliminary tests were conducted and appropriate adjustments were made to calibrate the tank and its components for the spraying of the tailings. During this time, arrangements were also made for all equipment and materials needed to be properly stationed for the spraying of the tailings. This included procuring pumps and hoses to pump fresh water from Rose Creek to where the tank would be filled and the relocation of the Soil Sement from storage to the first spraying location.

The three selected areas of the tailings impoundments, which can be seen in Appendix B, were staked out for testing. At all three of the areas identified the stakes were placed in rows spaced at intervals of 6.5m marking the path that should be followed when spraying to ensure the best coverage. Rows of stakes were placed every 25m along the bottoms of the different impoundment dams.

The spraying of the tailings was intended to take place starting the week of July 20, 2008. However, due to continuous rainfall with only brief periods of dry weather, the spraying was delayed and eventually postponed until the spring of 2009.

3.2 Equipment

Tank on Chassis

Some of the equipment needed for the spraying such as pumps and hoses for drawing fresh water from Rose Creek was readily available on site and was procured with the assistance of Anvil Range personnel. The actual tank system that holds the water and Soil Sement mixture had to be constructed specifically for the spraying project.

A 1000 U.S. gallon tank was available on site and was mounted onto a chassis with a hitch and axel to provide mobility for the tank when spraying, and when moving to and from site. Two spray arms with several nozzles that can be opened and closed individually as required were mounted to a valve at the back end of the tank. These bars, when not in use, can be detached and placed on the side of the tank along with any hoses. A pump sits on the back end of the chassis where the spray bars connect to the tank.

Spray Pattern of Nozzles

3.3 Preliminary Testing

On Monday, July 14th, 2008, the dimensions of the tank were measured and the preferred sections of the tailings impoundments to be sprayed were chosen. The tank was hitched to the hiab and brought

3.0 PROJECT PREPARATIONS (continued)

down to the lime bay at the mill where the tank was filled with water. It was then relocated behind bay 14 and a test run was performed to

determine the effectiveness of the spray pattern. The results showed that the spray pattern provided adequate coverage along the length of the spray bars, although there was substantial overlap of the water coming out of each of the nozzles. Half-inch spray valves and plugs were added to solve this issue by allowing for fine-tuning of the spray and the tank was then filled again with water from the lime bay. The tank was placed behind bay 14 for continued testing the next day.


Spray Valve

The morning of July 16th, the valves were installed on the spray nozzles and various combinations of open and closed valves were tested to determine what would provide minimal overlap while still maintaining sufficient coverage. It was found that having 4 of the 10 valves full open with the remainder closed was the optimal arrangement. Next a test run was performed to determine the volumetric flow rate with this configuration of nozzles. A pump was then brought down to Rose Creek and set up to pump water up to the first tailings impoundment. The tank was also placed by the turnoff to the first tailings impoundment from the main road. The hiab was then loaded up with 8 skids of Soil Sement barrels, which were delivered to the first tailings impoundment. All of the Soil Sement was later moved to the Yates guest house for storage over the winter months when the project was postponed.

The staking out of the three areas began on July 17th, and carried on into the following week. One at the toe of the first impoundment has a length of 600m resulting in a 6ha area. Another along the toe of the damn at the second impoundment running 300m, contributes another 3ha of test area. The final area was staked out alongside the main road to the Guard House going past the first tailings impoundment at a length of 300m. The total area identified for test coverage is 12ha.

4.0 CONTINUING OPERATION

In order for the spraying of the tailings to take place, certain conditions must be satisfied prior to operation.

1) The Soil Sement must be brought to the site where spraying will take place.
2) A supply of water must be made available.
3) The tank system requires some form of machinery that can pull it across the tailings.

Currently, 80 barrels of Soil Sement are in storage at the Yates guest house and should be brought to the mine site where the spraying will occur. A pump and a sufficient length of hose may be set up to draw water out of Rose Creek and into the tailings impoundment, where

4.0 CONTINUING OPERATION (continued)

the tank can be filled up. Alternatively, the vacuum truck located on site could be used to collect water and then fill up the tank. This second option although more difficult will likely be required for the

spraying of the area located on the Intermediate impoundment. A second pump is required to draw the Soil Sement out from the barrels and into the tank. With the selected test areas already staked out, it is then just a matter of spraying these areas with the appropriate application rate (see preliminary calculations in Appendix A). The rate of application can be adjusted both with the spray valves and the pump. Recirculating the tank contents with the pump can accomplish the required mixing in the tank.

5.0 CLOSURE

This report summarizes the process leading to the selection of Soil Sement as the dust control method of choice for the Anvil Range Mine site as previously discussed in greater detail in the report submitted by Brodie Consulting Ltd. It also outlines the preparations made on site for a test application prior to the project being postponed because of ongoing unfavorable weather conditions. Recommendations and guidance for operation have also been discussed in this report. All of the preparations should allow for the testing to begin as soon as the snow cover recedes from the tailings in the summer of 2009.

We trust that the information presented herein meets your current requirements. If you have any questions or require further information, please contact the undersigned.

Respectively submitted,

Michael Brewer, BASc	Chris Croy
Civil Engineer	Environmental Technician

6.0 REFERENCES

Brodie, J. Brodie Consulting Limited. (2008). *Tailings Dust Control*. Retrieved July 7th, 2008

APPENDIX A:

PRELIMINARY CALCULATIONS

Required Application Rate:	1000 L/ha undilute	
Dilution when adding 2 barrels per tank:	(2 x 55 gal)/(1000 gal) x 100% = 11%	
	→ 9000 L/ha dilute	(2377 gal/ha)
	→ 0.9 L/m²	(0.24 gal/m²)
Observed Spray Rate:	1000 gal/30 min	(33 gal/min)
Spray Arm:	21 ft	(assume 6.5 m coverage)
Coverage Per Tank:	(1000 gal/tank)/(0.24 gal/m²) = 4167 m²/tank	
	→ 641 m x 6.5 m	
Required Speed of tank and machine	(641 m)/(30 min) = 1.3 km/h	

APPENDIX B:

TAILINGS PERIMETERS

ANVIL RANGE MINE SITE
TAILINGS DUST CONTROL
TEST PROJECT