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**FARO MINE COMPLEX**  
**2011 CHINOOK SALMON SURVEYS**  
**ROSE & ANVIL CREEK**

**PREPARED FOR:**

YUKON GOVERNMENT, ASSESSMENT AND ABANDONED MINES  
ROOM 2C, 2<sup>ND</sup> FLOOR, ROYAL CENTRE  
WHITEHORSE, YUKON

**PREPARED BY:**



WHITEHORSE, YUKON  
PROJECT NO. 11-115  
MARCH, 2012

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## Executive Summary

Ecological Logistics & Research Ltd. (ELR) was retained by the Yukon Government, Energy, Mines and Resources, Assessment and Abandoned Mines (AAM) to conduct Chinook salmon surveys in Anvil and Rose Creeks at the Faro Mine Complex near Faro, Yukon. The focus of the surveys was to provide information on usage of Rose Creek and Anvil Creek by Chinook salmon, in relation to the Faro Mine Complex (i.e. the Site). Surveys were conducted on August 19 and 25, 2011, including a walking survey of the Rose Creek Diversion Channel (RCDC) and an aerial survey of Rose Creek, Anvil Creek, and a segment of the Pelly River.

Favourable survey conditions were encountered in Rose Creek and upper Anvil Creek during both surveys, while aerial surveys of lower Anvil Creek and the Pelly River were ineffective due to high turbidity levels. No Chinook salmon (live or carcasses) were observed, although 6 redd sites were identified in Rose Creek. It could not be distinguished with confidence, in either survey, whether the redd sites were from current or previous years use.

Based on the observations at the site and data from previous studies and the Blind Creek weir, it appears that timing and poor 2011 run strength may have been a factor influencing these surveys at the site. Earlier surveys are recommended, and surveys during a year of high returning numbers would aid in better defining local adult Chinook use. The establishment of a weir in lower Anvil Creek would provide the highest certainty of return timing and strength, and would allow for longer term comparisons between Rose/Anvil Creek and Blind Creek data.

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## **I. INTRODUCTION**

Chinook salmon are known to utilize Anvil Creek and Rose Creek which are located in the vicinity of the Faro Mine Complex (FMC) near Faro, Yukon; however the characteristics of this use are not well understood or documented. Recent study efforts have focused on better understanding the timing and characteristics of Chinook salmon returns in the area, as many details from post-mine closure habitat use have been anecdotal. With an ongoing care and maintenance program at the FMC, and closure/remediation planning for the mine proceeding, having a better understanding of the dynamics of Chinook salmon within the streams of this area will be important (i.e. at the FMC and downstream from it).

In order to help refine data collected in earlier years, the Yukon Government, Assessment and Abandoned Mines (AAM) retained Ecological Logistics & Research Ltd. (ELR) to conduct aerial and ground-based Chinook salmon surveys in Anvil and Rose Creeks in the FMC area.

### **I.1 STUDY AREA**

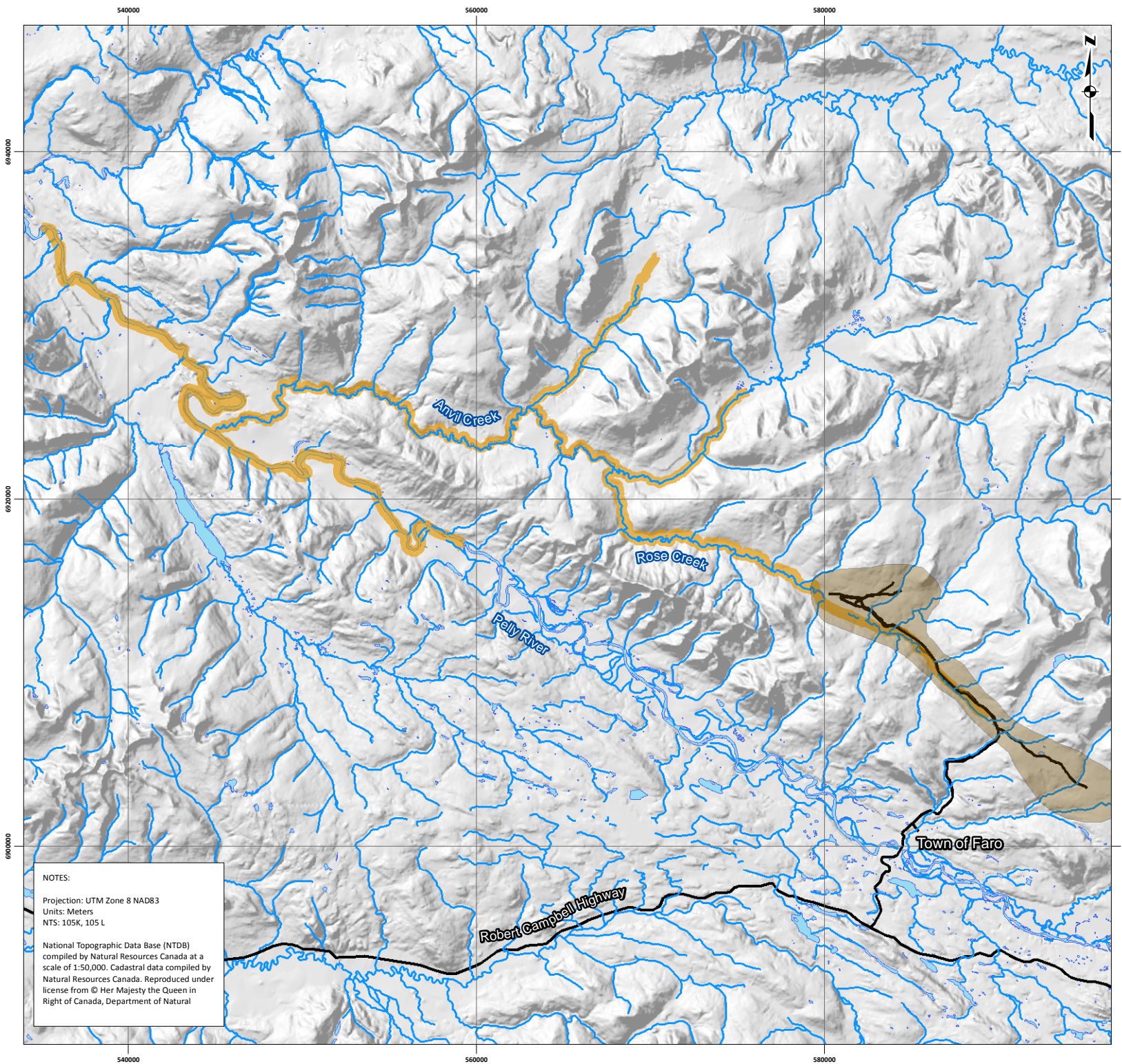
Rose Creek and Anvil Creek are tributaries to the Pelly River that are located in central Yukon, near the Town of Faro. Rose Creek originates as two forks in alpine areas northeast of the FMC. They join at the upper end of the 4.9 km Rose Creek Diversion Channel (RCDC) that circumvents the FMC tailings area before re-joining the natural creek channel in a subalpine valley down gradient of the site (Figure 2). From here, Rose Creek meanders for approximately 36 km before meeting Anvil Creek. Anvil Creek is a higher gradient stream which flows in a westward direction for approximately 32 km before joining the Pelly River (which is part of the Yukon River Drainage Basin).

Currently, treated water from the Faro Mine tailings area is released into Rose Creek below the diversion channel area. Groundwater from below the tailings area is believed to surface in several areas along the RCDC. It is believed that these factors may influence the Rose Creek and Anvil Creek systems, and are considered to contribute to the distribution of fish found in Rose and potentially Anvil Creeks. Therefore, these streams have been the target of ongoing effects monitoring programs for the site since the FMC first entered receivership.

### **I.2 STUDY OBJECTIVE**

The primary study objective of the 2011 Anvil/Rose Chinook salmon surveys was to identify any evidence of their spawning activity (i.e. adult fish, carcasses, redds, or other indicators). This was conducted using the following survey components:

- Aerial surveys of Rose Creek, Anvil Creek, and the Pelly River in the vicinity of Anvil Creek.
- Walking surveys of the RCDC.



**NOTES:**

Projection: UTM Zone 8 NAD83  
Units: Meters  
NTS: 105K, 105 L

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**2011 FMC  
Chinook Salmon Surveys**

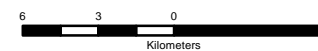


Client:



**Legend**

- Major Roads
- Watercourses
- Water Bodies
- Faro Mine Complex Area
- 2011 Survey Area Extent



March 25, 2012

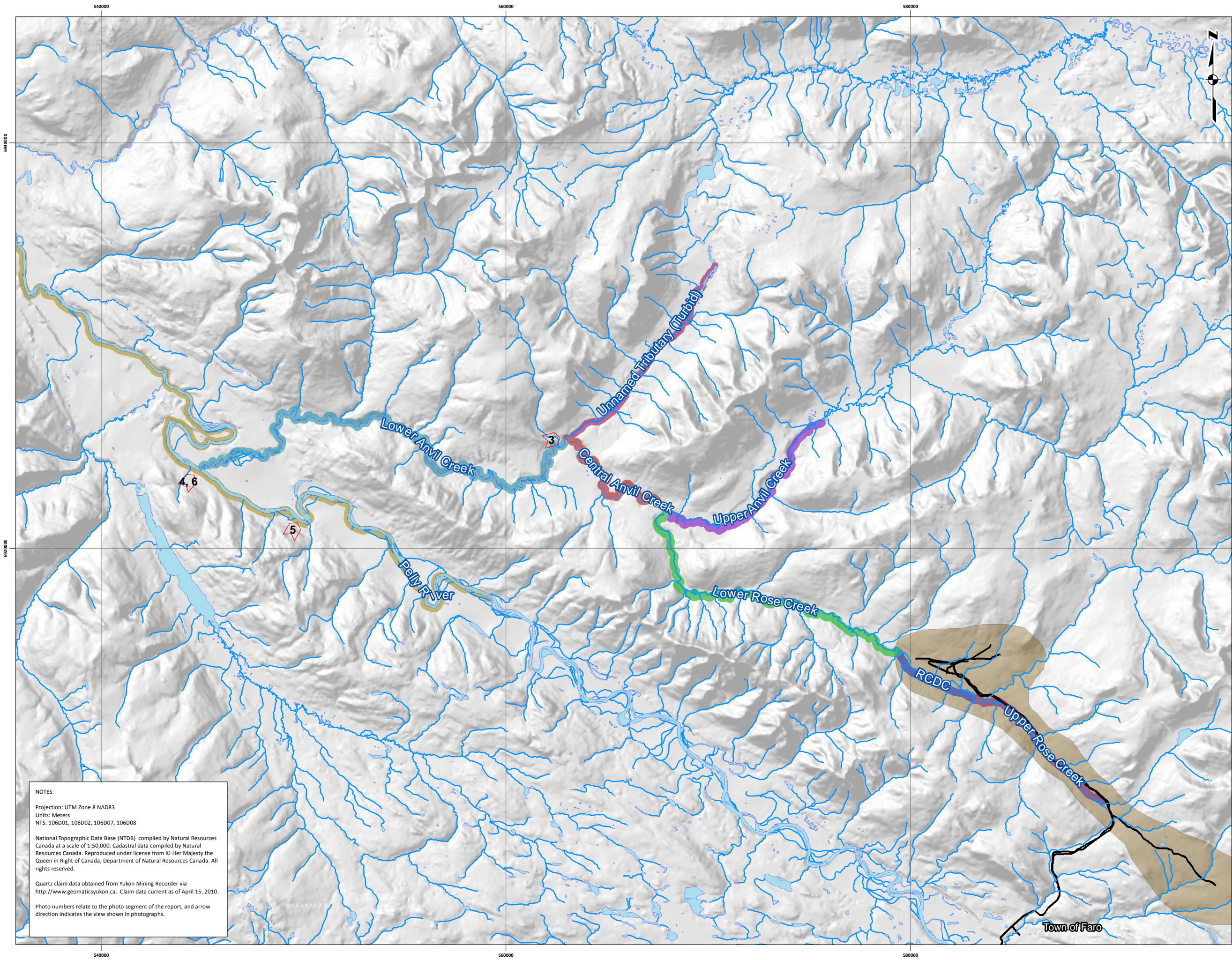
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Rev. #: 3

**FIGURE 1**  
**Faro Mine Complex  
Survey Area**





NOTES:

Projection: UTM Zone 8 NAD83  
Units: Meters  
NTS: 106D01, 106D02, 106D07, 106D08

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Quartz claim data obtained from Yukon Mining Recorder via <http://www.geomaticsyukon.ca>. Claim data current as of April 15, 2010.

Photo numbers relate to the photo segment of the report, and arrow direction indicates the view shown in photographs.

2011 FMC  
Chinook Salmon Surveys

Client:

Legend

Photo Locations / Numbers

Watercourses

Waterbodies

Major Roads

Faro Mine Complex Area

2011 Survey Area

Upper Rose Creek

RCDC

Lower Rose Creek

Upper Anvil Creek

Central Anvil Creek

Lower Anvil Creek

Pelly River

Unnamed Tributary (Turbid)

Project Area

Scale:

1:175,000

Date: March 25, 2012

Drawn by: CJJ

ELR Project #:11-115

Rev. #:2

FIGURE 2

Aerial and Ground Survey  
Areas and Photo Locations



## **2. STUDY METHODS**

### **2.1 STUDY TIMING**

Project surveys were initiated shortly after ELR received project approval from AAM, with the first survey being conducted on August 19, 2011. The second survey effort was planned for and conducted approximately one week after the first, on August 25, 2011.

Both survey events were conducted by the same ELR biologist and technician for consistency.

### **2.2 GROUND-BASED SURVEY**

During each survey event, a walking survey of the RCDC was first conducted to observe any evidence of Chinook salmon spawning or presence. For these surveys, the two observers wearing polarized glasses walked along the bank of the RCDC throughout its entirety (approximately 4.9 km) as shown in Figure 3. Both survey events were conducted walking downstream (roughly a northwest direction) to limit surface reflection, thereby maximizing visibility of the channel area.

During surveys both surveyors proceeded slowly downstream at different vantage points wherever possible (high and low terrain). Observations of fish, evidence of spawning activity (recently used or older redds), and other habitat features of note were recorded, and UTM waypoints were captured using handheld GPS so that these areas could be targeted for observation during the aerial survey.

### **2.3 AERIAL SURVEY**

Aerial surveys of Rose Creek, Anvil Creek, and the Pelly River were conducted using a Robinson R44 helicopter, with both observers positioned on the left of the aircraft (front/rear). On both survey dates, the aerial survey was conducted after completion of the ground survey.

Aerial surveys were conducted starting at the headwaters of Rose Creek and proceeded downstream to the Pelly River to minimize the surface reflection on the watercourses based on sun position. The target survey elevation was 75 – 100 m above water surface, with speed being adjusted according to visibility and flying conditions. The aerial surveys were first completed without reference to observations from the ground survey or from prior years' surveys in order to minimize observer bias. Following this primary survey, points from the ground survey and from a 2010 survey by White Mountain Environmental Consulting (WMEC; P. Sparling, pers. comm.) were then targeted to provide an aerial cross-reference.

All observations were recorded in reference to UTM waypoints captured on handheld GPS, and photographs were taken of both reference conditions and observations.



### **3. RESULTS**

#### **3.1 SURVEY CONDITIONS**

##### **3.1.1 Ground Based Survey**

The August 19 ground survey event was conducted between 09:34 and 11:33 with calm winds and a temperature of 7 to 8°C. Cloud cover ranged from 30 to 50 percent during the survey, and visibility below the water surface was excellent.

The August 25 ground survey event was conducted between 10:30 and 12:20 with light southwest winds and a temperature of 8°C. The sky was mostly clear, and visibility below the water surface was again excellent.

During both surveys, the entire 4.92 km length of the RCDC was surveyed, as shown in Figure 2.

##### **3.1.2 Aerial Survey**

The August 19, 2011 aerial survey was conducted between 13:04 and 15:33, with additional observations taken until approximately 16:30. Temperature was consistent at 7-8°C throughout the survey, with cloud cover increasing from 50 percent to 80 percent through the afternoon. Rain was encountered at the end of the survey day along the Pelly River. Consistent east winds at 10-15 km/h made the survey challenging as the helicopter was operating in a tailwind throughout most of the survey length.

The survey began with a length of approximately 33 km of Rose Creek, including the 4.9 km RCDC and the south fork of Rose Creek (Photos 1 and 2). The survey team then proceeded downstream on Anvil Creek from the outlet of Rose Creek, however at approximately 9.4 km further downstream from that point, an unnamed tributary to Anvil Creek was introducing a heavy sediment load to the Creek making the survey below this point unfeasible (turbidity was estimated at > 30 Nephelometric Turbidity Units [NTU]; Photo 3; shown in Figure 2). Following this, 12.3 km of the upper Anvil Creek (upstream of the base of lower Rose Creek) were surveyed successfully, and the crew proceeded to the Pelly River at the base of Anvil Creek. High turbidity levels were also encountered in the Pelly River, estimated to be between 10 and 20 NTU (higher below the outlet of Anvil Creek; Photo 4). The survey was attempted at several locations along a 46 km segment of the Pelly River, however visibility was found to be very low again due to high turbidity (Photo 5). Aside from poor conditions encountered in Anvil Creek and the Pelly River, the survey confidence was high for Rose and upper Anvil Creeks.

On August 25, 2011, the aerial survey was conducted between 14:35 and 16:30. Temperature ranged from 8-10°C, with sunny conditions throughout the survey (0-30 percent cloud cover). Winds were from the southwest at 15-25 km/h, providing a headwind that made for favourable survey flying conditions.

The August 25, 2011 survey followed the same route as described above, starting at the south fork of Rose Creek and proceeding down Anvil Creek to the Pelly River. As on August 19, 2011, the tributary of Anvil Creek at 9.4 km downstream of the outlet of Rose Creek was introducing sediment, although at a reduced level compared to the previous survey. Still, visibility was again not suitable for aerial survey below this point on Anvil Creek. Visibility in the Pelly River was found to be poorer than during the earlier survey, and a survey of this watercourse was not attempted on August 25, 2011 (Photo 6). Despite poor conditions downstream, survey confidence was again high for Rose and upper Anvil Creeks.

Turbidity measurements taken by ELR during the August 25, 2011 survey event are provided in Table 1, below (taken using a LaMotte 2020e turbidity meter):

**Table 1: Turbidity Observations Measured During the August 25, 2011 Survey Event**

Location	Turbidity (NTU)
Lower Rose Creek	0.19
Upper Anvil Creek	0.71
Lower Anvil Creek (below unnamed tributary which was source of elevated turbidity)	6.79
Pelly River (upstream of Anvil Creek)	17.5

## 3.2 OBSERVATIONS

No live adult Chinook salmon or carcasses were observed during either the ground or aerial surveys.

In the RCDC, six potential redd sites were identified; four from the ground survey and two from the aerial survey. Following the survey, the details of aerial and ground observations were compared (i.e. multiple photo angles, depth, substrate, and location with respect to stream morphology) and reviewed by an independent reviewer (P. Sparling, pers. comm.). Based on this comparison, two of the six sites identified in the RCDC were considered to be natural features, and not redd sites. No signs of recent activity were noted at the four confirmed redd sites (Photos 7 to 10).

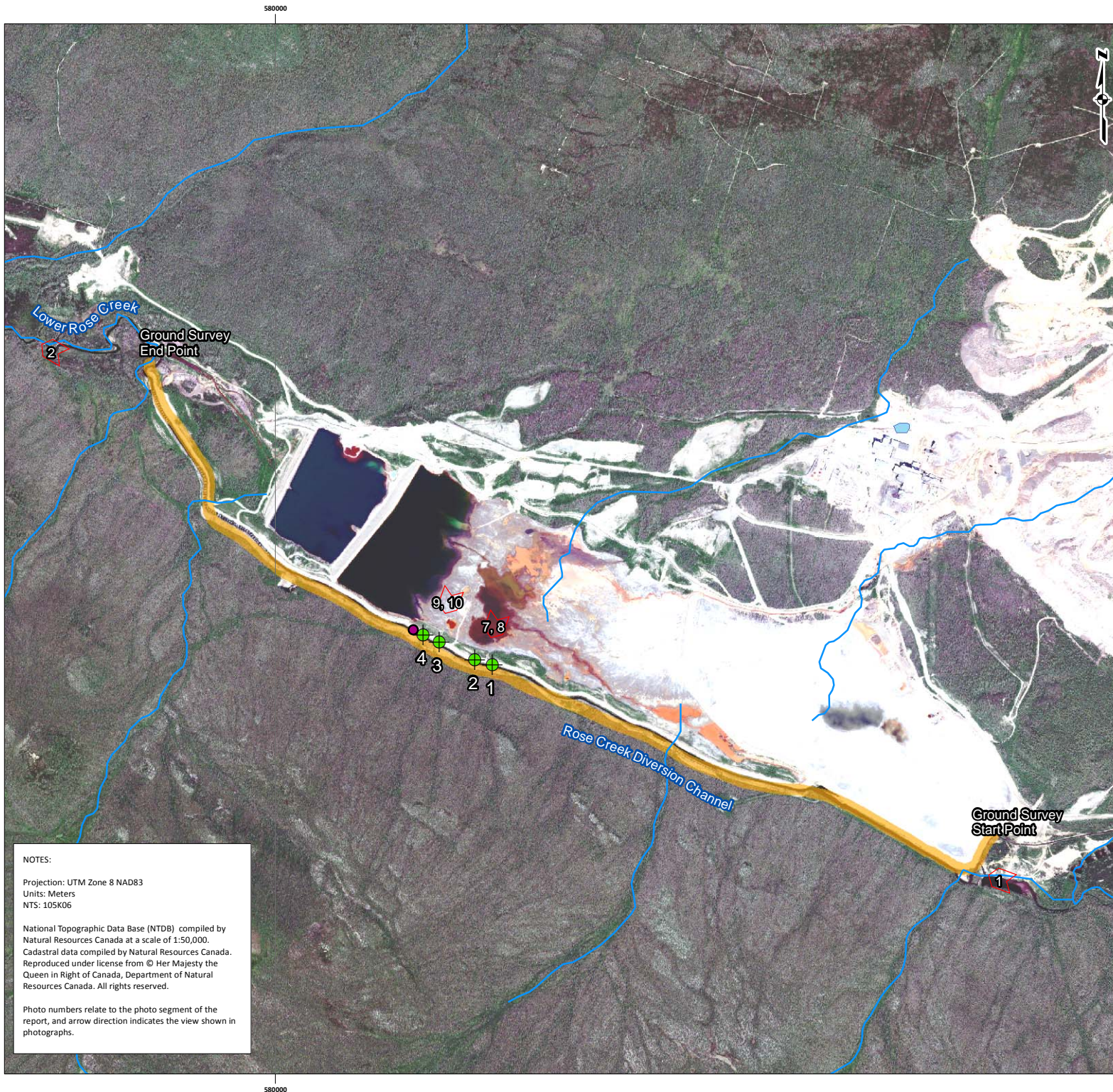
In lower Rose Creek (below the mine area), two likely redd sites were again recorded; however, there were no signs of recent activity at these sites.

Summary data for the Rose Creek redd observations are provided in Table 2 below, while locations are shown in Figures 3 and 4, attached.

**Table 2: Summary of 2011 Rose Creek Redd Observations**

Observation No.	Location	UTM Zone	UTM Easting	UTM Northing	Description
1	Rose Creek Diversion Channel	8	581008	6913481	Cobble area within RCDC
2	Rose Creek Diversion Channel	8	580927	6913506	Potential earlier or previous years redd. Cobble area within RCDC.
3	Rose Creek Diversion Channel	8	580760	6913587	Potential redd location.
4	Rose Creek Diversion Channel	8	580686	6913621	Cobble area ahead of riffle. Near 2009 spawning location noted by WMEC.
5	Lower Rose Creek	8	577006	6916066	Recognized from previous year survey, potential previous year redd.
6	Lower Rose Creek	8	572644	6917604	Potential redd location.





NOTES:

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2011 FMC  
Chinook Salmon Surveys

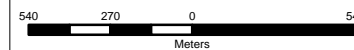


Client:



Legend

- Watercourses
- 2009 Redd Location
- 2011 Redd Observations
- RDCD Ground Survey Area
- ↗ Photo Locations / Direction



March 25, 2012

Scale: 1:25,000

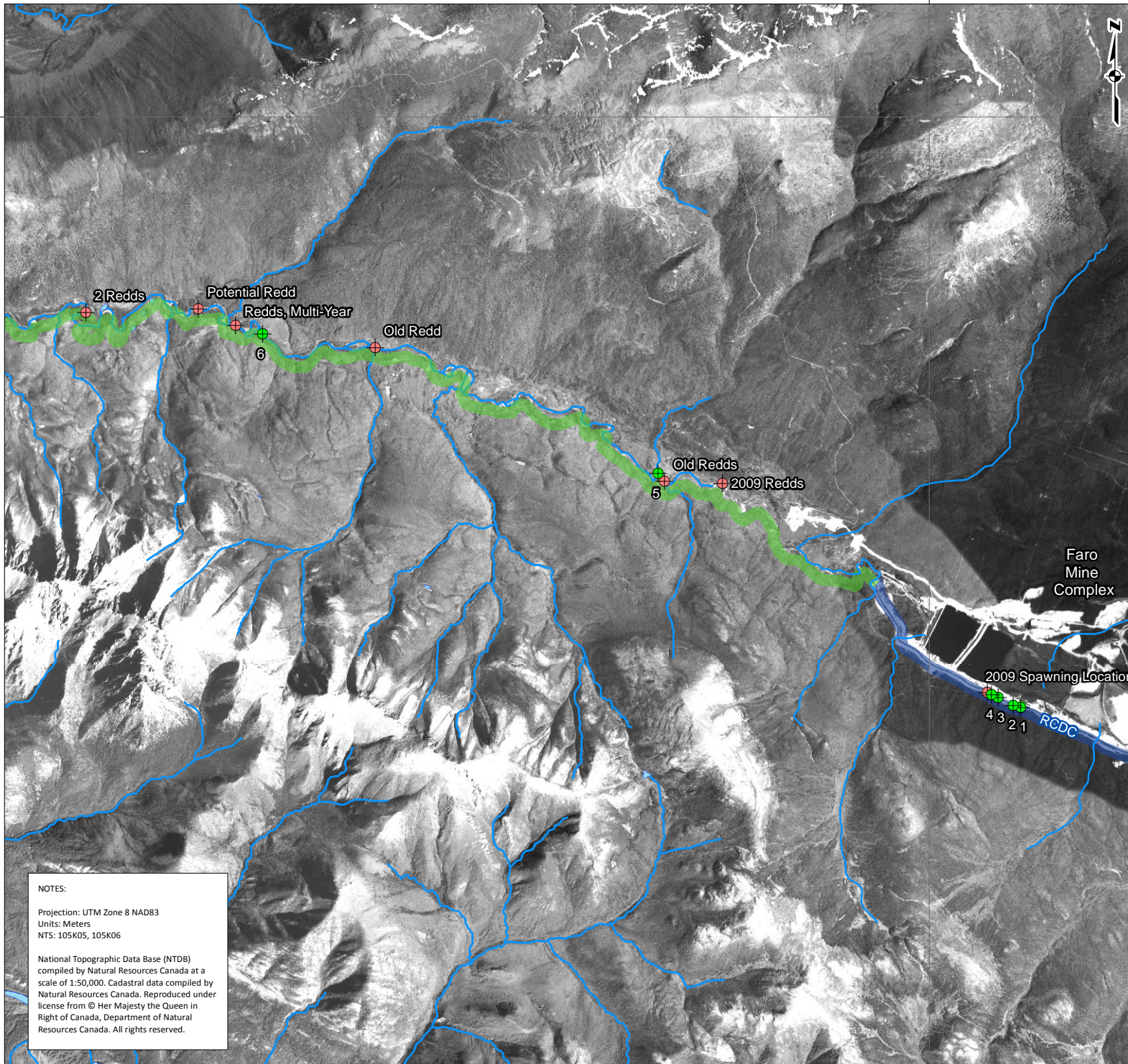
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FIGURE 3

Rose Creek Diversion Channel  
Study Area and Observations





**NOTES:**

Projection: UTM Zone 8 NAD83  
Units: Meters  
NTS: 105K05, 105K06

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## 2011 FMC Chinook Salmon Surveys



Client:

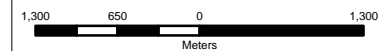


### Legend

- Watercourses
- + 2011 Redd Observations
- + Pre 2011 Observations

### 2011 Survey Area

- RCDC
- Lower Rose Creek
- Upper Rose Creek



March 25, 2012

Scale: 1:60,000

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**FIGURE 4**  
Rose Creek  
Study Observations

## 4. DISCUSSION

### 4.1 SURVEY CONDITIONS

Despite turbid conditions in the lower reaches of the study area, good visibility and a high survey confidence was achieved for the entire length of Rose Creek (upper Rose Creek, RCDC, lower Rose Creek; Figure 2). A combination of low water levels, minimal surface turbulence, and clear water make Rose Creek suitable for aerial survey.

The ground-based survey of the RCDC provided a useful addition to the aerial survey efforts at relatively small additional cost and effort, and can be completed easily because of the available road access at the FMC. Such ground surveys can provide more detailed observations and data for a given survey area, which will likely be of value during the closure and remediation planning process at the FMC (e.g. more precise locating of redds, more accurate descriptions of substrate types, depths, and habitat units). WMEC also successfully completed a ground- and boat-based survey of Rose Creek downstream of the RCDC (to Anvil Creek) in 2010 (P. Sparling, pers. comm.). This survey was successful in denoting redds, however the conditions observed suggest that it may only be possible to survey Rose Creek downstream of the RCDC in medium to high water years.

Anvil Creek (central and upper Anvil Creek; Figure 2) is not as well suited to an aerial survey, as this watercourse has lower water clarity (i.e. stained water potentially from naturally occurring tannins), a higher gradient, and numerous areas dominated by boulder substrates that create a large amount of surface turbulence. Several aerial survey attempts have been made on Anvil Creek in the past, and none have recorded many salmon. WMEC observed 7 adult Chinook salmon in the lower reaches of Anvil Creek in 2007 (during optimal conditions). However, during the same survey they were unable to see a known group of spawning Chinook salmon due to poor water clarity. The latter were barely visible from the ground in approximately 1 m of water, and were not visible from the air (P. Sparling, pers. comm.).

The high turbidity observed in the lower reaches of Anvil Creek is also a factor that may make consistent aerial surveys difficult. During the 2011 surveys, the high turbidity was tracked to apparent melting permafrost ice lenses near the alpine headwaters of the unnamed tributary to Anvil Creek (Figure 2), and communications with WMEC, who have performed monitoring on Anvil Creek previously, confirmed that this melting has previously been observed in this tributary (and therefore is likely to be encountered in future years; P. Sparling, pers. comm.).

Despite conditions encountered, the combination of aerial and ground survey of Rose and Anvil Creeks did provide a rapid assessment of Chinook presence and recent redd activity. As with other discrete (event-based) surveys, this type of observational survey is highly sensitive to achieving correct timing in line with Chinook presence, as described below.

### 4.2 STUDY TIMING

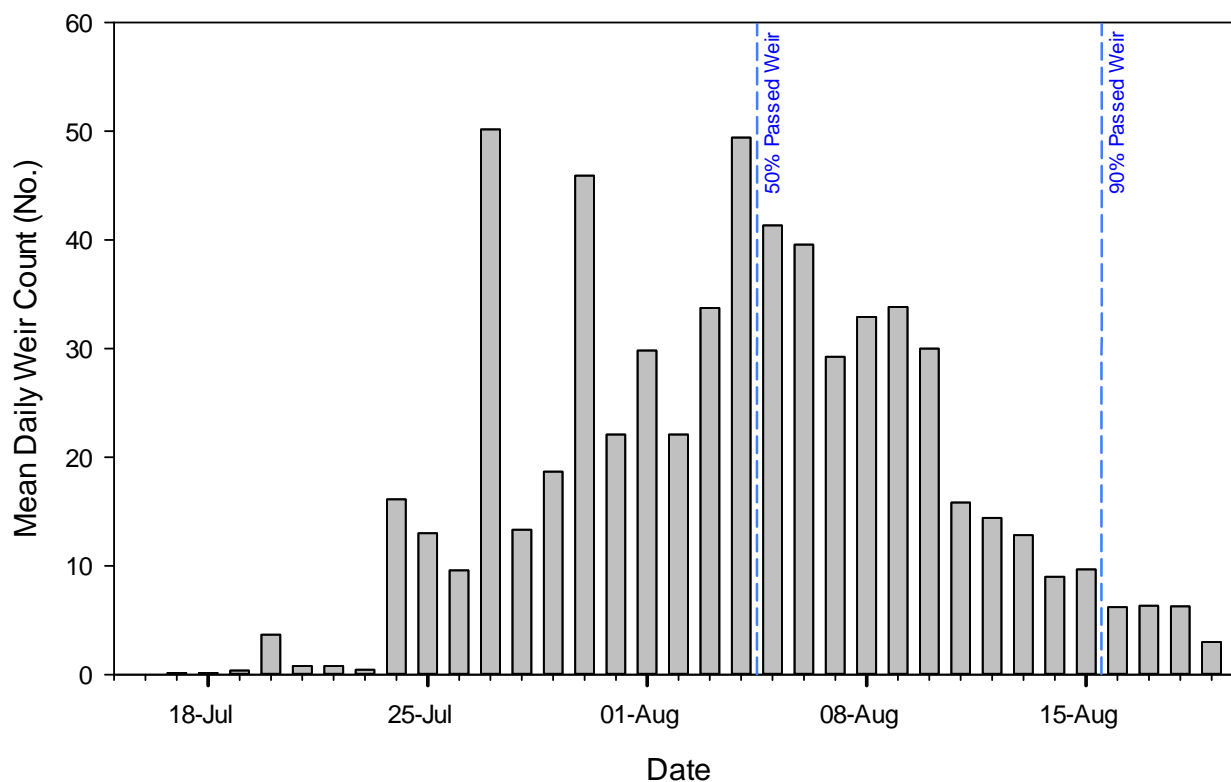
Timing of the 2011 surveys was likely a factor that limited applicability of current year results (including detections of adult fish or the ability to distinguish 2011 redd activity from previous years). Based on information for the mine site and adjacent areas, early August may be more appropriate for surveys at Rose and Anvil Creeks.

Observations made in 2009 at the site by WMEC found several adult Chinook salmon present in the RCDC around August 12, and by August 15, these fish were no longer present (P. Sparling, pers. comm.). Chinook



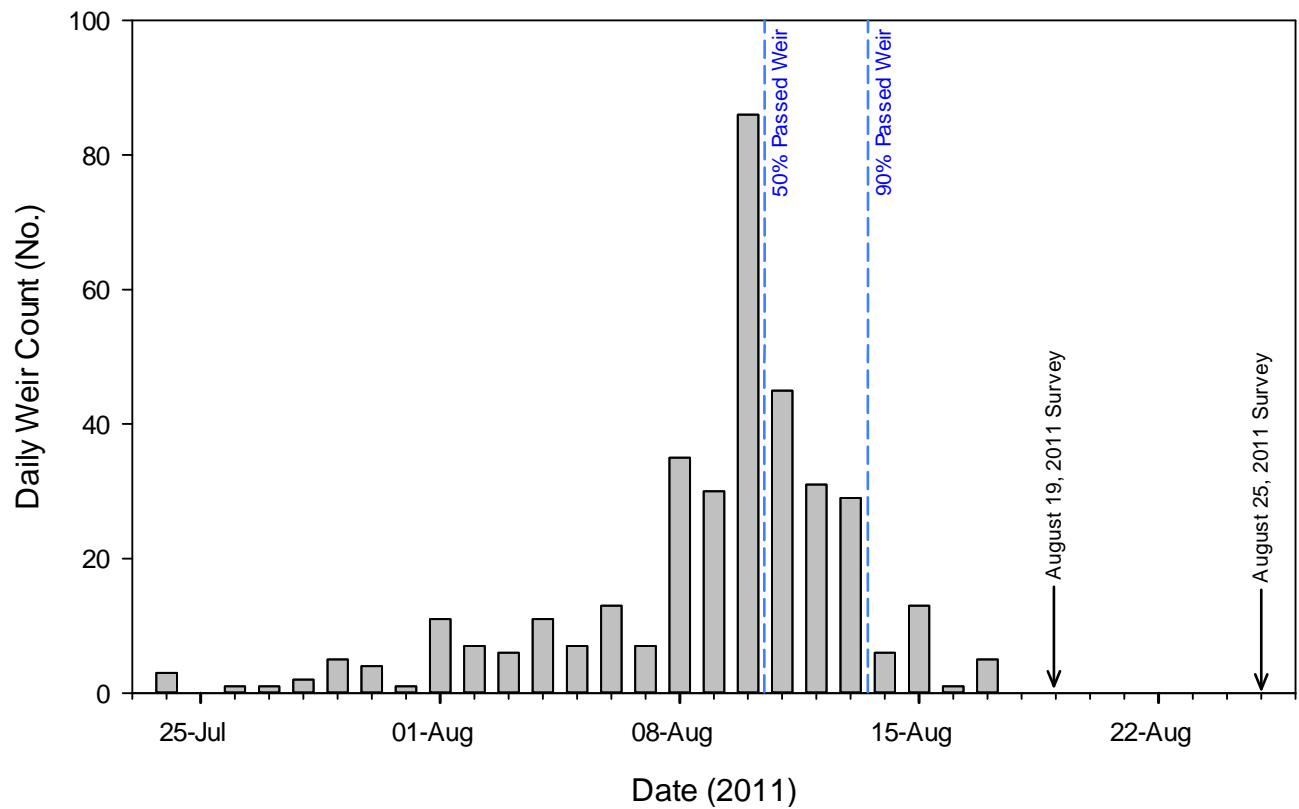
salmon surveys conducted by WMEC in 2010 did not result in any Chinook observations, although 2010 was also a generally low return year, as discussed below (Sparling 2010).

A Chinook salmon enumeration weir is located approximately 80 km upstream from Anvil Creek on the Pelly River at Blind Creek, where the run strength and timing of adult Chinook salmon has been tracked in most years since 2007. Blind Creek has one of the earliest runs in the upper Yukon River, and provides a good benchmark by which to anticipate Rose Creek spawning. The timing of adult Chinook spawning in the RCDC is thought to correspond well to the main run timing at the Blind Creek Weir (P. Sparling, pers. comm.) The 12 year average at Blind Creek saw 50 percent of fish passing by August 4, and 90 percent of fish passing by August 15 (Jane Wilson and Associates, 2010; Figure 5). Timing for 2011 was slightly later with 50 percent of the adults passing by August 10, and 90 percent passing by August 13 (J. Wilson, pers. comm.; Figure 6). The Blind Creek weir is generally closed by August 20, and at most only 1% of the annual return has been recorded beyond that date (Jane Wilson and Associates, 2010).



**Figure 5: Graph Showing the 12-year Mean Daily Totals of Adult Chinook Salmon Passing the Blind Creek Weir from 1997 to 2011 (based on data from Jane Wilson and Associates, 2010 and J. Wilson, pers. comm.).**





**Figure 6: Graph Showing the Daily Totals of Chinook Salmon Passing the Blind Creek Weir in 2011, in Relation to ELR 2011 Survey Dates (Based on data from J. Wilson, pers. comm.).**

### 4.3 2011 RUN STRENGTH

Although higher than that of 2010, the 2011 Chinook salmon run strength was still relatively low, which may have also influenced the presence of Chinook in the Rose Creek system. 360 Chinook salmon were enumerated at the Blind Creek weir in 2011, just over half of the 12 year mean of 620 fish per year. In comparison, 716 Chinook were recorded through the weir in 2009 when adults were last observed in Rose Creek (P. Sparling, pers. comm.). A summary of recent run strength data for Blind Creek and escapement data for the Yukon River at Eagle Alaska is provided below in Table 3, although final 2011 escapement data were not available as of the date of this report.

**Table 3: Recent Chinook Salmon Return Escapement / Return Estimates for Yukon River and Blind Creek**

Data Source	2011	2010	2009	2008	2007	2006
Upper Yukon River Escapement Estimate	46,227*	31,010	65,278	38,008	34,903	62,933
Blind Creek Weir Count	360	270	716	276	304	677

\* Preliminary estimate based on 2011 Yukon River post-season review.

## 5. RECOMMENDATIONS FOR FURTHER STUDY

Based on the observations of 2011 surveys and data from other recent studies at the site, it does appear that the aerial surveys of Rose Creek should be valuable in providing information on spawning activity in watercourses in relation to the FMC. As noted, the ground based surveys do also provide valuable additional data for a relatively small additional effort. Aerial surveys may not be an effective option for studying the overall run strength or timing in Anvil Creek, however.

Variations in technique, survey timing and run strength make for difficult comparisons between 2009, 2010, and 2011 survey data for the site. For example, multi-year redd sites identified by Sparling (2010) were not observed during the 2011 survey; however these had been identified from the water surface in 2010 and were not believed to have been recently used at the time of that survey. A consistent survey methodology, as well as data from strong Chinook return years will aid greatly in refining usage data for the study area.

Should the survey be conducted in future years, we recommend that planning for the project begin earlier in the summer season, and that run data (including communications with the Blind Creek weir operators) be monitored closely to determine the optimal survey time. Based on available information, it is likely that the window of August 5 – 10 may be appropriate for the Faro Mine site.

The establishment of a weir located in lower Anvil Creek (near the Pelly River) would be an effective way to determine the extent of salmon utilization in Anvil Creek and Rose Creek, and would provide baseline data to directly compare both the run timing and run strength in the Anvil Creek system with long term data from Blind Creek.



## **6. LIMITATIONS AND DISCLAIMER**

This report has been prepared for Yukon Government, Energy, Mines and Resources, Assessment and Abandoned Mines (AAM), for application to the Faro Mine Complex. The contents of this report have been prepared for the sole use of AAM or its agents, for application to the aforementioned project. ELR is not responsible for the report contents or for any information within the report when the report is used or relied upon by any Party other than AAM. This report has been prepared according to current professional standards, and using the information available as of the date of issue.

## 7. CLOSURE

We are pleased to present this 2011 Chinook salmon survey report to the Government of Yukon, Assessment and Abandoned Mines. We trust this report meets your requirements for this project, but we encourage you to contact us should you have any questions or comments regarding the project or report content.

Sincerely,

A handwritten signature in blue ink, appearing to read 'CJ', is positioned above the contact information.

Chris Jastrebski, M.Sc., R.P.Bio.  
Ecological Logistics & Research Ltd.  
867.668.6386  
[chris@elr.ca](mailto:chris@elr.ca)

## 8. REFERENCES

- Department of Fisheries and Oceans Canada (DFO). 2011. Yukon River Salmon Update, August 18, 2011. 5pp.
- The United States and Canada Yukon River Joint Technical Committee (JTC). 2011. Yukon River Salmon 2010 Season Summary and 2011 Season Update. Regional Information Report No. 3A11-01. Alaska Department of Fish and Game. Anchorage, Alaska.
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- Wilson, J. 2010. Blind Creek Chinook Salmon Enumeration Weir, 2009. Prepared for the Yukon River Panel, CRE-37-09.

## 9. PERSONAL COMMUNICATIONS

- Sparling, P. White Mountain Environmental Consulting. Contacted in October/November 2011.
- Tanner, T. Stock Assessment Biologist, Fisheries and Oceans Canada. Contacted in November 2011.
- Wilson, J. J. Wilson & Associates. Contacted in November 2011.

## 10. ACKNOWLEDGEMENTS

We would like to extend thanks to the following individuals for assistance with this project. Paul Sparling of White Mountain Environmental Consulting provided data from previous studies, an independent review of 2011 redd site data, and a technical review of the final report. Jane Wilson gratefully provided 2011 data from the Blind Creek weir and Trix Tanner provided updates regarding both the Blind Creek weir and escapement data for the upper Yukon River. Patricia Randell of AAM provided helpful comments on the final report.



## PHOTOS





**Photo 1:** View of the RCDC looking downstream (Northwest) during the aerial survey. Photo taken August 25, 2011.



**Photo 2:** View of lower Rose Creek, downstream of the mine area. Note the irregular meandering stream with low gradient and little surface turbulence. Photo taken August 25, 2011.



**Photo 3:** View of the heavy sediment load being washed into Anvil Creek approximately 9 km downstream of Rose Creek. Photo taken August 19, 2011.



**Photo 4:** View of the heavy sediment load in Anvil Creek on August 19, 2011, shown from its outlet at the Pelly River (shown in the foreground).





**Photo 5:** A representative view of conditions encountered in the Pelly River on August 19, 2011. Turbidity was high enough that an effective aerial survey of the Pelly River was not possible.



**Photo 6:** View of the relatively sediment loads of Anvil Creek and the Pelly River on August 25, 2011. Note how the relative sediment loads had reversed since the August 19th observation. Turbidity in Anvil Creek was measured at 6.75 NTU, and the Pelly River was measured at 17.5 NTU.



**Photo 7:** View of a redd site in the RCDC as observed from the ground. Photo taken August 25, 2011.



**Photo 8:** View of a redd site in the RCDC as observed during the aerial survey. Photo taken August 25, 2011.





**Photo 9:** View of a redd site in the RCDC as observed during the aerial survey. Photo taken August 25, 2011.



**Photo 10:** View of a redd site in the RCDC as observed from the ground. Photo taken August 25, 2011.