

Real Time Water Quality Report Tata Steel Minerals Canada Elross Lake Network

Deployment Period 2014-07-16 to 2014-08-13



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General

- The Water Resources Management Division, in partnership with Tata Steel Minerals Canada Limited and Environment Canada, maintain two real-time water quality and water quantity stations in close proximity to the Elross Lake Iron Ore Mine in western Labrador, near Schefferville, QC.
- The official name of each station is ELROSS CREEK BELOW PINETTE LAKE INFLOW and GOODREAM CREEK 2KM NORTHWEST OF TIMMINS 6, hereafter referred to as the *Elross Creek Station* and the *Goodream Creek Station*, respectively.
- Station sites were selected to monitor all surface water outflows from the Elross Lake mining site. The Elross Creek Station is situated downstream of the Timmins 1 pit, and downstream of Pinette Lake. The Goodream Creek Station will serve to monitor potential impacts from groundwater flowing from Timmins 6 pit into the surface water of Goodream Creek.
- The Water Resources Management Division will inform Tata Steel Minerals Canada Limited of any significant water quality events by email notification and by monthly deployment reports.
- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from July 16, 2014 to August 13, 2014, which was the second deployment of the 2014 field season.
- Several significant issues were encountered during this deployment period; firstly there were data transmission errors at Elross Creek and as a result stage data is missing for the first half of the deployment period, secondly low flow conditions occurred at Goodream Creek and the instrument was removed at the end of the deployment and could not be redeployed for the third deployment period. The low flow conditions at Goodream Creek meant that QA/QC readings could not be taken at the time of removal, and also the low flow conditions had a significant impact on water quality causing some parameters to be outside their normal range.

Quality Assurance / Quality Control

- Water quality instrument performance is tested at the beginning and end of its deployment period. The process is outlined in Appendix A.
- Instruments are assigned a performance rating (i.e., poor, marginal, fair, good or excellent) for each water quality parameter measured.
- Table 1 shows the performance ratings of five water quality parameters (i.e., temperature, pH, specific conductivity, dissolved oxygen and turbidity) measured by instruments deployed at the water monitoring stations.



	Elross	Creek	Goodream Creek		
Stage of deployment	Beginning	End	Beginning	End	
Date	2014-07-11	2014-08-13	2014-07-11	2014-08-13	
Temperature	Excellent	Excellent	Excellent	NA**	
pН	Good	Good	Good	NA	
Specific	Excellent	Excellent	Excellent	NA	
Conductivity					
Dissolved Oxygen	Excellent	Excellent	Excellent	NA	
Turbidity	Excellent	Excellent	Excellent	NA	

Table 1: Water quality instrument performance at the beginning and end of deployment

**At the end of the deployment period at Goodream Creek extreme low flow conditions meant there was no flowing water in the creek and therefore QA/QC readings were not taken.

The performances of all sensors were rated good to excellent at the beginning of the deployment period and good to excellent at removal for Elross Creek, while QA/QC measurements were not available at the time of removal at Goodream Creek due to extreme low flow conditions (Table 1).

Deployment Notes

- Water quality monitoring for this deployment period started at Elross Creek on July 16, 2014 at 5:30 pm and at Goodream Creek on July 16, 2014 at 1:15 pm. Continuous real-time monitoring continued at both sites until August 13, 2014 when the instruments were removed for maintenance and calibration.
- During this deployment period there were problems with data transmission at Elross Creek which meant Stage data was lost for the first half of the deployment period. At Goodream Creek there were extremely low flow conditions which impacted data quality and meant the field instrument could not be redeployed for the third deployment period.

Data Interpretation

- Data records were interpreted for each station during the deployment period for the following six parameters:
 - (i.) Stage (m)
 - (ii.) Temperature (°C)
 - (iii.) pH
 - (iv.) Specific conductivity (S/cm)
- (v.) Dissolved oxygen (mg/l)
- (vi.) Turbidity (NTU)



Stage

- Due to technical issues with data transmission, stage height values are not available for Elross Creek for the first half of the deployment period.
- For the period where data is available stage height values ranged from 1.04 m to 1.07 m at Elross Creek from August1, 2014 to August 13, 2014. At Goodream Creek stage height values ranged from 1.74 m to 2.03 m from July 16, 2014 to August 13, 2014 (Figures 1 and 2). Stage height is directly related to the volume of flow in a stream as defined by a rating curve which is unique for every site.
- For Goodream Creek there is one significant spike in stage height around June 30, 2014 (see inside red oval). This spike coincides with a significant rainfall event (Climate data located in Appendix B).
- For Goodream Creek there are several periods of extreme low stage height (see inside green ovals) during this deployment period. During these periods of extreme low stage height flow was critically low in Goodream Creek and many of the water quality parameters were affected as a result, and it is even likely that some or all of the water quality probes were exposed to air.



Stage Height

Figure 1: Stage Height (m) at Elross Creek –July 16, 2014 to August 13, 2014







Figure 2: Stage Height (m) at Goodream Creek – July 16, 2014 to August 13, 2014

Temperature

- Water temperature ranged from 8.74°C to 16.30°C at Elross Creek and from 8.30°C to 17.10°C at Goodream Creek from July 16, 2014 to August 13, 2014 (Figures 3 & 4).
- For both Elross Creek and Goodream Creek there are no appreciable increasing or decreasing temperature trends during the deployment period.
- Both Goodream and Elross stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.







Figure 3: Temperature (°C) - Elross Creek – July 16, 2014 to August 13, 2014

Water Temperature and Stage Level



Figure 4: Temperature (°C) - Goodream Creek - July 16, 2014 to August 13, 2014



pН

- pH values ranged from 5.47 units to 6.67 units at Elross Creek and from 4.43 units to 6.86 units at Goodream Creek from July 16, 2014 to August 13, 2014 (Figures 5 & 6).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is fairly weak during this deployment period but is still discernible at Elross Creek.
- At Goodream Creeks it appears that pH was significantly affected by low flow conditions (see inside red ovals). It appears that during these low flow periods pH was significantly affected dropping much lower than usual.
- At Elross Creek there is a noticeable dip in pH near the end of the deployment (see inside red oval) which appears to correspond with a small spike in flow.
- With a mean value of 6.19, pH values recorded at Elross Creek were mostly slightly below the minimum pH guideline set for the protection of aquatic life (i.e., 6.5 units), as defined by the Canadian Council of Ministers of the Environment (2007). With a mean value of 6.13, pH values recorded at Goodream Creek were mostly slightly below this guideline as well. It should be pointed out that at Goodream Creek pH values appear to be impacted by low flow conditions making them unusually low for several periods during the deployment. It should be noted that acidic waters are quite common in Canada, particularly in boreal and northern ecoregions, and pH is often naturally below this 6.5 unit guideline.



Water pH and Stage Level

Figure 5: pH at Elross Creek – July 16, 2014 to August 13, 2014







Figure 6: pH at Goodream Creek – July 16, 2014 to August 13, 2014

Specific Conductivity

- Specific Conductivity ranged from 5.7 μs/cm to 10.0 μs/cm at Elross Creek and from 3.9 μs/cm to 20.0 μs/cm at Goodream Creek from July 16, 2014 to August 13, 2014 (Figures 7 & 8).
- At Goodream Creek it appears that during low flow conditions specific conductivity displays a high degree of diurnal variation (see inside red ovals) relative to the diurnal trends during normal flow conditions, such as the period from July 26, 2014 to August 3, 2014.



Specific Conductivity of Water and Stage Level



Figure 7: Specific conductivity (us/cm) - Elross Creek – July 16, 2014 to August 13, 2014

Specific Conductivity of Water and Stage Level



Figure 8: Specific conductivity (us/cm) - Goodream Creek – July 16, 2014 to August 13, 2014



Dissolved Oxygen

- Dissolved oxygen (DO) values ranged from 7.72 mg/l (78.8% saturation) to 9.49 mg/l (93.0% saturation) at Elross Creek from July16, 2014 to August 13, 2014 (Figures 9). At Goodream Creek dissolved oxygen values were significantly impacted by low flow conditions (see inside red ovals) which makes it difficult to offer any meaningful comments on DO for this deployment period (Figure 10).
- Dissolved oxygen remains relatively stable over the deployment period for Elross Creek, however for Goodream Creek there are numerous points in the deployment were low flow conditions throw off the DO values and it is therefore impossible to comment on any trends.
- There is a diurnal trend for DO (mg/l & % saturation) which is clearly visible at Elross Creek and partially visible at Goodream Creek for the times when there is good data. These diurnal DO trends are related to the diurnal temperature trends.
- The DO values at Elross Creek were at or slightly below the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and above minimum guidelines set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007). At Goodream Creek DO values are thrown off significantly and repeatedly by low flow conditions and it is difficult to make any meaningful comparison to these guidelines.



Dissolved Oxygen Concentration and Saturation

Figure 9: DO (mg/l & % saturation) at Elross Creek – July 16, 2014 to August 13, 2014



Dissolved Oxygen Concentration and Saturation



Figure 10: DO (mg/l & % saturation) at Goodream Creek – July 16, 2014 to August 13, 2014

Turbidity

- Turbidity values ranged from 0.1 NTU to 642.0 NTU at Elross Creek and from 0.0 NTU to 4.1 NTU at Goodream Creek from July 16, 2014 to August 13, 2014 (Figures 11 & 12).
- A significant spike in turbidity at Elross Creek (see inside red ovals) corresponds with a significant rainfall event for the corresponding period.
- It appears that the low flow conditions at Goodream Creek did not have any significant impact on turbidity during this deployment period.







Figure 11: Turbidity (NTU) at Elross Creek – July 16, 2014 to August 13, 2014



Figure 12: Turbidity (NTU) at Goodream Creek – July 16, 2014 to August 13, 2014



Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from July 16, 2014 to August 13, 2014.
- The performances of all sensors were rated good to excellent at the beginning of the deployment period and good to excellent at removal for Elross Creek, while QA/QC measurements were not available at the time of removal at Goodream Creek due to extreme low flow conditions.
- Variations in water quality/quantity values recorded at each station are summarized below:
 - Field instruments for both stations performed quite well over the deployment period with no significant maintenance issues, however there were data transmission errors at Elross Creek which led to lost stage height data for the first half of the deployment. It should also be noted that extreme low flow conditions at Goodream Creek affected several water quality parameters for several periods during the deployment.
 - For Goodream Creek there is one significant spike in stage height around June 30, 2014 which coincides with a significant rainfall event.
 - For Goodream Creek there are several periods of extreme low stage height when flow was critically low and several of the water quality parameters were affected as a result.
 - For both Elross Creek and Goodream Creek there are no appreciable increasing or decreasing temperature trends during the deployment period.
 - Both Goodream and Elross stations display noticeable diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.
 - pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is fairly weak during this deployment period but is still discernible at Elross Creek.
 - At Goodream Creek it appears that pH was significantly affected by low flow conditions dropping much lower than usual.
 - At Elross Creek there is a noticeable dip in pH near the end of the deployment which appears to correspond with a small spike in flow.
 - With a mean value of 6.19, pH values recorded at Elross Creek were mostly slightly below the minimum pH guideline set for the protection of aquatic life (i.e., 6.5 units), as defined by the Canadian Council of Ministers of the Environment (2007). With a mean value of 6.13, pH values recorded at Goodream Creek were mostly slightly below this guideline as well.



- At Goodream Creek it appears that during low flow conditions specific conductivity displays a high degree of diurnal relative to the diurnal trends during normal flow conditions.
- Dissolved oxygen remains relatively stable over the deployment period for Elross Creek, however for Goodream Creek there are numerous points in the deployment were low flow conditions throw off the DO values and it is therefore impossible to comment on any trends.
- There is a diurnal trend for DO (mg/l & % saturation) which is clearly visible at Elross Creek and partially visible at Goodream Creek for the times when there is good data. These diurnal DO trends are related to the diurnal temperature trends.
- The DO values at Elross Creek were at or slightly below the cold water minimum guideline set for aquatic life during early life stages (9.5 mg/l), and above minimum guidelines set for other life stages (6.5 mg/l), as determined by the Canadian Council of Ministers of the Environment (2007). At Goodream Creek DO values are thrown off significantly and repeatedly by low flow conditions and it is difficult to make any meaningful comparison to these guidelines.
- A significant spike in turbidity at Elross Creek (see inside red ovals) corresponds with a significant rainfall event for the corresponding period.
- It appears that the low flow conditions at Goodream Creek did not have any significant impact on turbidity during this deployment period.



References

Canadian Council of Ministers of the Environment. 2007. Canadian water quality guidelines for the protection of aquatic life: Summary table. Updated December, 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. (Website: <u>http://ceqg-rcqe.ccme.ca/download/en/222/</u>)



APPENDIX A Quality Assurance / Quality Control Procedures

- As part of the Quality Assurance / Quality Control (QA/QC) protocol, the performance of a station's water quality instrument (i.e., Field Sonde) is rated at the beginning and end of its deployment period. The procedure is based on the approach used by the United States Geological Survey (Wagner *et al.* 2006)¹.
- At the beginning of the deployment period, a fully cleaned and calibrated QA/QC water quality instrument (i.e., QA/QC Sonde) is placed *in-situ* with the fully cleaned and calibrated Field Sonde. After Sonde readings have stabilized, which may take up to five minutes in some cases, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde. If the readings from both Sondes are in close agreement, the QA/QC Sonde can be removed from the water. If the readings are not in close agreement, there will be attempts to reconcile the problem on site (e.g., removing air bubbles from sensors, etc.). If no fix is made, the Field Sonde may be removed for recalibration.
- At the end of the deployment period, a fully cleaned and calibrated QA/QC Sonde is once again deployed *in-situ* with the Field Sonde, which has already been deployment for 30-40 days. After Sonde readings have stabilized, water quality parameters, as measured by both Sondes, are recorded to a field sheet. Field Sonde performance for all parameters is rated based on differences recorded by the Field Sonde and QA/QC Sonde.

	Rating						
Parameter	Excellent	Good	Fair	Marginal	Poor		
Temperature (°C)	$\leq \pm 0.2$	$>\pm 0.2$ to 0.5	$>\pm 0.5$ to 0.8	$>\pm 0.8$ to 1	>±1		
pH (unit)	$\leq \pm 0.2$	$>\pm 0.2$ to 0.5	$>\pm 0.5$ to 0.8	$>\pm 0.8$ to 1	$>\pm1$		
Sp. Conductance (µS/cm)	$\leq \pm 3$	$>\pm 3$ to 10	$>\pm 10$ to 15	$>\pm 15$ to 20	$>\pm 20$		
Sp. Conductance > 35 μ S/cm (%)	$\leq \pm 3$	> ±3 to 10	$> \pm 10$ to 15	$> \pm 15$ to 20	$>\pm20$		
Dissolved Oxygen (mg/l) (% Sat)	$\leq \pm 0.3$	$> \pm 0.3$ to 0.5	$> \pm 0.5$ to 0.8	$> \pm 0.8$ to 1	$>\pm1$		
Turbidity <40 NTU (NTU)	$\leq \pm 2$	$>\pm 2$ to 5	$>\pm 5$ to 8	$>\pm 8$ to 10	$>\pm10$		
Turbidity > 40 NTU (%)	$\leq \pm 5$	>±5 to 10	$> \pm 10$ to 15	$> \pm 15$ to 20	$> \pm 20$		

Performance ratings are based on differences listed in the table below.

¹ Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous waterquality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods 1– D3, 51 p. + 8 attachments; accessed April 10, 2006, at *http://pubs.water.usgs.gov/tm1d3*



APENDIX B

Environment Canada Weather Data – Schefferville (July 16, 2014 to August 13, 2014)

Date/Time	Max	Min	Mean	Heat	Cool	Total	Total	Total
	Temp	Temp	Тетр	Deg	Deg	Rain	Snow	Precip
	(°C)	(°C)	(°C)	Days (°C)	Days (°C)	Flag	Flag	(mm)
7/16/2014	20.2	11.4	15.8	2.2	0	М	М	5.1
7/17/2014	14.5	6.2	10.4	7.6	0	М	М	0.3
7/18/2014	20.5	4.8	12.7	5.3	0	М	М	0
7/19/2014	25.7	11.4	18.6	0	0.6	М	М	
7/20/2014	27.9	13.2	20.6	0	2.6	М	М	0
7/21/2014	27.8	12.1	20	0	2	М	М	0
7/22/2014	21.8	12.9	17.4	0.6	0	М	М	5.3
7/23/2014	13.5	7.7	10.6	7.4	0	М	М	13.3
7/24/2014	14.9	5.9	10.4	7.6	0	М	М	0
7/25/2014	16.1	9.6	12.9	5.1	0	М	М	0.6
7/26/2014	14.8	8.2	11.5	6.5	0	М	М	12.5
7/27/2014	17.3	8.2	12.8	5.2	0	М	М	2.4
7/28/2014	16.6	8.9	12.8	5.2	0	М	М	13.6
7/29/2014	18.4	8.4	13.4	4.6	0	М	М	28.1
7/30/2014	19.6	8	13.8	4.2	0	М	М	0
7/31/2014	22.1	7.3	14.7	3.3	0	М	М	0
8/1/2014	21.7	11.2	16.5	1.5	0	М	М	1.8
8/2/2014	18	10.9	14.5	3.5	0	М	М	4.8
8/3/2014	18	10.4	14.2	3.8	0	М	М	0.5
8/4/2014	20.3	7.7	14	4	0	М	М	0
8/5/2014	18.2	10.5	14.4	3.6	0	М	М	6.1
8/6/2014	17.5	10.7	14.1	3.9	0	М	М	3.6
8/7/2014	16.3	10.3	13.3	4.7	0	М	М	1.5
8/8/2014	19.9	9.6	14.8	3.2	0	М	М	0
8/9/2014	23.6	9.4	16.5	1.5	0	М	М	0
8/10/2014	23.6	10.6	17.1	0.9	0	М	М	0
8/11/2014	27.5	13.8	20.7	0	2.7	М	М	0
8/12/2014	23.1	13.6	18.4	0	0.4	М	М	5.5
8/13/2014	25	14.6	19.8	0	1.8	М	M	0