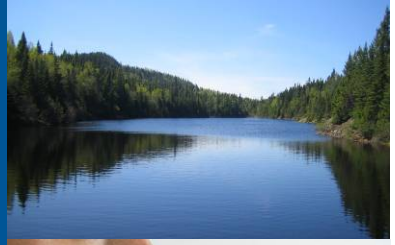




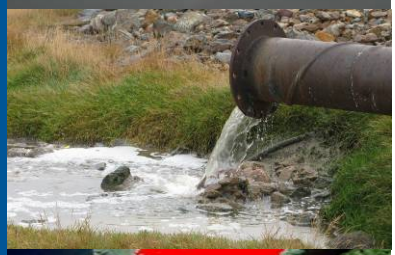


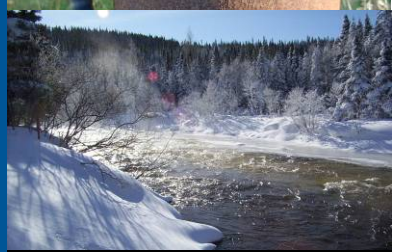

Real Time Water Quality Report

Tata Steel Minerals Canada

Elross Lake Network

Deployment Period
2013-09-11 to 2013-10-08

Government of Newfoundland & Labrador
Department of Environment and Conservation
Water Resources Management Division
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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 September 11, 2013 to October 08, 2013.
- This was the final deployment for the 2013 field season for both of these stations and the instruments were removed on October 8, 2013, and the sites were secured for the winter months. Instruments will be redeployed in Spring 2014.

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.

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

	Elross Creek			Goodream Creek	
Stage of deployment	Beginning	End		Beginning	End
Date	2013-09-11	2013-10-08		2013-09-11	2013-10-08
Temperature	Excellent	Excellent		Excellent	Excellent
pH	Excellent	Good		Good	Good
Specific Conductivity	Excellent	Excellent		Excellent	Excellent
Dissolved Oxygen	Good	Fair		Excellent	Good
Turbidity	Fair	Excellent		Excellent	Excellent

Deployment Notes

- Water quality monitoring for this deployment period season started at Elross Creek on September 11, 2013 at 5:00 pm and at Goodream Creek on the same date at 5:30 pm. Continuous real-time monitoring continued at both sites without any significant operational issues until October 08, 2013 when the instruments were removed for the end of the 2013 field season.

Data Interpretation

- Data records were interpreted for each station during the deployment period for the following six parameters:

  (i.) Stage (m)
  (ii.) Temperature (^{o}C)
  (iii.) pH
  (iv.) Specific conductivity (□S/cm)
  (v.) Dissolved oxygen (mg/l)
  (vi.) Turbidity (NTU)

Stage

- Stage height values ranged from 1.14 m to 1.23 m at Elross Creek and from 1.81 m to 2.03 m at Goodream Creek from September 11, 2013 to October 08, 2013 (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 both Elross Creek and Goodream Creek there are three significant spikes in stage height around September 12, 18, and 21 (see inside red ovals) which all coincide with significant rainfall events at the corresponding times (Climate data located in Appendix B).

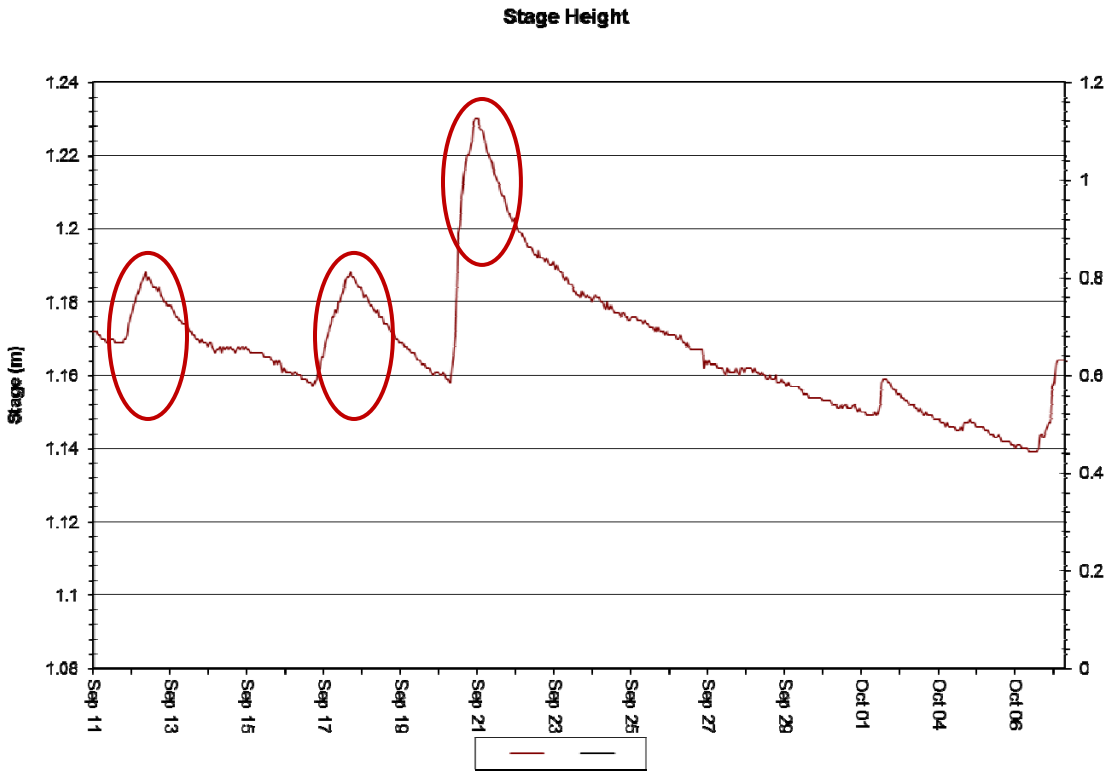

Figure 1: Stage Height (m) at Elross Creek –September 11, 2013 to October 08, 2013

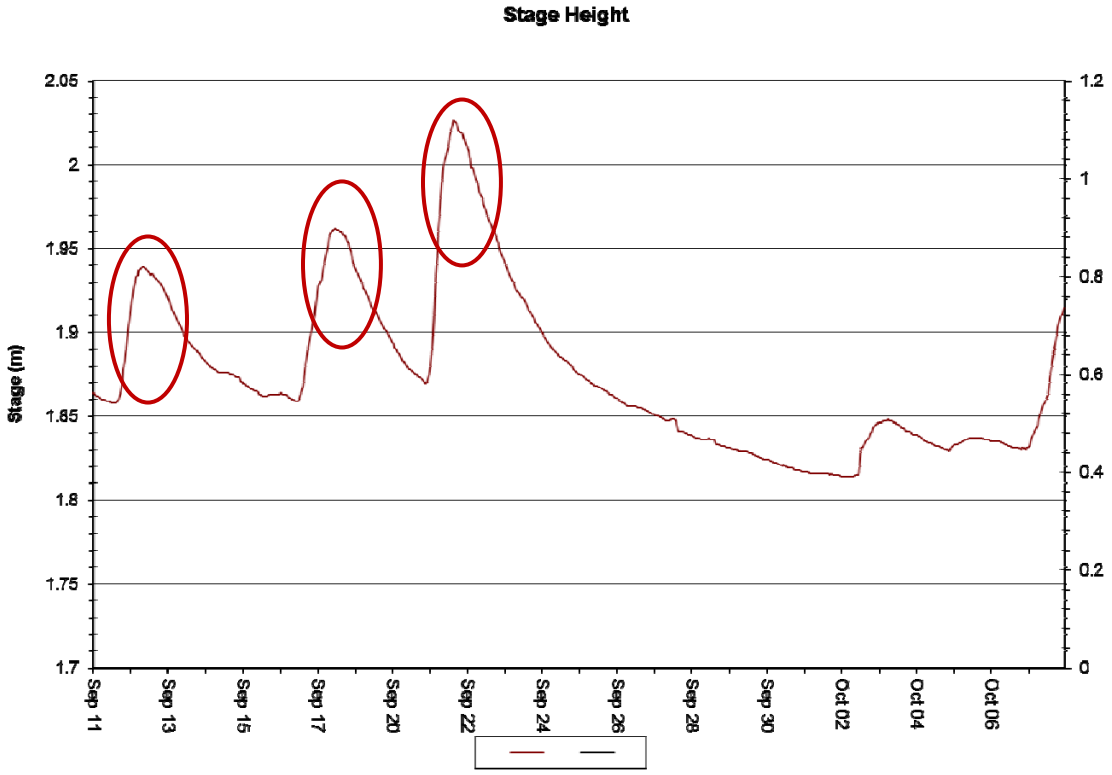

Figure 2: Stage Height (m) at Goodream Creek – September 11, 2013 to October 08, 2013

Temperature

- Water temperature ranged from 3.50˚C to 9.60˚C at Elross Creek and from 1.10˚C to 11.30˚C at Goodream Creek from September 11, 2013 to October 8, 2013 (Figures 3 & 4).
- For both Elross Creek and Goodream Creek temperature is relatively stable throughout the deployment period.
- Water temperatures at both stations display large diurnal variations, typical of shallow water streams and ponds that are highly influenced by diurnal variations in ambient air temperatures.

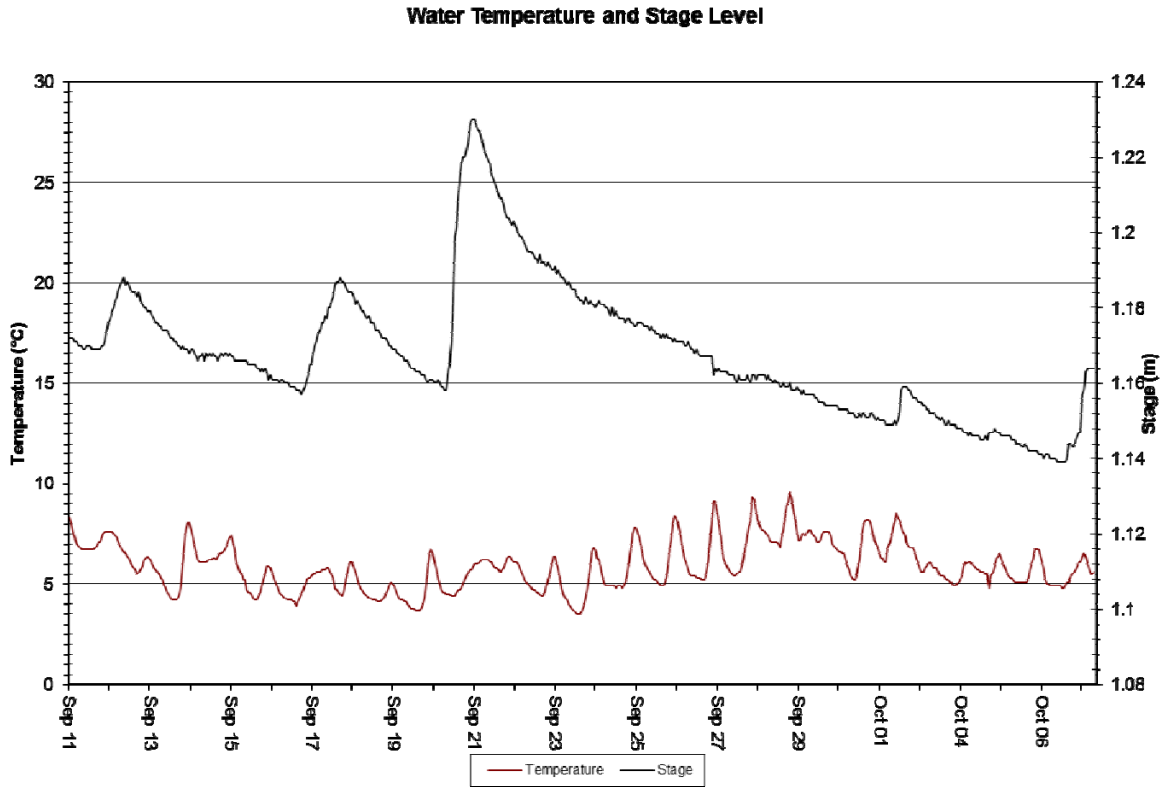

Figure 3: Temperature (°C) - Elross Creek – September 11, 2013 to October 08, 2013

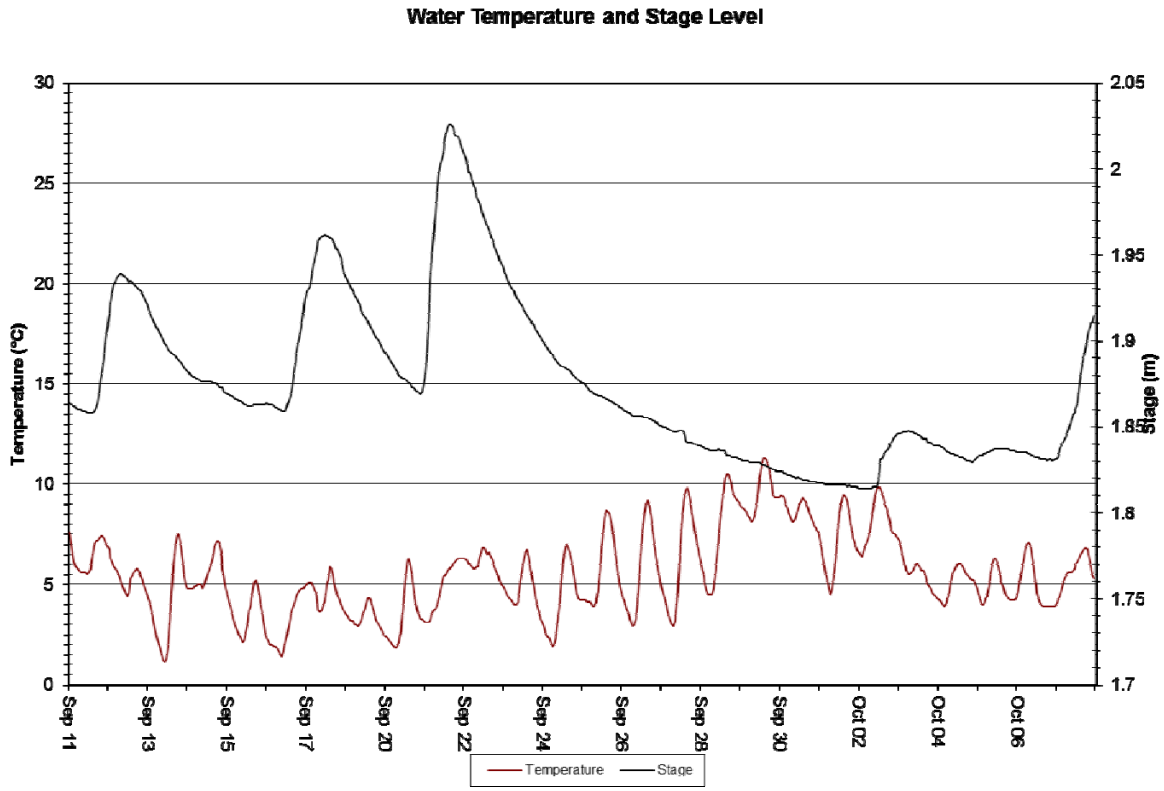

Figure 4: Temperature (°C) - Goodream Creek - September 11, 2013 to October 08, 2013

pH

- pH values ranged from 5.96 units to 7.02 units at Elross Creek and from 5.66 units to 6.63 units at Goodream Creek from September 11, 2013 to October 8, 2013 (Figures 5 & 6).
- pH tends to show a diurnal trend which is related to the diurnal temperature trend. This diurnal trend is quite weak during this deployment period but is still discernible.
- At both Elross and Goodream Creeks it appears that pH is affected by significant changes in stream flow (see inside red ovals), with a slight dip around September 21 for Elross Creek and September 12, 18 and 21 for Goodream Creek. These dips in pH all correspond to significant increases in flow caused by precipitation events.
- With a mean value of 6.91, pH values recorded at Elross Creek were at, or slightly above, 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 6.29, pH values recorded at Goodream Creek were slightly below this minimum guideline. 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.

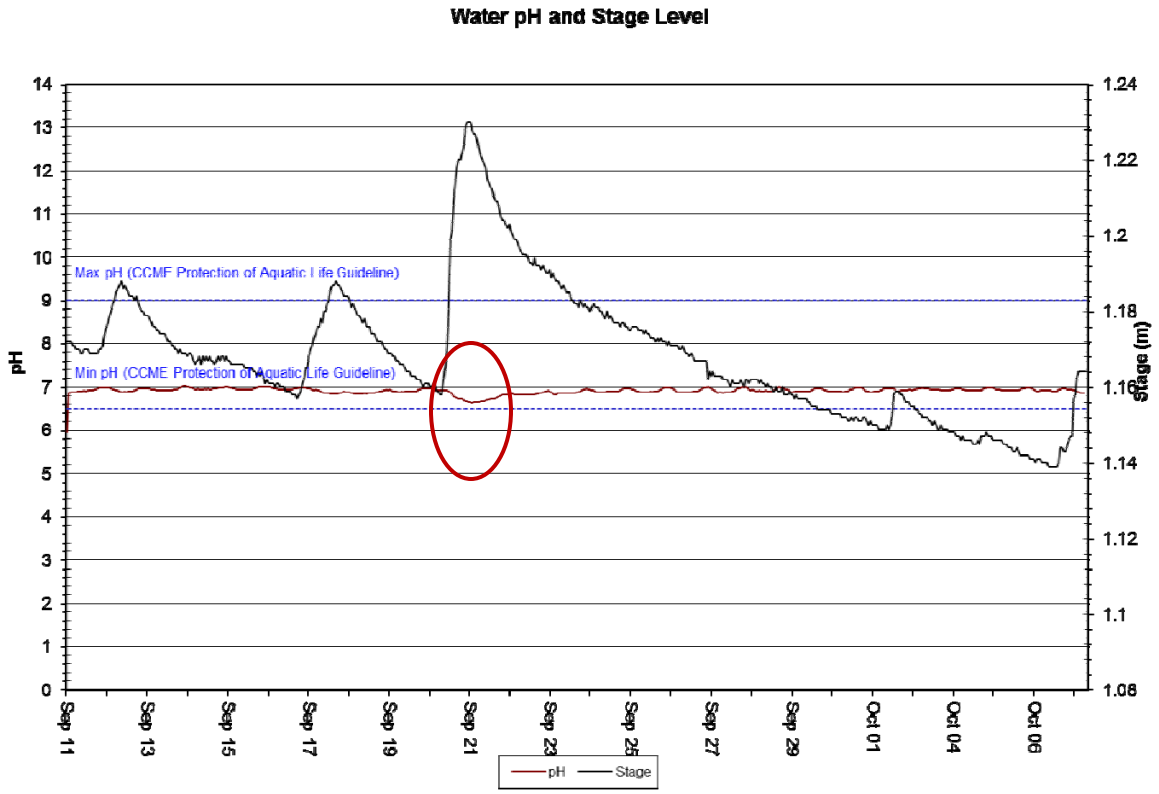

Figure 5: pH at Elross Creek – September 11, 2013 to October 08, 2013

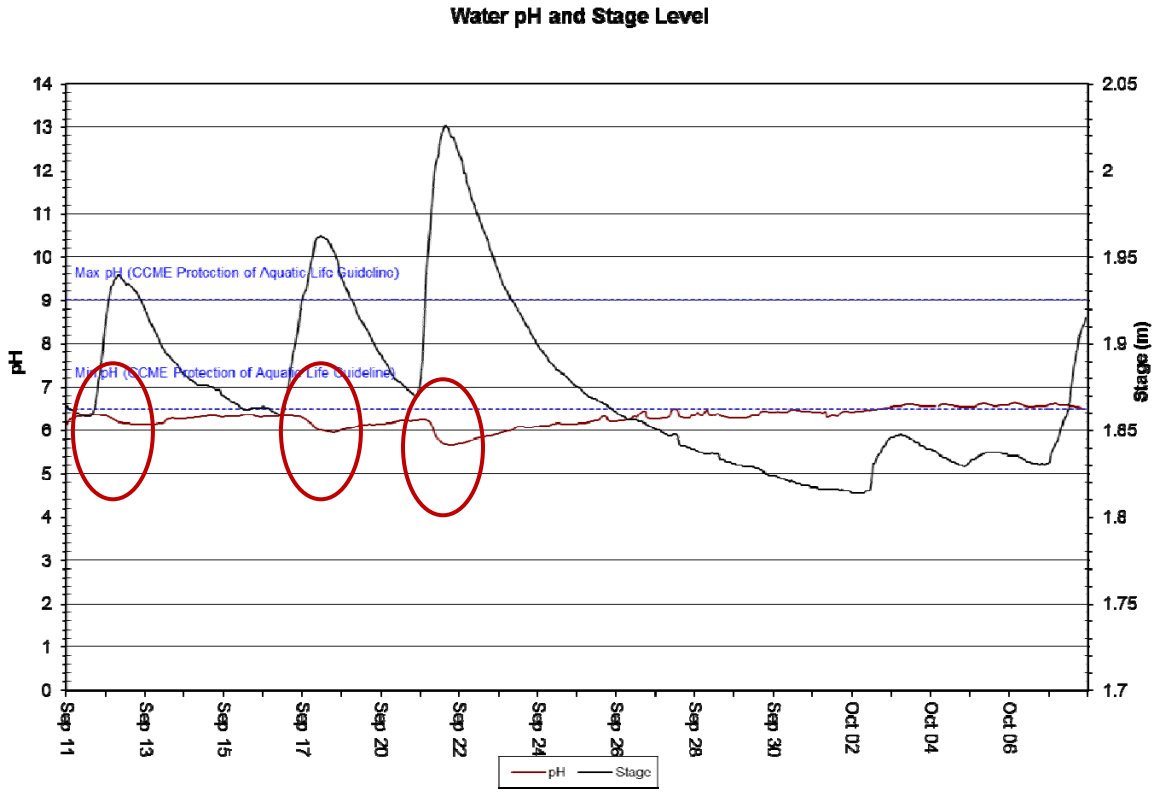

Figure 6: pH at Goodream Creek – September 11, 2013 to October 08, 2013

Specific Conductivity

- Specific Conductivity ranged from 17.2 µs/cm to 23.9 µs/cm at Elross Creek and from 4.4 µs/cm to 8.6 µs/cm at Goodream Creek from September 11, 2013 to October 8, 2013 (Figures 7 & 8).
- Sudden changes in flow appear to have a noticeable impact on specific conductivity (see inside red ovals). For Elross Creek there is a distinct dip in specific conductivity for all three of the spikes in flow. For Goodream Creek the specific conductivity data is more variable making it more difficult to notice the impact of changes in flow, however during the September 21 increase in flow there is an appreciable dip in specific conductivity, and the same is true for an event around October 3.

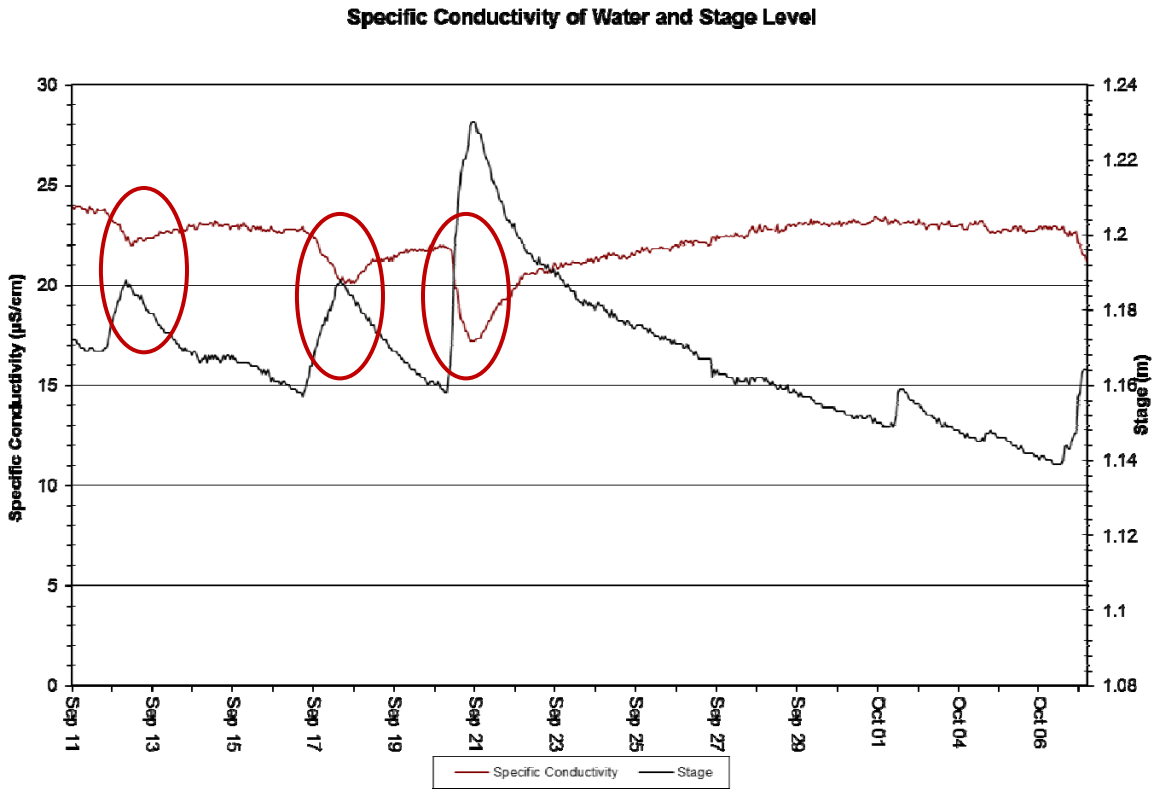

Figure 7: Specific conductivity (us/cm) - Elross Creek – September 11, 2013 to October 08, 2013

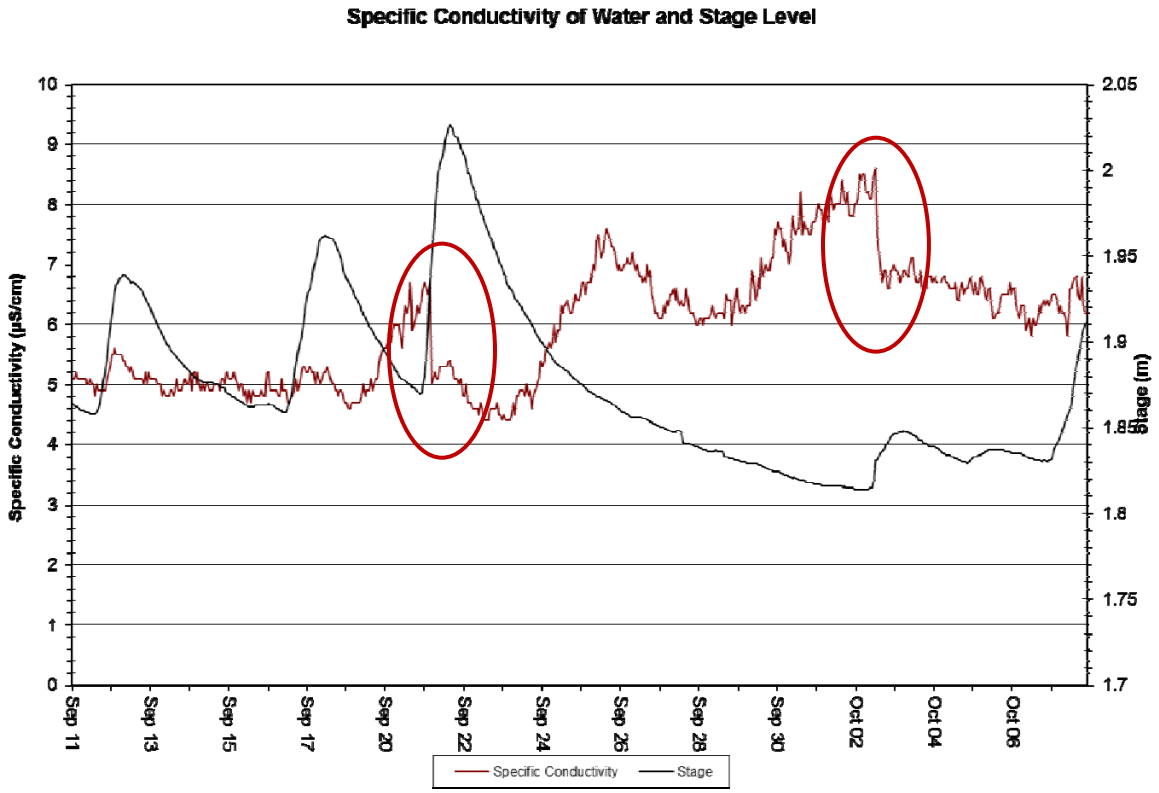

Figure 8: Specific conductivity (us/cm) - Goodream Creek – September 11, 2013 to October 08, 2013

Dissolved Oxygen

- Dissolved Oxygen (DO) values ranged from 10.05 mg/l (88.1% saturation) to 11.68 mg/l (93.8% saturation) at Elross Creek and from 9.79 mg/l (82.6% saturation) to 12.68 mg/l (102.9 % saturation) at Goodream Creek from September 11, 2013 to October 8, 2013 (Figures 9 & 10).
- Dissolved oxygen remains relatively stable over the deployment period.
- There is a distinct diurnal trend for DO (mg/l & % saturation) which is clearly visible at both sites. This diurnal trend is related to the diurnal temperature trends.
- The DO values at both stations were above 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).

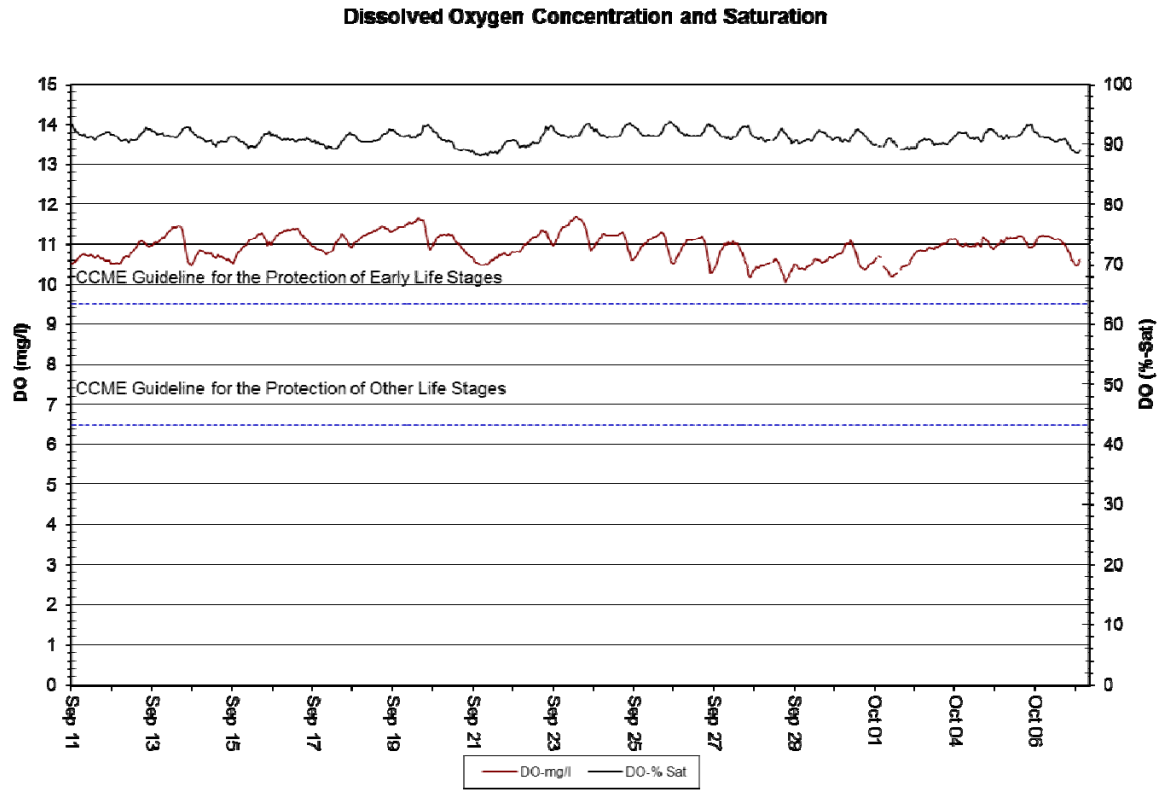

Figure 9: DO (mg/l & % saturation) at Elross Creek – Sept. 11, 2013 to October 08, 2013

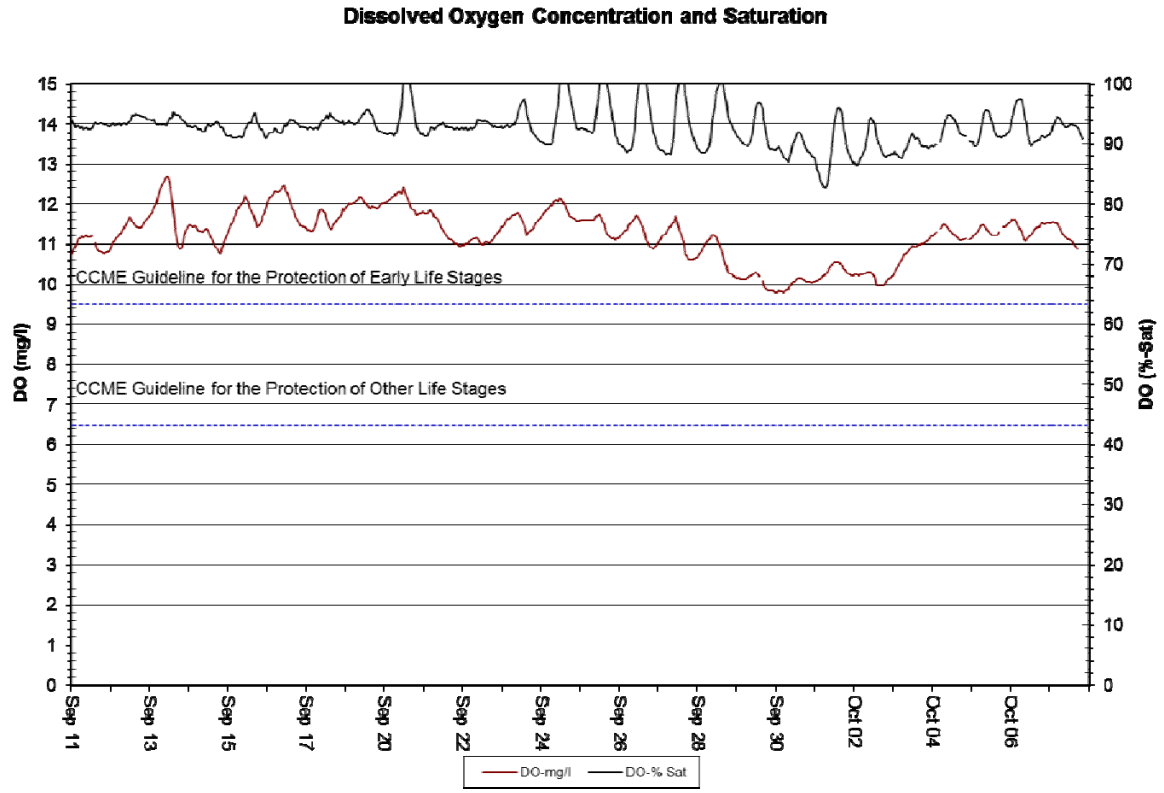

Figure 10: DO (mg/l & % saturation) at Goodream Creek – Sept. 11, 2013 to Oct. 08, 2013

Turbidity

- Turbidity values ranged from 15.7 NTU to 356.8 NTU at Elross Creek and from 0.0 NTU to 1.6 NTU at Goodream Creek from September 11, 2013 to October 8, 2013 (Figures 11 & 12).
- A spike in turbidity at Elross Creek (see inside red oval) corresponds with significant rainfall events and a subsequent increase in flow.
- Background turbidity values at Elross Creek remained consistently elevated for the duration of the deployment with a median of 19.6 NTU which is still lower that the median value reported for the previous deployment period.

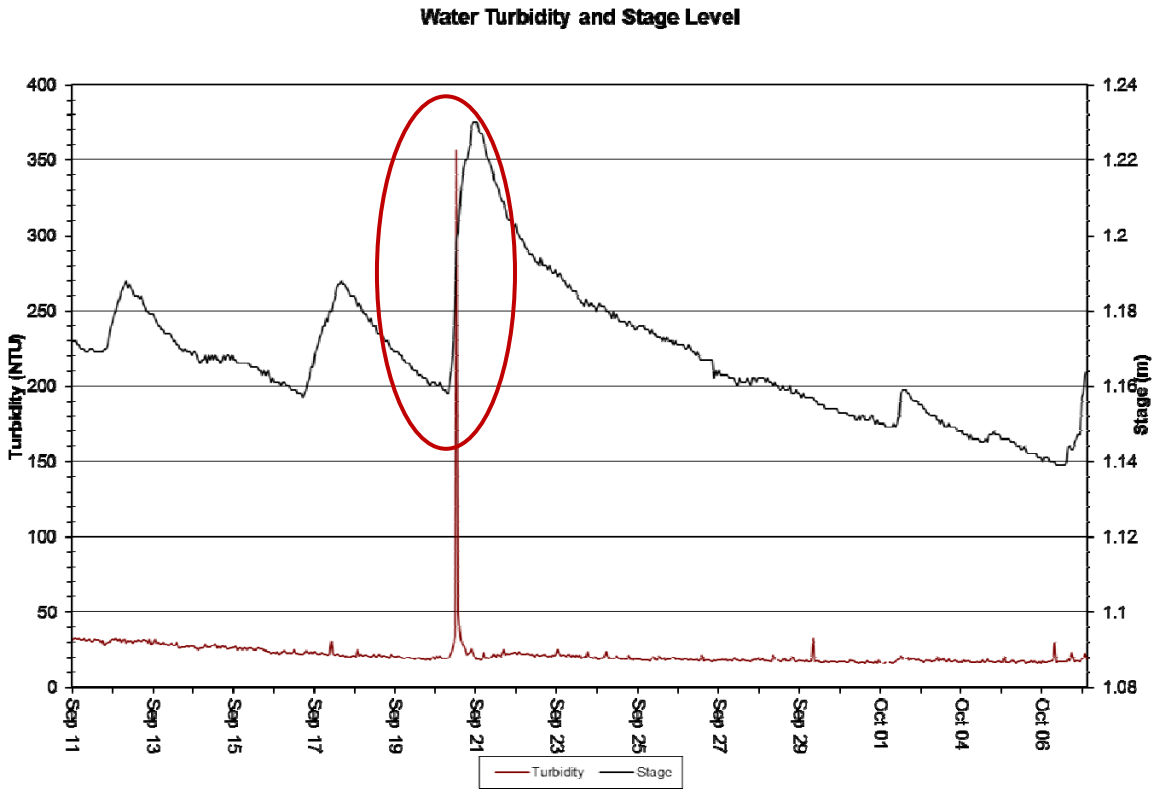

Figure 11: Turbidity (NTU) at Elross Creek – September 11, 2013 to October 08, 2013

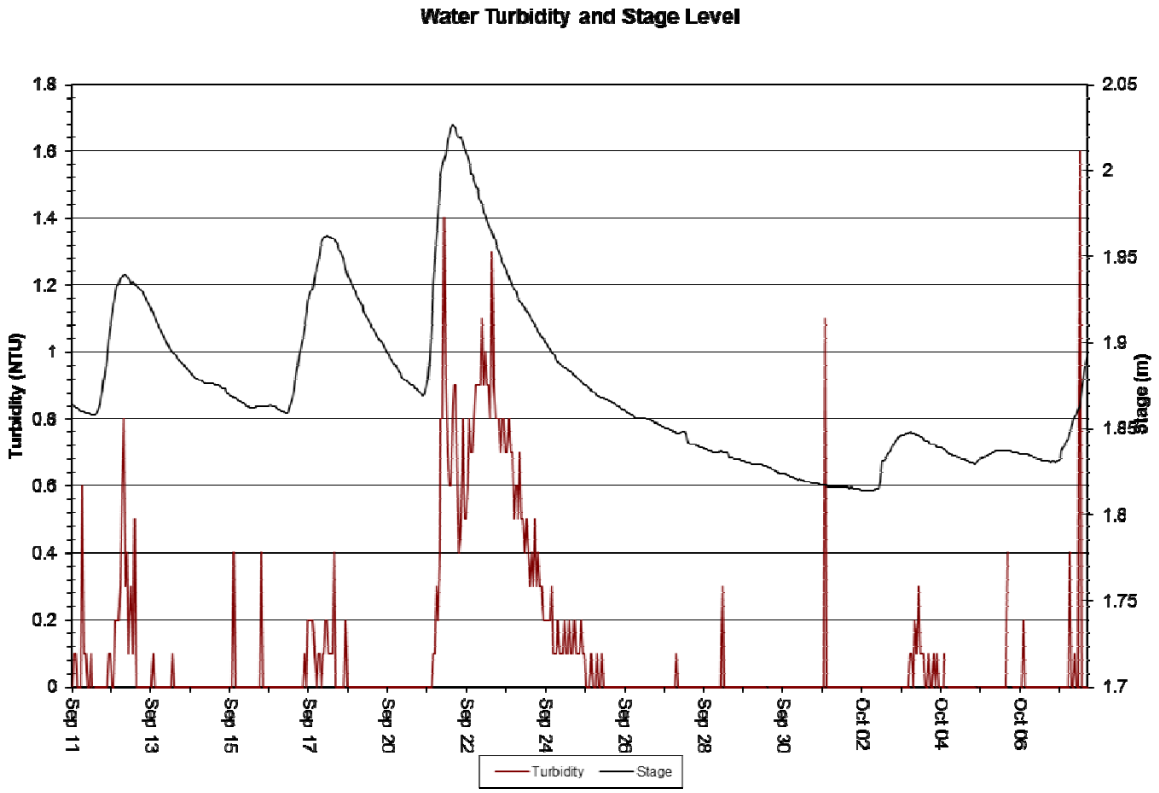

Figure 12: Turbidity (NTU) at Goodream Creek – September 11, 2013 to October 08, 2013

Conclusion

- This monthly deployment report, presents water quality and water quantity data recorded at the Elross Creek and Goodream Creek stations from September 11, 2013 to October 08, 2013.
- The performances of all sensors were rated fair to excellent at the beginning of the deployment and fair to excellent at the end.
- Variations in water quality/quantity values recorded at each station are summarized below:
    - For both Elross Creek and Goodream Creek there is are a series of three significant spikes in stage height in the first half of the deployment period which all correspond to significant precipitation events.
    - Diurnal fluctuations in water temperature corresponded with fluctuations in air temperature. This diurnal temperature trend is reflected in similar diurnal trends for pH and dissolved oxygen
    - At both Elross and Goodream Creeks it appears that pH is affected by significant changes in stream flow (see inside red ovals), with a slight dip around September 21 for Elross Creek and September 18 and 21 for Goodream Creek which all correspond to significant increases in flow caused by rainfall events.

- Sudden changes in flow appear to have a noticeable impact on specific conductivity for both Elross and Goodream Creeks with distinct dips in specific conductivity taking place at both stations during quick increases in flow.
- Turbidity at Elross Creek remained consistently high for the duration of the deployment with an average of 21.7 NTU

- Field instruments for both stations performed quite well over the deployment period with no significant maintenance issues.

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: http://ceqg-rcqe.ccme.ca/download/en/222/)

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.

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

	Rating				
Parameter	**Excellent**	**Good**	**Fair**	**Marginal**	**Poor**
Temperature (^{o}C)	≤ ±0.2	> ±0.2 to 0.5	> ±0.5 to 0.8	> ±0.8 to 1	> ±1
pH (unit)	≤ ±0.2	> ±0.2 to 0.5	> ±0.5 to 0.8	> ±0.8 to 1	> ±1
Sp. Conductance (µS/cm)	≤ ±3	> ±3 to 10	> ±10 to 15	> ±15 to 20	> ±20
Sp. Conductance > 35 µS/cm (%)	≤ ±3	> ±3 to 10	> ±10 to 15	> ±15 to 20	> ±20
Dissolved Oxygen (mg/l) (% Sat)	≤ ±0.3	> ±0.3 to 0.5	> ±0.5 to 0.8	> ±0.8 to 1	> ±1
Turbidity <40 NTU (NTU)	≤ ±2	> ±2 to 5	> ±5 to 8	> ±8 to 10	> ±10
Turbidity > 40 NTU (%)	≤ ±5	> ±5 to 10	> ±10 to 15	> ±15 to 20	> ±20

[1] Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality 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 (September 11, 2013 to October 8, 2013)

Date	Max Temp (°C)	Min Temp (°C)	Mean Temp (°C)	Heat Deg Days (°C)	Cool Deg Days (°C)	Total Rain Flag	Total Snow Flag	Total Precip (mm)
9/11/2013	11.8	-3.5	4.2	13.8	0	M	M	0
9/12/2013	8.1	3.1	5.6	12.4	0	M	M	10.1
9/13/2013	3.1	-2	0.6	17.4	0	M	M	0
9/14/2013	8.7	-4.2	2.3	15.7	0	M	M	4
9/15/2013	8.8	0.5	4.7	13.3	0	M	M	2.9
9/16/2013	2.5	-1.9	0.3	17.7	0	M	M	0.3
9/17/2013	9.4	-2.1	3.7	14.3	0	M	M	15.8
9/18/2013	4.4	-2	1.2	16.8	0	M	M	4.3
9/19/2013	0.3	-2	-0.9	18.9	0	M	M	0
9/20/2013	4.6	-2.5	1.1	16.9	0	M	M	6.3
9/21/2013	13.2	2.4	7.8	10.2	0	M	M	19
9/22/2013	8.7	1.1	4.9	13.1	0	M	M	0.3
9/23/2013	5.9	-1.4	2.3	15.7	0	M	M	0
9/24/2013	8.7	-3.4	2.7	15.3	0	M	M	0
9/25/2013	12.4	2.1	7.3	10.7	0	M	M	0
9/26/2013	17.4	1.6	9.5	8.5	0	M	M	0
9/27/2013	19.7	1.7	10.7	7.3	0	M	M	0
9/28/2013	22.2	7.1	14.7	3.3	0	M	M	0
9/29/2013	22.1	13.6	17.9	0.1	0	M	M	0
9/30/2013	13.7	7.6	10.7	7.3	0	M	M	0
10/1/2013	15.7	2.9	9.3	8.7	0	M	M	0
10/2/2013	14.4	7.3	10.9	7.1	0	M	M	8.5
10/3/2013	7.7	2.4	5.1	12.9	0	M	M	0.3
10/4/2013	5.4	1.6	3.5	14.5	0	M	M	0.9
10/5/2013	4.6	1	2.8	15.2	0	M	M	3.8
10/6/2013	7.3	2.1	4.7	13.3	0	M	M	0
10/7/2013	9.2	3.7	6.5	11.5	0	M	M	6.8
10/8/2013	10.7	0.3	5.5	12.5	0	M	M	2.1