
Storys Creek Water Quality Monitoring Results

28 November 2003

January 2004

A Report to Mineral Resources Tasmania

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1 Introduction

Mineral Resources Tasmania (MRT) has completed large-scale remediation works at the historic Storys Creek mine site in eastern central Tasmania. Water quality sampling is to be completed for 3 years to determine the concentrations and fluxes of pollutants of concern from the site to determine how the remediation works have altered discharges from the mine workings.

This report summarises the results from the second quarterly water quality-monitoring run, and compares the findings to previous results.

2 Sampling details

Water quality and flow monitoring was completed on 28 November 2003 by L. Koehnken of Technical Advice on Water and W. Grunn from MRT. Samples were collected at 9 sites within the Storys Creek catchment, including the outflow from the Anoxic Limestone Drain, one site in Aberfoyle Creek, and two sites in the South Esk River as listed in Table 1. At each of these sites pH, conductivity and temperature were measured *in situ* and a water sample was collected for subsequent analysis of metals, sulphate, fluoride and alkalinity, with the exception of the ALD site which was analysed for alkalinity only.

Table 1. Site number and location of monitoring points.

Site Number	Site Location	Justification
ALD	Anoxic Drain outflow at Storys Creek	Provide indication of alkalinity input to underground workings
2	Storys Cr above mine workings	Provides background water quality and indication of upstream changes
5	Storys Cr below Precipitation Dam	Provide record of changes since dam removal – should continue to change as groundwater ‘flushes’ through system
8	Storys Cr below Side Creek	Significant pollutant load enters via Side Creek-should reduce due to remediation works
13	Storys below Nisbet	Indicates inputs from diffuse sources downstream of Side Creek
14	Storys at Managers/Storys below Pumphouse*	Continue best long-term data collection point; indicates diffuse load entering between Nisbet and Pumphouse
21	Storys Above Aberfoyle	Final measurement of pollutant load in Storys Creek
23	Storys below Aberfoyle	Indicative of water entering South Esk
22	Aberfoyle Creek	Water is important for diluting Storys, and has elevated zinc values
24	South Esk above Storys	‘Background’ water quality in South Esk River
25	South Esk d/s Storys	Estimate of Storys Creek impact on S. Esk
4	Precip. dam outflow	Historic pollutant source
6	Side Creek	Historic pollutant source

***This site has been referred to as both Storys below Pumphouse and Storys at Manager’s. In this and subsequent reports ‘Storys at Manager’s’ will be used.**

At each river site in Storys Creek, flow was measured using a flow meter obtained from DPIWE. Due to the low flow conditions, flow was obtained at only one point in the channel at a depth of 0.6 of the water depth (from the surface). Flow from the ALD and Precipitate dam was measured using a calibrated bucket and stopwatch. Flow from the Eastern Adit was determined using the height of the water in the V-notch weir, and a USGS equation for calculating V-notch flow.

3 Results and discussion

Results are present in Table 3 and Table 3 for the riverine sites and in Table 4 for the Anoxic Limestone Drain.

3.1 Flows

On November 28, flow in Storys Creek was very low, following an extended period of dry weather. Due to the very low river levels and narrow channel, flow measurements were only completed at one point in the channel at each site. There is relatively poor agreement in flows between the sites above Nisbet Creek (Table 2), which is likely due to the irregular flow within the channel, and a variable proportion of flow occurring within the cobble river bed at each site, rather than within the channel. The lower sites, Storys at Managers, Storys above Aberfoyle and Storys Below Aberfoyle appear consistent, and there is good agreement between the sites.

Flow at Storys Cr at the Managers Residence was measured at 50 L/s using the flow meter. Based on the water level in the river (0.05 m) and the rating curve established by Hydro Tasmania, flow was 109 L/s. This discrepancy is likely due to the modelled nature of the hydrograph, which was based on two gaugings of higher flows (0.4 and 2.5 m³/s). For the calculation of fluxes, the measured flow of 50 L/s is used. The discrepancy between flows may also indicate that some of the previous low flows, as determined by the gauge height, may have been over estimated.

Compared to previous sampling runs, the 50 L/s flow is by far the lowest recorded flow at the Manager's Residence, with the previous low being 180 L/s. Photo 1 shows flow at the Manager's Residence under the November low flow conditions, and under the September 2003 high flow conditions.



Photo 1. Storys Creek at the Manager's Residence in November 2003 (left) and September 2003 (right). Flow in November was ~50 L/s, flow in September was ~1020L/s

In spite of the very low flows in Storys Creek, there was small but measurable outflow from the Precipitate Dam, Side Creek and Eastern Adit. Flow from these sources probably reflects elevated groundwater levels due to the high spring rains, such as was sampled in September 2003. The presence of precipitates in Storys Creek downstream of the confluence of each of these flows suggests they are sources of metals to the system. Precipitates were also observed where seeps from the jig tailings enter Storys below the Precipitate Dam and above Side Creek. Photo 2 shows the presence of iron precipitates downstream of the confluence of Side Creek and Storys Creek.



Photo 2. Iron precipitates in Storys Creek downstream of Side Creek.

Table 2. Flow, pH conductivity and temperature results collected in situ, 28 November 2003 and flux calculations based on flows and analytical results.

		Storys Ab Mine	Precip Dam Outflow	Storys Bel Precip	Side Cr	Storys Bel Side Cr	Storys Bel Nisbet	Storys at Manager	Storys Ab Aber	Storys Bel Aber	Aber Ab Storys	S. Esk Ab Storys	S. Esk Bel Storys
Parameter	Unit	28/11/03 10:45	28/11/03 11:15	28/11/03 11:30	28/11/03 11:55	28/11/03 12:15	28/11/03 13:00	28/11/03 14:10	28/11/03 15:15	28/11/03 15:45	28/11/03 15:30	28/11/03 16:00	28/11/03 16:15
Flow	L/s	23	0.2	17	2	12	36	50/109 [#]	78	146*	68		
pH (field)	pH units	7.5	6.4	6.94	3.57	5.62	6.48	6.69	6.54	7.15	7.06	7.32	7.27
Conductivity	µS/cm	22.8	406	47.7	265	256	141.2	144.5	128.3	198.2	284	105.3	113.2
Temp	°C	9.8	21.8	13.4	12.7	15.8	15.8	22.0	25.5	23.5	22.2	21.0	21.7
Zn tot flux	kg/d	<0.01	0.30	0.83	0.65	3.65	4.11	6.39	5.23	6.80	2.09	<0.01	0.30
Cd tot flux	kg/d	<0.01	0.01	0.03	0.02	0.13	0.16	0.27	0.25	0.32	0.08	<0.01	0.01
Mn tot flux	kg/d	<0.01	0.07	0.07	0.19	1.23	0.91	0.62	0.14	0.19	0.04	<0.01	0.07
Fe tot flux	kg/d	<0.04	<0.01	<0.03	0.31	4.73	0.27	0.45	0.20	<0.25	<0.12		
Sulphate flux	kg/d	0.66	2.76	10.72	16.07	114.05	149.30	198.72	215.65	605.49	411.26		

[#]50 L/s based on flow measurement; 109 L/s based on gauge height

*Sum of Storys Above Aberfoyle and Aberfoyle above Storys

Table 3. All units µg/L except Fluoride, Sulphate and Alkalinity, which are mg/L/

		Storys Ab Mine	Precip Dam Outflow	Storys Bel Precip	Side Cr	Storys Bel Side Cr	Storys Bel Nisbet	Storys at Manager	Storys Ab Aber	Storys Bel Aber	Aber Ab Storys	S. Esk Ab Storys	S. Esk Bel Storys
Date		28/11/03 10:45	28/11/03 11:15	28/11/03 11:30	28/11/03 11:55	28/11/03 12:15	28/11/03 13:00	28/11/03 14:10	28/11/03 15:15	28/11/03 15:45	28/11/03 15:30	28/11/03 16:00	28/11/03 16:15
Alkalinity Total	mg/L CaCO ₃	9	7	11	<1	<1	7	4	2	13	27	17	17
Fluoride	mg/L	<0.02	1.3	0.12	3.3	1.8	0.45	0.34	0.28	0.68	0.98	<0.02	0.05
Sulphate	mg/L	0.33	160	7.3	93	110	48	46	32	48	70	1.4	3.6
Al Dis	µg/L	<20	39	<20	2690	831	<20	<20	34	21	<20	31	<20
Al Total	µg/L	<20	85	30	2780	936	26	62	61	38	<20	38	52
As Dis	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
As Total	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cd Dis	µg/L	<1	535	20	125	121	50	61	37	25	12	<1	<1
Cd Total	µg/L	<1	537	21	129	127	50	62	37	25	13	<1	1
Co Dis	µg/L	<1	53	<1	13	12	3	1	<1	<1	<1	<1	<1
Co Total	µg/L	<1	54	<1	13	12	3	2	<1	<1	<1	<1	<1
Cr Dis	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cr Total	µg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cu Dis	µg/L	<1	6	7	280	92	13	41	20	14	11	<1	1
Cu Total	µg/L	<1	8	8	289	106	17	50	22	16	12	<1	2
Fe Dis	µg/L	<20	<20	<20	464	1040	<20	<20	<20	<20	<20	154	190
Fe Total	µg/L	<20	35	<20	1790	4560	87	105	29	<20	<20	229	297
Mn Dis	µg/L	<5	4000	51	1040	1100	291	142	21	15	6	<5	<5
Mn Total	µg/L	<5	4030	51	1080	1190	292	143	21	15	6	6	15
Ni Dis	µg/L	<1	49	2	28	23	8	6	4	4	3	1	1
Ni Total	µg/L	<1	51	2	30	23	10	7	4	4	4	2	3
Pb Dis	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Pb Total	µg/L	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zn Dis	µg/L	1	17200	564	3630	3480	1300	1470	771	537	324	<1	35
Zn Total	µg/L	2	17200	568	3770	3520	1320	1480	776	539	356	1	34
Flow	L/s	23	0.2	17	2	12	36	50	78	146	68		

Table 4. Results from the Anoxic Limestone Drain at Storys Creek, 28 November 2003.

	Anoxic Limestone Drain	Eastern Adit
Flow (L/s)	0.1	0.07
pH	7.66	6.4
Conductivity (µS/cm)	212	125.2
Temperature (°C)	12.9	10.1
Alkalinity (mg CaCO₃/L)	104	

3.2 Water quality results – concentrations

Compared to the water sample collected upstream of the Storys Creek mine workings, all metals analysed are elevated downstream of the site with the exception of chromium, arsenic and lead (Table 3). Sulphate and fluoride are also elevated in Storys Creek below the mine site. The highest concentrations of cadmium, manganese and zinc were found in the outflow from the Precipitate Dam and Side Creek. In Side Creek aluminium is also much higher than background, consistent with the low pH in the creek (pH = 3.6).

Figure 3.1 and Figure 3.2 compare the total zinc and total cadmium concentrations at three monitoring sites with previous results. The results are presented in chronological order, with flow indicated by colour. The zinc concentrations in the outflow of the Precipitate Dam and in Storys Creek below Side Creek are high compared to results from the previous 2 years. At Storys at the Managers site, zinc concentrations are high compared to September 2003, but well within the range of 'low flow' concentrations.

Cadmium shows similar trends (Figure 3.2), with concentrations at the Precipitation Dam and Storys below Side Creek being elevated compared to recent sampling runs, but within the range of recent results at the Storys at Managers site.

In general, the zinc and cadmium results were 2 – 3 times higher in November as compared to September when flows were about ~20-times greater, and more dilution was available.

The alkalinity result from the Anoxic Limestone Drain indicates that the drain is continuing to increase alkalinity in the water. Storys Creek above the Mine had an alkalinity of 9 mg/L CaCO₃, which can be considered as indicative of the local water entering the drain. The outflow from the drain was 104 mg/L CaCO₃, an increase of about 10-fold.

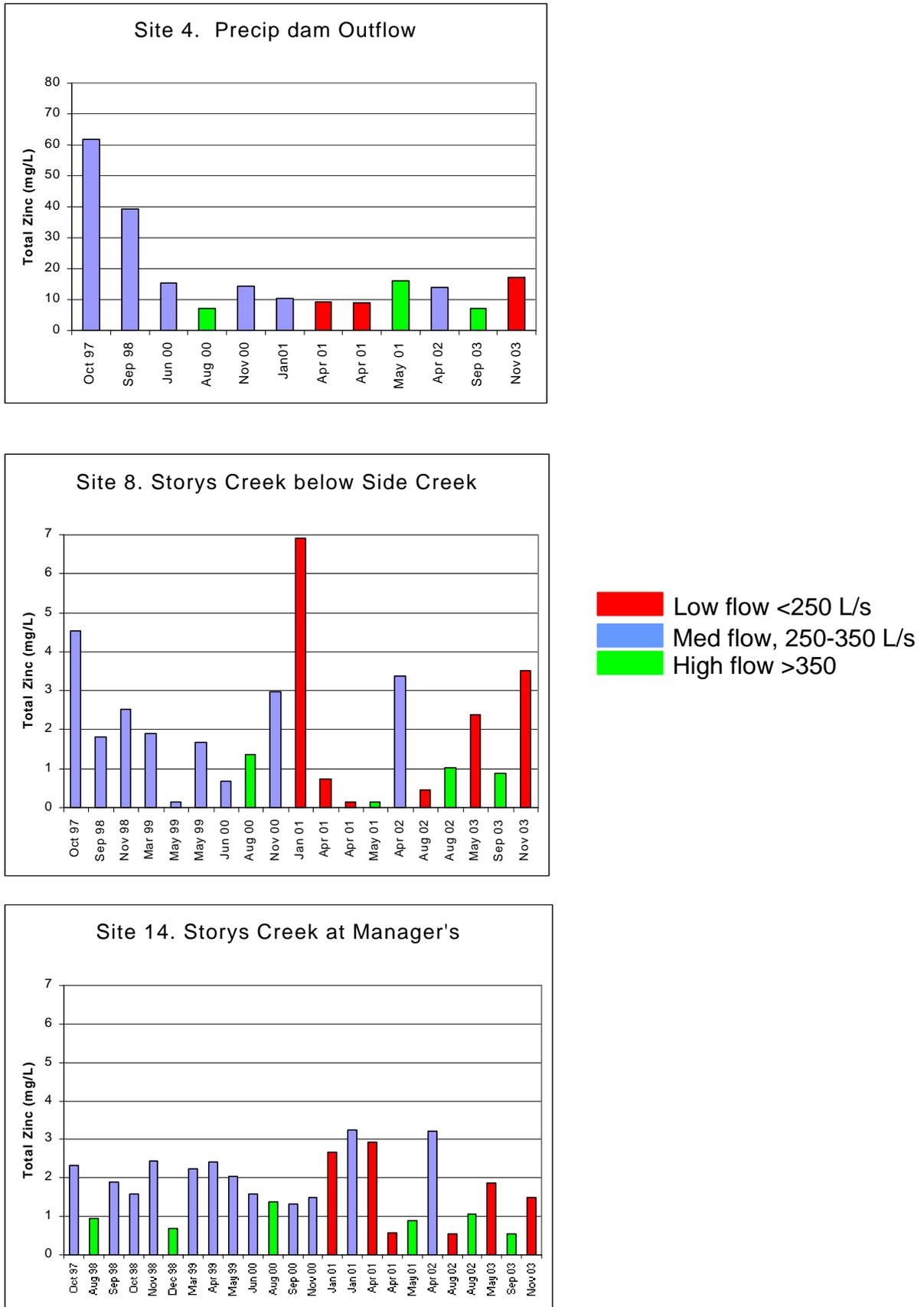


Figure 3.2 Figure 3.1. Total zinc concentrations at the Precipitation Dam outflow (top), Storys Creek below Side Creek (middle) and Storys Creek at Managers (bottom). Results are presented in chronological order, with colour indicating flow.

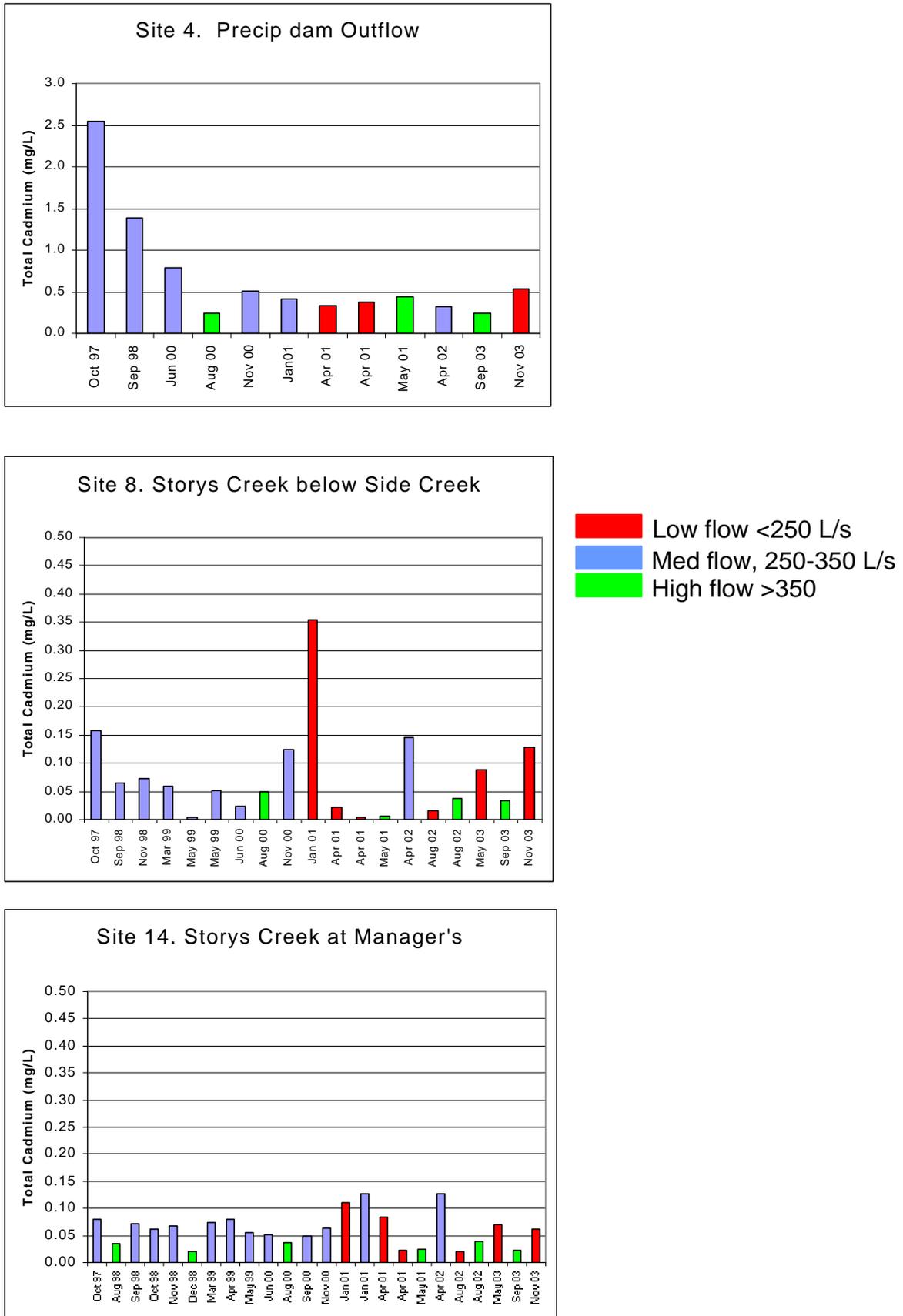


Figure 3.2. Total cadmium concentrations at the Precipitation Dam outflow (top), Storyst Creek below Side Creek (middle) and Storyst Creek at Managers (bottom). Results are presented in chronological order, with colour indicating flow.

3.3 Water quality results – metal fluxes

Using the flow estimates obtained with the flow meter and the analytical results, fluxes for total zinc, total cadmium, total iron, total manganese and sulphate were calculated and presented in Table 2. The zinc results are also presented graphically in Figure 3.3. Fluxes are about 10% of the values determined in September 2003, indicating that although concentrations were elevated, the very low flow was actually transporting much less metal than during the high flows of September. Although fluxes were low, the overall pattern remained similar, with the largest increase in flux occurring between Storys below the Precipitate Dam and Storys below Side Creek. This is consistent with both Side Creek and the jig tailings deposit in the river being a major source of zinc to the system. In the November sampling, there is also a sizeable increase in the zinc flux between Storys below Nisbet and Storys at the Managers Residence. This increase was not present in the calculated fluxes in September.

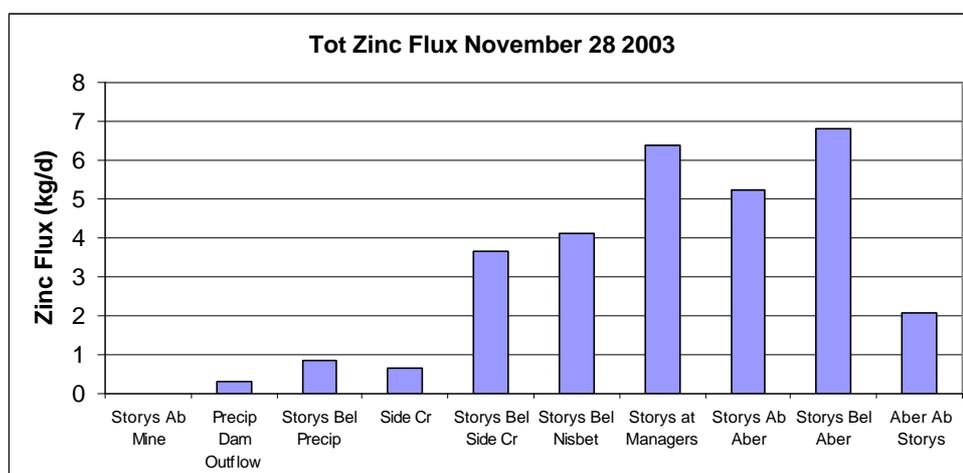


Figure 3.3. Total zinc fluxes in Storys Creek, 28 November 2003.

The distribution of zinc fluxes is similar to previous samplings, with ~13% of the total (as measured at the Manager’s Residence) present below the Precipitation Dam, 44% derived from between the Precipitation Dam and below Side Creek, and the remaining entering from downstream of Side Creek.

The contribution from Aberfoyle Creek to the total zinc flux in lower Storys Creek was 2 kg/day, or 30% of the total. This is consistent with previous findings where Aberfoyle contributed ~40% of the total zinc load. The zinc input to the South Esk River is estimated at 6.8 kg/day, which increased zinc concentrations in the South Esk from 1 µg/L to 34 µg/L. This is very similar to the results from September 2003, when concentrations increased from 1 µg/L to 39 µg/L.

The total zinc, cadmium and sulphate fluxes at Storys at the Manager’s Residence are shown in Figure 3.4 in chronological order. The November results are by far the lowest fluxes recorded. Even if flow estimates were doubled, the November fluxes would still be the lowest recorded.

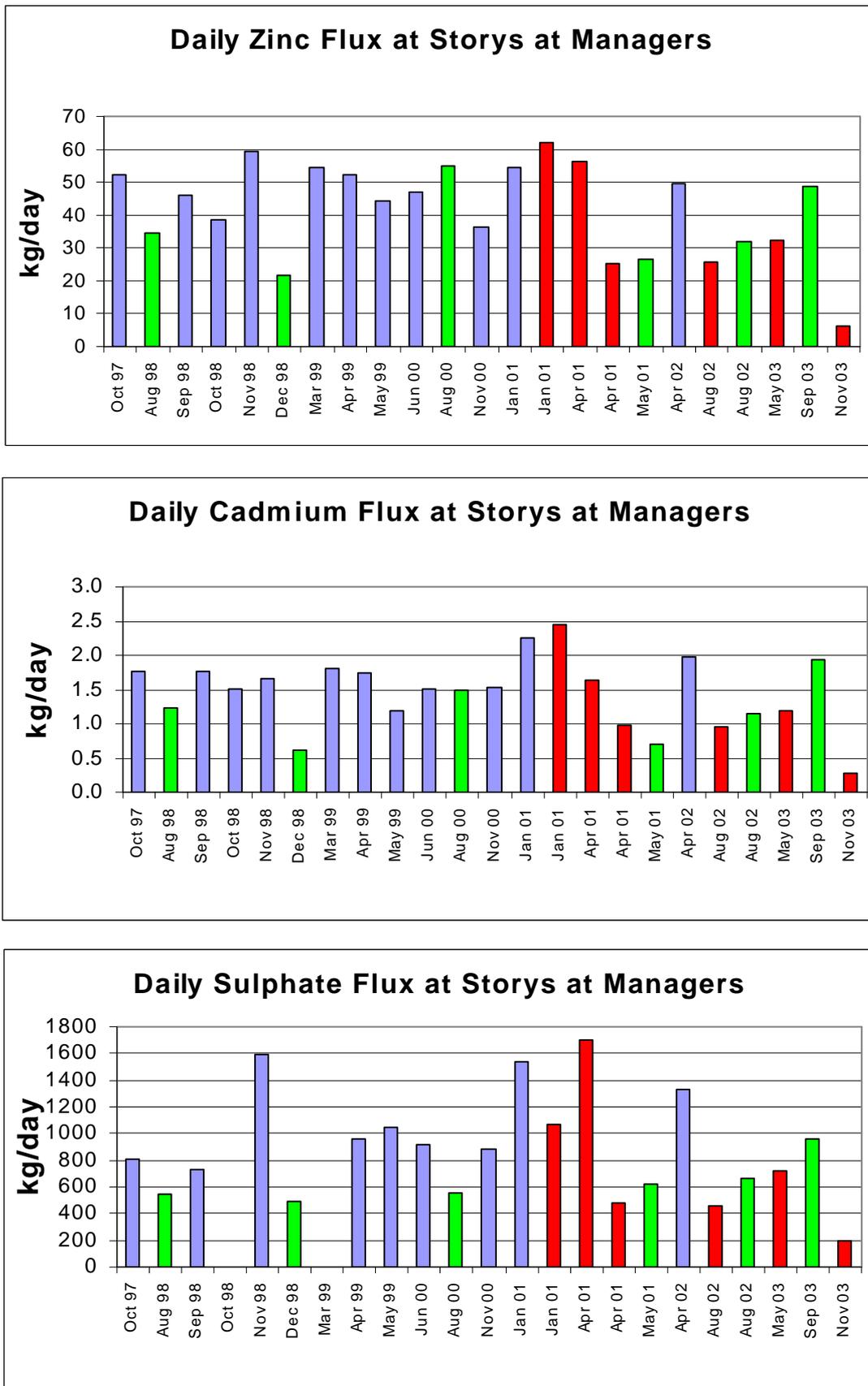


Figure 3.4. Total zinc, cadmium and sulphate fluxes at Site 14, Storys Creek at Managers Residence. Colour denotes flow regime: re = <250 L/s; blue = 250 – 350 L/s, Green = >350 L/s.

4 Impact of remediation works

Similar to the September 2003 sampling, comparing the November 2003 results with previous results is difficult because river flow was outside previously documented conditions. The very low fluxes from the site may indicate that the remediation works have reduced zinc output, however, the fact that the zinc contribution from Aberfoyle Creek continues to be 30% of the total suggests that hydrological conditions were responsible for the low zinc fluxes, rather than the remediation works. If the remediation works are reducing zinc fluxes in Storys Creek, the input from Aberfoyle should constitute a greater proportion of the total zinc flux, rather than a similar (or smaller) proportion.

It is interesting that the very low river flows and zinc fluxes resulted in the same impact on the South Esk River as compared to the very high flows in September. Under both scenarios zinc concentrations were increased from 1 µg/L to ~35 µg/L. This also suggests that hydrologic processes are controlling the present zinc fluxes in the Storys Creek and Aberfoyle catchments.