Storys Creek Water Quality Monitoring Results

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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 first quarterly water quality-monitoring run, and compares the findings to previous results.

2 Sampling details

Water quality monitoring was completed on 23 September 2003 by L. Koehnken of Technical Advice on Water and T. Webster from MRT. Samples were collected at 9 sites in Storys Creek, and 2 sites in the South Esk as listed in Table 1. An additional sample was collected from the outflow of the Precipitation Dam as it had a considerable discharge. At each of these sites, pH, conductivity and temperature were measured *in situ* and a water sample was collected for subsequent analysis for metals, alkalinity, and sulphate.

Table 1. Site number and location of monitoring points.

Site Number	Site Location	Justification
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 below Pumphouse	Continue best long-term data collection point; indicates diffuse load entering between Nisbet and Pumphouse
15	Storys at Rossarden	Establish additional pollutant load and dilution from tributaries – only monitor if tailings evident in river
21	Storys Above Aberfolye	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	Establish if reliable flow data available. 'Background' water quality in South Esk River
25	South Esk d/s Storys	Establish if reliable flow data available. Estimate of Storys Creek impact 3 km downstream
4	Precip. dam outflow	Water sample collected and analysed
	ALD outflow	pH & conductivity, alkalinity

At each river site in Storys Creek, flow was measured using a flow meter obtained from DPIWE. The width of the river channel was measured, and flow measurements were made at three equidistant points across the channel at 0.6 of the water depth (from the surface) at each point. A total flow estimate was derived by proportioning the flow rate to the cross-sectional area of the channel. Flow at Storys Creek below Aberfoyle was estimated by summing the measured flows from the Storys above Aberfoyle and Aberfoyle above Storys sites.

3 Results and discussion

Monitoring results are presented in Table 2 and Table 3 for the riverine sites, and in Table 4 for the Anoxic Limestone Drain. Flux calculations are also in Table 2.

3.1 Flows

The sampling run was completed following a period of wet weather, and river flows were high, with flow observed exiting the Precipitate Dam and Side Creek wetlands. Flow results are shown in Table 1 for each of the monitoring sites in Storys Creek. Based on a comparison of the measured flows with previously collected flow data, the flow during the monitoring run was almost twice as large as during any previous monitoring run.

Hydro Tasmania re-installed the gauge boards and completed several gaugings at the Pumphouse site in the weeks preceding the September monitoring run. The calculated discharge as determined by gauge height (999 L/s), was in excellent agreement with the discharge measurement made in the field (1,020 L/s), and provides a high degree of confidence that the flows (and fluxes) established during the September sampling are accurate.

Table 2. Flow, pH, conductivity and temperature results collected *in situ*, 23 September 2003.

		Storys Ab Mine	Precip Dam Outflow	Storys Bel Precip	Storys Bel Side Cr	Storys Bel Nisbet Cr	Storys Bel Pump	Storys Ab Aber Cr	Storys Bel Aber Cr	Aber Ab Storys	S. Esk Ab Storys Cr	S. Esk Bel Storys Cr
Parameter	unit	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03
Flow	L/s	280	10	435	358	1047	1020	1180	2051	871		
pH	pH units	6.9	6.1	6.7	5.8	6.3	6.3	6.4	6.8	6.8	7.0	7.0
Conductivity	µS/cm	14	290	18	42	40	40	41	57	93	54	56
Temp	°C	4.6	7.0	4.6	7.3	7.3	9.0	9.8	10.4	11.4	10.3	10.6
Zn tot flux	kg/d	<0.02	6.08	7.82	27.13	53.30	49.18	34.26	57.41	22.42		
Cd tot flux	kg/d	<0.02	0.21	0.26	1.02	1.99	1.94	1.43	2.13	0.68		
Mn tot flux	kg/d	<0.12	1.33	1.58	6.34	10.95	6.96	2.96	7.09	4.67		
Fe tot flux	kg/d	0.60	0.21	1.32	22.31	37.10	19.48	16.01	54.05	34.16		

Table 3. Monitoring results from Storys Creek, 23 September 2003. Analyses provided by Analytical Services Tasmania.

		Storys Ab Mine	Precip Dam Outflow	Storys Bel Precip	Storys Bel Side Cr	Storys Bel Nisbet Cr	Storys Bel Pump	Storys Ab Aber Cr	Storys Bel Aber	Aber Ab Storys Cr	S. Esk Ab Storys Cr	S. Esk Bel Storys Cr
Parameter	unit	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03	23-Sep-03
Alkalinity Total	mg CaCO3 /L	5	5	6	3	5	4	3	7	15	10	10
Fluoride	mg/L	<0.02	0.56	0.03	0.31	0.22	0.17	0.22	0.37	0.57	<0.02	0.04
Sulphate	mg/L	0.35	61	2.2	15	11	11	7.5	12	21	1.4	2.5
Al Dissolved	µg/L	<20	53	24	51	91	96	145	113	59	101	105
Al Total	µg/L	53	1050	84	307	227	215	342	405	431	279	323
As Dissolved	µg/L	<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
Cd Dissolved	µg/L	<1	236	7	32	22	22	13	11	8	<1	<1
Cd Total	µg/L	<1	237	7	33	22	22	14	12	9	<1	1
Co Dissolved	µg/L	<1	24	<1	2	1	<1	<1	<1	<1	<1	<1
Co Total	µg/L	<1	24	<1	2	1	<1	<1	<1	<1	<1	<1
Cr Dissolved	µg/L	<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
Cu Dissolved	µg/L	<1	6	<1	46	29	31	21	22	23	<1	3
Cu Total	µg/L	<1	10	<1	67	40	38	23	28	34	<1	3
Fe Dissolved	µg/L	<20	<20	<20	<20	256	128	76	79	87	133	130
Fe Total	µg/L	25	243	35	721	410	221	157	305	454	253	289
Mn Dissolved	µg/L	<5	1530	43	204	120	79	28	36	52	6	10
Mn Total	µg/L	<5	1540	42	205	121	79	29	40	62	6	12
Ni Dissolved	µg/L	<1	22	<1	4	2	2	1	2	3	<1	<1
Ni Total	µg/L	<1	22	<1	4	2	2	<1	2	4	<1	<1
Pb Dissolved	µg/L	<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
Zn Dissolved	µg/L	<1	6960	207	873	580	553	328	300	255	<1	31
Zn Total	µg/L	<1	7030	208	877	589	558	336	324	298	1	39

Table 4. Results from Anoxic Limetsone Drain at Storys Creek, 23 September 2003.

	Anoxic Limestone Drain
pH	8.7
Conductivity (µS/cm)	112
Alkalinity (mg $CaCO_3$/L)	45

3.2 Water quality results - concentrations

Consistent with previous water quality monitoring results, fluoride, sulphate, cadmium, copper manganese and zinc concentrations were elevated in the water samples collected at or downstream of the mine workings compared to the above mine values. Nickel and cobalt were also elevated in the outflow from the Precipitation Dam. Total aluminium and iron concentrations were greater than the dissolved values, indicated the presence of fine-particulates in the samples. The differences between the total and dissolved values for the other parameters were relatively small, suggesting the metals are generally present in a dissolved form.

Figure 3.1 compares the total zinc concentration at three monitoring sites (outflow of Precipitation dam, Storys Creek below Side Creek, and the Pumphouse site) with previous results. The results are sorted according to flow, and presented as pre- and post- remediation works for each flow category. The September 03 monitoring is the highest flow condition ever sampled, and is the final bar in the graph.

The total zinc concentrations are within the range of samples previously collected during high flows. High flow results have the lowest concentrations, presumably due to dilution. The zinc levels in the Precipitation Dam outflow continue to exceed the zinc levels at all other sites by over an order of magnitude.

Similar trends are apparent in the total cadmium results (Figure 3.2), with the September 2003 values consistent with previous results, and the Precipitation Dam outflow returning the highest concentration of all monitoring points.

Zinc, cadmium and copper values continue to be in excess of ANZECC (2000) Water Quality Guidelines for the Protection of Modified Ecosystems at sites in Storys Creek at or below the mine workings.

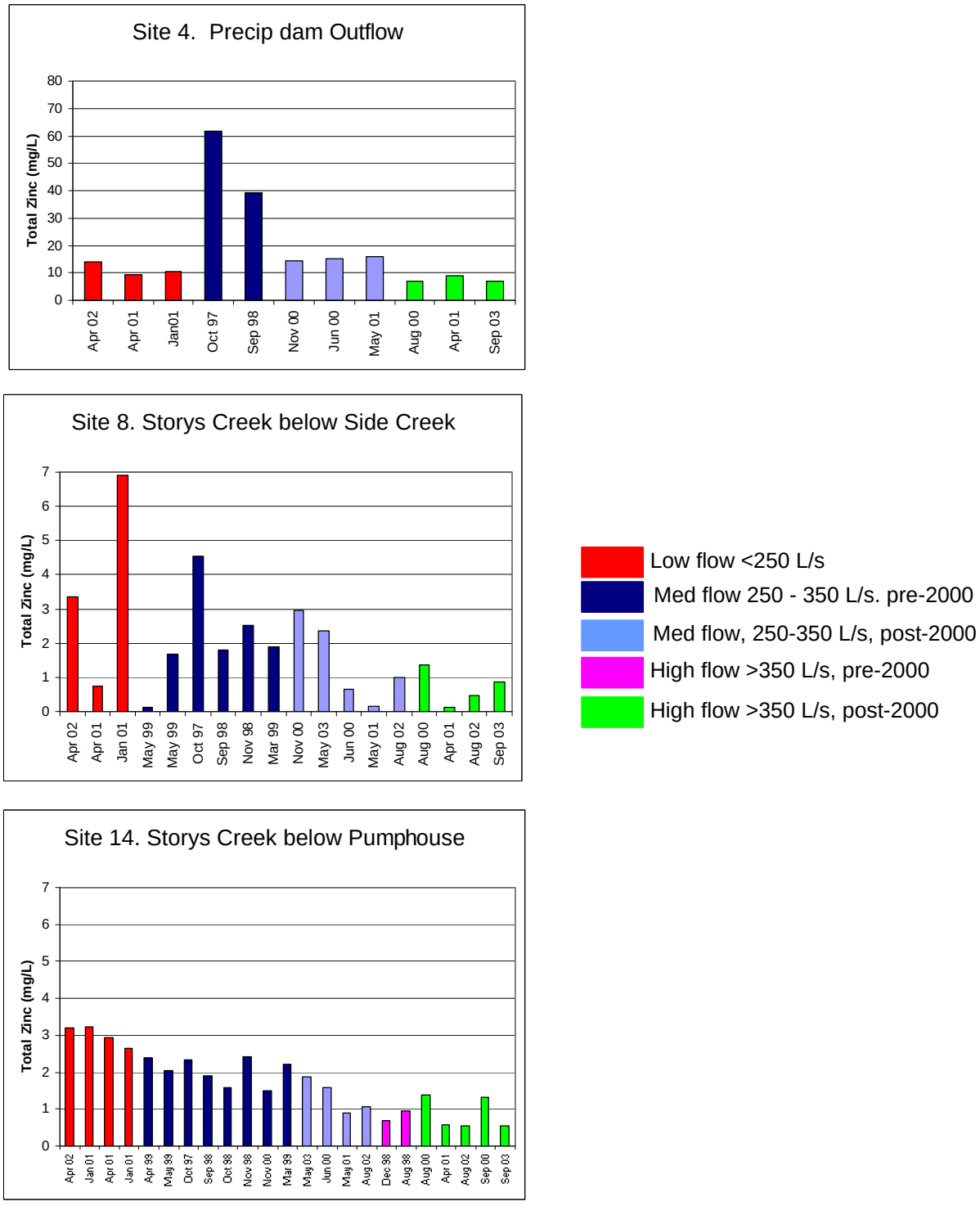


Figure 3.1. Total zinc concentrations at the Precipitation dam outflow (top), Storys Creek below Side Creek (middle) and Storys Creek below Pumphouse (bottom) sorted by pre- post-remediation, and river flow. September 03 flow is final bar on the graph, reflecting highest flow condition included in sample set. Note different scale on Precipitation dam outflow graph (top).

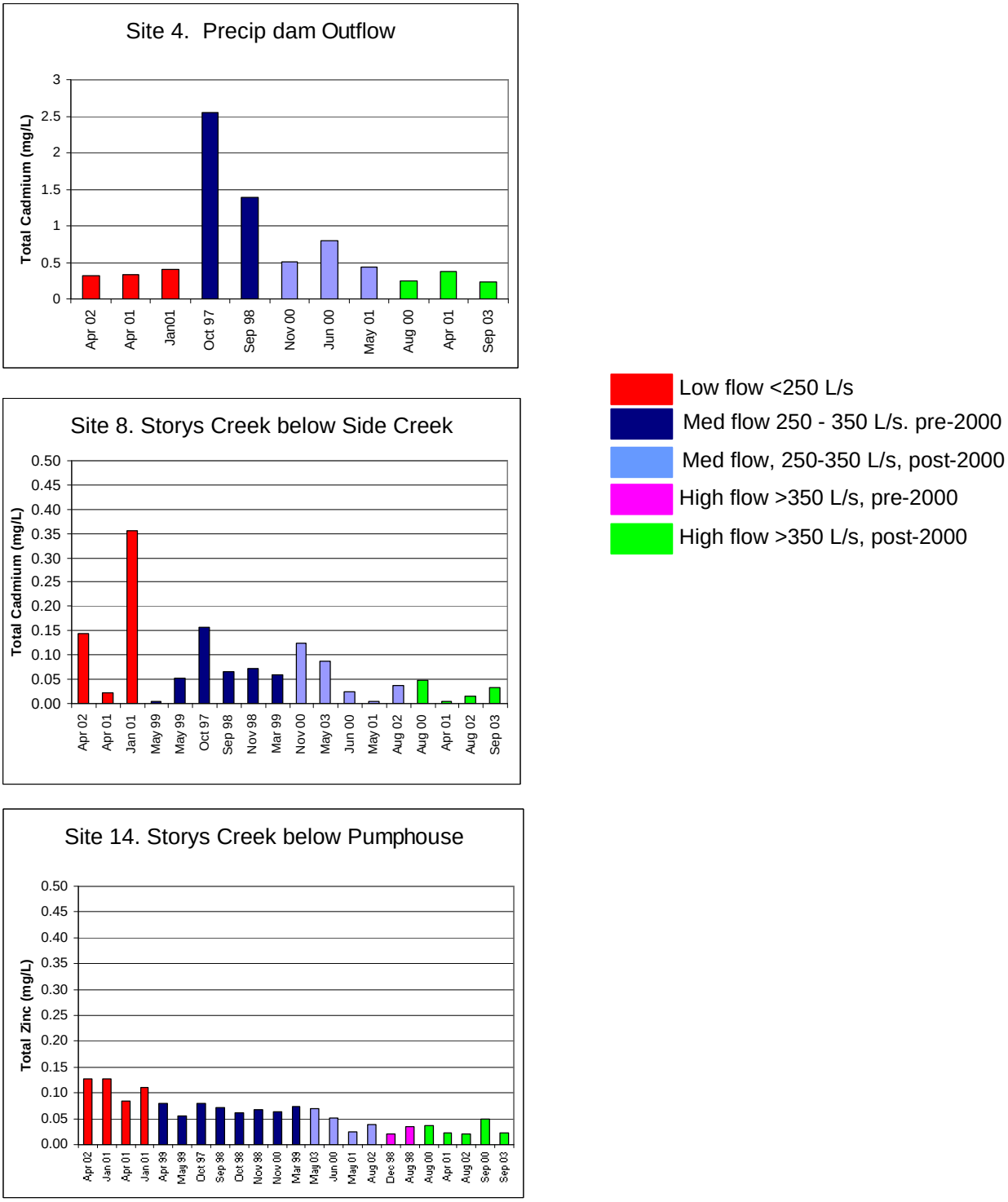


Figure 3.2. Total cadmium concentrations at the Precipitation dam outflow (top), Storys Creek below Side Creek (middle) and Storys Creek below Pumphouse (bottom) sorted by pre- post-remediation, and river flow. September 03 flow is final bar on the graph, reflecting highest flow condition included in sample set. Note different scale on Precipitation dam outflow graph (top).

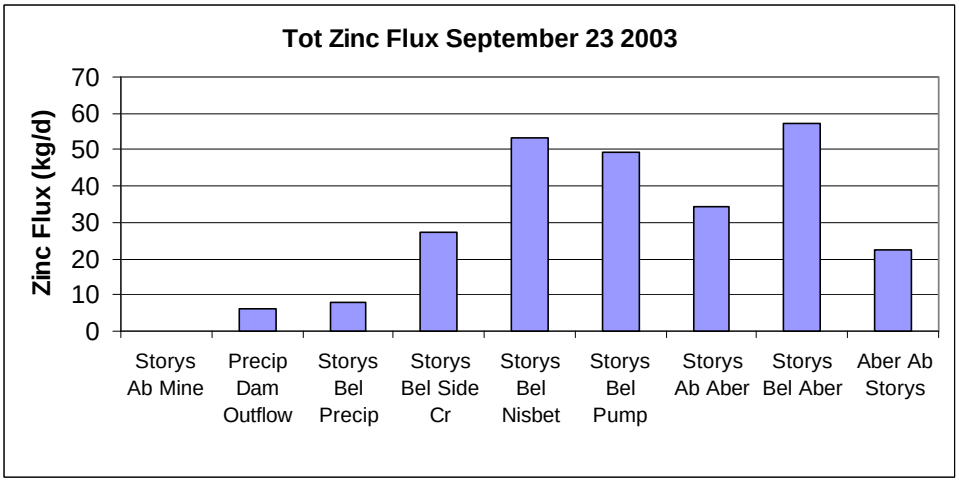
3.3 Water quality results – metal fluxes

Using the measured water flows and the analytical results for total zinc, total zinc fluxes for each site were established, and are presented in Table 2 and Figure 3.3. Above the mining area, zinc concentrations are below the level of detection, resulting in a flux below 0.02 kg/day. The Precipitation Dam outflow contributed about 6 kg/day to the river, which comprised ¾ of the load in Storys Creek below the Precipitation Dam. The largest zinc fluxes entered Storys Creek between the Precipitation Dam and Side Creek (19 kg/day), and between Side Creek and Storys Below Nisbet Creek (26 kg/day). These fluxes are associated with the large deposit of jig tailings lining the bank and bed of the rivers, and an adit which discharges to Side Creek. Nisbet Creek, which had a conductivity of only 23 µS/cm, is not considered a major source of metals to the system.

Zinc fluxes remained constant within the limits of the measurements between Storys Creek below Nisbet Creek and Storys Creek below Pumphouse, but decreased in the lower Creek (Storys Ab Aberfoyle). This decrease may indicate removal of zinc by sediments in the river, or variations in fluxes over time (ie, water sampled in upper Storys had not yet reached Storys above Aberfoyle site).

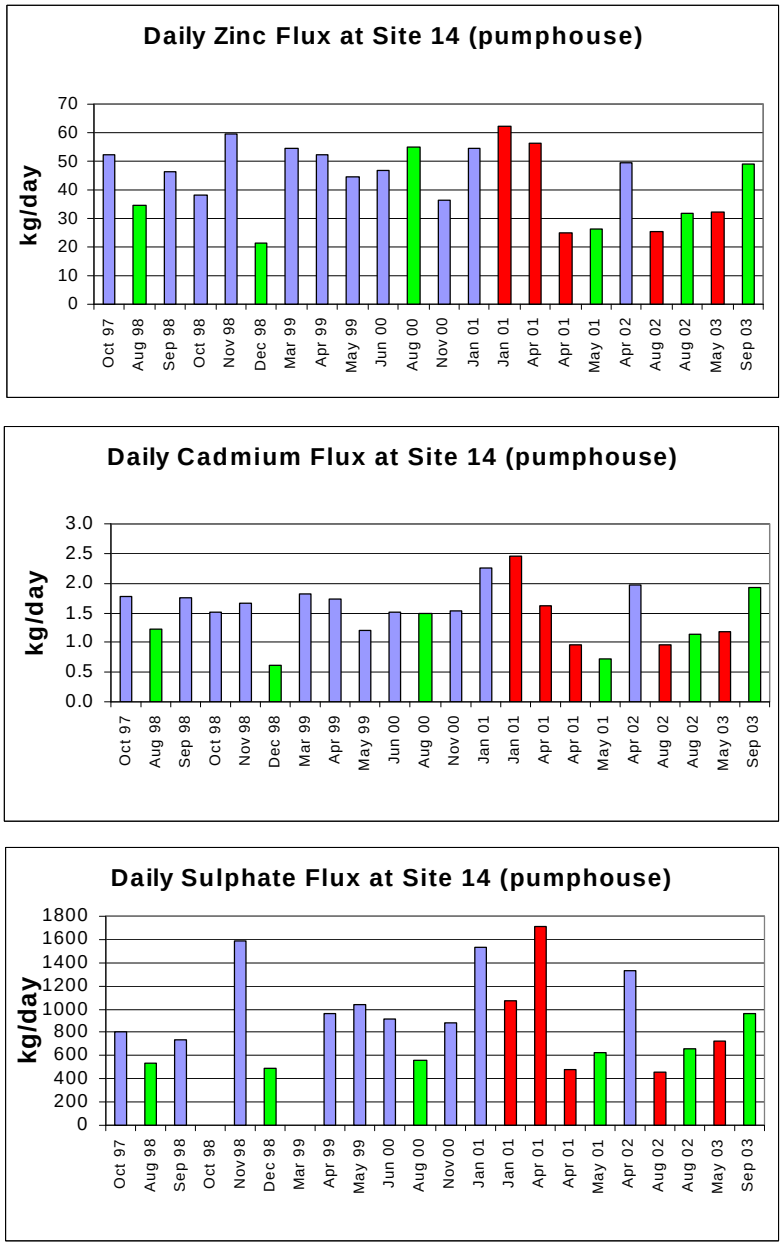
The total zinc contribution from Aberfoyle Creek was sizeable (22 kg/day), about 40% of the total Storys Creek flux entering the South Esk River. Combined, the two creeks contributed about 57 kg/day of zinc to the South Esk River. This input resulted in an increase in total zinc concentrations in the South Esk from 1 to 39 µg/L. The cadmium results show similar trends.

Figure 3.3. Total zinc flux in Storys Creek 23 September 2003.



The zinc, cadmium and sulphate fluxes at the Storys Creek below Pumphouse site are shown in Figure 3.4 with historic data for comparison. The results show that the September values are within the range of previously measured fluxes, but are higher than any value measured since April 2002.

Figure 3.4. Zinc, cadmium and sulphate fluxes at Stie 14, Storys Creek below Pumphouse. Colour denotes flow regime: red + low flow (250 L/s), Blud denotes medium flow (250 - 350 L/s), and Green denotes high flow (>350 L/s). Results presented in chronoloical order.



The distribution of fluxes is similar to previous investigations, with 12% of the zinc flux derived from the Precipitation Dam, and 43% derived between the Precipitation Dam and below Side Creek, as compared to 15% and 47% in December 2001 (based on 100% being Storys below Pumphouse in the recent investigation, and 100% being at Rossarden in the earlier work). A difference between the 2001 distribution and the present results is that in 2001, 15% of the total zinc flux entered Storys Creek between Side Creek and Nisbet Creek, whereas the recent results show the largest input from this area, about 50%.

4 Impact of remediation works

Because flow during the September 2003 sampling run was considerably higher (almost double) than during any other sampling period, it is difficult to interpret these results with respect to the impact the remediation works have had on the site. Overall, fluxes have increased relative to the last few sampling runs, and the input of metals is occurring in similar patterns as previously documented. However, it is unknown what level of pollutant were mobilised during very high flows before the remediation works were implemented.

The present increased zinc flux may also reflect longer-term precipitation patterns. Storys Creek has experienced a prolonged drought over the past couple of years, during which time metal fluxes from the site have been relatively low. The higher fluxes associated with the most recent sampling could reflect a 'flushing' of stored pollutants.

5 Next sampling

The next sampling run is targeted for a dry summer period with low flow conditions in December 2003 or January 2004. As numerous low flows have previously been monitored, this will provide an indication of how remediation works have affected groundwater inputs to the site.