

HEEMSKIRK TIN PROJECT

REVIEW OF FIRST 12 MONTHS WATER SAMPLING



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Stellar Resources

Heemskirk Tin Project Review of First 12 Months Water Sampling

May 2013

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1 Introduction

Stellar Resources hold a Retention Licence (RL 5/1997) over the historic mine field of Zeehan, in Western Tasmania. The main prospective part of the licence is situated on the North Western edge of the township of Zeehan. It contains, and is surrounded, by many historic mining operations which date back to the 1800's and there are many adits, shafts, surface excavations and mine workings. These operations are the source of substantive metal loads that flow into the Little Henty River Catchment via Pea Soup Creek and Zeehan Rivulet Creek. Stellar are intending to commence mining and processing operations of underground tin deposits with infrastructure concentrated on the northern side of Queen Hill.

Stellar Resources has commissioned John Miedecke and Partners (JMP) to evaluate the requirements for water management with future operations.. JMP have engaged Aquatic Science to assist with water quality auditing on the lease and surrounding catchments.

The monitoring program has included field measurements, laboratory analyses of grab samples with spot flow measurements via stream gauging and concentrated on the catchment to the north of Queen Hill which has many historic pollutant sources.

All data collected has been housed within the Schooner water Quality Database system to enable efficient analysis and can be made available as required to other professionals working on the project. Water quality data from the 1995 Earth Systems study commissioned by MRT has also been reviewed and included in the data base.

Initial monitoring has also been undertaken at the St Dizier lease, another site for potential mining operations.

Twelve months sampling has now been completed on a quarterly basis at Zeehan and this report documents the results and preliminary findings, including recommendations for future project planning and monitoring.

2 Historic Data Sources

There are several sources of historic data. The most recent was a study done for Mineral Resources Tasmania by Earth Systems in 1999 (Mineral Resources Tasmania, Remediation Investigations & Pilot Works In The Zeehan Mineral Field by Earth Systems Pty. Ltd. September 1999).

This work was of a good standard with sample collection and water gauging by HEC Tasmania. The sites sampled are shown in **Table 1**. These all the catchments draining to the Little Henty River.

Sample No.	Location	Grid Reference	Sampled 19/2/99	Sampled 11/03/99	Sampled 18/5/99
ZH001	Little Henty River at Strahan Road Bridge	(GR 645 547)	✓	✓	✓
ZH002	Zeehan Rivulet at Zeehan Hwy	(GR 630 609)	✓	✓	✓
ZH003	Pea Soup Creek above Zeehan Rivulet	(GR 616 622)	✓	✓	✓
ZH004	Zeehan Rivulet above Pea Soup Creek	(GR 618 622)	✓	✓	✓
ZH005	Queen No. 4 Shaft	(GR 604 618)	✓	✗	✗
ZH006	Silver Lead Creek above Queen No. 4 Shaft	(GR 603 617)	✓	✓	✗
ZH007	Zeehan Rivulet at Parting Creek Road	(GR 612 633)	✓	✓	✗
ZH008	Little Henty River at Zeehan Hwy	(GR 634 612)	✓	✗	✗
ZH009	Oonah South Workings	(GR 604 622)	✓	✗	✗
ZH010	Nike Creek above Pea Soup Creek	(GR 617 620)	✗	✗	✓
ZH011	Pea Soup Creek above wetland	(GR 603 620)	✗	✗	✓
ZH012	Oonah Creek above wetland	(GR 606 623)	✗	✗	✓

Table 1 Earth Systems Sampling Sites

The main conclusions and findings are set out below;

The water quality within Silver Lead Creek above Pea Soup Wetland is relatively good, with this catchment a small contributor of load. Pea Soup Creek above Pea Soup Wetland provides a more significant contribution to load particularly with regard to iron and acidity. The contribution to zinc load is low.

Water quality data from Oonah Creek indicates that this is a major source of pollutants. Acidity, iron, zinc, cadmium and lead loads are high, particularly if catchment size is used to estimate flow. Flow was difficult to determine from Oonah Creek because the creek bed is filled with mining wastes, probably resulting in substantial sub-surface flow.

The contribution of Pea Soup Wetland and the northern part of Queen Hill to pollutant load is difficult to quantify due to the number of diffuse pollutant sources within the wetland. Two of these sources were sampled (Queen No. 4 Shaft, Oonah South) and the results were indicative of severe acid drainage. Whilst Pea Soup Wetland is undoubtedly effective to some degree in acid drainage remediation (eg. trapping iron hydroxides, placing some sulphidic materials in an aqueous environment), there is a cumulative contribution from a number of sources in and around this wetland that probably contributes significantly to load. After Oonah Creek the area draining into the wetland is probably the second most significant source of pollutants to Pea Soup Creek.

Pea Soup Creek downstream of Pea Soup Wetland is thought to supply some pollutants to the catchment (eg. from sources such as Poverty Point, Donnelly's Lode) although its contribution like its catchment area is thought to be small. This is supported by field water quality sampling which indicates similar pH and conductivity values in Pea Soup Creek below

The Main Findings were;

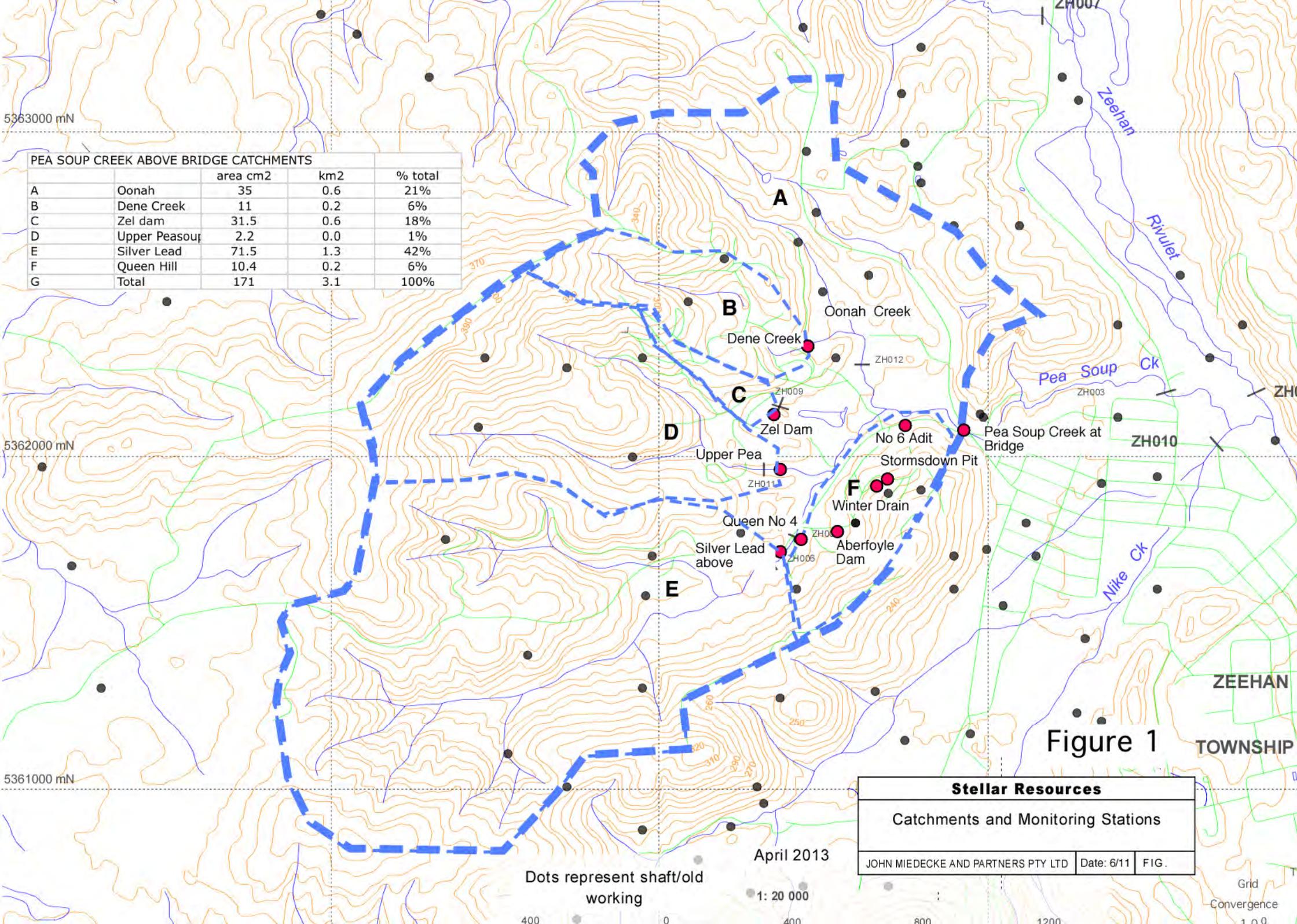
- Confirmation that the major pollutant loads in the Zeehan Rivulet are sourced from the area of the Zeehan Mineral Field draining into Pea Soup Creek (consistent with Parrs' conclusions).
- The major pollutant loads in Pea Soup Creek are derived from Oonah Creek, diffuse sources around Pea Soup Wetland (eg. Queen No. 4, Queen No. 5) and Pea Soup Creek, and
- Zinc lead, cadmium and aluminium are the contaminants most likely to be of ecological concern derived from the Zeehan Mineral Field.

These findings were used to concentrate the study area to Pea Soup Creek above the Corinna Road Bridge and in particular the possible source from the Queen Hill catchment and workings. This is discussed in the following sections.

The data for the other catchments is adequate for a minimum baseline and should be repeated as project commencement is eminent.

3 Monitoring sites and catchments

The map of monitoring sites is shown in **Figure 1** and includes catchment boundaries and monitoring sites. Site details are shown in Appendix A. As noted above more general historic water sampling covers the catchments draining to the Little Henty River (Earth Systems, 1999).



PEA SOUP CREEK ABOVE BRIDGE CATCHMENTS

		area cm2	km2	% total
A	Oonah	35	0.6	21%
B	Dene Creek	11	0.2	6%
C	Zel dam	31.5	0.6	18%
D	Upper Peasoup	2.2	0.0	1%
E	Silver Lead	71.5	1.3	42%
F	Queen Hill	10.4	0.2	6%
G	Total	171	3.1	100%

Figure 1 ZEEHAN TOWNSHIP

Stellar Resources
 Catchments and Monitoring Stations

JOHN MIEDECKE AND PARTNERS PTY LTD | Date: 6/11 | FIG.

April 2013

Dots represent shaft/old working

1: 20 000

Grid Convergence 1 0 0

5363000 mN

5362000 mN

5361000 mN

400 0 400 800 1200

The Queen Hill catchment is a small portion of the larger catchment monitored by the downstream sample site ‘Pea Soup Creek at Corinna rd Bridge’. The larger catchment includes other sources of ARD including the Montana workings, Oonah workings, tailings and other waste within the wetland in the lower lying catchment. The figure also shows documented locations of old workings (Source ; Earth Systems , MRT). The wetland is also the former site of a breached tailings dam (Ray Hazeldene *pers comm*).

Table 2 shows the catchment areas of the sampling sites (based on topography) and GDA locations.

Site Name	Data Owner	Catchment Area km2	Catchment Area Ha	Easting	Northing
Pea Soup Creek at Corinna rd Bridge (PeaatBr)	Stellar	3.1	100	361039	5362254
Silver Lead Creek above #4 Shaft (AgPbNo4)	Stellar	1.3	42	360532	5361924
Queen Hill Shaft #4 (Q4)	Stellar	0.2	6	360541	5361931
Storms Down Pit Overflow (SDPit)	Stellar	#1	#1	360794	5362110
Winter Drain Near Stormsdown Pit (WD)	Stellar	#1	#1	360786	5362097
Aberfoyle Dam at Overflow (AberDam)	Stellar	#1	#1	360614	5361962
Queen Hill Adit #6 (Adit6)	Stellar	#1	#1	360692	5362164
Upper Pea Soup Creek (at track crossing)	Stellar	0.6	18	360502	5362149
Zel Dam Outlet	Stellar	<0.1	1	360483	5362298
Dene Creek at v-notch	Stellar	0.2	6	360597	5362528
Webber Creek at Old Rail Line	Stellar			365717	5362645
St Dizier Creek above Tunnel	Stellar			344948	5368106

Table 2 Sites with catchment areas and coordinated (GDA 94)

Additional sampling sites were added to the program in October 2012 after the initial sampling confirmed that there was a significant missing pollutant source to the north of Pea Soup Creek. Stellar Resources constructed an access tracks to allow these sampling sites to be accessed (Upper Pea, Zel Dam, Dene Creek). Additional sampling was also undertaken at St Dizier Creek and Webber Creek (tailings dam site).

4 Current Water Quality

4.1 Pea Soup Creek Catchment

The water quality of the downstream monitoring site ‘Pea Soup Ck at Corinna Road Bridge’ has been used to assess the current impact of historic mining activities on the catchment and refine previous work. The data from this site is presented in **Table 3** ith the relevant ANZECC guidelines.

The possible contribution from the Queen Hill workings as a portion of the pollutant load monitored was the major objective, as mining will occur on the Queen Hill deposit (possibly by both open pit and underground mining).

The relative contribution of the Queen Hill workings is discussed later within the document.

The data suggests that the metal concentrations within the Creek are above the ANZECC trigger levels that are likely to be toxic to 80% of species for copper, lead, nickel and zinc (also cadmium). The lead and zinc levels are much higher than the trigger levels and

Date_Time	Average	ANZECC trigger 80%	Factor Exceed	Local tests/comments
Zinc (Total) as Zn mg/L	2.0	0.031	65	0.68 #3
Zinc (Dissolved) as Zn mg/L	1.4	0.031	45	0.68 #3
Lead (Total) as Pb mg/L	0.18	0.0094	19	
Lead (Dissolved) as Pb mg/L	0.17	0.0094	18	
Copper (Dissolved) as Cu mg/L	0.028	0.0025	11	0.035 #2 0.065 #3
Copper (Total) as Cu mg/L	0.025	0.0025	10	
Cadmium (Dissolved) as Cd mg/L	0.0046	0.0008	5.7	
Cadmium (Total) as Cd mg/L	0.0046	0.0008	5.7	
Nickel (Dissolved) as Ni mg/L	0.029	0.017	1.7	
Nickel (Total) as Ni mg/L	0.029	0.017	1.7	
Manganese (Dissolved) as Mn mg/L	2.4	3.6	0.67	
Manganese (Total) as Mn mg/L	2.3	3.6	0.64	
Arsenic (Total) as As mg/L	0.021	0.14	0.15	
Arsenic (Dissolved) as As mg/L	0.0057	0.14	0.041	
Chromium (Dissolved) as Cr mg/L	0.0012	0.04	0.03	
Chromium (Total) as Cr mg/L	0.001	0.04	0.025	
Acidity to pH 8.3 mg/L (CaCO ₃)	39			
Aluminium (Dissolved) as Al mg/L	0.9	ID		
Aluminium (Total) as Al mg/L	0.86	ID		
Calcium (Dissolved) as Ca mg/L	6.7	ID		
Chloride as Cl mg/L	17			
Cobalt (Dissolved) as Co mg/L	0.011	ID		
Cobalt (Total) as Co mg/L	0.01	ID		
Conductivity Field @ TRef 25 uS/cm	330			
Dissolved Organic Carbon mg/L	1.5			#4
Flow L/sec	130			
Iron (Dissolved) as Fe mg/L	8.1	ID		
Iron (Total) as Fe mg/L	8.1	ID		
Magnesium (Dissolved) as Mg mg/L	6.7			
pH field - sensor TC	3.5			
Potassium (Total) as K mg/L	0.87			
Sodium (Total) as Na mg/L	9.8			
Sulphate as SO ₄ mg/L	80	?		1700 #3
Total suspended solids (0.45um) mg/L	17			
Water Level (Flow) m	0.19			
Water Temperature Degrees C	11			

Table 3 – Water Quality at the Pea Soup Creek at Corinna rd Sample Site with ANZECC Guidelines and Local toxicity data

#1 Based on As V which is considered more toxic than As III, #2 Based on testwork conducted at Savage River (R. Eriksen 2002) #3 EC50 Toxicity results using local fauna for Zinifex (R. Eriksen 2007) #4 Local based tests carried out on water between 6 and 11 mg/L (R. Eriksen 2007)

should be targeted in any future remediation program. The levels will form a base-load for future operations being pre-existing pollutant loads.

4.2 St Dizier

The St Dizier Creek is situated amongst obvious alluvial mining activity from early last century. The water quality within the creek is good with only slight elevation of zinc and sulphate which may be associated with previous mining activity. It is not expected that there would toxicity associated with the zinc due to the dissolved organic carbon, typical of West Coast streams.

4.3 Webber Creek (possible tailings dam site)

The Webber Creek has been monitored on only one occasion. The analysis from this sampling represents good water quality. There is again minor elevation of zinc.

5 Mass loads from monitoring sites

For the calculation of mass loads, the different monitoring sites are sampled with the concentration of pollutants measured. The flow is also measured at the time of sampling and the mass loads are calculated by multiply the concentration and the flow. This enables the pollutant loads from the different sources to be compared with the total load within the catchment and significance assessed.

Table 1 shows a summary of the 12 months data and the average percentage load for each site within the Pea Soup catchment for the different parameters of interest are presented. The ‘Pea at track Crossing’, and ‘Dene Creek sample sites were only measured on the last two sample runs. The other sites were sampled 5 times.

Parameter	Aberfoyle Dam	Dene Creek	Upper Pea	QH Adit 6	QH Shaft 4	Silver Lead Ck	Storms Down Pit	Winter Drain	% Unquantified
Acidity (CaCO ₃ eq)	1.1	6.4	21.1	0.18	20.0	10.4	0.03	0.18	40.5
Sulphate (Total)	0.6	4.7	8.6	0.09	11.4	8.4	0.01	0.08	66.0
Aluminium (Total)	1.7	8.8	30.2	0.29	11.1	10.8	0.02	0.19	36.8
Copper (Total)	1.4	19.4	63.0	0.01	3.9	10.8	0.01	0.09	1.5
Iron (Total)	1.5	4.8	24.2	0.39	40.9	16.6	0.03	0.14	11.4
Manganese (Total)	0.1	2.5	1.0	0.06	8.6	16.7	0.00	0.00	71.0
Lead (Total)	0.2	5.4	3.5	0.10	3.3	3.7	0.03	0.29	83.5
Zinc (Total)	0.1	5.3	1.2	0.17	11.1	7.3	0.02	0.11	74.6

Table 1 – Proportion of the Pea Soup at Corinna Rd load (%) for the different sources within the catchment. Includes the percentage of load unquantified.

The Table shows that the majority of the input load for sulphate, manganese, lead and zinc remain unquantified (source not identified). Relevant important contaminants/indicators are discussed below.

Zinc

In **Figure 2** the mass load of zinc for the different sample sites within the Pea Soup catchment above the Corinna Road Bridge is presented. **Figure 3** presents the same data with the total mass load from the catchment. By comparing the graphs it can be seen that the majority of the zinc load has not been quantified. Queen Hill Shaft no. 4 and Dene Creek are the largest zinc sources monitored.

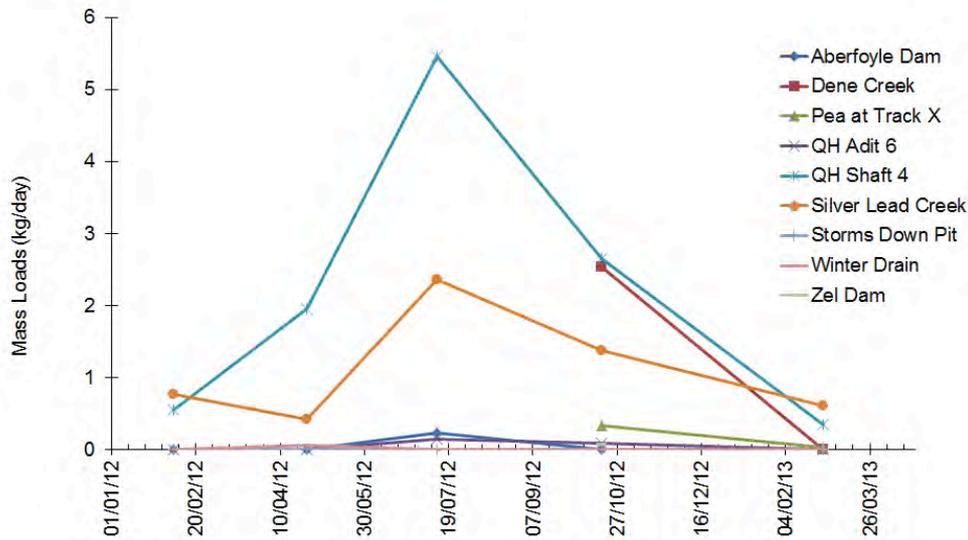


Figure 2 - Total zinc load over time for the individual sources within the Pea Soup Catchment.

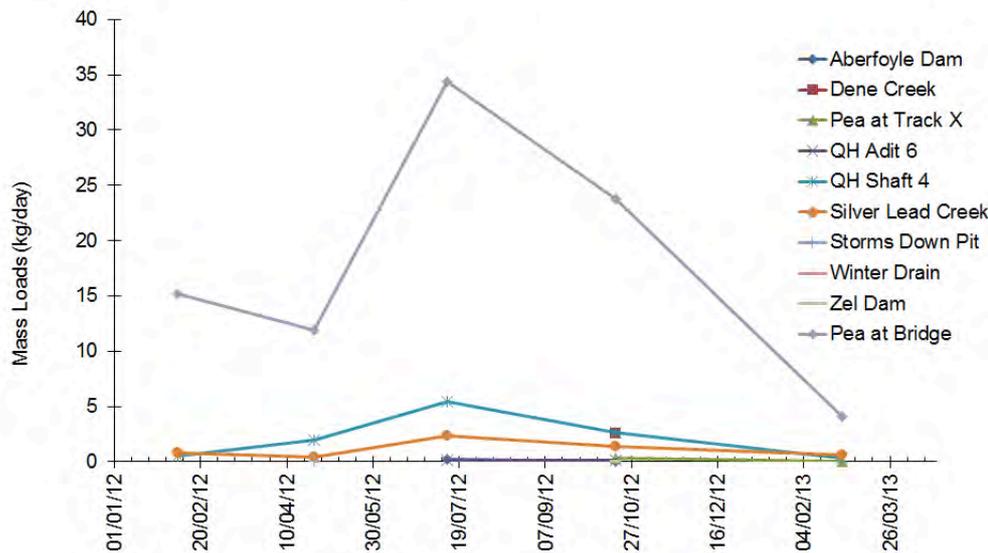


Figure 3 - Total zinc load over time for the Pea Soup Catchment and the individual sources

Lead

The majority of the lead load within the catchment has not been identified. In **Figure 4** the lead load from other sources are relatively small compared to the total load measured at the Pea Soup at Corinna Rd Bridge sample site. This may suggest that the lead is coming from a diffuse source such as tailings within the wetlands. Lead may be present within the ARD producing material but may not be released as it forms insoluble lead sulphate.

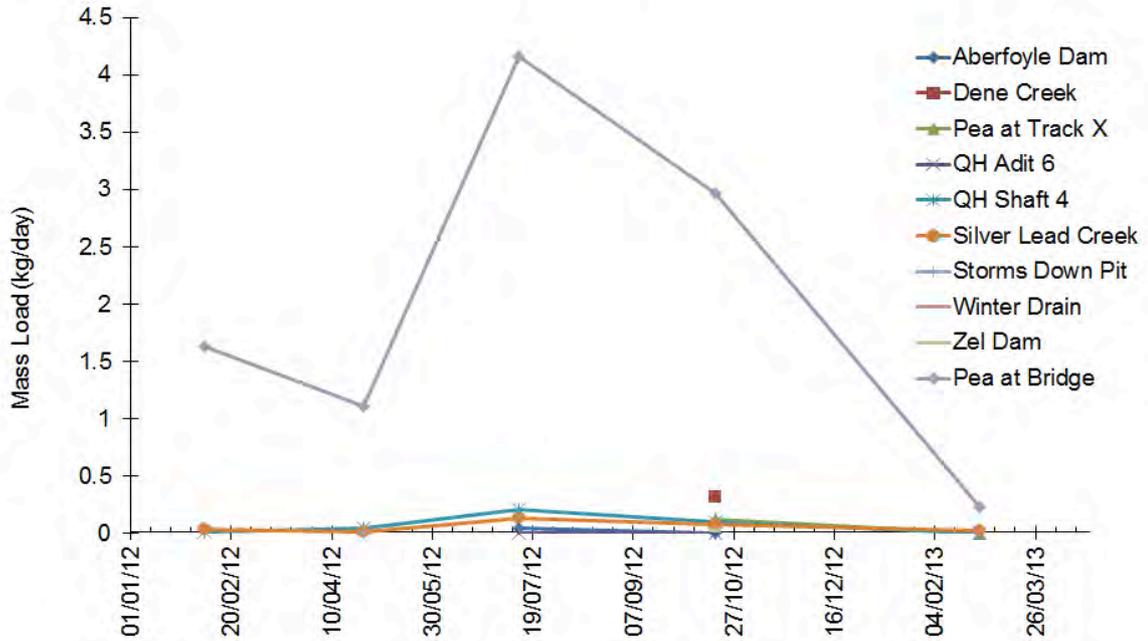


Figure 4 - Total lead load over time for the Pea Soup Catchment and the individual sources

Manganese, Sulphate and Aluminium

The mass loads for Manganese show similar trend and loads as zinc with the exception that the Silver Lead Creek appears to provide a relatively consistent manganese load of 5kg/day for all sampling events. Likewise the mass loads for aluminium also follow a similar trend with about half the zinc load.

Iron

Figure 5 shows the iron load data. Iron may be getting removed by the wetlands located above the Corinna Rd Bridge and the areas of iron deposition within the catchments such as within the Zel Dam and downstream of the dam. Given the iron removal processes within the catchment it is likely the majority of the iron load has not been identified.

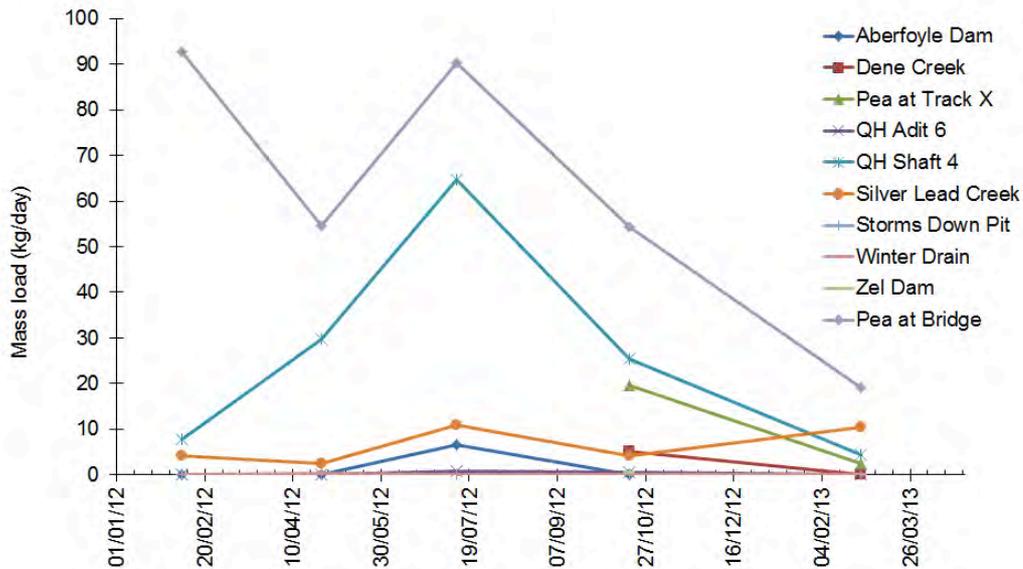


Figure 5 - Total iron load over time for the Pea Soup Catchment and the individual sources

Copper

Figure 6 shows the copper load data. The copper load from the Queen Hill sources are a relatively small in comparison to the catchment mass load. The western sources such as the upper Pea Soup Creek (Pea at Track X) and Dene Creek which drains the Oonah working are larger copper contributors. As these Western catchment sources have only been sampled a couple of time, further sampling is required to validate this conclusion.

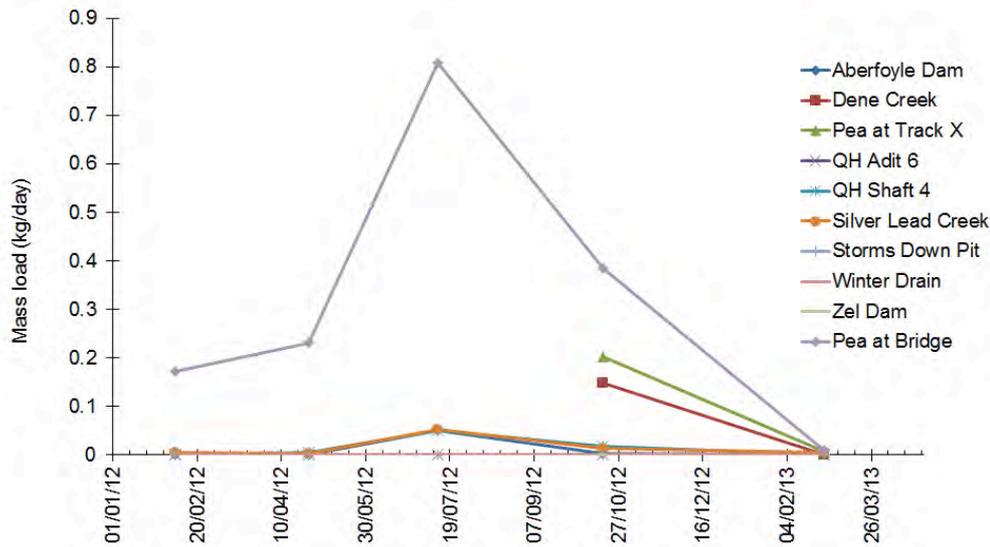


Figure 6 - Total copper load over time for the Pea Soup Catchment and the individual sources

Acidity

The acidity loads are presented in **Figure 7**. The major contributor from the Queen Hill Shaft No. 4 sample site averages 80 kg/day CaCO₃ equivalent. This would cost in the order of \$50 to \$100 per day to neutralised. Much greater loads would have to be neutralised in the event of drawing down the water table beneath Queen Hill and in the event of an open pit or acid forming rock being left exposed to oxygen. The control of acid generation will be an important requirement of future operations undertaken at Queen Hill.

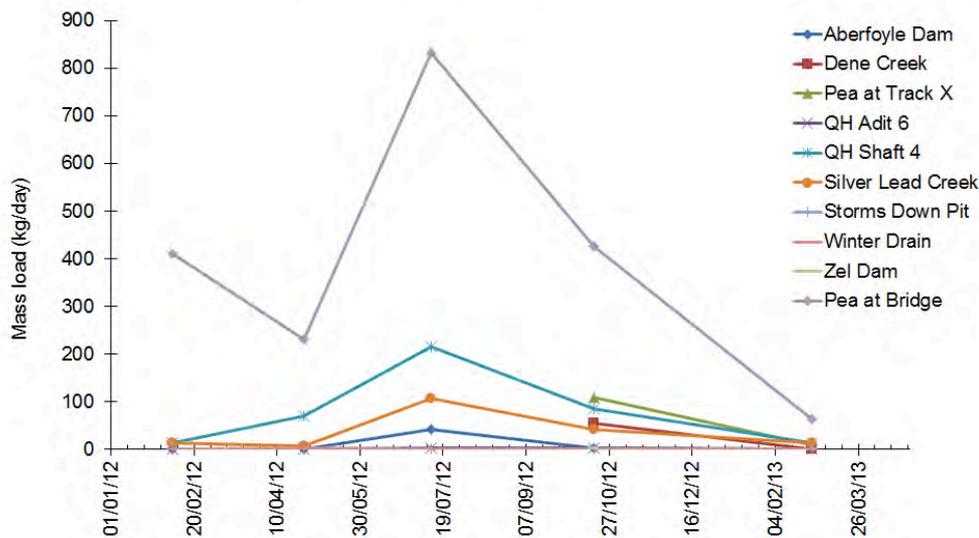


Figure 7 - Total acidity (CaCO₃ eq) load over time for the Pea Soup Catchment and the individual sources

6 Conclusions

Water monitoring to quantify the main contaminants to Pea Creek have confirmed the major contaminants as acidity, sulphate, copper, lead, nickel and zinc (also cadmium).

The Queen Hill catchment loads (including existing adits, mine workings and shaft drainage), while significant are not the major source. This will be important for project planning.

The major pollutant loads in Pea Soup Creek haven not been quantified and are believed to be in the catchment of Oonah Creek which drains from the north to Pea Soup Creek. This consists of a marshy low lying area where access is very difficult and possible drainage from the Oonah and Montana mine workings.

7 Further monitoring

Limited monitoring has been undertaken to try and quantify the missing sources that contribute to the Pea Soup catchment. This has involved exploring the low lying wetland areas of the Oonah Creek catchment. The thick vegetation has hampered efforts to further isolate sources. As part of the investigation the Pea Soup Creek was waded travelling upstream of the Corinna Rd Bridge. Due to the thick vegetation only a couple of 100 meters of river were investigated. No substantive inputs were identified over this stretch of river but when the section of creek waded was marked on a GIS it is likely that the contaminated waters entered the Creek along the section waded, and was not observed due to the thick vegetation. The Oonah (and Montana) Catchment is 21 per cent of the entire catchment and it is likely that the Dene Creek and a portion of the lower Wetland catchment also flow into the Creek along the stretch of River waded (~10% of catchment). While wading the conductivity was also observed to drop in the order of 20% while travelling upstream. This would suggest that a large proportion to 40% of the pollutant load is coming from the Montana and surrounding catchments.

Its is recommended that another Gauging station be placed in Pea Soup Creek above the Montana catchment area to measure the difference in flow and water chemistry. This would improve the understanding of the inputs entering lower within the catchment.

Other sampling site frequency could be reduced to 6monthly to reduce costs if required.

APPENDIX A Site Descriptions

Queen Hill sampling sites

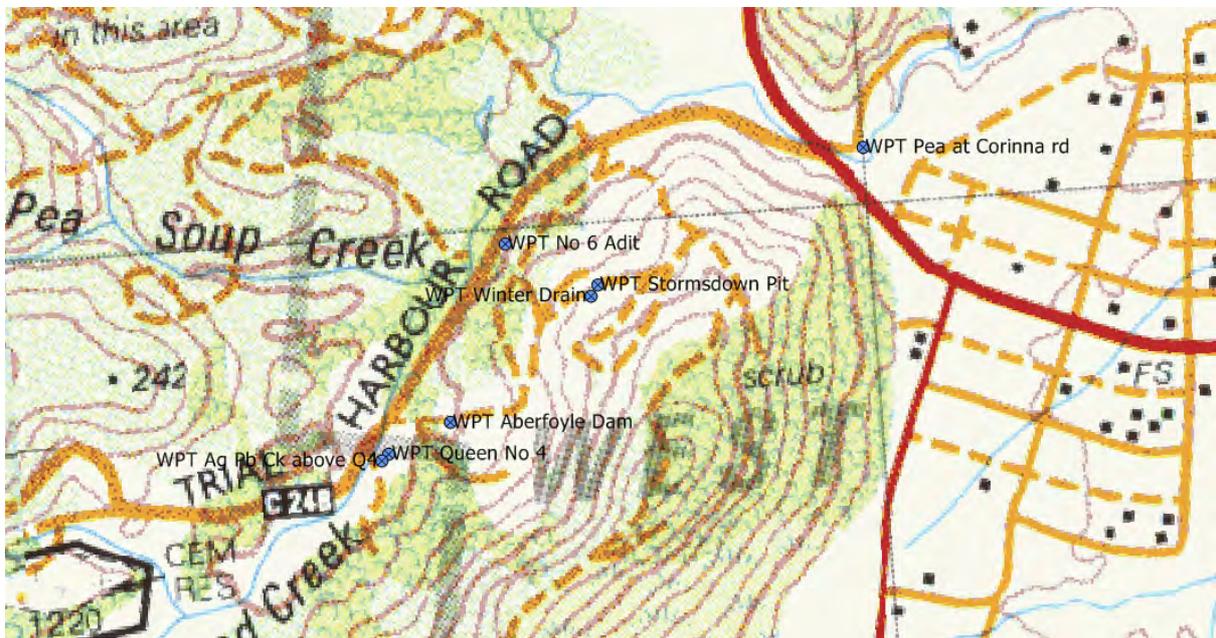
Introduction

The Queen Hill lease is being monitored to ascertain the pre existing water quality prior to further mining activity. The initial sample locations for the lease are presented in the figure below.

The Sample sites currently being monitored:

Since 7-2-2012

- Pea Soup Creek at Corinna Rd
- No 6 Adit above Trial Harbour Rd
- Queen No 4
- Silver Lead Creek above Queen No 4
- Aberfoyle Dam overflow
- Storms Down Pit
- Winter Drain



Pea Soup Creek at Corinna Rd

Sample Code for Lab submission and sample bottles PeaatBr

Sample Site Description

The sample site for this site is situated after the bend of the river approximately 40 m downstream of the bridge over the Corinna Road. This sample site is situated well downstream of the bridge to avoid localised effects of road drainage considered likely at the bridge. Downstream the road drainage is likely to be mixed into Pea Soup Creek.

Flow Measurement details

The gauge site is situated immediately upstream of the Bridge prior to water flowing into the culverts. The gauge board is situated precisely halfway between the 2 culverts with 0 level being at the well-defined corner between the vertical face of the bridge and the horizontal platform upstream of the bridge (See photo below taken before gauge boards were fitted, but Danny is standing in front.



No 6 Adit above Trial Harbour Rd

Sample Code for Lab submission and sample bottles Adit6

Sample Site Description

The adit is situated in bush about 10 meters from the Trial Harbour road. The sample is generally taken from the piped overflow prior to flow measurement.

Flow Measurement details

Flow measurement is taken by timing the rate at which a bucket fill from the pipe that has been dammed into the outflow of the adit. It is important to not disturb the pipe during both flow measurement and sampling if possible.

Queen No 4

Sample Code for Lab submission and sample bottles *Q4*

Sample Site Description

The Queen No 4 surfaces in man-made ponds within a fenced enclosure. The pond then drain to Pea Soup Creek via a poly pipe that runs several meters downstream.

Flow Measurement details

Flow measurement is taken by timing the rate at which a bucket fills from the pipe that drains the ponds to Pea Soup Creek. It is important to not disturb the pipe during both flow measurement and sampling if possible. The location of the

Silver Lead Creek above Queen No 4

Sample Code for Lab submission and sample bottles *AgPbNo4*

Sample Site Description

The Silver Lead Creek is sampled upstream from the Queen No4 ponds where the gauge board is situated (see photo below). Care should be taken not to disturb the Creek bed near Queen No 4 as the control for flow measurement is made from poorly consolidated material.



Flow Measurement details

Flow measurement is obtained by taking the water level from the gauge board. Gaugings are also taken from this location with care not to disturb the control which is made from loose rock and sediment. The 0 point for the gauge board is taken from the control being pointed at in the picture below. The control is made from a rio metal painted with fluoro paint. The 0 point for the gauge board is 1.443m below the top of the control.



Aberfoyle Dam overflow

Sample Code for Lab submission and sample bottles *AberDam*

Sample Site Description

The Aberfoyle Dam is situated about 80m from Queen No 4 to the right of the unsealed road that heads up toward Queen Hill. The site is a small dam with a v notch weir built at its outflow.

Flow Measurement details

The flow measurement at this site is made by recording the v-notch level and calculating using the 90 degree v-notch table or formula.

Storms Down Pit

Sample Code for Lab submission and sample bottles *SDPit*

Sample Site Description

Storm Down Pit is drained by a small drain that runs across a unsealed road. The drain only flows intermittently during the drier months. The water then flows through pipes that are used for sampling and flow measurement. The pipes are secured by sandbags as seen in the photo below

and will need to be maintained as required. The water samples are taken prior to any disturbance of the pipes, sandbags or the water as it drains over the road.



Flow Measurement details

Flow measurement is taken by timing a bucket to fill to a known volume from the pipes.

Winter Drain

Sample Code for Lab submission and sample bottles *WD*

Sample Site Description

The winter drain originates from diffuse sources above and to the south of the Storms Down Pit. The sampling and flow measurement are the same as for the drainage for the Storms Down Pits

Flow Measurement details

As for the Storms Down Pits.