



**ENVIRONMENT PROTECTION SECTION
CORNWALL AREA**

FINAL REPORT

**DELABOLE STREAM
(Abandoned Minewater)
WATER QUALITY INVESTIGATION
(TOTAL ZINC)**

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ENVIRONMENT AGENCY

Information Services Unit

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1. INTRODUCTION

1.1. Background

The Delabole Stream has been shown to experience elevated total Zinc concentrations downstream of Delabole slate quarry. Data from upstream of the quarry show Zinc concentrations to be generally low. The quarry is in the process of being consented for Zinc under the Dangerous Substances Directive.

Data since 1994 show that all sites on the Delabole Stream downstream of the quarry would have exceeded the current River Quality Objective (RQO) standards for Zinc, had there been designation.

An investigation in 1999 showed the quarry to be a significant source Zinc to the catchment. However, it was also found that abandoned mine workings discharging into the quarry were contributing significant Zinc loadings. Until the impact of this minewater discharge can be assessed, the consenting process can not be satisfactorily progressed.

1.2. Objectives

To provide data of Zinc loadings into Delabole slate quarry from the previously identified source of abandoned minewater drainage.

2. METHODS

Harmonised collection of water quality samples and hydrometric measurements from the identified abandoned minewater discharge and other relevant surface water sites associated with the consenting issue.

3. RESULTS

3.1. The survey area investigated is illustrated in Figure 1.

3.2. A summary of the data obtained during the investigation is set out in Figures 2 & 3.

3.3. The complete data sets from the 1999 and 2001 investigations are set out in the appendix.

4. OBSERVATIONS

4.1. The standard for total Zinc in fresh water, under the Dangerous Substances Directive, is dependent upon water hardness. The hardness of the Delabole stream has been seen to typically range between 50 and 100mg/l CaCO₃. The standard for a site along this watercourse would likely be 0.05mg/l. This stretch of the Delabole Stream would likely be non-compliant for Zinc under the Dangerous Substances Directive.

4.2. During this investigation, the Delabole stream was again seen to experience little significant Zinc contamination upstream of the slate quarry.

4.3. The concentration of total Zinc discharging from the abandoned mine workings was recorded at between 0.28 and 1.06mg/l (mean of 0.6mg/l), at a mean load of >0.2mg/s. *(NB February surveys (see Section 6) not used to calculate mean load due to absence of flow data, hence use of greater than here).*



- 4.4. The discharge from the abandoned mine workings constitutes a continuous source of Zinc to the quarry.
- 4.5. Total Zinc concentrations in the quarry discharge were recorded at between 0.58 and 0.65mg/l, with a calculated load of 19.3mg/s. (Recorded during a pumped discharge)
- 4.6. Total Zinc concentrations downstream of the quarry were recorded at between 0.57 and 0.65mg/l, with a calculated load of 21mg/s. (Recorded during a pumped discharge)
- 4.7. All waters within the quarry accumulate in a lagoon. From this lagoon water is drawn off for use in cutting/processing and the surplus is discharged to the Delabole stream via an old adit/culvert.
- 4.8. During the 1999 investigation surface water from the lagoon was shown to contain 0.69mg/l Zinc (total). In the current investigation levels of between 0.50 and 0.60 mgZn/l were recorded from the lagoon surface. These figures are of similar magnitude to that of the quarry final discharge to the Delabole Stream. The relationship between Zinc concentrations in the adit minewater, the quarry lagoon and quarry final discharge is illustrated in Figure 3.
- 4.9. The concentration of Zinc in the quarry lagoon would be expected to be a factor of the abandoned minewater input, dilution from the various clean water inputs to the quarry and evaporation from the surface of the lagoon. Also, as the area appears to have been subject to some degree of mineralisation, it is possible that quarrying and processing might expose and mobilise minerals, thereby contributing to the Zinc concentrations.
- 4.10. The concentration of Zinc in the quarry final discharge would be expected to be a factor of the lagoon quality and any other inputs (point or diffuse) between the lagoon and the final discharge point.
- 4.11. The sampling was undertaken over several months in order to record a range of weather and groundwater flow conditions. The groundwater level had been expected to rise during the sampling period, but September proved to be atypically dry. As a result the data set is limited to dry weather flow conditions. The higher groundwater levels observed in the late winter/early spring might result in concentrations and loadings significantly different from those recorded during the survey period. Further sampling during the winter might be advisable if time allows. *(This additional supplementary work (see Section 6) has now been undertaken).*

5. RECOMMENDATIONS

- 5.1. The primary action following this work will be the setting of consent conditions for the quarry discharge and the designation of the sampling point downstream of the discharge.

Action: EPI Consenting Team

- 5.2. The integrity of the culvert forming the quarry discharge should be considered. At the moment this discharge is diffuse across a large area of spoil face. This might lead to problems with sampling and obtaining representative and consistent data.

Action: EPI Consenting Team

- 5.3. ~~An additional sampling run in January/February might prove beneficial, should the consenting issue remain unresolved at that time.~~

Action: EPr Investigations Team
WR Hydrometric Team

6. SUPPLEMENTARY

Recommendation 5.3 has been carried out subsequent to the draft report circulation. Two surveys were conducted in early February, (04/02/02 and 12/02/02).

Flow rates were too great to be recorded on both occasions, but concentration data has been included in the report (Figures 2 & 3 and also in the Appendix table of data) and some text has been updated. Flow rates were arbitrarily estimated as being >1 litre per second in order to illustrate the relative loadings on these occasions.

The data from the February surveys illustrates well how the Zinc concentration can vary, with both an average and a high result being recorded within a few days of one another. Correlation of Zinc concentration against rainfall was considered (Figure 3), but this proved inconclusive. Should the range of concentrations and loadings recorded create problems in the determination of the consent conditions, further sampling could be arranged.

Figure 1. Delabole quarry & catchment survey area.

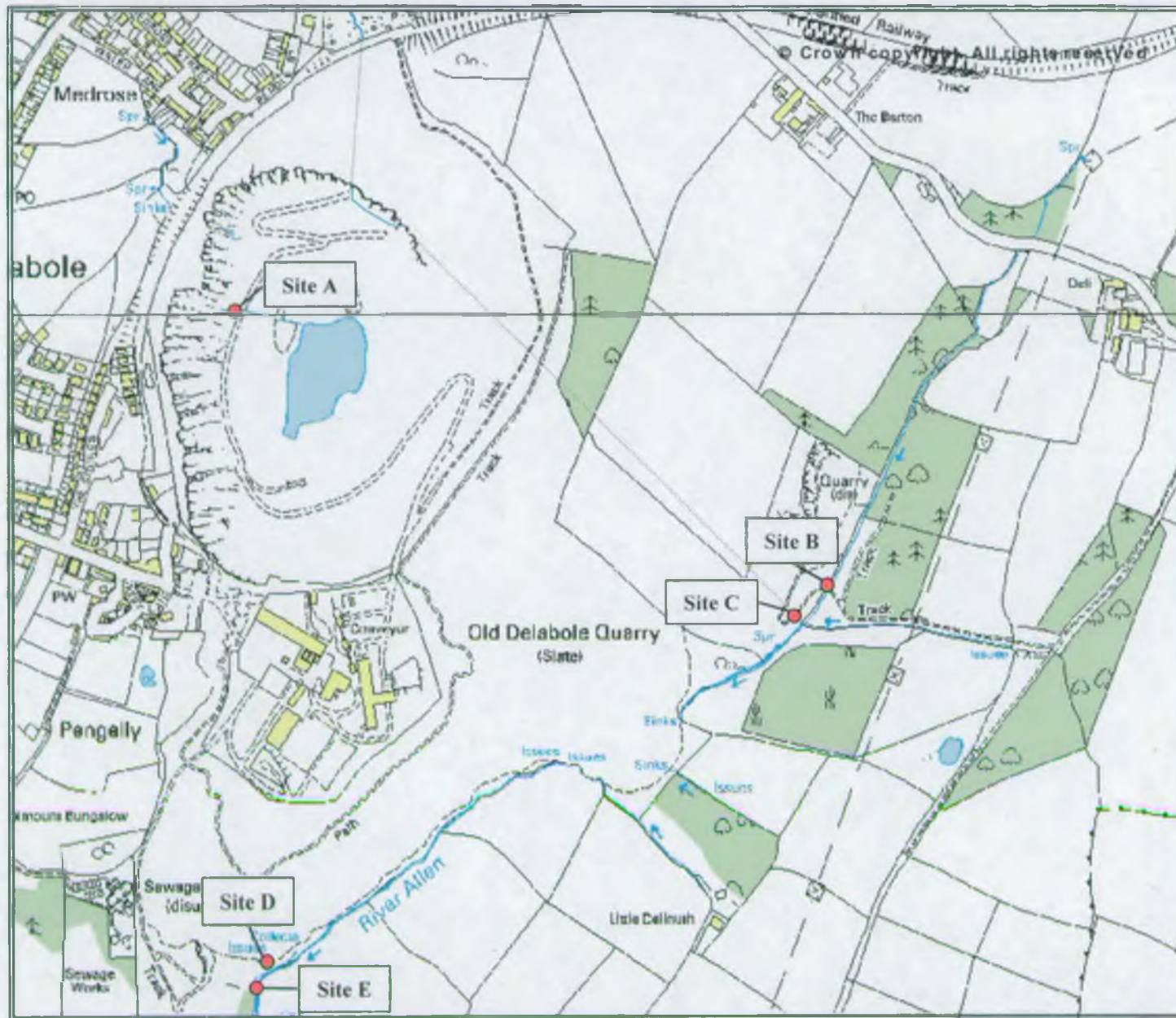
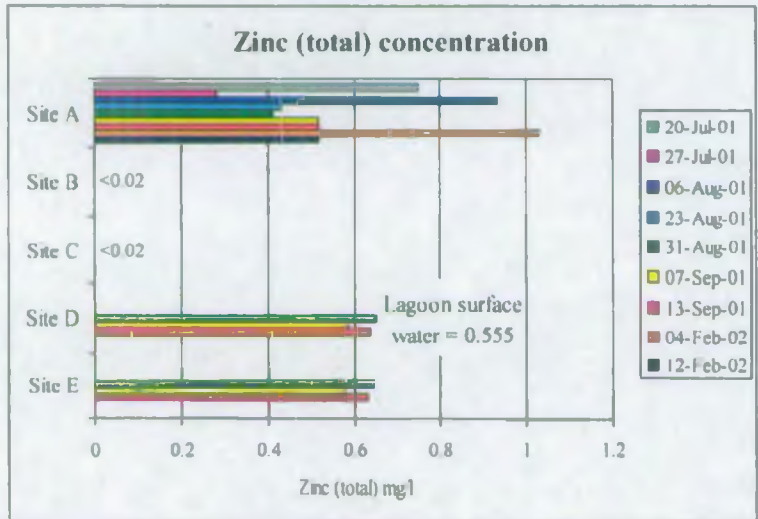
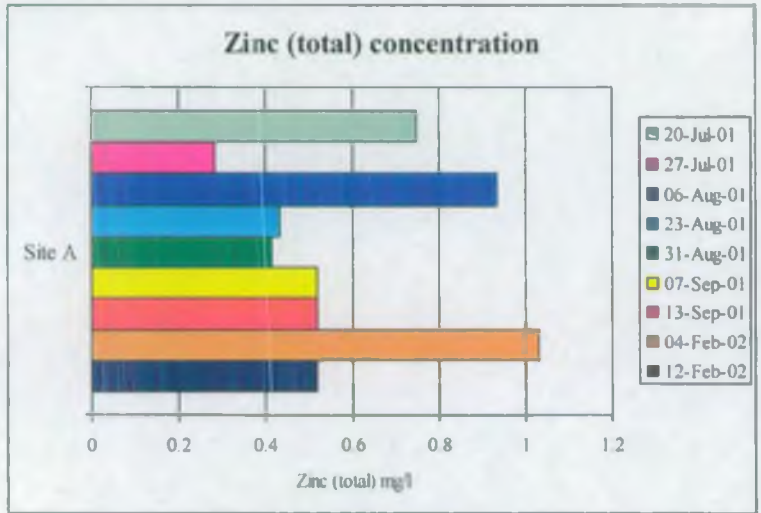
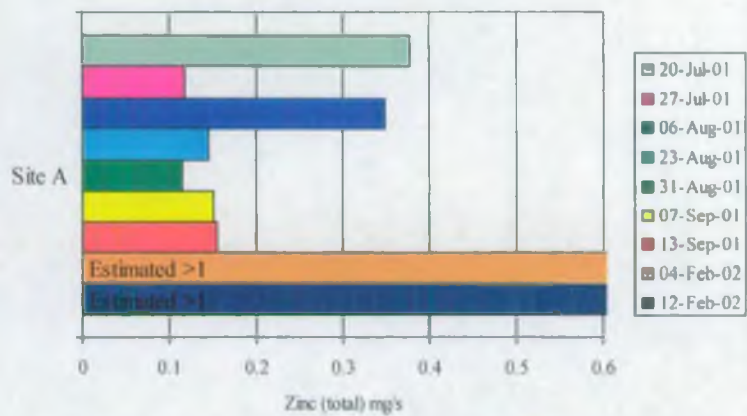


Figure 2. Summary of survey data.



Zinc (total) loading



Zinc (total) loading

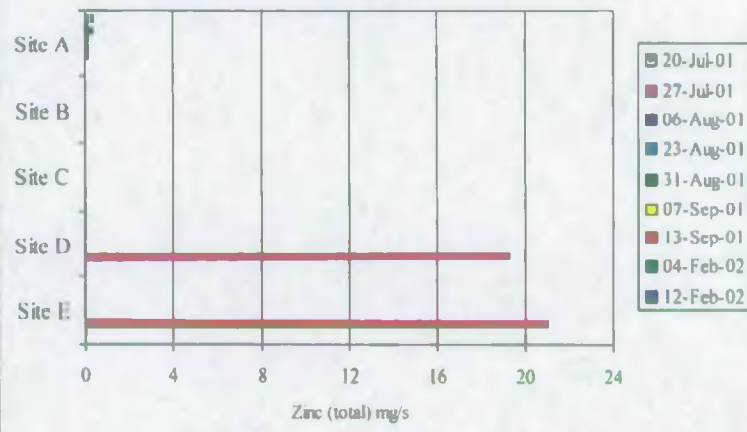
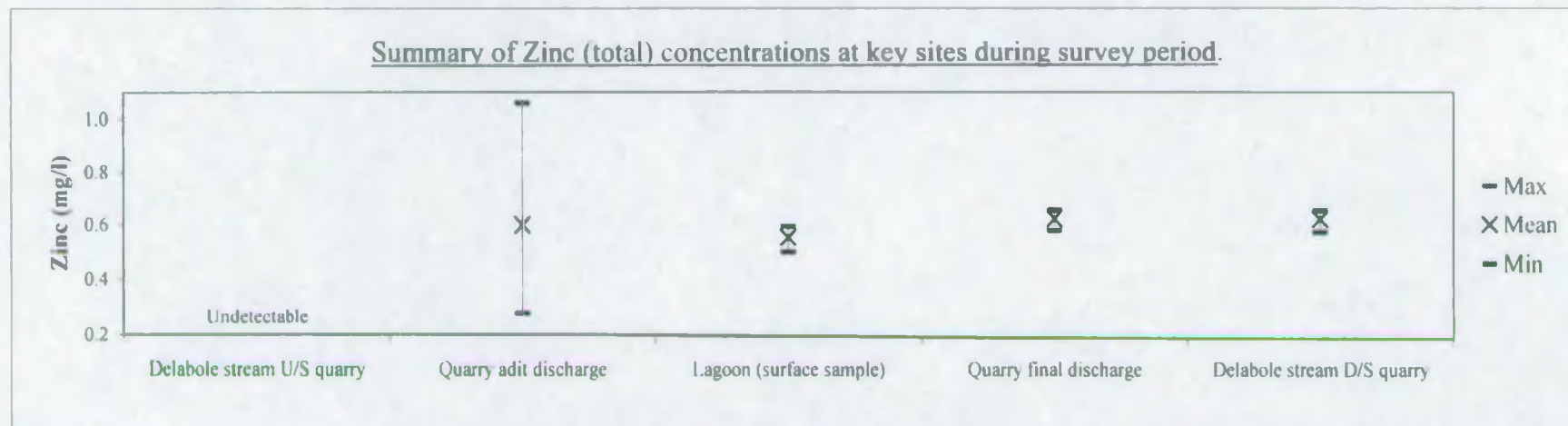
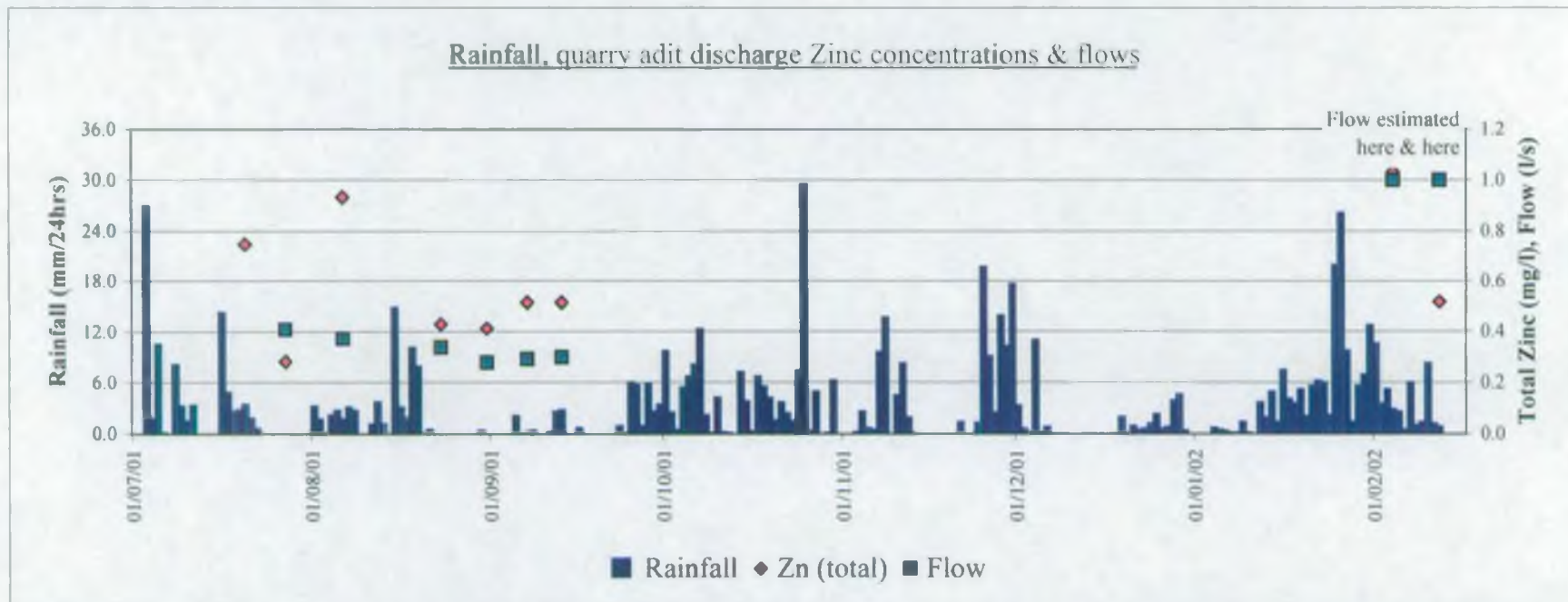


Figure 3. Further summary of survey data.



APPENDIX

Delabole Quarry (adit discharge) monitoring 2001 - Zinc (total & dissolved).

	A - Quarry adit SX 074 840					B - Delabole stream u/s site SX 08168 836653					C - Trib through quarry SX 08152 83661					D - Discharge from quarry SX 0742 8319					E - Stream d/s of quarry SX 0741 8313					
	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s	
20/07/01	0.747	0.740																								
	0.749	0.753																								
Mean	0.748	0.747		0.505	0.378				1					1												
27/07/01	0.279	0.301				0.005	0.005				0.005	0.005														
	0.285	0.287				0.005	0.005				0.005	0.005														
Mean	0.282	0.294	7.7	0.417	0.118	0.005	0.005	6.92	1	0.000	0.005	0.005	7.43	1	0.000											
06/08/01	0.913	0.933				0.020	0.020				0.020	0.020														
	0.925	0.945				0.020	0.020				0.020	0.020														
Mean	0.933	0.935	7.2	0.373	0.348	0.020	0.020	7	1.5	0.000	0.020	0.020	7.5	1.5	0.000											
23/08/01	0.352	0.483				0.020	0.020				0.020	0.020														
	0.475	0.492				0.020	0.020				0.020	0.020														
Mean	0.465	0.487	7.16	0.338	0.146	0.020	0.020	7.15	0.7	0.000	0.020	0.020	7.28	1.4	0.000											
31/08/01	0.408	0.412				0.020	0.020				0.020	0.020														
	0.407	0.421				0.020	0.020				0.020	0.020				0.655	0.656				0.654	0.652				
	0.425	0.430				0.020	0.020				0.020	0.020				0.648	0.650				0.653	0.659				
Mean	0.413	0.421	7.6	0.278	0.115	0.020	0.020	6.8	0.3	0.000	0.020	0.020	7.2	1.4	0.000	0.652	0.653	7.2			0.654	0.656	7.2			
07/09/01	0.515	0.506				0.020	0.020				0.020	0.020														
	0.498	0.509				0.020	0.020				0.020	0.020				0.581	0.589				0.573	0.577				
	0.538	0.516				0.020	0.020				0.020	0.020				0.587	0.576				0.584	0.586				
Mean	0.517	0.510	7.8	0.292	0.151	0.020	0.020	7.2	0.3	0.000	0.020	0.020	7.6	1.1	0.000	0.584	0.583	7.4			0.579	0.582	7.4			
13/09/01	0.520	0.523				0.020	0.020				0.020	0.020														
	0.516	0.522				0.020	0.020				0.020	0.020				0.638	0.647				0.637	0.618				
	0.516	0.519				0.020	0.020				0.020	0.020				0.635	0.644	Calculated			0.628	0.619		Measured		
Mean	0.517	0.521	7.5	0.3	0.155	0.020	0.020	6.9	0.6	0.000	0.020	0.020	7.3	1	0.000	0.637	0.646	6.9	30.3	19.286	0.633	0.619	6.9	33.3	21.062	
Mean	See below					0.018	0.018	7.0	0.8	0.000	0.018	0.018	7.4	1.200	0.000	0.624	0.627	7.2	30.3	19.286	0.622	0.619	7.2	33.3	21.062	

Supplementary data from additional 'high groundwater level' surveys - February 2002.

	A - Quarry adit SX 074 840					Quarry lagoon SX 0747 8396				
	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s	Total mg/l	Dissolved mg/l	pH	Flow l/s	Zn(t) load mg/s
04/02/02	1.060	1.010				0.590	0.565			
	1.020	0.943		Greater	Greater	0.578	0.545			
	1.010	0.972		than	than	0.596	0.550			
Mean	1.030	0.975		1	1.03	0.588	0.553			
12/02/02	0.515	0.506				0.532	0.503			
	0.498	0.509		Greater	Greater	0.500	0.522			
	0.538	0.516		than	than	0.534	0.520			
Mean	0.517	0.510	7.1	1	0.517	0.522	0.515	7.1		
Mean	0.60	0.60	7.4	>0.36	>0.20	0.56	0.53	7.1		

Note:

Grey text = less than values

Quarry final discharge is phased and as such these loadings are not comparable with continuous inputs.

Delabole Stream & Quarry Zinc (total) monitoring 1999.

2001 site equivalent		Total Zinc (mg/l)					
		18-Feb-99		15-Apr-99			
Site Name		Stream	Inputs	Stream	Inputs	Quarry	
A	Piped water source					0.070	
	Mine overflow					0.873	→ Mine overflow flows into quarry lagoon
	Middle spring					0.038	
	East spring					0.059	
	Lagoon water					0.694	→ quarry lagoon
	Quarry culvert					0.013	
B	Stream U/S of culvert discharge			0.011			
C	Culvert prior to stream				0.014		
	D/S culvert & tributary	0.003					
	U/S issue	0.006					
	Large issue		0.010				
	Issue U/S outcrop		0.003				
	Stream through marsh	0.003					
	Small tributary U/S outcrop		0.003				
	Small tributary at outcrop		0.003				
	Stream from under outcrop	0.003					
NB Source unknown	Discharge from outcrop		0.159				
	Stream between outcrops	0.156					
	U/S of quarry discharge	0.235		0.195			
	Non culverted discharge		1.180				
	Culverted discharge		1.020				
D	Quarry discharge prior to stream		1.080		0.805		→ from which pump system transfers water into an adit leading to the final discharge point
E	U/S WWTW	0.501		0.367			
	D/S WWTW	0.485		0.353			

Grey text = Less than values (i.e. undetectable levels)