

Catchment Load Monitoring
During the 2001/02 Wet Season
(Berry Creek, Elizabeth River and Bees Creek Stations)

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Introduction

Different activities (land uses) in the catchment may result in contaminants being transported to waterways which eventually discharge to coastal waters. These contaminants affect the quality of water in the waterways as well as the quality of the receiving waters to which they flow. The total amount of contaminant (mass) transported by waterways (rivers, creeks and drains) is referred to as the load (mass/unit time).

Since the 1990/91 wet season the department has been engaged in monitoring contaminants in run-off from different catchments in the greater Darwin region (Padovan 2001, 2000; Kernohan and Townsend 2000; Townsend 1992). The purpose of this monitoring is to determine what effect different catchment activities may have on the contaminant load to coastal waters, and to monitor these loads as the intensity of catchment use increases with time.

Eight locations in the Darwin region have been monitored at different times to determine how load varies with catchment activity and from year to year.

The aim of this report is to present the results of monitoring contaminant loads during the 2001-02 wet season at Berry Creek, Elizabeth River and Bees Creek stations. This report will summarise these results and will compare these to loads measured in previous years.

Methods

During the 2001/2002 wet season, monitoring was undertaken at Berry Creek (G8150028), Elizabeth River (G8150018) and Bees Creek (G8150036). Bees Creek was monitored for the first time this wet season. It was selected to represent a well-developed rural-residential catchment. This site is located where the creek intersects Horne Road. At this point the catchment has an area of 1,055 hectares (Rajaratnam 2001)

Each station was activated before the onset of the wet season, and was maintained until flow ceased. This study therefore does not consider dry season flows to the harbour which are considered negligible when compared to the dominant wet season flows.

A data logger was used to continuously record flow at all sites, and was programmed to activate an automatic water sampler after a pre-determined volume of water flowed past the gauging station. Sampling was therefore volume proportional and representative of all flow regimes (base flows and storm events). Note that the rating curves used at each site are the best available at the time. These curves are upgraded from time to time and may result in changes to the discharge, and therefore loads, that are calculated for each site.

At each station, pumped aliquots were combined in a 30 L polyethylene container to give a single large composite sample. At one to two week intervals, composite samples were well mixed and sub-sampled for chemical analysis of total nitrogen (TN

= total Kjeldhal nitrogen (TKN) + nitrate/nitrite (NO_x), total phosphorus (TP), aluminium (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni) and zinc (Zn), and total and volatile suspended solids (TSS and VSS). Metals were all measured as totals.

Suspended solids were analysed at the DBIRD laboratory using Standard Methods (APHA, 1998). TKN, nitrate/nitrite and total phosphorus was analysed at the Australian Water Quality Centre in Adelaide. Heavy metals were measured at the Australian Government Analytical Laboratory in Sydney.

The load for each contaminant (mass per wet season) at each site was calculated using the discharge data and chemical concentration data at each gauging station. For each sampling interval (one to two weeks) the mass of each contaminant exported from the catchment was calculated as the product of discharge volume and concentration. The mass for every sampling interval for the wet season was then summed to give the total load exported for the year. This load divided by the catchment area gives the export coefficient (or aerial load, mass per unit area per wet season). Therefore each contaminant for each site can be represented by a specific export coefficient. The total load divided by the total discharge gives flow-weighted mean concentration. This is a measure of the concentration of each contaminant at each site corrected for differences in run-off volumes between years and between sites.

If the concentration of a contaminant was reported by the laboratory to be below the level of detection, half the detection level was used for load calculations. If samples were not collected during a sampling period, the concentration was estimated as the average of the concentrations measured immediately before and after the period, or at the closest time.

At Bees Creek there was no flow data for the period up to 13 December 2001 due to equipment failure. The missing period corresponded with early wet season rains. Discharge was estimated by relating two run-off (storm) events after recording resumed in December to rainfall measured in the catchment. This resulted in a rainfall-run-off coefficient of 0.19. This was applied to rainfall records measured in the catchment to estimate the total discharge not sampled prior to 13 December.

Results and Discussion

Table 1 summarises the sampling intervals, and the corresponding number of sub-samples, discharge and concentration of constituents for all sites. Wet season flow commenced at Berry Creek on December 28 2001 and ceased on 18 June 2002. Over this time 38% of the total discharge was sub-sampled. The Elizabeth River flowed between 11 December 2001 and 17 June 2002. Over this time 87% of the total discharge was sub-sampled. At Bees Creek flow commenced in December, and was continuing to flow (although much reduced) in June when sampling ceased. During this time 94% of total discharge was sub-sampled.

Table 2 summarises total rainfall in Darwin measured at the Bureau of Meteorology Darwin Airport site. Rainfall during the 2001/02 wet season was 1,235 mm. This value is below the Darwin average of 1,706 mm, and is the driest year loads have been measured at all sites except at the Karama Drain in 1991/92. Note that the

average value for Darwin Airport is higher than the value of 1,600 mm reported in Padovan (2001) after revision of historical data by the Bureau of Meteorology.

Table 3 summarises aerial loads measured during the 2001/02 wet season at Berry Creek, Elizabeth River and Bees Creek. The aerial loads measured in the Elizabeth River are the lowest measured to date. Phosphorus, nitrogen, arsenic, copper, lead and nickel (all as totals) are at the lower end (or slightly lower) of levels measured in the past. Cadmium, chromium, zinc and total and volatile suspended solids are markedly lower (2-18 times) than measured in past years.

Similarly at Berry Creek all contaminants measured during the 2001/02 wet season are the lowest measured in the three years monitoring has been undertaken at this site (Table 3). Aerial loads measured in 2001/02 were typically a quarter to a half of the lowest levels measured in the past. Chromium was the exception where levels were 12 times less than measured in the past.

The site at Bees Creek was monitored for the first time in 2001/02. Most contaminants measured had aerial loads at the upper end of the range measured at the Berry Creek and Elizabeth River sites (considering all years). These sites measure rural catchments that are most comparable to the Bees Creek catchment. Using only the results from the 2001/02 wet season where rainfall was most similar across all sites, aerial loads at Bees Creek was on average 5 times greater (range 3-7) than at the other two sites. Most notable is the elevated level of zinc at Bees Creek which is 14 to 17 times greater (Table 3).

The flow-weighted mean concentrations (FWMC) presented in Table 4 is a measure of contaminant levels that takes into account the importance of high flows to the total discharge. It is calculated by dividing the annual load by the annual discharge. Because the annual discharge is used in this calculation, FWMC to some extent takes into account the 'size' of the wet season, and allows a better comparison of contaminant levels between different years where rainfall can vary greatly.

Flow-weighted mean concentrations measured in the Elizabeth River in 2001/02 were either at the lower end or below levels measured in the past for all contaminants. At Berry Creek levels were within the range measured in the past. The exceptions were total phosphorus and total and volatile suspended solids that were elevated relative to past levels (Table 4).

Bees Creek has not been monitored before in this manner and firm conclusions about contaminant levels in the creek relative to the other rural sites needs to be taken cautiously with only one year of results for comparison. An initial evaluation of contaminant levels in Bees Creek may be made by a comparison with the highest value measured at the combined Elizabeth River and Berry Creek sites. This shows concentrations of TN and TP to be 20% higher and iron 14% higher at Bees Creek (Table 4). By comparing Bees Creek to the other sites using data collected from the same wet season (2001/02) all contaminants except cadmium, manganese and total and volatile suspended solids were elevated. Those contaminants which were particularly elevated were nitrogen (22% higher), lead (25%), chromium (75%), phosphorus and copper (83%) and zinc (390%).

Additional years of data are required from Bees Creek to confirm that aerial loads and FWMC of some contaminants are elevated at this site. However, this result is not unexpected as the Bees Creek site is downstream of an almost fully developed rural-residential catchment, unlike the Elizabeth River and Berry Creek catchments that are much larger but not developed to the same extent.

References

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Berry Creek (G8150028)

Interval Start Date	Interval Start Time	Interval End Date	Interval End Time	No. Sub-Samples	Discharge (ML)	TKN (mg/L)	Nox (mg/L)	TN (mg/L)	TP (mg/L)	Al (ug/L)	As (ug/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Pb (ug/L)	Mn (ug/L)	Ni (ug/L)	Zn (ug/L)	TSS (mg/L)	VSS (mg/L)	
28-Dec-01	10:25	11-Jan-02	9:55	34	209	0.67	0.009	0.68	0.032	1500	0.25	0.05	0.3	1.3	1400	1	38	0.5	2.5	45	6	
11-Jan-02	9:55	23-Jan-02	10:30	15	241	0.45	0.005	0.46	0.015	410	0.25	0.05	0.05	1	670	0.3	20	0.4	1.8	12	3	
23-Jan-02	10:30	07-Feb-02	9:35	16	174	0.31	0.012	0.32	0.011	120	0.25	0.05	0.05	0.6	740	0.2	18	0.3	1.6	8	2	
07-Feb-02	9:35	11-Feb-02	22:05	141	636	0.39	0.003	0.39	0.022	600	0.25	0.05	0.05	1.5	1.5	1	44	0.5	4.6	41	8	
11-Feb-02	22:05	13-Feb-02	9:45	0	3,521	0.33	0.004	0.33	0.018	530	0.25	0.05	0.05	1.25	241	0.85	28.5	0.4	3.6	33	7	
13-Feb-02	9:45	14-Feb-02	9:00	141	4,668	0.26	0.006	0.27	0.013	460	0.25	0.05	0.05	1	480	0.7	13	0.3	2.5	25	5	
14-Feb-02	9:00	26-Feb-02	10:25	0	11,648	0.27	0.008	0.27	0.013	345	0.25	0.05	0.05	1	650	0.6	14.5	0.3	1.6	20	4	
26-Feb-02	10:25	04-Mar-02	11:20	141	6,292	0.27	0.010	0.28	0.012	230	0.25	0.05	0.05	1	820	0.5	16	0.3	0.6	15	3	
04-Mar-02	11:20	12-Mar-02	8:25	0	5,174	0.30	0.006	0.31	0.013	225	0.25	0.05	0.23	0.63	715	0.45	19	0.4	4.0	20	5	
12-Mar-02	8:25	26-Mar-02	9:55	18	2,922	0.30	0.006	0.31	0.013	225	0.25	0.05	0.23	0.63	715	0.45	19	0.4	4.0	20	5	
26-Mar-02	9:55	09-Apr-02	10:20	11	934	0.33	0.003	0.33	0.013	220	0.25	0.05	0.4	0.25	610	0.4	22	0.4	7.3	25	7	
09-Apr-02	10:20	23-Apr-02	9:30	29	1,075	0.24	0.003	0.24	0.010	180	0.25	0.05	0.3	0.25	570	0.3	14	0.3	1.9	8	3	
23-Apr-02	9:30	07-May-02	9:35	10	127	0.16	0.003	0.16	0.005	49	0.25	0.05	0.05	0.25	260	0.1	4.7	0.2	1.5	3	2	
07-May-02	9:35	23-May-02	9:25	41	46	0.07	0.003	0.07	0.005	10	0.25	0.05	0.05	0.25	110	0.05	4.7	0.1	0.4	1	1	
23-May-02	9:25	18-Jun-02	9:25	0	41	0.07	0.003	0.07	0.005	10	0.25	0.05	0.05	0.25	110	0.05	4.7	0.1	0.4	1	1	
23-May-02	9:25	18-Jun-02	9:25	0	41	0.07	0.003	0.07	0.005	10	0.25	0.05	0.05	0.25	110	0.05	4.7	0.1	0.4	1	1	
End of sampling					37,749																	

Elizabeth River (G8150018)

Interval Start Date	Interval Start Time	Interval End Date	Interval End Time	No. Sub-Samples	Discharge (ML)	TKN (mg/L)	Nox (mg/L)	TN (mg/L)	TP (mg/L)	Al (ug/L)	As (ug/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Pb (ug/L)	Mn (ug/L)	Ni (ug/L)	Zn (ug/L)	TSS (mg/L)	VSS (mg/L)	
11-Dec-01	12:00	28-Dec-01	9:35	343	343	0.60	0.030	0.63	0.018	1100	0.25	0.05	0.4	1.2	620	0.7	20	0.5	6.7	29	6	
28-Dec-01	9:35	11-Jan-02	9:20	79	493	0.61	0.015	0.63	0.014	720	0.25	0.05	0.3	0.7	660	0.4	1.2	0.4	3.8	10	3	
11-Jan-02	9:20	23-Jan-02	11:55	38	361	0.57	0.012	0.58	0.012	780	0.25	0.05	0.3	0.6	750	0.4	19	0.4	3	14	4	
23-Jan-02	11:55	07-Feb-02	11:05	21	187	0.38	0.060	0.44	0.02	360	0.25	0.05	0.3	0.6	1300	0.7	36	0.3	5	26	6	
07-Feb-02	11:05	11-Feb-02	12:20	141	1,235	0.51	0.012	0.52	0.019	440	0.25	0.05	0.5	1.2	650	0.6	12	0.5	2.3	20	5	
11-Feb-02	12:20	13-Feb-02	11:55	0	4,914	0.42	0.018	0.43	0.014	360	0.25	0.05	0.275	1	485	0.45	8.2	0.5	2.2	14	4	
13-Feb-02	11:55	27-Feb-02	14:15	7	16,430	0.32	0.023	0.34	0.009	280	0.25	0.05	0.05	0.8	320	0.3	4.4	0.5	2.1	8	2	
27-Feb-02	14:15	12-Mar-02	10:30	45	7,618	0.27	0.014	0.28	0.009	160	0.25	0.05	0.05	0.7	490	0.4	7.5	0.3	1.9	7	2	
12-Mar-02	10:30	26-Mar-02	12:00	31	3,534	0.45	0.068	0.52	0.01	78	0.25	0.05	0.05	0.25	360	0.1	4.2	0.2	1.7	4	1	
26-Mar-02	12:00	09-Apr-02	11:50	14	1,537	0.16	0.053	0.21	0.006	144	0.25	0.05	0.125	0.525	335	0.15	3.7	0.3	1.4	3	2	
09-Apr-02	11:50	23-Apr-02	11:00	46	1,383	0.21	0.016	0.23	0.007	210	0.25	0.05	0.2	0.8	310	0.2	3.2	0.4	1.1	4	2	
23-Apr-02	11:00	07-May-02	10:45	19	334	0.14	0.010	0.15	0.005	110	0.25	0.05	0.05	0.25	300	0.1	2.3	0.1	1.2	2	1	
07-May-02	10:45	23-May-02	10:40	55	179	0.22	0.011	0.23	0.005	110	0.25	0.05	0.05	0.25	330	0.1	4.5	0.2	2	3	1	
23-May-02	10:40	17-Jun-02	0:00	0	71	0.18	0.011	0.19	0.005	110	0.25	0.05	0.05	0.25	315	0.1	3.4	0.15	1.6	3	1	
End of sampling					38,620																	

Bees Creek (G8150036)

Interval Start Date	Interval Start Time	Interval End Date	Interval End Time	No. Sub-Samples	Discharge (ML)	TKN (mg/L)	Nox (mg/L)	TN (mg/L)	TP (mg/L)	Al (ug/L)	As (ug/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Pb (ug/L)	Mn (ug/L)	Ni (ug/L)	Zn (ug/L)	TSS (mg/L)	VSS (mg/L)	
19/09/2001	?	13-Dec-01	10:45	0	81	0.99	0.283	1.27	0.079	2200	0.6	0.05	0.7	6.8	1700	3.2	64	1.1	31	103	21	
13-Dec-01	10:45	28-Dec-01	9:00	125	592	0.99	0.283	1.27	0.079	2200	0.6	0.05	0.7	6.8	1700	3.2	64	1.1	31	103	21	
28-Dec-01	9:00	11-Jan-02	10:40	55	544	0.50	0.006	0.51	0.024	1200	0.25	0.05	0.2	2.4	810	0.7	11	0.6	14	17	4	
11-Jan-02	10:40	23-Jan-02	11:30	14	732	0.38	0.001	0.38	0.014	690	0.25	0.05	0.05	1.9	980	0.5	11	0.6	10	7	3	
23-Jan-02	11:30	07-Feb-02	10:30	0	308	0.38	0.052	0.43	0.021	440	0.25	0.05	0.13	1.7	760	0.6	12	0.5	9.7	11	4	
07-Feb-02	10:30	13-Feb-02	11:00	141	5,144	0.38	0.103	0.48	0.028	190	0.25	0.05	0.2	1.4	540	0.7	12	0.4	9.4	15	4	
13-Feb-02	11:00	26-Feb-02	15:40	23	2,745	0.31	0.042	0.35	0.017	240	0.25	0.05	0.2	1.3	670	0.5	13	0.4	7.8	11	3	
26-Feb-02	15:40	01-Mar-02	15:00	0	362	0.29	0.031	0.32	0.017	230	0.25	0.05	0.2	1.3	835	0.6	20	0.4	6.1	12	3	
01-Mar-02	15:00	12-Mar-02	9:40	14	405	0.26	0.020	0.28	0.017	220	0.25	0.05	0.2	1.3	1000	0.6	27	0.4	4.4	12	3	
12-Mar-02	9:40	26-Mar-02	11:15	21	1,069	0.22	0.039	0.26	0.012	180	0.25	0.05	0.05	1.2	810	0.5	1.5	0.4	4.7	9	3	
26-Mar-02	11:15	09-Apr-02	11:10	26	231	0.12	0.008	0.13	0.006	37	0.25	0.05	0.05	0.25	290	0.1	2.8	0.2	1.8	2	2	
09-Apr-02	11:10	23-Apr-02	10:25	40	218	0.18	0.015	0.20	0.01	110	0.25	0.05	0.05	0.7	530	0.2	9.4	0.2	7.3	5	2	
23-Apr-02	10:25	07-May-02	10:15	28	107	0.09	0.006	0.10	0.005	48	0.25	0.05	0.05	0.25	390	0.1	6	0.1	1.4	3	2	
07-May-02	10:15	23-May-02	10:05	115	99	0.06	0.003	0.06	0.005	49	0.25	0.05	0.05	0.25	420	0.05	3.3	0.1	1.1	2	1	
23-May-02	10:05	04-Jun-02	10:50	0	62	0.08	0.004	0.08	0.005	49	0.25	0.05	0.05	0.25	405	0.075	4.65	0.1	1.25	3	2	
End of sampling					12,700																	

Table 1. Summary of sampling intervals and corresponding discharge and water chemistry data for Berry Creek, Elizabeth River and Bees Creek gauging stations during the 2001-2002 wet season. Values in yellow shading were reported by the laboratory to be below levels of detection and are presented as half the detection limits. Values in blue shading is missing data that have been estimated as the average of the values immediately prior to and after the missing interval. See methods for explanation of chemical symbols used.

Land use	Site	Year	Rain (mm)
Undisturbed	Celia Creek	1995/96	1,453
	Celia Creek	1996/97	2,374
	Manton River	1996/97	2,374
Rural	Elizabeth River	1990/91	2,217
	Elizabeth River	1995/96	1,453
	Elizabeth River	1996/97	2,374
	Elizabeth River	2001/02	1,235
	Berry Creek	1999/00	2,209
	Berry Creek	2000/01	1,385
	Berry Creek	2001/02	1,235
	Bees Creek	2001/02	1,235
Urban	Karama drain	1990/91	2,217
	Karama drain	1991/92	1,038
	Moil drain	1995/96	1,453
	Moil drain	1996/97	2,374
Industrial	Winnellie drain	1995/96	1,453
	Winnellie drain	1996/97	2,374
	Winnellie drain	1999/00	2,209
	Winnellie drain	2000/01	1,385

Table 2. Rainfall as measured at Darwin airport during each wet season export coefficients were measured. The average for Darwin is 1,706 mm. The 1996/97 wet season is a record wet year. New data presented in this report is highlighted.

Land use	Site	Year	TP kg/Ha	TN kg/Ha	Al kg/Ha	As g/Ha	Cd g/Ha	Cr g/Ha	Cu g/Ha	Fe kg/Ha	Mn g/Ha	Pb g/Ha	Ni g/Ha	Zn g/Ha	TSS kg/Ha	VSS kg/Ha	Source
Undisturbed	Celia Ck	95/96	0.04	0.69	-	0.47	0.13	2.2	6.0	-	-	1.3	1.5	2.8	48	8.3	Padovan (2000)
	Celia Ck	96/97	0.50	6.6	-	3.7	1.3	14	22	-	-	12	9.8	-	288	64	Padovan (2000)
	Manton R	96/97	0.30	4.3	-	9.3	0.48	7.5	58	-	-	7.0	6.8	40	154	49	Padovan (2000)
Rural	Elizabeth R	90/91	0.05	2.4	-	-	-	13	21	-	-	13	16	110	57	-	Townsend (1992)
	Elizabeth R	95/96	0.04	1.5	-	1.4	0.63	2.5	21	-	-	1.8	2.1	116	60	16	Padovan (2000)
	Elizabeth R	96/97	0.29	5.2	-	4.8	0.72	7.6	4.7	-	-	4.9	4.7	104	204	55	Padovan (2000)
	Elizabeth R	01/02	0.04	1.4	1.0	0.96	0.19	0.43	2.9	1.5	23	1.2	1.6	7.9	33	8.7	This report
	Berry Ck	99/00	0.08	2.2	1.4	1.8	0.45	3.6	5.0	3.4	68	2.5	1.8	24	70	18	Padovan (2000)
	Berry Ck	00/01	0.05	1.0	2.2	1.2	0.25	3.8	6.3	2.8	73	2.9	3.1	29	79	13	Padovan (2001)
	Berry Ck	01/02	0.04	0.80	0.9	0.69	0.14	0.29	2.5	1.7	49	1.6	0.90	6.7	58	12	This report
	Bees Ck	01/02	0.29	5.3	4.6	3.2	0.60	2.3	20	8.6	172	8.7	5.4	114	204	52	This report
Urban	Karama	90/91	0.7	11	-	-	-	81	110	-	-	320	66	1900	610	-	Townsend (1992)
	Karama	91/92	0.4	5	-	-	-	55	38	-	-	361	-	331	956	228	Kernohan and Townsend (2000)
	Moil	95/96	2.0	13	-	14	5.0	14	145	-	-	352	10	695	714	321	Padovan (2000)
	Moil	96/97	2.3	17	-	14	1.7	17	52	-	-	350	9	670	820	218	Padovan (2000)
Industrial	Winnellie	95/96	5.7	19	-	47	8	469	300	-	-	551	60	3750	1802	303	Padovan (2000)
	Winnellie	96/97	15	72	-	253	19	1723	794	-	-	901	138	9327	1798	422	Padovan (2000)
	Winnellie	99/00	5.1	17	22	41	22	247	234	19	529	338	40	4527	923	188	Padovan (2000)
	Winnellie	00/01	3.5	12	15	23	3.5	287	210	14	465	253	38	4147	697	161	Padovan (2001)

Table 3. Summary of export coefficients (aerial loads) from this and past studies for catchments in and around Darwin harbour.

Land Use	Site	Year	TP mg/L	TN mg/L	Al ug/L	As ug/L	Cd ug/L	Cr ug/L	Cu ug/L	Fe ug/L	Hg ug/L	Mn ug/L	Pb ug/L	Ni ug/L	Zn ug/L	TSS mg/L	VSS mg/L	
Undisturbed	Celia	95/96	0.021	0.34	-	0.23	0.07	1.09	2.92	-	<0.1	-	0.7	0.8	1	23	4	Padovan (2000)
	Celia	96/97	0.044	0.57	-	0.32	0.11	1.20	1.90	-	<0.1	-	1.0	0.9	-	25	6	Padovan (2000)
	Manton	96/97	0.031	0.45	-	0.97	0.05	0.77	6.03	-	<0.1	-	0.7	0.7	4	16	5	Padovan (2000)
Rural	Elizabeth	90/91	0.008	0.37	-	-	-	2.00	3.00	-	-	-	2	3	18	9	-	Townsend (1992)
	Elizabeth	95/96	0.008	0.31	-	0.30	0.13	0.54	4.40	-	<0.1	-	0.4	0.4	25	13	3	Padovan (2000)
	Elizabeth	96/97	0.020	0.36	-	0.34	0.05	0.53	0.33	-	<0.1	-	0.4	0.3	7	14	4	Padovan (2000)
	Elizabeth	01/02	0.010	0.36	261	0.25	0.05	0.11	0.75	405	-	6	0.3	0.4	2.1	9	2	This report
	Berry	99/00	0.011	0.31	-	0.25	0.06	0.52	0.71	-	-	-	0.4	0.3	3	10	3	Padovan (2000)
	Berry	00/01	0.010	0.21	455	0.25	0.05	0.78	1.27	578	-	15	0.6	0.6	6	16	3	Padovan (2001)
	Berry	01/02	0.013	0.29	332	0.25	0.05	0.10	0.91	621	-	18	0.6	0.3	2	21	5	This report
Bees	01/02	0.024	0.44	380	0.27	0.05	0.19	1.66	710	-	14	0.7	0.4	9	17	4	This report	
Urban	Karama	90/91	0.037	0.6	-	-	-	5.00	6.00	-	-	-	18	4	100	34	-	Townsend (1992)
	Karama	91/92	0.062	0.81	-	-	-	8.50	5.90	-	-	-	56	-	51	149	35	Kernohan and Townsend (2000)
	Moil	95/96	0.107	0.68	-	0.74	0.27	0.77	7.87	-	<0.1	-	19	0.5	38	39	17	Padovan (2000)
	Moil	96/97	0.087	0.65	-	0.55	0.07	0.65	2.01	-	<0.1	-	13	0.3	26	31	8	Padovan (2000)
Industrial	Winnellie	95/96	0.270	0.89	-	2.22	0.36	22.10	14.14	-	<0.1	-	26	3	177	85	14	Padovan (2000)
	Winnellie	96/97	0.246	1.19	-	4.18	0.31	28.43	13.10	-	<0.1	-	15	2	154	30	7	Padovan (2000)
	Winnellie	99/00	0.159	0.53	678	1.28	0.67	7.69	7.28	602	<0.1	17	11	1	141	29	6	Padovan (2000)
	Winnellie	00/01	0.162	0.58	689	1.07	0.16	13.44	9.87	646	-	22	12	2	195	33	8	Padovan (2001)

Table 4. Flow weighted mean concentration of contaminants measured in this and past studies.