

## **Pesticide and nutrient monitoring in the Roper River region during the 2015 dry season**



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Aquatic Health Unit

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## 1. Summary

In the 2015 dry season six sites in the Roper River region were sampled for pesticides, herbicides and a range of other common contaminants. The “passive sampling” method used allows the detection of very small traces of chemicals that are undetectable with conventional methods.

Of the 122 chemicals tested for, 10 were detected in this study, with a maximum of 7 in a single site. Detections included 3 herbicides (*diuron*, *simazine*, *tebuthiuron*), one insecticide (*imidacloprid*), one flame retardant (*TDCPP*), several ingredients of insect repellents and cosmetics (*DEET*, *galaxolide*, *tonalid*, *piperonyl butoxide*) and one medical drug (*carbamazepine*).

The detected herbicides and insecticides are highly water soluble and are known to pose a risk to groundwater. DEET and fragrances were at their highest concentrations near popular swimming areas.

Australian guideline values for ecosystem protection were only available for two of the contaminants. In both cases, the detected concentrations were well below these guidelines. The remaining chemicals were found at extremely low concentrations that would have been undetectable with conventional water sampling. The available literature on the toxicity of these substances indicates that they are not a cause for concern at such low concentrations.

The springs are a major source of nitrate to the Roper River. The high nitrate concentrations in the springs indicate that nitrate levels are elevated in groundwater of the region. Nitrate was 50-200 times higher in springs than at sites on the lower Roper River. Concentrations of all other nutrients were (nitrite, ammonia, filterable reactive phosphorus, total phosphorus) were low at all sites.

The detection of any chemicals in our waterways serves as a reminder to ensure the use and storage of chemicals meets best practice to avoid environmental contamination.

## 2. Definition of “Pesticide”

“Pesticide” means a chemical substance that is used to destroy or deter any pest. This can include weeds, insects, fungi and other pests. The term pesticide as used in this report therefore encompasses both herbicides and insecticides as well as other substances to treat pests including fungicides, rodenticides and insect repellents.

### 3. Introduction

In the Darwin, Katherine and Ooloo regions of the Top End, dry season stream and spring flows have been found to contain very low concentrations of some herbicides and insecticides (Schult 2012, Schult 2014, Schult 2016a). Low level contamination of groundwater with pesticides has also been found in some bores in the Katherine region (Schult 2016b).

Groundwater contamination can occur when pesticides are applied to the surface and carried into deeper soil layers by rain and irrigation water until they reach the aquifer. The risk of groundwater contamination is therefore greater from highly water-soluble substances than from those that adhere strongly to soil particles. Where the groundwater contains contaminants, these can be carried to groundwater-fed streams and affect stream quality and ecosystems.

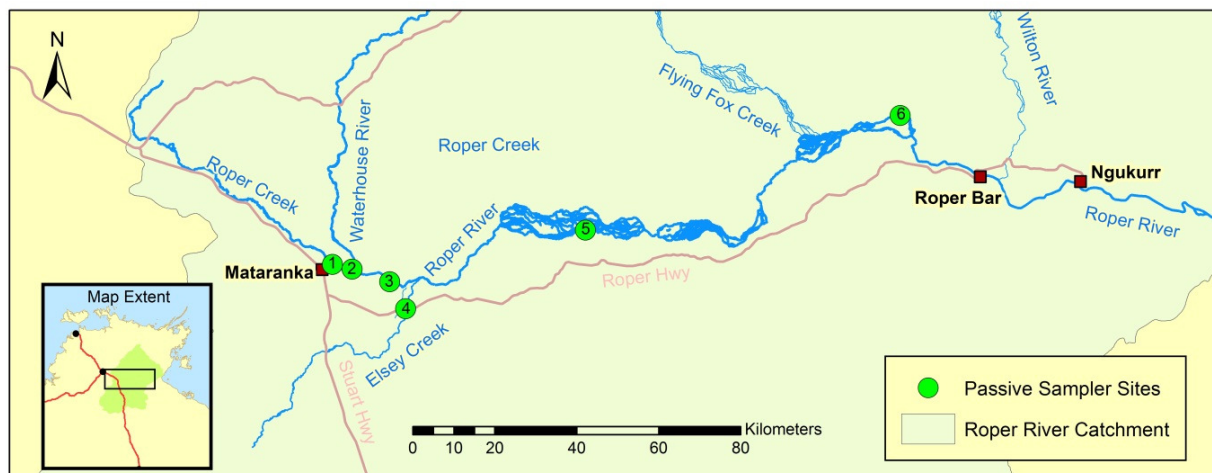
Another common anthropogenic contaminant of groundwater throughout the world is the nutrient nitrate ( $\text{NO}_3$ ). Sources of human-generated nitrate include fertilisers, sewerage, domestic animal manure and atmospheric deposition from burning fossil fuels. Because nitrate is highly water soluble it is easily transported through the soil to the water table with rain or irrigation. Elevated nutrient levels in streams can contribute to environmental problems like algal blooms.

Dry season flows in the Roper River are mainly supplied by groundwater from the Mataranka Tindall aquifer. This study examined some springs and streams in the Roper River catchment to investigate whether any chemical contamination is currently present in dry season flows in this region. Samples were tested for the standard laboratory suite of contaminants which includes herbicides, insecticides and also a range of other common contaminants, as well as nitrogen and phosphorus nutrients.

### 4. Methods

Six sites in the Roper River catchment were sampled during the 2015 dry season (**Error! Reference source not found.**).

Sites 1-3 represent major spring inflows from the Tindall aquifer to the Roper River in the upper catchment, where the river gains flow from groundwater sources. Site 4 is located on Elsey creek, a tributary to the Roper River from the southern part of the catchment, and sites 5 and 6 are located on the main channel of the Roper River, downstream of all the major groundwater inflows.



**Figure 1. Location of sampling sites in the Roper River region**

Passive samplers were used to detect pesticide contamination. These samplers can detect very low concentrations of chemicals that are not detectable with conventional grab sampling, by accumulating chemicals over a period of several weeks. The analysis provides an average concentration for the deployment period. Two different types of samplers were used to detect different classes of chemicals: The *Empore Disc* sampler (ED) accumulates hydrophilic (water soluble) substances, the second device, a polydimethylsiloxane sampler (PDMS), attracts hydrophobic (water repellent) substances. Most herbicides belong to the former, most insecticides to the latter class.

Samplers were deployed for approximately six weeks from mid-August to mid-September 2015 (Table 1). Depending on the water depth at the site, the samplers were either suspended from a rope where the water was deep enough, or attached to bricks or a weighted steel frame in shallower sites. Upon retrieval, the passive samplers were stored on ice during transport to the Aquatic Health Unit laboratory and air-freighted to the National Research Centre for Environmental Toxicology (Entox, University of Queensland, Brisbane) for extraction and analysis.

A total of 122 chemicals were tested for. A full list of chemicals and their detection limits are provided in Appendix A. The listed detection limits apply to the concentrated extract from the passive samplers which has accumulated chemicals over several weeks. Final stream concentration estimates may appear to be below the detection limit because the total detected amount from the extract is divided by the estimated flow over the deployment period.

The sampler at Site 4 (Eisey Creek) was tampered with during the deployment period. It was found in the creek, approximately 20 m downstream of the original deployment site at the end of the period. Because the samplers appeared intact and were still submerged on the retrieval date, they were analysed and the data is presented here.

**Table 1. Passive sampler locations and deployment dates.**

Site No	Site	Latitude	Longitude	Date in	Date out
1	Bitter Springs	14.9131633	133.0901	11/8/15	24/9/15
2	Rainbow Springs (hot spring)	14.9232957	133.1334	11/8/15	24/9/15
3	Fig Tree Spring	14.9510095	133.2156	11/8/15	24/9/15
4	Elsey Creek @ Roper Highway	15.0102692	133.2509	12/8/15	23/9/15
5	Roper River at Moroak Station Rd Crossing	14.8379605	133.6450	12/8/15	23/9/15
6	Roper River at Mt McMinn Station	14.586870	134.3361	12/8/15	15/9/15

### *Nutrient sampling*

Total and soluble nutrient samples were collected from all six sites on collection of the passive samplers. Soluble nutrient samples were filtered in the field through a PES 0.45 µm syringe filter. All samples were stored on ice and frozen upon return to the laboratory. Samples were analysed according to APHA (2005) standard methods by the Northern Territory Environmental Laboratories (NTEL Intertek) for total nitrogen (TN) and total phosphorus (TP), nitrite (NO<sub>2</sub>), nitrate (NO<sub>3</sub>), ammonia (NH<sub>3</sub>) and filterable reactive phosphorus (FRP). Details of the analysis methods are provided in Appendix B.

## 5. Results and Discussion

### *Pesticides and other contaminants*

Ten of the 122 chemicals were detected at the study sites, with individual sites having between 0 and 7 detections (Table 2, Figure 2).

Detections included 3 herbicides (*diuron*, *simazine*, *tebuthiuron*), one insecticide (*imidacloprid*), one flame retardant (*TDCPP*), several ingredients of insect repellents and cosmetics (*DEET*, *galaxolide*, *tonalid*, *piperonyl butoxide*) and one medical drug (*carbamazepine*).

Table 3 provides a summary of common uses of these chemicals and some trade names of products that contain them.

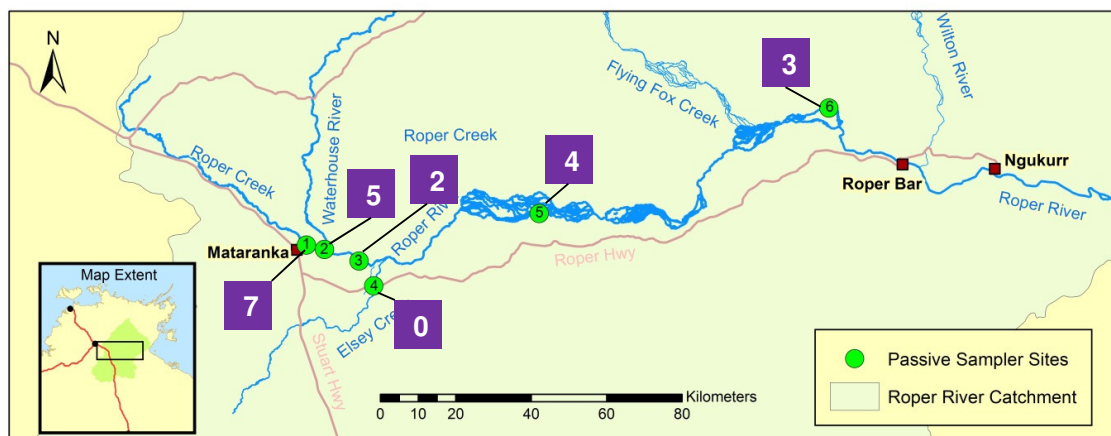
**Table 2.** Chemicals detected in Roper region springs and streams and estimated concentrations (ng/L)

	ANZECC Guideline 95% protection	Bitter Springs	Rainbow Springs	Fig Tree Springs	Eley Creek	Moroak Station Rd	Mt McMinn Station
DEET	NL	<b>110</b>	<b>8.7</b>	ND	ND	<b>20</b>	ND
Galaxolide	NL	<b>0.39</b>	ND	ND	ND	ND	ND
Tonalid	NL	<b>0.07</b>	<b>0.02</b>	<b>0.02</b>	ND	<b>0.02</b>	ND
TDCPP isomers	NL	ND	ND	ND	ND	<b>3</b>	<b>0.71</b>
Piperonyl Butoxide	NL	<b>2.4</b>	ND	ND	ND	ND	ND
Imidacloprid	NL	<b>0.04</b>	ND	ND	ND	ND	ND
Diuron	ID	ND	<b>0.06</b>	ND	ND	ND	<b>0.07</b>
Simazine	3200	ND	ND	<b>0.01</b>	ND	ND	ND
Tebuthiuron	2200	<b>0.22</b>	<b>0.02</b>	ND	ND	<b>0.12</b>	<b>0.09</b>
Carbamazepine	NL	<b>0.02</b>	<b>0.01</b>	ND	ND	ND	ND

ID: insufficient data to determine guideline value

NL: not listed in ANZECC guidelines

ND: not detected



**Figure 2.** Number of chemicals detected at Roper River sites.

The highest number of different chemicals, as well as the highest concentrations of these chemicals were found at Bitter Springs (Site 1), a popular swimming spot for tourists and locals, especially during the dry season. Seven chemicals were detected in total at this site.

Four of the detected chemicals are commonly associated with the use of insect repellents and cosmetics. It is likely that the source of DEET, galaxolide, tonalid and piperonyl butoxide contamination is not the groundwater from the spring itself but that it stems from the application of these repellent and cosmetics products by swimmers. The sampler was located downstream of the swimming area.



Similarly, carbamazepine, a medical drug which was detected at Bitter Springs and Rainbow Springs, is also likely to originate from swimmers rather than groundwater contamination.

The concentrations of DEET at Bitter Springs were similar to concentrations found in the Katherine River in 2011 (Schult 2012), while tonalid and galaxolide concentrations were 10-100 times lower at Bitter Springs than those found at some Katherine River sites.

The insecticide imidacloprid and the herbicide tebuthiuron, which were also detected at Bitter Springs, are more likely to have entered the stream from the groundwater spring. Both substances are used widely for weed and insect control and are known to have a high leachate risk because of their high water solubility.

At Rainbow Springs (Mataranka Hot Springs), which is also a popular swimming area, fewer chemicals were detected. The spring is situated off the Waterhouse River and flows into this river upstream of its confluence with Roper Creek (the beginning of the Roper River proper). DEET, tonalid and carbamazepine were found at Rainbow Springs but at lower concentrations than at Bitter Springs, possibly owing to the location of the sampler slightly upstream of the high use area at this site. Two herbicides (diuron and tebuthiuron) were also detected in Rainbow Springs.

Fig Tree Spring is a small spring on the southern bank of the Roper River, located within Elsey National Park. It is accessible to the public, but is not used for swimming due to its small size. Only small traces of tonalid were found in the spring, along with traces of one herbicide.

Site 4 on Elsey Creek had no detections of chemicals at all. The creek is located on the southern side of the Roper River with groundwater input from the southern section of the Tindall aquifer. The samplers at this site appeared to have been moved by members of the public during the deployment period, so that the results should be considered with caution. However, since the samplers remained submerged, and were found close to the original deployment site, results are presented here. There is little development in the catchment of Elsey Creek and the site is not frequented by tourists, the lack of detections is unlikely to be the result of the tampering.

Site 5 is located on the Roper River itself. It is downstream of the all major inflows from the Tindall aquifer, and integrates flows from sites 1 to 4. Four chemicals were detected at site 5, three of which were also found upstream. DEET and tonalid were still present at the site albeit at lower concentrations than upstream. Since the site and the area immediately upstream are not used for swimming or heavily frequented by tourists or locals it is possible that these substances persist and are carried downstream from the heavy use areas in the upper catchment. Similarly, the herbicide tebuthiuron which was also detected upstream is still present at Site 5 at a lower concentration.

The flame retardant TDCPP was detected at site 5. TDCPP is used as a flame retardant in a range of plastic foams, resins and latexes (WHO 1998) such as foam padding in vehicles and furniture. The source of TDCPP in the Roper River is not known. Given that it was not detected in the springs upstream it is not clear whether it entered the river with groundwater inflows or originated from elsewhere. TDCPP is widespread in the environment (Betts, 2013) and is not readily degraded in surface waters (WHO 1998). It is found in household dust where household items contain TDCPP and can leach into the groundwater from items in

landfills. TDCPP is toxic to aquatic organisms at levels much higher than those detected in the Roper River (NICNAS 2001). There is currently no Australian guideline value available for TDCPP, however, the Minnesota Department of Health (USA) recommends a drinking water guidance value of 800 ng/L (MDH 2013), indicating that the current concentrations found in the Roper River ( 0.7-3 ng/L) are not a cause for concern.

At Site 6, TDCPP and the herbicides tebuthiuron and diuron were detected. TDCPP was present at a lower concentration than at Site 5 upstream. DEET and tonalid, still present at Site 5, were not detected at Site 6.

DEET, galaxolide, tonalide and piperonyl butoxide, all substances associated with use of topical repellents and cosmetics, were found at their highest concentrations in high use areas upstream. Further downstream they were found at lower concentrations or not at all. At Site 6, the furthest downstream sampling location, none of the four chemicals was detectable, suggesting that they are gradually removed from the water column, either by chemical breakdown or adsorption to soil and settling out.

Although guideline values are currently not available for many of the detected chemicals, the available ecotoxicological literature suggests that higher concentrations are required before effects on aquatic organisms become apparent (TOXNET 2016).

The herbicides and pesticide detected in this study are commonly found to contaminate groundwater due to their high water solubility and mobility. All four chemicals have been detected in other studies in the Top End of the NT (Schult 2012, 2014, 2016a&b).

Although the concentrations found were very low, the presence of any chemical in groundwater or surface water should act as a reminder to use best practice for the handling, application and storage of these chemicals.

The sampling program was not designed to detect the sources of contamination for pesticides. More extensive testing of groundwater directly from domestic and production bores in the region would be required to provide a comprehensive picture of groundwater quality. The study provides baseline information of pesticide contamination of selected sites in the Roper River catchment, and can be used to compare against in future monitoring results to assess long-term contaminant trends.

**Table 3.** Description of chemicals detected in Roper region streams

<b>Chemical name</b>	<b>Description</b>	<b>Examples of trade names</b>
<i>Carbamazepine</i>	An anticonvulsant drug used to treat epilepsy, bipolar disorder and other medical conditions.	
<i>DEET</i>	A common personal insect repellent found in most tropical strength repellent products.	Bushman's Rid Aerogard
<i>Diuron</i>	A general herbicide often used on hard surfaces. Breaks down very slowly in water. Can be toxic to fish and invertebrates. High risk of leaching.	Diuron Diurex
<i>Galaxolide</i>	A synthetic musk fragrance commonly used in personal care products, laundry detergents and cosmetics.	
<i>Imidacloprid</i>	Very commonly used systemic insecticide of the neonicotinoid class. Used on trees to control insect pests, and domestically to control termites, ants and cockroaches. High leachate risk. Highly toxic to aquatic invertebrates at higher concentrations than those found in this study.	Confidor Premis
<i>Piperonyl butoxide</i>	Used in the manufacture of stabilisers and antioxidants . It is mainly used to inhibit the breakdown of pesticides and reduce the amount of pesticide needed to be effective. It is also a common ingredient in mosquito control products (NPIC 2000). Highly toxic to some aquatic organisms but considered short-lived in the environment.	
<i>Simazine</i>	Systemic triazine herbicide. Absorbed through roots. Stable in water, decomposed by UV light, binds to soil. Controls broad-leaf weeds in a variety of crops and at higher rates of application, grasses and broad-leaved weeds in other areas. Used in citrus and for non-crop weed control on roads, railways etc. High risk of groundwater leaching.	Accensi
<i>TDCPP (Tris(1,3-dichloro-2-propyl) phosphate) isomers</i>	Flame retardant used in a range of plastic foams. Carcinogenic to rats at high levels, not readily degraded in natural waters. Toxic to aquatic organisms (NICNAS 2001).	
<i>Tebuthiuron</i>	A general herbicide that is commonly used to control weeds. It is slightly toxic to aquatic vertebrates and invertebrates at higher concentrations but has little potential to accumulate in the environment.	Farmalinx Graslan Tebulan
<i>Tonalide</i>	A synthetic musk fragrance commonly used in personal care products, laundry detergents and cosmetics. Low water solubility.	

### *Nutrients*

Total nitrogen concentrations ranged from 0.1 to 0.3 mg/L, while total phosphorus was relatively low with concentrations of <0.005 to 0.15 mg/L. Nitrite and ammonia concentrations were low at all sites with maximum concentrations of 0.004 mg/L for both analytes. Filterable phosphorus was below 0.010 mg/L with the exception of Fig Tree Springs which had a slightly higher FRP concentration of 0.014 mg/L. Nitrate was very low at sites in the lower reaches of the Roper River at Sites 5 and 6 (0.001 mg/L), and also in Elsey Creek with 0.002 mg/L. However, the springs in the upper catchment had nitrate concentrations that were more than 50-200 times higher than those in the lower reaches (Table 4).

**Table 4. Nutrient concentrations (mg/L) at passive sampler sites.**

No.	Site	Date	NO2_N	NO3_N	PO4_P	NH3_N	Total N	Total P
1	Bitter Springs	24/09/2015	0.004	0.272	0.008	0.004	0.300	0.008
2	Rainbow Springs	23/09/2015	0.002	0.155	0.007	<0.001	0.170	0.007
3	Fig Tree Springs	24/09/2015	0.001	0.058	0.014	0.002	0.150	0.016
4	Elsy Creek	23/09/2015	0.003	0.002	0.005	0.002	0.200	0.015
5	Moroak Station	23/09/2015	0.001	0.001	0.005	<0.001	0.100	0.005
6	Mt McMinn Station	23/09/2015	<0.001	0.001	0.004	0.002	0.130	<0.005

Nitrate is a common anthropogenic contaminant of groundwater throughout the world. Sources of human-generated nitrate include fertilisers, sewerage, domestic animal manure and atmospheric deposition from burning fossil fuels. Because nitrate is highly water soluble it is easily transported through the soil to the water table with rain or irrigation. Elevated nutrient levels in streams can contribute to environmental problems like algal blooms.

The springs are a major source of nitrate to the Roper River. The high nitrate concentrations in the springs indicate that nitrate levels are elevated in groundwater of the region. The source of the elevated nitrate is not known, however, studies in other regions of the Top End indicate that nitrate can be elevated under some agricultural land (Schult 2016a &c).

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## Appendix A: List of analytes for passive samplers

Table 5. List of hydrophobic compounds tested. Limit of Reporting (LOR) applies to the concentrated extract

Chemical	LOR (µg/L)	Chemical	LOR (µg/L)
Is 1	0.1	Ddd o,p	0.1
1h-benzotriazole	0.7	DDD p,p	0.1
1-hydroxy-2,3-epoxychlorodene	0.1	Dde o,p	0.1
1-methyl-1h-benzotriazole	0.1	Dde pp	0.1
2,4-di-t-butylphenol	0.1	DDT o,p	0.1
2,6-di-t-butyl-p-cresol (bht)	0.1	Ddt p,p	0.1
2,6-di-t-butylphenol	0.3	DEET	0.1
2-benzyl-4-chlorophenol	0.2	Deltamethrin isomers	0.1
3,4-dichloroaniline	0.1	Demeton-o-methyl	0.1
4-chloro-3,5-dimethylphenol (dettol)	0.1	Demeton-s	0.1
5-methyl-1h-benzotriazole	0.2	Demeton-s-methyl	0.1
Acephate	0.1	Desethylatrazine	0.1
Aldrin	0.1	Desisopropylatrazine	0.1
Allethrin	0.1	Diazinon	0.1
Ametryn	0.1	Dichlorvos	0.1
Amitraz	0.1	Dicofop methyl	0.1
Anthracene-d10	0.1	Dicofol o,p	0.1
Atrazine	0.1	Dicofol o,p bd	1.5
Azinphos ethyl	0.1	Dicofol p,p	0.1
Azinphos methyl	0.1	Dicofol p,p bd	0.1
Benalaxyl	0.1	Dieldrin	0.1
Bendiocarb	0.1	Dimethoate	0.1
Benzenesulfonanilide	0.2	Dimethomorph e,z isomers	0.2
Bifenthrin	0.1	Dioxathion	0.1
Bioresmethrin	0.1	Disulfoton	0.1
Bisphenol A	0.1	Diuron bd	0.1
Bitertanol isomers	0.1	Endosulfan alpha	0.5
Bromacil	0.1	Endosulfan beta	0.1
Bromophos ethyl	0.1	Endosulfan ether	0.1
Cadusaphos	0.1	Endosulfan lactone	0.5
Captan	0.1	Endosulfan sulphate	0.1
Carbaryl	0.1	Endrin	0.2
Carbophenothion	0.1	Endrin aldehyde	0.1
Chlordane cis	0.1	Ethion	0.1
Chlordane trans	0.1	Ethoprop	0.1
Chlordene	0.1	Etrimiphos	0.1
Chlordene epoxide	0.1	Famphur	0.1
Chlordene, 1-hydroxy	0.1	Fenamiphos	0.1
Chlorfenvinphos e+z isomers	0.1	Fenchlorphos	0.1
Chlorothalonil	0.1	Fenitrothion	0.1
Chlorpyrifos	0.1	Fenthion ethyl	0.1
Chlorpyrifos me	0.1	Fenthion methyl	0.1
Chlorpyrifos oxon	0.1	Fenvalerate isomers	0.1
Coumaphos	0.1	Fipronil	0.1
Cyfluthrin isomers	0.1	Fluazifop butyl	0.1
Cyhalothrin isomers	0.1	Fluometuron	0.1
Cypermethrin isomers	0.1	Flutriafol	0.1

<b>Chemical</b>	<b>LOR (µg/L)</b>	<b>Chemical</b>	<b>LOR (µg/L)</b>
Fluvalinate isomers	0.1	Phosphamidon peak1 **200**	0.1
Furalaxyl	0.1	Phosphamidon peak2 **800**	0.1
Galaxolide	0.1	Phosphate TRI-n-butyl	0.1
Haloxypop methyl	0.1	Piperonyl butoxide	0.1
Haloxypop, 2-ethoxyethyl	0.1	Pirimicarb	0.2
HCB	0.2	Pirimiphos methyl	0.1
HCH-a	0.1	Praziquantel	0.1
HCH-b	0.1	Procymidone	0.1
HCH-d	0.1	Profenophos	0.1
Heptachlor	0.1	Prometryn	0.1
Heptachlor epoxide	0.1	Propagite	0.1
Hexazinone	0.1	Propanil	0.1
Icaridin	0.1	Propazine	0.1
Iprodione	0.1	Propiconazol isomer	0.1
Is 2-6	0.1	Propoxur	0.1
Isophenophos	0.1	Prothiophos	0.1
Lindane (HCH-g)	0.1	Pyrazaphos	0.1
Malathion	0.1	Quintozene	0.1
Metalaxyl	0.1	Rotenone	0.1
Methamidophos	0.1	Simazine	0.1
Methidathion	0.1	Sulprofos	0.1
Methomyl	0.1	Sur1 2-nitro-m-xylene	0.1
Methoprene	0.1	Sur2 dibromobiphenyl	0.1
Methoxychlor	0.1	Sur3 pyrene -d10	0.1
Metolachlor	0.1	Sur4 triphenylphosphate	0.1
Metribuzin	0.1	Sur5 decachlorobiphenyl	0.1
Mevinphos z+E	0.1	TCEP	0.1
Moclobemide	1	TCPP isomers	0.1
Molinate	0.1	TDCPP isomers	0.1
Monocrotophos	0.1	Tebuconazole	0.1
Musk ketone	0.1	Tebuthiuron	0.1
Musk xylene	0.1	Temephos	0.1
N-butyl benzene sulfonamide	0.1	Tep	0.1
n-butyltoluenesulfonamide	0.1	Terbuphos	0.1
Nicotine	0.1	Terbuthylazine	0.1
Nonachlor cis	0.1	Terbutryn	0.1
Nonachlor trans	0.1	Tetrachlorvinphos	0.1
Omethoate	0.2	Tetradifon	0.1
Oxadiazon	0.1	Tetramethrin isomers	0.1
Oxychlor	0.1	Thiabendazole	0.2
Oxydemeton methyl	0.2	Tonalid	0.1
Oxyfluorfen	0.1	Transfluthrin	0.1
Parathion ethyl	0.1	Triadimefon	0.1
Parathion methyl	0.1	Triadimenol isomers	0.1
Pendimethalin	0.1	Triallate	0.1
Permethrin isomers	0.1	Triclosan	0.1
Phenothrin isomers	0.1	Triclosan methyl ether	0.1
Phorate	0.1	Trifluralin	0.1
Phosmet	0.1	Vinclozalin	0.1



**Table 6. List of hydrophilic compounds tested (positive charge). Limit of reporting applies to the concentrated extract.**

<b>Chemical Name</b>	<b>Limit of Reporting (µg/L extract)</b>	<b>Chemical Name</b>	<b>Limit of Reporting (µg/L extract)</b>
3,4 DiCl Aniline 1	0.2	Paracetamol 1	0.1
Ametryn 1	0.5	Paraxanthine 1	0.1
Ametryn hydroxy (=Atrz hydroxy) 1	0.2	Pendimethalin 1	0.2
Asulam 1	0.1	Picloram 1	0.2
Atenolol 1	0.5	Prometryn 1	0.1
Atorvastatin 1	0.1	Propazine 1	0.1
Atrazine 1	0.1	Propiconazole 1	0.1
Bromacil 1	0.1	Propoxur 1	0.5
Caffeine 1	0.1	Sildenafil 1	0.5
Carbamazepine 1	0.1	Simazine 1	0.1
Carbofuran 1	0.1	Simazine hydroxy 1	0.1
Chlorpyrifos 1	0.2	Tadalafil 1	0.1
Citalopram 1	0.1	Tebuthiuron 1	0.1
Clopyralid 1	0.1	Temazepam 1	0.2
Codeine 1	0.1	Terbutylazine 1	0.2
DCPMU 1	0.2	Terbutylazine des ethyl 1	0.1
DCPU 1	0.1	Terbutryn 1	0.2
DEET 1	0.1	Tramadol 1	0.1
Desethyl Atrazine 1	0.1	Venlafaxine 1	0.1
Desisopropyl Atrazine 1	0.2		
Desmethyl Citalopram 1	0.2		
DesmethylDiazepam 1	0.1		
Diazinon 1	0.5		
Dichlorvos 1	0.2		
Diuron 1	0.2		
Fenamiphos 1	0.1		
Flumeturon 1	0.2		
Fluoxetine 1	1		
Gabapentin 1	0.1		
Hexazinone 1	0.1		
Imazapic 1	0.2		
Imazethapyr 1	0.1		
Imidacloprid 1	0.1		
Iopromide 1	0.1		
Malathion 1	0.5		
Methiocarb 1	1		
Methomyl 1	0.1		
Metolachlor 1	0.1		
Metribuzin 1	0.1		
Metsulfuron-Methyl 1	0.2		
Naproxen +ve 1	0.1		

**Table 7. List of hydrophilic compounds tested (negative charge). LOR applies to the concentrated extract.**

<b>Chemical Name</b>	<b>Limit of Reporting (µg/L extract)</b>	<b>Chemical Name</b>	<b>Limit of Reporting (µg/L extract)</b>
2,4 DB 1	0.20	Hydrochlorthiazide 1	0.10
24 D 1	0.10	Ibuprofen 1	1.00
245T 1	0.20	Iopromide 1	0.10
Acesulfame 1	0.10	MCPA 1	0.20
Asulam_neg 1	0.10	Mecoprop 1	0.20
Atorvastatin 1	0.10	Naproxen 1	0.50
Bromoxynil 1	0.10	Picloram 1	0.50
Dicamba 1	0.20	Salicylic acid 1	0.10
Furosemide 1	0.10	Triclopyr 1	0.20
Haloxypol 1	0.10	Triclosan 1	0.10

## Appendix B: Analytical methods and APHA standard method numbers

Parameter	Method	APHA (1998) number
NO <sub>3</sub> /NO <sub>2</sub>	Automated cadmium reduction method	4500-NO <sub>3</sub> -F
NH <sub>3</sub>	Automated Phenate method	4500-NH <sub>3</sub> F
Total N	Persulfate method	4500-N C
Filterable reactive P	Flow injection analysis for orthophosphate	4500-P F (B1)
Total Phosphorus	Flow injection analysis for orthophosphate	4500-P F (B3)