CONTAMINANT SOURCE IDENTIFICATION USING AT-SOURCE TREATMENT DEVICES

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ABSTRACT

Stormwater managers are faced with unworkable costs to implement the total stormwater management. Therefore it makes sense to prioritise implementation, it also make sense to apply treatment in areas of the highest contamination.

Stormwater pollution is a wild and variable. Site specific characteristics greatly affect the contaminant generation and transportation process. Contaminant characteristics can vary within 100m. Factors such as topography, vegetation and population can greatly influence contaminant characteristics, loads and toxicity.

By identifying areas of "contaminates of concern", areas of high contaminant generation, and catchment specific characteristics, appropriate and prioritised implementation of management practices can be achieved. This paper discusses a 5 months study of contaminant loading characteristics and the subsequent implementation of stormwater management practices in the Hobart Docks and Salamanca Area, Hobart, Tasmania.

Enviropod filters were installed in selected gully pits in the Hobart CBD. The contents retained in the filters were removed monthly and analysed for metals, sediments, litter, hydrocarbons and organics. The data obtained has been used to develop and implement site specific non-structural solutions such as enforcement, advice, education, rubbish and cigarette bins. The analysis of contaminant loads also lead to the prioritisation and implementation of future structural solutions in areas of the highest contamination.

The approach and methodology adopted by Hobart City Council is a new assessment tool that could prove valuable to stormwater managers and the development of catchment management plans.

KEYWORDS

Stormwater Treatment, At Source Treatment, Catchpit Inserts, Contaminant Hotspot Identification,

1 INTRODUCTION

Hobart, Tasmania, a municipal council with a small population of 46,000, concentrated on the shores of the River Derwent and largely urbanized has made stormwater management a priority issue.

The Hobart City Council has been at the forefront managing stormwater pollution of in Tasmania. The council has implemented a high number of projects concerned with stormwater quality , approved and partly funded by the Natural Heritage Trust.

Hobart City Council has carried out a series of unique projects that have included intensive monitoring of these practices. With the improved localised knowledge of contaminant sources and characteristics they have strategically implemented appropriate management practices to protect their city

One of the first projects carried out was the use of "at source" treatment devices to identify hotspots within Hobart's urban centre. In 2001, 20 Enviropod filters were installed in strategic locations to identity contaminate loads and characteristics for different land uses within the Hobart central area.

The study catchments have a number of different land use activities, each of which can significantly influence capture loads. The catchments were divided into the following four classifications based on land use activities:

- Commercial: - mixed retail centre, includes Salamanca Place;
- Light Industrial: - industrial areas service stations/ heavily trafficked areas;
- Outside Bars: - directly outside pubs or bars;
- Arterial Roads: - on the outskirts of the catchment.

Ingal Environmental Services (formally Enviropod NZ Ltd) and Hobart City Council monitoring involved emptying the contents of the Enviropods on a monthly basis. Contents were separated into Litter, organic material and sediment. Samples were collected and analysed for lead, copper, zinc. Catchment areas were determined and loading rates were ascertained to identify areas and contaminates of concern.

An integral part of the overall stormwater improvement project has been this monitoring. As an alternative to costly automatic sampling, the use of the Enviropod has enabled Hobart City council to gain a large amount of localised stormwater contaminant knowledge and with this knowledge. This knowledge has enabled Hobart City Council to improve its urban stormwater quality by planning future projects in the most efficient and cost-effective way.

This project, initiated by Hobart City Council and funded in part through Coasts & Clean Seas, aimed to minimise pollution and to improve water quality in the stormwater system surrounding the Salamanca and Hobart Docks area. Prior to the project it was evident that gross litter and liquid waste was causing offensive odours and unsightly litter around the docks area.

2 THE TRIAL AREA – HOBART DOCS / SALAMANCA

This area of Hobart is old and has gentrified into a major commercial centre of the region with cafes, restaurants, retail outlets, art galleries and markets. The stormwater infrastructure of the area consists of many old gully pits and pipes connected to numerous stormwater branches that all discharge directly into the Derwent River.

There are a high volumes of pedestrian movements along Salamanca Place and Montpellier Retreat, with Pubs and Cafes being located in this area and a weekly Saturday market at Salamanca Place that attracted over 1,300, 000 people in 2000/2001. In addition January-February sees a higher attendance in the study area with the Hobart Summer Festival attracting 600,000 visitors in 2000/2001.

Generally there is a high organic loading throughout the trial area with many deciduous trees in the catchment. There is high traffic loading on Davey Street and Sandy Bay Road, with average daily totals (ADTs) of +22,000 vehicles on these streets. Rainfall in Hobart is reasonably consistent, with approximately 40 to 60mm of rainfall per month. Historically the wettest months are October, November and December.

20 Enviropod Filters were installed throughout the trial area, treating a total area of approximately 1.9 Hectares of 100% impervious road and footpath runoff. 200 micron filters were installed throughout the site.

3 THE ENVIROPOD

The Enviropod filter is a gully pit insert which comprises a supporting framework, overflow system and a removable filter bag. Fitted with a 200 micron filter bag, fine sediment can be trapped. Highest concentrations of contaminants are encountered in the fine sediments.

The enviropod requires servicing every 2 – 6 months. This is easily performed with inductor or by hand. The frequency of servicing is dependant on many natural and physical factors.

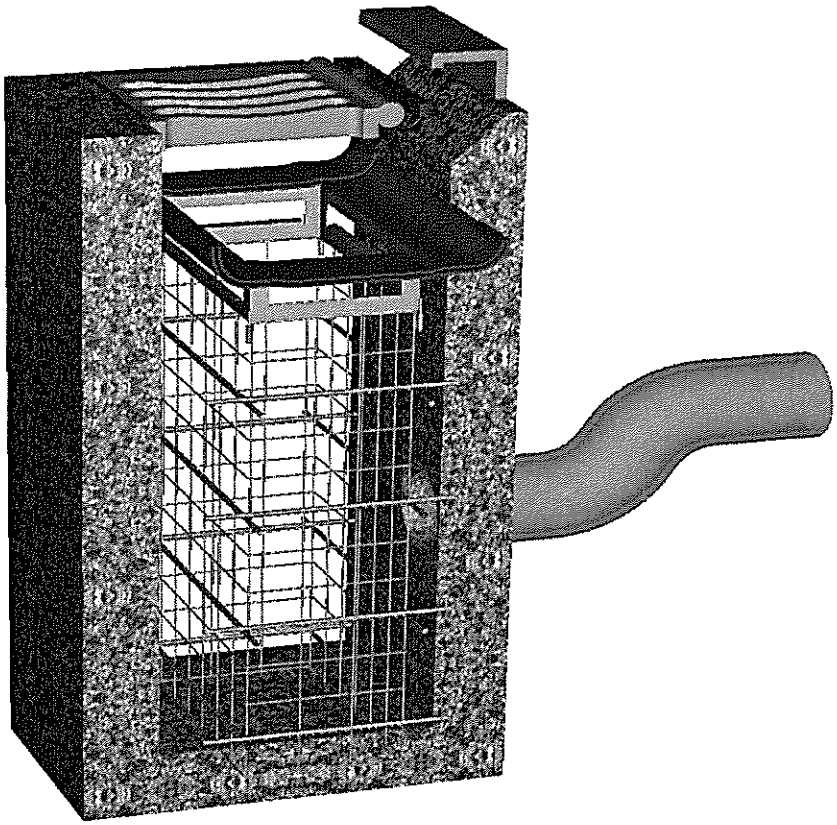
Ingal Environmental Services have installed over 4000 Enviropod filters throughout Australasia.

3.1 A STORMWATER SAMPLER

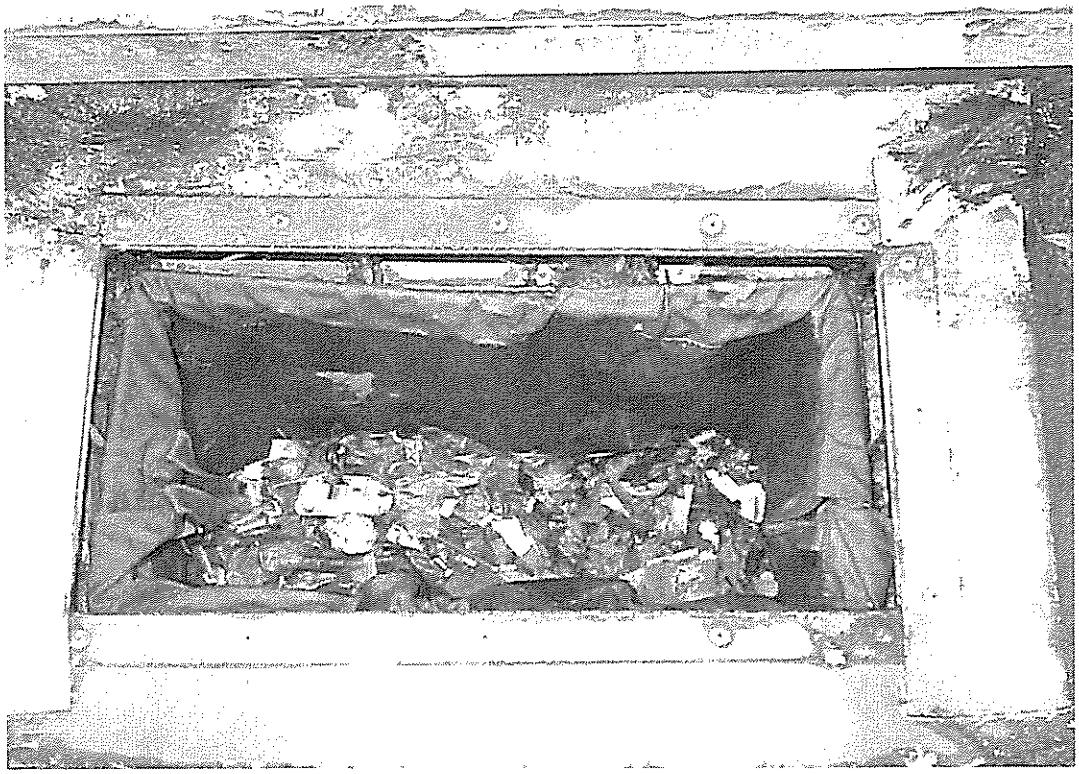
An enviropod filter can be used as an environmental sampler or indicator. The small catchment areas, enables easy identification of contaminant sources within the catchment.

The Enviropod retains gross pollutants and coarse to fine sediments. A conventional sampler does not sample gross pollutants. Gross pollutants are often a transportation mechanism for more toxic contaminants, however if they are retained in a dry environment they can aid in removal of other contaminants such as dissolved metals.

By strategically placing a number of Enviropods through a catchment a large amount of localised information about stormwater contamination can be obtained.

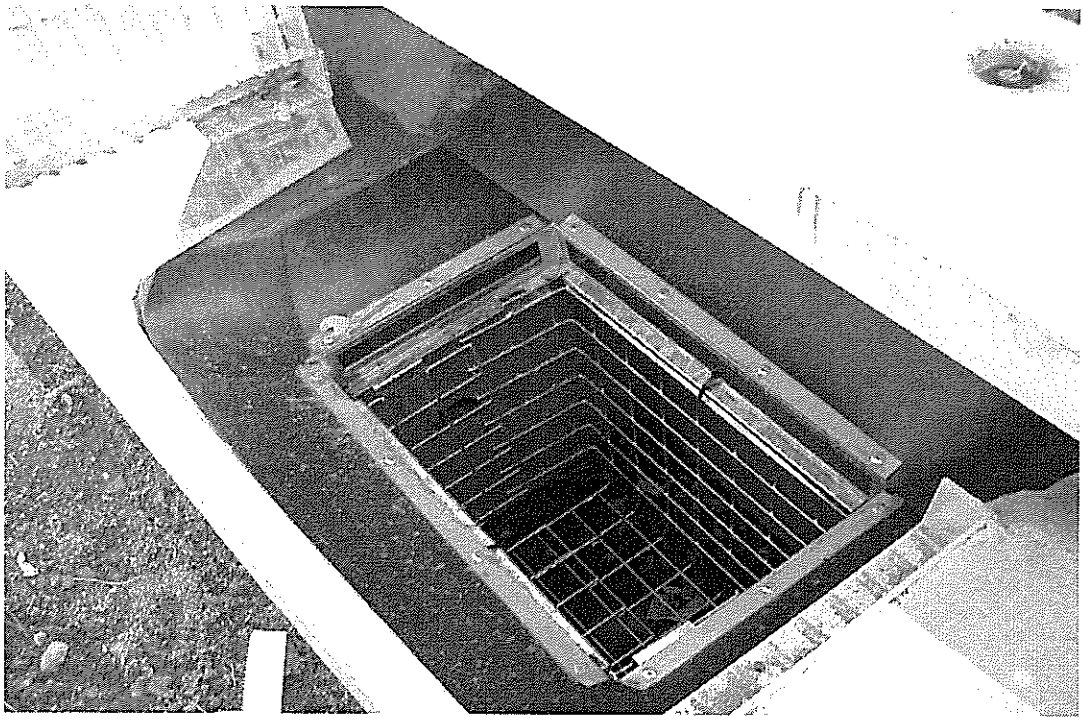


Photograph 1: The Enviropod Filter



Photograph 2: The Enviropod Filter installed

Photograph 2: Removable 200 micron FilterBag.



Photograph 2: Suporting Frame Work.

4 REMOVAL LOADS

4.1 TOTAL LOADS

During the monitoring period, 1124.5 kg (wet weight) of material was captured in the 20 pits. Removal Loads varied from location to location. The highest capture loads were recorded for Enviropods in the Light Industrial areas and outside bars. The source of the high capture loads outside bars is most likely due to the common practice for these businesses to hose down outdoor seating areas as a cleaning procedure. Litter and sediment from this activity invariably ends up in stormwater pits.

4.2 HIGH LEVEL OF ORGANIC MATERIAL

A high level of organic matter was retained in all of the Enviropods. Of 1124.5 kg (wet mass) collected in the 20 Enviropods, 96.6% or 1074.6 kg was organic material and sediment. If organic matter and sediments are allowed in watercourses, they settle out as deposits in riverbeds and estuarine areas. Organic matter is known to reduce dissolved oxygen (DO) levels in receiving water bodies. The rate of DO reduction is dependent on many factors i.e. type of organic material, time of exposure and existence of anaerobic conditions. Organic matter tends to increase the Biological Oxygen Demand (BOD), which in turn reduces DO reducing the pH level of the settled sediment. The acidic condition of the sediment, in turn promotes the release of attached heavy metals. It is advisable to minimise organic loading on the receiving water bodies by installing at-source pollutant traps.

4.3 LITTER LOADS

Litter only made up approximately 4.4% of the total exported load. This value is much lower than other Australian trials e.g. South Sydney CC Trial 27.8% litter, Marrickville trial 34.5% and Woollahra MC Trial 30%. It is presumed low litter loading is because of the lower pedestrian densities, This is evident in examination of Figure 2 where much high litter loads were encountered during December, January-and February because of Christmas shopping and the Hobart Summer Festival. Approximately 600,000 visitors were in the study area during the Hobart Summer Festival. The highest loading was encountered in the Enviropods located on the kerbside outside Pubs and Cafes on Salamanca Place and Montpelier Retreat. Another area of high litter loading was Hampden Road. This road is a pedestrian route for commuters travelling to and from work in the CBD.

Enviropods located near cafes, pubs and public buildings had a high loading of discarded cigarette butts. The amount of cigarette butts retained in the Enviropods was high in comparison with Enviropod Trials in other Australian Cities. Cigarette butts represented 53% (18599 items) of all litter items collected from the 20 Enviropods. Research has shown that cigarette butts increase phosphorous, suspended sediment, conductivity and COD levels.(Aboom and Riely, 1997)[i]

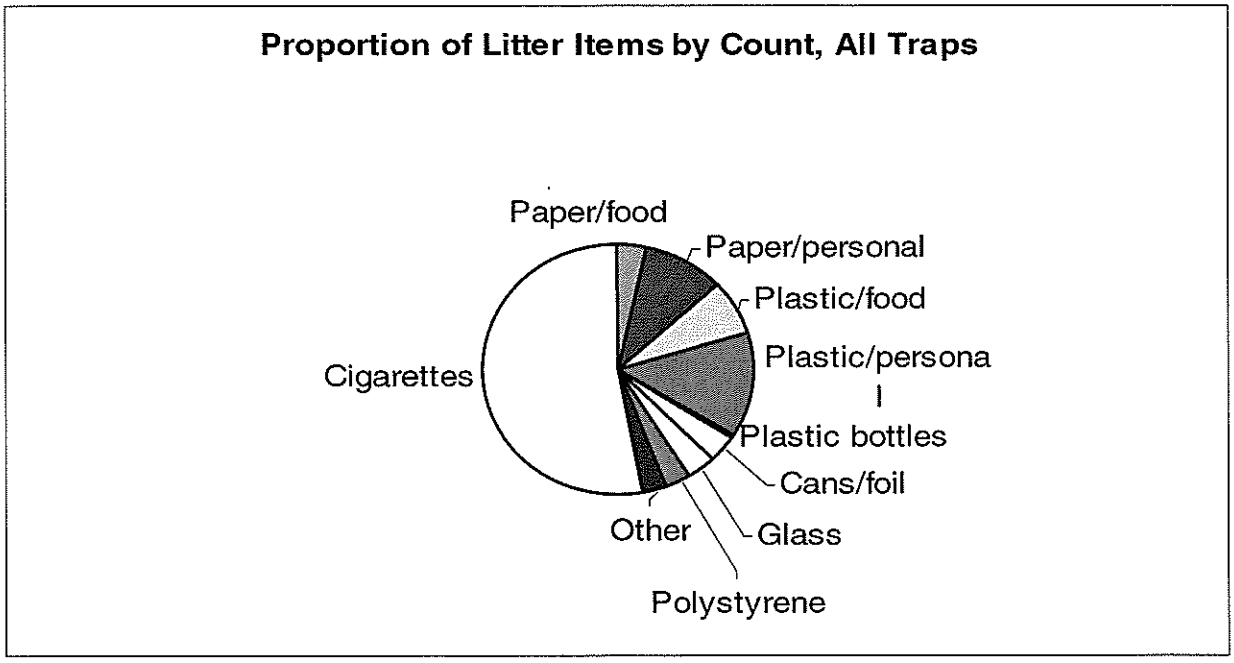


Figure 1: Litter Characteristics

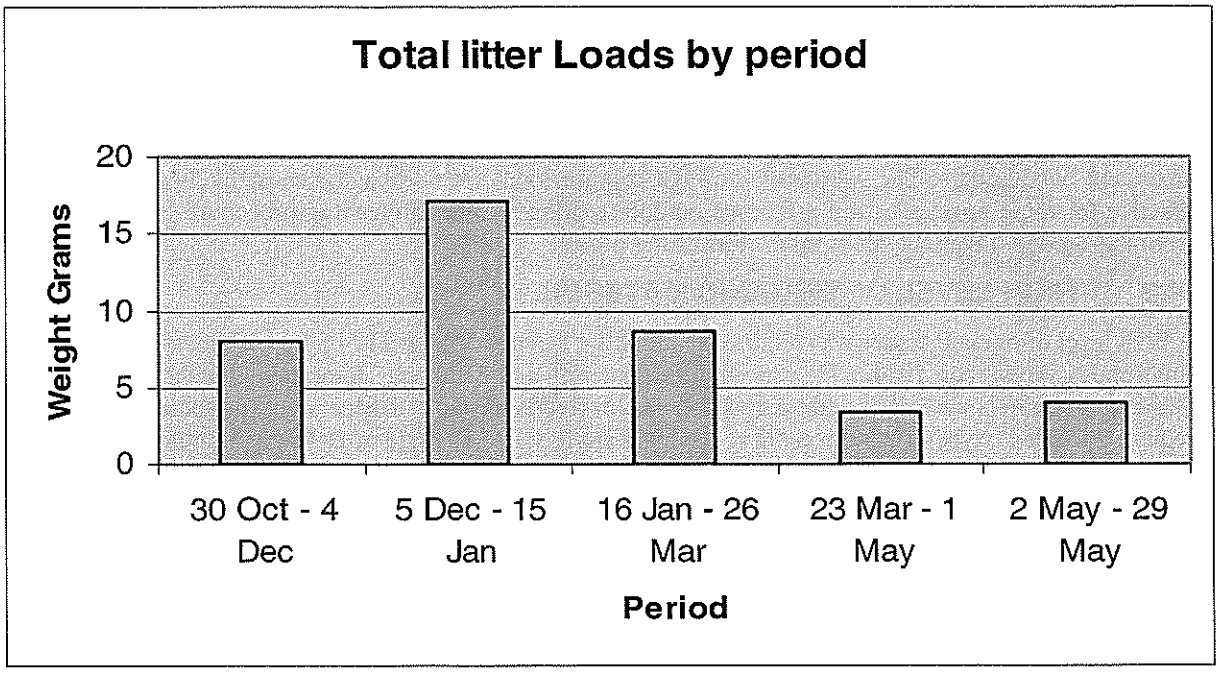


Figure 2: Monthly Loads

5 LOADING RATES

5.1 TOTAL EXPORTED CONTAMINANTS

To determine areas and times with high stormwater contamination, loading rates need to be calculated to take into account different rainfall and catchment areas.

Loading rates are typically expressed as Kg/ha/yr or Kg/ha/mm of rainfall. The average loading rates were 702 kg/hec/yr and 2.86kg/hec/mm

Removal rates varied from location to location and showed a seasonal trend. Removal loads were lower in the commercial areas than in other parts of the city. Higher loading rates were encountered in the last period with the early onset of autumn and associated higher organic loading.

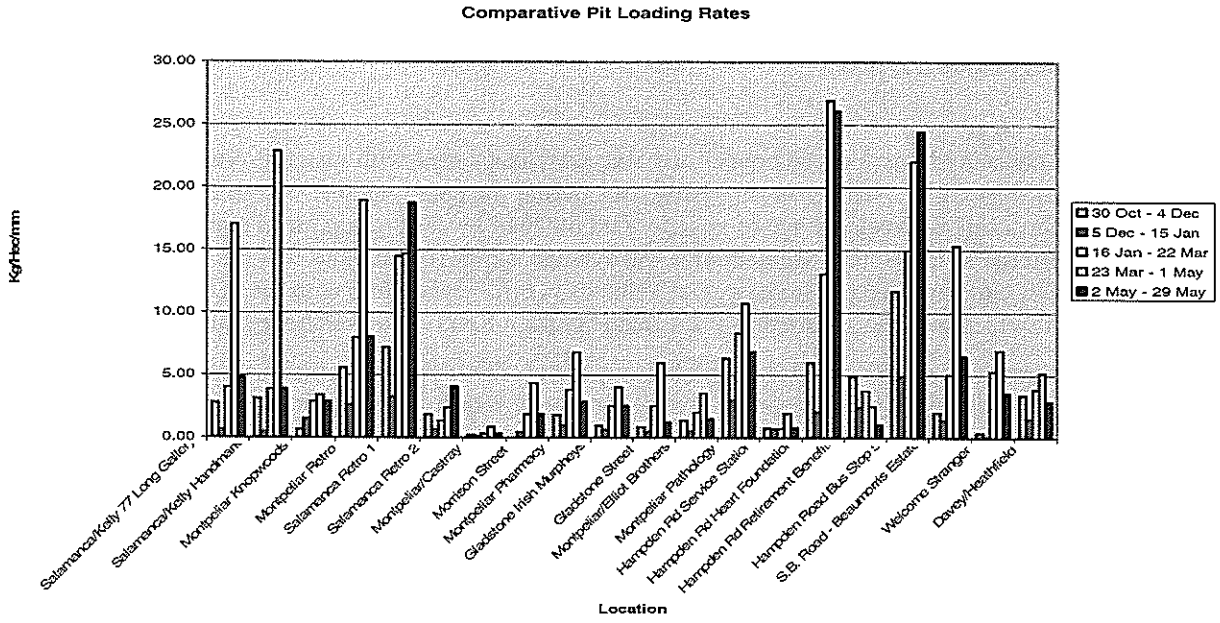


Figure 3: Monthly Loads

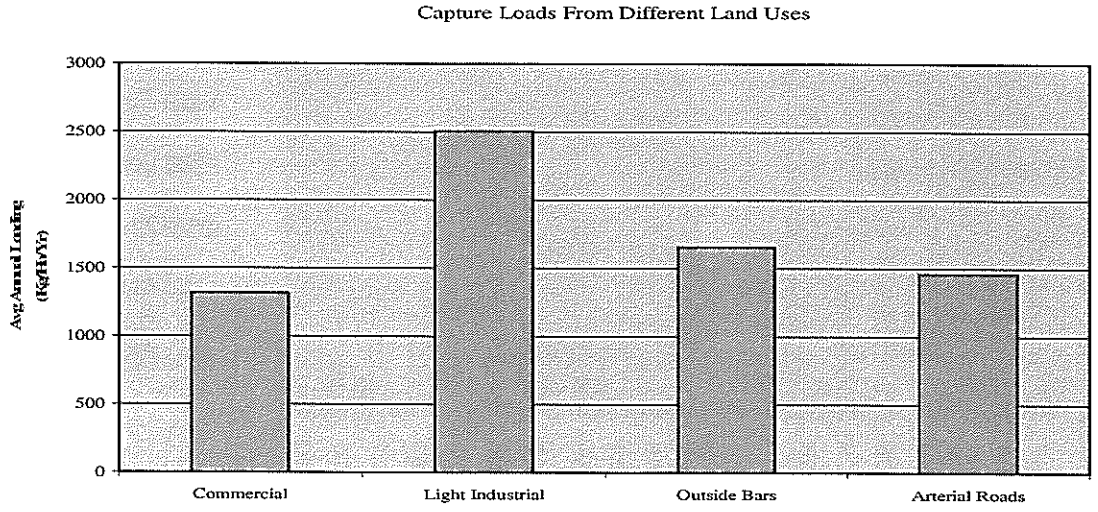


Figure 4: Capture Loads from Different Land Uses

Overall total exported contaminant loading rates in the study were lower than other Enviropod studies in other Australian Cities. This is probably due to the lower rainfall the city experiences and the investigative nature of the project. Subsequent targeted enviropod installation tripled the removal rate.

Comparison Loadings	Kg/ha/yr
Hobart Docks and Salamanca	**702**
Brisbane CDB, QLD	**639**
Woollahra , NSW	**2173**

Table 1: Australian Loading Rate Comparison

5.2 HEAVY METALS

The average concentrations for lead copper and zinc were consistent with material retained in Enviropod Units in other Australian Cities. This was surprising considering the small number of vehicles registered in Hobart. There could be a link between the age of vehicles and the high level of heavy metal contaminants. Of the 44,082 vehicles registered in the Hobart Municipality, the average age is 10 years old. Of the 13,267 cars registered in the Hobart CBD, the average registered age of vehicles is 6.75 years while with the 1,352 vehicles registered in Battery Point (which includes Salamanca Place and Hampden Road), the average registered age is 10.325 years.

Vehicles generate fine particulates loaded with heavy metals through engine, brake, clutch and tyre wear. One of the principal sources of copper in stormwater sediments is wear of vehicle brake pads. Older vehicles would generate higher volumes of heavy metals through wear compared with newer vehicles.

Another possible reason is the high organic loading encountered in the Hobart Trial. Research (Clark. et all) [ii]has indicated that tree leaves have the ability to remove dissolved metals and hydrocarbons from stormwater passing through them. These contaminants are retained with the organic matter and are removed from the runoff by cation exchange with organic material in plant matter.

Most locations throughout the study area were in excess of ANZCECC [iii]guidelines for environmental investigation. There were also a few locations that warranted further investigation into possible source of this heavy metal contamination as they were not on major arterial roads.

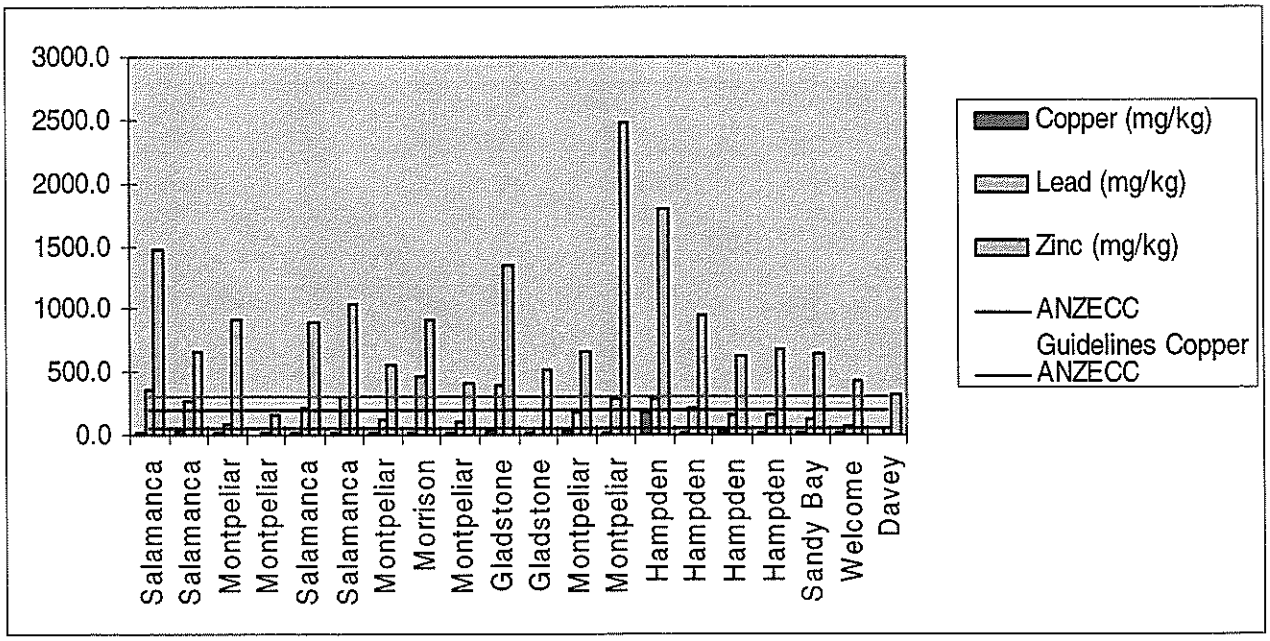


Figure 5: Heavy Metal Concentrations of Retained Sediment

High metal loading rates were encountered on arterial roads and in the light industrial areas. Future stormwater treatment in these areas will have to target fine particulates and possible dissolved contaminants

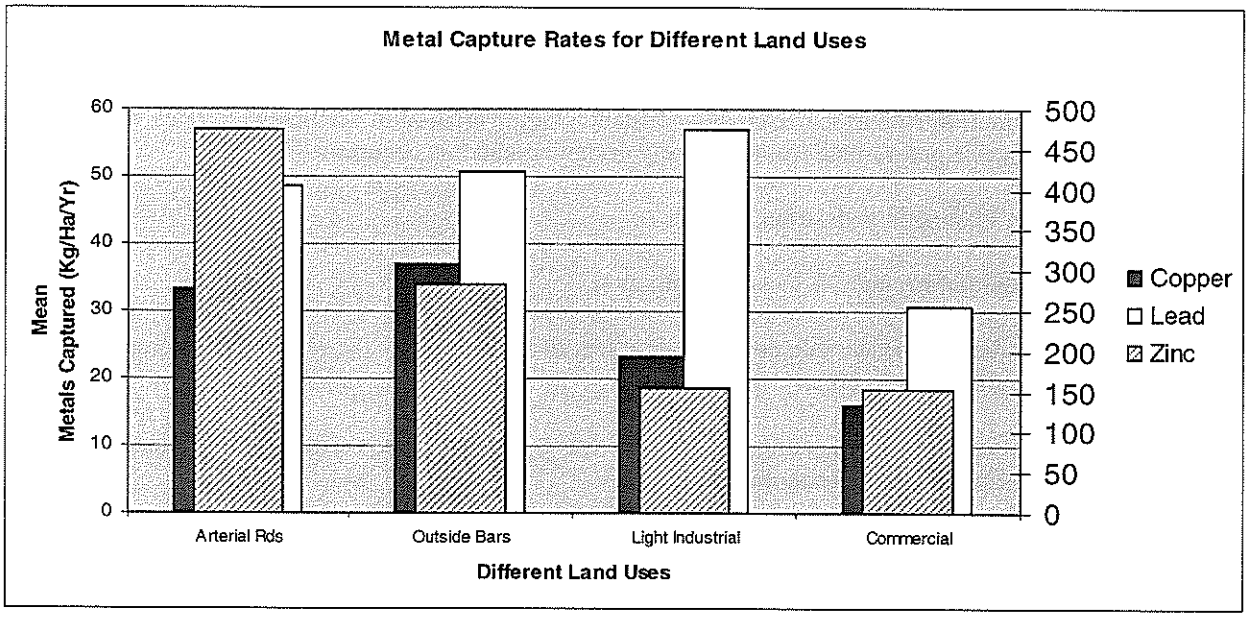


Figure 6: Metal Capture Rates for Different Land Uses

Traffic loadings suggest that at certain locations Hobart stormwater is highly contaminated. The study also identified other isolated locations not on highly trafficked roads with very high loading rates. Illegal discharge of stormwater contaminates could be occurring at these pits and investigation into there sources is being carried out.

Site	Hobart (mean)	Salamanca	Darvy	Montpelier	M1	Hwy - 794	Harrisburg	Street
Location		Hobart	Hobart	Hobart	England	USA	USA	England
Vehicles Per Day		4280	22000	3395	32000	53000	24000	500
Pb (g/ha/mm)	0.5	1.42	0.18	1.36	5.9	16	16.5	0.25
Zn (g/ha/mm)	2.42	5.76	1.06	11.56*	11.5	3.8	1.4	0.19
Cu (g/ha/mm)	0.06	0.13	0.03	0.12		0.84	0.7	0.04

Table 2: International Loading Rate Comparison [iv](Williamson)

6 SUMMARY OF FINDINGS

Listed below is a summary of the specific findings and recommendations for Hobart's stormwater pollutions problem that have been identified by the project

- High concentrations of metals in sediment.

- Some locations have very high metal contamination, higher than other cities.
- Low litter loading, however isolated hot spots area very high.
- Substantial problem with cigarette buts.
- While rainfall in Hobart is reasonably constant a large variation in accumulation rates was encountered. A maintenance programme was effectively design around this occurrence
- High litter loading in pedestrian areas.
- Identification of irregular heavy contamination
- There has been a measurable downstream effect demonstrated by the reduction in complaints about the poor state of the docks area.
- Adequate attention to cleaning, and maintenance is required to sustain the efficiency of the traps. Which has subsequently been implemented
- The project has had spin-offs beyond the initial project e.g. transfer of technology to other sites in Hobart.
- The project has helped to build momentum for stormwater management in Hobart.

6.1 CONTAMINANT HOTSPOTS

The following roads were identified as sediment and organic hotspots because of the high loading rates encountered in Enviropods located on them. Additional Enviropods have now been installed at these hotspots

- Hampden Road, between Davey Street and Sandy Bay Road
- Sandy Bay Road, between St Georges Terrace and Hampton Road
- Montpellier Retreat, between Sandy Bay Road and Salamanca Place
- Salamanca Place, between Davey Street and Runnymede Street

The following areas were identified as Litter Hotspots, additional Enviropods and education have been applied to these hotspots

- Salamanca Place, between Gladstone Street and Runnymede Street
- Hampden Road, between Davey Street and Sandy Bay Road

6.2 EDUCATION AND OTHER SOURCE CONTROL OPPORTUNITIES.

The following list other stormwater management initives developed by the project

1. Enforcement or education to identified illegal discharges.
2. On site control of stormwater runoff from the service station on the Corner of Sandy Bay Rd and Hampden Rd.
3. Examination of street cleaning practices - in particular increases in organic loading in autumn.
4. Further heavy metal and oil and grease investigation
5. Continued monitoring of the seasonal nature of contaminant loadings is carried out in order to allow efficient maintenance programs.
6. Further monitoring and record keeping of installed Enviropod Filters.

7. Education programs are put in place at pubs, cafes and public buildings to promote disposal of cigarette butts into rubbish bins.
8. Ensure the provision and relevant placement of rubbish bins and cigarette disposal bins.
9. Installing of additional Enviropods in streets where regular flushing occurs has prevented discharge of contaminants into the River Derwent. Street flushing is the most cost effective way to clean the streets. Installation of additional Enviropods mitigate against some of the adverse effects associated with it.

7 FOLLOW ON PROJECTS

7.1 HOBART DOCKS/SALAMANCA CBD STORMWATER IMPROVEMENT PROJECT PHASE II

Phase two involved the further retrofit of 65 additional Enviropods in the recommended hotspots across the CBD. Phase two demonstrates effectiveness of the proactive monitoring approach that Hobart City Council has adopted.

Over a period of approximately 10 months, a total of 7.05 tonnes of material was emptied from the units. This equates a loading rate of 2275kg/ha/yr over the 3.3 ha catchment. Removal loads were tripled by strategically installing the Enviropods in identified Hotspots. Phase II also included relocating some of the enviropod that had low removal rates in Phase I

Phase II also included investigating some of the identified illegal discharges and implementing education activates. Waste disposal methods used by businesses and stall holders in the area were monitored, and there was an awareness raising educational program highlighting stormwater issues utilising the Enviropods..

7.2 HOBART CITY CLEAN STORMWATER PRACTICES

Drawing on the findings of the "at source control" project, this project aimed to minimise contamination of the Hobart Rivulet, through effective stormwater management practices that will primarily target litter, sediment and hydrocarbons.

This will be done through installation and testing of a variety of stormwater treatment technologies at further identified 'hotspots' in the central business district. Management devices treat stormwater collected from 6 hectares of the CBD.

A variety of products were installed include: 10 at-source pollution filters (Enviropods) and an oil filter system (Ingal StormFilter); an in-line GPT (Ecosol RSF4600); and a floating boom to collect gross solids at the rivulet outfall. The project also included monitoring and development best practice guidelines for stormwater catchments.

Also included in the project was an education program. The program entailed visits to schools by project officers for stormwater education talks as well as the development and distribution of two stormwater education storybooks, which were very well received.

The project has also been of benefit to Regional Councils in providing performance information on several 'at source' pollution control devices.

7.3 CORNELIAN BAY – AN INTEGRATED APPROACH TO STORMWATER MANAGEMENT

The aim of this project is to improve the quality of stormwater entering the Derwent from the Cornelian Bay catchment through the installation of a range of 'at source' stormwater treatment devices focusing primarily on the Brooker Highway (Enviropods) and Cleary's Gates depot (Puraceptor). The balance of diffuse stormwater pollution generated in the catchment is to be treated by a gross pollutant trap and bio retention channel designed to target pathogens, nutrients, heavy metals, hydrocarbons, sediment and litter.

The locally designed bioretention cell consists of a channel approximately forty metres long, three metres wide and about fifty centimetres deep. The channel is filled with water tolerant vegetation native to Tasmania. Water quality is improved by filtration through the cover of vegetation and then through a soil and gravel profile. Both chemical and biological processes break down pollutants in the system. Water then enters buried polyethylene tanks where bacteria continue to improve water quality until it flows to the Cornelian Bay stormwater outfall.

Monitoring and raising community awareness, particularly through drain stencilling, are also important components of the project. The monitoring, which includes a broad range of parameters, will be used to better assess stormwater pollutant loads, sources and ecosystem effects.

7.4 BUTTSOUT BINS AND PERSONAL ASHTRAYS

Other outcomes included public education on cigarette butt littering involving the distribution of 2,000 personal ashtrays. These BUTTsOUT bins were given to the public during the Hobart Summer Festival to reduce the amount of cigarette butts littering the Hobart Docks.

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