New Zealand Transport Agency

SH58 Stormwater Treatment Trial of Catchpit Filter Systems

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Quality Assurance Statement	
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Contents

1 Executive Summary

This trial was to evaluate the effectiveness of two obtainable proprietary Catchpit Filter Systems (CFSs) retrofitted into existing sumps in a sensitive receiving environment (Ivey Bay on SH58). The trial was not to provide a definitive analysis of these two CFSs as the sample is too small and variables to numerous to account for.

The trial comprised of identifying at least five suitable sumps in the area. One sump was kept as a comparative (control) sump which would be used just to compare results with the CFSs. A desktop study was carried out that identified Ecosol and Enviropod CFSs appeared to have been tested and proved to be effective in the field.

Two sumps were then fitted with Ecosol CFSs and two with Enviropod CFSs. The trial evaluated the installation process, sampled the sediment for heavy metal retention and observed the maintenance process.

It was found that the Enviropod CFS was quicker and easier to retrofit into an existing sump than the Ecosol CFS. Both types of CFSs had issues related to maintenance and overflows which need to be considered when retrofitting CFSs into varying sump types and environments.

Both CFSs demonstrated they can remove the heavy metals of copper, zinc and lead but there was a difference in the capacity of the filter bags used in this trial. The Enviropod appeared to have a greater sediment capturing capacity than the Ecosol CFS, however it should be noted that this finding needs to be considered in relation to the sumps used and their relative locations.

In maintaining the CFSs the trial showed that a vacuum truck appeared the most efficient way to clean the CFSs. , However the time saved here was offset by the fact that in general the filter bags overflowed and so material also had to be sucked from the sump itself on the removal of the bag.

The trial demonstrated that a maintenance period of around three months would be more effective in terms of filter operation than cleaning after six months as filter bags accumulated large amounts. However, it should be noted again that the maintenance period would need to be tailored to the local environment conditions. Overall costs were fairly comparable with Enviropod coming out slightly cheaper to install. However if bag replacement became an issue then Ecosol may offer some savings here.

Subject to appropriate trials for a particular proprietary product, it appears from this trial CFS filter bags have a role to play in removing particulate material and heavy metals as a means of stormwater treatment from the state highway network, particularly near sensitive receiving environments.

Based on this very simple trial we would recommend the use of Enviropod in this particular environment. However there are a number of areas which need further investigation such as a benefit cost analysis, compilation of an operation and maintenance manual as well as a more detailed study into the durability of each of the CFS filter bags.

2 Introduction

In late 2006, an application was made to New Zealand Transport Agency (NZTA) for funding to field trial a number of proprietary catchpit filter systems (CFS) on a selected part of the state highway in order to determine their suitability for inclusion in a stormwater retrofit programme designed to improve the quality of runoff discharging to sensitive receiving environments.

The area selected for the field trial was the section of highway alongside Ivey Bay situated on the western end of SH58, close to its intersection with SH1 at Paremata. The section of road had been identified as a priority for potential stormwater treatment (Gardiner and Armstrong. 2007: “Identifying Sensitive Receiving Environments at Risk from Road Runoff”, Land Transport New Zealand Research Report 315).

This part of SH58 carries a comparatively large traffic volume and road runoff discharges directly into the adjacent Pauatahanui Inlet, a sensitive waterbody. In addition, steep banks along the southern part of the narrow road corridor in this section prevent consideration of conventional stormwater treatment devices, making a catchpit filter approach a more suitable choice.

This report outlines the findings of a field trial of two types of proprietary CFSs retrofitted into a number of existing sumps along the chosen section of SH58. The units were installed in March 2007 and monitoring took place until April 2008 when the devices were removed.

The first part of the project comprised a desktop study to identify proprietary CFSs that could be appropriate for field testing in this section of SH58, considering features relating to ease of installation, maintenance and effectiveness in retaining the main contaminants of concern (copper and zinc) associated with sediment in road runoff. Two suitable devices were chosen for field testing.

The next stage was to identify the sumps for trialling and to develop a methodology that would assess the effectiveness of their performance under two maintenance regimes. One maintenance regime would approximate the manufacturer’s recommendations and the other a typical NZTA maintenance contract.

As well as assessing the performance of each CFS in place, it was considered that assessment of the installation process and maintenance requirements were important as these would have a direct impact on both the cost and the ultimate effectiveness of the units.

Following installation of the CFSs, the trial comprised two elements:

1. Field observations noting the CFSs physical and hydraulic performance under the two maintenance regimes over an extended period (approximately one year) and their ability to retain material over a period of 3-6 months.
2. Collecting samples of retained sediment for particle size and heavy metals analysis.

This report is set out generally in chronological order and describes the initial desktop study, the catchment analysis and selection of test sumps, and the field trial process. Findings from the field trial are discussed in terms of installation, inspection and maintenance of the units, and retained sediment analysis. The report provides conclusions on the performance of each CFS in the field as well as recommendations on other aspects identified by the trial that deserve further consideration should this type of device be taken forward under a retrofit programme.

3 Objectives and Scope of Work

3.1 Objectives

The objectives of the field trial were:

1. Primarily to evaluate the performance of proprietary filters in existing sumps under field conditions.
2. To assess the concentration of heavy metal contaminants (zinc, lead and copper) in sediment retained by the filter that would otherwise be discharged from the state highway into an adjacent sensitive waterbody.

It should be noted that existing sumps on the state highway comprise what are classed as 'typical' sumps, as well as 'non-standard' sumps that can have one or more of the following features:

- Are very shallow
- Have sloping/uneven bases
- Have little or no sump feature to collect material
- Have irregular dimensions
- Have the discharge pipe close to the grate.

While for the purposes of installing a CFS it is not advantageous to have 'non-standard' sumps, these have been constructed for a number of reasons on the existing state highway network, including the section tested in this field trial. While these non-standard sumps raised a number of installation issues, this was seen as an integral component of the evaluation process as any standard CFS adopted for use on the state highway needs to be readily adaptable to fit such circumstances.

3.2 Scope of Work

The scope of work comprised the following:

- A desktop study of CFSs used by both Australian and New Zealand local authorities to narrow down at least two appropriate proprietary CFSs for the study and establish a performance specification
- Evaluate installation of the CFSs into existing sumps within the study area
- Evaluate the field performance of the CFSs over approximately one year
- Evaluate the maintenance regime required for each of the CFSs
- Sample the sediment retained in each of the CFSs
- Comment on the hydraulic performance of the CFSs
- Report findings to the NZTA.

4 Desktop Study and Summary of Findings

A desk top study was undertaken to review published data on field trials of proprietary Catchpit Filter Systems (CFS) in order to assist selection of filters for the subject study and to determine factors for evaluation.

The methodology comprised a general internet search and making contact with selected Regional Councils and local authorities who have previously undertaken field evaluations of these devices.

A brief account of a number of these studies is contained in Appendix A while a summary of the main findings from these studies is given below.

4.1 Summary of Findings

The following general points are drawn from the literature review:

- There is currently a range of CFS types available in New Zealand and Australia. They are all designed to treat litter/gross pollutants, sediment and vegetation to varying degrees; certain types are promoted as having higher capture rates for other stormwater pollutants including fine sediment (<0.1mm material retained), suspended solids, nutrients, heavy metals and oil and grease.
- Of the devices available, the Enviropod and Ecosol are the most tested and generally show a superior performance for treating stormwater.
- It is clear from all studies that careful specification of filter systems and sump installation is required to ensure good quality control.
- In general, most of the studies noted that modified catchpits or catchpits with a CFS could be a practical and economical form of sediment capture in retrofit situations such as heavily built-up urban areas.
- The ARC study, in particular, showed that an appropriately maintained standard catchpit (without a CFS) can remove the majority of sediment down to 500 microns in size. Test results show that with the addition of a CFS, the majority of sediment down to 100 microns in size can be removed. As the majority of heavy metals are associated with fine sediments, removal via CFS will result in considerable reduction in zinc, copper and lead loads from the road network to the receiving environment.
- Stormwater catchpit inserts must be designed to remain outside the periphery of the catchpit outlet pipe to limit hydraulic constraints and the potential for minor flooding.
- All traps need to be fitted tightly against the catchpits to prevent pollutants passing through the gaps. Stormwater catchpit inserts may not properly seal in offset and obstructed catchpits, causing bypass of low flows and a significant portion of the “first flush”.

- Good drainage diagrams are essential for efficient trap installation.
- Location of the catchpits should allow reasonable access for maintenance and operations. Difficulties such as parked vehicles and access to restricted areas need to be considered early in the design stage.
- The recommended frequency of cleaning and maintenance of CFSs varied with each study with suggested periods from 1-6 months. However, studies have shown that each site is unique and maintenance is dependant on site characteristics. In addition, the finer the CFS filter bag mesh, the more sediment is trapped, and the more frequently it must be cleaned with consequent higher maintenance costs.
- Most studies highlighted that essential maintenance (including inspections, recording and reporting) be carried out in a systematic manner by qualified and experienced personnel. Reporting and record keeping also facilitate compliance auditing.
- When determining a maintenance regime, both the number of days between cleans and the rainfall event occurring in this period need to be considered together. A minimum of a two-person cleaning team is necessary for safety reasons.
- Further inspections, particularly during and after storm events, are necessary to determine the durability and efficiency of the devices.
- Manual cleaning is cost-prohibitive. The use of a vacuum unit is recommended as the most efficient option.

5 Catchment Analysis and Design Flow

5.1 Location of Sumps

The trial was limited in the choice of sumps that could be chosen due to the short length (approximately 0.4 km) of state highway along Ivey Bay. The location of the sumps under test are shown in Appendix H.

An important aspect prior to testing the CFS units was to establish the capacity of the sumps chosen so that overflows could be predicted and evaluated based on storm event, catchment characteristics and filter performance. This aspect is discussed below.

5.2 Methodology for Sizing Catchment Area

The methodology for sizing the catchment areas for each of the sumps along the section of State Highway 58 near Ivey Bay was as follows:

- The distance between the sumps was determined using a measuring wheel. This data was then compared to the information obtained from GIS and NZTA's RAMM database.
- The boundaries of adjacent catchments along the road were determined by a simple water test. Thus, water was poured on the road at various locations and the direction of flow noted until a point of contra-flexure was found.
- The catchment boundaries of the permeable hillside surfaces were assessed from contour maps.
- The size of the internal diameters of the discharge pipes were measured with a tape measure. The discharge pipe from S2 was unable to be located (see below under Assumptions).
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<u>Assumptions</u>

The following assumptions were made in the estimation of catchment areas and in the calculations of peak runoff values:

- Several discrepancies were apparent between the location of the sumps recorded manually with the measuring wheel and the information provided by GIS. In such cases, the manual wheel data was assumed to be the most accurate method as

the location of sumps could be verified in the field by cross-referencing to buildings, trees and other notable features on the aerial photograph of the section.
- The field visit included a drive along the upper part of the catchment on the hill above the study area. From this it was concluded that the stormwater system in place will trap all the runoff from the remainder of the hill. Thus the upper limit of the SH58 permeable catchment area was determined to be Kahu Road
- The discharge pipe from sump S2 was unable to be located. It was assumed for the pipe capacity calculations to be 225mm diameter which is in line with the discharge pipes of the adjacent sumps.
- A typical road width of 6.5 metres was used.
- A 'typical' sump capacity of 30l/s was used as a guide.
- Flow capacities were calculated using the Colebrook-White formula for each of the discharge pipes from the sumps at each location for 2, 5, 10 and 20-year events.

5.3 Sump Capacity Review Findings

The sump review found that using a 'typical' sump capacity of approximately 30l/s, most of the sumps would manage a 1 in 5 year rainfall event.

Sumps were similar with regard to overall dimensions apart from S4N which was significantly shallower than the other sumps. This sump, in particular, did not meet the requirements of what local authorities or indeed NZTA would expect as 'good engineering practice'. It should be noted, however, that this situation is not uncommon throughout the NZTA network and was an important aspect of this trial. This situation was also noted by the CFS suppliers prior to the filter systems being installed.

6 Selection of CFSs for Field Testing

The desktop study identified two candidate CFSs which met the criteria of being available in New Zealand and with good sediment retention characteristics. The two devices chosen for the field trial were the Ecosol RSF 100 and the Enviropod.

The majority of the findings from Section 4.1 were adopted as part of the field trial. It was indicated to the suppliers that the CFS to be tested should capture material with particle sizes of 100 microns and above as this material would retain the majority of heavy metal load (copper, lead and zinc).

The field trial was designed to address the following aspects:

1. Investigate ease of installation.
2. Assess retention of zinc, copper and lead through analysis of retained sediment.
3. Maintain one of each CFS on a 3-monthly and 6-monthly cycle to represent what the manufacturer recommends and what the NZTA expects in its maintenance contract.
4. Observe how filters operate when not in an ideal sump design.
5. Observe operation in the field through random visits as well as planned maintenance inspections.

Initial concerns were raised that the filter mesh size may restrict discharge to a greater extent than the rainfall events indicated in Section 5.3. Discussion with the suppliers indicated that the filter bags would not have a significant effect on sump discharge as long as the sumps were of a ‘typical’ design.

7 Field Trial

This section describes aspects of the field trial covering installation, inspection and maintenance of the CFSs and analysis of retained sediment.

7.1 Installation

This section describes the installation process for each of the two types of filters and provides comments based on observations at the time.

Installation of the CFSs took place in May 2007. Two Ecosol units were fitted into sumps S3 & S4N and two Enviropod units were installed in sumps S1 and S4S. It was not possible to establish a `control' sump (i.e. without a CFS) as the sumps received runoff from different parts of the catchments and variable lengths of highway. However, one catchpit (S2) in the study area (not fitted with a CFS) was used as a qualitative indicator for comparison purposes in relation to the amount of material and indicative concentrations of heavy metals retained by the CFSs.

Sump dimensions were as follows:

- S4N – 600x440mm area x 440mm depth
- S4S - 600x440mm area x 650mm depth
- S3 - 600x440mm area x 620mm depth
- S1 - 600x440mm area x 600mm depth

S1 was a double sump so to provide consistency one of the sumps was plugged for the purposes of this trial.

7.1.1 Installation Procedure and Observations

The installation procedure for each of the tested CFSs is contained within the brochures supplied by each of the suppliers. A brief description of the procedure, together with field observations made at the time the units were installed, is described below.

Enviropod

The installations were carried out at Sump Numbers S1 and S4S in conjunction with Stormwater 360 Ltd on 24th May 2007, using the following steps (refer to photographs):

- The sump was vacuum cleaned;
- The dimensions of the sump were taken;
- An off-the-shelf cage was supplied in two pieces fitted together using screws;

- The cage was then cut down to the appropriate length using wire cutters. (Note: this length of the cage is equal to the depth of the sump minus 200mm, but can be cut to fit as appropriate);

- A removable base made of the same material as the cage was inserted into the cage;
- The deflector panel (rectangular frame with plastic flaps) was then cut to size with a Stanley knife which involved cutting off excess plastic to fit the dimensions of the sump;
- The deflector panel was then placed onto the cage using allocated slots found at the top of the cage;
- The cage was then placed into the sump;

- The Enviropod filter bag was then threaded onto an aluminium ring, the tabs at the side of the bag were turned inside the bag and the bag and ring were seated onto a ledge on the inside of the deflector panel.

It took approximately 15-20minutes to install each filter in the sump.

S1 was very shallow and was less than what the supplier believed was considered appropriate for use with an Enviropod CFS. When the CFS was installed into S1 it was clear that the overflow from the filter was below the obvert of the outlet pipe, with the result that any material captured by the filter system may flow out of the filter through the overflow and outlet during heavy rainfall events.

It was noted that if the base of the sump was uneven (as in the case of S1) this would result in the cage not sitting flat and the unit would therefore oscillate.

It was also noted that there were some small gaps between the deflector panel and the sump walls in S1. The supplier pointed out that this gap would fill with sediment creating a barrier over time.

Ecosol

The original Installation of the CFS in S4N was carried out in conjunction with an Ecosol representative on 1st May 2007 using the following steps (refer to photographs):

- The sump was vacuum cleaned;
- The dimensions of the sump were taken;

- Two holes at the same level were drilled into the two shorter sides of the sump wall using a hammer drill and generator;
- An aluminium bracket was then secured to each wall with 8mm nylon anchors;

- Longer brackets were bolted to the aluminium brackets on the shorter side of the sump through predrilled holes;
- An overflow flap was then shaped to fit the area of the sump below the backflow opening using a grinder powered by the generator;
- This fixed flap was bolted to the top of the side brackets along the north side of the sump facing internally and a spring-loaded hinged overflow flap was bolted at the same location facing into the sump;
- The small gaps around the edges of the frame were sealed between the frame and wall using a silicon sealant to prevent any overflow;
- The filter bag (described as a 200 micron filter bag with an oyster mesh surround) was then inserted into the catchpit filter frame using a metal slot and the edges of the bag were folded away from the centre of the bag.

Installation of the CFS in S4N was initially carried out incorrectly. The overflow flap was used to deflect water that comes into the sump through the backflow opening into the filter. This flap was jammed open with debris from road runoff and meant that any runoff that entered the sump through the backflow opening bypassed the catchpit filter.

A second installation of the CFS in S4N was carried out by another representative of Ecosol on 23rd August 2007. A summary of the installation method is described below:

- The entire CFS that was in place was taken out;
- A further two holes at the same level were drilled into the two shorter sides of the sump wall;
- An aluminium bracket was then secured as previously with 8mm nylon anchors, with longer brackets fixed to this aluminium bracket on the shorter side of the sump;
- The same overflow flap that was shaped to fit the area of the sump below the backflow opening was used in the new installation;

- This fixed flap was bolted to the top of the bracket along the north side of the sump;

- Another fixed flap was shaped using a grinder to fit between the section between the lower bracket and the upper bracket on the north side of the sump;
- A spring-loaded hinged overflow flap was bolted to the bracket on the south side of the sump and kept in place using a nail in the sump wall;
- The gaps around the edges of the frame were sealed as described above and the filter bag installed.

The Ecosol filter originally installed in S4N took 100 minutes to install. The second installation took 60 minutes.

After the original installation of the Ecosol filter on 1st May 2007, the sump grate was dropped into the sump while being placed back into position. This slightly bent a section of the bracket used to hold the filters in place. This section was replaced at a later date.

Installation of the Ecosol CFS required a generator, hammer drill, grinder and other hand tools.

Installation of the second Ecosol CFS (in sump S3) was carried out by the second representative of Ecosol on 15th May 2007 using the following steps:

- The first five steps followed those of S4N on 1 May 2007;
- A spring-loaded hinged overflow flap was bolted to the northern side of the two side brackets and kept in place using a nail in the sump wall;
- The small gaps around the frame and wall were sealed using a silicon sealant to prevent any overflow;
- The filter bag was then inserted into the catchpit filter frame using a metal slot and the edges of the bag were folded away from the centre of the bag.

The Ecosol filter in sump S3 was installed in approximately 25 minutes.

7.1.2 Cost of Installation

In costing each of the CFSs it is envisaged that a number of these would be installed at any one time. The following unit costs from suppliers are based on the supply and installation of approximately 100 CFSs (as at Aug 2008) with the costs exclusive of any traffic management (as each installation is likely to require a different degree of traffic management):

<u>Enviropod</u>
Supply and Installation $ 700 (excl GST)

<u>Ecosol</u>
Supply and Installation $ 790 (excl GST)

7.2 Inspection

Field inspections were generally carried out on a random basis but where possible a number were timed to coincide with a rainfall event in order to check performance of the units under actual runoff conditions.

Inspections were carried out using the Monitoring Checklist (Appendix E). In total, four inspections were carried out, one in June 2007, one in July 2007 and two in September 2007. These inspections outside of the formal maintenance regime were useful in observing CFSs in operation in the field and noting issues that arise over a period of time.

Below is a brief snapshot of observations relating to the first two inspections looking at operational and hydraulic issues.

1st inspection 19 June 2007

S1: The deflector panel had come away from the sump wall on the southern side of the sump as shown below. The sump was full of water up to the invert of the outlet pipe and there were signs of overflow from the CFS.

S4N: The filter appeared to be operating well. There was a relatively large amount of material in the filter bag although the amount was difficult to quantify. Some material was caught between the overflow flap and frame.

S4S: The filter appeared to be operating well. The sump was full of water up to the invert of the outlet pipe. Twigs, leaves and litter were visible in the catchpit filter bag.

2nd inspection 10 July 2008

S1: The deflector panel had come away from the sump wall on the southern side of the sump, shown in the photo below.

There was a large amount of litter captured in the filter bag and a large amount of material (twigs, grass, leaves, litter) on the surface of the grate and the road adjacent to the grate.

S2: The control pit was filled with water up to the outlet pipe invert level.

S3: The CFS had the water level up to the invert of the outlet. No signs of flooding were evident.

S4S: The CFS appeared to be operating successfully. Twigs, leaves and litter were visible in the catchpit filter bag.

S4N: The overflow flap on the CFS was jammed open by twigs and litter with a gap approximately 10mm wide.

7.3 Maintenance

This section of the report describes issues related to maintenance of the CFSs, under the following subsections:

- Maintenance procedure
- Observations of CFS at time of maintenance
- Cost of maintenance

7.3.1 Maintenance Procedure

The maintenance regime for each of the sumps was aimed at replicating both the maintenance regime as recommended by the suppliers (which was generally every 3 months) and comparing this with the current 6-monthy maintenance regime as generally followed with NZTA involving the inspection and clearing drainage structures including sumps.

The maintenance regime adopted for the CFSs is summarised in Table 1.

Table 1: Maintenance regime of CFSs in field trial

Date	S1	S2	S3	S4S	S4N
	Enviropod	(none)*	Ecosol	Enviropod	Ecosol
23/08/07	NC	C	NC	C	C
27/11/07	C	C	C	C	C
03/03/08	C	C	C	C	C

Note: NC – Not cleaned, C – Cleaned * sump not fitted with a CFS for comparison purposes

Filters were initially installed around May 2007 and the maintenance was designed to cover a typical year. Sumps S1 and S3 were not cleaned after the first 3-month period in order to replicate the NZTA maintenance regime. The trial location was a particularly dangerous section of highway due to its winding nature and the large number of vehicles per day. Because of this, traffic management represented an important aspect and a significant cost of the maintenance.

After the CFSs were installed in May 2007, the first sumps to be cleaned in August 2007 were S4S and S4N.

Normal practice was for the vacuum (sucker) truck driver to insert the hose into the sump after lifting the grate and carefully vacuum debris out of the CFS without removing the bag. When filter sampling occurred at the same time as carrying out maintenance, it was necessary to remove the bag first in order to weigh and observe the debris content and obtain a representative sample. The procedure followed in this trial, therefore, was for the filter bags to be removed by hand and sampled, and the remaining contents of the filter bag emptied into the vacuum truck. The vacuum truck then sucked any remaining debris from the sump with the bag removed. The cleaned bag was then replaced into the catchpit.

7.3.2 Maintenance Observations

Appendix E contains the monitoring checklists and comments relevant to the three maintenance dates as outlined in Table 1 for each of the sumps fitted with a CFS. A brief summary of some of the more significant observations of the maintenance process for each of the CFSs is given below.

Enviropod

From the first maintenance inspection after three months (on 23/8/2007), the Enviropod filter bag at S4S contained approximately 25kg of debris comprising twigs, leaves, plastic and soil combined with water.

This was also the case from the observations made on sump S1, although S1 was not cleaned after the three month period but was left until the six-month maintenance cycle.

It was noted at S4S that the bottom of the grate structure was required to be removed before the vacuum truck was able to suck remaining debris from the sump base. For this reason, a new filter bag was provided by Enviropod and installed at this sump. This procedure was not planned and raised a question in relation to whether or not this was standard practice (i.e. if standard practice this has implications for the overall cost).

As mentioned above in relation to S4, there was evidence that the overflow system had been activated due to some material being found at the base of the sump after removal of the filter bag. The second maintenance cycle on 27 November 2007 found that S4S again had around 33 kg of debris with further evidence of bypassing.

S1 underwent its first maintenance on 27 November 2007 (after 6 months use) and contained approximately 67kg of material. Prior to lifting the bag out some material had to be partially dug out of the filter bag to reduce the weight so the bag could be lifted out, a process which proved to be quite difficult. The extent of material and emptying process is shown in the two photographs below.

The photograph below shows evidence of a tear which may have occurred digging out material or ripping when lifting the bag out of the cage. As previously observed there were signs of overflowing and the filter bag being bypassed.

After the third maintenance cycle on 3 March 2008 it was found that S1 had collected around 20kg of material while S4S had collected around 48kg of material. Both CFSs showed evidence of overflows but the bags this time appeared to be in adequate condition.

Ecosol

During the first maintenance inspection after three months (23/8/2007), the Ecosol filter bag at S4N was reinstalled due to the overflow flap being incorrectly installed. The presence of material in the bottom of the sump highlighted the effect that incorrect installation had on the working of the CFS. The build-up of material that had bypassed the filter in the base of the sump is shown on the photograph below

During the second maintenance inspection on 27 November 2008 (after 6 months in situ), both sumps S4N and S3 were cleaned. At the time it was noted that both the overflow flaps were jammed open with twigs and debris.

In S4N, which collected material over 3 months, there was approximately 10kg of material in the filter bag. It was difficult to remove the bag and the top bars of the bag had become bent out of shape (these were however bent back into place with a hammer). Once the bag was removed and material sampled and emptied into the vacuum truck the base of the sump was vacuum cleaned. The bag appeared in reasonable condition.

In S3, where material had been collecting for 6 months, there was a total of around 6.5kg (approx one quarter full), and evidence of around 25mm of material at the base of sump indicating some overflow.

On the third maintenance clean (3 March 2008), the CFS in S3 and S4N had each collected approx 7kg of material. Both units showed some evidence of material bypassing the bags, as seen by material in the sumps following removal of the filters.

7.3.3 Cost of Maintenance

In costing the maintenance of each of the CFSs it is envisaged that a number of these would be maintained at any one time. The following unit costs are therefore based on the maintenance of approximately 100 CFSs approximately 4 times per year, with the costs exclusive of any traffic management as this is site-dependent.

.Enviropod
Maintenance per unit: Approx $30 (excl GST)
Cost if buying 10 bags: Approx $78/per bag (excl GST)

Ecosol
Maintenance per unit: Approx $47 (excl GST)
Cost if buying 10 bags: Approx $60/per bag (excl GST)

The above costs are based on information provided in August 2008 by the respective suppliers and are indicative if some bags need to be replaced when say burned or ripped when pulling out. It is assumed that bags will last at least one year if 'good maintenance' practice is followed. The above costs do not include any training costs which we would envisage being incorporated as part of the installation.

8 Sediment Analysis

This section of the report describes all aspects related to the sampling and analysis of sediment materials captured by the CFSs.

8.1.1 Methodology

A retained sediment sample was obtained from two of the four CFSs once every three months with the other sumps sampled after six months (to represent maintenance regimes) for laboratory analysis. Representative samples of retained sediment were obtained by using a small spade scooping material out of the centre of the filter bag.

The approximate total retained wet sediment load was estimated at the end of each test period by weighing the CFS in the field using a calibrated spring balance. If the quantity of retained sediment was too large to weigh in one sample (e.g. greater than 40 kg) then the retained mass was weighed in discreet amounts.

Samples of retained material in the sump filter bags were collected on three occasions; September 2007, November 2007 and March 2008. During the first sampling event (September 2007), only two of the four filter bags were sampled (one Ecosol, one Enviropod and the control/comparative sump containing no filter bag). Two of the four filter bags were left unsampled so as to assess their performance over a six-month period.

Table 2 provides the approximate weights of the sediment in each filter bag at the time of sampling over each of the three sampling events; no weights are available for S2, the comparative sump, as no filter bag was fitted in this sump.

Table 2: Approximate weight (kg) of retained sediment in each filter bag by catchpit

Date	S1	S2 (Comparison)	S3	S4S	S4N
	Enviropod	NA	Ecosol	Enviropod	Ecosol
23/08/07	NS	-	NS	24.3	6.5
27/11/07	66.5	-	6.5	20.5	10
3/3/2008	19.7	-	6.7	49.4	7.1

Notes: NS = no sample; NA = catchpit with no CFS installed

Two representative samples were collected from the sediment retained in the filter bags and at the base of S2, one for heavy metals analysis, and the other for the particle size distribution analysis. Sediment samples obtained from each CFS were analysed at Hills Laboratories for moisture content and heavy metal concentration (zinc, lead and copper), and at Waikato University for particle size distribution. Results are discussed below (refer to Appendix F for the laboratory analytical reports).

8.1.2 Heavy Metals in Retained Sediment

Sediment samples collected from the filter bags were analysed for their dry weight of copper, lead and zinc. Charts 1, 2 and 3 show the dry weight of each the three metals present in the samples.

The results are shown with sediment quality guidelines developed by Long and MacDonald (1998) and used by the National Oceanic and Atmospheric Administration (NOAA) for the Marine and Estuarine Ecosystems. The two guideline classes are Effects Range Low (ERL) and Effects Range Median (ERM). ERL values represent concentrations below which sediment dwelling fauna is likely to be adversely affected only infrequently, while ERM values represent levels above which adverse effects are expected (Long and MacDonald, 1998).

The results indicate concentrations of the metals varied greatly between the sites and sampling rounds. The monitoring frequency, of 3 or 6 months, did not have a distinguishable impact on the concentration of metals accumulating in the filter bags. There was also no distinction between concentrations of metals retained in sediment in each type of bag. In fact, the most notable feature between the filter bags was the amount of sediment that accumulated in them.

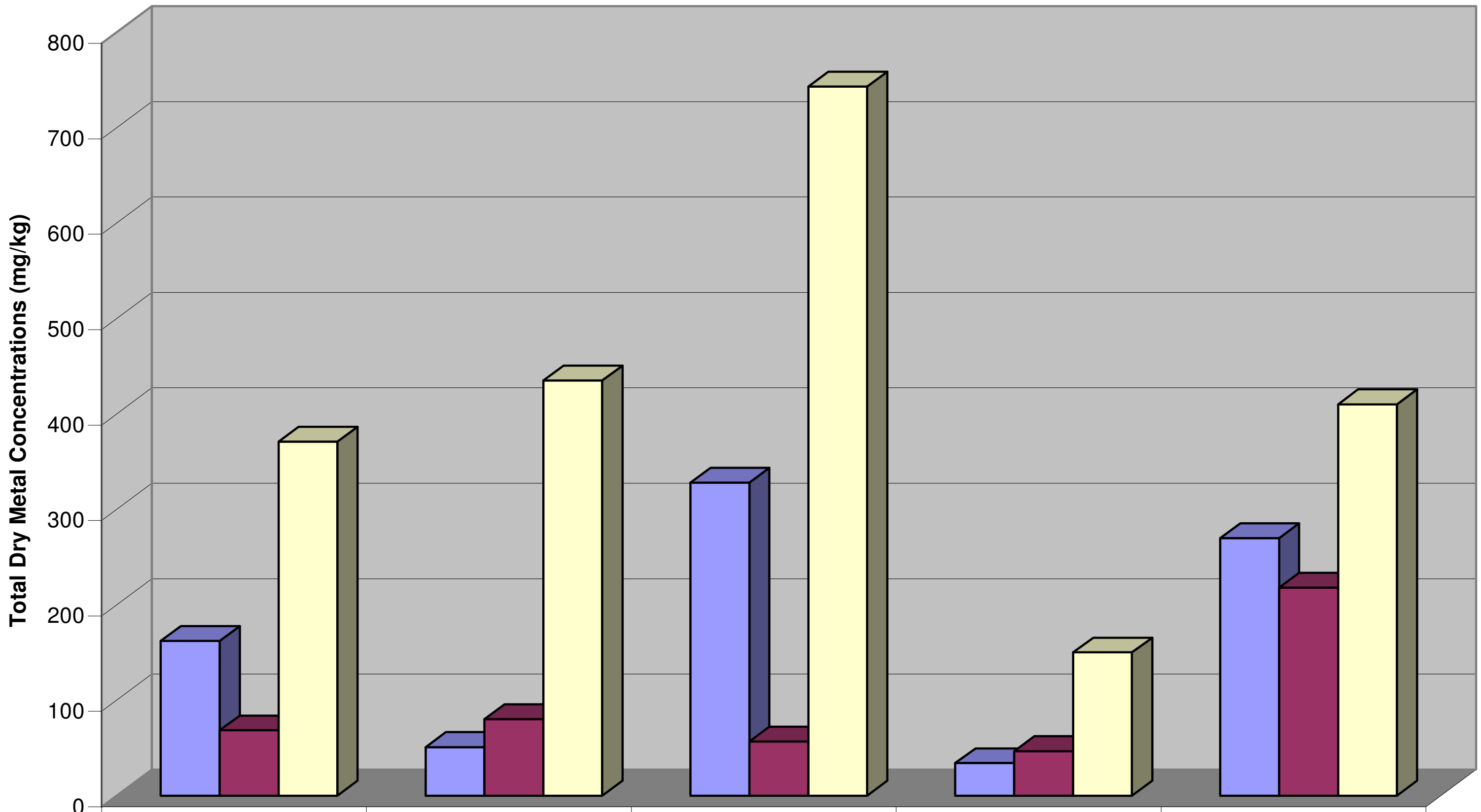
Enviropod filter bags contained more sediment than the Ecosol bags on all sampling occasions. However, it is not clear if this difference in sediment retention is due to the differences in the bags and how they function or because of differences in the catchments drained by each sump, or the size of the sump holding each bag. It is possible that all three reasons may contribute to retention differences. It is worth noting, however, that Enviropod bags have a greater capacity for retaining larger volumes of sediment.

In terms of the actual concentrations of the metals, zinc was typically present in highest concentrations while lead was typically lowest. In comparison to the sediment quality guideline values, only zinc consistently exceeded the ERM value in the sediment retained in most filter bags, while both lead and copper were generally below their respective ERM values. Due to no data being available for heavy metal concentrations downstream of the filter bags, the effectiveness of the bags at retaining heavy metals cannot be quantified.

For comparison purposes, Table 3 gives the heavy metal concentrations recorded from Enviropod filter bags in four locations around the Auckland region in a 2000-2001 study. The results are from a 5-month study commissioned by North Shore City Council into the use of Enviropod filters. A comparison of the three sampling rounds carried out along the test section of SH58 and those presented in Table 2 indicates generally higher levels of lead and lower levels of copper in the Enviropod study in Auckland. A similar range of zinc levels is present in both studies.

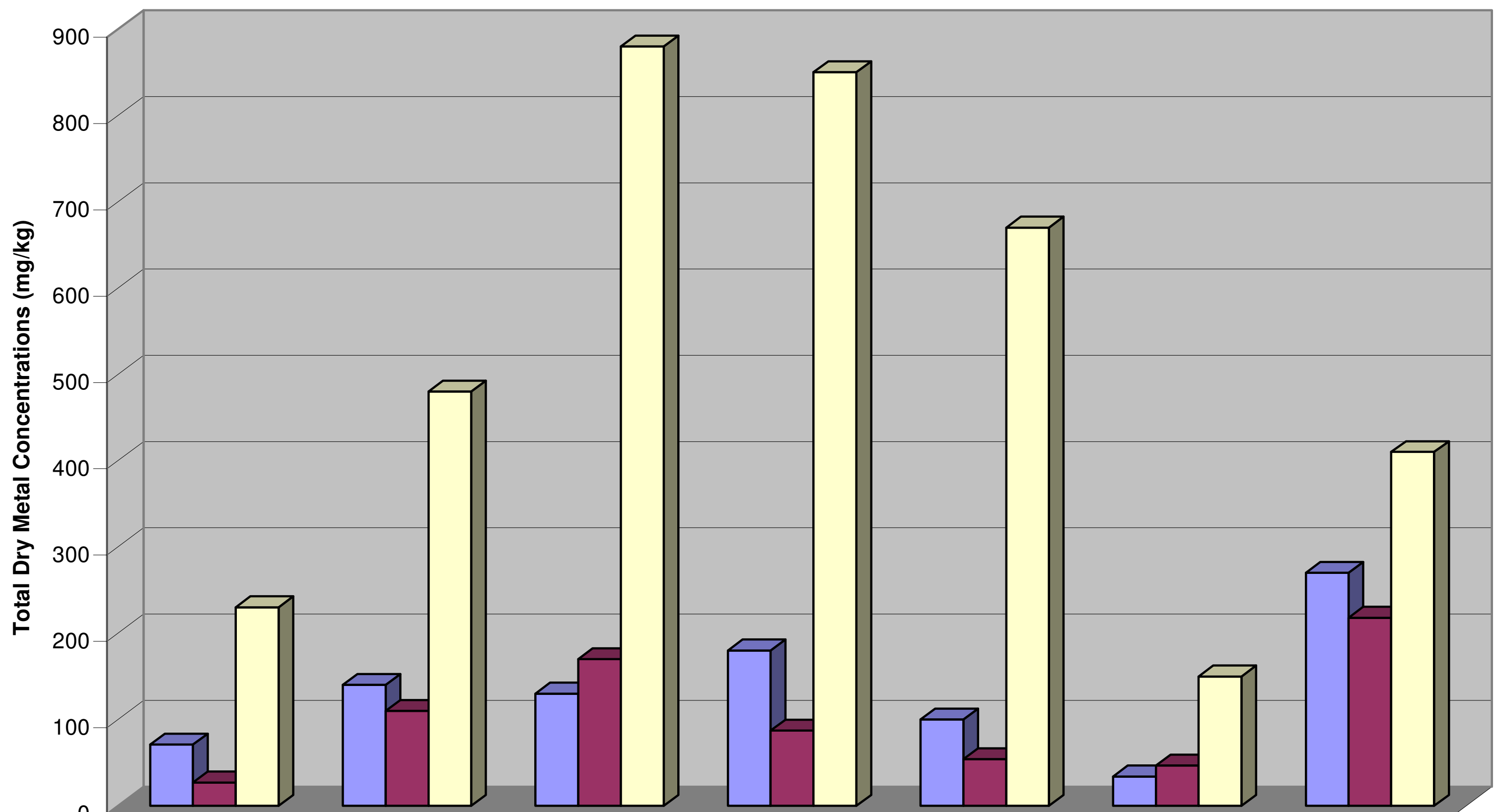
Table 3: Metal concentrations in sediments retained by a CFS in the Auckland region
(Source: Enviropod NZ Ltd, 2001)

	Lake Pupuke	**Takapuna Beach**	**Browns Bay**	**Kaipatiki**
Lead (mg/kg)	123	274	237	409
Copper (mg/kg)	38	77	68	137
Zinc (mg/kg)	268	1415	890	629



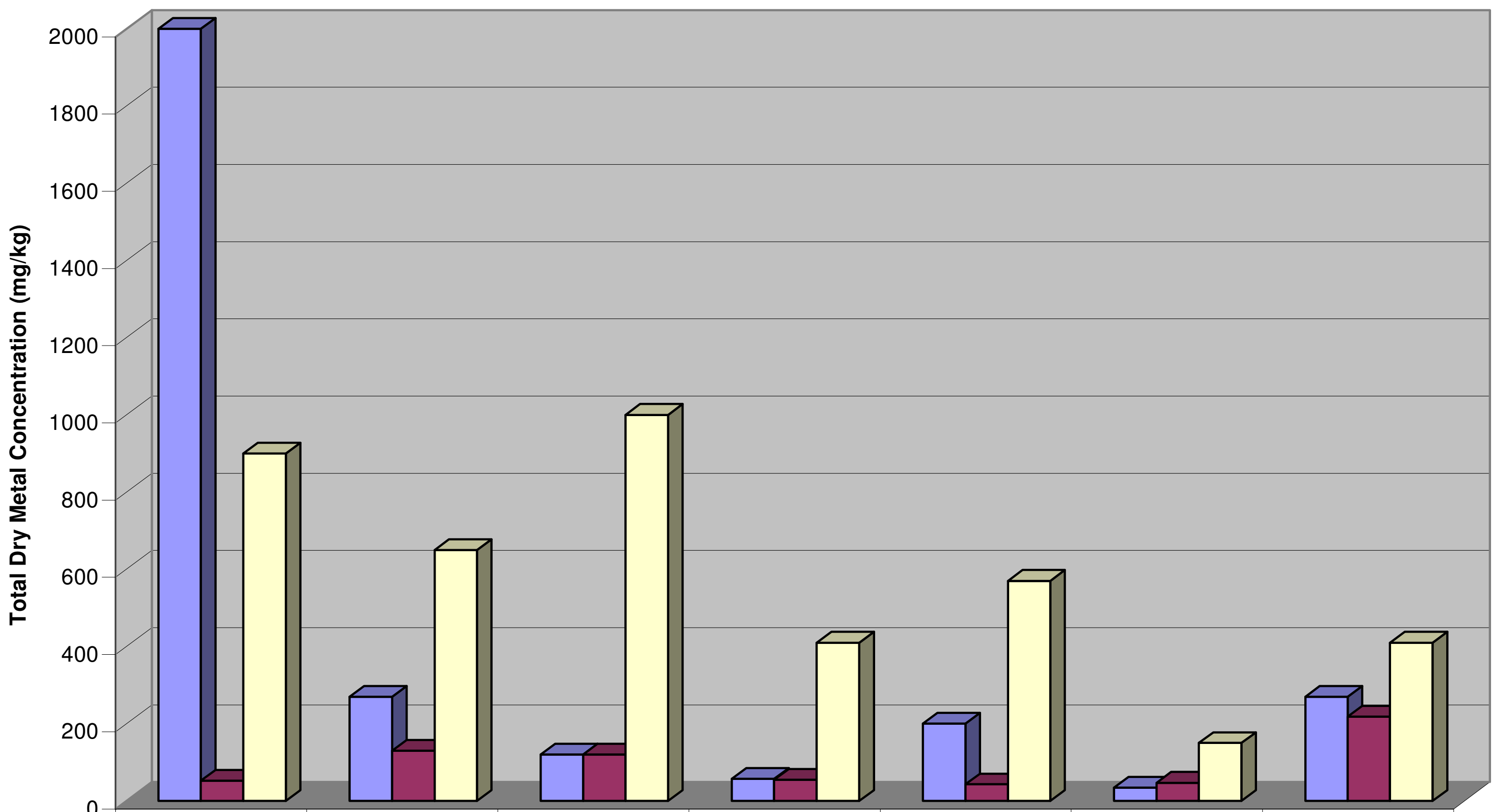
	S2 (Control)	S4S	S4N	ERL	ERM
Cu (mg/kg)	162	51	328	34	270
Pb (mg/kg)	68.4	80.3	56.5	46.7	218
Zn (mg/kg)	371	435	743	150	410

Chart 1: Heavy metal concentrations in retained sediment collected from catchpit filter bags on 23/08/2007



	S1	S2 (Control)	S3	S4S	S4N	ERL	ERM
Cu (mg/kg)	71	140	130	180	100	34	270
Pb (mg/kg)	27	110	170	87	54	46.7	218
Zn (mg/kg)	230	480	880	850	670	150	410

Chart 2: Heavy metal concentrations in retained sediment collected from catchpit filter bags on 27/11/2007



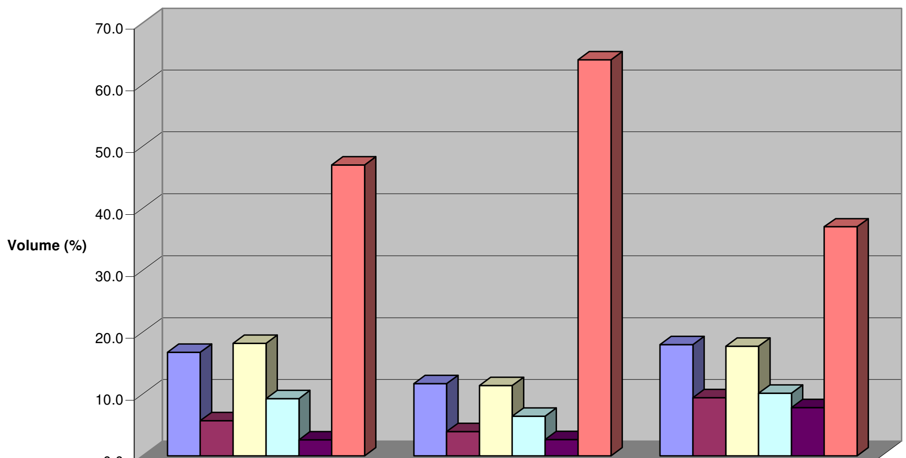
	S1	S2 (Control)	S3	S4S	S4N	ERL	ERM
Cu (mg/kg)	2000	270	120	57	200	34	270
Pb (mg/kg)	52	130	120	55	43	46.7	218
Zn (mg/kg)	900	650	1000	410	570	150	410

Chart 3: Heavy metal concentrations in retained sediments collected from catchpit filter bags on 03/03/2008

8.1.3 Particle Size Distribution

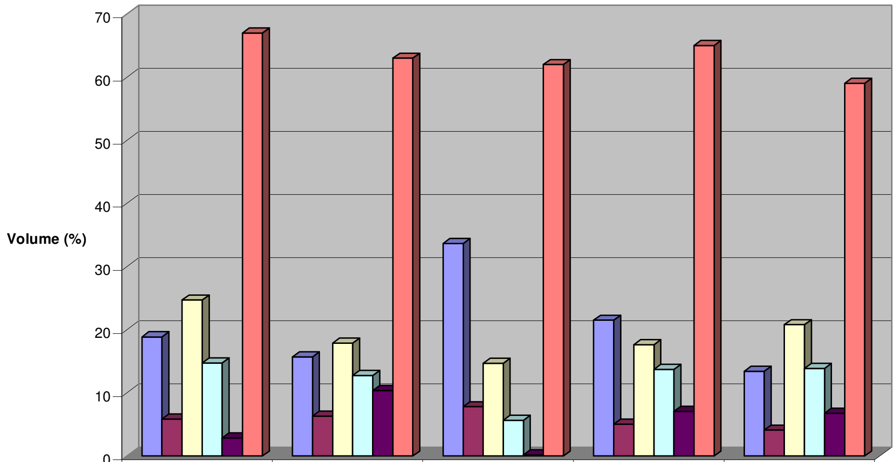
Charts 4, 5 and 6 present particle size distribution results for the retained sediment samples. These results have been summarised into six classes for presentation purposes.

The samples from the filter bags in the test sumps contained a high percentage of sediment >2000 microns (2mm), most likely due to the position of the SH58 at the base of a steep slope, and the significant quantity of organic matter captured by the filter bags. The particle size distribution charts also show how both types of filter bags were able to retain silt-sized particles with all the distributions showing relatively high percentages of retained sediment in the <63 micron class.



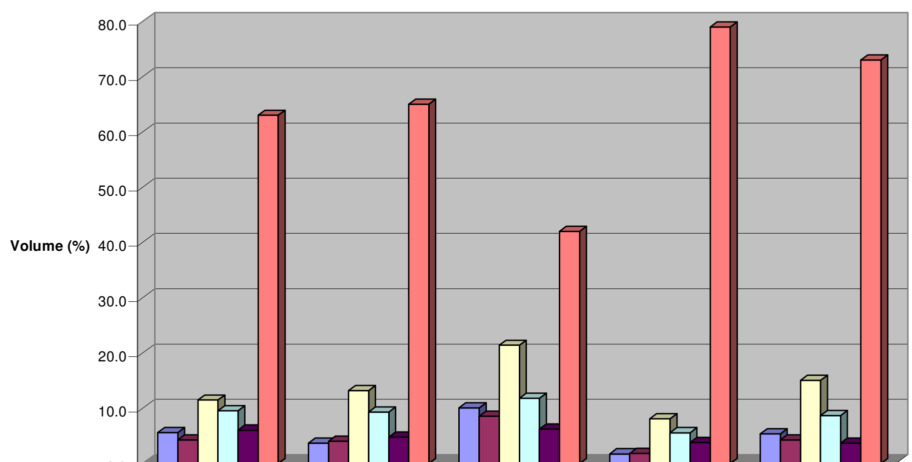
	S2 (Control)	S4S	S4N
<0.63	16.7	11.7	18.0
0.63-124	5.7	3.9	9.4
125-499	18.2	11.4	17.7
500-999	9.2	6.4	10.1
1000-1999	2.6	2.6	7.8
>2000	47.0	64.0	37.0

Chart 4: Size distribution of sediments removed from selected filter bags on 23/08/2007



	S1	S2 (Control)	S3	S4S	S4N
<0.63	18.8605	15.6807	33.666	21.515	13.4107
0.63-124	5.8759	6.3126	7.812	5.044	4.1064
125-499	24.6895	17.8731	14.6816	17.641	20.8034
500-999	14.7266	12.7575	5.6606	13.728	13.8886
1000-1999	2.8475	10.3761	0.1674	7.0655	6.7909
>2000	67	63	62	65	59

Chart 5: Size distribution of sediments removed from the filter bags on 27/11/2007



	S1	S2 (Control)	S3	S4S	S4N
<0.63	5.6	3.7	10.0	1.7	5.4
0.63-124	4.3	4.0	8.6	1.8	4.3
125-499	11.5	13.2	21.4	8.1	15.0
500-999	9.5	9.3	11.8	5.6	8.6
1000-1999	6.0	4.8	6.2	3.8	3.7
>2000	63.0	65.0	42.0	79.0	73.0

Chart 6: Size distribution of sediments removed from the filter bags on 03/03/2008

9 Discussion

This section discusses findings from the field trial evaluation of the selected CFS units in terms of their installation and maintenance aspects, as well as sediment retention characteristics.

It should be noted that this trial was designed to satisfy a relatively straightforward retrofit test of 4 sumps with 2 proprietary products, in line with NZTA's wish to trial suitable available products that would readily `fit' into their existing stormwater system.

The design of the trial was not intended to evaluate the many variables that may affect the relative performance of filter systems in the field. It is acknowledged that there are numerous other variables that impact on the operation of CFSs e.g. Relative locations, effect of events between cleans (such as spills), the duration, intensity and number of antecedent rainfall events and effects of positioning of sumps relative to geographical features to name but a few.

9.1 Installation

Installation of the CFSs was originally planned to be undertaken solely by MWH field engineers to mimic a situation where installation was the responsibility of the client buying the units. Following discussion with the suppliers, it was agreed that the suppliers would install the units to ensure this was correctly done and eliminate bias in the comparison of findings. The actual installation was carried out by the suppliers with MWH field engineers providing assistance and making observations.

The Enviropod required wire cutters to trim the cage and a knife to trim the rubber flaps, and took approximately 15-20 minutes to install in the chosen sumps. The Ecosol required power tools, a generator and various hand tools and took between 25-100 minutes to install, with a significant amount of drilling and fastening of bolts.

As described in Section 7.1.1, the initial installation of the Ecosol CFS was incorrect and this was remedied on the second visit. There were some alterations and adaptations required by a suitably qualified Ecosol representative to enable the Ecosol CFS to fit the sump.

The Enviropod appeared to be able to be relatively easily adapted to fit both yard or back throat sumps whereas the Ecosol CFS did not appear to be as easily adaptable, with the overflow mechanism appearing to regularly block up and remain jammed open.

The Enviropod required the sump base to be flat so the frame could sit without movement. This device also requires a minimum distance between the obvert of the outlet pipe and the bottom of the sump grate and between the invert of the pipe and the base of the sump.

It was noted that both suppliers indicated that the sumps chosen were, in general, not suitable for their CFSs as the sump depths were generally shallower than the 'normal' sump types. However, the trial was about the practicalities of retrofitting existing sumps, of which there will be a number similar to those tested in this field trial throughout the NZTA network. This being the case, the trial indicated that a degree of additional training as well as tools would be required to retrofit an Ecosol CFS into the existing non-standard sumps on the state highway compared with an Enviropod CFS.

9.2 Inspection and Maintenance

Sump S4N was clearly shallower than the other three sumps which were similar in depth (see dimensions in Section 7.1 above). This would have had an effect on the performance of the Ecosol filter placed in sump S4N. However, as noted elsewhere in this report, the selection of sumps in this trial was dictated by what was available in the test area (itself chosen as a candidate site for retrofit stormwater treatment using a CFS). One of the aims of the trial was to look at issues relating to the performance of filter devices in existing sump situations and comment on their applicability in these kinds of environments. The existing sumps in the study area therefore provided a realistic test of the suppliers' ability to respond to atypical conditions.

From this trial it appeared that the Enviropod was able to collect and retain more material than the Ecosol CFS. Weight considerations aside, it was also generally felt that it was more difficult to remove the bags of the Ecosol CFS than the Enviropod.

Both CFSs appeared to have difficulties being retrofitted into the existing sumps in the study area, and this affected their maintenance. For example, because material was able to bypass the filters, for reasons of overflow flaps being jammed (in the case of Ecosol) or cages not being stable (in the case of Enviropod), both filter bags had to be removed so that the sumps could be cleaned at their base rather than simply vacuumed from the bags.

Because of the large weight of debris collected in the 3-month collection period, it would seem best practice to use the vacuum truck to directly suck material from the bag left in place in the sump. However, care would need to be taken to ensure the vacuum hose does not pierce the bag.

Regarding durability of the filter bags, apart from one Enviropod bag that was replaced and a tear in another bag (possibly caused during sampling), it appeared that Enviropod bags would have lasted the length of the trial. The Ecosol bags lasted the duration of the trial. Although not proven by the findings, and while the Ecosol bags did not have the same capacity as the Enviropod bags, it was felt that they would likely have a longer life and be slightly more robust due to the second 'oyster mesh' surround layer.

With the amount of debris collected, it became evident that some bags could become clogged up in the interval between bag maintenance, and hosing down or washing would definitely be required to allow runoff to continue to flow through them. However this could impact on maintenance times because rather than just suck material from the bag the maintenance contractor would be required to lift out the emptied bag and hose this down (presuming a hose is attached to the truck). This could be an additional maintenance cost and would need to be considered in designing a CFS maintenance regime.

9.3 Sediment Analysis

Heavy metals analyses for copper, lead and zinc and particle size distributions were carried out for the sediment samples collected from the test CFSs. From the results the most distinguishing feature between the two types of filters was the volume of sediment collected in each during the trial periods. While only the heavy metal retained on sediment was measured it would have been interesting to measure the heavy metal concentrations of the inflow and discharge from the filter in order to evaluate the effectiveness of the CFSs. This would have been a very expensive exercise and was outside the scope of the trial.

In the case of one of the sumps (S4N, containing an Ecosol CFS), the sump depth was significantly shallower than the other three sumps and this reduced the capacity of sediment capable of being collected. For the devices tested in this trial, the Enviropod filter bags collected more sediment than the Ecosol bags.

Both types of CFS appeared equally effective in the retention of heavy metals as there is no distinction between the two in terms of heavy metal concentrations. Actual metal concentrations were highly variable. Zinc was generally present in the highest concentrations in the samples, although in the final sampling trial on March 2008 copper registered an extremely high value in S1 that was well above the zinc concentration for the same sample. It was interesting to note that S1 appeared to be the lowest sump in this localised area.

Zinc concentrations recorded in the sediment samples generally exceeded the ERM value of the sediment quality guidelines used by NOAA for Marine and Estuarine Ecosystems, implying that sediment dwelling fauna in the Pauatahanui Inlet are likely to be adversely affected by runoff from SH58. Both copper and lead were generally below the ERM guideline values.

The particle size distributions for samples collected from the CFSs contained high percentage of large sediment (>2000 microns), most likely as a result of the position of the sumps on this section of state highway being at the base of a steep vegetated bank. The results also showed that both types of CFSs were effective at retaining silt-sized particles carried by stormwater. Neither filter bag type appeared to perform better than the other in terms of retention of fine sediment.

10 Conclusions

The main conclusions from this study are as follows:

- In terms of installation, it was found that the Ecosol was more complex to install then the Enviropod. The Ecosol required more effort and time to retrofit into an existing sump and had some specialist features such as the overflow flap that required some training in order to get the installation right.

- While the Enviropod appeared easier and faster to install, in that it required the cutting of the wire cage to suit prior to fitting and trimming the rubber sealing flaps, it did require the sump to have a flat base, otherwise the cage rotated and the rubber flaps did not then provide an ideal seal.

- Cost of installing each type of filter was very similar but the Enviropod does come out slightly cheaper. The main cost involved was the cost of traffic management which will vary according to the location.

- Both Enviropod and Ecosol CFSs appear to be effective in retaining silt-sized sediment (and therefore heavy metals), thereby reducing the concentrations of these in the stormwater reaching the outlet points. The key difference between the two types of filters is the capacity of the Enviropod CFS for retaining larger volumes of sediment.

- In maintaining the CFSs it is advantageous from both a health and safety and practical point of view to clean the sumps using a vacuum truck placed into the device. It was found that care does need to be taken when cleaning filter bags as tears and rips can easily occur. It is important that the vacuum nozzle is checked for burrs and sharp protrusions before sweeping the filter bag.

- Hand cleaning was used during the trial as this was the only way to gain a representative sample but lifting between 20-60kg does represent a health and safety hazard and is not recommended.

- Close attention needs to be paid when installing CFSs to ensure that they are installed correctly as this will save a lot of time in future maintenance.

- With regard to cleaning intervals this really depends on the location and material entering the sump, but it was found that in this location 6 months was too long and that maintenance should be on at least 3-monthly intervals.

- Both bags appeared to be relatively robust apart from the tear in the Enviropod bag; however Ecosol bags do have a second layer and are slightly cheaper so there may be savings to be made if bags need to be replaced regularly.

11 Recommendations

With regard to recommendations, these are presented below in terms of findings from the trial itself and those related to future work.

In relation to this trial, the Enviropod was found to be easier to retrofit into the existing non-standard sumps in the study area and had a larger bag capacity with costs appearing to be very comparable. For these reasons its use is recommended in the type of situation where a reduction in sediment load is required in stormwater discharging to sensitive receiving environments. Notwithstanding this recommendation, it is noted that the field trial demonstrated that both proprietary CFSs tested would be adequate for stormwater retrofit purposes.

With regard to future issues to be investigated in relation to possible application of CFSs to stormwater management on the state highway under a retrofit programme, we would recommend the following:

- Investigation into the optimum design of sumps to enable CFSs to operate most efficiently.
- Preparation of an Operations and Maintenance manual, based on the findings of this trial, for retrofitting CFSs into existing sumps (this would include looking more closely at the benefit/cost relationship).

Glossary of Terms

To avoid ambiguity, the use of the following terminology in the report and site observation sheets has been adopted:

Bag: Refers to the filter bag for the CFS

C: Control

CFS: Catchpit Filter System

Catchpit bypass: This refers to the situation where flow is bypassing the catchpit completely. This occurs when the water level within the catchpit has built up above the level of the catchpit grate and water is flowing over the top of the catchpit and flowing downstream.

EC: Ecosol

EP: Enviropod

Filter **bypass:** Refers to the situation where flow has entered the catchpit, but is somehow bypassing the CFS unit, possibly due to flow leaking past a gap in the seal between the CFS and the catchpit wall or with an overflow jammed open

Flaps/lids: Refers to the part of the CFS that is used to divert the flow into the filter bag.

Overflow: Refers to a situation where high flows will enter engineered overflow, missing the filter bag but still flowing into the catchpit and entering the stormwater system.

Pit: Catchpit

Seal: Refers to the seal between the CFS and the catchpit wall.

Water line: During a rain event the water level in the CFS and the catchpit is seen to build up. Once the flow stops, and the water level subsides, a `water line' is seen as the point where the water level was at its highest.

Appendix A Desktop Study

The study was not an exhaustive review but was intended to provide an overview of findings from independent evaluations of proprietary devices available in New Zealand to assist the design of the field trial. A brief account of the findings is outlined below.

Summary of Previous CFS Evaluation Studies

Summaries of the main findings from field evaluation of CFSs in Australia and New Zealand are given below based on the literature search.

Great Lakes Council, NSW

The Great Lakes Council, on the mid-north coast of New South Wales, identified the need to address the quality of stormwater discharges from the CBD's of several townships and decided that at-source filtration was the most appropriate solution. The Council considered different systems and decided to install 114 Ecosol At-Source RSF100 Solid Pollutant Filter systems. Monitoring results showed that a total of more than 7,100 kg of sediment material was collected from June 2001 to January 2002, equating to approximately 62 kg per filter over this 7-month period.

Penrith City Council, NSW

A number of proprietary stormwater quality improvement devices were examined to investigate the issues that should be considered with selecting a particular proprietary device to control stormwater pollution. Particular attention was given to issues regarding the location of the devices within the catchment, and their operation and maintenance.

Hobart City Council, TAS

This study was undertaken to determine if CFSs were effective for Hobart conditions. Trials were performed to evaluate their performance with two `hotspots' selected within Hobart with different CFSs chosen to suit the catchment conditions:

Sullivans Cove – 63 devices were installed including 20 Enviropods, 11 Ecosol RSF 100 At-Source Pollutant traps, and 32 side entry traps designed by the Hobart City Council.

Brooker Highway – 83 devices were installed including 65 Enviropods and 18 Stormwater Pollution Interceptors (SPI).

In both trials, the monthly load captured in each trap was recorded with material captured being separated into litter and sediment/vegetation. At Sullivans Cove, the Enviropods and Ecosols had higher capture loads, although results were extremely variable reflecting seasonal variations in the data and outliers such as land uses, illegal discharges and pollutant hotspots. The study found both Enviropods and Ecosols provide high capture efficiencies for `fine' sediment (40-60% of material <0.1mm diameter captured). The Enviropods at Brooker Highway had higher capture loads than the SPI's.

Auckland City Council

Auckland City Council (ACC) commissioned Tonkin and Taylor Ltd to undertake a field and laboratory testing programme to compare the performance of commercial CFSs. Four devices were observed over a 5-month period in 2002 assessing aspects of installation, performance and maintenance. The field trial compared the Enviropod, Ecosol RSF 100, Fillspill Cesspit filter and Flogard.

Results indicated that the Ecosol RSF 100 and Fillspill Cesspit filter did not perform as well as the Enviropod and Flogard CFS. The laboratory study compared the Flogard and Enviropod CFS. Efficiencies of 80% for the Flogard and 90% for the Enviropod were found. With regular cleaning, it was reported that the CFS units could process 90% of all flows without losses due to engineered overflow with regular cleaning (2 to 5 times per year for the Enviropod and Flogard, respectively).

In addition to the above study, Tonkin and Taylor undertook a `suitability' study of CFS devices for treatment of stormwater in the Oakley Creek catchment, Auckland, where 36% of the sediment yield from the catchment was required to be removed. The study used the findings from the above trial and factored in variables including the predicted sediment removal from the catchment. An economic analysis was also undertaken accounting for variables such as maintenance. As a result of the above analysis, the Enviropod CFS was chosen.

Ku-Ring-Gai Council, NSW

Ingal Environmental Services was contracted by Ku-Ring-Gai Council to undertake an investigation into the performance of the Enviropod 80 units in removing nutrient loads over a 12-month period in a sub-urban catchment. The study found removal loads exhibited seasonal variations with highest loads encountered in autumn and during months of high rainfall. A relationship was found between rainfall, load and volume rates. The study findings indicated that Enviropods should be cleaned after approximately 100mm of rainfall. Land use and topography were found to greatly affect the loads and composition of contaminants in stormwater. Finally, the study suggested locating filters at the base of steep slopes to obtain the highest removal of influent load.

Holroyd City Council, NSW

This study summaries four projects in the Upper Parramatta River Catchment, west of Sydney evaluating the following treatment devices: Dencal, Enviropod, Ecosol RSF 100 and Pit Bull. Results indicate that the Dencal CFS favoured coarse litter, the Pit Bull effectively retained sediment and the Enviropod and Ecosol CFS provided overall pollutant retention capabilities. In terms of cleaning time, the Dencal was the most efficient, and the Pit Bull was the least efficient. The study found that selection of CFSs had to be carefully considered in order to maximize their performance according to location and operating environment. Further, the study noted access to catchpits is important and CFS units should be cleaned at least once per month, with the cost of cleaning being a critical factor affecting decisions on implementation of the devices.

Tauranga City Council

Tauranga City Council conducted a field trial of CFSs in 2004. Four products were initially considered (i.e. the Total Treatment System from Filtration Services, Hynds Catchpit Filter, Ecosol RSF 100, and Enviropod), and the Ecosol and Enviropod were taken forward for field evaluation. Initially, the CFSs were installed in the CBD with the intention of seeing how the devices would perform in service i.e. their effectiveness, efficiency, required frequency of cleaning and cost, as opposed to evaluating the different units.

The trial was conducted over a three-month period with the retained sediment in the filter bag being sampled and sent for laboratory analysis. Both types of proprietary filters were found to be effective in removing sediment material. The Council has since installed about 35 Ecosol units in the CBD with the intention of installing more in current roading upgrades.

North Shore City Council

The report details the results of approximately 5 months of monitoring of 294 Enviropod filters installed in selected catchpits within North Shore City. Results indicated high contaminant loading was the main determining factor in calculating most of the maintenance frequencies. Generally, Enviropods in the study reached maximum storage capacity before the filter media was clogged. Results also indicated that the Enviropods were effective in removing heavy metal contaminants (attached to suspended sediment particles).

Appendix B Specifications of CFS

Appendix C Field Trial Programme

Appendix D Field Observation Method & Checklist Sample

A new observation sheet was used for each observation event. The catchpit ID corresponds to the ID number of the catchpit (see attached).

Four main types of observations have been made throughout the trial:

Rain: Corresponds to observations made during a rain event (>10mm).

Inspection: Corresponds to observations made during routine inspections.

Sampling: Corresponds to observations made during a sampling event and subsequent cleaning of the CFS.

General: Corresponds to all other general comments about the CFS products, not necessarily related to any particular catchpit.

Photographs were downloaded and saved in the electronic project file upon return to the office and labelled with the catchpit number and date e.g. 29986 10-04-07.

Sample Checklist

Date: **Time:** **Catchpit ID:**

Recorded By:

Observation Type:

Description:

Monitoring checklist

Photograph taken (circle): Y / N

Visual defects noted including:
(NB if Y, please detail in comments and observations box on next page and provide photo)

Torn, cracked, corroded or broken material	Y / N
Clogged filters	Y / N
Faulty mechanisms	Y / N
Evidence of scouring or re-suspension of captured pollutants	Y / N
Evidence of bypassing device	Y / N
Blockages of pipes and potential flooding	Y / N
Poor sealing of device against pit walls	Y / N
Are pollutants in device in standing water?	Y / N
Estimate the proportion of pollutants captured as % volume of total load	Y / N
During cleaning events, evidence of sediment in the bottom of the catchpit	Y / N
Remaining storage capacity for removed sediment	Y / N
Degree of clogging of the filter media	Y / N
Effect of litter and organics on the CFS performance	Y / N
General hydraulic performance	Y / N

Comments and Observations:

Appendix E Field Observation Data

Appendix F Laboratory Analytical Reports (heavy metals and particle size distribution of retained sediment)

Appendix G Site Photographs

Appendix H Site Location Map