

# **FIELD EVALUATION OF CATCHBASIN INSERT PERFORMANCE**

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## EXECUTIVE SUMMARY

### Introduction

A number of studies carried out (between 1992 and 1995) by Auckland Regional Council (ARC) on stormwater quality in Auckland Region, New Zealand, reveal that suspended solids, heavy metals (such as lead, copper and zinc), and petroleum-based hydrocarbons are present in significant concentrations in stormwater. They may potentially have an adverse effect on receiving waters. The main source of these contaminants has been identified as the transport system, including run-off from roads and emissions from vehicles.

This project, carried out in 1998-99, follows a 1995 laboratory study conducted at Auckland University, in which a catchbasin-insert device designed to trap stormwater sediments in run-off from roads was developed and tested. The laboratory study showed that the catchbasin-insert device was effective in removing sediments from stormwater, and may promote the removal of contaminants that are sorbed onto sediment surfaces. This report describes the testing and evaluation of this catchbasin-insert device (with some modifications) for improving stormwater quality following its installation in selected catchbasins in the Auckland Region.

### Phasing of Project

The project was conducted in two phases. Phase I of monitoring included the measurement, over a ten-week period, of sediment accumulation, particle size distribution of trapped sediments, and concentrations of polycyclic aromatic hydrocarbons (PAHs), oil and grease, and heavy metals in sediments trapped in 10 catchbasins in the absence of the insert device.

Phase II (initiated after Phase I was completed) included the installation of the insert devices in 4 of the 10 catchbasins in the Auckland Central Business District (CBD), and monitoring over a further twenty-week period of sediment accumulation, particle size distribution of trapped sediments, and concentrations of PAHs, oil and grease, and heavy metals.

### Results

The major findings of the study are:

- Installing the catchbasin insert allows more sediments to accumulate in catchbasins. To increase sediment detention times, insert installation is required in catchbasins that have outlet pipes close to the catchbasin bottom.
- The present cleaning frequency of three times a year is not appropriate for all catchbasins. Certain catchbasins require more frequent cleaning while others will continue to function with a reduced cleaning frequency of once in six months.
- Installation of the insert devices ensure that sediments are detained in catchbasins for periods of six months or more, and therefore the cleaning frequency can be reduced to once in six months.

- The sediment concentration in stormwater flow into catchbasins is a complicated function of rainfall and catchment characteristics. The study identifies catchment slope as a major factor during periods of heavy rainfall.
- The study demonstrates that the concentrations of PAHs, oil and grease and heavy metals sorbed to sediments show a large variation. A more comprehensive study involving more frequent sampling is required to demonstrate the benefits of insert installation.

### **Conclusion**

The study clearly demonstrates that the installation of catchbasin-insert devices results in increased detention of sediments that would otherwise have discharged to receiving waters.

## **ABSTRACT**

Studies carried out (between 1992 and 1995) on stormwater quality in Auckland Region, New Zealand, reveal that suspended solids, heavy metals (such as lead, copper and zinc), and petroleum-based hydrocarbons are present in significant concentrations in stormwater. The main source of these contaminants is the transport system, including run-off from roads and emissions from vehicles.

A catchbasin-insert device designed to trap stormwater sediments in run-off from roads was tested and evaluated for improving stormwater quality in selected catchbasins in the Auckland Region. The project demonstrated that the devices were effective in removing sediments from stormwater, and may promote the removal of contaminants that are sorbed onto sediment surfaces because they cause increased detention of sediments that would otherwise have been discharged to receiving waters.

## 1. INTRODUCTION

### 1.1 Motivation

Urbanisation leads to changes in stormwater run-off characteristics, such as peak flow, total run-off, and stormwater quality. Urban development increases the proportion of impervious area as new roads, car parks and buildings are built, which reduce the infiltration and increase surface run-off following rainfall. As a result rainwater flows over surfaces, and the erosion of surface sediments leads to sediment-bound contaminants being entrained and transported into waterways.

The type and amount of contaminants present in stormwater depend on various factors, such as land use, vehicle density, extent of air pollution before precipitation. Constituents transported by stormwater may include suspended solids, heavy metals, petroleum derivatives, nutrients, litter, and a range of other contaminants specific to the catchment.

Suspended solids are present in stormwater in the greatest concentration and constitute the primary pollutant (McKergrow 1994). Furthermore, suspended solids usually carry considerable quantities of organic and inorganic contaminants sorbed onto their surfaces (Godfrey 1995; City Design 1997). Petroleum-based organics such as hydrocarbons, oil, grease, have high affinity for sorption onto sediments (McKergrow 1994).

Most parts of the Central Business District (CBD) stormwater drainage system of Auckland City, New Zealand, discharge stormwater directly into freshwater streams, estuarine reaches, and the sea. Previous studies (e.g. Kingett Mitchell 1992) revealed that the discharged stormwater is often contaminated with petroleum-based organics, and other pollutants such as heavy metals, suspended solids, etc. Also the road transport system has been identified as the major source of the contaminants. These reports recommended that further studies be carried out to evaluate and identify methods that would mitigate the adverse effects of these contaminants on receiving waters.

### 1.2 Background

The most common solution to the stormwater problem is to provide a detention pond so that contaminants settle out before the stormwater enters its receiving waters. However this solution may not be economical in heavily urbanised areas such as Auckland because of limited land availability and the high price. As an alternative solution, several studies have proposed inserting various retrofit devices in catchbasins to improve sediment capture, thereby improving the stormwater quality.

A catchbasin is the unit constructed between the road and the stormwater pipe network to receive surface run-off, and convey it to the drainage system that

discharges to the receiving waters. Catchbasins are also referred to as catchpits, sumps, gully pits, and mud tanks.

One such insert device was designed by Godfrey (1995), and tested in the laboratory. He installed the above device in a live-scale catchbasin to assess the sediment detention characteristics of contaminants. The results showed that significant improvements in detention performance could be achieved by installing the device in catchbasins. Godfrey recommended that further studies be carried out to evaluate the performance of the insert device under field conditions. This study extends Godfrey's work to the field using a slightly modified insert device.

### **1.3 Objectives**

The objectives of this study carried out in 1998-99 are to:

- Extend the findings of Godfrey's 1995 study to the field;
- Modify the basic design of catchbasin insert devices proposed by Godfrey to withstand the rigours of field placement;
- Monitor and evaluate the performance of this catchbasin insert device in the field for improving stormwater quality; and
- Submit recommendations on its possible adoption for field use.

### **1.4 Approach and Work Plan**

This study is divided into two phases – Phase I and Phase II. Phase I involved background characterisation of the influent stormwater and sediment accumulation in ten catchbasins in the Auckland region.

Following the completion of Phase I after 10 weeks of monitoring, Phase II was initiated during which the insert devices were installed in four of the ten catchbasins. All ten catchbasins were then monitored over the following 20 weeks for characteristics of sediment accumulation, oil and grease, heavy metals, and PAHs sorbed to the trapped sediments.

### **1.5 Report Layout**

Chapter 2 discusses typical stormwater characteristics and ways by which stormwater quality can be improved.

Chapter 3 presents details of the stormwater drainage system in the Auckland CBD, the catchbasin selection criteria used in this study and details of the proposed catchbasin-insert device.

Chapter 4 describes the monitoring programme, sample collection procedures and the analytical techniques used.

Chapter 5 analyses the field data, followed by a summary of major findings of the study and the conclusions in Chapter 6.

## 2. STORMWATER CHARACTERISTICS

### 2.1 Stormwater Quality

Stormwater is the major pathway by which pollutants generated by the transport system enter aquatic environments. Stormwater quantities increase with urbanisation and piping of natural stream drainage systems. Pipe networks carry the run-off very efficiently and discharge at higher rates than natural streams. Therefore contaminants that accumulate on surfaces during dry weather are entrained in the run-off and carried into receiving waters faster and quicker than through natural streams.

The characteristics of stormwater contamination are complex because of the variability in the concentrations of contaminants, and interactions between different contaminants. The wide range of chemicals and materials typically found in stormwater can be classified in four primary groups as follows (Snelder 1995):

- Suspended solids      Soil, road material, corrosion products, and litter.
- Nutrients              Nitrogen, phosphorus, and oxygen-consuming organic materials (e.g. sewage, plant materials, oil and grease).
- Toxic substances      Petroleum hydrocarbons, heavy metals, biocides.
- Human Pathogens      Micro-organisms, e.g. viruses, bacteria.

*Suspended Solids:* In urban stormwater, suspended solids are largely soil particles washed off construction sites, road works, road grit, and dust (Snelder 1995). High concentrations of suspended solids can degrade the aquatic environment by decreasing water clarity and by changing the nature of sediments in the receiving water. The solids also act as carriers of most contaminants transported to the aquatic environment.

*Nutrients:* Most nutrients in urban stormwater are leached from decaying plants or washed from soils. Nutrients enrich and stimulate the growth of aquatic plants and micro-organisms. Excess nutrients in stormwater can lead to eutrophication, resulting in depletion of dissolved oxygen in the receiving water body.

*Toxic substances:* Petroleum hydrocarbons - urban run-off contains relatively high concentrations of polycyclic aromatic hydrocarbons (PAHs), some of which are highly toxic to aquatic animals and are animal carcinogens. The main source of PAHs in stormwater is the transport system, primarily vehicle exhaust and abraded bitumen. The PAHs are generally associated with particulate material.

Heavy metals - have been identified as common contaminants in urban run-off, especially in street-gutter sediment and dust. Concentrations of heavy metals such as lead, copper and zinc are fairly high in parts of Auckland that have high traffic flow (Kingett Mitchell 1992). Inputs of heavy metals are generally in particulate forms because dissolved metals rapidly become sorbed to sediment particles.

Biocides - herbicides are used to control plants on sides of roads and drains. However their presence in stormwater does not have significant adverse effects on receiving water because the concentrations typically found in run-off are about 1000 times lower than lethal concentrations. Insecticides such as DDT, Lindane, etc. are now banned, and other insecticides are present in only negligible amounts in Auckland stormwater (Kingett Mitchell 1992).

*Human pathogens:* Even though bacteria and viruses in stormwater can cause human health problems, they do not harm the aquatic environment itself. Moderate levels of non-enteric pathogens (i.e. of non-intestinal origin) are also found in stormwater but there is no clear evidence that these have any significant effect on receiving waters.

In summary, Auckland City's stormwater is contaminated mainly by the transport system and the primary constituents of concern are suspended solids, petroleum-based hydrocarbons, and heavy metals.

## **2.2 Effect on Environment**

The receiving waters may suffer from the following effects caused by the discharge of untreated stormwater:

- Deposition of sediments leading to loss of water depth;
- Deterioration in the quality of receiving waters;
- Depletion of dissolved oxygen in receiving waters;
- Increase in turbidity of water and reduction in light depth penetration; and
- Acute and/or chronic toxicity by trace elements in stormwater.

## **2.3 Stormwater Quality Improvement**

A number of techniques are commonly used to mitigate the adverse effects on receiving waters. Source control of contaminants and treatment of stormwater are the two main techniques adopted at present.

### **2.3.1 Source Control of Contaminants**

Source control may be the most cost-effective and environmentally sound option, where achievable. It can be achieved by implementing better management practices. As the main source of contaminants in Auckland City stormwater is the transport system, some of the management options are:

*Street sweeping:* If street sweeping is carried out effectively and frequently a significant reduction in contaminants may be achieved (Kingett Mitchell 1992). Cleaning frequencies must be linked to the recurrence period of storm events, type of land use, slope, traffic flow, etc.

## 2. *Stormwater Characteristics*

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*Litter disposal:* Rubbish and litter is a common component in stormwater. Reduction of rubbish and litter dumped on streets will help to control the amount of material entering the drainage system. This is a difficult task but is not impossible if handled tactfully. Public awareness programmes to change public attitude, provision of litter bins at close intervals on main streets, regular cleaning of bins, are some of the factors that need to be addressed.

*Clean vehicles:* Vehicle emission is a major source of contaminants. Old vehicles or un-tuned engines emit more hydrocarbons and generate more oil and grease through leakage. Some of the factors presently under consideration are inclusion of vehicle emission assessments and other important aspects in fitness certificates, fixing a treatment unit at the vehicle exhaust, and research studies aimed at zero emission.

*Other:* A number of other techniques may be considered to reduce contaminants in stormwater, such as improving ways of transporting and handling chemicals, and implementing cleaner production methods at domestic and industrial levels in urban areas.

### **2.3.2 Treatment of Stormwater**

The quality of stormwater can be improved by treatment methods that reduce the concentrations of contaminants before stormwater is discharged to receiving waters. Some of the treatment methods are discussed here.

*Detention ponds:* Detention ponds are the most commonly adopted stormwater treatment technique. The purpose of a detention pond is to intercept stormwater run-off, allowing time for contaminant removal or degradation, and finally for settling during sedimentation and other processes. However, the quantity of stormwater varies widely with the rainfall and, in the case of Auckland, large areas will be required to implement this treatment option. This makes it uneconomical.

*End of pipe treatments:* Trapping the contaminants at the outlet of a stormwater system to the receiving waters, dredging the outlet areas at regular intervals, extension of the outlet into the deep sea, are some of the mitigation measures adopted elsewhere worldwide.

*Infiltration systems:* The function of the infiltration system is to reduce the amount of water and contaminants moving downstream, especially during the first flush where it originates. Soak holes and trenches for roof run-off, porous pavements, subsurface infiltration pipes from catchbasins, are few of the infiltration systems commonly used elsewhere in other countries.

*Catchbasin cleaning:* Stormwater systems are fitted with catchbasins to convey the run-off into the urban drainage piping system. Objects which are carried by water will settle in the catchbasin if they are sufficiently heavy. As such, the catchbasin provides a means of removing a part of the solids and their associated contaminants transported by stormwater. Therefore regular cleaning of catchbasins forms an important part of stormwater management.

*Catchbasin-based treatments:* Stormwater quality could be improved by installing treatment devices such as a filter in the catchbasin. “Enviropod Catchbasin Device” is such a unit designed to trap sediments in catchbasins (Enviropod NZ 1997). However, the enormous number of catchbasins in a system often results in high capital and operational costs. Also such devices are prone to clogging. Therefore a simple and economical device with less operation and maintenance cost would, ideally, be a more suitable option.

### **3. PRESENT SYSTEM**

#### **3.1 Drainage Layout and Design Data**

In Auckland Region, part of the stormwater enters the sanitary sewer system and flows to the Mangere Sewage Treatment Plant (in South Auckland), in a combined sewer system. The remaining stormwater in the region is generally discharged to freshwater streams, estuarine reaches of streams, and marine environments.

The present stormwater drainage system in the Auckland City comprises approximately 23,000 catchbasins. The catchment areas of individual catchbasins range between 250 m<sup>2</sup> and 2000 m<sup>2</sup> (average 750 m<sup>2</sup>) with 80% to 95% of the impervious surface being mostly roads. Inflow into a catchbasin can be up to 20 litres/second (l/s) depending on factors such as rainfall intensity, duration, catchment area, topography, etc. For a catchment with 90% imperviousness and an average rainfall of 10 mm/h, the inflow is estimated to be 2 l/s.

#### **3.2 Role of Catchbasins**

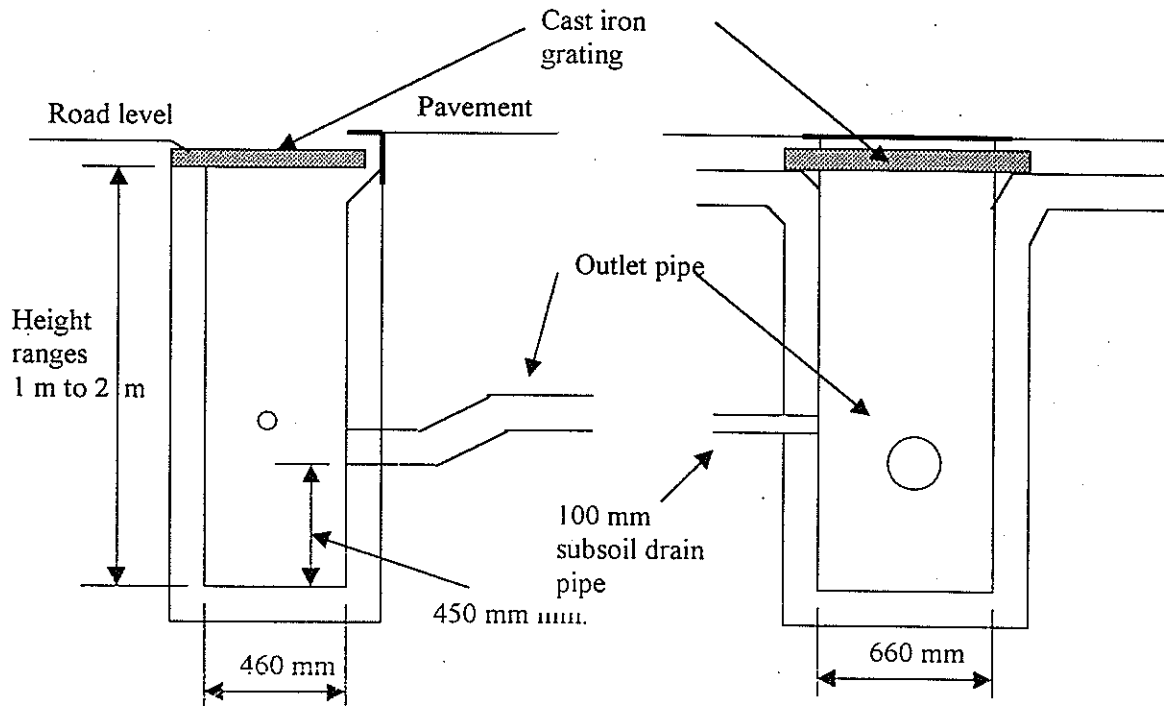
Catchbasins referred to in this study include a sump to accumulate debris and sediments thereby reducing the solids load into the receiving waters. These pits need to be cleaned regularly. The outlet pipe is connected through a half siphon to control odours and prevent floating materials from entering the drainage system. A vertical section through a typical catchbasin in the Auckland City stormwater drainage system is given in Figure 3.1.

A part of the solids in stormwater settles down in these catchbasins. With time, sediment accumulates in the catchbasin, and the sediment level approaches the bottom of the outlet pipe. As the gap between the sediment top layer and the outlet pipe decreases, turbulence caused by incoming water tends to re-suspend the previously settled sediments. Sediments flowing into the catchbasin thereafter will tend to re-suspend and enter the outlet pipe, and reach the receiving waters.



### 3. Present System

Figure 3.1 Vertical section through a typical catchbasin.



The rate of sediment accumulation in catchbasins depends on the following factors.

- The height of outlet pipe above the bottom of the catchbasin;
- Level of sediment accumulated in the catchbasin;
- Flow rate of influent stormwater;
- Size of the catchbasin which affects the detention time; and
- Particle size distribution of suspended solids.

### 3.3 Operation and Maintenance Aspects

At present (1999), catchbasins are cleaned three times each year. Cleaning is done as a routine component of the road maintenance programme and is independent of the amount of sediment that has collected in the catchbasins. However efforts are made to de-clog the clogged catchbasins whenever the problem is brought to the attention of the contractor. Cleaning costs for catchbasins are the major component of the overall maintenance costs of the stormwater drainage system.

### **3.4 Prevailing Problem**

In Auckland Region, most of the stormwater is discharged into Waitemata and Manukau Harbours where the tidal flow is insufficient to adequately flush out the materials, such as sediments, contaminants, litter and rubbish, brought in by stormwater. Previous studies reveal that levels of contaminants in some estuarine sediments have reached and often exceed recognised international sediment quality criteria, e.g. for the protection of aquatic life (Kingett Mitchell 1992). Water quality in a number of Auckland's freshwater streams has also been found to have deteriorated below the limits of the criteria set for protection of aquatic organisms.

All of these problems, if unattended, will lead to degradation of the environmental quality (leading to fewer opportunities for bathing, fishing, boating, navigation and other water-related activities), loss of life-supporting capacity, reduction in the ecological health of the region, and overall economic loss.

### **3.5 Catchbasin-Insert Devices**

#### **3.5.1 Use of Catchbasin-Insert Device**

Treatment devices installed in the catchbasin can improve stormwater quality. The purpose of the insert device constructed and tested in this project is to increase the sediment detention capacity of the catchbasin. Following insert installation, the water level of the catchbasin has to rise to the top of the insert before any discharge from the catchbasin can occur. This will reduce the turbulence caused by high inflows, and sediments will have more time to settle because the detention time of the catchbasin is increased.

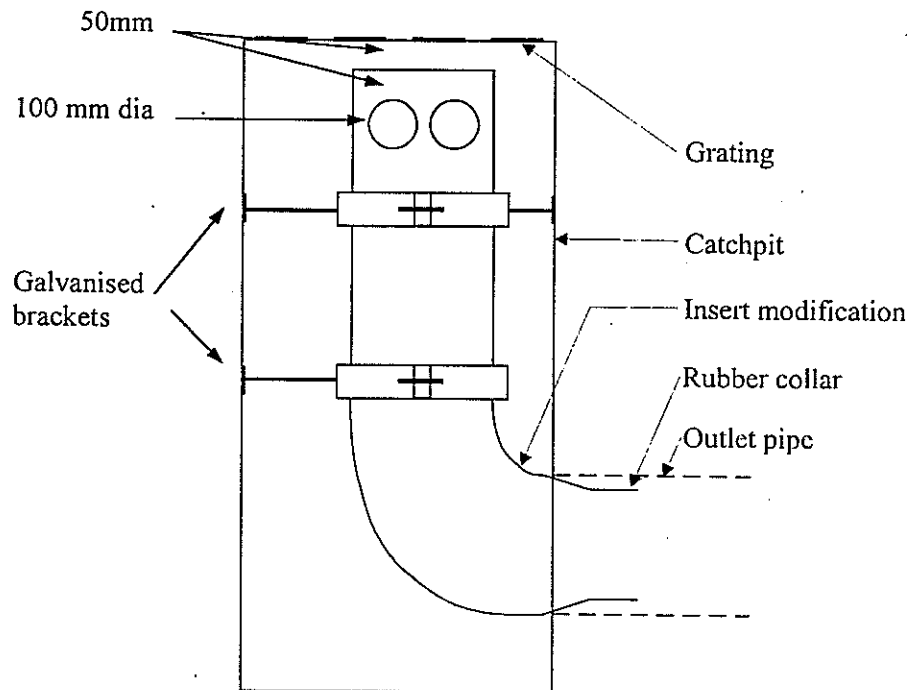
This study presents the performance of such a device in selected catchbasins of the Auckland City stormwater drainage system and its effectiveness in improving the stormwater quality.

#### **3.5.2 Details of Catchbasin-Insert Device**

Each insert is made of 300 mm-PVC pipe with a 90° short-radius bend. A tapered rubber collar is fixed at the end of the bend to ensure a proper seal with the outlet pipe. The top of the pipe is left open, and five holes of 100-mm diameter each are made 50 mm below the top for water inflow. If the holes get blocked, water will enter from the top. (A filter had initially been fitted around the five holes but was later removed because it blocked frequently with leaves and other suspended and floating matter.) Galvanised brackets are fixed at two levels with adjustable bolts to ensure that the insert device could withstand the rigours of cleaning during the entire study.

The cost of each insert device, including installation costs, is estimated to be \$400 approximately. Details of the basis for this cost estimate are given in the Appendix.

Figure 3.2 Details of catchbasin-insert device.



### 3.5.3 Installation Procedure

The insert device was lowered into the catchbasin and the rubber collar was inserted in the outlet pipe. Bolts of the lower bracket were tightened against the wall, then the bolts for the top brackets were tightened. Installation procedure is a very simple “single person operation” and should not take more than fifteen minutes.

## 3.6 Criteria for Selecting Catchbasins

Previous studies done by ARC (McKergrow 1994) reveal that, in Auckland City, stormwater contamination is mainly caused by vehicle emission and the high suspended-sediment loading from roads. Accordingly, the selection of catchbasins to trial and monitor the device was based on the following criteria:

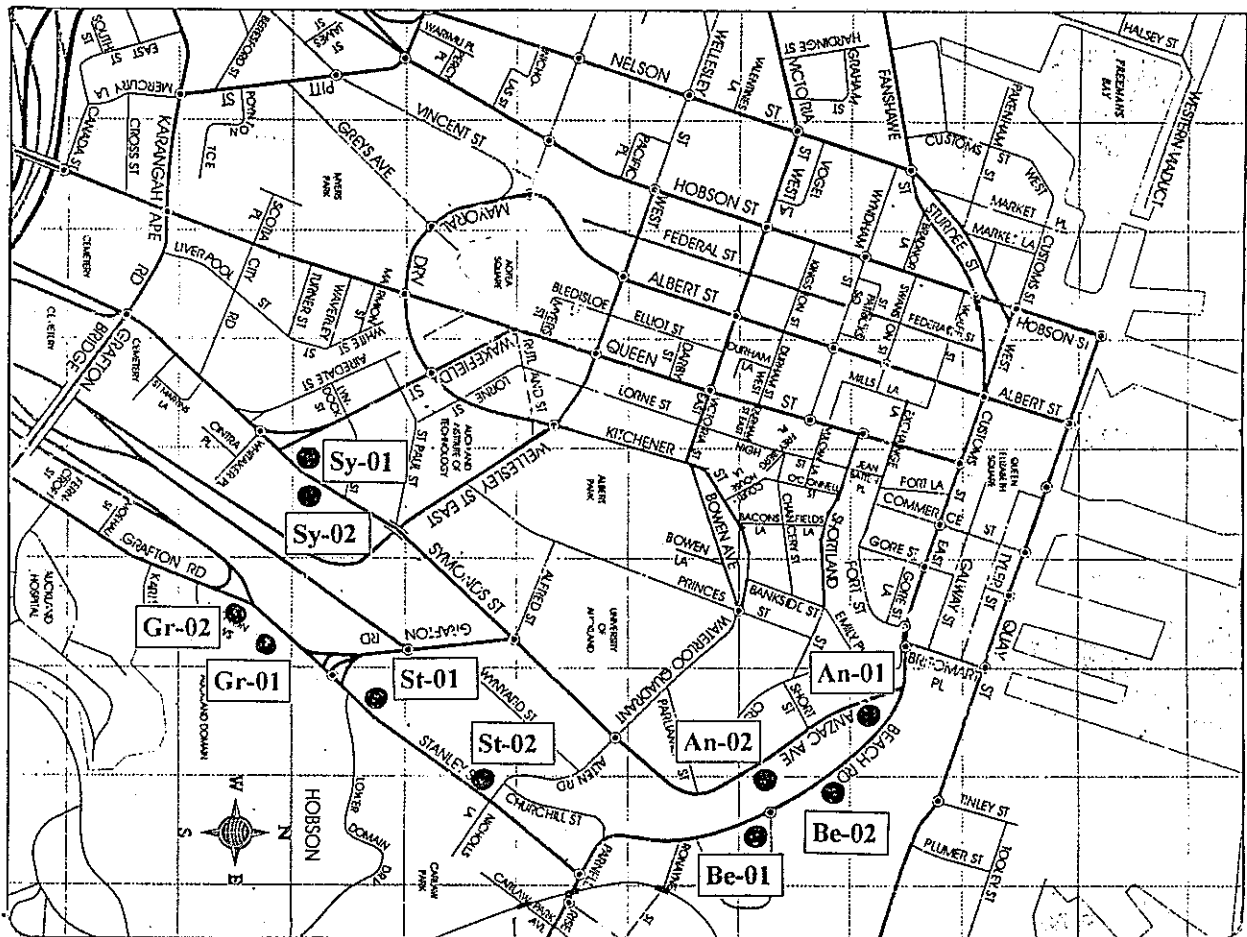
- Average daily traffic (ADT) to be more than 12,000 vehicles per day (vpd);
- Depth to the outlet to be at least 600 mm below the road surface (to accommodate the insert device);
- Catchbasin to have a defined catchment area;
- Both sloping and flat catchment areas to be selected;
- Pairs of catchbasins to be selected;
- Each pair of catchbasins to be at very close intervals and have similar catchment characteristics (with the insert to be installed in one);
- Facilities for monitoring (e.g. easy access and parking) to be available.

Table 3.1 Selected characteristics of catchbasins.

Catchbasin	ADT (vpd)	Catchment Area (m <sup>2</sup> )	Slope (degrees)	Imperviousness (%)	Overall depth (m)	Depth to outlet (m)
Gr-01	22,000	980	4	88	1.77	1.2
Gr-02		1800	5	88	1.70	1.10
St-01	30,000	540	4	95	1.61	0.98
St-02		954	1	95	1.39	0.86
Be-01	25,000	1816	1	96	1.30	0.86
Be-02		1550	1	95	1.38	0.70
An-01	18,000	1508	2.5	90	1.30	0.65
An-02		2270	3	95	1.30	0.78
Sy-01	13,000	450	2	95	1.78	1.10
Sy-02		660	2	98	1.10	0.65

ADT Average daily traffic (vehicles per day)

Figure 3.3 Locations of the ten catchbasins in Auckland City.



#### *4. Monitoring Programme*

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The characteristics of the ten catchbasins that were selected are presented in Table 3.1 and their locations are shown on Figure 3.3. They are:

Gr-01; Gr-02	On Grafton Road close to the intersection of Stanley Street just before the on-ramps for Southern and North Western motorways.
St-01; St-02	On Stanley Street opposite to Lower Domain Drive and just before Alten Road.
Be-01; Be-02	On Beach Road 200 m and 50 m from Anzac Avenue intersection.
An-01; An-02	First two catchbasins on left side of Anzac Avenue from Beach Road end.
Sy-01; Sy-02	On Symonds Street near the Wakefield Street intersection and opposite.

## **4. MONITORING PROGRAMME**

### **4.1 Introduction**

The monitoring programme consisted of two phases of field and laboratory testing. Phase I of the monitoring programme commenced at the beginning of July 1998 and lasted ten weeks. During this phase all ten catchbasins were monitored for background performance without using the proposed catchbasin-insert devices. At the completion of this phase, all catchbasins were cleaned and inserts were installed in four catchbasins.

Phase II commenced then, in mid-September, and lasted for twenty weeks until it was completed at the end of January 1999. It was a substantially longer sampling period than Phase I because during Phase II rainfall was low and little run-off occurred.

### **4.2 Field tests**

#### **4.2.1 Sediment Accumulation**

At the beginning of the monitoring programme, the selected catchbasins were cleaned with the assistance of the contractor responsible for maintaining all the catchbasins in Auckland City. The depth of sediment accumulation was measured twice a week in all catchbasins. The depth of sediment build-up was estimated by measuring the depth below the road level to the top of the sediment layer, using a ruler inserted in the catchbasin, and subtracting the noted depths between successive visits to the catchbasin. As the sediments were not evenly distributed in the catchbasin, the average depth was used to estimate sediment accumulation.

#### **4.2.2 Sample collection**

Sediment samples of approximately 450-500 cm<sup>3</sup> were collected from each catchbasin at four-week intervals. To make a representative sample, sediments were well mixed in the catchbasin just before the sample collection. Each 500 ml-capacity sample container was filled with sediments to the top, allowing water to drain as much as possible. However, the samples did contain approximately 20-35% of water. Two such samples were collected from each catchbasin in each phase. Until the tests were conducted all samples were stored at 2°-6°C to minimise potential chemical or biological degradation.

### **4.3 Laboratory Tests**

#### **4.3.1 Particle Size Distribution**

Particle size distribution for each sample was determined by sieve analysis on a dry weight basis. Approximately 400 cm<sup>3</sup> of sediments collected in the field were sieved using 0.25, 0.5, 1.0, 2.8 and 4.0 mm sieves, on a shaker for 3 minutes under continuous water flow. Sediments retained on each sieve were then dried at 105°C for 24 h and weighed to determine the particle size distribution.

#### **4.3.2 Oil and Grease**

EPA method 9071A (solvent extraction using Soxhlet apparatus, US EPA 1994a) was used to analyse the oil and grease concentrations in the sediment samples. After thoroughly mixing the sediments in the sample container, approximately 10 g of wet sediments were taken out for oil and grease analysis. The exact weight of the water-drained sediments was then measured in milligrams and mixed with approximately 10 g of anhydrous sodium sulphate and placed in an extraction thimble. Solvent extraction using petroleum ether (trichlorotrifluorocarbon) was performed in a Soxhlet apparatus for 4 h at 20 cycles per hour. After extraction, the solvent was filtered using grease-free cotton into a pre-weighed boiling flask. The solvent was then boiled until only oil and grease are retained. These were then weighed to determine the amount of oil and grease in the flask. Another 5 to 10 g of the original sediment sample was dried at 105°C for 24 h to determine the dry weight fraction.

#### **4.3.3 PAHs**

The determination of Polycyclic Aromatic Hydrocarbons (PAHs) involves a number of steps: extraction of PAHs from sediments, concentration of PAHs, solvent exchange, silica gel clean up, and gas chromatographic (GC) analysis.

*Extraction:* Extraction was performed according to EPA method 3550A (US EPA 1994b), using a 300W Ultrasonic disrupter with #200 ¾ inch horn-type probe. As in the oil and grease test, approximately 30 g of wet sediment was taken out of the sample container and weighed to the nearest milligram. Then the sediments were mixed with approximately 60 g of anhydrous sodium sulphate in a 400 ml beaker. After adding 100 ml of 1:1 v/v methylchloride:acetone, the solution was placed below the probe so that the tip of the probe is approximately 10 mm above the sediment. The

#### 4. Monitoring Programme

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disrupter was operated for 3 minutes with 50% pulse control. This extraction was repeated two more times by replacing 100 ml of the above solvent with fresh solvent each time. The final volume of 300 ml solution was filtered through Whatman 41 filter ready for concentration.

*Concentration:* The above extract was then concentrated to 1-2 ml according to the EPA method 3540B (US EPA 1994c). The solution was placed in a Kuderna-Danish apparatus with a three-ball Snyder column and heated up to 60-80°C allowing the solvent to evaporate through the Snyder column until the volume reduced to 1-2 ml. To analyse the sample in the GC, solvent exchange is required. This was done by adding 50 ml of cyclohexane, concentrating to 1 ml using the two-ball Snyder column and heating at 70-90°C.

*Silica Gel Clean-up:* To avoid interference in the GC analysis, the sample was cleaned up using silica gel as per EPA method 3630B (US EPA 1994d). A slurry of silica gel in methylene chloride was placed in a 10 mm-ID chromatography column and topped up with 2 cm of anhydrous sodium sulphate. This column was pre-eluted with 40 ml of pentane. Then the sample was passed through the chromatographic column followed by 2 ml of cyclohexane. The elution was continued with 25 ml of pentane. All eluents were discarded. Finally, 25 ml of 2:3 v/v methylene chloride/pentane was added to the column and the elution was collected for GC analysis. The volume of the collection was precisely measured and the sample was ready to analyse in the GC for sixteen selected PAHs:

naphthalene,	fluoranthene,
2-bromonaphthalene	benzo(b)fluoranthene,
acenaphthylene,	fluorene,
acenaphthene,	phenanthrene,
anthracene,	pyrene,
benzo(a)anthracene,	benzo(a)pyrene,
dibenzo(a,h)anthracene,	indeno(1,2,3-cd) pyrene,
chrysene,	benzo(g,h,i)perylene

*GC Analysis:* This was performed as per EPA method 8000A (US EPA 1992a) using HP 6890 GC with a HP-5 30 m x 0.32 mm x 0.25  $\mu$ m capillary column. Helium was used as the carrier gas at a constant flow rate of 135 ml/min.

The GC was first calibrated using a standard solution containing each of the sixteen PAHs at concentration of 2000  $\mu$ g/ml (obtained from SUPELCO). Five concentrations - 200, 40, 8, 1.6, 0.32  $\mu$ g/ml - of the standard solution were prepared and 1.0  $\mu$ l of each was injected into the GC using the auto-injector to obtain the calibration curve. Good hydrocarbon separation was achieved using the above column operated at 315°C.

#### 4.3.4 Heavy Metals

Heavy metal concentrations in sediments were determined using direct aspiration atomic absorption techniques. Sediment samples were acid digested before analysis in the Atomic Absorption Spectrometer (Varian Spectra AA-50/55).

**Acid digestion (sample preparation)**

EPA method 3050A (US EPA 1992b) was used to prepare the sample for AA analysis. Similar to other tests, approximately 2-3 g of wet sediment was taken out of the sample container and weighed to the nearest milligram. Then 10 ml of 1:1 HNO<sub>3</sub> was added to the sediments in a 25 mm-diameter 250 mm-long glass tube and heated at 95°C for 15 minutes. Addition of 5 ml of concentrated HNO<sub>3</sub> and heating at 95°C for 10 minutes followed, and then the addition and vaporisation of HNO<sub>3</sub> was repeated. The glass tube was closed with a ribbed watch glass and the volume of the solution was reduced to 10 ml by maintaining the solution at 95°C.

After cooling the sample, hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) and water were added at 2:3 v/v ratio in 3 ml quantities until vigorous reaction ceases. The maximum quantity of H<sub>2</sub>O<sub>2</sub> added was 10 ml. The final solution was filtered through a Whatman 41 filter and diluted to 100 ml with de-ionised water and tested, using the AA, for heavy metals.

**AA Analysis**

Direct aspiration AA methods, specified by the manufacturer Varian, were used to determine the heavy metal concentrations in sediments. Hollow cathode lamps with oxidising flame (fuel lean) of acetylene/air were used in the AA. The testing process involved a number of steps, such as setting up the specific parameters for the particular heavy metal (copper, zinc or lead), defining calibration standards, optimising the cathode lamps, calibration, and sample analysis. Both standards and samples were injected using an automated sample injector.

*Copper:* The required parameters for which the instrument should be set depend on the expected concentration of the metal. In general copper concentration of sediment in urban stormwater is between 100 to 400 mg/kg and therefore the concentration of the samples was estimated to approximate to 10 mg/l. The parameters used for copper analysis are given in Table 4.1. A calibration curve was prepared for the range of expected concentrations.

*Zinc:* The procedure was similar to that for copper and the respective parameter values are given in Table 4.1. Expected concentrations of the zinc samples were estimated to approximate 20 mg/l as zinc concentrations in sediments generally range between 500 and 1000 mg/kg.

*Lead:* In general, concentration of lead in stormwater sediments is similar to that of copper, and therefore the method used was the same as for copper. Table 4.1 gives the parameter values used.

**Table 4.1 Parameter values for heavy metals used in AA Spectrometer.**

Heavy Metal	Lamp Current (mA)	Wave length (nm)	Slit width (nm)
Copper	4.0	327.4	0.5
Zinc	5.0	213.9	1.0
Lead	5.0	217.0	1.0



## 5. DATA ANALYSIS

### 5.1 Introduction

The catchbasin loading was characterised in terms of sediment accumulation, particle size distribution of sediments, total PAHs, metals, and oil and grease in the sediments retained in catchbasins. Phase I data were used as reference to evaluate the potential benefits obtained from installation of the insert devices. During Phase II, insert devices were installed at sites An-02, Gr-02, St-01 and Sy-01. The physical characteristics of the ten catchbasins selected in this study are re-stated in Table 5.1.

**Table 5.1 Physical characteristics of the ten catchbasins.**

Insert Not Installed				Insert Installed			
Catchbasin No.	Area <sup>1</sup>	Slope (°)	Outlet Height <sup>2</sup>	Catchbasin No.	Area <sup>1</sup>	Slope (°)	Outlet Height <sup>2</sup>
An-01	1357	2.5	0.65	An-02	2157	3	0.52
St-02	906	1	0.53	Gr-02	1584	5	0.6
Gr-01	862	4	0.57	St-01	513	4	0.63
Be-01	1743	1	0.44	Sy-01	428	2	0.68
Be-02	1473	1	0.68				

<sup>1</sup> Effective area (m<sup>2</sup>) = catchment area x Imperviousness (see Table 3.1)

<sup>2</sup> Height (m) = height above the catchbasin insert

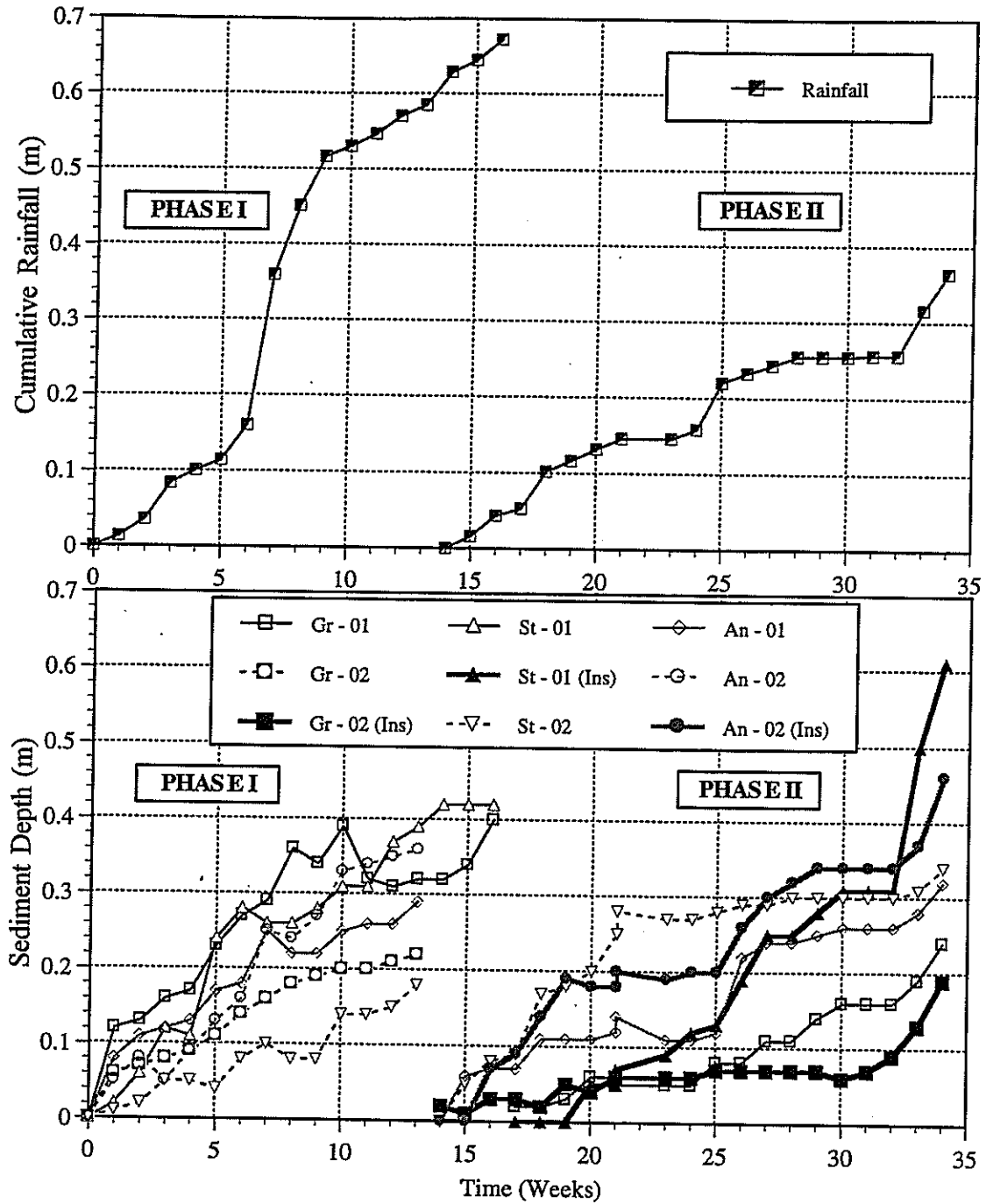
### 5.2 Sediment Accumulation

The data for sediment accumulation in the nine catchbasins are shown in Figures 5.1 and 5.2. Catchbasin Sy-02 could not be sampled as it was continually getting clogged.

The figures clearly show that some catchbasins show greater accumulation than others. Additionally, a comparison of Phase I and Phase II data shows the effect of change in rainfall intensity on the rate of sediment accumulation. For example, Gr-01 shows the largest rate of sediment accumulation in Phase I, when the rainfall intensity was high but a very slow rate of sediment accumulation during Phase II, when rainfall intensity was low.

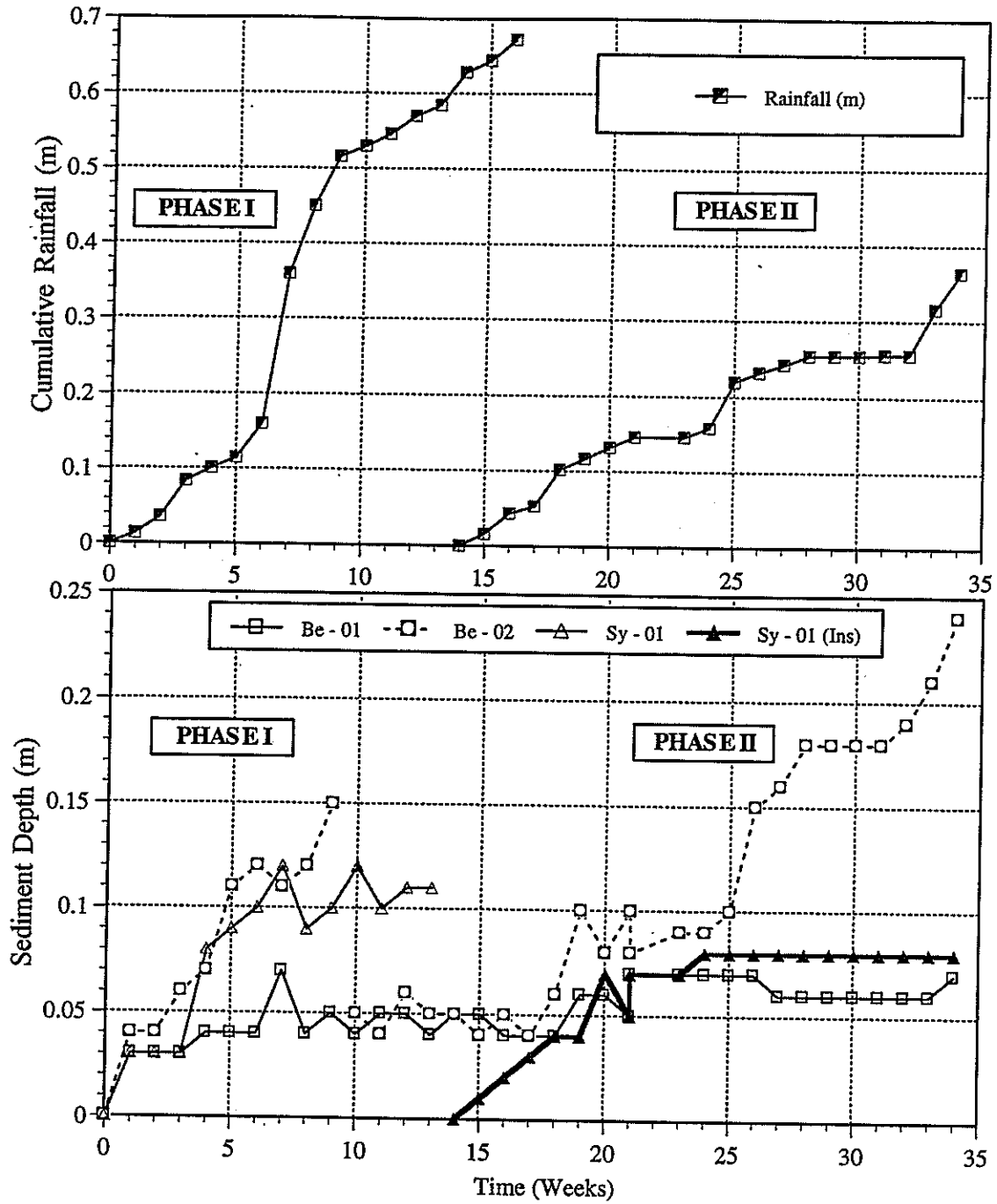
On the other hand, St-01 shows a high rate of sediment accumulation in Phases I and II. These data also show the effect of the height of the discharge pipe above the catchbasin invert. Catchbasins Sy-01, Gr-01 and St-01 show a flattening and finally stagnation in sediment accumulation. Additional sediment build-up in these catchbasins is prevented by re-suspension of sediments and subsequent drainage in the outlet pipe.

Figure 5.1 Sediment depths (m) for catchbasins with high sediment accumulation rates compared with rainfall (m).



5. *Data Analysis*

Figure 5.2 Sediment depths (m) for catchbasins with low sediment accumulation rates compared with rainfall (m).



The benefit of catchbasin insert installation is evident in the case of St-01. While sediment accumulation in St-01 during Phase I was limited to 0.42 m, following the installation of the insert device in Phase II, sediment build-up continued to 0.62 m (at which point further monitoring was stopped). In the case of An-02 this conclusion could not be verified as sediment accumulation in Phase I, while lesser than the accumulation in phase II, had not peaked.

For the remaining two catchbasins in which insert devices were installed, in the case of Gr-01 sediment accumulation in Phase II was severely limited by the decrease in rainfall intensity, and in the case of Sy-01 (Figure 5.2) it appears that the insert device did not form a complete seal with the discharge pipe and therefore no benefit was derived from the installation of the insert device.

These observations support the original claim that the increase in detention time would lead to higher rates of sediment accumulation in the catchbasins.

To analyse the effect of catchment area and slope on sediment accumulation rate, a table summarising the catchment characteristics for the ten catchbasins was prepared as Table 5.2. This table presents a matrix of cells containing comparisons of two catchbasin characteristics – catchment area and catchment slope – with rates of sediment accumulation.

Using this summary a second table (Table 5.3) quantifying this information was prepared as follows:

- if catchment parameter for the catchment in left column was less than that for catchment in the top column, a value of –1 was assigned;
- if the parameter values in the two catchments are equal, a value of zero was assigned; and
- if the parameter value for the catchment in the left column was greater, a value of 1 was assigned to the table cell.

Multiple regression was performed for sediment accumulation in Phase I and Phase II against catchment area and catchment slope as follows:

$$\text{Sediment accumulation} = \alpha + \beta \times \text{catchment area} + \gamma \times \text{catchment slope} + \text{error}$$

The results are summarised in Table 5.4 for a multiple regression conducted using Microsoft EXCEL.

5. Data Analysis

Table 5.2 Summary of sediment accumulation data.

	An-01	An-02	Be-01	Be-02	Gr-01	Gr-02	St-01	St-02	Sy-01	Sy-02
An-01	Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area < Slope ~ Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area ~ Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area ~ Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area ~ Slope < Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area > Slope ~ Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope ~ Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
An-02		Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area ~ Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> ~ Acc <sub>Phase-II</sub> >	Area > Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> ~	Area > Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope > Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
Be-01			Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area ~ Slope ~ Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area ~ Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope ~ Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope < Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
Be-02				Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area > Slope ~ Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> ~	Area ~ Slope < Acc <sub>Phase-I</sub> ~ Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope ~ Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area > Slope < Acc <sub>Phase-I</sub> ~ Acc <sub>Phase-II</sub> ~	Area > Slope < Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
Gr-01					Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area < Slope ~ Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area > Slope ~ Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area ~ Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area > Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area > Slope > Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
Gr-02						Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area > Slope ~ Acc <sub>Phase-I</sub> < Acc <sub>Phase-II</sub> <	Area > Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area > Slope > Acc <sub>Phase-I</sub> ~ Acc <sub>Phase-II</sub> ~	Area > Slope > Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
St-01							Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area < Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> <	Area ~ Slope > Acc <sub>Phase-I</sub> > Acc <sub>Phase-II</sub> >	Area ~ Slope > Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
St-02								Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area > Slope < Acc <sub>Phase-I</sub> ~ Acc <sub>Phase-II</sub> >	Area > Slope < Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
Sy-01									Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =	Area < Slope ~ Acc <sub>Phase-I</sub> NA Acc <sub>Phase-II</sub> NA
Sy-02										Area = Slope = Acc <sub>Phase-I</sub> = Acc <sub>Phase-II</sub> =

NOTES:

\* Each cell in the Table contains a comparison of the column-catchbasin with the row-catchbasin for the following parameters: catchment area, catchment slope, sediment accumulation rate during Phase I, and sediment accumulation rate during Phase II. (For example, the cell at the intersection of An-01 and Be-01 states that the catchment area of An-01 is approximately equal to the catchment area of Be-01, slope of An-01's catchment is greater than the slope of Be-01's catchment, during Phase I sediment accumulation rate in An-01 is greater than in Be-01, and during Phase II sediment accumulation rate in An-01 is greater than Be-01.)

Table 5.3 Summary of comparisons between catchments.

Catchments Being Compared	Area	Slope	Acc <sub>Phase-I</sub>	Acc <sub>Phase-II</sub>
An-01 vs. An-02	-1	0	-1	-1
An-01 vs. Be-01	0	1	1	1
An-01 vs. Be-02	0	1	1	1
An-01 vs. Gr-01	1	-1	1	-1
An-01 vs. Gr-02	0	-1	1	1
An-01 vs. St-01	1	-1	-1	-1
An-01 vs. St-02	1	1	1	-1
An-01 vs. Sy-01	1	0	1	1
An-02 vs. Be-01	0	1	1	1
An-02 vs. Be-02	1	1	1	1
An-02 vs. Gr-01	1	-1	-1	1
An-02 vs. Gr-02	1	-1	1	1
An-02 vs. St-01	1	-1	0	1
An-02 vs. St-02	1	1	1	0
An-02 vs. Sy-01	1	1	1	1
Be-01 vs. Be-02	0	0	-1	-1
Be-01 vs. Gr-01	1	-1	-1	-1
Be-01 vs. Gr-02	0	-1	-1	-1
Be-01 vs. St-01	1	-1	-1	-1
Be-01 vs. St-02	1	0	-1	-1
Be-01 vs. Sy-01	1	-1	-1	-1
Be-02 vs. Gr-01	1	0	-1	0
Be-02 vs. Gr-02	0	-1	0	1
Be-02 vs. St-01	1	-1	-1	-1
Be-02 vs. St-02	1	0	1	-1
Be-02 vs. Sy-01	1	-1	0	0
Gr-01 vs. Gr-02	-1	0	1	1
Gr-01 vs. St-01	1	0	1	-1
Gr-01 vs. St-02	0	1	1	-1
Gr-01 vs. Sy-01	1	1	1	-1
Gr-02 vs. St-01	1	0	-1	-1
Gr-02 vs. St-02	1	1	1	-1
Gr-02 vs. Sy-01	1	1	0	0
St-01 vs. St-02	-1	1	-1	-1
St-01 vs. Sy-01	0	1	1	1
St-02 vs. Sy-01	1	-1	0	1

**Table 5.4 Multiple regression summary of results.**

Parameter	Phase I	Phase II
No. of observations	36	36
Multiple R	0.573	0.129
Intercept $\alpha$	0.229	-0.012
P value	0.204	0.957
lower 95%	-0.130	-0.460
upper 95%	0.588	0.437
Catchment area coeff. $\beta$	-0.031	-0.168
P value	0.883	0.521
lower 95%	-0.453	-0.695
upper 95%	0.391	0.359
Catchment slope coeff. $\gamma$	0.595	0.043
P value	0.0005	0.826
lower 95%	0.283	-0.347
upper 95%	0.907	0.432

Table 5.4 shows that, during Phase I, sediment accumulation correlates best against catchment slope and that, during Phase II, sediment accumulation fails to correlate against either catchment area or slope. During Phase I,  $\alpha$  and  $\beta$  are equal to zero with probabilities of 0.20 and 0.88, respectively, while the probability that  $\gamma$  may equal to zero is only 0.0005. However during Phase II,  $\alpha$ ,  $\beta$  and  $\gamma$  are equal to zero with probabilities of 0.96, 0.52, and 0.83, respectively.

In summary, sediment accumulation in catchbasin is a result of complex interactions. Some factors such as rainfall intensity and duration have not been considered in this study, and may correlate better with the observed sediment accumulation in catchbasins.

### 5.3 Particle Size Distribution

Particle size distribution (% passing by weight) for each catchbasin before and after insert installation is given in Figure 5.3. Each line represents the mean of two samples with one exception. The graph of Sy-01 after insert installation represents only one sample since not enough sediments could be collected in the first sampling round following the installation of insert.

Following insert-device placement, there is a slight increase in fine particles in all catchbasins except Sy-01, which shows a very high percentage of larger particles. This resulted from the Sy-01 sample containing a small number of very large particles in the sediments. Comparatively more fine particles were retained in catchbasins Gr-02, St-01 and St-02 during Phase II.

This is an interesting observation as inserts were installed only in Gr-02 and St-01. The reason for these variations could not be determined but the following shortcomings in insert installation probably contributed to these variations.

- The inserts did not tightly fit the outlet pipe and water most likely leaked through gaps carrying fine particles in its flow, as these tend to remain in suspension and settle slowly ; and
- Water level does not rise if the joint is not sealed. In this case, turbulence occurs when water flows into the catchbasin, thus disturbing the settled particles and causing the loss of fine particles.

In summary, the limited sampling performed in this study could not demonstrate any appreciable benefit of insert installation on detention of relatively higher % fractions of the finer sized sediments.

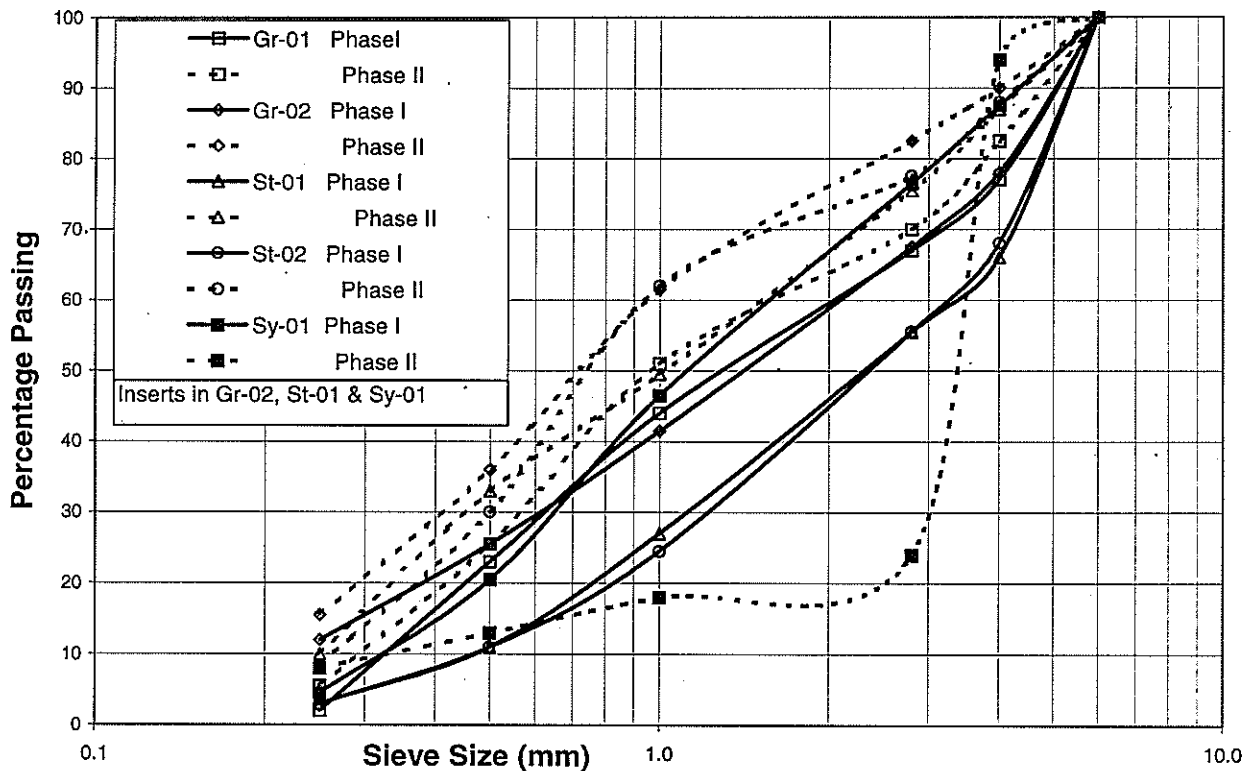


Figure 5.3 Particle size distribution of trapped sediments in Phases I and II.



## 5.4 Oil and Grease

Oil and grease concentrations range between 2.7 and 15.7 mg/kg in all samples, as given in Table 5.5.

**Table 5.5 Oil and grease concentrations (mg/kg) in samples.**

Catchbasin	Oil & Grease Concentration (mg/kg)	
	Phase I	Phase II
Gr-01	6.5 (N/A, 6.5)*	6.5 (5.2, 7.9) (No Insert)
Gr-02	9.2 (10.9, 7.5)	12.5 (13.8, 11.2) (Insert installed)
St-01	5.3 (4.0, 6.5)	7.3 (4.6, 10.0) (Insert installed)
St-02	10.9 (15.7, 6.1)	7.7 (8.6, 6.9) (No Insert)
Sy-01	6.1 (7.9, 4.3)	4.1 (2.7, 5.6) (Insert installed)

\* Values are: Mean (Sample 1, Sample 2)

The limited sampling could not demonstrate significant difference in oil and grease concentrations before and after the installation of inserts. This is comparable with other studies carried out, as oil and grease does not have much impact on the oxygen-demand of the receiving waters. However oil and grease contain a wide array of hydrocarbons, some of which are known to be toxic to aquatic life even at low concentrations. Results of hydrocarbon (PAHs) tests are described under Section 5.5.

## 5.5 PAHs

Samples were tested for sixteen polycyclic-aromatic hydrocarbons and the maximum possible total concentrations are listed in Table 5.6.

**Table 5.6 Total PAH concentrations (mg/kg) in samples.**

Catchbasin	PAH Concentration (mg/kg)	
	Phase I	Phase II
Gr-01	<2.7 (N/A, <2.7)*	<3.7 (<1.8, <5.6) (No Insert)
Gr-02	<5.25 (<5.3, <5.2)	<10.4 (<11.2, <9.6) (Insert installed)
St-01	<3.7 (<4.8, <2.6)	<10.6 (<7.8, <13.4) (Insert installed)
St-02	<2.9 (<3.2, <2.6)	<2.3 (<1.2, <3.4) (No insert)
Sy-01	<2.2 (<0, <4.4)	<3.2 (<3.5, <2.8) (Insert installed)

\* Values are: Mean (Sample 1, Sample 2)

The above concentrations are similar to results of other studies carried out by ARC (McKergrow 1994). The limited sampling fails to reveal significant effect of insert installation on the accumulation of PAHs in the catchbasins.

## 5.6 Heavy Metals

Sediment samples were tested for zinc, copper and lead, using AA Spectrometer. Results are listed in Table 5.7.

These results show significant variations in concentrations from catchbasin to catchbasin and from sample to sample. Also the heavy metal concentrations are much lower in Sy-01 in all samples collected before and after the insert installation. Some of the other catchbasins show very high concentrations of PAHs in sediments. As in the case of PAHs, catchbasin inserts do not appear to have a significant effect on heavy metal concentrations in the trapped sediments.

Table 5.7 Heavy metal concentrations (mg/kg) in samples.

Catchbasin	Monitoring Phase	Lead		Copper		Zinc	
		Mean	Max	Mean	Max	Mean	Max
Gr-01	I	323	647	117	234	258	516
	II	584	700	275	301	891	1090
Gr-02	I	596	736	250	291	367	422
	II	459	546	283	389	410	469
St-01	I	395	624	177	182	248	399
	II	216	235	125	181	425	473
St-02	I	346	407	135	152	392	402
	II	136	160	126	217	138	246
Sy-01	I	255	255	171	183	192	210
	II	189	220	89	97	100	123

Note: Mean and maximum values are from two samples in each phase.  
Inserts were installed in Gr-02, St-01 and Sy-01.

## 5.7 Summary of Problems

*Leakage through joints:* As discussed in Section 5.1 there was no increase in the rate of sediment accumulation in Sy-01 and Gr-02 (with insert). One of the reasons may be that the joint between the insert and the outlet pipe was not properly sealed. Sediments could have escaped in the water flowing through the pipes. Inserts are installed while catchbasins contain some water and it is not practically possible to achieve a complete seal. The tapered rubber collar fixed to the insert should be tightly pushed into the outlet pipe by screwing the bolt. It is suggested that the rubber collar be replaced by a PVC flange with rubber packing to provide a tight fit with the wall.

## 5. *Data Analysis*

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*Blockage by leaves:* One of the inserts was blocked with leaves during the field trial. However the insert functioned properly at later times after clearing. In order to minimise the operational problems it is recommended that insert top be left open.

*PAH Analysis:* PAH analysis was by gas chromatography (GC). To avoid interference, extreme care was taken during the sample preparation. However, GC analysis of field samples was complicated by the presence of numerous interfering organic compounds.

Therefore PAH concentrations were approximated as values of the largest peak closest to the respective detention times. For that reason PAH values in this report represent the maximum probable total concentration in each sample.

*Catchbasin Sy-02:* This catchbasin was prone to frequent blockage and had to be abandoned.

## **6. CONCLUSIONS AND RECOMMENDATIONS**

The following conclusions may be drawn:

- Insert installation allows more sediment to accumulate in catchbasins, and therefore detention times are increased. Insert installation is required in catchbasins where the outlet pipe is close to the catchbasin bottom.
- The cleaning frequency of three times a year (as at 1999) is not appropriate for all catchbasins. Certain catchbasins require more frequent cleaning while others can continue to function with a lower cleaning frequency of once in six months.
- Installation of the insert device will ensure that more sediments are detained in catchbasins for periods of six months or more, and therefore cleaning frequency could be reduced to once in six months.
- The sediment concentration in stormwater inflow is a complicated function of rainfall and catchment characteristics. The study identifies catchment slope as a major factor during periods of heavy rainfall.
- The insert should be modified to have a proper seal with the outlet pipe.
- The study demonstrates that the concentrations of PAHs, oil and grease, and metals sorbed to sediments show a large variation. A more comprehensive study involving more frequent sampling is required to demonstrate the benefits of insert installation.
- The operation of catchbasins can be made more efficient in one of two ways:
  - Option 1 – Catchbasins should be cleaned depending on the rate of sediment accumulation;
  - Option 2 – All catchbasins should be cleaned every six months following insert installation in specific catchbasins.

Further work and more comprehensive sampling is required to fully evaluate the performance of the insert devices.

Nevertheless, the study clearly demonstrates that the installation of catchbasin-insert devices results in increased detention of sediments that would otherwise have discharged to receiving waters.

## 7. LITERATURE

### 7.1 References

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## Appendix. Preliminary Cost Estimate of Catchbasin-Insert Devices

Assume 100 catchbasins are retrofitted with the insert device:

		\$
Supply and fabrication of 300 mm pvc Inserts, including supply and fixing tapered rubber collar	100 no.	18,000
Supply of 50 mm x 10 mm galvanised brackets with necessary bolts and nuts	100 sets	6,000
Installation cost including labour, tools, transport, etc.	Item	12,000
Sub Total		36,000
Allow for contingencies (10%)		3,600
Total (for 100 nos)		39,600
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Therefore Supply and Installation Cost of one Insert	=	\$396
(after rounding)	=	\$400
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