SUSPENDED SOLID LEVELS IN TWO CHEMICALLY DOSED SEDIMENT RETENTION PONDS DURING EARTHWORKS AT SH20, AUCKLAND.

A thesis
submitted in partial fulfilment
of the requirements for the Degree
of
Master of Science in Earth and Ocean Sciences
at the
University of Waikato
by

KATE MAREE JACKSON

KO TE TANGATA

THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

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2008

The Somerset Road Sediment Retention Pond on a crisp July morning 2007.

The Richardson Road Sediment Retention Pond in August 2007.

Abstract

Earthworking activities have the potential to accelerate soil erosion through vegetation clearance and soil compaction processes. The eroded sediment can have many detrimental effects on receiving aquatic environments, and thus its discharge is controlled under the Resource Management Act, 1991. Two chemically dosed sediment retentions ponds at the SH20 extension project in Mount Roskill, Auckland were investigated, and the impact of the discharge of one of these ponds on a receiving waterbody was assessed using the Stream Ecological Valuation (SEV) method.

Rainfall and suspended solid data was collected for a nine month period between November 2006 and August 2007, although sampling did not commence at one of the ponds until March 2007. Two SEV samples were undertaken within the receiving waterbody; one in November 2006 and the other in November 2007 to assess environmental changes resulting from the sediment retention pond discharge.

The suspended solids results measured within the sediment retention ponds during this study were much lower than those reported by other studies on earthwork sites. This is believed to be due to the effective implementation of sediment and erosion control measures onsite.

The Somerset Road pond was very effective at removing suspended solids throughout the sampling period, with the majority of suspended solid removal occurring in the forebay as it typically did not become full enough to overflow into the main pond. When the forebay was full of water, the PAC dosing system resulted in large reductions in suspended solid levels over a short horizontal distance within the forebay. A smaller amount of suspended solid reduction was achieved in the main pond, predominately through dilution, with the major function of the main pond being additional storage capacity for runoff. Discharge from the Somerset Road Pond was not continuous due to low water levels in the main pond. However, when discharge did occur, the suspended solids levels were very low compared with other studies investigating sediment retention pond discharge.

The Richardson Road pond was less effective at removing suspended solids due to the flow regime within the forebay. There were two runoff channels entering the forebay, as well as a continual flow of groundwater. Only one of the runoff channels was directly dosed with PAC, and as the water level in the forebay was typically at, or just below, the level spreader at all times, there was a decreased potential for the PAC to become evenly distributed through the forebay and achieve dosing of all runoff. Furthermore, the main pond discharged continuously during the study period, resulting in reduced residence times of runoff within the pond system. Nonetheless, the discharge from the main pond was much lower than other studies, implying suspended solid reduction was being achieved.

The SEV method indicated that the receiving environment was already degraded due to modifications to the riparian vegetation, increased dissolved oxygen demand, and moderate bank erosion. This was reflected in the macroinvertebrate population, with only pollution tolerant taxa being collected, thus limiting the use of macroinvertebrates as an assessment tool in this study. However, the SEV method, which assesses a wide range of ecological functions, implied that very little environmental change occurred as a result of the sediment retention pond discharge. A small increase in deposited sediment was observed on the stream bed, however indications are that deposited sediment is rapidly washed away once earthworks are completed. Thus this deposited sediment may not have a permanent impact within the receiving environment.

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Chapter 1:
Introduction

1.1 Aims and Objectives

Soil erosion is one of the leading resource management problems worldwide because, while it occurs naturally, it is easily accelerated by human activities such as mining, forestry, agriculture and earthworks (Fangmeier *et al.*, 2005). Increased erosion on earthworks sites occurs due to the removal of protective vegetation and topsoil, and the subsequent cutting, filling, levelling and compacting of the land surface. This decreases the infiltration capacity of the soil, and increases its erodibility.

This eroded sediment may accumulate in natural environments where it can have many detrimental effects including: increased turbidity, and therefore reduced light penetration within watercourses; a reduction in feeding ability of fish, invertebrates and other aquatic organisms; and the blanketing of surfaces and vegetation with fine sediments (Nearing *et al.*, 1994).

The Auckland Regional Council requires that methods to avoid, remedy or mitigate adverse effects of erosion on water quality be employed on earthworks sites, and recommend the use of sediment retention ponds for catchments greater than 0.3 ha in size. These are ponds designed to hold site runoff long enough for suspended solids to settle out of the water column (Auckland Regional Council, 1999; 2001). Two of these ponds were investigated during the course of this study.

Therefore, this investigation has two aims:

1) to consider the effectiveness of two chemically dosed (Polyaluminium chloride) sediment retention ponds in removing suspended solids from the runoff on an earthworks site; and

2) to determine the value of using the Stream Ecological Valuation (SEV) method, particularly the changes in the macroinvertebrate community composition, to assess the environmental impact of sediment retention pond discharge on the receiving watercourse during the study period.

In order to achieve these aims, the following three objectives have been identified:

1) to accurately measure suspended sediment levels in the forebays, main ponds and discharges at two sediment retention ponds over a given time period;

2) to collect rainfall data onsite to determine the correlation between periods of rainfall and increases in suspended solids levels in the ponds; and

3) to undertake a SEV analysis and sample macroinvertebrates in the receiving environment, and determine any long term changes between November 2006 and November 2007.

1.2 State Highway 20 Extension works

The investigation site is located in Mt Roskill, Auckland. The study area consists of two sediment retention ponds which were constructed by Fulton Hogan Ltd. as part of the environmental protection associated with the development works on the site. This project, known as the SH20 Mt Roskill Extension, will extend the existing south western motorway (SH20) four kilometres to the west from its current ending at Queenstown Rd.

1.3 Thesis Outline

Chapter One briefly introduces the topic, and gives the aims and objectives of the study. Chapter Two provides a literature review relevant to soil erosion processes; the impact of earthworks on these processes; the effect of sediment on receiving aquatic environments, particularly the impact of suspended and deposited sediment on macroinvertebrates; and finally, an overview of sediment and erosion control measures, with a focus on chemically dosed sediment retention ponds. In Chapter Three the study site is introduced and details of two sediment retention ponds and the Oakley Creek Tributary where samples were collected are provided. Chapter Four outlines the methodologies used to: collect of samples from within the two sediment retention ponds and the Oakley Creek Tributary; measure daily rainfall onsite; undertake Stream Ecological Valuation (SEV) surveys in November 2006 and November 2007, including macroinvertebrate surveys; analyse water samples for suspended solids in the laboratory; and finally to analyse the rainfall, SEV and macroinvertebrate data. Chapter Five presents the results collected during the study, and includes the rainfall, suspended solids, and SEV data. Chapter Six provides a discussion of these results. Chapter Seven details the conclusions drawn from the study, and provides avenues for future research.

Chapter 2:
Literature Review

2.1. Introduction

Erosion occurs when the land surface is stripped by the action of water, wind, ice or other geological processes (Nearing *et al.*, 1994), and is one of the most important resource management problems in the world (Fangmeier *et al.,* 2005). Erosion involves the detachment, transport, and deposition of soil particles by the force of raindrops and the surface flow of water (Nearing *et al.*, 1994). An erosion assessment undertaken in New Zealand during the 1980's found that 13.8 million hectares, or 52% of the land area, was affected by erosion (Roche, 1997); this value is unlikely to have decreased.

Eroded sediment can have many negative impacts on receiving environments such as streams, lakes, rivers and the coast. These impacts result from increased turbidity, and include: a reduction in the feeding efficiency of fish, invertebrates and other organisms; smothering of instream substrate and vegetation; and increased water temperatures due to heat absorption by suspended particles. This may result in species displacement or changes in species diversity and abundance. Increased sediment in water bodies can also lead to substrate composition changes or habitat infilling (Nearing *et al.*, 1994).

This chapter will detail the processes, both natural and anthropogenic, by which erosion occurs, and outline the effects it has on the environment, with a key focus on the use of macroinvertebrates in assessing these effects. The methods by which erosion is regulated and controlled in New Zealand will then be outlined, and a detailed description of the use of chemically-dosed sediment retention ponds given.

2.2. Soil erosion processes

Soil erosion processes have been described by a number of authors including Owoputi and Stolte (1995), Lal (2001) and Fangmeier *et al.* (2005). A brief summary of the key aspects of soil erosion are given below. These are infiltration, particle detachment and particle transport. The impact of earthworks on infiltration and runoff generation will also be described.

2.2.1 Introduction

The soil acts as a separating surface, dividing precipitation into two parts: groundwater and overland flow, or runoff (Horton, 1933; Fig. 2.1). Infiltration is the process of water entry into the soil, and the rate at which this occurs is known as the infiltration rate. Runoff is generated when this infiltration rate is exceeded, resulting in water moving across the soil surface (Gerits *et al.,* 1990). Erosion occurs when soil particles are detached from the soil surface, and transported elsewhere by runoff. This process occurs naturally, however human activities such as mining, forestry, agriculture and earthworks reduce vegetation cover and increase soil compaction, thus accelerating soil erosion rates (Fangmeier *et al.,* 2005).

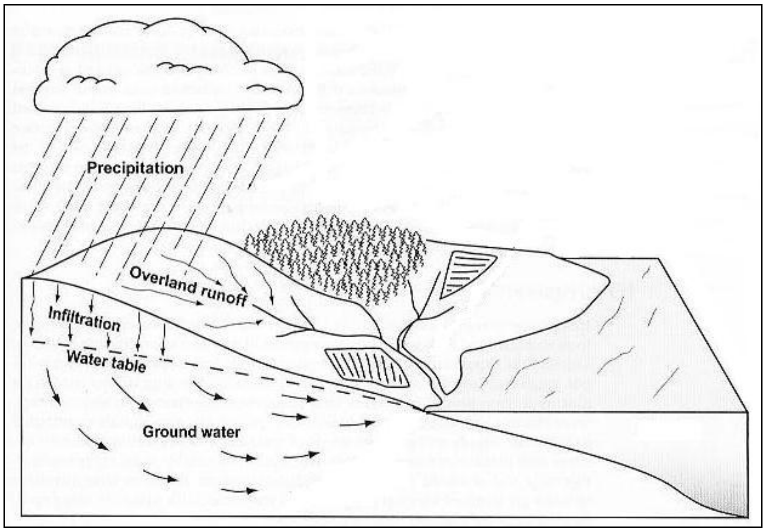


Fig 2.1: Schematic of the division of rainfall (adapted from Fangmeier *et al.*, 2005).

2.2.2 Infiltration

The factors which influence infiltration rates, and hence runoff, can be broadly defined as precipitation characteristics and catchment characteristics. The amount, duration, intensity and distribution pattern of precipitation influences the rate and volume of runoff. The catchment characteristics affecting runoff are catchment size, shape and orientation, topography, soil characteristics and land use and management (Fangmeier *et al.*, 2005).

Soil characteristics have a major influence on the infiltration rate of a soil; in particular, the size of soil particles, their position within the soil, and the degree of aggregation between soil particles. Porosity refers to the amount of space available for water (Davie, 2004), and is influenced by the size and position of soil particles because they determine the size of pore spaces. Soils with larger pore spaces will have greater porosity, and therefore a higher infiltration capacity, than those with small pore spaces (Sherman and Musgrave, 1942).

Land use and management practices have the potential to significantly alter infiltration and therefore runoff generation processes. For example, mining and production forestry commonly result in the removal of vegetation cover over vast areas of land (Harding *et al.,* 2000). Vegetation cover intercepts rainfall, slows overland flow, increases infiltration rates and improves soil structure and water holding ability, therefore reducing runoff and erosion (Stocking, 1994; Fangmeier *et al.*, 2005). The impacts of earthworks on infiltration and runoff rates will be detailed in Section 2.3.

2.2.3 Detachment and transport of soil particles

Soil erosion occurs when particles are detached and transported from the soil mass by erosive agents such as water, wind and ice (Owoputi and Stolte, 1995). In general, soil detachability increases as the size of the soil particles increase, and soil transportability decreases with an increase in particle size. Therefore, while clay particles are more difficult to detach than sand, they are more easily transported (Schwab *et al.,* 1981). The erosion of clays is accelerated because they have a reduced infiltration rate, due to low porosity, and therefore generate more runoff (Lal and Elliot, 1994).

The most common eroding agent on forestry, mining, agriculture, and earthworks sites is water, through raindrop impact and overland flow. Water erodes soil in many different ways including; splash, sheet, rill and gully erosion (ARC, 1999).

Splash erosion occurs when soil aggregates are broken apart by the impact of raindrops, which are then transported away from the site by surface runoff (Gerits *et al.,* 1990). This process is influenced by several factors including the intensity and duration of the rainfall event, the size of the raindrop, and the type of soil being impacted (Owoputi and Stolte, 1995).

Sheet erosion occurs when the infiltration capacity of the soil is exceeded. The soil is removed in uniform layers across the exposed area and, if left unattended, sheet erosion will strip nutrients and organic matter from the soil (ARC, 1999). Sheet erosion is the mechanism by which particles detached by splash erosion are transported (Wischmeier and Smith, 1958).

Rill erosion is the removal of soil as runoff moves in concentrated paths within flow channels. As the velocity increases, the flow is able to detach and transport larger particles of soil, and is therefore very destructive (Nearing *et al.,* 1994). This is estimated to be the dominant erosion process on hillslopes. As the rills become deeper, gully erosion develops (Fig. 2.2). Gullies are more than 300mm deep, and can not be removed by ploughing (Lal and Elliot, 1994). The prevention and remediation of gullies is important for soil conservation due to the significant amount of soil that may be eroded from them (Winter, 1998).

Fig. 2.2: Gully erosion on a bank.

2.3. The impact of earthworks

Thousands of hectares are exposed every year in New Zealand for earthworks associated with subdivisions, roads, landfills and other developments. When protection measures are not in place, significant erosion can result (ARC, 1999). A comparison of the storm-generated suspended sediment yields of five small basins under differing land use was undertaken by the National Institute for Water and Atmospheric Research (NIWA) on behalf of the ARC. The catchment undergoing housing development (urbanising) was found to generate an average of 961 t/km^2/year, compared to that of a mature urban catchment which generated an average of 107 t/km^2/year. Within the urbanising catchment, 28% of the land area (around 0.6 km^2) was undergoing earthworks and the yield from this subcatchment was estimated to be 6600 t/km^2/year. This figure is based on a measured yield of 3300 t/km^2/year, downslope of silt traps with an assumed operation efficiency of 50%. Thus the expected sediment yield from a catchment undergoing earthworks without sediment controls was estimated to be 6600 t/km^2/year. This is more than 16 times the 58 t/km^2/year recorded in 1980-1981 when only 1% of the catchment was bare ground (ARC, 1994). During the 1996-1997 earthworks season, l000 ha of bare land was worked in the Auckland Region. If left unprotected, this could have resulted in a discharge of 66,000 tonnes of sediment (based on the above figures) to receiving aquatic environments (ARC, 1994; 1999), with potentially dire consequences, as outlined in Section 3.

Earthworks commonly involve the removal of existing vegetation and topsoil, and cutting, filling, compacting and levelling of the land surface, often across large areas. These common practices may result in increased levels of runoff and erosion, as detailed below.

Retaining as much vegetation as possible onsite is very important because this cover provides a number of benefits to the soil. The most important role vegetation plays in erosion protection is the interception of raindrops, and the absorption of their kinetic energy, because this reduces their potential to cause soil detachment. In addition, organic matter slows the flow of runoff at the surface, and improves the structure and water-holding qualities of the soil. Plant roots improve infiltration by providing channels along which water can flow, and increase the soil stability by binding it together (Stocking, 1994; Fangmeier *et al.*, 2005).

Compaction leads to reduced soil pore space, decreased movement of water into and within the soil, and decreased soil water storage (Nearing *et al.*, 1994). When rainfall occurs at intensities exceeding the infiltration rate, water will pond on the surface (Fig. 2.3). If this water begins to flow across the surface, it will result in erosion.

Fig. 2.3: Water ponding on a compacted surface.

In addition, heavy machinery such as diggers, trucks and bulldozers, drive across the site during the construction process, resulting in further compaction of the land surface (Fig. 2.4).

Fig. 2.4: Large earthmoving machinery on an earthworks site.

Basher and Ross (2001) investigated the infiltration and erosion rates of compacted wheel tracks on an agricultural site in Pukekohe, New Zealand. They found that compacted areas had very low infiltration rates (average 1.4×10^{-7} m/s). This meant that any rainfall event exceeding an intensity of 0.5 mm/hr would result in the generation of runoff. However, when the wheel tracks were ploughed, infiltration in these areas increased by two orders of magnitude (average $> 9.7 \times 10^{-5}$ m/s), and erosion was reduced by 95%, from 21 t/ha to 1 t/ha. This has important implications for earthwork sites, where minimising erosion is of the utmost importance.

2.4. The effects of sediment

The amount of sediment in a watercourse determines its clarity, use for recreation and drinking water, and its suitability as a habitat for aquatic organisms. Watercourses which contain high volumes of suspended sediment tend to have reduced light penetration and limited photosynthesis. This makes it harder for fish and birds to feed (Hicks *et al.*, 2004), and reduces the quality of the habitat in the stream. Sediment also has a negative economic impact. Between 1980 and 1990, the Alemeda County Flood Control and Water Conservation District, California, spent an estimated US$2.5 million per year on dredging. It would cost an estimated US$30 million per year to dredge the construction-related sediment from the San Francisco lakes and reservoirs (Harbor, 1999).

2.4.1 Effects of sediment on benthic macroinvertebrates

The focus of this review is on the impact sediment has on benthic macroinvertebrates living in watercourses.

Invertebrates are animals without backbones. In aquatic ecosystems, this includes aquatic insects, larvae of insects with terrestrial (often flying) adult forms, and molluscs, snails and worms that are aquatic throughout their life cycle. Benthic macroinvertebrates are those organisms retained by mesh sizes >200 µm to 500µm, that occupy the bottom substrates, such as sediments, debris, logs, macrophytes, and filamentous algae of freshwater habitats (Rosenberg and Resh, 1993).

Many quantitative physical and chemical measures, such as temperature, pH and dissolved oxygen levels, have been established to assess water quality. However, these methods are limited by the fact that they only represent water quality at the time of sampling (Boothroyd and Stark, 2000). In contrast, biological monitoring methods, such as the use of macroinvertebrates, can be used to assess a variety of environmental changes over time and space because (Rosenberg and Resh, 1993; Boothroyd and Stark, 2000):

- macroinvertebrates are found in the majority of freshwater habitats, therefore standard classifications can be established;
- they have a high species diversity, giving a variety of responses;
- their sedentary nature allows for spatial analysis; and
- temporal changes can be assessed due to their relatively long lifecycles.

Many studies have been undertaken, both nationally and internationally, to determine the effect of sediment on macroinvertebrates following an environmental change. The findings of some of this research are presented below, and have been divided into suspended sediment, and deposited sediment.

2.4.1.1 Suspended sediment

All natural waterways carry some suspended solids, such as organic material, silica, clay and silt (ARC, 1996). Following rainfall events, these natural levels may increase (Hellawell, 1986). For example, values of up to 77,000 mg/L have been recorded in the headwaters of the Hokitika River, New Zealand (Hicks *et al.*, 2004). Because the elevated suspended solids levels are diluted by increased water volumes, or particle settling, the macroinvertebrates living in these streams are able to withstand them. It is only when the suspended solids levels become unnaturally high, or are present for long periods of time, that a change in community composition results (Hellawell, 1986). This often occurs as the result of poor land management practices in agriculture, forestry, mining, or during road construction (Wood and Armitage, 1997; Harding *et al.*, 2000). Suspended sediment may negatively impact streams by reducing light penetration, and abrading macroinvertebrates. This is described below.

2.4.1.1.1 Primary production

Streams containing large amounts of suspended sediment are referred to as having high turbidity (Davies-Colley and Smith, 2001). High turbidity results in less photosynthetically available radiation (PAR), due to absorption and scattering of light by the particles in suspension (Davies-Colley *et al.*, 1992). This will reduce the photosynthetic rate of macrophytes (submerged plants), thereby decreasing the amount of energy available to the food chain, and potentially resulting in an overall decline in stream productivity (Kirk, 1994). Alluvial gold mining on New Zealand's West Coast reduced light penetration by 10-80%, resulting in 45-90% lower benthic primary production (Davies-Colley *et al.*, 1992**).** However, in streams which rely on outside sources, such as decaying leaves, for energy (known as allochthonous energy), the impact of this sediment, provided that it remains suspended, may be negligible (Ryan, 1991).

2.4.1.1.2 Physical effects on macroinvertebrates

Rowe *et al.* (2002) investigated the short-term effects of high suspended sediment levels on several macroinvertebrates commonly found in New Zealand. Two species of mayfly *(Deleatidium* sp. and *Zephlebia* sp.), two caddisflies *(Polyplectropus* sp. and *Triplectides obsoletus)* and the damselfly *Xanthocnemis zealandica* were exposed to a sediment solution consisting of yellow-brown clay taken from a sediment retention pond in Auckland. Even after being exposed to extremely high suspended sediment concentrations (20,500 mg/L) over a 24 hour period, *Xanthocnemis zealandica, Deleatidium* sp. and *Polyplectropus* sp. all had a 100% survival rate. Rowe *et al.* (2002) also investigated the impact of natural short-lived rises in suspended solid levels following rainfall events by exposing *Deleatidium* nymphs to an 1100 mg/L solution over a 14 day period. No difference in survival rates were recorded between the control and test solutions. These results indicate that suspended material has little or no direct impact on macroinvertebrates (Rowe *et al.,* 2002; Suren *et al.,* 2005).

2.4.1.2 Deposited sediment

One of the direct results of elevated suspended solids levels is increased sediment deposition. This deposited sediment can negatively impact watercourses in several ways (Ryan, 1991; Wood and Armitage, 1997), including reducing food supply and available habitat, resulting in changes in community composition. These will be discussed below.

2.4.1.2.1 Food supply

Deposited clay particles downstream of a placer-gold mine on the West Coast of the South Island resulted in a 10.5% reduction in the organic content of epilithon (organic matter which attaches to rock surfaces, also known as biofilm or periphyton). This resulted in a 9 to 45% reduction in macroinvertebrate densities downstream of the discharge, as epilithon is an important food source for some macroinvertebrates (Davies-Colley *et al.,* 1992). Graham (1990) investigated the effects of deposited sediment on epilithon in a pristine stream environment, and found a 28% reduction in organic content. The suspended sediment concentration of the water was between 1 - 10 mg/L, indicating that even low concentrations can have a negative impact on the stream environment.

2.4.1.2.2 Interstitial habitat

As particles settle out of suspension, they fill the spaces between the coarser substrates such as cobbles and gravel on the stream bed, changing the available habitat. This has negative impacts for those invertebrates and fish which rely on these interstitial spaces for feeding and respiration (Hellawell, 1986; Wood and Armitage, 1997).

Extence (1978) examined the impact road construction had on the river Roding, in Essex, Great Britain. There was a notable reduction in substrate size during the study period: in late 1974, the streambed consisted mainly of large stones and coarse gravel (particle size 10-150 mm), but by July 1975, this substrate was blanketed by particles, most of which were small enough to pass through a 1 mm mesh. A corresponding change in the macroinvertebrate community was observed. A decline in the number of leeches is attributed to a lack of coarse particles, and despite the fact that *Chironomidae* (midges) are burrowing organisms, the constantly shifting fine deposits downstream of the discharge did not provide them with a suitable habitat.

Jowett *et al.* (1991) investigated the habitat preference of 12 benthic macroinvertebrates, and found that the mayflies, stoneflies and caddisflies studied preferred sediment of gravel-size or larger. The only species abundant in the finer substrates were *Potamopyrgus antipodarum* (aquatic snail), *Chironimidae* (midge) and *Naidiae* (worm). No species showed a clear preference for fine substrate (Jowett *et al.,* 1991), confirming that there is low productivity in fine substrate when compared to larger substrate (Minshall, 1984).

2.4.1.2.3 Changes in community composition

Paul and Meyer (2001) reviewed studies on the impact of urbanisation on macroinvertebrates. They found that all studies looking at a gradient of increasing urbanisation within a single catchment reported a decrease in invertebrate diversity as urban land use increased. This decrease was most evident in the more sensitive orders- *Ephemeroptera* (Mayflies), *Plecoptera* (Stoneflies), and *Trichoptera* (Caddisflies), while the relative abundance of *Chironomidae* (midges), oligochaetes (worms), and tolerant gastropods increased (Paul and Meyer, 2001).

Many studies have been undertaken comparing macroinvertebrate communities upstream and downstream of some form of discharge such as urban land clearing (Cline *et al.*, 1982, Hogg and Norris, 1991; Ehrhart *et al.*, 2002), mining (Quinn *et* *al.*, 1992) and forestry (Harding *et al.*, 2000). In all cases, while the sites upstream showed an abundance of "sensitive" species, the downstream sites were dominated by pollution tolerant species such as oligochaetes and chironomidae, with the more sensitive species being largely absent.

Quinn *et al.* (1997) compared the impact differing land use had on the macroinvertebrate community, and found that while several mayfly and stonefly taxa were common in the pine and native forest catchments, they were largely absent in the pasture catchments. Instead, these streams were dominated by chironomids, snails and oligochaetes. The former groups are considered to be more tolerant to environmental degradation than the latter group (Quinn *et al.*, 1997).

Suren and Jowett (2001) assessed the impact of deposited sediment on invertebrate drift by adding fine sediment to artificially created channels. They found that the drift rate (macroinvertebrates drifting downstream to reach move favourable conditions) from the sediment-laden channels was more than double that from the untreated control channels. The drift response of benthic invertebrates could be the result of either a physical change in benthic habitat (Hellawell, 1986) or a reduction in food quality and availability due to smothering (Graham, 1990).

2.5. Control measures

The uncontrolled discharge of sediment poses a significant environmental threat in New Zealand, and consequently the Government has enacted laws to prevent them occurring. Section 2.5.1 details these laws, and Section 2.5.2 sets out methods by which the intention of these statutes can be achieved.

2.5.1 Regulatory framework and "best practice" guidelines

Within New Zealand, the discharge of sediment from earthworks sites is regulated by a number of legislations, with the overarching statute being the Resource

Management Act (RMA), 1991 which is designed to *“promote the sustainable management of natural and physical resources”* where sustainable management means:

“managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while:

a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and

b) safeguarding the life supporting capacity of air, water, soil and ecosystems; and

c) *avoiding, remedying, or mitigating any adverse effects of activities on the environment.”* (RMA, 1991).

Section 30(1) of the RMA, 1991, specifies the functions of Regional Authorities throughout New Zealand. These include:

a) The control of the use of land for the purpose of:

  i. soil conservation
  ii. the maintenance and enhancement of the quality of water bodies and coastal water….

f) The control of discharges of contaminants into or onto land, air or water and discharges of water into water” (RMA, 1991).

In order to carry out these functions, and therefore achieve the purpose of the Act, the ARC has implemented a Regional Plan for sediment control, in accordance with Sections 63 to 70 of the RMA (ARC, 2001).

This plan addresses the issue of increased sediment generation and discharge from areas which are cleared of vegetation and / or subject to land disturbance, and seeks to avoid, remedy or mitigate the adverse effects of elevated sediment within the Auckland Region. This has been achieved through the creation of objectives, policies, methods and rules. Policy 5.2.1 states that “land disturbance activities which may result in the discharge of elevated levels of sediment will be required to employ methods to avoid, remedy or mitigate adverse effects on water quality", and thus resource consents are required for all activities not meeting the criteria for permitted activities in the Auckland Region (ARC, 2001).

The ARC has also produced guidelines for land disturbing activities in the Auckland region, known as Technical Publication 90, or TP90. It is designed to provide a comprehensive guideline for erosion and sediment control and to minimise adverse effects of sediment discharge through the appropriate use and design of control measures, but is not a legal obligation under the Resource Management Act (ARC, 1999).

2.5.2 Physical controls

Winter (1998) stated that there are two key ways to control soil loss from earthworks sites: (1) minimising soil detachment; and (2) intercepting and retaining the eroded material prior to discharge from the site.

2.5.2.1 Minimising soil detachment (Erosion control)

Erosion control is very important, because if there is little or no sediment eroding, there is no need for sediment control onsite. The most effective form of erosion control is to minimise the area of disturbance by retaining as much of the existing vegetation as possible, particularly on steep slopes or near watercourses (ARC, 1999; Harbor, 1999).

Construction should be staged so that the time and area of soil exposure is minimised. Exposed areas such as access ways, steep slopes and finished construction areas must be revegetated as soon as possible. This can be achieved through the use of hydroseeding, mulching, and / or geosynthetic materials which provide rapid protection (Fig. 2.5) (ARC, 1999).

Fig 2.5: Protective hay covering a completed earthworks site.

2.5.2.2 Intercepting and retaining eroded material (Sediment control)

Where soil exposure is unavoidable, there are many ways of intercepting and retaining eroded material provided that these measures are applied and installed correctly. These methods include the installation of silt fences, hay bale barriers, decanting earth bunds, as well as sediment retention ponds.

2.5.2.2.1 Sediment retention ponds

ARC (1999) considers sediment retention ponds to be the most effective sediment control measure for catchments greater than 0.3 ha in size, with a maximum catchment area of 5 ha per pond. A sediment retention pond is a pond designed to hold site runoff long enough for suspended solids to settle out of the water column (Fig. 2.6). These ponds are designed so that small runoff events achieve a high level of settlement, and large events achieve at least some settlement. The uppermost layer of the pond is discharged via a floating dewatering structure, usually a T-bar device, designed to remove water at a rate of 3 litres/second/ha of contributing catchment. These ponds are generally 1 - 2 m deep. Shallow ponds do not have adequate retention times to achieve settlement, and deeper ponds may result in short circuiting during large storm events (ARC, 1999), because stratification allows the relatively warm incoming water to skim along the surface of the pond, rather than plunging to the bottom and remaining in the pond.

A forebay is a smaller pond connected to the main pond, into which all runoff is directed (Fig. 2.6). It is approximately 2 m wide and 1 m deep, and is designed to trap most of the suspended sediment and bed load. Bed load is that portion of the total sediment load in runoff which is not in suspension or solution. The installation of a forebay is recommended because it is much easier to clean out than the main pond (ARC, 1999). A level spreader is constructed between the forebay and the main pond to promote the even dissipation of flow velocities between the two segments. The level spreader spans the width of the pond (ARC, 1999) (Fig. 2.6).

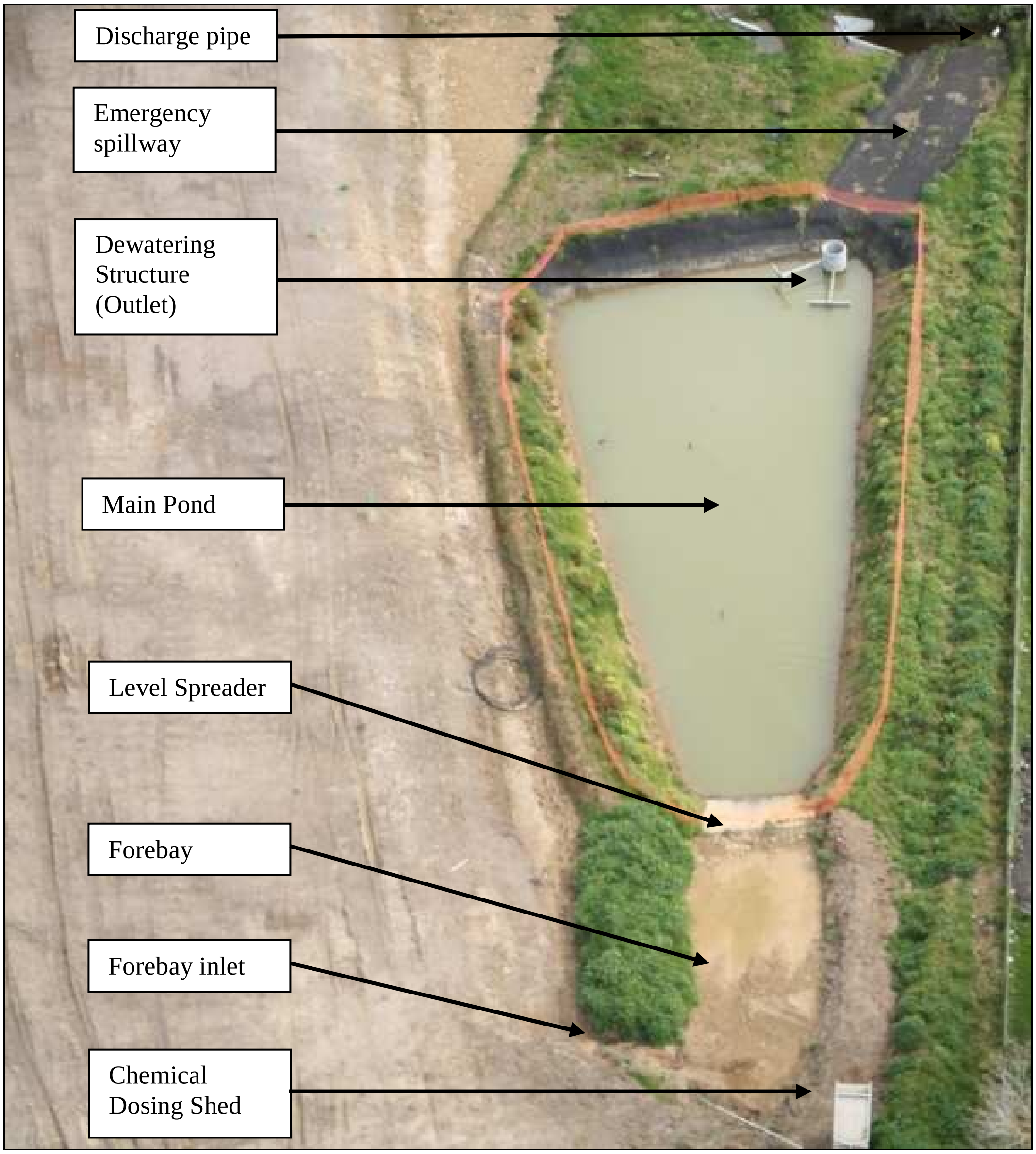


Fig. 2.6: The major components of a sediment retention pond (Photo courtesy of Transit, 2006).

A 924 m^3 pond, treating the runoff of a 5 ha site was established in Albany, Auckland (Winter, 1998). Overall, 90% (376 tonnes) of the suspended material transported to the pond was retained, while 10% (39 tonnes) was discharged to the receiving environment. The peak sediment concentration entering the pond during the earthworks season was 56,219 mg/L, with a calculated pond efficiency of 96%. During winter this peak sediment concentration reduced to 33,819 mg/L, and the retention efficiency reduced to 87% (Winter, 1998). Winter (1998) believed that the higher pond efficiency in summer was due to higher loading of suspended solids entering the pond, thus aiding natural flocculation processes.

2.5.2.2.1.1 Chemical dosing of retention ponds

Colloidal particles are made of very fine material (1-1000 nm), and may be divided into two groups- *hydrophilic* and *hydrophobic* (“water loving” and “water hating”). When used in terms of colloidal particles, hydrophobic refers to particles which are insoluble in water, rather than particles which are not easily wetted by water (Gregory, 2006).

The boundary between a particle and water has a distinctive interfacial energy, in the form of an electrostatic surface charge, which may be positive or negative (Gregory, 2006). Hydrophobic colloids, such as clay, are not thermodynamically stable (because they are insoluble), meaning that they should clump together and quickly settle out of suspension. However, kinetic stability occurs when two particles have the same charge, because they repel each other via a process known as electrical repulsion. When this happens, the particles will remain in suspension for long periods of time (Gregory, 2006). Clays have a negative surface charge, and are unlikely to settle out in a sediment retention pond under natural conditions (ARC, 2004b).

Increasingly, flocculants and coagulants are being used on earthwork sites to reduce the kinetic stability, and thereby increase the settlement rates of these particles (ARC, 2004b). There is a lot of confusion surrounding the terms coagulant and flocculant, and coagulation and flocculation, and these terms are often used interchangeably. To add to the confusion, these terms have different meanings depending on which industry is using them (Gregory, 2006). The following paragraphs provide definitions and explanations of these processes in terms of water and wastewater treatment.

Coagulation refers to the destabilisation (charge neutralisation) of colloidal material by an additive, while flocculation is the formation of aggregates (Fig. 2.7). Thus these processes can be divided into chemical (coagulation) and physical (flocculation) processes.

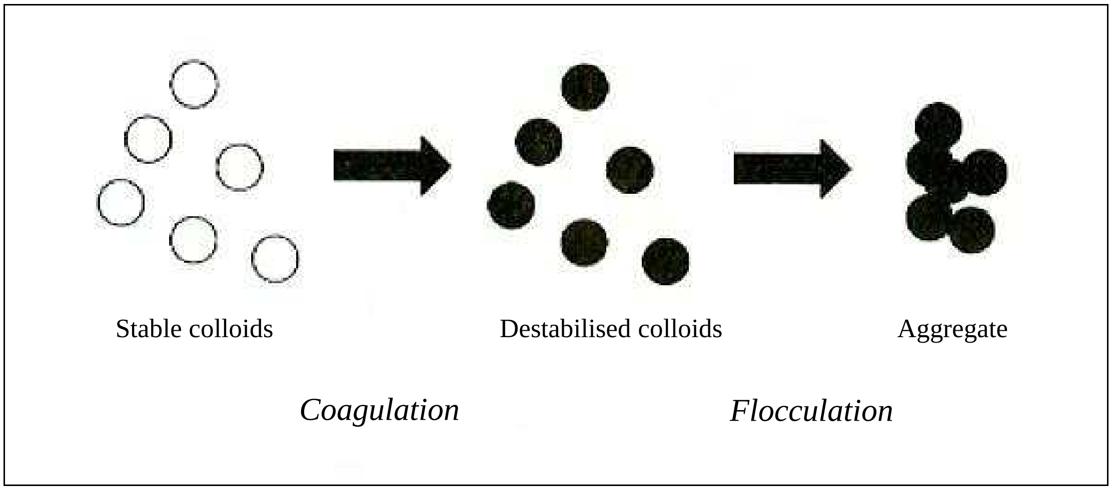


Fig. 2.7: Destabilisation and aggregation of particles (adapted from Gregory, 2006).

Based on the definitions above, those additives used in the coagulation process can be termed coagulants or flocculants, depending on how they achieve destabilisation of particles (Gregory, 2006). Coagulants are inorganic salts, while flocculants are long-chain polymers which form bridges between molecules. This is outlined below.

Flocculants

Flocculants are mainly synthetic polyacrylamides, and may be anionic (negatively charged), cationic (positively charged) or non-ionic (uncharged). Absorbing, non-ionic flocculants work simply by forming “bridges” between colloidal particles, causing them to adhere to each other via the flocculant ions, resulting in larger particles which will settle more rapidly (Fig. 2.8) (ARC, 2004b). This is simply flocculation; however, when charged flocculants are used, charge neutralisation (coagulation) may also play a role in the flocculation process (Gregory, 2006).

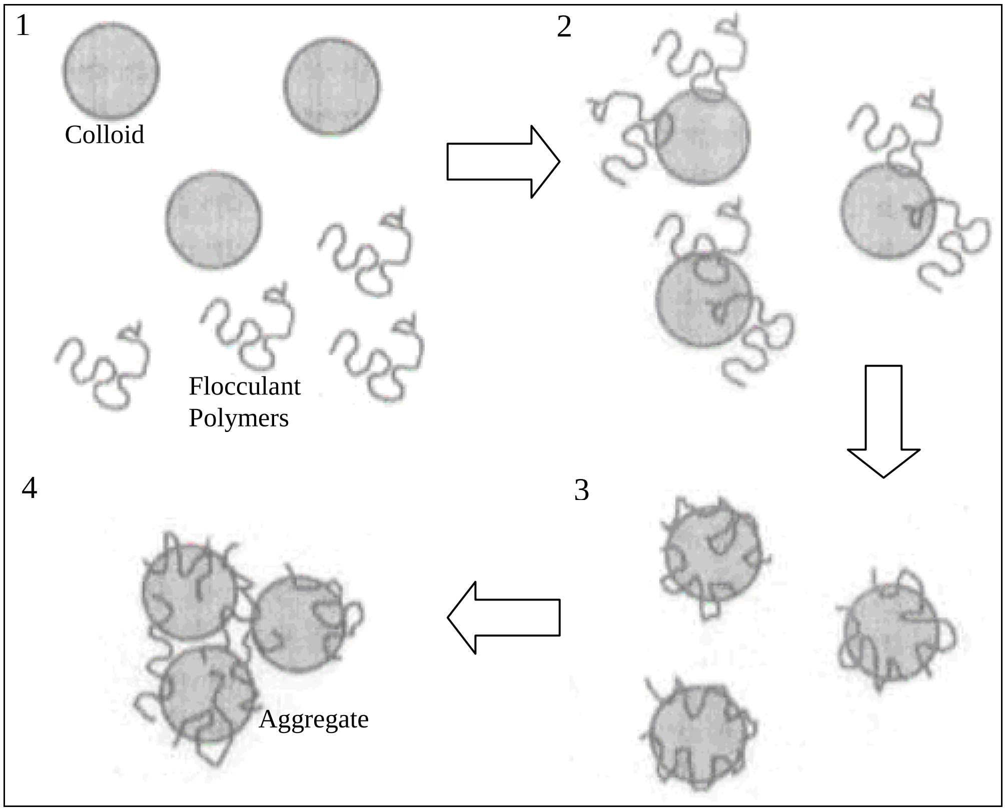


Fig. 2.8: Schematic diagram showing the stages of polymer absorption and flocculation; **1:** Flocculant added, **2:** Absorption of polymers onto the surface of the colloid particles, **3:** Reconformation, or rearrangement, of the polymers, and **4:** Flocculation achieved via bridging of flocculant polymers between colloids (adapted from Gregory, 2006).

Flocculants were not investigated during this study, and therefore will not be discussed further. For more information please refer to Chapter 6, Gregory (2006).

Coagulants

Coagulants work by neutralising the surface charge of colloidal particles (Gregory, 2006); this is achieved by adding reagents which develop positive charges around the colloidal material. In this way, the particles are prevented from repelling each other (Fig. 2.9; ARC, 2004b), and all interparticle collisions result in the formation of aggregates (Matsui *et al.*, 1998) which have a higher density, and therefore drop out of suspension. These aggregates are also termed ‘flocs’ (ARC, 2004b).

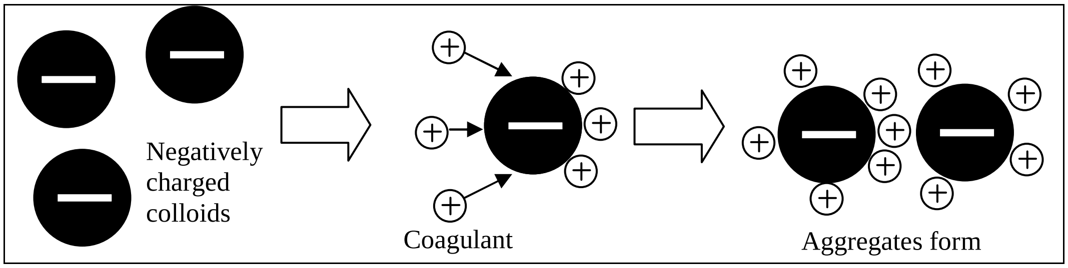


Fig. 2.9: Destabilisation of negatively charged colloids, such as clay, through the addition of positively charged coagulant molecules to achieve settlement (adapted from Fernz Chemicals (NZ) Ltd., undated; Gregory, 2006).

Aluminium coagulants

Aluminium (Al) salts are extremely versatile coagulants in the treatment of water, and can be applied across a wide range of chemical and biological conditions (Van Benschoten and Edzwald, 1990). These coagulants include aluminium sulphate (Alum) and polyaluminium chloride (PAC) (Gregory, 2004). Traditionally, alum ($Al_2(SO_4)$) was widely used in the water treatment industry, however polymerised forms of aluminium, such as PAC, are increasingly being used (Van Benschoten and Edzwald, 1990) because they are known to give superior performance at lower temperatures, resulting in the rapid formation of large ‘flocs’ (Gregory, 2004).

Aluminium has a very complex aqueous chemistry, and when Al coagulants are added to water containing suspended solids, phosphorous, metals and other dissolved or suspended material multiple reaction pathways occur. The aluminium undergoes hydrolysis, where the bonds split and combine with hydrogen in the water to form aluminium hydroxide ($Al(OH)_3$) (Van Benschoten and Edzwald, 1990). $Al(OH)_3$ is relatively insoluble, and forms ‘flocs’ which attach to suspended solids, forming aggregates which rapidly sink to the bottom (Gensemer and Playle, 1999).

Environmental impact of aluminium coagulants

Aluminium coagulants contain high levels of ionic aluminium, which is the toxic form. This toxicity is very dependant on pH, increasing in the lower (<5.5) and upper (>9) pH ranges. The bioavailability and toxicity of aluminium is greatest in acid solutions, with a maximum toxicity at around pH 5.0-5.2 (ANZECC, 2000). However, within the pH range of 6.5-8 (the normal range of natural waters within New Zealand (Quinn *et al.*, 1997)), aluminium poses no toxicity threat because it is relatively insoluble (Gensemer and Playle, 1999). When then pH of natural waters is outside this range, the life supporting capacities of the stream, such as dissolved oxygen levels, are lessened, and therefore it is likely that any species present in these environments are pollution-tolerant (ARC, 2004a). Gensemer and Playle (1999) provide an extensive literature review on the biological effects of aluminium to algae, macrophytes, aquatic invertebrates and fish. They found that in general, aquatic invertebrates show a hardiness to increased levels of Al, while fish are impacted by Al because its binds to their gills, reducing respiration. However, this effect is most noticeable in the pH range of 5-6, which is outside the natural range of aquatic waters. The impact of Al is also lessened by dissolved organic matter, as it complexes the Al, and reduces the amount available in solution.

ARC (2004a) found that in sediment retention ponds dosed with PAC, dissolved aluminium concentrations in the ponds' outflows ranged between 0.010–0.072 mg/L, which is below the USEPA chronic criterion of 0.087 mg/L (4 day average not to be exceeded) (USEPA, 2008). In most cases, dissolved aluminium levels in the outflows were well below inflow concentrations, leading to the conclusion that the risk to receiving environments from PAC dosing is low, and thus within the Auckland Region this is the recommended chemical coagulant (ARC, 2004b). Chemical dosing of ponds has been recommended in the Auckland Regional since 1998 (L. Babington, *pers. comm.,* 2007).

Rainfall Driven Dosing Systems

After extensive field experiments at ALPURT (ARC, 2004b), a rainfall driven dosing system was designed to be used with PAC. A chemical dosing shed (also referred to as a flocculant, or ‘floc’, shed in other literature) is located adjacent to every sediment retention pond (Fig. 2.10).

Fig. 2.10: A Chemical Dosing Shed located near the forebay of a sediment retention pond.

There is a rainfall collection tray on the roof of the shed (Fig. 2.11) which is proportional to the required PAC dose and the size of the catchment which drains to the pond (ARC, 2004b).

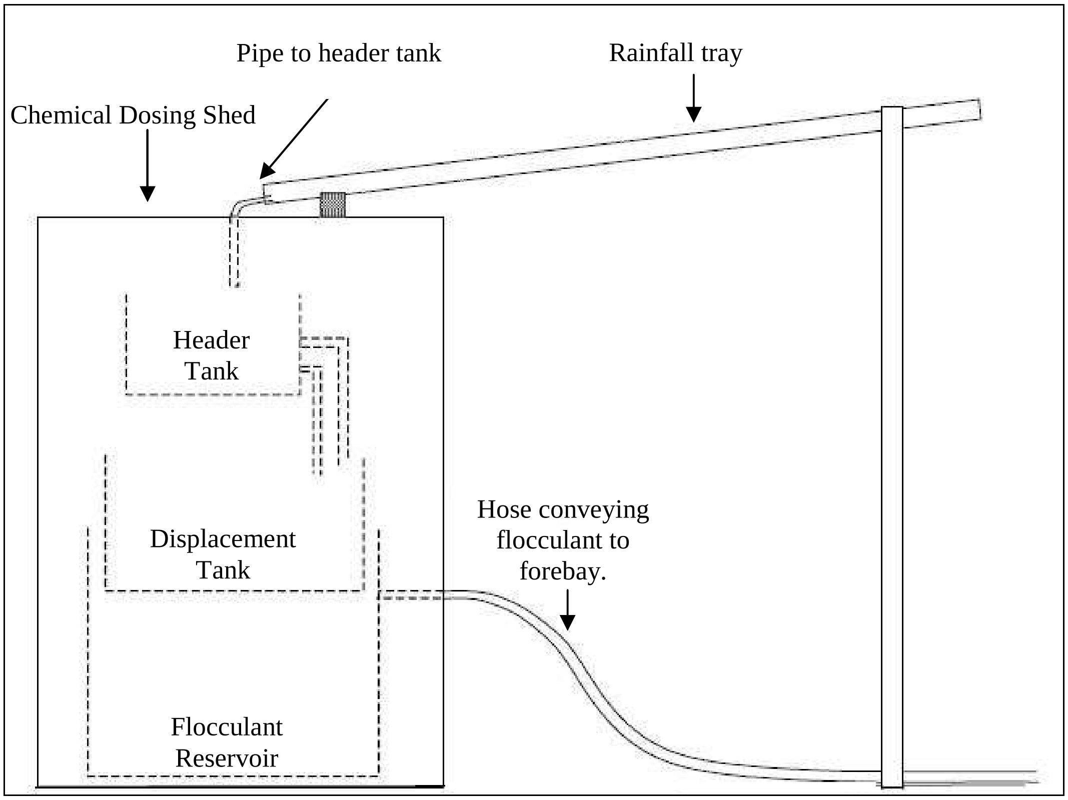


Fig. 2.11: Schematic of a Chemical Dosing Shed, showing the components of the dosing system (adapted from ARC, 2004b).

When it rains, water falling on the tray is directed inside the shed to a header tank. From here, the water flows in a 400 L displacement tank, which is floating in a larger 550 L tank of PAC. As the displacement tank fills with water, it becomes heavier, displacing the PAC from the flocculant reservoir, which then flows to the forebay, via a pipe (Fig. 2.12) (ARC, 2004b).

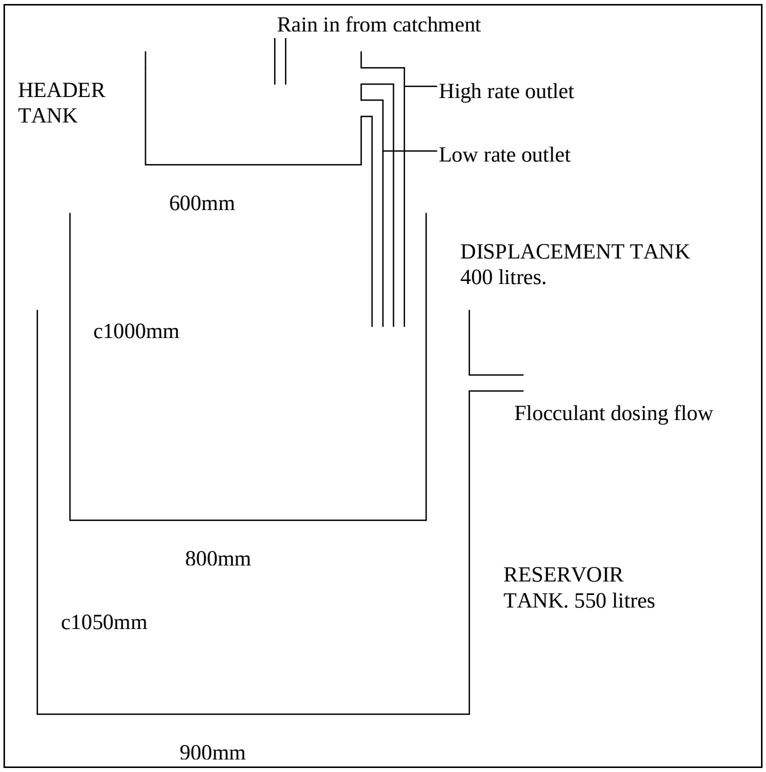


Fig. 2.12: Schematic drawing of the tank arrangement for an automatic rainfall driven dosing system (Fulton Hogan, 2005).

Therefore, in order to dose the pond with the correct amount of PAC, a known volume of rainfall must be collected. This process, and a worked example, is detailed in the following sections.

Determination of the required PAC dose

The required PAC dose is based on soil type, and is determined through bench testing, whereby differing doses of coagulant are added to 1 L runoff samples collected from the site. The optimum aluminium dose (mg/L) is the one which provides the greatest clarity for the smallest change in pH, as very high concentrations of PAC can increase pH levels (ARC, 2004b); however the clarity has to be over 100 mm depth visibility (ARC, 1999). This dose rate is commonly between 4-8 mg Al per litre of stormwater to be treated.

Liquid PAC (‘*Liquipac*’) supplied by Orica Chemicals contains a minimum of 10% Al_2O_3 by weight (Orica Chemicals, 2005). This is equivalent to 53,470 mg/kg aluminium, or 64,164 mg/L aluminium as the specific gravity of PAC is 1.20 (ARC, 2004b; Orica Chemicals, 2005; L. Babington, *pers. comm.,* 2007). Therefore, 1 L of PAC at a dosing rate of 4 mg Al/L will treat 16,041 L (16.04 m^3) of runoff (ARC, 2004b) This is calculated by dividing the amount of aluminium available in 1 L of PAC (62,164 mg), by the amount of Al required per litre of stormwater (4 mg).

Catchment Size

For ARC design calculations a 50 mm storm is used, and it has been assumed that 100% of rain falling on saturated earthworks areas will become runoff, and therefore require chemical treatment, while only 60% of that falling onto stabilised areas will require treatment. Thus, for a 1 ha earthworks catchment, 500 m^3 of runoff will be generated (ARC, 2004b).

Worked example

For a 1 ha earthworks catchment with a required dose rate of 4 mg Al/ L runoff:

- At this dose rate, 1 L of PAC will treat 16.04 m^3 of runoff,
- During a 50mm storm, 500 m^3 will be generated.
- Therefore the required amount of PAC is 500 / 16.04 = 31.17 L of PAC.

The pond requires a dose of 31.17 L, and as previously stated, PAC has a specific gravity of 1.2. Therefore 37.4 L of rainfall will be required (31.17 L x 1.2) to displace the PAC. The roof size can now be calculated: 50 mm of rainfall on a 1 m^2 tray will result in the collection of 50 L. Therefore 37.4 L of rainfall will require a tray area of 37.4 / 50, or 0.75 m^2 (ARC, 2004b). The size of the catchment tray will increase as the required aluminium dose increases, because more PAC will need to be displaced, and therefore more rainfall collected (Table 2.1).

Table 2.1: Required Tray Area for different PAC* dose rates (ARC, 2004b).

Aluminium Dose (mg/L)	Catchment Tray Area (m^2) per hectare of catchment#
2	0.375
4	0.75
6	1.125
8	1.5
10	1.875
12	2.25

* PAC with 10.1% Al_2O_3 by weight.
# For stabilised catchments, area is 60% of that given.

The importance of the header tank

The header tank (Fig. 2.13) provides a storage capacity which ensures that the pond is not dosed during rainfall following a dry period, as it is likely that there will be little or no runoff, because the infiltration capacity of the soils will be high (ARC, 2004b). Fig. 2.13 shows a rainfall activated dosing system. Notice the storage area between the bottom of the header tank, and the low rate outlet.

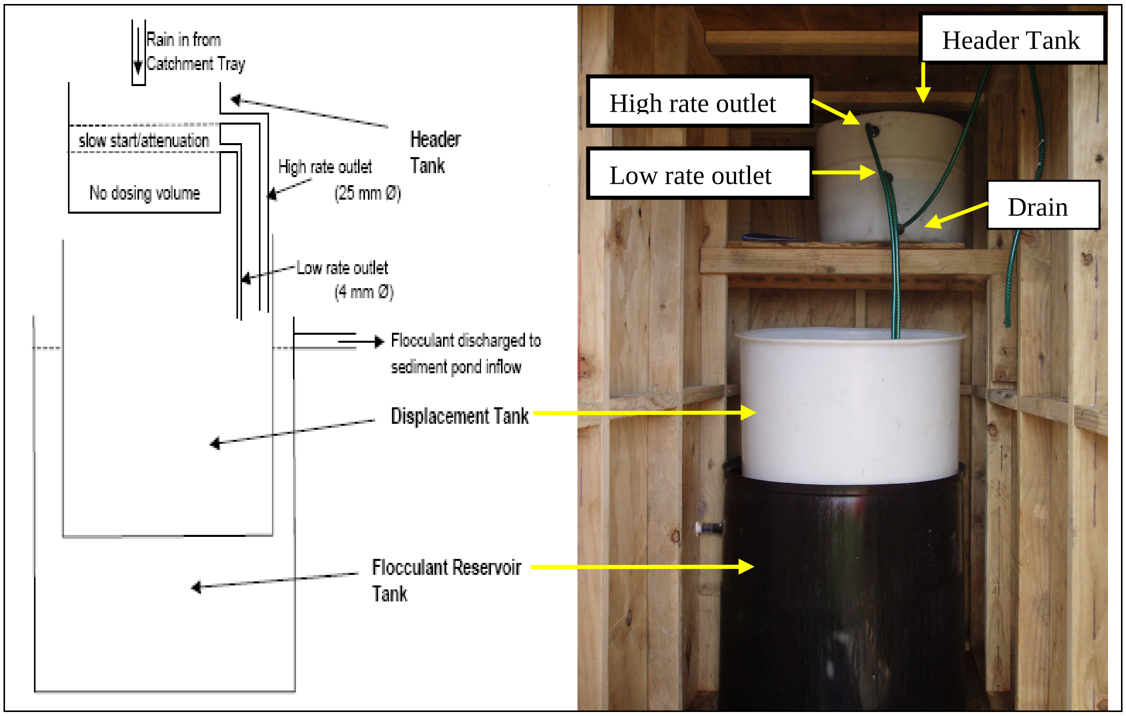


Fig. 2.13: Rainfall Activated dosing system showing the header tank (modified from ARC, 2004b).

System Maintenance

These chemical dosing systems require ongoing monitoring and maintenance to ensure that they are operating correctly.

Following three days of dry weather, the volume of water in the header tank must be reduced by 50%, and after six days, it should be emptied completely (ARC, 2004b). This guarantees a delayed start to dosing during the next rainfall event, and is achieved by installing a drainage hose at the base of the header tank (Fig. 2.11). Similarly, in wet weather, water may need to be added to the header tank to increase the volume of stored water, thus reducing the delay in dosage (ARC, 2004b).

The reservoir tank should always contain enough chemical to dose a major storm event, and should be filled to the level of the outlet pipe. The displacement tank should be emptied when it is 50% full, to prevent overtopping during periods of high rainfall (ARC, 2004b).

These maintenance procedures are always set out in the approved chemical treatment management plans required under the resource consent conditions associated with earthwork sites.

2.6. Summary

Soil erosion involves the detachment, transport, and deposition of soil particles by the force of raindrops and the surface flow of water, and can have many negative impacts on receiving environments through increased turbidity. This reduces light penetration, limits photosynthesis, and may result in species displacement or changes in species diversity and abundance. Many studies on the impact of erosion on macroinvertebrates have reported a decrease in the downstream invertebrate diversities.

Earthworks typically involve the removal of existing vegetation and topsoil, and cutting, filling, compacting and levelling of the land surface, and therefore have the potential to significantly alter infiltration and runoff generation processes. There are two key ways to control soil loss from earthworks sites: erosion control and sediment control. While erosion control is the more effective measure, sediment controls are required on all earthwork sites as erosion is unavoidable.

Sediment retention ponds are the most effective sediment control measure for catchments greater than 0.3 ha in size. Increasingly, coagulants such as Polyaluminium Chloride, are being used on earthwork sites to promote the settlement rate of colloidal particles within these ponds, and are typically applied through the use of a rainfall driven dosing system.

Chapter 3:
Study Area Characteristics

3.1. Introduction

This chapter describes the physical environment of the study area, giving a brief overview of the State Highway 20 (SH20) Mount Roskill Extension project, as well as a detailed description of the Somerset Road and Richardson Road sediment retention ponds, and the Oakley Creek tributary.

3.2. Site Location

The study site is located at the northern end of Auckland's south western motorway (SH20), approximately 7 km south of the central business district (CBD) (Fig. 3.1).

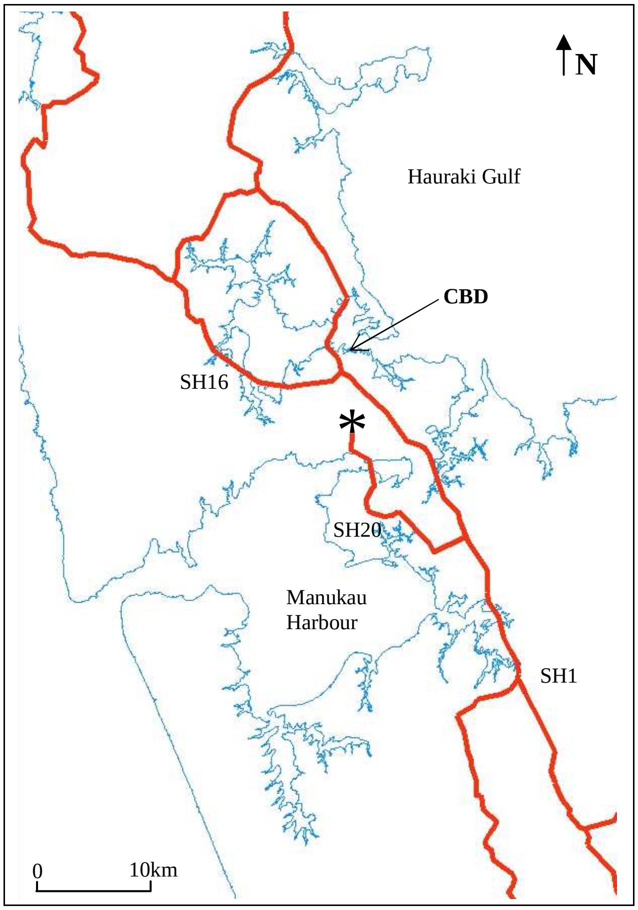


Fig. 3.1: Map of the Auckland Region showing the study site location (*), CBD, and major state highways (Map: J. Krippner).

3.2.1 State Highway 20 Extension Project

Transit New Zealand has identified the need to improve Auckland’s State Highway network. A key feature of this improvement is the development of the Western Ring Route (Fig. 3.2), which will create an alternative route north through Auckland City, thus reducing congestion on SH1. The completed Western Ring Route will be a single 48 km motorway, linking Manukau, Auckland, Waitakere, and North Shore cities. The Western Ring Route consists of several construction projects: a connection between the Southern Motorway (SH1) at Manukau and SH20, the extension of SH20 to the Northwestern Motorway (SH16), and the creation of the Upper Harbour Corridor (SH18) to connect SH16 with the Northern Motorway (SH1) at Albany (Transit, 2006).

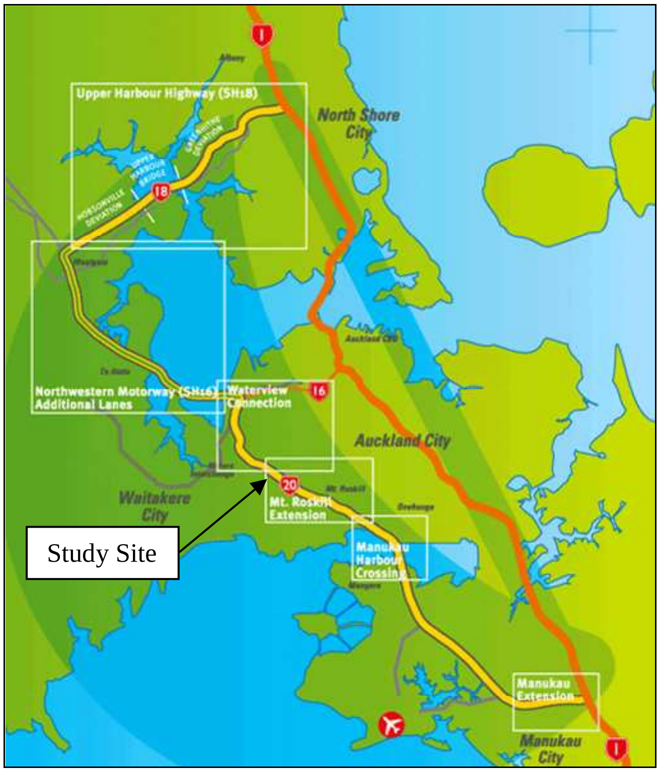


Fig. 3.2: Auckland Region, showing the Western Ring Route and the individual construction projects (Map courtesy of Transit, 2006).

The SH20 Mount Roskill Extension Project will extend the pre-existing motorway 4 km to the west, from its current ending at Queenstown Road, to connect with SH16 at Waterview. This will improve access to Auckland’s western suburbs, increase the motorway capacity, and decrease traffic flow in residential areas. The new motorway will have interchanges at Hillsborough and Dominion Roads as well as motorway overbridges for local roads. In addition, dedicated pedestrian and cycle bridges will be created at Ernie Pinches Street and Keith Hay Park, and a cycleway will run alongside the motorway (Transit, 2007). These features are shown in Fig. 3.3.

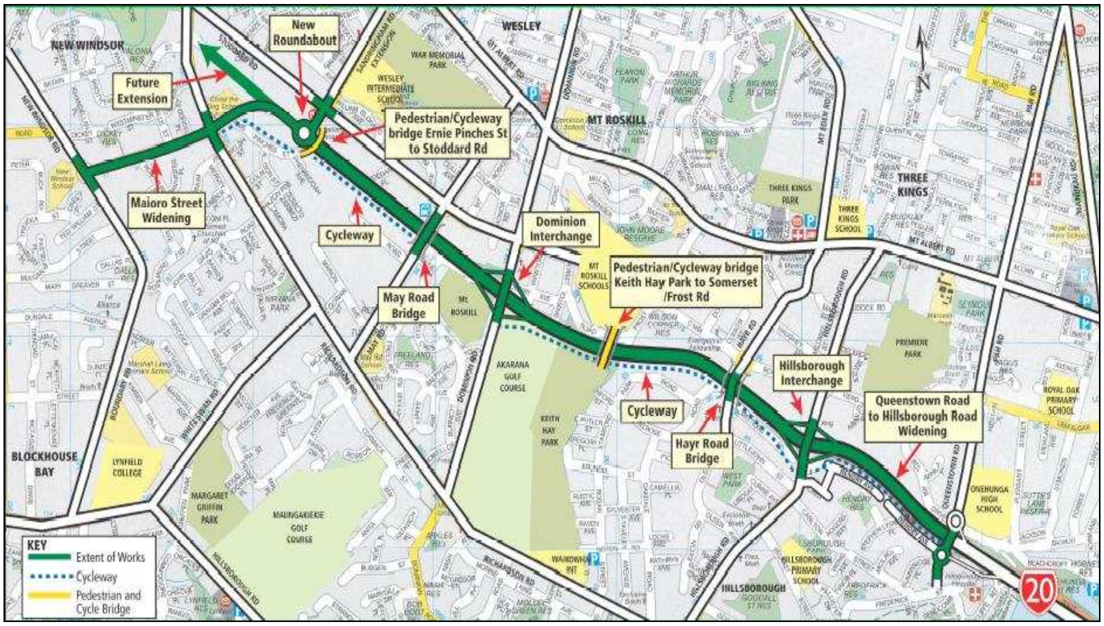


Fig. 3.3: Key features of the SH20 Mount Roskill extension project (Map courtesy of Transit, 2007).

Construction started on 30 August 2005, and is expected to be completed in early to mid 2009. The estimated cost of this project is $169 M, and it involves approximately 21.05 ha of earthworks (Transit, 2007). Fulton Hogan Ltd. are the contractors appointed to complete the motorway construction.

The site is underlain by Waitemata Group deposits, consisting of East Coast Bays Formation sediments. Prior to the commencement of earthworks, the soil stratigraphy consisted of stiff silt and clay, derived from the weathering of the Waitemata Group deposits, overlain by topsoil.

3.3. Sediment Retention Ponds

There are a total of 13 sediment retention ponds onsite at SH20. Two of these ponds were investigated as part of this study: the Somerset Road pond located approximately 2.7 km from the start of the project at Hillsborough Road, and the Richardson Road pond located approximately 3.8 km from the start of the project (Fig. 3.4). The discharge from both the ponds flows to the Oakley Creek via tributary streams (Fig. 3.5).

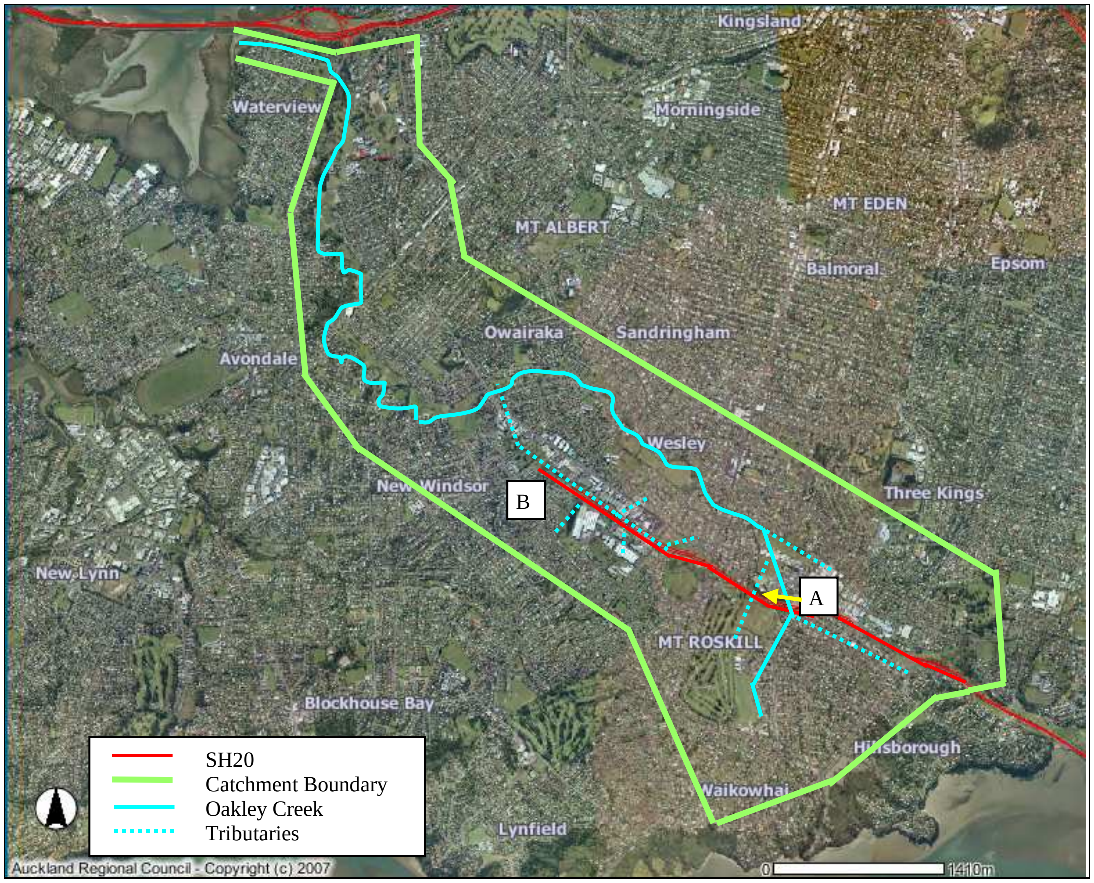


Fig. 3.5: Aerial view of Auckland showing the Oakley Creek catchment boundary, the Oakley Creek and its tributaries, the SH20 Extension, and the Somerset Road pond (A) and Richardson Road pond (B) (Photo courtesy of ARC, 2007).

Further details of these discharges will be provided in Sections 3.3.1.3 and 3.3.2.3.

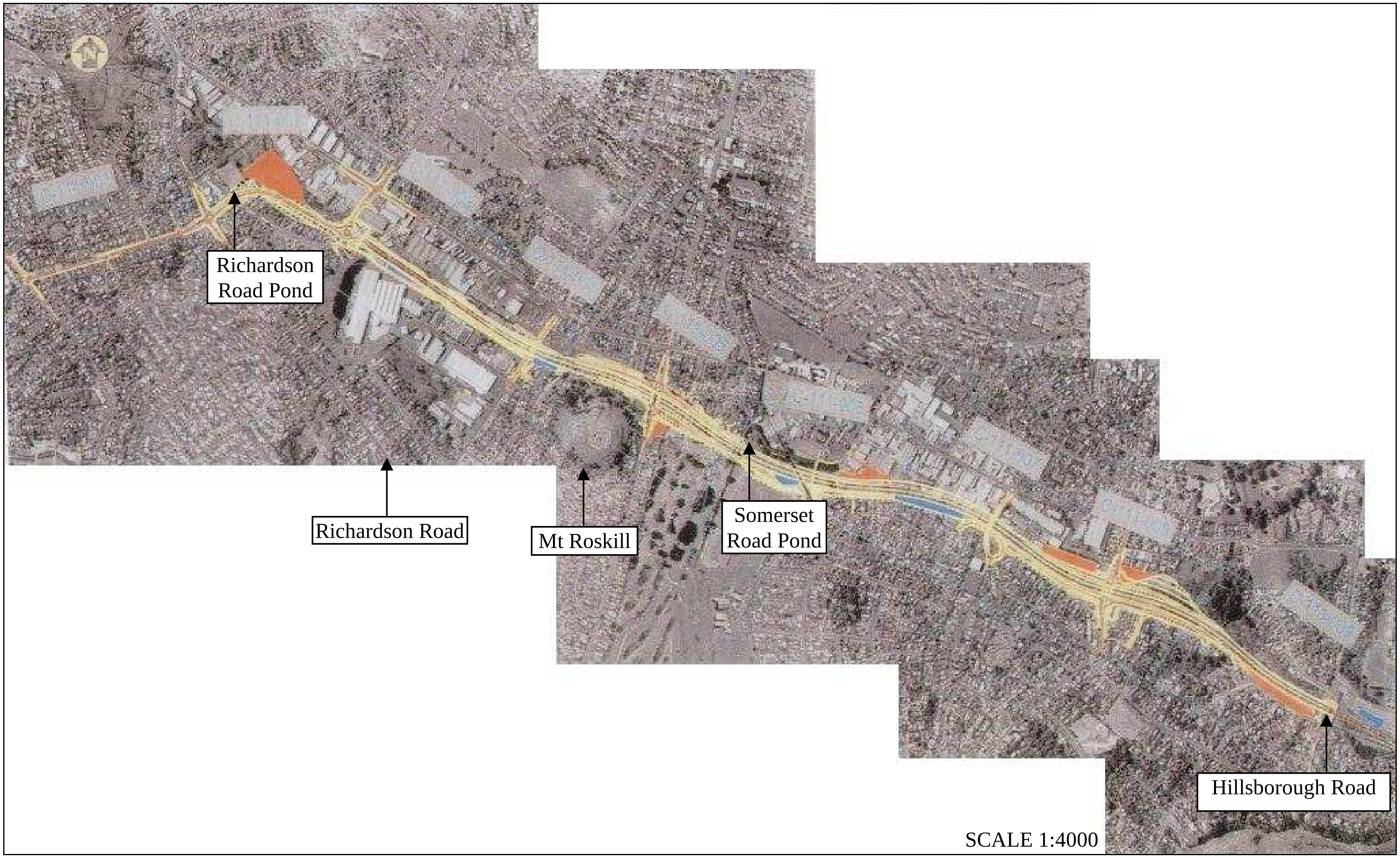


Fig. 3.4: Aerial photo of the SH20 Mount Roskill Extension showing the location of the ponds studied (Photo courtesy of Transit, 2007).

3.3.1 Somerset Road Pond

The Somerset Road pond (hereafter referred to as “the pond”) is located adjacent to Somerset Road in Mount Roskill, Auckland (NZ Tranverse Mercator Projection: N 5913299.14, E 1755379.06). Fig. 3.6 shows the pond location, and the SH20 extension.

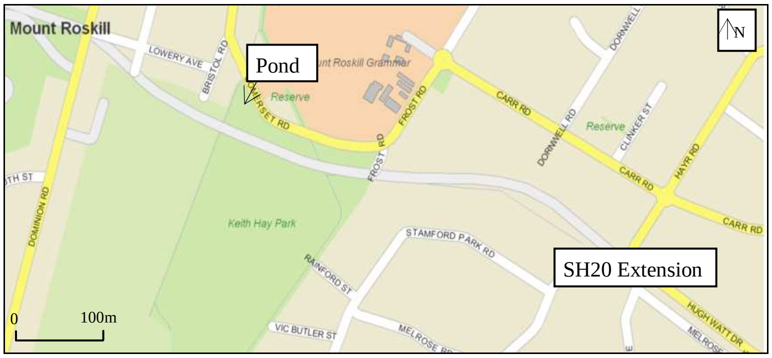


Fig. 3.6: Map showing the location of the Somerset Road pond (Adapted from Wises Maps, 2008).

The pond is separated from Somerset Road by a park, and is fenced in to prevent members of the public entering the site. It is located below the motorway project so that runoff will flow into the pond under the influence of gravity (Fig. 3.7).

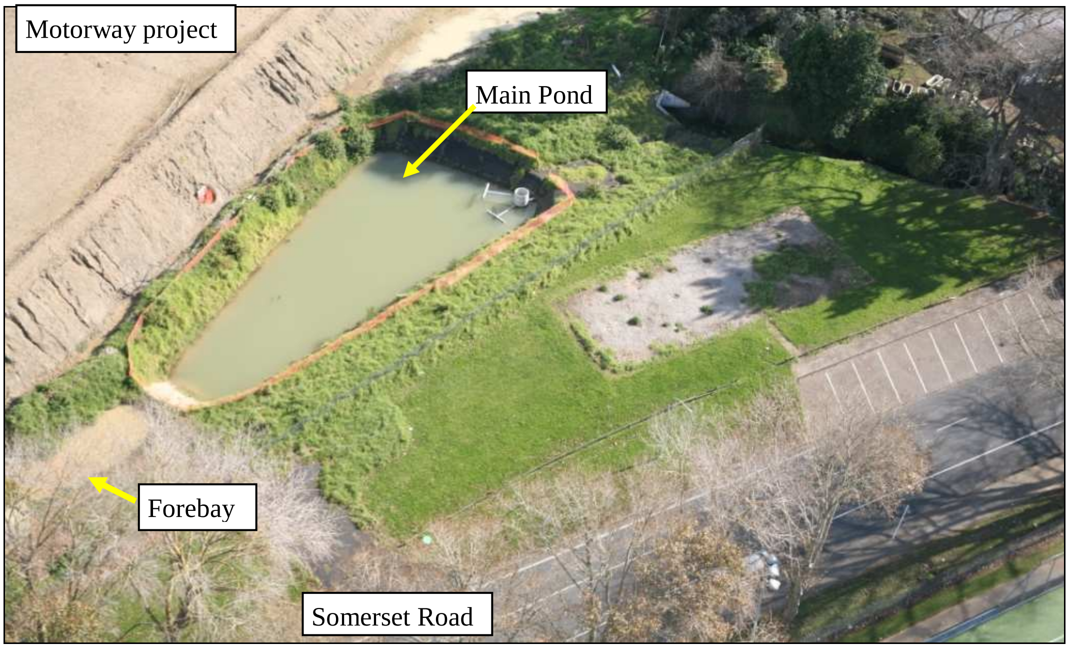


Fig. 3.7: The location of Somerset Road pond in relation to Somerset Road and the motorway project (Photo courtesy of Transit, 2007).

The SH20 extension is being built in an area designated for roading development, and is bounded by a mix of industry and housing on both sides. Opposite the pond, on the western side of the motorway, there is Keith Hay Park and the Akarana Golf Course, which have extensive grassed areas (Fig. 3.8).

Fig. 3.8: Aerial view of part of the SH20 extension showing; **A:** the Somerset Road pond, **B:** Keith Hay Park, and **C:** Akarana Golf Course (Photo courtesy of Transit, 2007).

3.3.1.1 Pond Design

As part of the resource consent process, sediment retention ponds are required to meet storage volume criteria based on the slope length and steepness of the contributing catchment. Because the catchment of the Somerset Road pond has slopes greater than 10% and longer than 200 m, the pond is required to have a minimum storage volume of 3% of the contributing catchment. This is a 3 m^3 storage volume for every 100 m^2 of catchment (ARC, 1999). The contributing catchment for this pond is approximately 2.6 ha (Fig. 3.9), and the main pond has a total as-built storage capacity of 855 m^3, and is therefore larger than the required 780 m^3. This pond is dosed with PAC at a rate of 5 mg/L. The pond is approximately 1.5 m deep, and is designed to withstand the 100 year return frequency (1% AEP) storm event without breaching (Fig. 3.10).

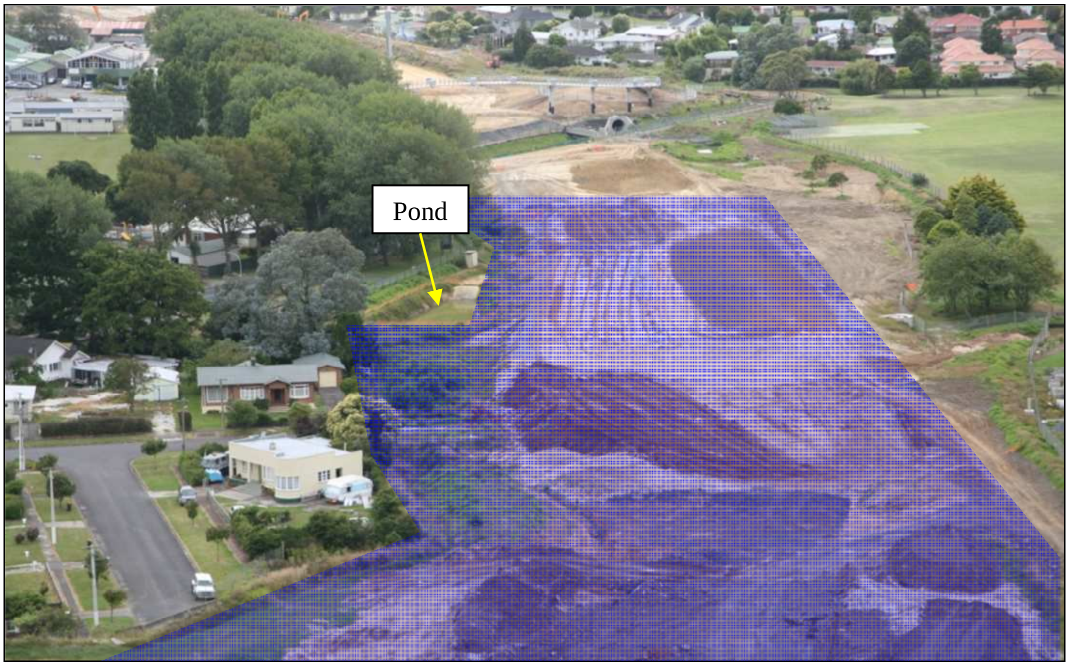


Fig. 3.9: Aerial photo (Photo courtesy of Transit, 2007) showing the Somerset Road pond, pond catchment (Blue) and the surrounding land use. Note that this catchment changed throughout the study as fill was added or removed from the site, and as new work took place.

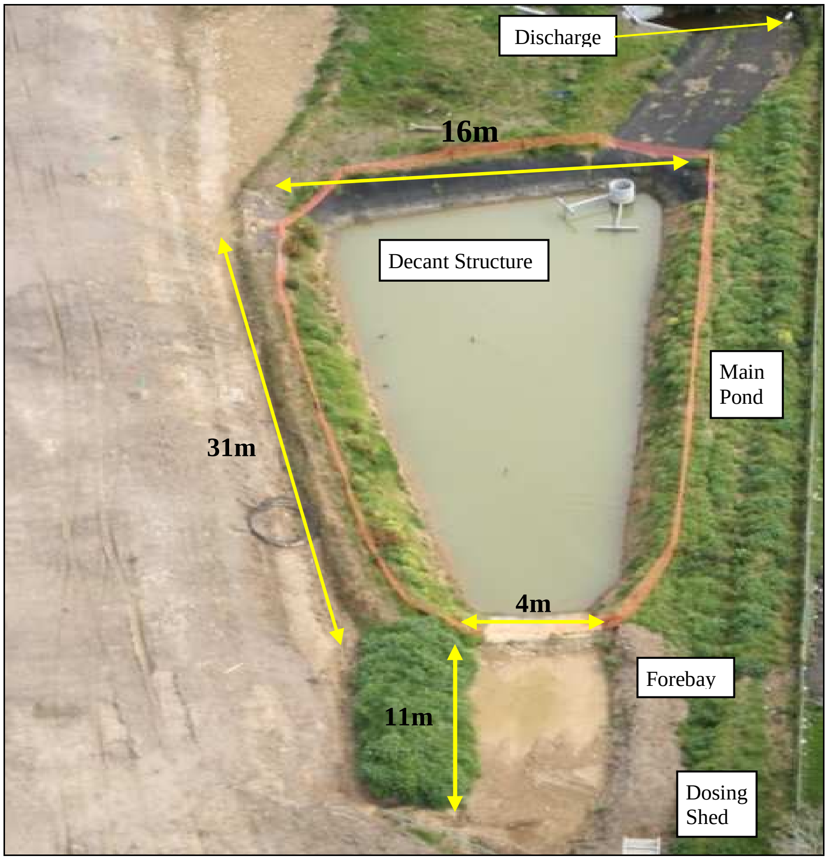


Fig. 3.10: Key features and approximate dimensions of Somerset Road pond (Photo courtesy of Transit, 2006).

3.3.1.2 Inflow

The site was progressively built-up while field investigations were being undertaken. Initially, the motorway surface was level with the pond and water flowed into the pond via an earth channel (Fig. 3.11a). Between December 2006 and February 2007 the road increased in height due to the progressive addition of fill. Upon completion of works, a polyurethane stabilised channel was created (Fig. 3.11b).

Fig. 3.11a: Unstabilised entrance to the Somerset Road pond, November 2006.

Fig. 3.11b: Stabilised inlet to the Somerset Road pond, July 2007.

3.3.1.3 Outflow

Discharge from the pond occurs when the water level rises above the lower decant arm of the dewatering device (Fig. 3.12a). The water then enters a 12m long, 300mm diameter PVC pipe, and discharges to a tributary of the Oakley Creek (Fig. 3.12b). Further details on this tributary are given in Section 3.4.

Fig. 3.12a: View of the decanting structure

Fig. 3.12b: Discharge pipe above the Oakley Creek Tributary

3.3.1.4 Flow Regime

As previously stated, the pond is located below the level of motorway surface, and therefore water flows into the pond under the influence of gravity. Fig. 3.13 illustrates the flow direction of water into the pond. Earth bunds are used to direct runoff towards the pond.

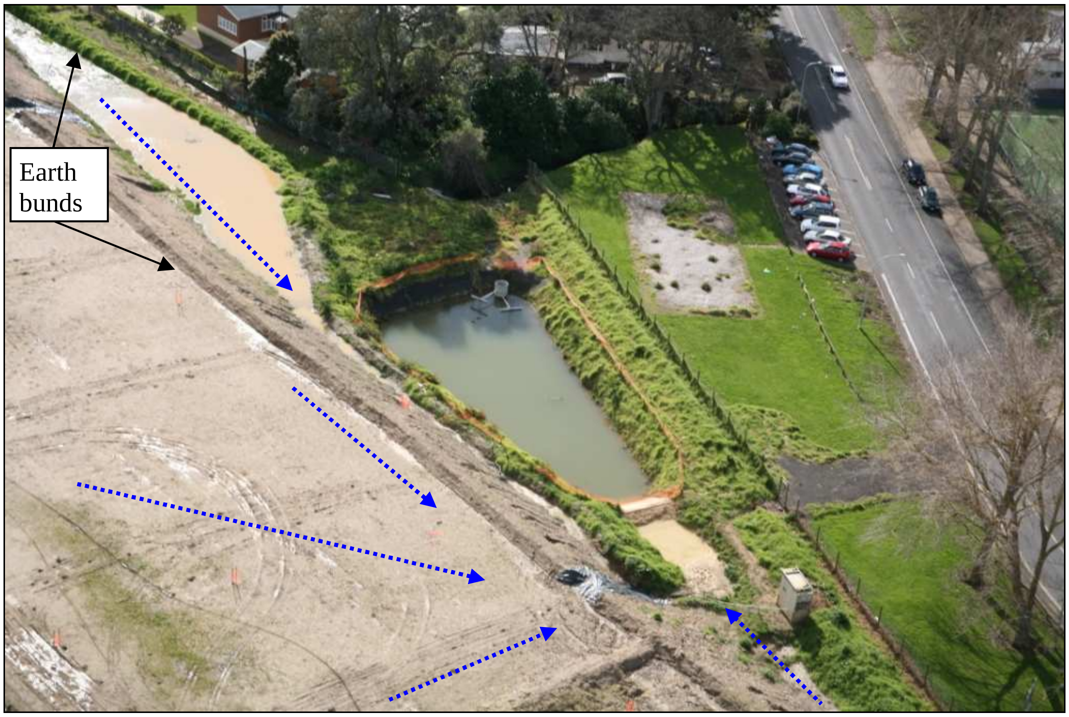


Fig. 3.13: General flow direction towards the Somerset Road pond (Photo courtesy of Transit, 2007).

The contributing catchment for this pond was stabilised for the majority of the sampling period, therefore it can be assumed that only 60% of total rainfall reached the pond as runoff (ARC, 2004b). These reduced runoff levels mean that this pond is characterised by low water levels (Fig. 3.14); the forebay does not always contain water (Fig. 3.15), and the pond does not always discharge following rain events.

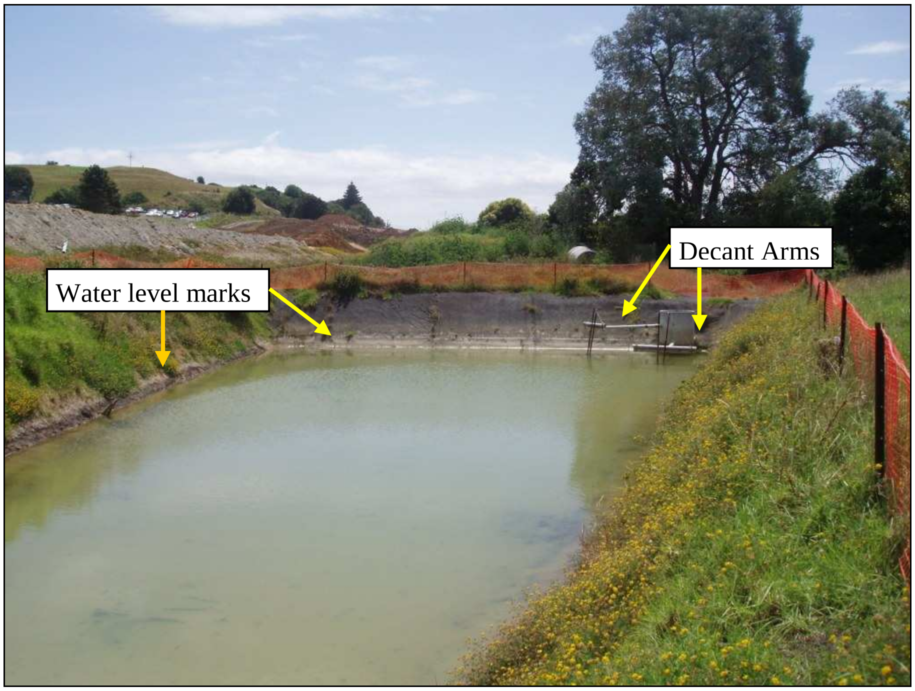


Fig. 3.14: Low water levels in the Somerset Road pond in January 2007. Note the gap between the water level and the decanting arms, and the water level marks on the side of the pond.

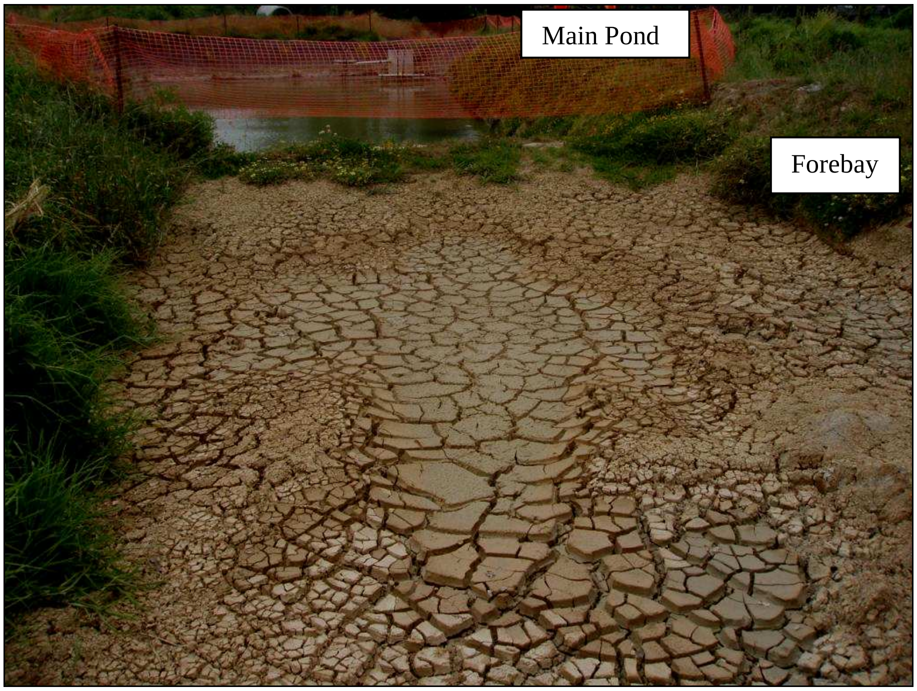


Fig. 3.15: Dry forebay and low water levels in the Somerset Road pond in December 2006.

3.3.1.5 Onsite Works

During the October 2005 - April 2006 earthworks season, ~20,000 m^3 of engineered fill was added to the site above the pond. During the October 2006 - April 2007 season ~50,000 m^3 of engineered fill was added. This was to increase the height of the building platform so that the motorway would meet design specifications. This fill was sourced from an area onsite where cutting operations were being undertaken, and comprised of highly weathered to moderately weathered Waitemata Group deposits.

Following the completion of works in April 2007, the site was mulched and grass seed sown to achieve stabilisation over the winter period (Fig. 3.16a). At the same time, earth bunds were established to divide the motorway site into sections, thus reducing runoff flow lengths and encouraging water to filter down through the ground, rather than flowing to the pond (Fig. 3.16b). This limited the size of the catchment predominately to the area indicated by the centre arrow in Fig. 3.16b.

Fig. 3.16a: Mulch applied to all exposed surfaces areas at the Somerset Road pond to reduce erosion.

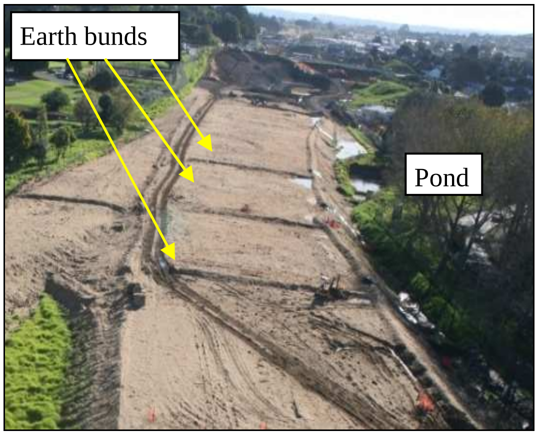


Fig. 3.16b: Earth bunds were used to reduce erosion onsite (Photo courtesy of Transit, 2007).

The Somerset Road pond was chemically dosed with PAC (as outlined in Chapter 2). When earthworks ceased for the winter period, the chemical dosing system was decommissioned (9/05/2007). However it was reconnected several times during large rain events to ensure suspended sediment levels were controlled. Unfortunately no accurate records of when this occurred were made onsite.

3.3.2 Richardson Road Pond

The Richardson Road pond (hereafter referred to as “the pond”) is located at the end of Ernie Pinches Street in Mount Roskill, Auckland (NZ Tranverse Mercator Projection: N 5914495.25 E 1753476.85). Fig. 3.17 shows the pond location, and the route the SH20 motorway extension will take.

Fig. 3.17: Location of the Richardson Road pond (Adapted from Wises Maps, 2008).

3.3.2.1 *Pond Design*

Richardson Road pond is also a 3% pond because it has slopes greater than 10% and longer than 200 m. The contributing catchment for this pond is approximately 2.96 ha (Fig. 3.18), and the total as built storage capacity is 888.31 m^3. The pond is approximately 2 m deep, and is also designed to withstand a 1 in 100 year flood. The key features of the pond are shown in Fig. 3.19.

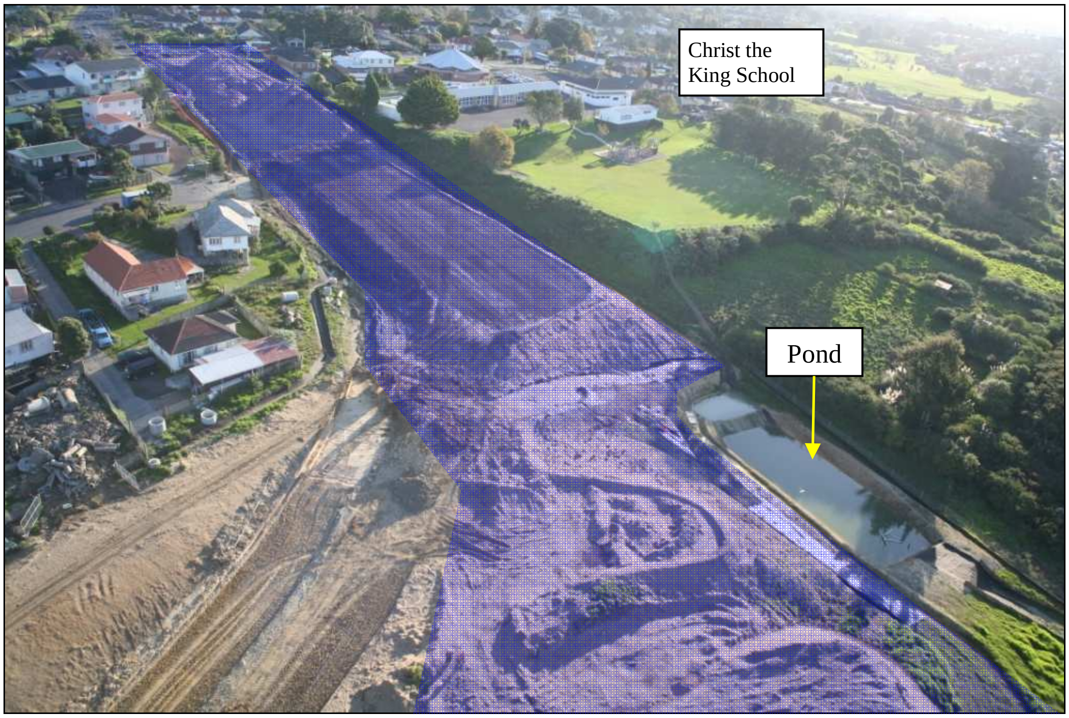


Fig. 3.18: The Richardson Road pond, its catchment (blue) and surrounding landuse (Photo courtesy of Transit, 2007).

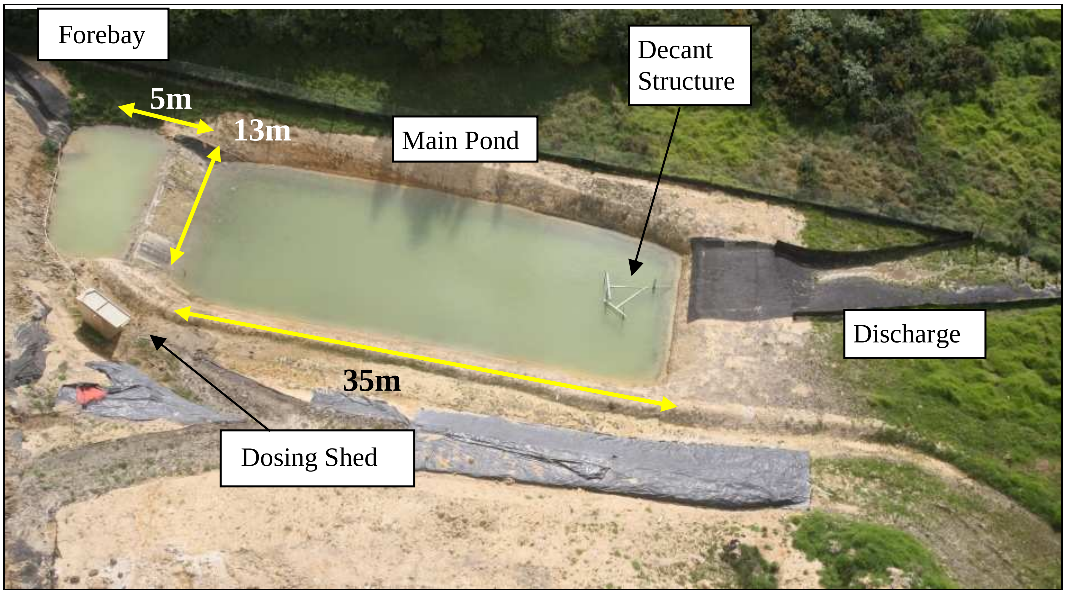


Fig. 3.19: Key features of the Richardson Road pond (Photo courtesy of Transit, 2007).

3.3.2.2 Inflow

Water enters the pond through one of two entrances. The first entrance is through an inlet stabilised with erosion matting which carries water from the site upslope of the pond (Fig. 3.20). This inlet enters the pond in the top corner of the forebay, where the water is dosed with PAC. The second entrance is an earth channel which flows alongside the pond, and enters the forebay on the opposite side to the main inlet. This water does not have PAC added directly to it, and thus relies on mixing within the forebay to ensure adequate dosing (Fig. 3.20). These channels are termed the “runoff flow” and “forebay diversion” channels respectively, for the purpose of this study.

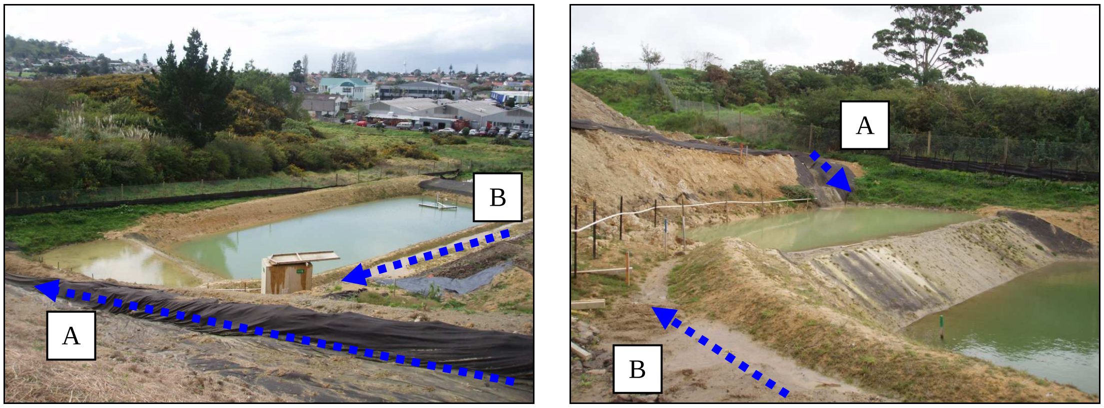


Fig. 3.20: The two inlets to the Richardson Road pond; **A:** Stabilised entrance and **B:** Earth channel.

3.3.2.3 *Outflow*

Discharge from the pond occurs when the water level rises above the lower decant arm of the dewatering device. Water discharges from the pond via a 12 m long, 150 mm PVC pipe; discharge is directly on to erosion matting to ensure the flow of water does not result in further erosion (Fig. 3.21).

Fig. 3.21: Aerial view of Richardson Road pond (Photo courtesy of Transit, 2007), showing the discharge pipe at the end of the pond.

Once water has discharged from the pond, it flows across a vegetated floodplain into a tributary of the Oakley Creek (Fig. 3.22).

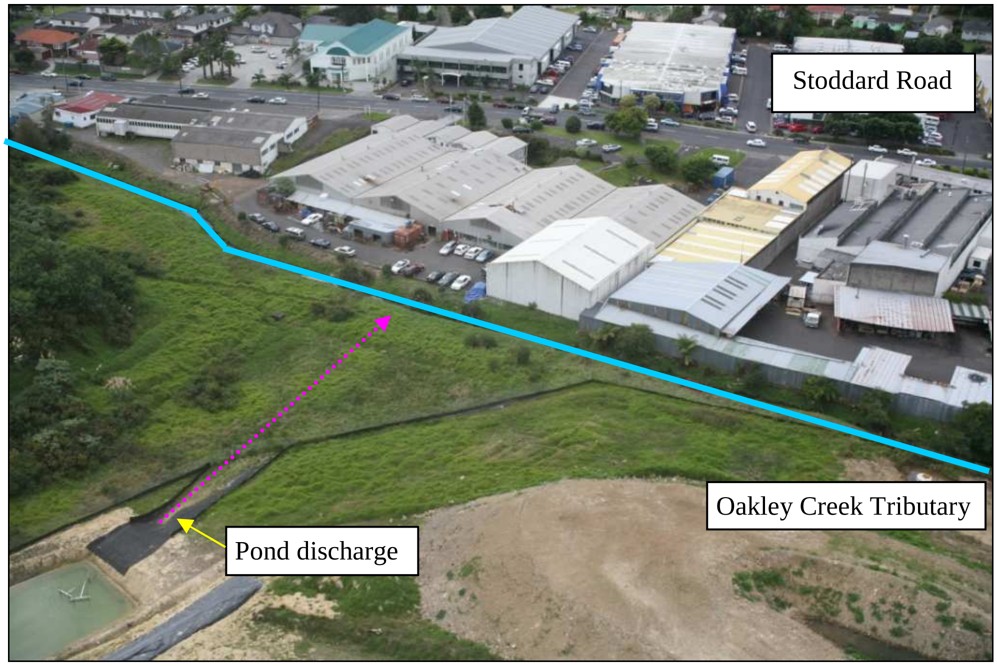


Fig. 3.22: The discharge flow path from Richardson Road pond to a tributary of the Oakley Creek (Photo courtesy of Transit, 2006).

3.3.2.4 Flow Regime

Within the area surrounding the Richardson Road Pond, there is significant groundwater flow. In order to ensure the engineered fill was not undermined by this flow, a drainage blanket was installed upslope of the pond. It is a Bidim geotextile blanket, which is covered by free draining 60 / 20 aggregate, and up to 12m of engineered fill. Water is collected on the blanket, and is then directed into the forebay of the pond (Fig. 3.23).

As previously described in Section 3.3.2.2, water enters the forebay through either the stabilised channel, or the earth channel (Fig. 3.20). Due to the sloping nature of the site, the forebay always contained water, and was generally full enough to be overflowing into the main pond. During rainfall events, the two entrance channels conveyed large volumes of runoff to the pond, and water was often observed pooled alongside the main pond in the earth channel.

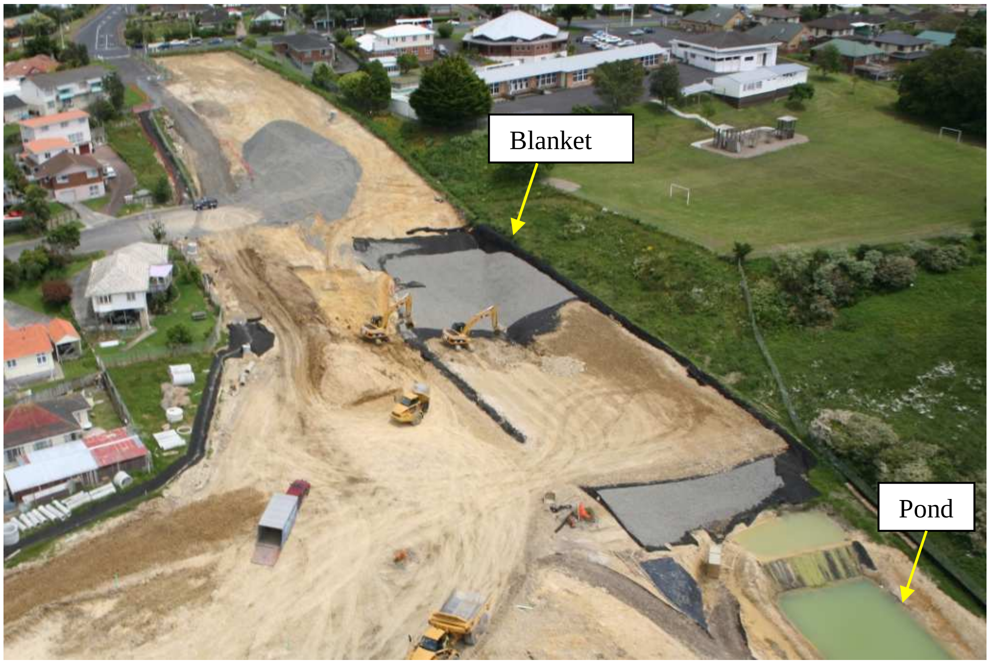


Fig. 3.23: Aerial image of the installation of the drainage blanket (black) upslope of the Richardson Road pond. The aggregate is currently being added (grey) (Photo courtesy of Transit, 2006).

3.3.2.5 Description of works

Approximately 25,000 m^3 of engineered fill was imported to the site between October 2006 and April 2007, and a further 16,000 m^3 is expected to be added between October 2007 and April 2008 to provide the necessary platforms for road construction. This fill was sourced from onsite and comprised highly weathered to moderately weathered Waitemata Group deposits.

3.4. Oakley Creek Tributary

The unnamed stream studied during this investigation originates from a man made lake on the Akarana Golf Course, Mount Roskill (Fig. 3.24I). It has been termed the “Oakley Creek Tributary” here, because it joins the Oakley Creek downstream of the field site (Fig. 3.24H; Fig. 3.26a; Fig. 3.26b).

The stream is approximately 600 m long, 1 – 2 m wide, and less than 1 m deep, and is bounded by the golf course and Keith Hay Park (Figs. 3.24C; 3.25C). From the man made lake, the stream flows for 400 m, before entering a 72 m long culvert beneath the motorway (Figs. 3.24F; 3.25F). It then becomes an open channel for 30 m, and then enters a 10 m long culvert beneath Somerset Road (Figs. 3.24G; 3.25G). The stream flows for a further 100 m before entering the main channel of Oakley Creek (Fig. 3.24H).

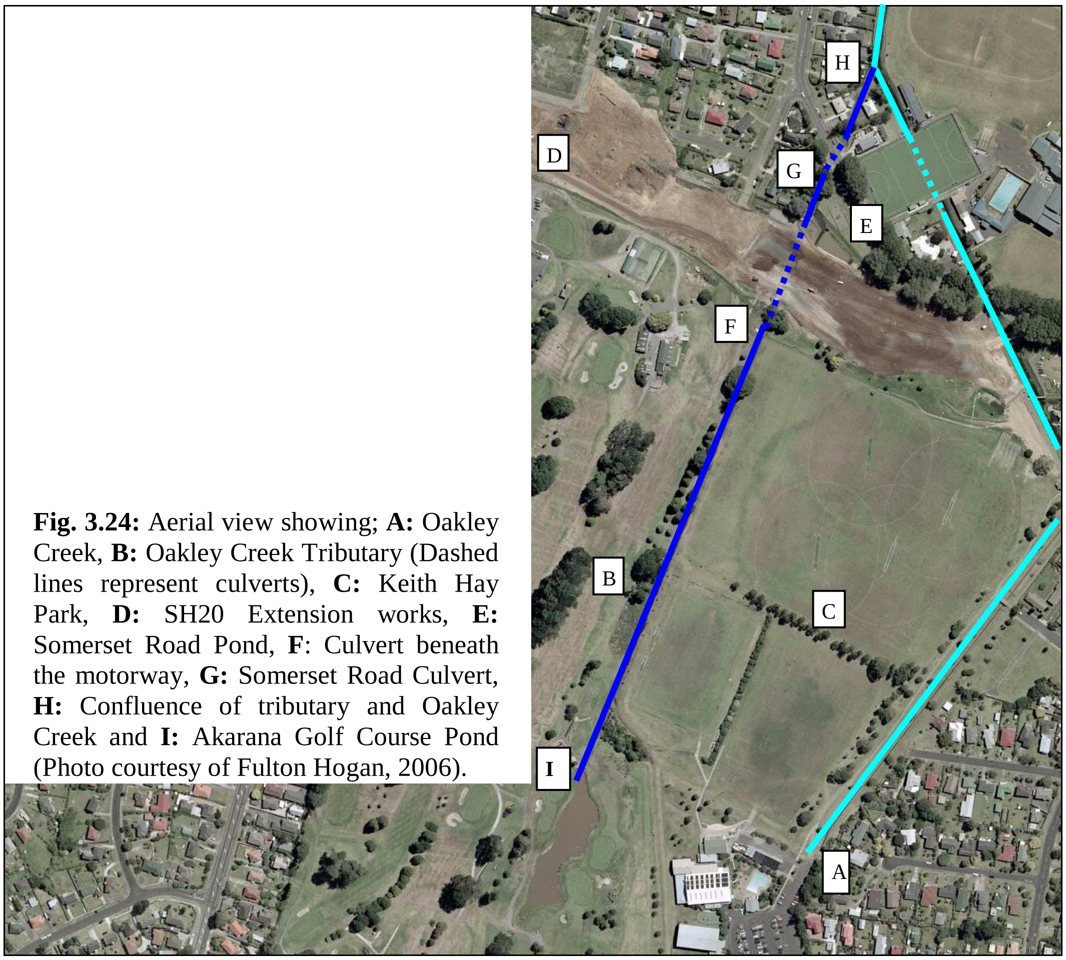


Fig. 3.24: Aerial view showing; **A:** Oakley Creek, **B:** Oakley Creek Tributary (Dashed lines represent culverts), **C:** Keith Hay Park, **D:** SH20 Extension works, **E:** Somerset Road Pond, **F**: Culvert beneath the motorway, **G:** Somerset Road Culvert, **H:** Confluence of tributary and Oakley Creek and **I:** Akarana Golf Course Pond (Photo courtesy of Fulton Hogan, 2006).

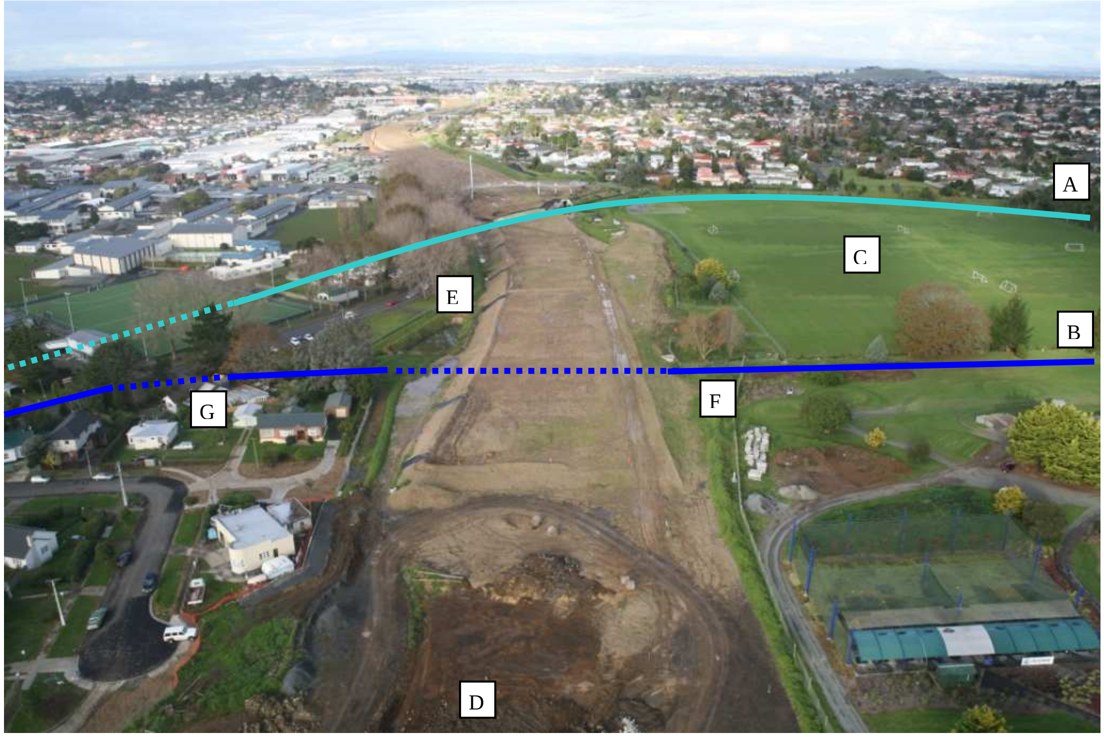


Fig. 3.25: Oblique view of the SH20 Extension looking south-east from Mount Roskill, showing; **A:** Oakley Creek, **B:** Oakley Creek Tributary (Dashed lines represent culverts), **C:** Keith Hay Park, **D:** SH20 Extension works, **E:** Somerset Road pond, **F**: Culvert beneath the motorway, and **G:** Somerset Road Culvert (Photo courtesy of Transit, 2007).

Fig. 3.26a: Oakley Creek Tributary looking upstream towards the Somerset Road pond (not shown).

Fig. 3.26b: Confluence between the Oakley Creek Tributary (A) and the main Oakley Creek (B).

Stark *et al.* (2001) describe soft-bottomed streams as having a low-gradient, where the streambed is dominated by sand, silt, mud and/or clay. Larger substrate such as gravel, cobble, and boulders are generally absent. Macrophytes tend to dominate unshaded streams, and those streams in forested areas often have woody debris, which forms stable habitat for macroinvertebrates. Therefore, the Oakley Creek Tributary is a soft bottomed stream (Fig. 3.27), with several large patches of macrophytes, and often coarse woody debris as the result of overhanging vegetation. The riparian vegetation consists primarily of grass (Fig. 3.28a); however there are several large shade trees along its length (Fig. 3.28b).

Fig. 3.27: Substrate of the Oakley Creek Tributary (Photo courtesy of A. Graettinger, 2006).

Fig. 3.28a: Alligator Weed and Raupo growing in the Oakley Creek Tributary.

Fig 3.28b: Large riparian vegetation overhanging the Oakley Creek Tributary.

3.4.1 Flow Regime

The stream showed clear seasonal variations in water level, with low levels during the summer months (Fig. 3.29a) and much higher levels during winter (Fig. 3.29b). The stream generally had sluggish flows of less than 0.5 ms^{-1}, however during periods of rain, this rate increased to approximately 2 ms^{-1}. This was assessed by measuring the time it took for a tennis ball to travel 1 m.

The major source of water in the tributary is groundwater (which feeds the Akarana Golf Course Lake); however stormwater enters the culvert, and thus the stream, through cesspits on Somerset Road. In addition, upon completion of the project, stormwater will enter the stream through additional pipes beneath the motorway.

Fig. 3.29a: Summer (February, 2007) water levels in the Oakley Creek Tributary.

Fig. 3.29b: Winter (July, 2007) water levels in the Oakley Creek Tributary.

3.4.2 Water Quality

The water quality in the stream is highly variable, with prolific algal growth in summer. In winter, the surface of the stream is covered in leaves, as there are several large oak trees growing on the stream bank, which are deciduous. Rubbish such as empty beer bottles, toys, plastic bags, and polystyrene were often observed in the stream (Fig. 3.30).

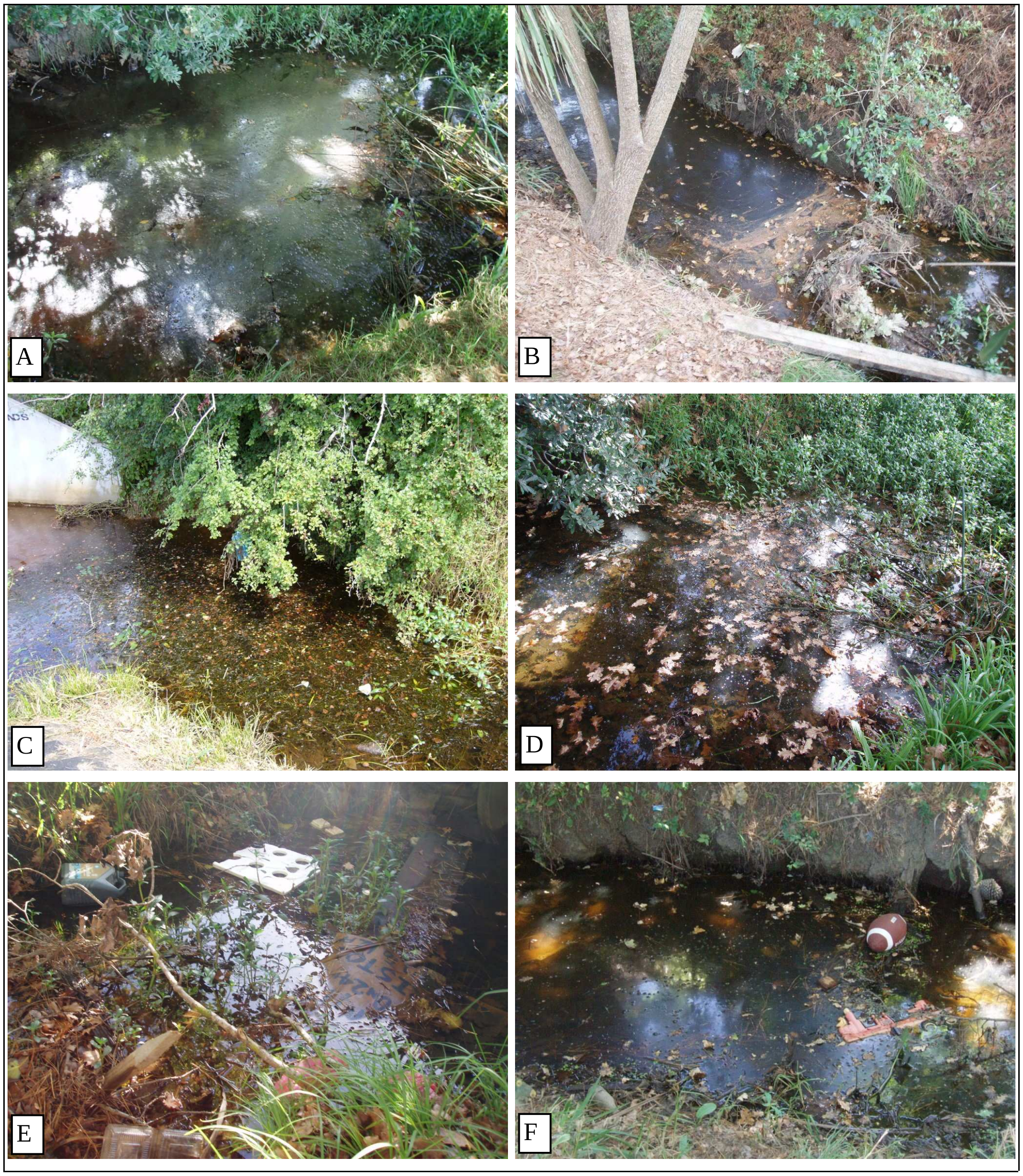


Fig. 3.30: Reduced water quality in the Oakley Creek Tributary due to algal growth (A, B), floating leaves (C, D) and rubbish (E, F).

3.4.3 Aquatic Life

Despite the variable flow and water quality conditions, the stream is home to short-finned eels (*Anguilla australis)* (Fig. 3.31), and countless mosquito fish *(Gambusia affinis)* (Boffa Miskell, 2002).

Fig. 3.31: Short-finned eel in the Oakley Creek Tributary (Photo courtesy of L. Ward, 2007).

Due to the presence of a waterfall approximately 7 km downstream of the Somerset Road pond (Fig. 3.32), a significant natural barrier to migration exists. This barrier excludes all non-climbing native fish, and despite numerous ecological studies, only one banded kokopu has ever been recorded in Oakley Creek upstream of this point (Letter from URS Consultants 2002, ARC files, viewed 14/01/08). In addition, eels are abundant in the Oakley Creek, and therefore any fish which are successful in climbing the waterfall, are at risk of predation (Boffa Miskell, 2002).

Fig. 3.32: View of the Oakley Creek Waterfall and walking track (Photo courtesy of Friends of Oakley Creek, 2007).

3.5. Summary

The SH20 extension project involves approximately 21 ha of earthworks and requires the exposure, placement and compaction of several thousand cubic metres of clay material. Two chemically dosed sediment retention ponds in the SH20 Extension form the basis of this research project. They both discharge to tributaries of the Oakley Creek. The Oakley Creek catchment is largely urbanised.

Chapter 4:
Methodology

4.1 Introduction

Field work involved the collection of water samples from two sediment retention ponds - Somerset Road and Richardson Road- as well as from the nearby Oakley Creek Tributary on a near weekly basis between November 2006 and August 2007. These were analysed for suspended solids levels in the laboratory. A rain gauge was also installed on the roof of the chemical dosing shed at Somerset Road, to record daily rainfall. Stream Ecological Valuations (SEV) including macroinvertebrate samples were undertaken to assess the changes in ecological values within the Oakley Creek Tributary between November 2006 and November 2007 resulting from the SH20 extension works.

4.2 Sample locations

4.2.1 Somerset Road Pond: 1 November 2006 – 12 August 2007

In the Somerset Road pond, samples were collected from two locations within the forebay, as shown in Fig. 4.1 - at the inlet to the forebay (inflow), and close to the level spreader at the end of the forebay (outflow). A sample of the water flowing into the forebay was collected on 10/06/07, and is termed the runoff flow (Fig. 4.1). Samples were collected from three locations within the main pond - labelled as start, middle and end in Fig. 4.1. Marker pegs were used to ensure that samples were collected at the same point each week. Discharge samples were collected from the end of the discharge pipe (Fig. 4.1). Discharge was only sampled seven times (15/11/06, 02/04/07, 11/07/07, 17/07/07, 25/07/07, 01/08/07 and 12/08/07) because the pond level was generally too low to be discharging.

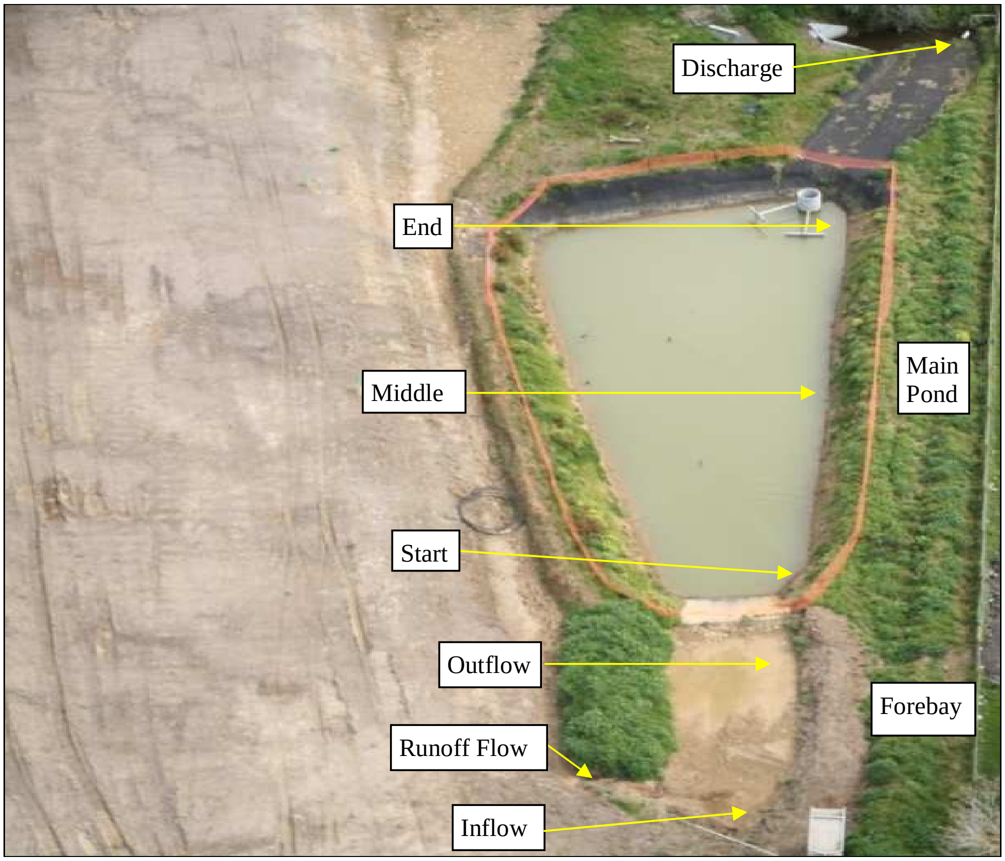


Fig. 4.1: Somerset Road pond, showing the sampling locations (Photo courtesy of Transit, 2007).

4.2.2 Richardson Road Pond: 5 March 2007 – 12 August 2007

Due to the installation of a drainage blanket there was a continuous flow of groundwater into the forebay, and samples of this flow were taken where the groundwater entered the forebay (Fig. 4.2). Samples were collected from two locations within the forebay (Fig. 4.2) - at the inlet to the forebay (inflow) and close to the level spreader at the end of the forebay (outflow). Samples were collected from three locations within the main pond - start, middle and end (Fig. 4.2). Marker pegs were used to ensure that samples were collected at the same point each week. Discharge samples were collected from the outlet of the discharge pipe (Fig. 4.2).

During periods of high rainfall, water ponded alongside the main pond, and ran into the forebay via a constructed earth channel, termed the forebay diversion channel (Fig. 4.2). Samples were collected from this channel just prior to where it entered the forebay. Runoff was also directed to enter the forebay via a channel protected with geotextile, termed the runoff flow to forebay (Fig. 4.2). Samples were collected from here when water was present - this was generally while sampling during, or immediately after, rainfall events.

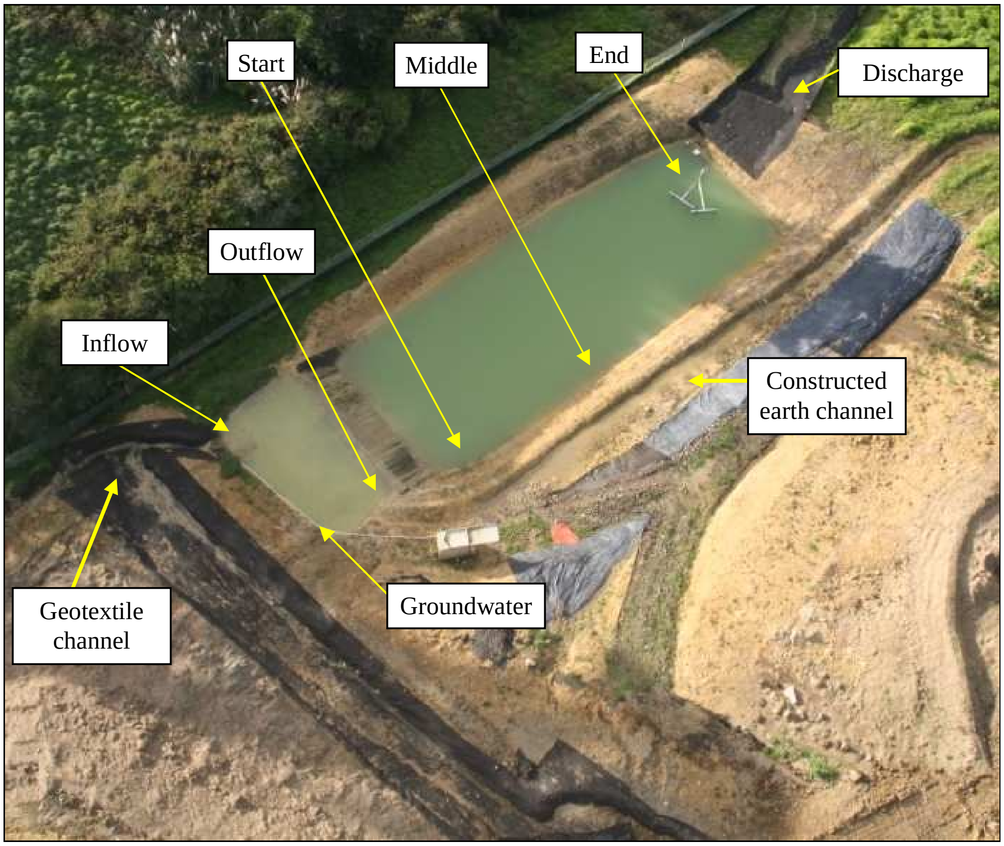


Fig. 4.2: Richardson Road Pond, showing sampling locations (Photo courtesy of Transit, 2006).

4.2.3 Stream Samples: 8 December 2006 –12 August 2007

Samples were collected from 5 points along the Oakley Creek Tributary (Fig. 4.3) - two on the upstream side of the earthworks site, one beside (but upstream of) the discharge pipe, and two downstream of the discharge pipe, one on either side of the culvert beneath Somerset Road. The approximate locations of the samples are given in Table 4.1.

Table 4.1: Approximate New Zealand Transverse Mercator Projection coordinates for the sample locations within the Oakley Creek Tributary

	Approximate Location - New Zealand Transverse Mercator Projection	
Sample Location Name	*Northing*	*Easting*
Upstream A	5913099	1755175
Upstream B	5913254	1755230
Stream	5913382	1755284
Downstream A	5913434	1755306
Downstream B	5913468	1755322

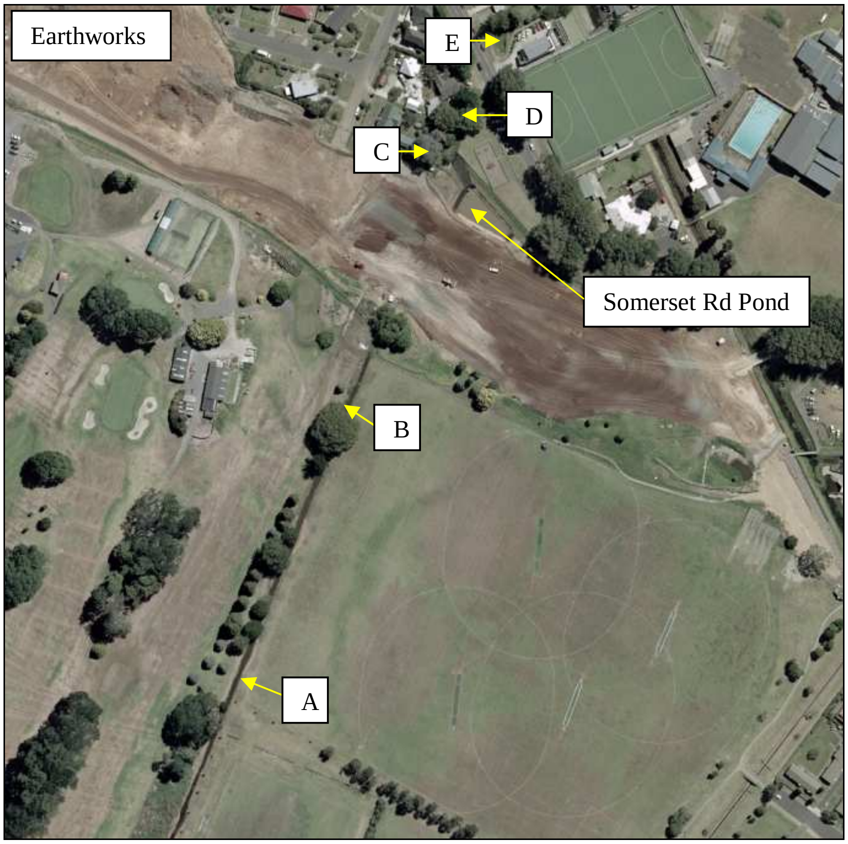


Fig. 4.3: Aerial photo showing the location of sampling points; **A:** Upstream A, **B:** Upstream B, **C:** Stream, **D:** Downstream A, **E:** Downstream B (Photo courtesy of Fulton Hogan, 2006).

The water quality in the Oakley Creek Tributary was often to poor to sample, due to likely contamination by organic matter such as algae (Fig. 4.4).

Fig. 4.4: Poor water quality in the Oakley Creek Tributary.

4.3 Collection of samples on site

This section details the process by which the optimum number of sample replicates was determined and the methods used to collect samples from within the two sediment retention ponds and the Oakley Creek Tributary. It describes the set up and installation of the rain gauge, and outlines the methods used to undertake the SEV assessment and to collect macroinvertebrate samples.

4.3.1 Determination of the optimum sample number

In order to determine the optimum number of sample replicates to collect at each site, ten duplicate samples were collected from the start, middle and end of the Somerset Road pond on 24th November, 2006 (Table 4.2, raw data in Appendix A). The pond was very shallow at this time, and the sampling equipment touched the bottom while collecting replicate 8 from the middle of the pond, thus this sample was not included in the analysis. Likewise, replicate 3 from the end of the pond was not included, as the sample was observed to contain a large amount of vegetation, which would have come from the surface of the pond.

Table 4.2: Average suspended solids results (mg/L) from the 10 replicate sampling run on 24/11/2006.

Location	**Date**	**Replicate Number (results in mg/L)**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Start	24/11/06	1.8	1	0.7	1.1	1	0.9	1.4	2.4	0.2	2.2
Middle	24/11/06	2	1.4	2.1	1.5	1.8	0.4	2	54	1.4	3.1
End	24/11/06	1.2	1.5	9.3	3.5	1.3	2	2	2.2	1.9	1.5

The mean suspended solids (mg/L) and standard deviation of the above sample results were then calculated (Table 4.3), and Equation 4.1 used to determine the optimum sample number to collect:

(Equation 4.1):

$$N = \left(\frac{\underline{\textit{standard deviation (\%)}}}{\textit{standard error}} \right)^2$$

A ‘roundup’ function was used to increase the optimum sample number to the nearest whole number, as it would not be possible to take partial samples. Table

4.3 shows a series of accuracy levels (% above or below the mean) and the number of samples required to achieve this accuracy.

Table 4.3: Determination of the optimum number of samples required to achieve a given accuracy, based on a 10 replicate sample collected on 24/11/2006.

Location	**Mean mg/L**	**Std. Dev**	**Std. Dev (% Mean)**	**Optimum Sample Replicates**						
				5%	**10%**	**20%**	**25%**	**30%**	**40%**	**50%**
Start	1.27	0.68	54	117	30	8	5	4	2	2
Middle	1.74	0.72	42	70	18	5	3	2	2	1
End	1.90	0.69	36	54	14	4	3	2	1	1

From the results of this pilot study, it was decided to collect 4 samples at each location within the Somerset Road pond and the Oakley Creek Tributary. This number was selected because all suspended solids results measured would be within ± 20 - 30% of the actual mean in the pond. Logistically, it would have be difficult to collect higher numbers of sample replicates due to the amount of time it takes to collect and analyse each sample.

In March, the Richardson Road pond was added to the sampling regime, and the decision was made to reduce the number of sample replicates to 3, as there were now up to 20 sample locations (across both ponds and the stream), and this would have involved too much field and laboratory time. As shown in Table 4.3, an accuracy of between 25 - 40% of the mean could be expected for 3 sample replicates.

4.3.2 Pond Samples

Samples were collected using a battery-driven pump attached to a long pole which allowed access to the ponds (Fig. 4.5). The pump was lowered to 100 mm below the water surface, and then connected to a 12 V battery. Water samples were taken at 100 mm water depth to represent the water discharging from the pond, but avoid any floating debris.

Water was allowed to flow through the collection hose for one minute prior to the hose being placed into a sample bottle, thus ensuring there was no cross-contamination from other areas of the pond. At each location, enough water was collected to fill four, and later three, 1L samples bottles. This was to ensure a representative sample was collected, as outlined in Section 4.3.1.

Fig. 4.5: Sample collection using a battery-driven pump (Photo courtesy of L. Ward, 2006).

4.3.3 Stream Samples

The stream samples were collected using a "bucket-on-a-pole" (Fig. 4.6). Three 1L samples were collected at the surface level, as it was not possible to sample below the surface using this equipment. Marker pegs were used to ensure samples were collected from a consistent point each week, however if this spot was covered in floating debris, a sample was collected from the nearest clear patch (Fig. 4.6). This was to ensure the sample was not contaminated.

Fig. 4.6: Sample collection using the "bucket-on-a-pole" (Photo courtesy of E. McElhannan, 2007).

4.3.4 Rain Gauge

Rainfall was measured onsite using a tipping bucket rain gauge (0.2 mm/tip, model Rain-o-matic Professional, Pronamic, Silkeborg, Denmark). This was installed on top of the chemical dosing shed at Somerset Road, as shown below (Fig. 4.7). Rainfall was recorded as 30-minute rainfall totals by a data logger (Model CR200, Campbell Scientific Inc., Logan, Utah, USA) which was stored inside the shed. Data was downloaded from the logger on a weekly basis.

Fig. 4.7: Rain Gauge installed on the roof of the chemical dosing shed at Somerset Road pond.

4.3.5 Stream Ecological Valuation (SEV)

The SEV was developed in 2006, and provides a multi-variable approach to the assessment of the ecological importance of a stream. The 16 most important functions within a stream were determined, and the variables which reflect these functions were identified. These form the basis of the SEV, and are summarised in Table 4.4. The SEV has been adopted as the *best practice* for determining environmental compensation requirements for consent applications (Rowe *et al.*, 2006). The SEV provided an excellent tool for determining the ecological value of the Oakley Creek Tributary, and was used to assess the change in the stream between November 2006 and November 2007.

Table 4.4: Important stream ecological functions, and the assessment factors used in the SEV (adapted from Rowe *et al.*, 2006).

Ecological function	Factors assessed
Hydraulic functions	
Natural flow regime	- extent of stream channel modification - amount of bank erosion - amount of impermeable land within the upstream catchment
Connectivity to the floodplain	- flood plain width - frequency of flooding
Connectivity for species migration	- barriers to migration within the sampled reach - the proportion of the catchment affected by barriers
Connectivity to groundwater	- composition of the stream bed (concrete lining etc)
Biogeochemical factors	
Water temperature control	- amount of shade - water depth - water velocity
Dissolved oxygen maintenance	- dissolved oxygen demand (sediment and plant description)
Organic matter input	- proportion of stream covered by overhanging vegetation - proportion of canopy cover over reach that is deciduous
Instream particle retention	- distance leaf particles travel within the stream - proportion which are retained within the stream
Decontamination of pollutants	- surface area for biofilms (micro-organisms which break down pollutants) to develop on
Flood plain particle retention	- the thickness of vegetation on the floodplain
Habitat provision	
Fish spawning habitat	- available habitat for galaxiids and bullies to spawn
Habitat for aquatic fauna	- instream cover - run / riffle / pool habitat
Fish Fauna Intact	- fish species present
Invertebrate fauna intact	- macroinvertebrate species present
Aquatic biodiversity intact	- comparison of what is present in the stream with what is "expected" to be there
Riparian vegetation intact	- condition of the riparian vegetation

Rowe *et al.* (2006) provides a series of field sheets which must be filled in when undertaking a SEV analysis in order to ensure all factors are adequately assessed. These were used during the assessment of the Oakley Creek Tributary, and are given in Appendix B. Fig. 4.8 shows the section of the Oakley Creek Tributary which was assessed during the SEV.

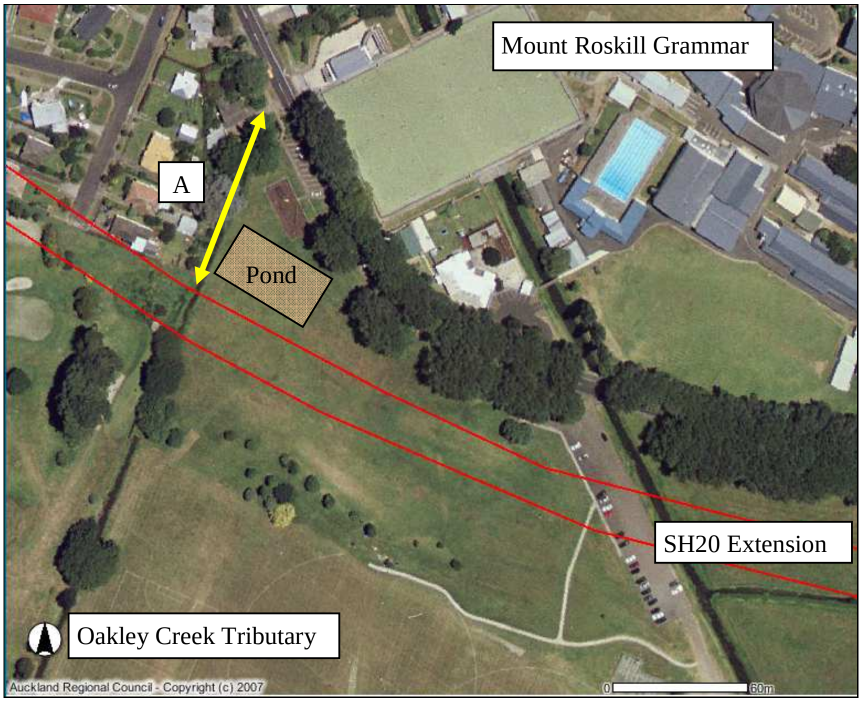


Fig. 4.8: Aerial view of the Oakley Creek Tributary showing the location of the SEV assessment (A) in relation to the Somerset Road pond and the SH20 extension works (Photo courtesy of ARC, 2007).

4.3.5.1 Collection of Macroinvertebrate sample

Macroinvertebrate sampling is required as part of the SEV assessment, and was collected in accordance with Protocol C2 in Stark *et al.* (2001) using a 0.5 mm mesh net. This method involves collecting a composite sample comprised of ten sampling units each with a nominal area of 0.3 m^2, giving a total sampling area of 3 m^2. One sampling unit may comprise a 1 m stream bank, 1m length of wood, or 1m of macrophyte bed (Fig. 4.9). Samples were collected on 1/11/2006, and again on the 2/11/2007 so that an impact assessment could be made.

Fig. 4.9: Macroinvertebrate sampling of the stream bank and woody debris (Photo courtesy of C. McKinnon, 2007).

4.4 Analysis of samples

The following sections outline the methods by which the suspended solids, rainfall, SEV and macroinvertebrate data were analysed.

4.4.1 Suspended solids analysis

Suspended solids analysis was carried out by filtering the water samples using a Buchner Funnel and filtration flask. This method is in accordance with the methodology set out by the American Public Health Association (APHA, 1992). Advantec Glass Fiber GC-50 70 mm filter papers were used for these experiments.

4.4.1.1 Lab equipment

This filtration system operates using the suction created by running water. The filtration flask is connected to a pipe, which in turn is connected to a hose. When the tap is turned on, water flows down the hose, creating a suction effect as it passes the air pipe. A filter paper is placed on the Buchner funnel, and the sample to be filtered added. The water is drawn down into the filtration flask, leaving the suspended solids behind (Fig. 4.10).

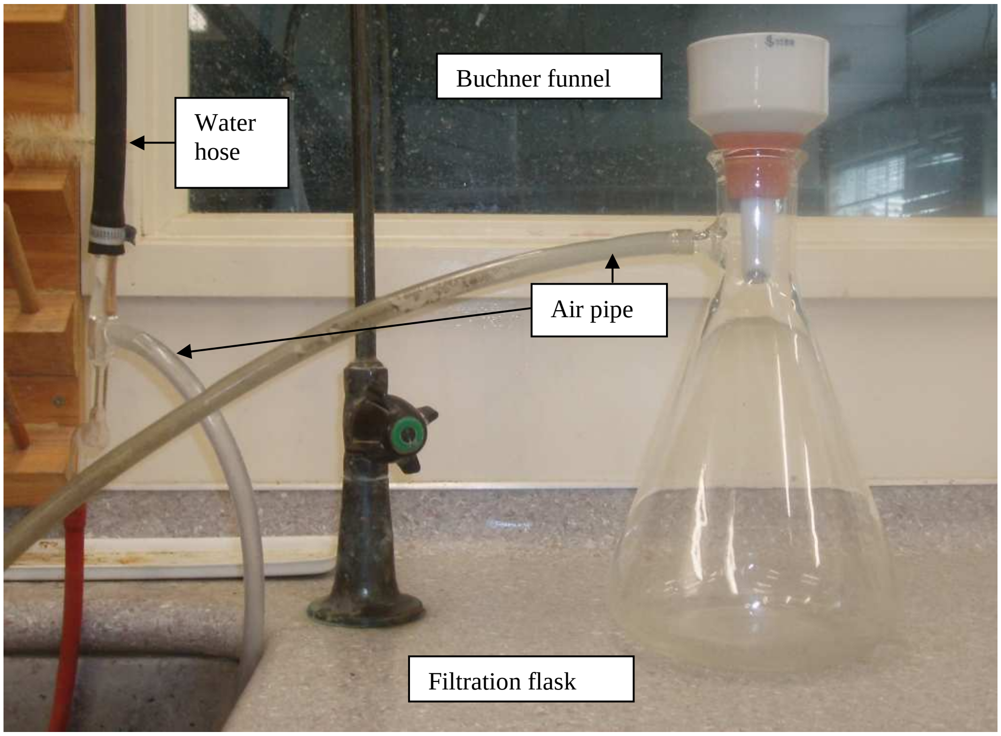


Fig. 4.10: Equipment set up in the lab, including a Buchner funnel and filtration flask.

The following sections outline the methodology by which the samples were analysed.

4.4.1.2 Filter paper prewash and weigh

1) Place a filter paper on the filtering equipment, apply vacuum, and rinse filter paper using 150ml of deionised water;
2) Carefully remove the filter paper and place in an oven proof dish (ceramic crucibles were used in place of inert planchets for these experiments);
3) Dry filter paper in oven at 105ºC for one hour;
4) Take out of oven and place in a dessicator to cool;
5) Weigh each filter paper and record weight (mg)- this is W_b; and
6) Return filter papers the dessicator until needed.

4.4.1.3 Running the sample

Because some of the samples contained high levels of suspended solids, it was decided to divide the 1L samples into two 500ml samples, as the filter papers can only hold small levels of sediment before they become blocked. The test procedure is described below.

1) Set up filtration equipment and place filter paper in equipment. Apply vacuum, and wet the filter paper with distilled water to ensure a tight seal against the Buchner funnel.
2) Mix sample bottle thoroughly by tipping from end to end several times, and pour 500ml into a 1L graduated cylinder;
3) Mix the water in the cylinder with a glass stirring rod, and then filter a known volume (L);
    a. If there is a lot of suspended solids use a small amount of sample (to prevent the filter paper becoming blocked), if not very much then use a larger volume of sample. Aim to use at least 250ml (50% of the sample).
    b. Record volume filtered.
4) Discard the remaining sample (if any), and then rinse the cylinder with a small amount of distilled water and pour onto filter paper.
5) Continue suction until the sample has passed through the filter paper.

6) Squirt a small amount of distilled water around the edge of the Buchner funnel to ensure all suspended solids are rinsed down onto the filter paper
7) Continue suction until filter paper appears dry (usually approximately 30 seconds).
8) Remove any pieces of vegetation or other debris from the filter paper.
9) Carefully take out the filter paper, fold into quarters, and place in an ovenproof dish. Put the dish in the oven at 105ºC for two hours.
10) For the second 500ml of the sample repeat steps 1-9.
11) After two hours, take dishes out of oven and place in dessicator to cool.
12) Weigh each filter paper and record weight (mg)- this is W_a
13) Subtract weight before (W_b) from weight after (W_a) and use Equation 4.2 to get the amount of suspended solids (mg/L):

(Equation 4.2): $$\frac{(W_a - W_b)}{\text{Litres used}}$$

4.4.1.4 *Washing bottles and lab equipment*

Once sampling was completed, the bottles, and other lab equipment were rinsed with tap water, and then filled with detergent and water. The cleaning agent "Cleanaid Powder - Pyrogenically Negative Cleaner", distributed by Global Science, Auckland, was used to rinse the bottles. They were left to soak overnight, and then double rinsed with both tap water and distilled water. They were then allowed to dry prior to being used again.

4.4.1.5 *Statistical Analysis*

Once the lab results had been recorded, they were entered into an excel spreadsheet, and analysed in the following way:

1) The two results from each 1L sample bottle were averaged, giving three results for each location in the pond or stream. These three results were averaged to get one overall result for each location.

2) The standard deviation for the three samples was calculated, and then used to work out the standard error within the three samples.

3) The standard error was calculated using Equation 4.3:

(Equation 4.3):
$$\text{Standard Error} = \frac{\textit{Standard Deviation}}{\sqrt{\textit{Number of samples}}}$$

4) This was then used with the average value as calculated above to give a suspended solids result in mg/L.

These results are presented in Appendix C.

4.4.2 Rain Gauge

As previously stated in Section 4.3.4, rainfall was measured half – hourly onsite. The raw data was converted to text format using Campbell datalogger software, and transferred to Microsoft Excel for analysis. The raw data are presented in Appendix D.

4.4.3 Stream Ecological Valuation (SEV)

Rowe *et al.* (2006) have prepared a Microsoft Excel based spreadsheet for compiling measured data. Once this information has been entered, the ecological score from this data is automatically calculated. These spreadsheets for the Oakley Creek Tributary are presented in Appendix D.

4.4.3.1 Macroinvertebrate Analysis

As previously detailed in Chapter 2, macroinvertebrates are commonly used as a biological indicator for water quality. Several classification systems have been developed to aid in the use of biological monitoring programs within New Zealand, including the Macroinvertebrate Community Index (MCI). The MCI method can be used to rank streams according to their ecological value, as well as to assess spatial or temporal changes within a stream (Stark, 1985). The influences of sampling method, water depth, current velocity and substratum size were assessed by Stark (1993), and found to have no impact on the MCI scoring system, making it a highly robust assessment technique. A brief summary of the development process of the MCI will be given below, as this was the method used in this study to assess changes in water quality.

4.4.3.1.1 Development of the MCI

The MCI was first proposed by Stark (1985), as a derivative of the United Kingdom's Biological Monitoring Working Party (BMWP), to be used for macroinvertebrates living in stony riffles. It ranks macroinvertebrates according to their pollution tolerance, by giving them a score between 1 (pollution tolerant) and 10 (pollution intolerant), thus a stream obtaining a high MCI score has a very low level of pollution (Stark, 1985). These tolerance values were determined by a weighting procedure based on the relative percentage occurrence of taxa at three sites of varying environmental quality (unpolluted, moderately polluted, and very polluted) (Stark, 1985). A table setting out the scores for a large number of species can be found in Stark (1998). Stark and Maxted (2007a) developed a MCI which can be applied to New Zealand's soft bottomed streams, as previous MCIs were designed for hardbottomed streams which have vastly different microhabitats and invertebrate communities. This gives new tolerance scores to the macroinvertebrates commonly found in soft bottomed streams.

The MCI is calculated using Equation 4.4:

(Equation 4.4):

$$\mathrm{MCI} = \frac{\sum_{i=1}^{i=S} a_i}{S} \times 20$$

Where S = the total number of taxa in the sample, and a_i is the tolerance value for the *i*th taxon, and 20 is a scaling factor (Stark, 1985).

The quantitative MCI (QMCI) was developed for those situations where a simple presence/ absence scale (such as the MCI) would not suffice. For example, when assessing the longitudinal changes along a stream, similar species lists may be obtained from each site, but there may be changes in percent species composition, which would not be reflected in the MCI. This is overcome in the QMCI by calculating the score for each taxa, then scaling this as a portion of the overall sample using Equation 4.5:

(Equation 4.5): $$\text{QMCI} = \sum_{i=1}^{i=S} \frac{(n_i \times a_i)}{N}$$

Where S = the total number of taxa in the sample, n_i is the number of individuals for the ith scoring taxon, a_i is the tolerance value for the ith taxon, and N is the total number of individuals in the entire sample (Stark, 1985).

The semi-quantitative MCI (SQMCI) was developed to reduce the cost of collecting multiple macroinvertebrate samples, and uses a five-point scale of coded abundances (Rare; Common; Abundant; Very Abundant; Very, Very Abundant) (Stark, 1998). The SQMCI is also calculated using Equation 4.6 except that coded abundance scores are substituted for abundances (n) and N is the total of the coded abundances for the entire sample (Stark and Maxted, 2007b).

In 2001, Stark *et al.* produced a standardised set of protocols for sampling macroinvertebrates in wadeable streams within New Zealand, which is designed to be used by regional councils and other interested parties for the purpose of State of the Environment (SOE) monitoring, Assessment of Environment Effects (AEE) for resource consent applications, as well as for resource consent compliance monitoring. This document provides four collection protocols; two each for hard and soft bottomed streams. There is a quantitative and semi-quantitative method, so that the collection process can be tailored to the specific needs of the study. The quantitative method involves a full count of macroinvertebrates from a known area in the stream. This allows the density of organisms to be estimated (e.g. number per m^3), and accurate percentages of community composition to be determined. Semi-quantitative methods consist of either a fixed count or coded abundance sample. A fixed count sample involves counting a pre-determined number of organisms (e.g. 100, 200), and provides a good estimation of percentages of community composition. Coded abundance gives an approximation of the actual abundance of individual taxa within the stream, by placing each species into an abundance category such as rare, common, and so on (Stark *et al.*, 2001). This is based on the SQMCI developed by Stark (1998).

4.4.3.1.2 Sample processing

The two macroinvertebrate samples collected during this investigation were analysed in accordance with Protocol P3 of Stark *et al.* (2001), as this is the recommended method for impact assessments where the anticipated impact is a change in macroinvertebrate densities.

1) The sample was placed into a white sorting tray and leaves and other large debris were removed from the tray. These items were carefully checked to ensure no macroinvertebrates remained and placed in a jar containing 70% ethanol for storage.
2) After the large items were removed, a scan for macroinvertebrates was undertaken, working systematically across the tray. Each individual was removed from the tray and placed into a petri dish containing 70% ethanol for later identification
3) Once all taxa had been removed, the remaining sample was placed in the jar with the large items, and labelled for storage.
4) The macroinvertebrates were identified using Winterbourn *et al.,* 2006, and an overall tally of each species made.
5) Following identification, they were placed in a vial containing 70% ethanol to ensure they remained preserved.

4.4.3.1.3 Sample analysis

Samples were analysed using both Equations 4.4 and 4.5 to obtain MCI and QMCI scores for the Oakley Creek Tributary in 2006 and 2007.

4.5 Summary

During the course of this investigation, suspended solids samples were collected from the Richardson Road and Somerset Road sediment retention ponds. Rainfall measurements were recorded using a datalogger, and a SEV and macroinvertebrate analysis undertaken to provide an assessment of impacts on the Oakley Creek Tributary as a result of the SH20 extension works

Chapter 5:
Results

5.1 Introduction

This chapter presents the data collected during the course of the study, and includes the precipitation data; the suspended solids data collected in the Somerset Road and Richardson Road sediment retention ponds, and in the Oakley Creek Tributary; and the results of the Stream Ecological Valuation surveys and the macroinvertebrate samples undertaken in the Oakley Creek Tributary.

These results are presented and summarised in the following sections, and will be discussed and interpreted in Chapter 6.

5.2 Precipitation

As previously described in Chapter 4, an automatic tipping-bucket rain gauge was installed on the roof of the Somerset Road chemical dosing shed on 08/02/07. Prior to the installation of this gauge, rainfall information was sourced from NIWA's Climate Database (NIWA, 2008). The rain gauge installed onsite made half hourly rainfall measurements; the complete rainfall data set is presented in Appendix D. Table 5.1 provides daily and monthly totals of these rainfall measurements.

During the study period, the recorded monthly rainfalls ranged from a minimum of 10.4 mm in February to a maximum of 160.0 mm in July (Fig. 5.1). Table 5.2 presents the average monthly rainfall from 1971 to 2000 at the Mount Albert Research Centre (Owairaka), which is located at approximately NZTM 5915717N 1753861E. This is 3.2 km (as the crow flies) from the Somerset Road Pond and approximately 1.4 km from the Richardson Road Pond (NIWA, 2008).

Table 5.1: Daily rainfall between November 2006 and August 2007.

	Month, 2006		Month, 2007							
Day	**Nov** [a]	**Dec** [a]	**Jan** [a]	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
1	0	3.6	0.40	0	0	0.4	0.6	0	6	2.4
2	0	1.6	0	1.4	0	0.4	0.8	3.6	8	5.4
3	0	0	0	0	0	0	2.4	3.4	0.8	0.4
4	0	0	0	0	0	0	0	2.6	11	12.2
5	0	0	0	0	0	0	0	0.4	2.2	0.4
6	0	0	0	0.8	0	0	0	2.2	29.4	2.4
7	2.8	0	0	1.6	4.6	0	0	2.6	11.6	10.2
8	18.6	2	0	0.6	0.2	0	0	0.4	2.6	0.6
9	2.4	12.4	6.2	0	0	0	0	0.6	0.6	0
10	1	0.2	6	4	0	2.4	0	5.8	8.2	0.8
11	0	0	0	0	0	0.2	0.2	1.4	2.2	0
12	0.4	0	7.6	0	46	11.8	1.8	2.4	0	11.2
13	3.4	0	11.4	0	6.8	7.8	0	2.6	0	0.8
14	0	0	2	0	15.6	2.2	0.4	0	0	0.2
15	15.2	0	0	0	1.2	1	0.2	0	0	0
16	2	0	0	0.6	1.4	1.6	0.4	0	16.8	7.8
17	0	1.6	0	0	0	1	1.8	0	0.8	14.4
18	8.4	4	0	0	1.2	0	0	0	0.2	5.2
19	2.4	4.6	0	0	0	0	0	0	0	0.6
20	0	8.8	0.4	0	0	0	0.4	5.8	1	0.8
21	0	0.2	0	0	0	0	1.4	2.4	15.6	0
22	0	0	0	0	0.8	0	0.2	9	1.6	0.6
23	0	2.6	0	0	0	0	4.2	4.6	0	0
24	0.8	0	0	0	0	0	0.2	0.2	0.2	0
25	0.2	0	0	0	0	0	1.6	8.4	2.2	0.6
26	0	0	0	0	0	0	1.8	1.6	2.4	0
27	10.2	3.8	0	1.2	0	0	0	0	2.2	5
28	0	0.2	14.4	0.2	6.6	15.2	0	0	0	8
29	0	0	7		22.6	7	0	3.6	26	0.2
30	12.6	1	4.4		9	7.8	0	7.2	5.2	0.2
31		0.6	0		0.4		0		3.2	0
Total	**80.4**	**47.2**	**59.8**	**10.4**	**116.4**	**58.8**	**18.4**	**70.8**	**160.0**	**90.4**

[a] Source: NIWA (2008).

Auckland received 1096 mm of rainfall in 2007, which was 12% below the long term annual average (NIWA, 2008). All months between November 2006 and August 2007, excluding March and July 2007, received less rainfall than the long term monthly average. February 2007 and May 2007 had the greatest reduction in rainfall (by 54.8 mm and 68.5 mm respectively). In Auckland, the “earthworks season” is from October 1st to April 30th, as these are generally the months with the lowest rainfall (ARC, 1999). However as shown in Fig. 5.1, there was a large volume of rainfall in March 2007 (116.4 mm), which was 23% (22 mm) above the long term monthly average. The rainfall in July 2007 was 10% (13.9 mm) higher compared with the long term monthly average.

Table 5.2: Comparison of the 2006 – 2007 rainfall data for the Somerset Road Pond with the long term monthly average rainfall (mm) recorded at Owairaka between 1971 and 2000.

Month	Long term monthly average [a] (mm)	Somerset Road (mm)	Difference (mm)	Difference (%)
Jan	74.8	59.8 [a]	-15	-20%
Feb	65.2	10.4	-54.8	-84%
Mar	94.4	116.4	22	23%
Apr	105.3	58.8	-46.5	-44%
May	102.7	18.4	-84.3	-82%
June	139.3	70.8	-68.5	-49%
July	146.1	160	13.9	10%
Aug	121	90.4	-30.6	-25%
Sep	115.9	Not measured		
Oct	91.3	Not measured		
Nov	92.6	80.4 [a b]	-12.2	-13%
Dec	91.1	47.2 [a b]	-43.9	-48%
Annual	1239.7	1096 [a]	-143.7	-12%

[a] Source: NIWA (2008); [b] Recorded in 2006.

Fig. 5.1 shows that February 2007 had the lowest rainfall (10.4 mm), followed by May 2007 (18.4 mm). The highest rainfall of the year was in July (160 mm; Fig. 5.1), and March had the second highest rainfall (116.4 mm). Therefore these two months will be considered in additional detail.

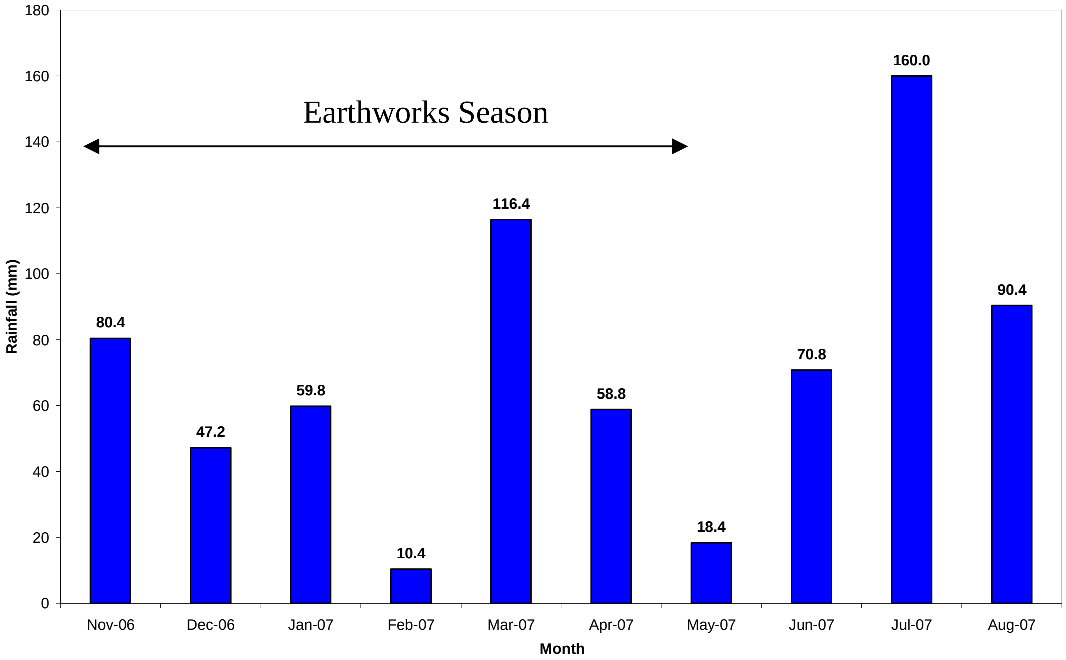


Fig. 5.1: Total Monthly Rainfall (mm) recorded at Somerset Road between November 2006 and August 2007.

5.2.1 Precipitation in March 2007

March 2007 had 116.4 mm of rainfall, the second-highest monthly rainfall recorded during the study (Fig. 5.1). There were two clear rainfall events in March: the first between the 12th and 16th and the second between the 28th and 30th (Fig. 5.2).

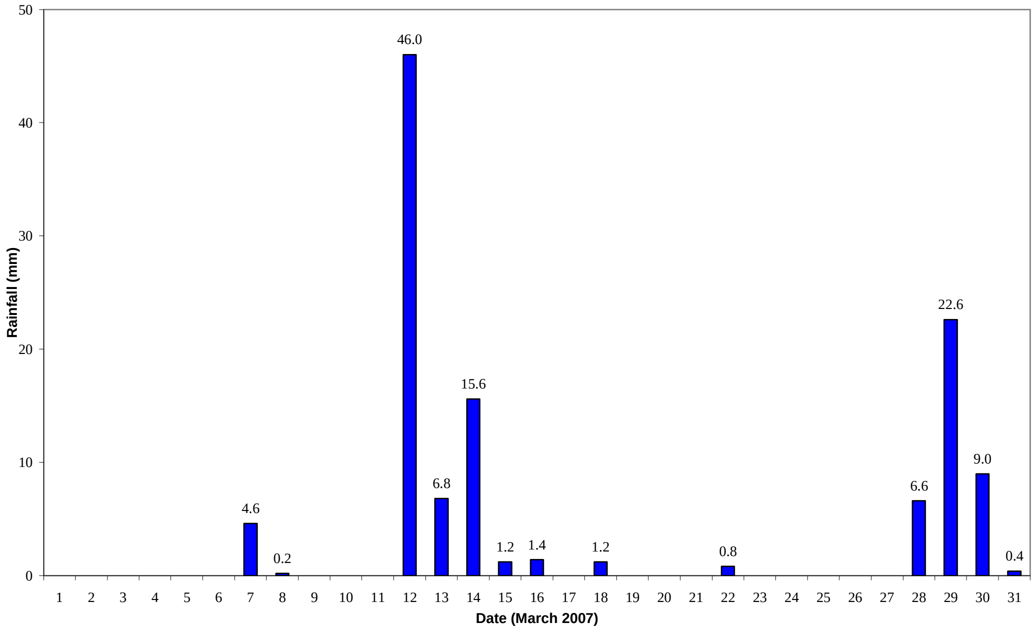


Fig. 5.2: Daily Rainfall (mm) recorded at Somerset Road in March 2007.

There was 71 mm of rainfall during the first event, of which more than half (46 mm) fell on 12/03/07 (Fig. 5.2). On this day, there was over 40 mm of rainfall between 9 pm and 10 pm (Fig. 5.3), which is more rain in an hour than fell in the months of February and May combined (28.8 mm). This amount of rainfall in such a short time period would have quickly exceeded the infiltration capacity of the soil, and resulted in runoff to the ponds. Because March was preceded by a very dry February, with only 10.4 mm of rainfall, the soils within the catchments would have been very dry; however little water is likely to have infiltrated, as at this time fill was being added to the site, and then compacted to achieve a flat surface. On the 16/03/07 it was observed that the forebays at both Somerset Road and Richardson Road contained large volumes of sediment as the result of significant erosion and transportation by runoff.

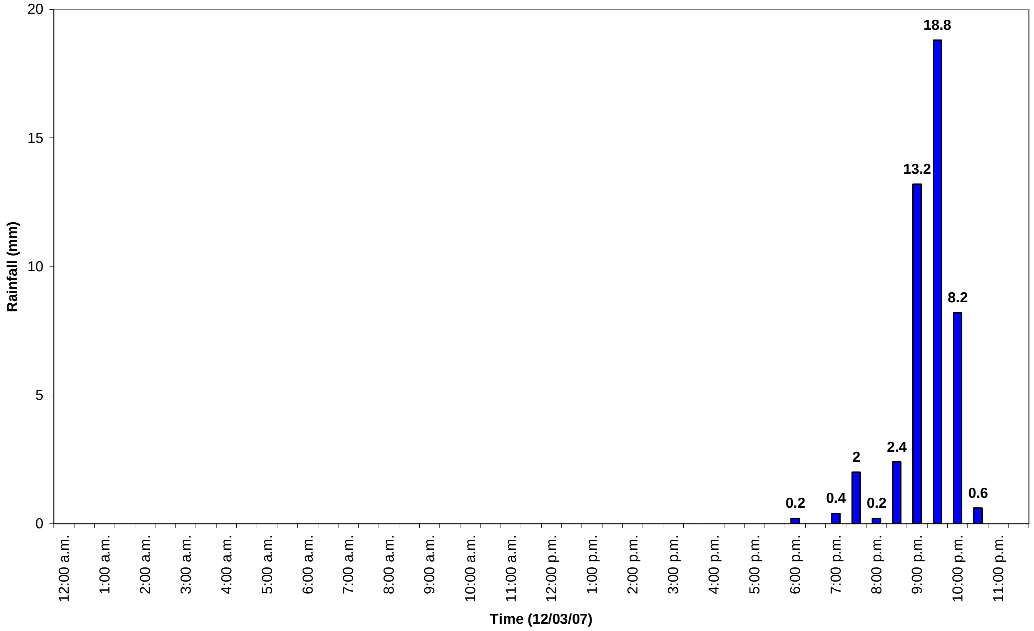


Fig. 5.3: Half - hourly rainfall on 12/03/07 recorded at Somerset Road.

The second rainfall event involved 38.6 mm of rainfall. There was no single high intensity period; rather the majority of rainfall fell between 6pm on 28/03/07 and 5am on 30/03/07, with 22.6 mm falling on 29/03/07 (Fig. 5.4). The infiltration capacity of the soil onsite was exceeded, and considerable runoff occurred as indicated by elevated water levels in the forebays and main ponds at both sites.

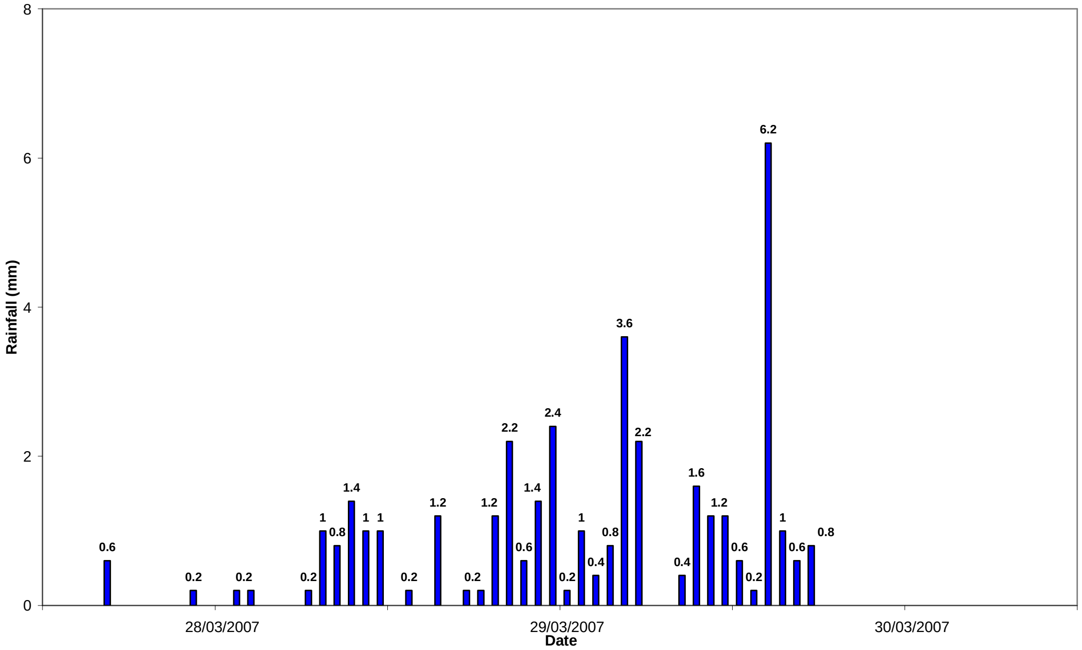


Fig. 5.4: Hourly rainfall between 28/03/07 and 30/03/07 (Note that the date is marked at 12pm).

5.2.2 Precipitation in July 2007

July had the highest recorded rainfall during the study period (160 mm), with 24 days experiencing rainfall, and an average of 6.67 mm / day. There was a period of continuous rainfall between 29/06/07 and 11/07/07, with 93.4 mm falling (Fig. 5.5). As June had a relatively high level of rainfall, the soils onsite are likely to have been wet, and this amount of rain is likely to have resulted in significant amounts of runoff to the ponds in a short period of time. In addition, because the rainfall in July was spread across a number of days, it is likely that the soil remained wet for the majority of the month, and therefore had a low infiltration capacity, resulting in relatively high volumes of runoff. However, as the worked surfaces around both retention ponds had been stabilised with mulch, it can be expected that both runoff volumes and suspended solids levels would be reduced, compared with when the site was being worked.

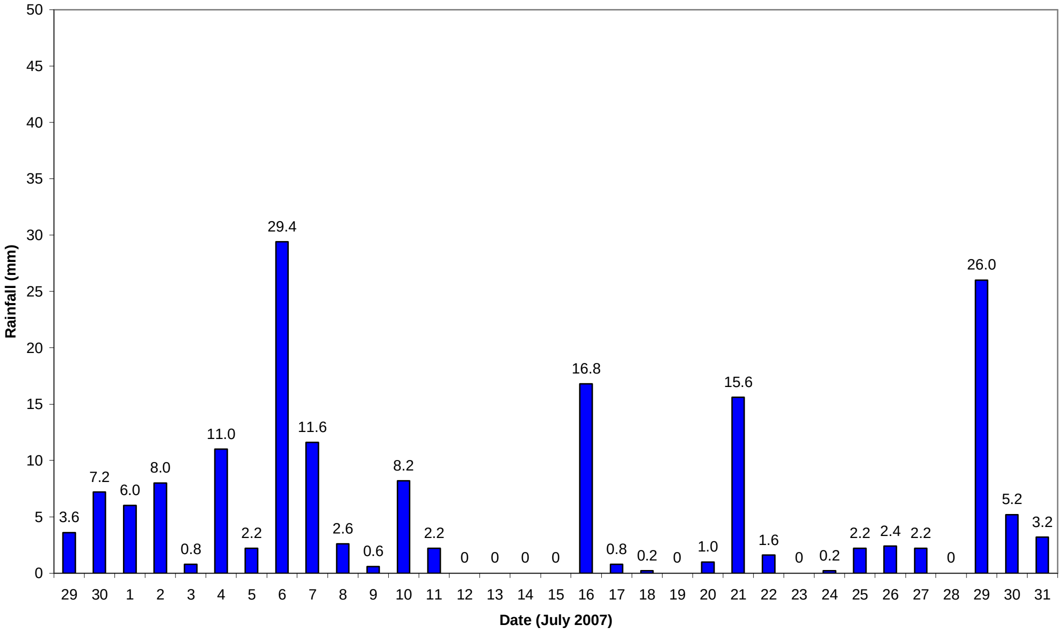


Fig. 5.5: Daily rainfall in July 2007; includes 29/06/07 and 30/06/07 as they were part of the rainfall event.

5.3 Sediment Retention Ponds

Suspended solid measurements were made in the Somerset Road retention pond over a ten month period from November 2006 until August 2007, and in the Richardson Road retention pond over a six month period between March 2007 and August 2007. A total of 957 samples were collected over the course of the investigation, of which 359 were collected from the Somerset Road pond, 404 from the Richardson Road pond, and 191 from within the Oakley Creek Tributary.

The samples were analysed for suspended solids in the laboratory, and the results are presented in Appendix C.

5.3.1 Somerset Road Sediment Retention Pond

This section presents the monthly average suspended solids values collected in the Somerset Road pond, and includes analysis and comparison of the results in the forebay, main pond and discharge.

5.3.1.1 Suspended solids overview

Table 5.3 presents monthly averages (mg/L) and standard error (mg/L) of suspended solids in the Somerset Road pond between November 2006 and August 2007.

Table 5.3: Suspended solid monthly averages (mg/L; $\bar{x}$) and standard error (mg/L; S_E) by location in the Somerset Road pond between November 2006 and August 2007 (Where FB = Forebay, MP =Main Pond. A '-' indicates no standard error due to the collection of only one sample. A blank indicates that the sample was not taken, due to no flow).

	Nov-06		**Dec-06**		**Jan-07**		**Feb-07**		**Mar-07**		**Apr-07**	
	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E
Runoff flow to FB												
FB Inflow												
FB Outflow	234.67	-	263	23.26					9.87	0.21	32.89	6.76
MP Start	1.47	0.28	1.50	0.20	0.15	0.08	3.43	0.82	25.55	7.95	4.59	0.96
MP Middle	1.74	0.24	0.98	0.08	0.27	0.05	2.90	0.66	24.23	8.13	4.01	0.78
MP End	3.03	0.69	1.01	0.14	0.42	0.09	3.85	1.29	26.19	8.48	4.68	0.85
Discharge	1.70	-									4.67	0.33

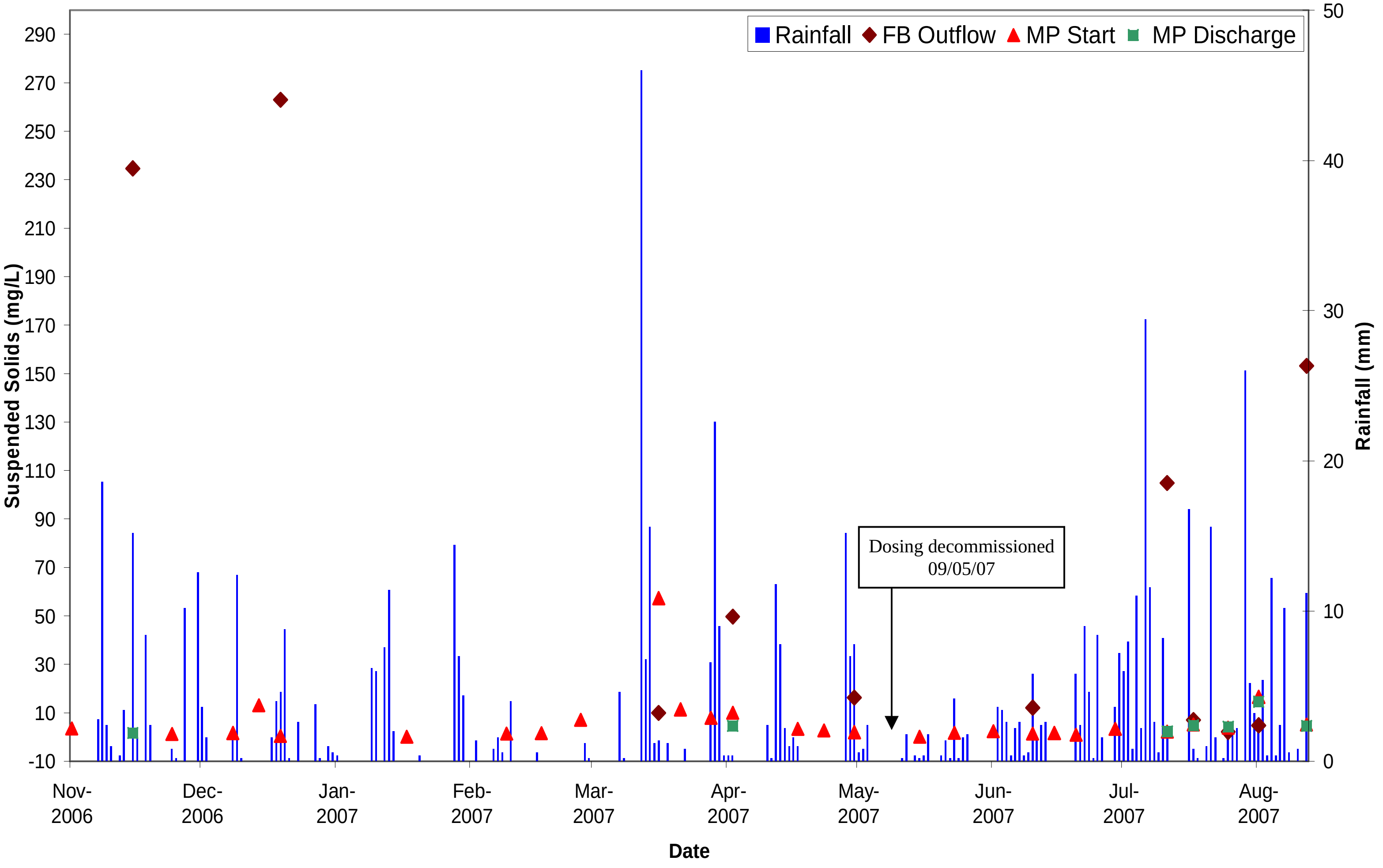
	May-07		**Jun-07**		**Jul-07**		**Aug-07**		**Total Period**	
	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E
Runoff flow to FB			13.34	0.84					13.34	0.84
FB Inflow					64.11	18.34	71.77	29.24	67.94	3.83
FB Outflow			12.15	0.58	16.87	6.67	78.97	33.23	92.63	11.78
MP Start	1.80	0.13	1.94	0.24	3.76	0.44	10.87	2.63	5.51	2.42
MP Middle	0.88	0.22	1.75	0.12	3.51	0.31	10.11	2.42	5.04	2.31
MP End	0.91	0.20	1.90	0.18	3.94	0.39	9.93	2.19	5.59	1.45
Discharge					3.78	0.42	9.64	0.54	3.70	0.70

During the sampling period, the highest levels of suspended solids at the Somerset Road pond were in the forebay inflow and outflow (an average of 67.94 ± 3.83 mg/L and 92.63 ± 11.78 mg/L respectively), with the highest value (234.67 mg/L) recorded in November 2006. The main pond values were considerably lower than the forebay over the total period; the highest levels in the main pond were in March 2007, and the lowest in May 2007. The suspended solids values in the discharge were generally the lowest measured (average of 3.70 ± 0.7 mg/L for the entire sampling period); the discharge was highest in August 2007 (9.64 ± 0.54 mg/L) and lowest in November 2006 (1.70 mg/L).

Fig. 5.6 shows the daily rainfall (mm) and suspended solids (mg/L) values measured in the Somerset Road pond between November 2006 and August 2007. Only the forebay outflow, main pond start and the main pond discharge are shown here to ensure clarity on the graph; these are considered to be representative of the sampling locations within the pond. These locations will be described separately in the following sections.

5.3.1.2 Forebay

This section details the observations made while onsite undertaking sampling, and presents the suspended solids results for the forebay inflow and forebay outflow. Initially, a description of the flow regime to, and within, the forebay will be provided to establish the reasons behind some of the trends in the data. This will be followed by a detailed analysis of the suspended solids values recorded in the forebay outflow, and a comparison of these levels to those recorded in the forebay inflow.



Dosing decommissioned 09/05/07

Fig. 5.6: Daily rainfall (mm) and suspended solids (mg/L) values as measured in the Somerset Road pond between November 2006 and August 2007. (FB = Forebay, MP = Main Pond).

5.3.1.2.1 Flow Regime

Due to an accumulation of sediment at the entrance to the Somerset Road forebay, water would often pool in the lower “outflow” portion of the bay, while the upper “inflow” end would remain dry (Fig. 5.7). This is because when sediment was manually removed from the forebay in February 2007, only the lower (outflow) portion was dug out, creating a dip towards this end. Overall, 11 samples were collected from the forebay outflow (Fig. 5.7), and only 4 from the forebay inflow between November 2006 and August 2007. ‘Inflow’ and ‘Outflow’ refer to the position of samples within the forebay, rather than samples of water flowing into or out of the forebay.

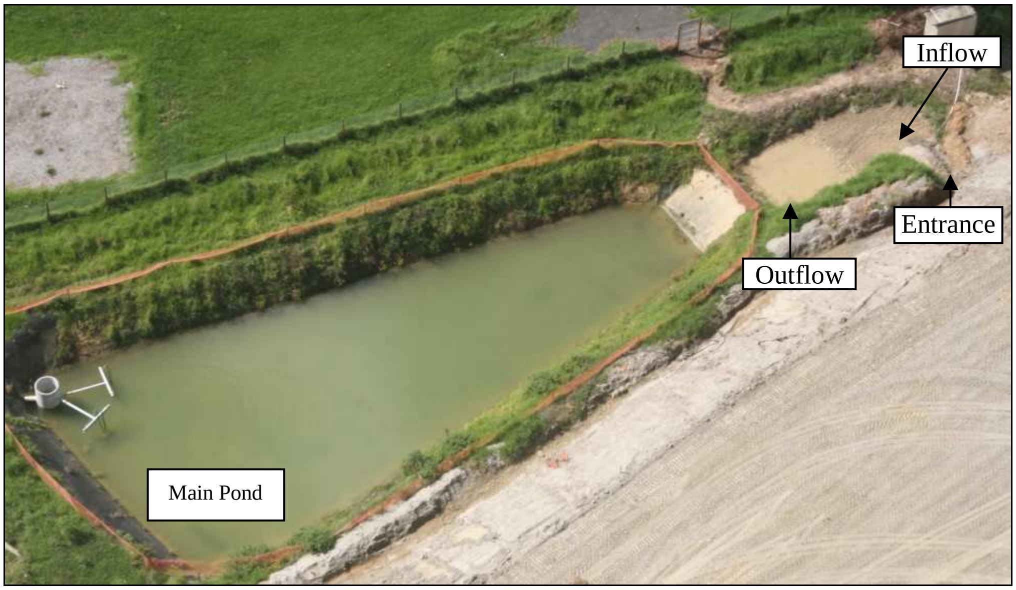


Fig. 5.7: View of the Somerset Road retention pond. Note that the lower (outflow) portion of the forebay contains water while the upper (inflow) portion of the forebay does not (Photo courtesy of Transit, 2007).

Rainfall in November and December 2006 resulted in the presence of water in the forebay outflow. During January, February and early March 2007, the forebay was very dry with large shrinkage cracks in the clay, as the result of decreased rainfall (Fig. 5.8a). May 2007 also had very low levels of rainfall (18.4 mm) and while it was observed that some water had reached the forebay, it had infiltrated through the sediment (Fig. 5.8b).

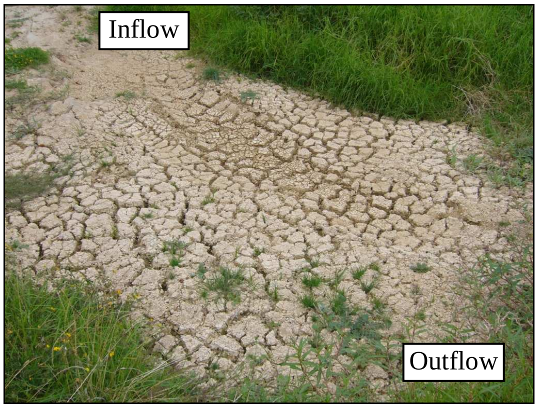


Fig. 5.8a: Shrinkage cracks in the clay contained in the Somerset Road forebay on 08/02/07.

Fig. 5.8b: Damp mud in the Somerset Road forebay on 16/05/07 following earlier rainfall.

The forebay inflow did not contain water during June despite 22.8 mm of rain between 01/06/07 and 13/06/07. This is most likely a reflection of the stabilisation of the earthworks surface above the pond, with grass now beginning to grow through the mulch, and the installation of bunds to section the flow of water (Fig. 5.9a). Water was observed flowing down the polyurethane lined inlet (flow to forebay) on 10/06/07 (Fig. 5.9b) and into the forebay, but was following an eroded channel straight to the lower portion of the forebay.

Fig. 5.9a: Grass beginning to grow through the mulch (background) and an earth bund (foreground).

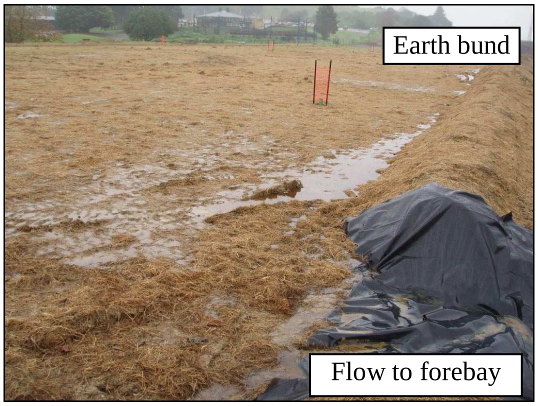


Fig. 5.9b: Earth bund and mulch. Note the stabilised entrance to the forebay.

Large volumes of rainfall over an extended period in July and August 2007 resulted in the continuous presence of water within the entire forebay (inflow and outflow). This is shown in Fig. 5.10.

The chemical dosing shed was decommissioned on 09/05/07 because the site was considered stabilised, and therefore protected from erosion (Fig. 5.9). There were several significant rain events in June and July: 28 mm between 02/06/07 and 13/06/07; 32 mm between 20/06/07 and 26/06/07; 93.4 mm between 29/06/07 and 11/07/07 and a further 77.4 mm over the remaining days of July (Fig. 5.5; page 82). The chemical dosing shed was reconnected during some of these rainfall events to ensure dosing of the runoff occurred, however this was not recorded. Site observations indicate it was operating on 11/07/07, 17/07/07, 26/07/07 and 01/08/07.

Fig. 5.10: Sampling the forebay inflow on 17/07/07. Forebay is full of water following prolonged rainfall in June and July 2007 (Photo courtesy of L. Ward, 2007).

5.3.1.2.2 Sample Results

Fig. 5.6 (page 85) shows that for the period November 2006 to August 2007, the suspended solid results in the forebay outflow range from a minimum value of 2.05 ± 0.18 mg/L (25/07/07) to a maximum value of 263 ± 23.26 mg/L (19/12/06). The two highest levels were recorded on 15/11/06 (234.67 mg/L) and 19/12/06 (263 ± 23.26 mg/L).

These values are considerably lower than those reported by Winter (1998), who recorded a mean suspended sediment concentration of 10 170 mg/L entering a sediment retention pond in Albany, Auckland. This was recorded during the earthworking period, with the suspended solids reducing to 8 366 mg/L over the non - earthworking period. The values recorded by Winter (1998) are measurements of runoff which has not been treated with PAC, and therefore a direct comparison can not be made, however it is likely that the runoff entering the forebay at Somerset Road contained suspended solid levels well below these values.

There are four spikes in the forebay outflow results: 234.67 mg/L (15/11/06), 263 ± 23.26 mg/L (19/12/06), 49.67 mg/L (02/04/07) and 153.16 ± 4.08 mg/L (12/08/07). These will be described in more detail.

The first two spikes occurred during the height of the earthworks season, during which time the site was being actively worked, and therefore large areas of soil were exposed to the erosive forces of rainfall (Fig. 5.11). There was 43.8 mm of rain between 07/11/06 and 15/11/06, which would have generated sizeable runoff to the forebay. However, from the NIWA data, there was only 10.6 mm of rainfall between 17/12/07 and 19/12/07, which does not explain the elevated suspended solids level in the forebay, as this is unlikely to have been enough rainfall to exceed the infiltration capacity of the soil. Therefore, it is likely that there was a localised rainfall event at the site, which was not recorded by the NIWA climate station at Owairaka.

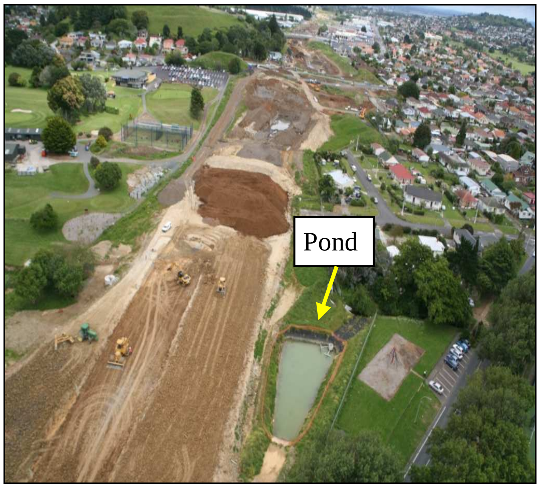


Fig. 5.11a: Earthmoving works in the catchment of the Somerset Road pond on 24/11/06. (Photo courtesy of Transit, 2006).

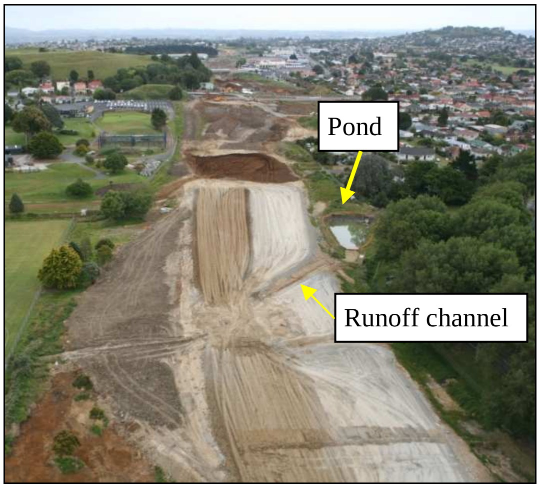


Fig. 5.11b: Earthmoving works in the catchment of the Somerset Road pond on 17/12/06. (Photo courtesy of Transit, 2006).

The third spike in the data occurred on 02/04/07, when suspended solids in the forebay outflow increased to 49.67 mg/L, following 39.4 mm of rainfall between 28/03/07 and 02/04/07. Interestingly, there was 71 mm of rainfall between 12/03/07 and 16/03/07, which would be expected to generate more runoff, and thus higher concentrations of suspended solids, however only 9.87 ± 0.21 mg/L suspended solids were recorded on 16/03/07. An additional 30 mm of rainfall between 28/04/07 and 30/04/07 increased levels in the forebay to 27.54 ± 5.16 mg/L on 30/04/07, and while this level is higher than the increase recorded on 16/03/07, it is still half that recorded on 02/04/07. The reason for this spike will be discussed in Chapter 6.

Finally, on 12/08/07 the suspended solids level in the forebay outflow was 153.16 ± 4.08 mg/L, this value is more than 30 times greater than that measured in the forebay outflow on 01/08/07 (4.79 ± 0.23 mg/L), despite heavier rainfall in the days prior to sampling on 01/08/07 (Table 5.1). The reason for this spike will be discussed in Chapter 6.

5.3.1.2.3 Comparison between forebay inflow and outflow

As stated previously, the suspended solids results in the forebay outflow range from a minimum value of 2.05 ± 0.18 mg/L (25/07/07) to a maximum value of 263 ± 23.26 mg/L (19/12/06). The average monthly suspended solids in the forebay inflow range from a minimum of 6.45 ± 1.46 mg/L (01/08/07) to a maximum of 137.10 ± 2.40 mg/L (12/08/07). Water was observed flowing into the forebay from the stabilised motorway surface above the retention pond on 10/06/07 (Fig. 5.9b), and is termed runoff flow for the purpose of this study.

Fig. 5.12 compares the monthly average suspended solids in the runoff flow, the forebay inflow and the forebay outflow. In July 2007, the monthly average suspended solids were significantly higher in the forebay inflow than the outflow (64.11 ± 18.34 mg/L, compared with 16.87 ± 6.67 mg/L), while in August 2007, the inflow had an average suspended solid level of 71.77 ± 29.24 mg/L, which was lower than the average in the outflow (78.97 ± 33.23 mg/L). On 12/08/07, the forebay was observed to contain high levels of suspended solids (Fig. 5.13), and laboratory analysis showed the levels in the forebay were 137.10 ± 2.40 mg/L (inflow) and 153.16 ± 4.08 mg/L (outflow). This will be discussed in Chapter 6.

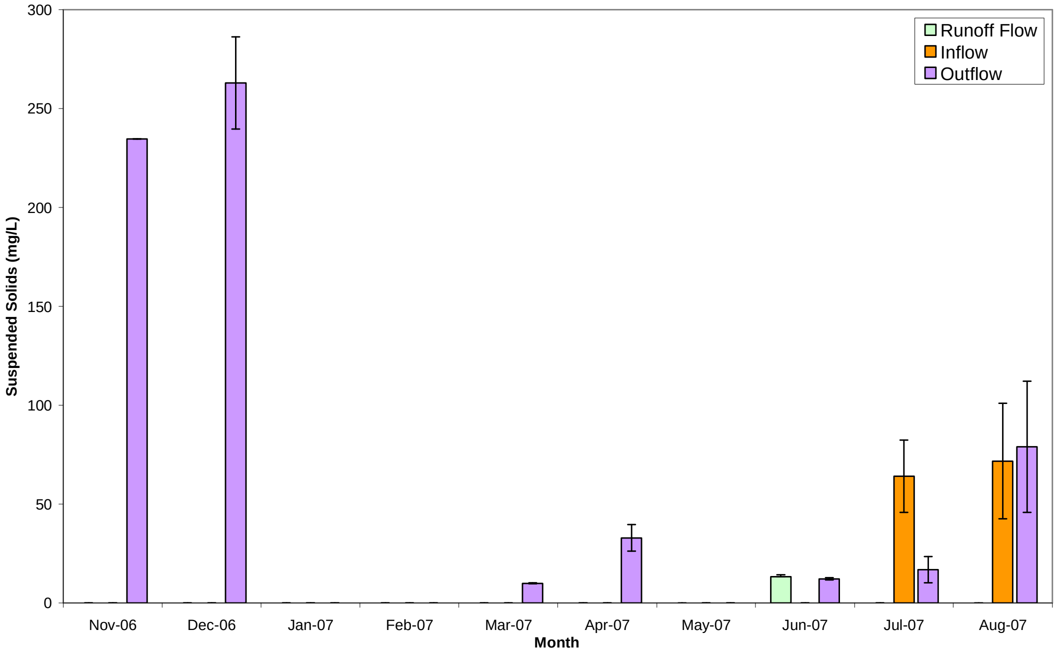


Fig. 5.12: Suspended solids levels in the Somerset Road forebay (Dec 2006-Aug 2007), showing standard error.

Fig. 5.13: View of inlet to forebay showing high levels of suspended sediment in the water.

5.3.1.3 Main Pond

This section details the observations made while onsite undertaking sampling, and presents the suspended solids results for the main pond. This will be followed by a comparison of these levels to those recorded in the forebay.

5.3.1.3.1 Sample Results

Fig. 5.6 (page 85) shows that the lowest suspended solids levels at the start of the main pond were recorded in December 2006 and May 2007, and the highest suspended solids levels recorded were during March 2007, followed by August 2007.

Between November 2006 and February 2007 the suspended solids levels at the start of the main pond were generally less than 3 mg/L (range: 0.5 mg/L 19/12/06 – 3.50 mg/L 01/11/06), with two minor spikes in the data: 13.14 ± 1.74 mg/L (15/12/06) and 7.2 ± 0.42 mg/L (26/02/07). As there was no rainfall in the days immediately before these measurements were taken, it is likely that these elevated levels are due to either organic matter such as algae growing in the pond (as indicated by the green tinge to the water in Fig. 5.14a), or convection currents resuspending settled sediment within the pond (due to low water levels in the pond; Fig. 5.14b).

Fig. 5.14a: Water quality in the Somerset Rd pond on 15/12/06.

Fig. 5.14b: Water quality in the Somerset Rd pond on 26/02/07. Note the low water level.

The low baseline concentrations at the start of the main pond indicate that no runoff (and therefore sediment) was entering the main pond, despite the occurrence of rainfall between November 2006 and early March 2007. This is further supported by the fact that discharge was not recorded from the pond between the end of November 2006 and the beginning of April 2007 (Fig. 5.6; page 85), as detailed in Section 5.3.1.5.

The high suspended solids levels in mid to late March 2007 are associated with significant inflow to the main pond. This is evident in the rapid increase in water levels in the pond between 05/03/07 and 21/03/07, following 77 mm of rainfall in that time period (Fig. 5.2; page 80). On the 05/03/07 the water level in the main pond was too low to sample (Fig. 5.15a), but by the 21/03/07, the water level had increased to approximately 5cm below the lower decant arm (Fig. 5.15b). A further 40.2 mm of rainfall (Fig. 5.2) between the 21/03/07 and 02/04/07 resulted in the pond becoming full enough to discharge for the first time in 2007 (Fig. 5.15c).

Despite a total of 160 mm of rainfall in July 2007, and increased levels of runoff to the pond compared to June 2007 (as indicated by the presence of water in the forebay), the main pond had an average of 3.74 ± 0.35 mg/L suspended solids. While this is double the average of June (1.86 ± 0.18 mg/L), it is three times lower than the average in the main pond in August 2007 (10.3 ± 2.41 mg/L). During August 2007 there was an increase in the suspended solids levels in the main pond start from 3.85 ± 0.11 mg/L (26/07/07) to 14.61 ± 0.67 mg/L (01/08/07) as the result of 41 mm of rainfall; the level then declined to 5.15 ± 0.33 mg/L on 12/08/07, despite a further 34.8 mm of rainfall (Table 5.1; page 78). This will be discussed in Chapter 6.

Fig. 5.15a: Very low water level in the main pond (05/03/07). The gap between the decant and water level is approximately 30cm.

Fig. 5.15b: Heavy rainfall has resulted in runoff, and thus an increase in water levels in the main pond (21/03/07), reducing the gap between the water level and decant.

Fig. 5.15c: Following further rainfall and runoff, the water level of the main pond has increased to above the lower decant arm (02/04/07).

Fig. 5.16 presents the monthly average suspended solids for all locations within the main pond between November 2006 and December 2007.

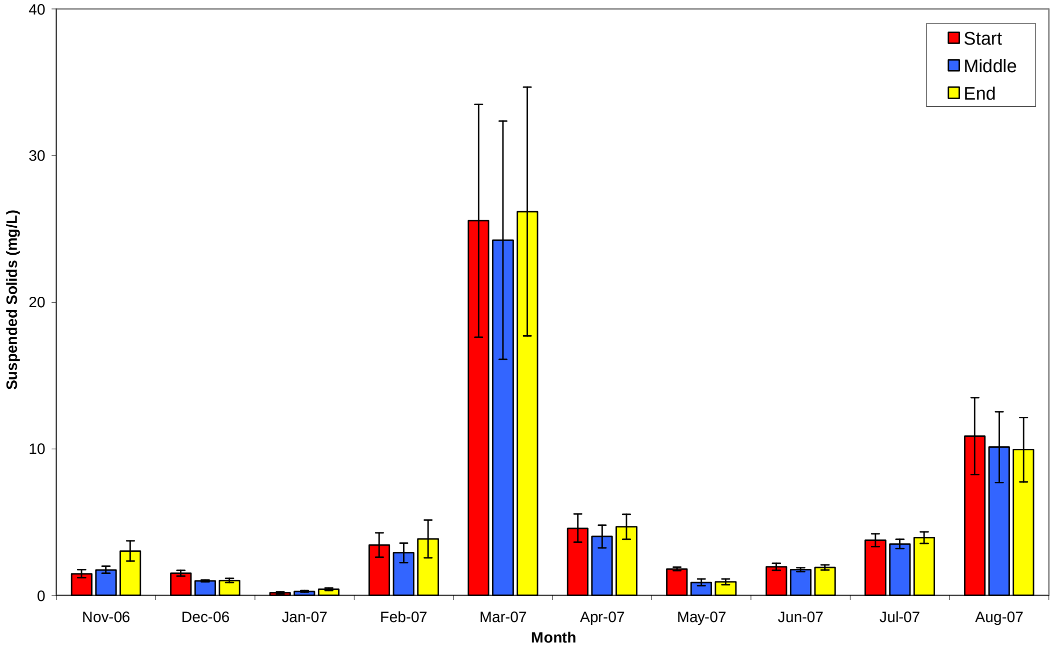


Fig. 5.16: Monthly average suspended solids (mg/L) and standard error levels (mg/L) in the Somerset Road main pond.

In general, the average monthly suspended solids levels in the main pond were less than 5 mg/L, with the exception of March 2007 and August 2007. The main pond appears to be well mixed, with similar suspended solids levels along its length. August was the exception to this, showing a small decline in suspended solids levels from the start of the main pond to the end.

The highest monthly average suspended solids in the main pond were in March 2007, with an average of 25.55 ± 7.95 mg/L at the start, 24.3 ± 8.13 mg/L at the middle and 26.19 ± 8.48 mg/L at the end. The high suspended solids levels are the result of 116.4 mm of rainfall during the month, particularly as this rainfall was concentrated in two rainfall events (Fig. 5.2). August 2007 also had elevated suspended solids levels, with a monthly average suspended solid level of 10.87 ± 2.19 mg/L at the start, 10.11 ± 2.42 mg/L at the middle and 9.93 ± 2.19 mg/L at the end. These levels were 50% lower than those recorded in the main pond in March 2007, and will be discussed in Chapter 6.

5.3.1.3.2 Comparison between the forebay and the main pond

Fig. 5.6 (page 85) shows that between November 2006 and August 2007 the suspended solid levels (mg/L) at the start of the main pond were generally lower than those in the forebay, which is what would be expected as primary settling occurs in the forebay, reducing the level of suspended solids flowing into the main pond. The largest differences were observed on 15/11/06 (229.57 mg/L (start not sampled, so end value used)), 19/12/07 (262.5 mg/L) and 12/08/07 (131.95 mg/L). The water level in the forebay outflow in December was very low, and therefore this sediment laden water would not have entered the main pond. However on 15/11/07 and 12/08/07 the forebay was full enough to be flowing into the main pond. This indicates that additional settling is occurring in the main pond prior to the water discharging from the pond.

There were two occasions when the start of the main pond had higher suspended solid concentrations than those in the forebay outflow: 16/03/07 and 01/08/07. The largest difference in suspended solids levels (47.4 mg/L) was measured on 16/03/07 with 9.87 ± 0.21 mg/L in the forebay outflow compared to 57.27 ± 0.32 mg/L at the start of the main pond. Observations onsite indicate that the forebay never became full enough to overflow into the main pond during March. Thus elevated levels in the main pond were not the result of sediment laden water leaving the forebay. This will be further discussed in Chapter 6.

On 01/08/07 the suspended solid levels at the start of the main pond were higher than those in the forebay, with a difference of 10.96 mg/L (16.58 ± 1.32 mg/L (start) compared to 5.62 ± 0.85 mg/L (overall average)). Observations made onsite show that the water in the forebay appeared to contain few suspended solids (Fig. 5.16a), while the water in the main pond was turbid (Fig. 5.16b). This will be further discussed in Chapter 6.

Fig. 5.17a: Clear water in the forebay (01/08/07).

Fig. 5.17b: Turbid water in the main pond (01/08/07).

5.3.1.4 Discharge

This section details the suspended solids results measured in the discharge from the Somerset Road pond, and compares these levels to those recorded in the main pond.

5.3.1.4.1 Sample Results

Between November 2006 and August 2007, the water level in the main pond was generally below the lower decant arm, and therefore discharge was only sampled 7 times, although it is likely the pond was discharging continuously during July and August 2007 due to increased rainfall levels. The suspended solids levels measured are presented in Table 5.4.

Table 5.4: Suspended solids levels (mg/L) in the discharge from Somerset Road main pond between November 2006 and August 2007.

Date	**Suspended Solids (mg/L)**
15/11/06	1.70
02/04/07	4.67 ± 0.33
11/07/07	2.29 ± 0.40
17/07/07	4.80 ± 0.10
26/07/07	4.24 ± 0.41
01/08/07	14.61 ± 0.67
12/08/07	4.66 ± 0.08
Average:	4.95 ± 0.43

The suspended solids levels in the discharge were below 5 mg/L in all samples except that taken on 01/08/07. The average of these samples is 4.95 ± 0.43 mg/L. This is more than 30 times smaller than the values measured by Ehrhart *et al.* (2002) who recorded median suspended sediment concentrations of 159 mg/L in the discharge from a sediment retention pond in Pennsylvania, USA. The values they measured ranged between 40 and 355 mg/L. In addition, Moores *et al.* (2007) recorded discharge values of 24 – 288 mg/L suspended solids in the discharge from a PAC treated pond, and 1603 – 7228 mg/L from an untreated sediment retention pond in Orewa, Auckland, New Zealand. Furthermore, Moores *et al.* (2007) recorded a peak discharge of 11 130 mg/L suspended solids from the PAC treated pond, following a storm event in March 2007. These values are substantially larger than those discharging from the Somerset Road pond.

5.3.1.4.2 Comparison between the main pond and the discharge

Fig. 5.6 (page 85) indicates that suspended solid levels in the discharge were similar or slightly lower than those at the start of the main pond for the sampling period (November 2006 to August 2007.

5.3.1.5 Effectiveness of the pond components

Table 5.5 presents ratios of suspended solids through the pond system. These ratios were calculated using the monthly average data presented in Table 5.3 (page 83). The forebay average was calculated by taking the average of the monthly values at the forebay inflow and outflow, and the main pond average was calculated by taking the average of the monthly values at the start, middle and end of the main pond. These ratios describe the rate of suspended solid removal between different locations within the forebay and main pond of the Somerset Road retention pond. It must be noted that these results are based on a monthly average figure, and are therefore intended to be an indicative value only.

Table 5.5: Ratios of suspended solid values in the forebay, main pond and discharge of the Somerset Road retention pond (Where FB = Forebay, MP = Main Pond and AVG = Average. A blank indicates the value could not be calculated due to missing variables).

Ratio of:	**Nov-06**	**Dec-06**	**Jan-07**	**Feb-07**	**Mar-07**	**Apr-07**	**May-07**	**Jun-07**	**Jul-07**	**Aug-07**	**Total Period**
Runoff Flow/ FB Avg.								1			
FB Avg. / MP Avg.	113	225				7		7	11	7	18
FB Avg. / Discharge	138					7			11	8	19
MP Avg. / Discharge						1			1	1	1

Runoff flow was only measured once during the sampling period (10/06/07), and the ratio of runoff flow to forebay average was 1, indicating that no settling was occurring in the forebay during this time. Due to no further measurements being collected, it is not possible to use the ratios to draw conclusions about the effectiveness of the forebay.

The ratio of the forebay average to the main pond average was 18 for the entire sampling period (November 2006 to August 2008), indicating that substantial reductions in suspended solid concentrations occurred within the main pond. The high ratios for November and December 2006 should be discounted however, as the forebay did not become full enough to overflow into the main pond. Thus the ratio between the forebay average and main pond average is typically 5 (June 2007 – August 2007) indicating that the suspended solids levels in the forebay are 5 times higher than those in the main pond.

The ratio of main pond average to discharge is 1, indicating that the water in the main pond and the discharge contain the same level of suspended solids; this is to be expected given that the discharge is simply decanted from the water surface of the main pond.

5.3.1.6 Summary of the Somerset Road Pond

Fig. 5.18 presents the monthly average suspended solid (mg/L) levels in the forebay outflow, main pond start and main pond discharge between November 2006 and August 2007.

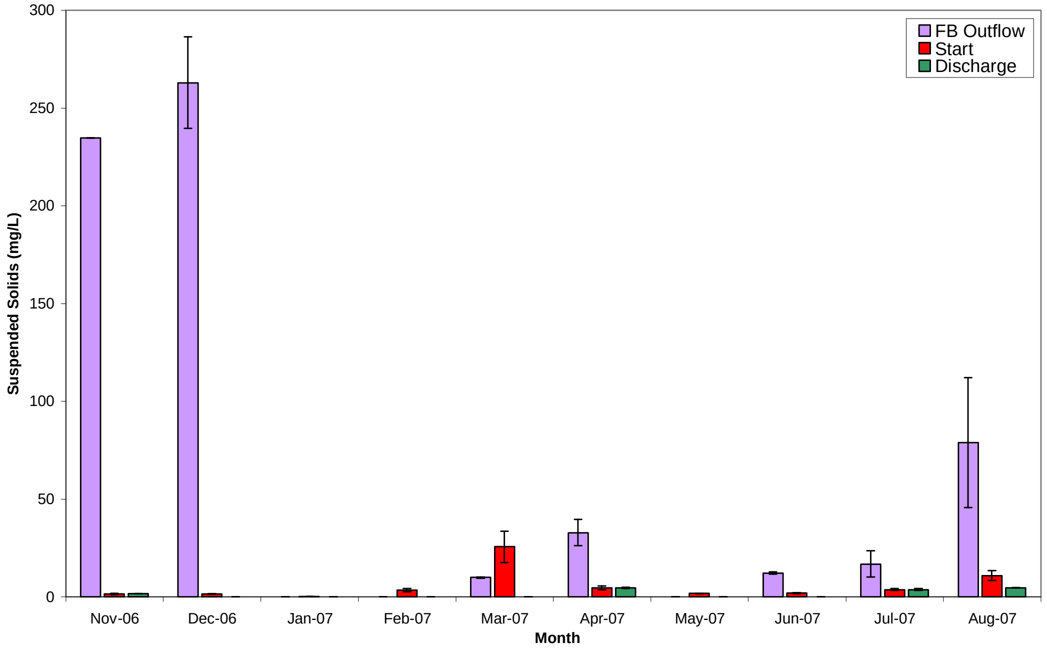


Fig. 5.18: Comparison of suspended solids levels in the forebay outflow, main pond start and main pond discharge at Somerset Road between November 2006 and August 2007.

This figure further supports the ratios presented in Table 5.5, and shows that overall there is a significant reduction in the level of suspended solids between the forebay outflow and the start of the main pond (equivalent to all locations in the main pond as it is well mixed (Section 5.3.1.31)). The reduction in suspended solids between the start of the main pond and the discharge is negligible.

5.3.2 Richardson Road Sediment Retention Pond

This section presents the monthly average suspended solids values collected in the Richardson Road pond, and includes analysis and comparison of the results in the forebay, main pond and discharge.

5.3.2.1 Suspended solids overview

Table 5.6 presents monthly averages and standard error of suspended solids (mg/L) in the Richardson Road pond by sample location between March and August 2007.

Table 5.6: Suspended solid monthly averages (mg/L;$\bar{x}$) and standard error (mg/L; S_E) by location in the Richardson Road retention pond between March 2007 and August 2007 (Where FB = Forebay, MP =Main Pond. A blank indicates that the sample was not taken, due to no flow).

	Mar-07		**Apr-07**		**May-07**		**Jun-07**		**Jul-07**		**Aug-07**		**Total Period**	
	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E
FB Div Channel									95.54	11.59	27.83	5.72	61.69	8.65
Runoff flow to FB							27.06	3.52	277.68	24.55	28.67	1.76	111.14	9.95
G/W Input			1.25	0.52	0.62	0.23	1.67	0.82	4.08	2.26	1.80	0.29	1.88	0.82
FB Inflow	15.57	2.34	9.09	1.62	34.14	3.38	9.76	0.85	23.40	6.71	16.03	1.37	18.00	2.71
FB Outflow	25.37	5.22	12.16	3.26	26.34	5.07	10.23	1.10	24.50	7.65	23.63	1.14	20.37	3.91
MP Start	6.44	2.25	4.97	0.77	5.82	0.57	8.62	0.97	11.37	1.31	11.75	0.21	8.16	1.01
MP Middle	6.80	2.05	5.14	0.77	5.68	0.56	9.03	0.85	11.13	1.19	12.44	1.01	8.37	1.07
MP End	7.21	2.14	5.56	1.01	4.71	0.65	9.40	0.84	10.42	1.24	12.11	0.39	8.24	1.04
Discharge	8.25	0.05	10.00	2.44	4.51	0.84	9.88	0.91	10.84	1.28	13.05	1.26	9.42	1.13

Table 5.6 shows that the highest average suspended solids levels recorded between March 2007 and August 2007 were in the forebay diversion channel and the runoff flow (an average of 61.69 ± 33.86 mg/L and 111.14 ± 9.95 mg/L respectively). The lowest levels were recorded in the groundwater input to the forebay (an average of 1.88 ± 0.82 mg/L). These levels are well below those reported by Winter (1998), who measured a mean suspended solid concentration of 10 170 mg/L in runoff from an earthworks site in Auckland. The suspended solid levels in the forebay inflow (18.00 ± 2.71 mg/l) and forebay outflow (20.37 ± 3.91 mg/L) were lower than the water flowing in, but higher than those in the main pond (an average of 8.26 ± 3.37 mg/L across the main pond). The discharge had an average of 9.42 ± 1.13 mg/L for the total sampling period; which is higher than the main pond, but within the quoted error bounds.

Fig. 5.19 presents the daily rainfall (mm) and suspended solids (mg/L) values measured in the Richardson Road pond between March 2007 and August 2007. Only the forebay inflow, main pond start and the main pond discharge are shown here to ensure clarity on the graph, and are considered to be representative of the sampling locations within the pond. These three locations will be discussed separately in the following sections.

5.3.2.2 Forebay

This section details the observations made while onsite undertaking sampling at Richardson Road, and presents the sample results collected. Initially, a description of the flow regime within the forebay will be provided, followed by an analysis of the data.

5.3.2.2.1 Flow Regime

There was a continuous flow of groundwater into the pond from the drainage blanket. The suspended solid levels in this water were very low, with an average concentration of 1.88 ± 0.82 mg/L, and therefore this flow did not make a significant contribution to suspended solids levels within the pond. During periods of runoff, water entered the pond through two channels- termed here as the forebay diversion channel and the runoff flow to forebay. The runoff flow channel is intended to be the major conveyor of runoff, and is therefore stabilised with geotextile, while the diversion channel has simply been formed by excavation.

As described in Section 5.2.1, the elevated rainfall levels in March 2007 occurred during the earthworks season. The area above the Richardson Road pond was undergoing works during the period immediately prior to the first rainfall event of 12/03/07 to 16/03/07 (Fig. 5.20), meaning that runoff was able to easily detach and transport large quantities of suspended solids. In addition, localised slumping of the banks above the pond provided preferential flow paths for the water, accelerating erosion through these areas (Fig. 5.21).

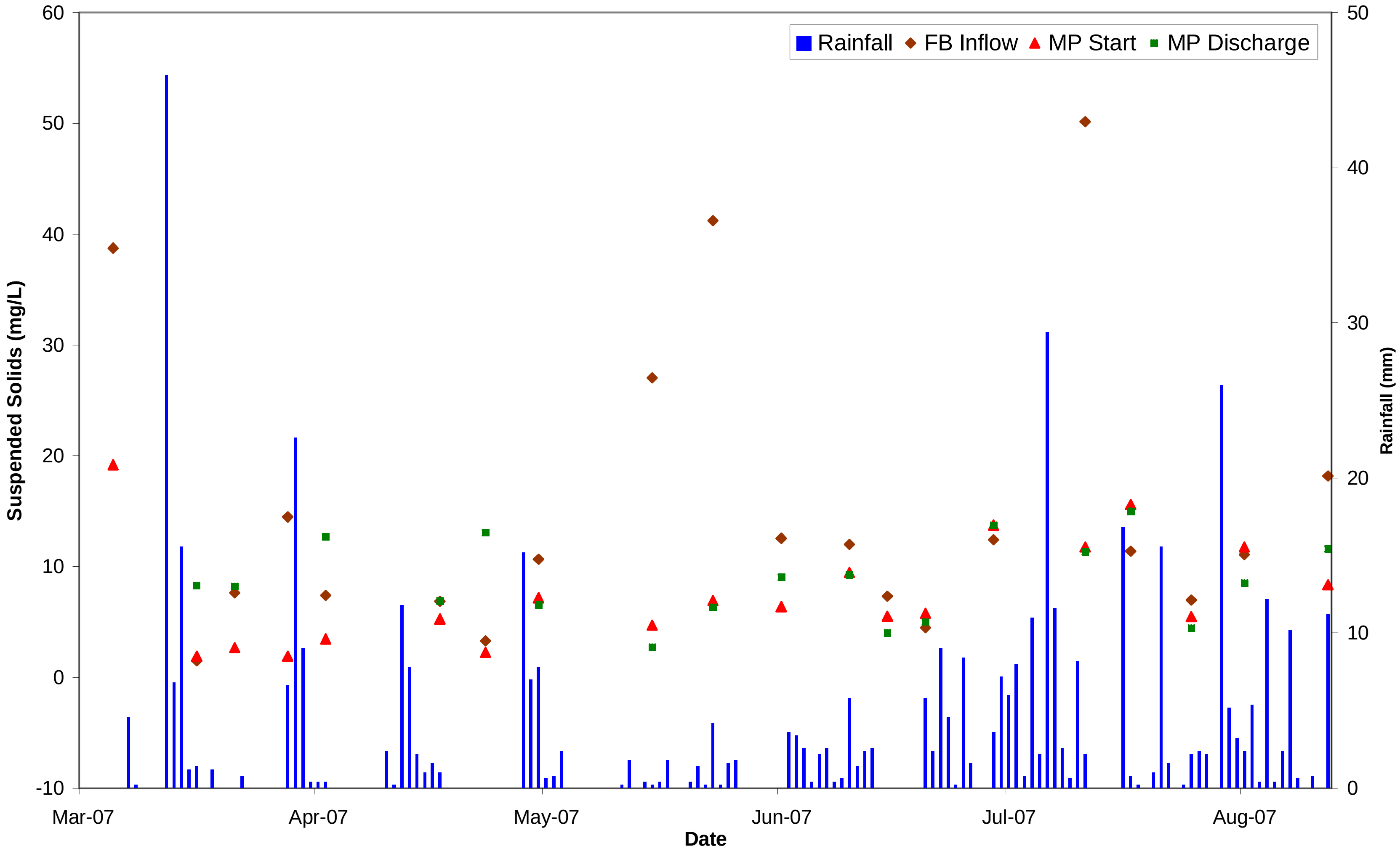


Fig. 5.19 : Rainfall (mm) and suspended solids values as measured in the Richardson Road pond between March 2007 and August 2007. (FB = Forebay, MP = Main Pond).

Fig. 5.20: Aerial view of the Richardson Road pond on 09/03/07. The site is being actively worked, and the high turbidity levels in the pond are evidence of sediment laden runoff (Photo courtesy of Transit, 2007).

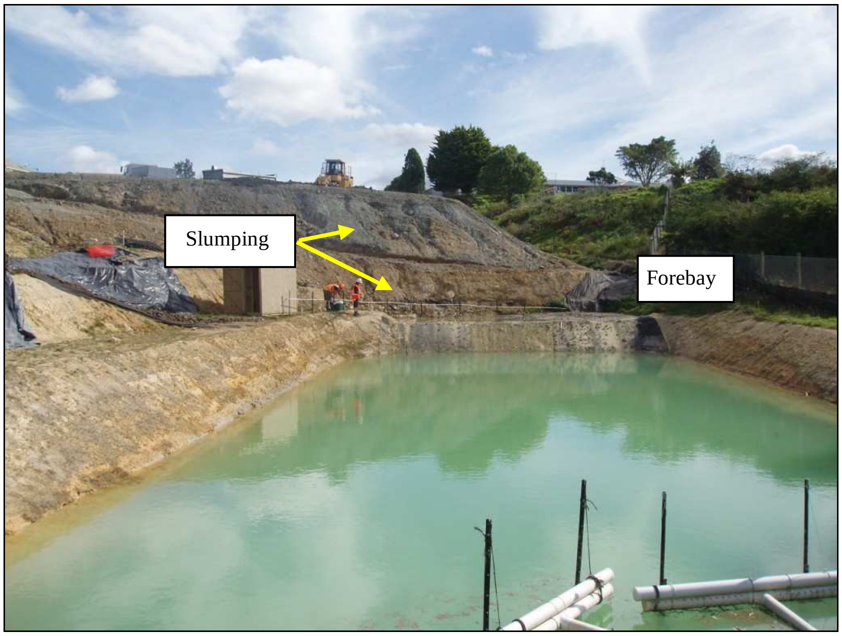


Fig. 5.21: View of eroded banks above the forebay on 16/03/07, as the result of rainfall-driven runoff.

The forebay was full of water on 05/03/07, and water was flowing over the level spreader into the main pond (Fig. 5.22A). Between 05/03/07 and 16/03/07 there was 137 mm of rainfall, and the subsequent runoff resulted in the forebay filling with sediment, especially near the runoff flow channel where a delta developed (Fig. 5.22B). Sediment was manually removed between 21/03/07 and 28/03/07, increasing the freeboard to approximately 1 m (Fig. 5.22. C, D). By 02/04/07, the forebay had filled with water (Fig. 5.22E), and the main pond was discharging from both decant arms (Fig.5.22F). The formation of a delta and the rapid filling of the forebay following sediment removal indicate significant runoff and erosion occurred in March 2007.

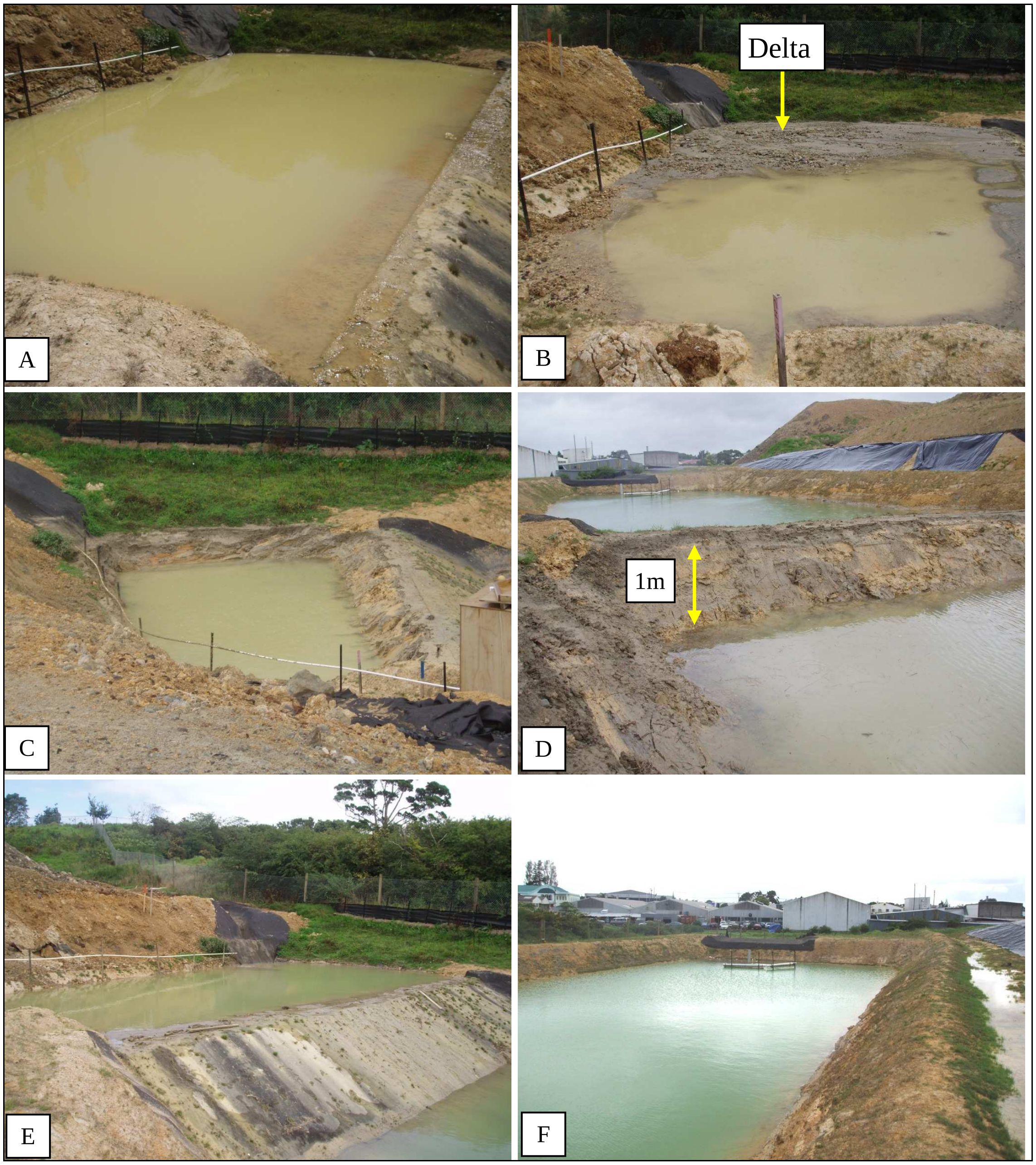


Fig. 5.22: Chronological view of the Richardson Road forebay, showing the accumulation, and subsequent removal of sediment; A: 05/03/07, B: 16/03/07, C and D: Forebay cleaned out on 28/03/07, E and F: Forebay and main pond are full of water on 02/04/07.

5.3.2.2.2 Sample Results

Fig. 5.19 (page 103) shows that the suspended solids levels in the forebay inflow were generally in the order of 10 mg/L between March and May 2007, and showed a positive response to rainfall levels. The levels ranged from a minimum of 0.43 ± 2.13 (16/03/07) to a maximum of 50.12 ± 0.29 (11/07/07). There were four sizeable spikes within the data set: 05/03/07, 15/05/07, 23/05/07 and 11/07/07. These will be described below.

As shown in Table 5.1 (page 78), only 2.4 mm of rainfall occurred in the days preceding 05/03/07, and therefore the elevated levels of suspended solids measured on 05/03/07 (38.74 ± 3.15 mg/L) do not appear to be related to rainfall. However, it is possible that a localised shower occurred at the Richardson Road site, which was not recorded by the rain gauge at Somerset Road. Indeed, the forebay was completely full of water indicating runoff had occurred (Fig. 5.22A).

As shown in Fig. 5.19 (page 103) the suspended solid levels in the forebay inflow were elevated on 15/05/07 and 23/05/07 (27.03 ± 2.01 mg/L and 41.24 ± 1.55 respectively), despite very low levels of rainfall in the preceding days (11.2 mm between 11/05/07 and 23/05/07). There were large volumes of exposed soil upslope of the pond as the site was still be actively worked in May 2007 (Fig. 5.23); consequently water running into the forebay would have contained disproportionately high suspended solids levels.

As established in Section 5.2.2, July had the highest level of rainfall, and consequently the water flowing into the forebay contained high levels of suspended solids (Table 5.6; page 101). The forebay inflow contained 50.12 ± 0.29 mg/L suspended solids on 11/07/07, as the result of increased volumes of rainfall in the preceding days (91.2 mm of rainfall between 30/06/07 and 10/07/07). This will be discussed further in Chapter 6.

Fig. 5.23: Large areas of unstabilised soil upslope of the Richardson Road pond on 07/05/08 (Photo courtesy of Transit, 2007).

5.3.2.2.3 Comparison between forebay inflow and outflow

Fig. 5.24 presents the monthly average suspended solids at all sample locations within the forebay for the period between March 2007 and August 2007.

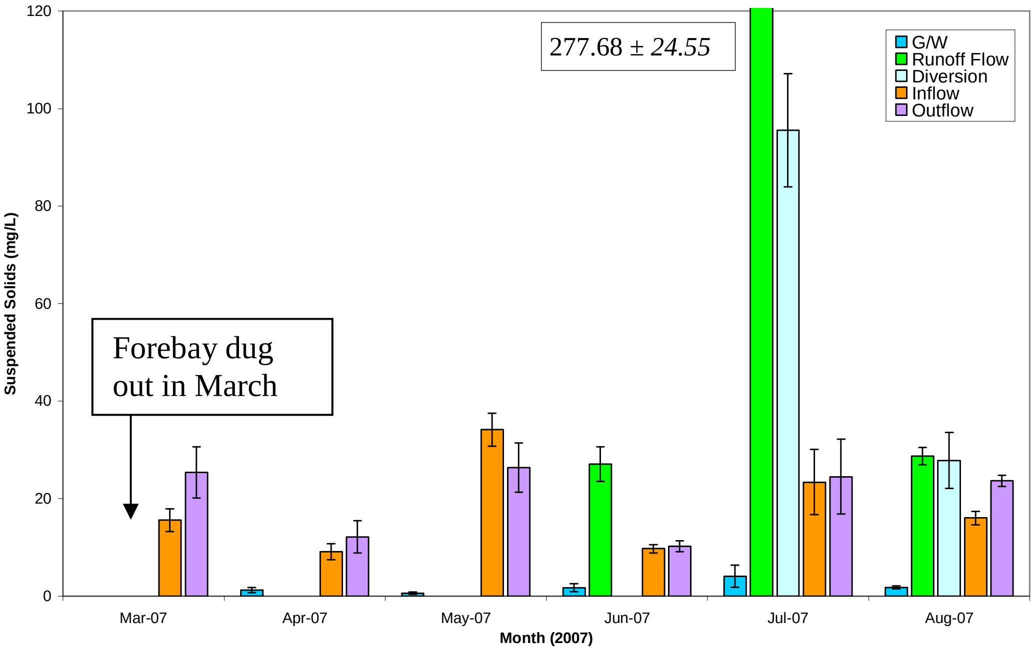


Fig. 5.24: Average monthly suspended solids (mg/L) in Richardson forebay.

Fig. 5.24 shows that the water flowing into the forebay (runoff flow and diversion channel) contained higher levels of suspended solids than were measured at the inflow and outflow points of the forebay for the period between March 2007 and August 2007. The suspended solid levels were higher in the forebay outflow than the forebay inflow for the total sampling period (an average of 20.37 ± 3.91 mg/L compared with an average of 18.0 ± 2.71 mg/L respectively), excluding May 2007. The highest levels of suspended solids in the forebay diversion channel and the runoff flow (95.54 ± 11.59 mg/L and 277.68 ± 24.55mg/L respectively) were in July 2007, while the highest suspended solid levels in the forebay inflow and outflow were recorded in May (34.14 ± 3.38 mg/L and 26.34 ± 1.14 mg/L respectively).

This will be discussed further in Chapter 6.

5.3.2.3 Main Pond

This section details the observations made while onsite undertaking sampling, and presents the suspended solids results for the main pond. This will be followed by a comparison of these levels to those recorded in the forebay.

5.3.2.3.1 Sample Results

Fig. 5.19 (page 103) shows that the suspended solids levels at the start of the main pond were generally below 10 mg/L for the period between March 2007 and June 2007, with the exception of 05/03/07 (19.21 ± 1.21 mg/L). The suspended solids levels in the main pond then increased to between 10 mg/L and 15 mg/L in July 2007 and August 2007. April had the lowest average suspended solids (4.97 ± 0.77 mg/L), and August had the highest (11.75 ± 0.21 mg/L). The overall average for the sampling period was 8.16 ± 1.01 mg/L (Table 5.6). Fig. 5.19 suggests that the suspended solid levels at the start of the main pond are positively related to rainfall events.

Fig. 5.25 compares the average monthly suspended solids (mg/L) at all sampling locations within the Richardson Road main pond.

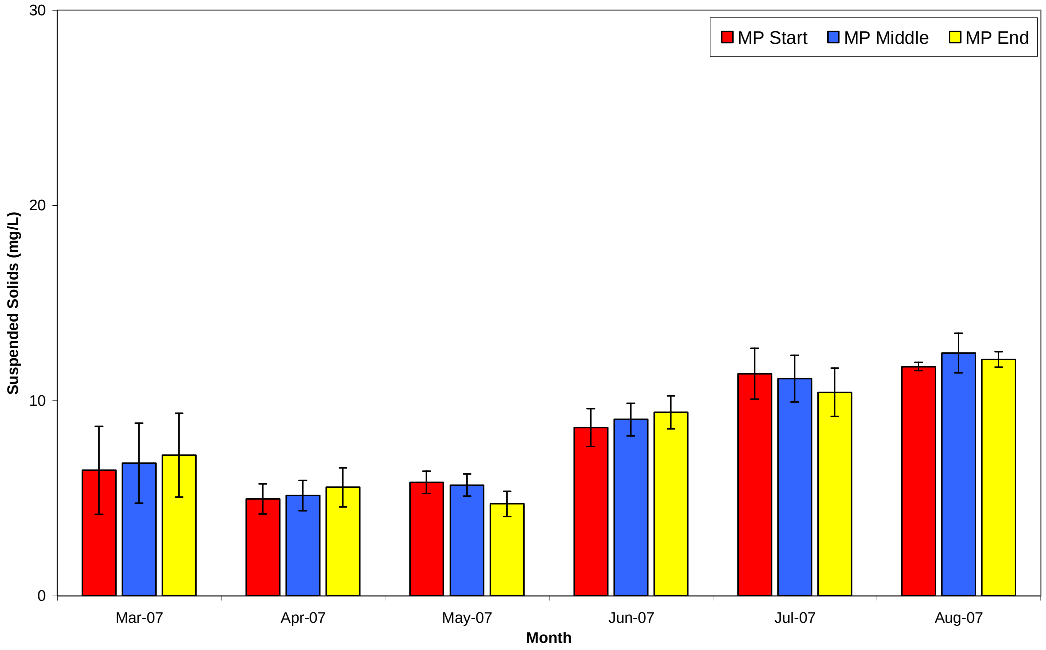


Fig. 5.25: Average monthly suspended solids (mg/L) and standard error (mg/L) in Richardson main pond between March 2007 and August 2007.

Fig. 5.25 shows that the suspended solids levels in the main pond were relatively stable between March 2007 and May 2007, remaining between 4 and 7 mg/L, after which time they increased steadily between June 2007 and August 2007. There is no discernable pattern in the levels of suspended solids along the main pond, as there is an increase in levels between the start and end of the pond in March, April, June and August, and a decrease in May and July. These differences are around 1 – 2 mg/L, and are therefore not substantial. The higher levels of suspended solids in the main pond are related to increased rainfall during the months of March 2007 and June – August 2007.

5.3.2.3.2 Comparison between the forebay and the main pond

Fig. 5.19 (page 103) shows that the suspended solids levels in the forebay inflow were generally higher than those at the start of the main pond for the period between March 2007 and August 2007, indicating that suspended solids were being removed from the runoff entering the forebay. May 2007 showed the largest reduction in suspended solids levels, after which the differences became smaller, following increased rainfall from June 2007 to August 2007. The exceptions to this were 20/06/07, 29/06/07 and 17/07/07, when levels were higher at the start of the main pond compared with those in the outflow. On 20/06/07 and 29/06/07 floating organic debris was observed on the surface of the start of the main pond, which may have impacted these samples, as it was not possible to avoid (Fig. 5.26). On 17/07/07 short circuiting of runoff was occurring in the forebay, as will be further discussed in Chapter 6.

Fig. 5.26: Floating debris at the start of the Richardson Road main pond.

5.3.2.4 Discharge

This section details the suspended solids results measured in the discharge from the Richardson Road pond, and compares these levels to those recorded in the main pond.

5.3.2.4.1 Sample Results

As shown in Fig. 5.19 (page 103), the main pond discharge contained an average of 9.42 ± 1.13 mg/L suspended solids between March 2007 and August 2007, with a minimum value of 2.72 ± 0.46 mg/L (15/05/07) and a maximum value of 14.91 ± 0.17 mg/L (17/07/07). This average discharge value is 16 times smaller than the median suspended sediment concentrations of 159 mg/L measured by Ehrhart *et al.* (2002) and 2.5 times lower than the minimum discharge value (24 mg/L) measured by Moores *et al.* (2007).

5.3.2.4.2 Comparison between the main pond and the discharge

In general, the suspended solids levels at the start of the main pond were higher than those discharging from the pond; however in March and April 2007 the discharge contained more suspended solids than measured at the start of the pond. As outlined in Chapter 4, the discharge pipe was placed on geotextile, and therefore algae were able to grow on the mat and within the pipe. Low flows during early March 2007, and again in April 2007 meant that this algae and other debris was able to accumulate at the end of the pipe (Fig. 5.27a), and thus discharge samples taken in March and April were contaminated. This was overcome by extending the pipe by 500mm (Fig. 5.27b), thus preventing water pooling in front of the pipe, and stopping the growth of algae.

Fig. 5.27a: Accumulation of algae on the geotextile mat below the Richardson Road discharge pipe (02/04/07).

Fig. 5.27b: The extended discharge pipe on 15/05/07.

5.3.2.5 Effectiveness of the pond components

Table 5.7 presents ratios of suspended solids through the pond system. These ratios were calculated using the monthly average data presented in Table 5.6 (page 101). The main pond average was calculated by taking the average of the monthly values at the start, middle and end of the main pond. These ratios describe the rate of suspended solids removal between different locations within the forebay and main pond of the Richardson Road retention pond. It must be noted that these results are based on a monthly average figure, and are therefore intended only to be an indicative value.

Table 5.7: Ratios of suspended solid values (mg/L) in the forebay, main pond and discharge of the Richardson Road retention pond (Where FB = Forebay, MP = Main Pond, AVG = Average and Div. = Diversion. A blank indicates the value could not be calculated due to missing variables).

Ratio of:	**Mar-07**	**Apr-07**	**May-07**	**Jun-07**	**Jul-07**	**Aug-07**	**Total Period**
Runoff flow/ FB Avg.				3	12	1	6
FB Div. / FB Avg.					4	1	3
FB Avg / MP Avg.	3	2	6	1	2	2	2
Runoff Flow / Discharge				3	26	2	10
FB Div / Discharge					9	2	5
FB Avg / Discharge	3	1	7	1	2	2	2
MP Avg. / Discharge	(0.8)	(0.5)	1	1	1	1	1

The ratio of the runoff flow channel to the forebay average is 6, and the ratio between the forebay diversion channel and the forebay average is 3 for the period between March and August 2007. This indicates that a reduction in suspended solids is occurring within the forebay. The reason for the difference in these ratios will be discussed in Chapter 6.

The ratio of the forebay average to the main pond average is 2, thus a reduction in suspended solid levels is being achieved within the main pond. The ratio of the main pond average to the discharge is 1, and therefore there is no difference between the suspended solids levels in the main pond, and the discharge. As previously established, the discharge samples were contaminated with algae in March and April, resulting in main pond to discharge ratios which were less than one. They are bracketed in Table 5.7 as they have not been included in the ratio calculation for the total period.

Overall, the ratio of suspended solids in the water coming into the forebay (average of forebay diversion and runoff flow channels) to the discharge is 10 (calculation not shown in Table 5.7), thus substantial suspended solid removal was achieved through the Richardson Road pond system.

Chapter 6 provides a comparison between the two ponds.

5.3.2.6 Summary of the Richardson Road Pond

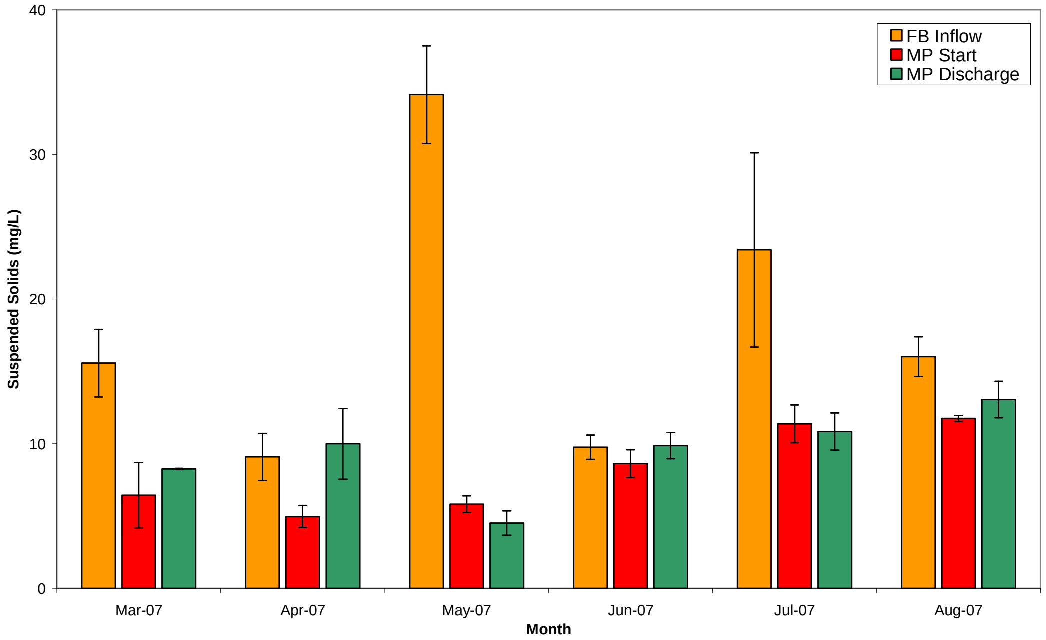


Fig. 5.28: Comparison of suspended solids levels in the forebay outflow, main pond start and main pond discharge at Richardson Road between March 2007 and August 2007.

Fig. 5.28 shows that overall there is a reduction in the level of suspended solids between the forebay outflow and the start of the main pond. This reduction was largest in May 2007, due to elevated suspended solids levels in the forebay resulting from the large area of exposed soil upslope of the pond (Section 5.3.2.2.2). The levels in the discharge were lower than that in the forebay inflow, indicating that a reduction in suspended solids was achieved. The exception to this was April 2007, when levels increased, however this can be attributed to algae contaminating the sample.

5.4 Oakley Creek Tributary

5.4.1 Suspended solids

Suspended solids measurements were made in the Oakley Creek Tributary between December 2006 and August 2007, however sampling at Downstream A and B did not commence until February 2007.

Table 5.8 presents monthly averages (mg/L) and standard error (mg/L) of suspended solids in the Oakley Creek Tributary by sample location between December 2006 and August 2007. Samples ‘Upstream A’ and ‘Upstream B’ were collected from the section of the Oakley Creek Tributary which runs parallel to Keith Hay Park, and therefore the results are considered to be independent of the discharge from the Somerset Road sediment retention pond (“the pond”). The ‘Stream’ sample was collected 0.5 m upstream of the pond discharge pipe, and the ‘Downstream A’ and ‘Downstream B’ samples were collected 20m and 35m downstream of the discharge pipe respectively. ‘Downstream B’ is also affected by stormwater running off Somerset Road. These results are presented graphically in Fig. 5.29.

Table 5.8: Suspended solid monthly averages (mg/L; $\bar{x}$) and standard error (mg/L; S_E) by location in the Oakley Creek Tributary (Where ‘-’ indicates no standard error due to the collection of only one sample, and a blank value indicates that samples were not collected).

	Dec-06		**Jan-07**		**Feb-07**		**Mar-07**		**Apr-07**	
	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E
Upstream A			5.38	0.63	61.79	53.96	13.29	6.60	2.98	0.58
Upstream B					13.75	2.75	7.85	1.23	2.24	0.37
Stream	10.00	6.33	6.40	1.48	51.88	22.88	6.83	0.17	4.46	1.85
Downstream A					9.42	3.75	9.40	2.32	3.32	0.29
Downstream B					21.17	-	9.28	1.98	3.89	0.93

	May-07		**Jun-07**		**Jul-07**		**Aug-07**		**Total Period**	
	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E	$\bar{x}$	S_E
Upstream A	2.27	0.50	1.06	0.11	5.26	0.35	6.66	1.69	12.34	7.19
Upstream B	2.51	0.20	2.39	0.91	4.50	0.31	5.45	1.23	5.53	1.57
Stream	2.70	0.34	1.61	0.22	4.28	0.33	2.80	0.20	10.11	5.29
Downstream A	1.48	0.55	2.95	1.20	3.68	0.14	3.31	0.26	4.79	1.22
Downstream B	3.98	0.75	1.16	0.27	2.96	0.27	4.00	0.55	6.63	2.60

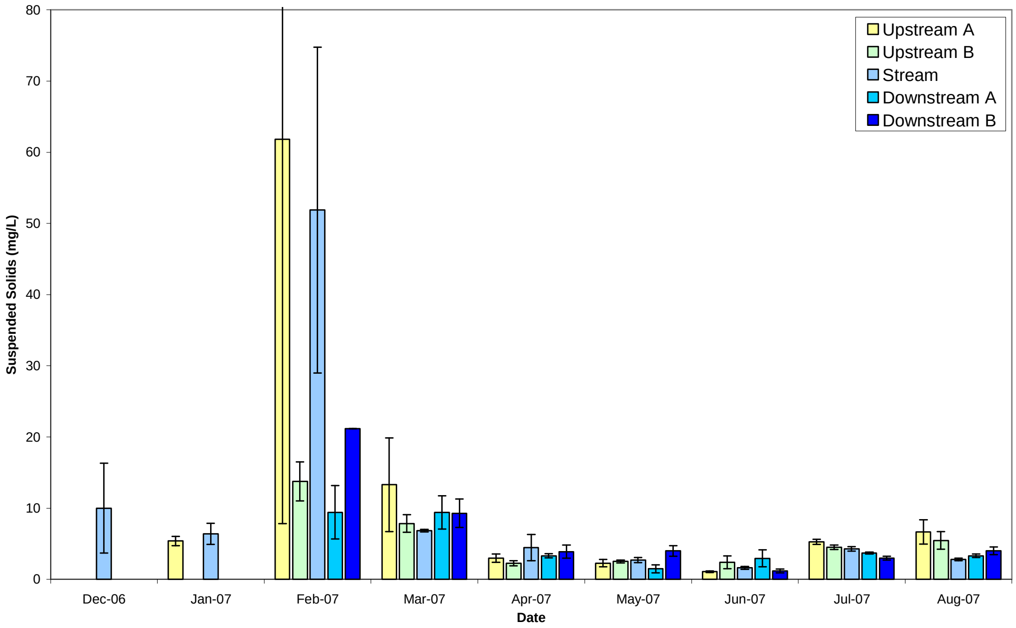


Fig. 5.29: Average monthly suspended solids (mg/L) and standard error (mg/L) by sample location in the Oakley Creek Tributary between December 2006 and August 2007.

The data in Table 5.8 show that the samples collected from within the Oakley Creek Tributary between December 2006 and August 2007 display strong seasonal variation. The highest suspended solids levels were measured in February and March 2007 (late summer to early autumn), suspended solids levels then decreased in April, May and June 2007 (autumn to early winter), and increased again in July and August 2007 (winter), although the winter levels were lower than those in the summer months, as can be seen in Fig. 5.29. This graph also illustrates that the sampling sites do not show a uniform pattern; with often highly variable suspended solid concentrations in any one month.

5.4.1.1 Suspended solids in February and March, 2007

As presented in Table 5.8 and Fig. 5.29, February 2007 had the highest suspended solids levels (average of 31.6 mg/L across the five sampling locations), followed by March 2007 (9.33 ± 2.46 mg/L). This is because of algal growth in the water, rather than suspended sediment (Figs. 5.30a; 5.31; 5.33). On some days it was not possible to collect samples as these algal growths were too extensive across the surface of the water (Fig. 5.30b).

Fig. 5.30a: Sample collection at 'Downstream B' on 17/02/07. Despite extensive algal growth, the sample was able to be collected from a clear patch (Photo courtesy of K. Ballard, 2007).

Fig. 5.30b: View of the 'Downstream B' sampling site on 26/02/07. A sample was not taken on this day.

The highest levels of suspended solids in February 2007 were recorded at the Upstream A site (monthly average: 61.79 ± 53.96 mg/L; Fig. 5.31a), and at the Stream site (51.88 ± 22.88 mg/L; Fig. 5.31b). March 2007 had an average suspended solid level of 9.33 mg/L across the 5 sampling sites, with the highest levels being recorded at the Upstream A site (25.60 mg/L on 05/03/07).

Fig. 5.31a: Algal growth at 'Upstream A' (26/02/07). The suspended solid concentration was 115.75 mg/L.

Fig. 5.31b: Organic matter at 'Stream' on 09/02/07. The measured suspended solids on this date were 74.75 mg/L.

The effects of high rainfall in March (Table 5.1; Fig. 5.2) were also reflected in the suspended solids levels within the Oakley Creek Tributary, with increased water flows flushing the algal growths away. The 'Stream' site could not be sampled on

05/03/07 as the growths had become more prolific since 26/02/07 (Fig. 5.31b), however suspended solids levels taken on 16/03/07 had decreased to 7 mg/L (Fig. 5.32b), following 77.6 mm of rainfall between 26/02/07 and 16/03/07. The suspended solids levels at Upstream A decreased from 115.75 mg/L on 26/02/07 (Fig.5.31a) to 3.02 mg/L on 16/03/07 (Fig. 5.32a).

Fig. 5.32a: Upstream A on 16/03/07 following a period of intense rainfall. Algal growths have been flushed from the stream.

Fig. 5.32b: Accumulated organic matter has been flushed from the Stream sampling site following heavy rainfall (16/03/07).

There was very little rainfall during the period between 16/03/07 and 21/03/07 (1.2 mm), allowing the rapid regrowth of these organisms, and samples could not be collected from either Upstream A, Upstream B or Stream on 21/03/07 due to algal growth (Figs. 5.33a, b).

Fig. 5.33a: Prolific algal growth at the Upstream A sampling site on 21/03/07.

Fig. 5.33b: Thick algal growth at the Upstream B sampling site on 21/03/07.

5.4.1.2 Suspended solids in April, May and June, 2007

Cooler temperatures reduced the growth of algae in the Oakley Creek Tributary between April 2007 and June 2007, reducing the levels of suspended solids measured during this time period.

April 2007 had an average suspended solids level of 3.38 mg/L, and ranged from a minimum of 2.24 mg/L at Upstream A to a maximum of 4.46 mg/L at the Stream site. May 2007 had an average suspended solid level of 2.6 mg/L, ranging from 1.48 mg/L at Downstream A, to 3.98 mg/L at Downstream B. Fig. 5.34 presents some images of the Oakley Creek Tributary during April 2007 and May 2007. These images show that there was minimal algal growth and the water had low turbidity.

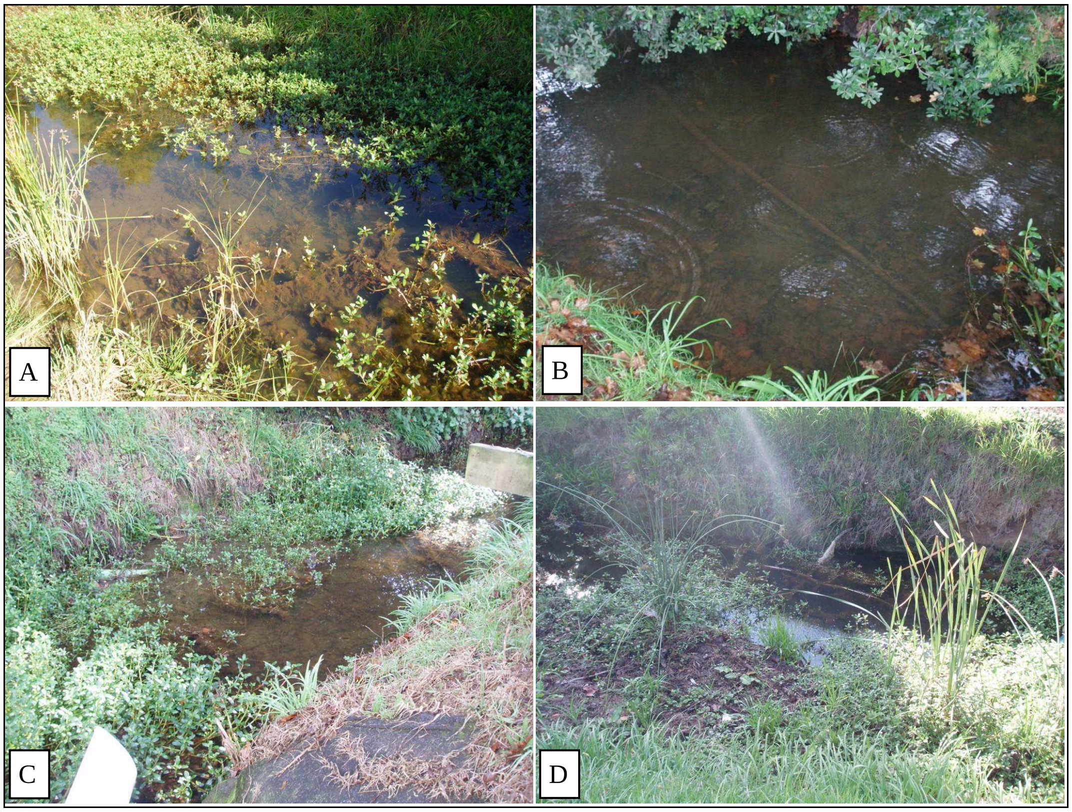


Fig. 5.34: Images of the Oakley Creek Tributary; **A:** Upstream A (17/04/07), **B:** Upstream B (30/04/07), **C:** Stream (24/05/07), and **D:** Downstream B (23/04/07).

While samples could not be collected on several occasions during April 2007 and May 2007, this was predominately due to the accumulation of household rubbish

(Fig. 5.35a), or coarse organic matter such as leaves from overhanging trees at the Upstream B and Downstream A sampling sites (Fig. 5.35b), rather than algal growths.

Fig. 5.35a: Discarded rubbish at the Downstream A sampling site.

Fig. 5.35b: Accumulation of Oak leaves on the water surface at the Upstream B sampling site.

June had the lowest suspended solids levels during the sampling period (December 2006 – August 2007), with an average of 1.8 mg/L across the 5 samples. In June, the average suspended solid concentrations at the 'Upstream A' site was 1.06 ± 0.11 mg/L (Fig. 5.36a), and the 'Stream' sample had an average of 1.61 ± 0.22 mg/L (Fig. 5.36b). This is a large reduction compared with the levels recorded at these sites in March 2007 (Fig. 5.31a, b).

Fig. 5.36a: The 'Upstream A' sampling site on 01/06/07. There is no algal growth, and samples had an average suspended solids concentration of 0.88 ± 0.34 mg/L.

Fig. 5.36b: View of the 'Stream' sampling site on 29/06/07. Algal growth has declined, and samples had a suspended solid concentration of 1.41 ± 0.12 mg/L.

5.4.1.3 Suspended solids in July and August, 2007

Prolonged rainfall combined with cooler temperatures in July and August 2007, meant that the impact of algae in the Oakley Creek Tributary was reduced, and the values measured in the stream were more likely to be inorganic rather than organic suspended solids. The water levels were much higher than those observed over the preceding months, and the water appeared more turbid (Figs. 5.37, 5.38). As presented in Table 5.8, July 2007 had an average suspended solid concentration of 4.1 ± 0.28 mg/L, ranging from a minimum of 2.96 ± 0.27 (Downstream B) to a maximum of 5.26 ± 0.35 (Upstream A). August 2007 had an average suspended solid concentration of 4.4 ± 0.79 mg/L, and ranged from a minimum of 2.8 ± 0.2 mg/L (Stream) to a maximum of 6.66 ± 1.69 mg/L (Upstream A).

Fig. 5.37: Water level at the Downstream A sampling site on; A: 01/11/06, B: 17/11/07, and C: 01/08/07. The water levels have increased in both the pool area and within the culvert.

Fig. 5.38: View of the Upstream A sampling site on 16/03/07 (left) and 11/07/07 (right) showing the difference in water level. The arrow indicates the position of a drainage pipe for comparison.

An additional rise in water level was observed at the Downstream B site in July and August 2007 due to increased stormwater runoff from Somerset Road. The Oakley Creek Tributary enters a culvert at the Downstream A site (Fig. 5.37), and passes beneath Somerset Road, where road runoff is piped into the stream by way of cesspits on the road. This runoff contains pollutants in the form of heavy metals and other suspended solids from the road, and can negatively impact the water quality at this point. For example, samples were not collected on 01/08/07 due to an oily sheen on the water surface, and a sludgy build up beside the stream which had a noticeable petrol smell (Fig. 5.39).

Fig. 5.39: View of the Downstream B site, showing the culvert beneath Somerset Road, and the sludgy sediment beside the stream (inset).

5.4.1.4 Comparison with the Somerset Road retention pond discharge

Table 5.9 presents the suspended solid values (mg/L) for the 7 measurements made of the discharge from the Somerset Road sediment retention pond (“the discharge”), as well as the values measured within the Oakley Creek Tributary on these dates. The upstream values have been averaged to give an indication of the upstream levels, while the downstream values are presented individually as the Downstream B site is also impacted by the runoff from Somerset Road.

Table 5.9: Comparison between the Somerset Road sediment retention pond discharge values (mg/L) and those in the Oakley Creek Tributary on the specified days between November 2006 and August 2007.

Date	**Upstream Average**	**Stream**	**Discharge**	**Downstream A**	**Downstream B**
15/11/06	-	-	1.70	-	-
02/04/07	2.74	9.67	4.67 ± 0.33	-	5.54
11/07/07	4.51 ± 0.25	5.19 ± 0.28	2.29 ± 0.40	4.21 ± 0.08	-
17/07/07	5.25 ± 0.57	4.96 ± 0.52	4.80 ± 0.10	3.52 ± 0.05	3.54 ± 0.13
26/07/07	-	3.00 ± 0.40	4.24 ± 0.41	3.32 ± 0.09	2.38 ± 0.08
01/08/07	9.12 ± 1.28	2.43 ± 0.25	14.61 ± 0.67	3.68 ± 0.46	-
12/08/07	7.55 ± 2.53	3.16 ± 0.09	4.66 ± 0.08	2.94 ± 0.06	4.00 ± 0.55
Average:	5.83 ± 1.16	5.08 ± 2.16	5.88 ±0.33	3.53 ± 0.15	3.87 ± 0.25

On average, the suspended solids levels in the discharge were very similar to those measured at the Stream site between November 2006 and August 2007. The discharge contained lower suspended solids than were measured at the Stream sampling site on 02/04/07, 11/07/07 and 17/07/07, but contained higher levels on 26/07/07, 01/08/07 and 12/08/07. Samples were not collected from the Oakley Creek Tributary on 15/11/06, however based on observations it is likely that the measured discharge of 1.70 mg/L was below the suspended solids levels at the Stream site.

Table 5.10 compares the overall average suspended solid concentrations at the 5 stream sampling locations with the discharge values measured between November 2006 and August 2007.

Table 5.10: Average suspended solids (mg/L) and standard error (mg/L) for the Oakley Creek Tributary and Somerset Road retention pond discharge for the period between November 2006 and August 2007.

	Average	S_E
Upstream A	12.34	7.19
Upstream B	5.53	1.57
Stream	10.11	5.29
Discharge	5.88	0.33
Downstream A	4.79	1.22
Downstream B	6.63	2.60

There are no obvious trends in the suspended solids levels with distance along the stream, and the average discharge from the Somerset Road pond contained higher suspended solid levels than the Upstream B and Downstream A sites, but was lower than Upstream A, Stream and Downstream B.

5.4.1.5 Summary

The suspended solids levels in the Oakley Creek Tributary showed a strong seasonal variation, with the highest levels being recorded in the summer months as the result of algal growths. The levels within the stream were highly variable throughout the sampling period, and did not show a clear longitudinal pattern on any sampling days. The discharge from the Somerset Road retention pond contained lower suspended solids than the average concentration at the Upstream A and Stream sampling sites, and did not appear to dramatically increase the levels at the Downstream A site.

5.4.2 Stream Ecological Valuation (SEV)

5.4.2.1 Introduction

As detailed in Chapter 4, two SEV assessments were undertaken on 01/11/06 and 02/110/7 to assess the change in the Oakley Creek Tributary between November 2006 and November 2007. The completed assessment sheets are presented in Appendix B, however a summary of the ecological functions assessed, and the observations made in the Oakley Creek Tributary in 2006 and 2007 are presents in Table 5.11

Table 5.11: Summary of the functions assessed as part of the SEV, and the major observations made in the Oakley Creek Tributary in 2006 / 2007.

Ecological function	Stream condition in 2006 / 2007
Hydraulic functions	
Natural flow regime	- natural channel bed, some unnatural sediment loading. - 31 – 60% bank erosion. - no impermeable land within the upstream catchment.
Connectivity to the floodplain	- flooding very rare due to steep bank sides, and therefore there is no defined floodplain.
Connectivity for species migration	- no barriers to migration with the sample reach. - 100% of the catchment is affected by the presence of a barrier downstream.
Connectivity to groundwater	- natural channel, substrate predominately silt / sand.
Biogeochemical factors	
Water temperature control	- average of 60% of the water surface is shaded. - average of 0.8 m depth. - flow velocity is <1 m/s.
Dissolved oxygen maintenance	- stream substrate marginal (with some anaerobic sediment).
Organic matter input	- average of 60% of the water surface is shaded by overhanging vegetation, of which 80% is deciduous.
Instream particle retention	- 2006: 76% retention rate. Particles travelled average 4 m - 2007: 81% retention rate. Particles travelled average 4.5 m
Flood plain particle retention	- There is no defined flood plain on which retention would occur (see above).
Habitat provision	
Fish spawning habitat	- 3.9 m of medium quality habitat.
Habitat for aquatic fauna	- 30 – 50% of channel contains stable habitat. - Wide variety of habitat types (e.g. vegetation, woody debris).
Aquatic biodiversity intact (Fish and invertebrate fauna)	- fish species present (see Section 5.4.1). - macroinvertebrate species present (see Section 5.4.2).
Riparian vegetation intact	- minimal shade provided by riparian vegetation. The riparian vegetation has been extensively impacted by human activity.

In addition to the field sheets, Rowe *et al.* (2006) provide an Excel spreadsheet which is designed to be used in conjunction with the field sheets to provide an automatic calculation of the SEV. This is presented in Appendix D.

Each of the 16 functions receives a score between 0 and 1, giving a maximum SEV score of 16. The results of the 2006 and 2007 SEV analyses are presented in Table 5.12 below.

Table 5.12: Summary table of the SEV Function scores measured in the Oakley Creek Tributary in November 2006 and November 2007.

Ecological function	01/11/06	02/11/07
Hydraulic functions		
Natural flow regime	0.45	0.45
Connectivity to the floodplain	0.25	0.25
Connectivity for species migration	1.00	1.00
Connectivity to groundwater	0.7	0.7
Biogeochemical factors		
Water temperature control	0.62	0.61
Dissolved oxygen maintenance	0.59	0.58
Organic matter input	0.35	0.36
Instream particle retention	0.76	0.81
Decontamination of pollutants	1.00	1.00
Flood plain particle retention	0.25	0.25
Habitat provision		
Fish spawning habitat	0.49	0.19
Habitat for aquatic fauna	0.63	0.58
Fish Fauna Intact	0.17	0.17
Invertebrate fauna intact	0.03	0.03
Aquatic biodiversity intact	0.32	0.26
Riparian vegetation intact	0.5	0.5
Overall SEV Score	7.88	7.73

Overall, the SEV scores were very similar between November 2006 and November 2007. There was a small reduction in the SEV score between 2006 and 2007 from 7.88 to 7.73. The greatest change was the decline in the fish spawning habitat score from 0.49 to 0.19 between 2006 and 2007, as the result of an accumulation of fine sediment on the stream bed.

5.4.2.2 *Fish*

As part of the resource consent process at SH20, a baseline (pre-construction) survey was undertaken in April 2002 (Boffa Miskell, 2002), with a construction-phase survey undertaken in April 2006 (Boffa Miskell, 2006). The Boffa Miskell survey programme included taking cross-sectional profiles within the stream and sampling fish and macroinvertebrates at 9 sites within the Oakley Creek and its tributaries. One of these sites was in the Oakley Creek Tributary within Keith Hay Park (Fig. 5.40), and is used as a comparison here.

In order to carry out the fish survey, Boffa Miskell (2002; 2006) deployed ten baited Kilwell bait traps and two unbaited Fyke nets overnight, and electrofished an area of approximately 50m^2. All fish were captured, measured, and returned to their habitat. The results of these samples are presented in Table 5.13, along with observations made while undertaking suspended solid sampling in the Oakley Creek Tributary between December 2006 and August 2007.

Table 5.13: Comparison of the two fish samples collected in the Oakley Creek Tributary in 2002 and 2006, and the observations made between 2006 and 2007. The samples are classified as 'Upstream' and 'Downstream' to indicate their location in relation to the SH20 extension project. Where: A '-' indicates the species was not present, rare (R) = 1 fish, occasional (O) = 2 – 4, common (C) = 5 – 9, abundant (A) = 10 or more fish.

Species	Upstream, 2002 [a]	Upstream, 2006 [b]	Downstream, 2006	Downstream, 2007
Shortfinned eel (*Anguilla australis*)	C	C	-	-
Mosquitofish (*Gambusia affinis*)	C	-	-	-
Eels (observed)	O	-	R	R
Mosquitofish (observed)	-	-	A	A

a = Boffa Miskell (2002), b = Boffa Miskell (2006).

Only two fish species were recorded in the Oakley Creek Tributary: the native shortfinned eel (*Anguilla australi)* and the introduced mosquitofish (*Gambusia affinis).* Shortfinned eels are the most commonly occurring fish species in the Auckland Region, recorded in 41% of regional fish records, while mosquitofish occurred in 7.5%, the highest scoring introduced species (ARC, 2000). The low fish diversity is attributed to poor habitat quality, low water quality and the restrictions to fish passage due to the presence of a large waterfall downstream (Boffa Miskell, 2006). While fish samples were not undertaken during the course of this study, a shortfinned eel was often observed near the Stream sampling site, as were large schools of *Gambusia*. These were also observed while collecting the Upstream samples in 2006 and 2007. Boffa Miskell (2006) attributes the absence of *Gambusia* from the 2006 sample to seasonal conditions.

5.4.2.3 Macroinvertebrates

This section presents the results of the 2006 and 2007 macroinvertebrate surveys, and compares these results to those collected by other studies within the Oakley Creek Tributary.

5.4.2.3.1 Comparison with other studies

As with the fish sampling, Boffa Miskell (2002) undertook a baseline macroinvertebrate survey in the Oakley Creek Tributary in 2002 (Fig.5.40), followed by a construction phase monitoring sample in 2006 (Boffa Miskell, 2006). These samples were undertaken in accordance with Stark *et al.* (2001) following collection Protocol C2- *Soft-bottomed, semi-quantitative,* and analysis Protocol P1- *Coded Abundance* in. The results are presented in Table 5.14 (Upstream 2002 and 2006). Protocol P1 substitutes coded abundances for actual counts, and is based on the 5-level protocol developed by Stark (1998) where: Rare (1 – 4 individuals); Common (5 – 19); Abundant (20 – 99); Very Abundant (100 – 499); and Very, Very Abundant (500 +) (Stark, 1998; Stark *et al.,* 2001).

As detailed in Chapter 4, two macroinvertebrate samples were collected during this study; one in 2006 and one in 2007. They were also taken in the Oakley Creek Tributary, but were downstream of the SH20 extension works (Fig. 5.40). These samples were also collected in accordance with Protocol C2 but were analysed in accordance with Protocol C3- *Full Count* in Stark *et al.* (2001). These data are presented in Table 5.16. In order to allow comparison with the data presented by

Boffa Miskell (2002, 2006), the data have been assigned coded abundances (Stark, 1998), and are presented in Table 5.14 (Downstream 2006 and 2007).

Fig. 5.40: Aerial view of the Oakley Creek Tributary (blue), showing the location of the Upstream and Downstream sample sites in relation to the SH20 extension (Photo courtesy of ARC, 2007).

Overall, the four samples had similarly low taxonomic richness (8 to 11 taxa) and low SQMCI scores (2.82 – 4.02), placing the Oakley Creek Tributary in the "fair" category in 2002, and in the "poor" category in 2006 and 2007 (Table 5.15). The 2002 upstream samples had the highest score of 4.02 (out of a possible 10). The macroinvertebrates present had low MCI-sb scores, with the highest being 6.7 (Diptera Tanypodinae), and lowest being 0.1 (Mollusca Physa). This indicates that the Oakley Creek Tributary was not a pristine stream before construction works started. The Upstream SQMCI score declined to 3.39 in 2007 and, despite having a higher taxonomic richness, the 2006 and 2007 downstream sites scored lower than the upstream sites (2.95 and 2.82 respectively). This is due to the absence of the less pollution - tolerant organisms downstream (which have higher MCI-sb scores), and reflects the superior macroinvertebrate habitat upstream compared with the downstream sampling site (including instream vegetation, overhanging riparian vegetation, shallower water, more consistent flow rates). This will impact on the presence of some macroinvertebrates (Fig. 5.41).

Table 5.14: Comparison of the four macroinvertebrate samples collected in the Oakley Creek Tributary between 2002 and 2007. The samples are classified as 'Upstream' and 'Downstream' to indicate their location in relation to the SH20 extension project. R = Rare, C = Common, and A = Abundant; '-' indicates the taxon was absent.

Taxa		**MCI-sb Value** [a]	**Upstream 2002** [b] **(1)**	**Upstream 2006** [c] **(2)**	**Downstream 2006 (3)**	**Downstream 2007 (4)**
Odonata	*Ischnura*	3.1	C	-	-	-
	Hemicordulia	0.4	-	R	-	-
Trichoptera	Triplectides	5.7	C	R	-	-
	Oxyethira	1.2	-	-	R	R
Hemiptera	*Sigara* sp.	2.4	A	R	R	C
	Anisops sp.	2.2	R	-	-	-
Coleoptera	*Enochrus*	2.6	R	-	-	-
	Hydrophilidae	8.0	-	R	-	-
	Dytiscidae	0.4	-	-	R	-
	Elmidae	7.2	-	-	R	R
Diptera	Tanypodinae	6.5	A	C	-	-
	Tanytarsini	3.0	-	C	-	-
	Aphrophila	5.6	-	-	R	R
	Chironomus	3.4	-	A	A	A
	Empididae	5.4	-	-	R	-
	Orthocladiinae	3.2	-	-	A	A
Mollusca	Physa	0.1	R	-	-	-
	Potamopyrgus	2.4	-	-	R	R
Hirudinea	Hirudinea	1.2	C	C	A	A
Oligochaeta	Oligochaeta	3.8	-	-	A	A
	Taxonomic Richness		8	8	11	9
	Total Coded Abundance		58	39	87	89
	SQMCI:		**4.02**	**3.39**	**2.95**	**2.82**

Where; a = Stark and Maxted (2007a), b = Boffa Miskell (2002), c = Boffa Miskell (2006).

Table 5.15: Guide to interpreting MCI-type results (Stark and Maxted, 2007b).

Quality Class	**Descriptions**	**MCI / MCI-sb**	**QMCI & SQMCI / QMCI-sb & SQMCI-sb**
Excellent	Clean water	> 119	> 5.99
Good	Doubtful quality or possible mild pollution	100 – 119	5.00 – 5.90
Fair	Probable moderate pollution	80 – 99	4.00 – 4.99
Poor	Probable severe pollution	< 80	< 4.00

Fig. 5.41: Comparison in the macroinvertebrate habitat within the Oakley Creek Tributary between the Upstream (A, B) and Downstream (C, D) sampling locations.

The most abundant taxa across the four samples were flies (Diptera), waterbugs (Hemiptera), and "worms" - segmented worms and leeches (Oligochaeta and Hirudinea respectively). This is a reflection of the modified nature of the Oakley Creek Tributary, with its low flows, general lack of riparian vegetation, increased nutrient inputs, and the installation of the culvert beneath the motorway in 2005. In addition, these factors favour the accumulation of fine sediments and the development of macrophyte beds (Suren, 2000). Boffa Miskell (2006) observed that the deep, soft sediment in the Oakley Creek Tributary is likely to build up over time.

The accumulation of fine sediments in a stream often results in a compositional change in the invertebrate community, with a decline in sensitive species such as stoneflies and mayflies, and an increase in the densities of organisms such as chironomids and oligochaetes which can burrow in the sediments (Suren, 2001). When the stream bed is blanketed by fine sediments, it effectively enlarges the habitat for these burrowing taxa, as well as reducing predation from other organisms, and thus they rapidly reproduce to exploit these conditions (Hellawell, 1986). This phenomenon is evident in the Oakley Creek Tributary; there were no chironomids present in 2002. However, they were found to be abundant in both the 2006 upstream and downstream samples, as well as the 2007 downstream sample. Oligochaetes and Orthocladiinae were not present upstream of the SH20 extension works. However, they were 'abundant' in both the 2006 and 2007 downstream samples, indicative of increased sedimentation downstream (Jowett *et al.,* 1991) compared to the upstream samples.

In addition, no Odonata sp. (Dragonflies) or Trichoptera *Triplectides* (stick cased caddisfly) were found downstream. This is an indication of the reduced macroinvertebrate habitat downstream (Fig. 5.41).

5.4.2.3.2 Calculation of the MCI-sb

Table 5.16 presents the full count results of the 2006 and 2007 macroinvertebrate samples collected downstream of the Somerset Road sediment retention pond discharge. This table contains both the MCI-sb and QMCI-sb scores. However, studies have shown that the QMCI-sb has an error of ± 12 – 22%, while the MCI-sb has an error of ± 4 – 9% (Stark and Maxted, 2007b), and therefore the MCI will be used to compare this data.

MCI scores range from 0 to 200 (Stark, 1985), and scores of 66 and 68 place the Oakley Creek Tributary in the "Poor" quality class (Table 5.12) for 2006 and 2007 respectively. The 2007 sample had a higher MCI score than the 2006 sample. However, these scores are very similar, and do not necessarily indicate an improvement during the study period. They do suggest that conditions have not deteriorated between 2006 and 2007 in the portion of the Oakley Creek Tributary that was sampled.

Table 5.16: Full count data for the macroinvertebrate samples collected in 2006 and 2007 downstream of the Somerset Road sediment retention pond discharge.

Taxa		**MCI-sb Score**	**2006**	**2007**
Hemiptera	*Sigara*	2.4	3	5
Trichoptera	*Oxyethira*	1.2	4	2
Coleoptera	Dytiscidae	0.4	1	-
	Elmidae	7.2	1	1
Diptera	*Aphrophila*	5.6	4	1
	Chironomus	3.4	34	46
	Empididae	5.4	4	-
	Orthocladiinae	3.2	23	38
Mollusca	*Potamopyrgus*	2.4	2	4
Oligochaeta	Oligochaeta	3.8	47	36
Hirudinea	Hirudinea	1.2	21	25
		Total Abundance	144	158
		Total Richness	11	9
		EPT Richness (excl. *Oxyethira)*	0	0
		MCI-sb	66	68
		QMCI-sb	3.20	3.05
		% Dominant Taxa	23.61%	29.11%
		Dominant Taxa	Oligochaeta	*Chironomus*

Where; a = Stark and Maxted (2007a).

The 2007 sample had a higher total abundance (158 compared with 144), but a lower total richness (9 compared with 11) than the 2006 sample. There were no EPT taxa (Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly)) in either sample- the pollution tolerant Trichoptera *Oxyethira* (axehead caddisfly) was not included, as it is not considered to be as pollution intolerant as the other EPT taxa.

The community composition was very similar between the 2006 and 2007 samples, with the major differences being the absence of Dytiscidae (Coleoptera) and Empididae (Diptera) from the 2007 sample. There was also a change in the dominant taxon between 2006 and 2007. Oligochaetes were the numerically dominant taxon in 2006, comprising 47 individuals, or 23.6% of the sample, whereas Chironomids were dominant in 2007, with 46 individuals, or 29.1% of the sample. This is not of great significance as both of these taxa were present in the 2006 and 2007 samples, and are considered to be indicators of degraded environments (Stark and Maxted, 2007b).

5.4.2.4 Summary

Overall, the sites were in relatively poor ecological health, supporting predominately pollution tolerant taxa, with the sensitive species such as EPT largely absent from all samples. This is in agreement with the findings of other studies involving streams in urban areas including Suren (2000), Hogg and Norris (2001), and Paul and Meyer (2001).

There was a decline in the SQMCI of the upstream samples between 2002 and 2006, and the downstream samples scored below the upstream samples in both 2006 and 2007. The four macroinvertebrate samples undertaken in the Oakley Creek Tributary indicate that the taxa present are generally pollution tolerant, and are therefore likely to be resistant to potential impacts of the SH20 Project. This was further supported by a small increase in the MCI scores of the downstream samples between 2006 and 2007.

5.5 Summary of Results

Precipitation was recorded at the Somerset Road site using a tipping bucket rain gauge between February and August 2007 while prior to this, rainfall data was sourced from the NIWA Climate Database (NIWA, 2008). The 2007 annual rainfall in Auckland was 12% below the long term annual average, and all months except March and July received lower than average monthly rainfall. March and July 2007 had the highest monthly rainfalls during the study period, while February and May 2007 had very low levels of rainfall.

Suspended solid measurements were made in the Somerset Road sediment retention pond between November 2006 and August 2007. The majority of runoff from the contributing catchment was retained in the forebay and only overflowed into the main pond following the heavy or prolonged rainfall, meaning that the majority of suspended solid removal occurred in the forebay. When water did overflow into the main pond, a small reduction in suspended solid levels was achieved in the main pond. Due to low water levels in the main pond, discharge was only recorded 7 times during the study. The suspended solid levels in this discharge were substantially lower than those reported by other studies such as Ehrhart *et al.* (2002) and Moores *et al.* (2007).

Suspended solid measurements were made in the Richardson Road sediment retention pond between March 2007 and August 2007. There was a continual groundwater input into the forebay, and due to the increased slope gradient onsite, large volumes of runoff entered the forebay following rainfall events. This resulted in the forebay overflowing into the main pond for the majority of the sampling period, and consequently the main pond was always discharging. The suspended solids levels were higher throughout the pond system compared to Somerset Road, but were still well below those levels reported in other studies on sediment retention ponds (Winter, 1998; Ehrhart *et al.*, 2002; and Moores *et al.*, 2007).

Suspended solid measurements were made in the Oakley Creek Tributary between December 2006 and August 2007. The average suspended solids being discharged from the sediment retention pond were very similar to the average suspended solid levels in the stream, indicating that there was no substantial impact on the stream. Furthermore, while the SEV analysis showed that a layer of fine sediment had been deposited on the bed of the stream between November 2006 and November 2007, there was no impact the macroinvertebrate taxa within the stream, which had very similar community compositions in 2006 and 2007.

Chapter 6:
Discussion

6.1 Introduction

This chapter provides a discussion of the results presented in Chapter 5, and includes the suspended solids measured in the Somerset Road and Richardson Road sediment retention ponds, as well as the suspended solids and Stream Ecological Valuation samples undertaken in the Oakley Creek Tributary.

6.2 Somerset Road Sediment Retention Pond

This section discusses the Somerset Road sediment retention pond, and is divided into three parts: forebay, main pond and the discharge.

6.2.1 Forebay

The majority of suspended solid removal occurred in the forebay of the Somerset Road sediment retention pond. This is because the forebay did not often become full enough to overflow into the main pond, as outlined below. Therefore the majority of runoff from the site was retained in the forebay, and either infiltrated through the base, or was lost to evaporation.

The presence of water in the Somerset Road forebay is strongly correlated to rainfall, onsite earthworks, and the erosion and sediment control measures installed. The amount of rainfall must exceed the infiltration capacity of the soil before runoff to the forebay will occur, but onsite works have the ability to impact the infiltration capacity of a soil: when the clay is compacted the infiltration rate of the soil is severely reduced, resulting in the rapid generation of runoff, even following relatively small runoff events.

For example, the rainfall in November 2006 and December 2006 was relatively low, but the runoff contained comparatively high levels of suspended solids, as outlined in Section 5.3.1.2.2. This was due to the onsite works during this time period, with fill being added to the site, resulting in a compacted surface (Fig. 6.1), and is indicative of the high levels of suspended sediment which can be eroded from an unprotected earthworks site. While the site remained exposed to erosion in January and February 2007, there was insufficient rainfall to generate runoff to the forebay.

Fig. 6.1a: Aerial view of the onsite works adjacent to the Somerset Road pond in November 2006 (Photo courtesy of Transit, 2006).

Fig. 6.1b: Aerial view of the onsite works adjacent to the Somerset Road pond in December 2006 (Photo courtesy of Transit, 2006).

Between March and June 2007, water was only present in the forebay outflow following large rainfall events, with no water being observed in the forebay inflow during this time period. This is attributed to the progressive installation of erosion and sediment control measures, such as surface mulching which aids infiltration and decreases runoff, and earth bunds which direct the flow of runoff (Fig. 6.2), following the completion of the earthworks season in late April 2007.

Fig. 6.2: Earth bunds and mulch were used to slow the flow of runoff and aid the establishment of grass. Water has ponded against the earth bund rather than flowing down the bank.

Heavy and prolonged rainfall in July 2007 exceeded the infiltration capacity of the soil, resulting in the continued presence of water in the forebay during July and August 2007.

When the PAC dosing system was connected, large reductions in suspended solid levels were observed over a short horizontal distance within the forebay. For example, following 13 consecutive days of rainfall (91.2 mm) at the end of June and start of July 2007, the suspended solids levels in the forebay inflow on 11/07/07 were 104.84 ± 4.61 mg/L, which is significantly higher than the level measured in the forebay outflow (41.51 ± 8.43 mg/L) on the same day. This indicates that the PAC is causing particles to rapidly settle out of suspension within the forebay.

Conversely, on 12/08/07 the suspended solids levels were lower in the inflow (137.10 ± 2.40 mg/L) compared with the outflow (153.16 ± 4.08 mg/L, as outlined in 5.3.1.2.2). While onsite it was noticed that the pipe conveying the PAC to the forebay had pulled away from the reservoir tank and the PAC was running down the side of the shed (Fig. 6.3a). Thus the runoff entering the forebay was not receiving any chemical dosing, and consequently had elevated levels of suspended solids (Fig.

6.3b), further supporting the observation that PAC causes suspended solids to rapidly settle out of suspension within the forebay.

Fig. 6.3a: Pipe disconnected from the side of the chemical dosing shed on 12/08/07.

Fig. 6.3b: Increased turbidity within the Somerset Road forebay on 12/08/07.

Therefore, as the forebay did not generally overflow into the main pond, it was providing a long retention time for runoff, and was very effective at sediment removal. When the forebay was full and the chemical dosing system connected, the concentrations varied along the length of the forebay, with generally low suspended solids values at the outflow end, indicating successful settlement. However, when the system was not connected, the forebay was well mixed and not indicating significant suspended solid removal. Overall, the chemical dosing system aids suspended solid settlement even when the site is stabilised.

6.2.2 Main Pond

The main pond was very well mixed longitudinally throughout the study period. As depth samples were not taken, no comment can be made regarding vertical mixing. However, due to the often shallow water levels (and thus resultant convection currents) in the pond, it is unlikely that stratification occurred.

Between November 2006 and May 2007 (excluding late March and early April, 2007) the volume of water in the main pond was controlled by the capture and storage of smaller rainfall events within the forebay and therefore the main pond did not contribute to the overall suspended solids removal during this time period.

Because runoff did not leave the forebay between December 2006 and early March 2007, the water level in the Somerset Road main pond decreased, and the water became warmer. This resulted in the growth of algae within the pond, and is likely the cause of the spikes observed at the start of the main pond on 15/12/06 and 26/02/07 (Section 5.3.1.3.1). This algal growth had no impact on the pond's operating efficiency.

However, during heavy or prolonged rainfall events, such as occurred in late March and early April 2007, and periodically between June 2007 and August 2007, the forebay would overflow into the main pond, which then provided additional storage capacity for the runoff.

For example, the forebay was not full of water on 26/07/07 (Fig. 6.4a), and the main pond had an average suspended solids concentration of 3.96 ± 0.18 mg/L. Large volumes of water were observed alongside the main pond on 26/07/07 (Fig. 6.4b) and, as the result of a further 41.4 mm of rainfall between 26/07/07 and 01/08/07, it is likely that the majority of this water, as well as additional runoff, flowed into the forebay, causing the forebay to fill and overflow into the main pond. Due to the subsequently reduced residence times, this water contained elevated suspended solids levels, and increased the average suspended solids levels within the main pond to 15.64 ± 0.67 mg/L on 01/08/07. Despite the continuous input of water from the forebay, this level had reduced to 4.97 ± 0.15 mg/L on 12/08/07, indicating that a reduction in suspended solid concentration occurred within the main pond. However, it is likely that part of this reduction was due to a dilution effect within the main pond, rather than actual settlement.

Fig. 6.4a: Water accumulated in the lower "outflow" portion of the Somerset Road forebay on 26/07/07.

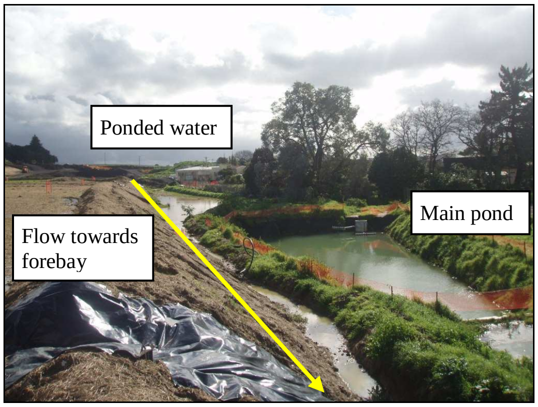


Fig. 6.4b: Water ponded alongside the Somerset Road main pond on 26/07/07.

The importance of the forebay in removing suspended solids prior to runoff entering the main pond was demonstrated at the beginning of March 2007. Following the heavy rainfall previously described in Section 5.2.1, the average suspended solids level in the main pond were almost 6 times higher than the levels in the forebay outflow at the same time (Section 5.3.1.3). Extensive gully erosion was observed in the banks alongside the pond on 16/03/07, and a visual observation was made that the pond was very turbid (Fig. 6.5), indicating that considerable runoff had occurred. As the forebay was not full enough to overflow at this time, it can be concluded that the runoff was bypassing the forebay and going directly into the main pond from the side, therefore not receiving any chemical treatment.

Fig. 6.5: Pronounced gully development in the banks alongside the Somerset Road pond, and high turbidity levels are apparent in the main pond.

On 02/04/07 the suspended solid levels in the main pond were 5 times lower than that recorded in the forebay outflow. This was the direct result of the construction of a bund alongside the main pond in late March (Fig. 6.6), which ensured that all sediment laden runoff passed through the forebay, rather than entering the main pond directly. This demonstrates the importance of the forebay and the PAC dosing system.

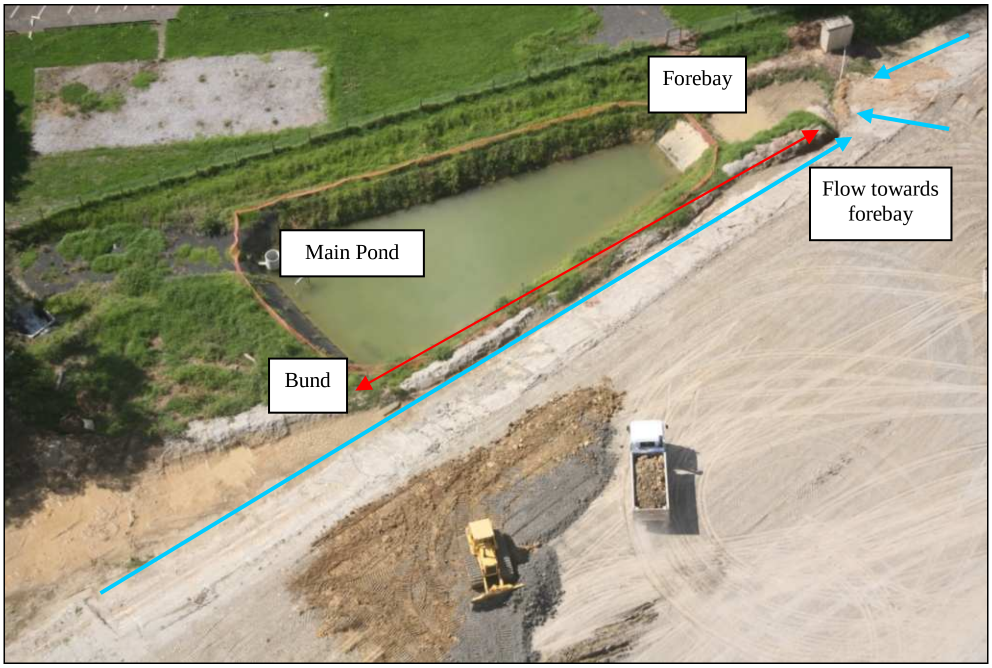


Fig. 6.6: Aerial view of the Somerset Road pond on 10/04/07, showing the creation of channels and bunds to direct the flow of runoff into the forebay (Photo courtesy of Transit, 2007).

6.2.3 Discharge

Discharge volumes from the pond are directly related to runoff volumes, because if no water is entering the pond, there is no water to discharge from it. The flow regime within the forebay, as described above, meant that the Somerset Road pond seldom discharged between November 2006 and June 2007. However, based on site observations, it is likely that discharge occurred almost continuously in July and August 2007.

The suspended solids levels in the discharge had an average concentration of 3.70 ± 0.7 mg/L, which is very low compared with other studies investigating discharge from sediment retention ponds (Winter 1998; Ehrhart *et al.* 2002; Moores *et al.* 2007). While Graham (1990) found that suspended solids levels of between 1 – 10 mg/L had a negative effect on a pristine stream environment, the discharge from the Somerset Road pond is likely to have little effect on the receiving environment (the Oakley Creek Tributary) because of the naturally high baseline suspended sediment concentrations, relative to discharge concentrations, within the stream (an average of 9.51 ± 6.51 mg/L at the upstream and stream sites between December 2006 and August 2007).

6.2.4 Summary

The forebay average to discharge ratio for the period between November 2006 and August 2007 was 19, however when November and December 2006 are excluded (because of the high suspended solid concentrations in the runoff, which did not enter the main pond during this period), the ratio is 6. This implies that substantial suspended solid removal occurred within the Somerset Road pond system: the bulk of which was achieved in the forebay, particularly as it was not always overflowing into the main pond. A smaller amount of suspended solid reduction was achieved in the main pond, predominately through dilution. The elevated levels of suspended solids recorded in the Somerset Road forebay in November and December 2006 are an indication that even small volumes of rain falling on an unstabilised earthworks catchment can result in the generation of runoff containing high levels of sediment.

6.3 Richardson Road Sediment Retention Pond

The following section provides a summary of the trends measured and observed within the three components; forebay, main pond, and discharge, of the Richardson Road Pond.

6.3.1 Forebay

Water flowed into the forebay through one of two channels: the runoff flow channel which conveyed runoff from directly upslope of the pond, and the forebay diversion channel, which conveyed runoff from the slopes alongside the pond. The runoff flow channel was considered to be the main inlet channel, and therefore the PAC dosing pipe was suspended above it to ensure treatment of the water as it entered the forebay. However, this meant that the runoff entering through the forebay diversion channel was not directly dosed with PAC. The water level in the forebay was typically at, or just below, the level spreader at all times, as the result of continual flow of groundwater from the drainage blanket. The subsequently reduced residence time decreased the potential for the PAC to become evenly distributed through the forebay and therefore dose the water entering through the forebay diversion channel.

The continuous flow of groundwater from the drainage blanket into the forebay effectively increased the size of the catchment draining to the pond. While the groundwater contained very low levels of suspended solids (average of 1.88 ± 0.82 mg/L) and therefore did not require treatment, it diluted the PAC within the forebay, reducing its effectiveness. In addition, it caused water from the forebay diversion channel to short circuit the forebay and enter the main pond with minimal mixing with the PAC dosed runoff. This is because the groundwater input and the forebay diversion channel entered on the same side of the forebay (Fig. 6.7), and as the groundwater entered the pond, it forced the flow of water from the diversion channel away from the middle of the forebay, and over the level spreader.

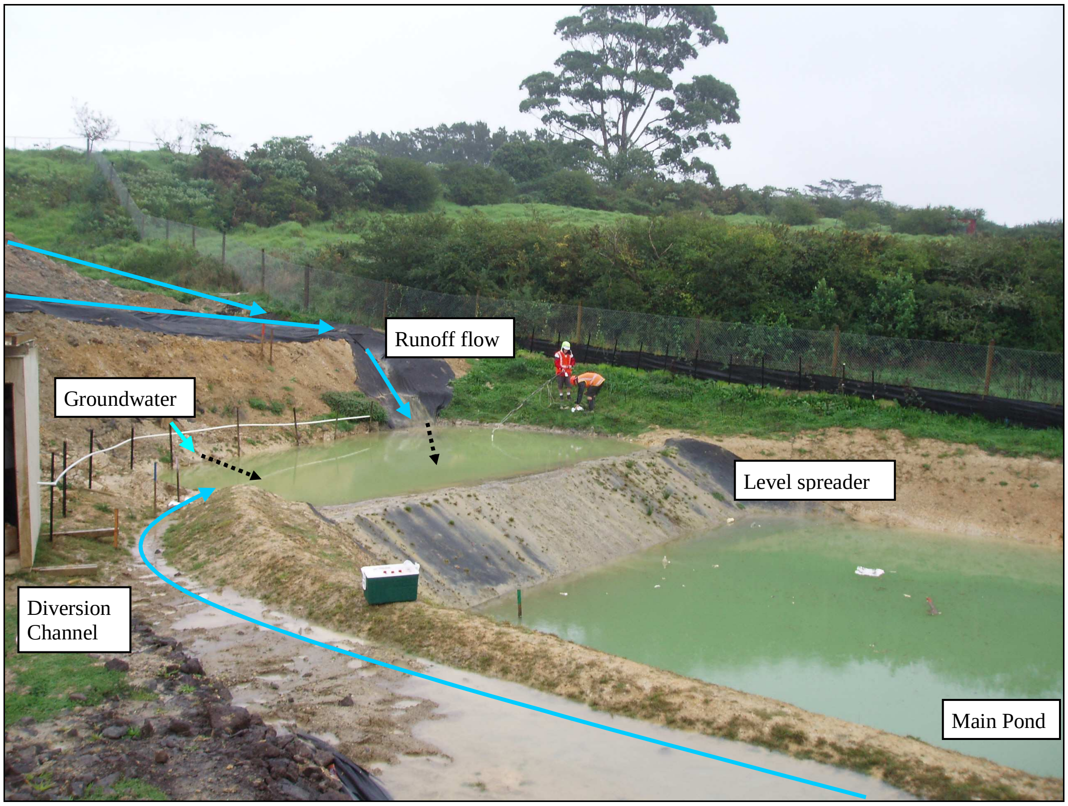


Fig. 6.7: The Richardson Road pond showing the entry point of two channels which convey runoff to the pond and the groundwater input. The flow of water to the forebay is indicated by the solid arrows, while the assumed flows within the bay are shown by the broken arrows. Water overflows from the forebay down the level spreader into the main pond.

The forebay diversion channel contained water for the majority of the sampling period (March 2007 – August 2007). However, as it had minimal slope, water would only began to flow to the pond following heavy rain, such as occurred in March, July and August 2007. For the remainder of the time, water would either infiltrate or be evaporated. Analysis of the suspended solids results shows that the suspended solids levels were generally higher in the forebay outflow compared to the forebay inflow when water was flowing into the forebay through the diversion channel. Thus, during March, July and August 2007, it is likely that elevated levels of suspended solids were leaving the forebay and entering the main pond as the result of shortcircuiting. The ratio of the runoff flow channel to the forebay average was 6 for the sampling period (March – August 2007), compared with 3 for the forebay diversion channel to the main pond average, further demonstrating that water entering from the forebay diversion channel was not achieving satisfactory PAC dosing or retention time within the forebay.

The flow regime described above was clearly demonstrated on 11/07/07 following continuous rainfall over the preceding 13 days (91.2 mm). Substantial volumes of water were observed flowing across the stabilised earthworks surface upslope of the Richardson Road pond (Fig. 6.8A), as well as rapidly flowing into the forebay through the forebay diversion channel (Fig. 6.8C, D) and runoff flow channel (Fig. 6.8B, C, E, F). The groundwater input was observed to be flowing faster than normal, and filled a 1 L sample bottle in approximately 6 seconds; a flow rate of 0.17 L/s.

As a result of the increased water volumes entering the pond, the residence time of water in the forebay was short. Because the water did not remain in the forebay for any length of time, the rate of settling would have been reduced, and therefore increased volumes of suspended sediment would have entered the main pond. In addition, as shown in Fig. 6.8F, the runoff entering the forebay was very turbulent. This turbulence would have resulted in larger particles remaining in suspension, and the potential resuspension of settled particles, which would then be carried by currents into the main pond. The increased flow of groundwater redirected the flow of the diversion channel towards the level spreader, and over into the main pond, resulting in elevated suspended solids levels in the main pond on 17/07/07, as detailed in Chapter 5. The suspended solid ratio between the runoff flow channel and the forebay average was 12 in July 2007 indicating that a large proportion of the incoming suspended solids were settling out in the forebay. In comparison, the suspended solid ratio between the forebay diversion channel and the forebay average was only 4, so while settling was occurring in the forebay, it was substantially lower.

Fig. 6.8: The Richardson Road forebay on 11/07/07 where: **A:** Preferential flow path across the surface; **B:** Runoff flow channel to the forebay; **C:** Location of the forebay diversion and runoff flow channels and the groundwater input; **D:** View of the diversion channel looking towards the main pond discharge; **E:** Sediment - laden water flowing down the runoff flow channel; and **F:** Turbulence in the forebay caused by the runoff flow.

The suspended solid settlement ratios for July 2007 (12 and 4, as detailed above) are higher than the overall averages (6 and 3) despite the reduced residence time of runoff within the forebay. During July 2007, large areas of soil were exposed upslope of the pond (Fig. 6.9). Because of the increased slope gradients onsite, the subsequent high runoff velocities resulted in the entrainment of bedload, which was then transported to the forebay by way of the runoff flow channel (Fig. 6.9).

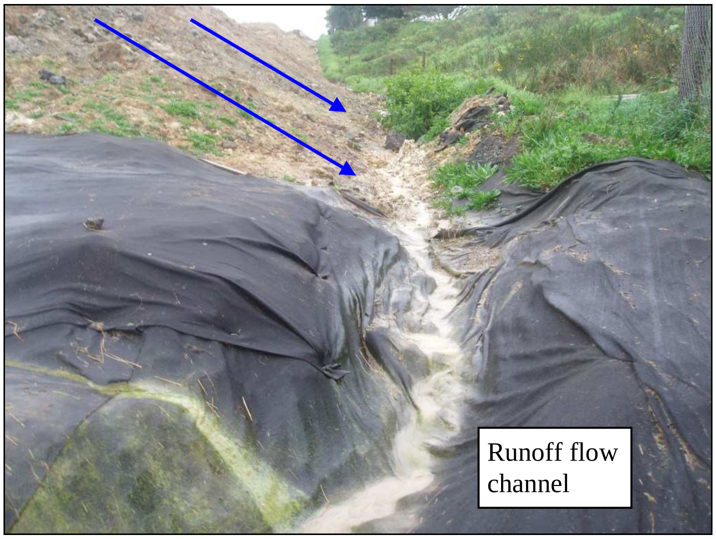


Fig. 6.9: Exposed soil and high runoff velocities meant that increased sediment reached the Richardson Road pond.

Following a reduction in flow velocity, this material dropped out of suspension, forming a delta at the point where the runoff flow channel enters the forebay (Fig. 6.10). Thus the comparatively high levels of suspended solid removal in the Richardson Road forebay in July 2007 are most likely due to the deposition of larger grain sizes, rather settling of fine particles following PAC dosing.

Fig. 6.10: Development of a sediment delta at the entrance to the Richardson Road forebay on 17/07/07.

As reflected by the increased suspended solid levels in the main pond during July and August 2007, it is unlikely that the runoff was retained in the forebay long enough for the fine suspended material to settle out of suspension.

6.3.2 Main Pond

As with Somerset Road, the main pond was well mixed longitudinally, and no comment can be made on the degree of vertical stratification. The contributing catchment at Richardson Road had a higher slope grade, and therefore experienced less ponding and increased runoff following rainfall events compared to Somerset Road. This, coupled with the continuous flow of groundwater into the forebay, meant that the main pond discharged continuously during the study period (March 2007 – August 2007). Further comparisons between the two ponds are provided in Section 6.4.

Due to the shortened residence times in the forebay (Section 6.3.1), the suspended solids levels within the main pond increased through June, July and August 2007 (Table 5.6; Fig. 5.25). The ratio of the forebay average to the main pond average was 2 for the total sampling period, and therefore settlement of suspended solids was being achieved in the main pond. As with Somerset Road, this is likely to be due to dilution within the main pond, rather than actual settlement being achieved, however this ratio is lower than that achieved at Somerset Road, and will be discussed in Section 6.4.

6.3.3 Discharge

The Richardson Road sediment retention pond had an average suspended solid concentration of 9.42 ± 1.13 mg/L, and was correlated to the main pond, with a ratio of 1 between May 2007 and August 2007. The suspended solids levels in the discharge increased steadily between June and August as the result of decreased retention times in the main pond, however as the discharge flows through a wetland prior to entering the stream (a tributary of Oakley Creek), it is likely that some of the suspended solids would have been filtered out, further reducing the impact of this discharge. Furthermore, these levels were significantly lower than those reported in other studies (Winter, 1998; Ehrhart *et al*., 2002; Moores *et al.*, 2007).

6.4 Comparison of the two ponds

The variations in the flow regime of the two retention ponds results from the different characteristics of the onsite earthworks within the contributing catchments. The Somerset Road pond was characterised by low runoff volumes as the result of a flat catchment which was stabilised for the majority of the time. In contrast, Richardson Road pond had greater slope grades, and onsite earthworks continued for a longer time period, meaning that during rainfall events, increased runoff was generated, and it had the potential to cause more erosion because of the steeper flow paths and greater extent of exposed soil. These differences will be discussed further in the following sections.

6.4.1 Forebay

The major difference between the forebays of the two ponds is that the Richardson Road forebay was full of water throughout the sampling period due mainly to the continuous groundwater input, resulting in reduced retention times. The forebay at Somerset Road was typically empty, and therefore runoff did not enter the main pond (except during large or prolonged rainfall events), and was instead lost to evaporation or infiltration. Both forebays effectively captured the coarse particle material (bedload) entrained in the runoff requiring the Somerset Road forebay to be manually dug out in February 2007 and resulting in the development of a delta in the Richardson Road forebay in March 2007, which subsequently required digging out.

While there is evidence that fine particles were settling out in the Somerset Road forebay, with the surface water in the forebay inflow having higher suspended solid concentrations than the forebay outflow, there is no solid evidence for the settling of fines in the forebay at Richardson Road. This is likely to be due to dilution of the PAC within the forebay by the groundwater input, as well as the reduced residence time in the forebay as the result of high water levels and shortcircuiting. Therefore, the Somerset Road forebay was much more effective at removing suspended solids.

6.4.2 Main Pond

Due to the differing flow regimes in the two forebays, the main ponds at Somerset Road and Richardson Road also operated differently. The Somerset Road pond was typically well below the decant level, as comparatively low volumes of runoff overflowed from the forebay. This increased the retention time within the main pond, and thus the forebay average to main pond average was 5. In contrast, the Richardson Road pond was always above the level of the lower decant arm, and therefore discharged continuously, reducing the residence time and thus settling potential within the main pond. Subsequently, the ratio of the forebay average to the main pond average for Richardson Road was 2. This much lower than that of the Somerset Road pond, indicating that the Somerset Road main pond was more effective at reducing suspended solid levels in runoff prior to it being discharge to receiving environments.

6.4.3 Discharge

As previously stated, the Richardson Road pond discharged continuously during the sampling period (March – August 2007), while discharge at Somerset Road was only collected 7 times between November 2006 and August 2007. The Somerset Road pond discharge had an average suspended solids level of 3.70 ± 0.7 mg/L, while the Richardson Road pond had an average of 9.42 ± 1.13 mg/L, and was therefore 2.5 times higher. This is considered to be a reflection of the differences in the contributing catchment characteristics, and the subsequent differences in flow regimes between the two ponds. The reduced residence time in Richardson Road results in less potential for suspended solid settlement to occur, and therefore higher levels of suspended solids in the discharge. Nonetheless, the suspended solid levels in the discharge from both ponds were well below those reported in other studies (Winter, 1998; Ehrhart *et al*., 2002; Moores *et al.,* 2007).

6.4.4 Comparison of overall effectiveness

The ratio of suspended solids in the water entering the forebay (average of the forebay diversion and runoff flow channels) to the discharge at the Richardson Road pond for the period between March 2007 and August 2007 is 10. Therefore, substantial suspended solid removal was achieved through the pond system. As only one measurement was made of the water coming into the Somerset Road forebay, the same comparison can not be made. However when the ratios of the forebay average to the main pond discharge for the period of March 2007 to August 2007 are compared, there is a noticeable difference between the two ponds. The ratio of the Somerset Road pond was 6, compared to just 2 in the Richardson Road pond. This ratio is much lower than the comparison of runoff to discharge (10), indicating that the majority of suspended solid removal was occurring as the runoff entered the forebay at Richardson Road. Shortcircuiting and reduced residence times within the forebay means that this was likely to be the deposition of entrained bedload from the incoming runoff, rather than settling of fine suspended solids within the forebay and main pond.

Therefore, the major difference between the two ponds is the reduced residence time within the Richardson Road pond system, which results in decreased suspended solid settlement throughout the pond system. This problem could be overcome by:

1) ensuring that both the runoff flow and forebay diversion channels are dosed with PAC, either by splitting the dose between the two channels, or having all the runoff enter the pond through a single channel. Splitting the PAC could prove difficult, as both pipes would need to have identical slopes to prevent a preferential flowpath and ensure even division of the PAC. Therefore, it would be more effective to have all runoff entering the forebay through one channel, which is then dosed with PAC;

2) decreasing the likelihood of short circuiting, the groundwater should be diverted away from the pond by a diversion bund or channel. The water could be directed alongside the pond (on the opposite side to the forebay diversion channel) and discharged through the wetland or if it must go through the pond, it should enter the main pond directly or;
3) increasing the length and depth (volume) of the forebay. This would increase its storage capacity and retention time and help to dissipate the turbulent energy of the runoff flow channel. It would also reduce the resuspension of settled particles and allow more time for resuspended sediment to settle again

6.5 Oakley Creek Tributary

This section summarises the water quality within the Oakley Creek Tributary, and the effectiveness of the Stream Ecological Valuation and Macroinvertebrate Community Index methods at assessing changes over time. The impact of the Somerset Road sediment retention pond discharge is also discussed.

6.5.1 Water Quality

Investigations undertaken by Boffa Miskell (2002) prior to the commencement of the SH20 extension works showed that the Oakley Creek Tributary was not a pristine stream environment degraded stream system. Furthermore, the Stream Ecological Valuation (SEV) survey undertaken at the commencement of sampling in November 2006 indicated that the Oakley Creek Tributary was already degraded; scoring 7.88 out of a possible 16. This was due to modifications to the riparian vegetation, increased dissolved oxygen demand, and moderate bank erosion. The decreased ecological value within the stream was reflected in the macroinvertebrate survey, with only pollution tolerant taxa being collected, and the subsequent Macroinvertebrate Community Index (MCI) score rating the Oakley Creek Tributary as “poor”.

The Stream Ecological Valuation (SEV) undertaken in 2007 found that there had been increased deposition of fine sediment on the bed of the stream, which could be sourced from the sediment retention pond discharge. As reported in several studies (e.g. Quinn *et al.* (1997), Wood and Armitage (1997) and Paul and Meyer (2001)), an increase in deposited sediment can smother a stream bed, reducing the interstitial habitat, and resulting in an increase in burrowing organisms such as Chironomids, Oligochaetes and Orthocladiinae. These organisms were found in both the 2006 and 2007 macroinvertebrate samples, but there was no obvious increases in densities in the 2007 sample, indicating that the build up of deposited sediment did not result in a community composition change. Hellawell (1986) observed that deposited sediment was rapidly washed away during winter flooding following the completion of earthworks, thus indicating that the build up of deposited sediment may not be a permanent feature within the Oakley Creek Tributary, particularly once earthworks are completed.

The effectiveness of the MCI in assessing environmental changes in the Oakley Creek Tributary between November 2006 and November 2007 was limited by the already degraded nature of this stream. The MCI assesses stream quality by measuring changes in the macroinvertebrate community composition, and is therefore not sensitive enough for use in degraded urban environments where major changes in taxonomic richness are not anticipated. Thus when the organisms present have an increased pollution tolerance, such as recorded in the Oakley Creek Tributary, it will only provide a coarse assessment of environmental change.

In contrast, the SEV method was more effective because it measured a wider range of ecological functions, rather than just the macroinvertebrate community composition. These functions show change over time irrespective of the baseline stream conditions, thus minor changes in the complete system are more evident, providing a better assessment of the quality of a stream.

6.5.2 Suspended Solids Levels

In terms of suspended solid levels, the discharge from the Somerset Road Pond had little impact on the water quality of Oakley Creek Tributary because the suspended solids levels in the discharge (5.88 ± 0.33 mg/L) were within the range of suspended solid values measured within the stream. Studies, such as those undertaken by Rowe *et al.* (2002), indicate that macroinvertebrates are tolerant to increases in suspended solids far above the levels measured in the Somerset Road discharge. Furthermore, the pond was not discharging for the majority of the study period, further reducing its impact on the suspended solid concentrations within the stream.

There are no water inputs between the Discharge and Downstream A sampling sites, and yet despite the input of additional suspended solids within the discharge, Downstream A had the lowest average suspended solids levels during the sampling period (December 2006 – August 2007). This indicates that the water volumes within the stream are able to dilute the additional suspended solids, negating their impact.

6.6 Summary

Elevated suspended solids levels were recorded in both the Somerset Road and Richardson Road ponds during the earthworking period of November – April, as the result of exposed and compacted soil surfaces. Heavy rainfall during the non-earthworks period in July and August resulted in substantial volumes of runoff to the sediment retention ponds, despite stabilisation of the catchments. This indicates that sediment control structures such as sediment retention ponds are important in preventing the discharge of suspended solids to receiving environments year round. Furthermore, the suspended solids levels measured during July and August illustrate the importance of continued chemical dosing during the winter months.

The Oakley Creek Tributary was a degraded stream environment prior to the commencement of the State Highway 20 development works, as the result of human activities within the catchment. The SEV indicated an increase in fine sediment on the bed of the stream, however this deposition had no impact on the macroinvertebrate community composition within the stream. The deposition of sediment is attributed to the discharge of fine suspended solids from the Somerset Road sediment retention pond, but the average suspended solid level in this discharge is below the natural baseline of the stream, indicating that overall, it is not negatively impacting on the stream.

Chapter 7:

Conclusions and Future Research

7.1 Introduction

Water samples were collected from two sediment retention ponds (Somerset Road and Richardson Road) at the SH20 extension project in Mount Roskill, Auckland between November 2006 and August 2007, although sampling did not commence at Richardson Road until March 2007. Samples were collected from within the forebay, main pond and discharge of these two ponds, and from the runoff flowing to the ponds, when available. Samples were then analysed in the laboratory for suspended solids. Samples were also collected from the Oakley Creek Tributary to assess the environmental impact of the discharge from the Somerset Road pond. The Stream Ecological Valuation method (*Rowe et al.,* 2006) was used to assess environmental changes within the Oakley Creek Tributary between November 2006 and November 2007.

The aims of this study were:

1. to consider the effectiveness of two chemically dosed sediment retention ponds in removing suspended solids from runoff on an earthworks site and:

2. to determine the value of using the Stream Ecological Valuation (SEV) method, particularly the changes in the macroinvertebrate community composition, to assess the environmental impact of sediment retention pond discharge on the receiving watercourse during the study period.

7.2 Major Findings

7.2.1 Suspended solids levels

The suspended solids results measured during this study were much lower than those reported by other studies on earthwork sites, both within the Auckland Region, and overseas (Winter, 1998; Ehrhart *et al.* 2002; Moores *et al.* 2007). This may be due, in part, to the SH20 extension being located in an area with less erodible soils, although the soils onsite are considered to be typical of Auckland soils; or a reflection of the gentle slopes onsite which resulted in slow flow velocities, and thus limited potential for erosion to occur. However the major reason behind the reduced suspended solids results is believed to be through erosion and sediment control management practices. These practices included staging earthworks to minimise the area of exposed soil; installing bunds to direct runoff flow and reduce the flow length and velocity on site; and the use of mulching to protect the soil surface from erosion. These practices are recommended by ARC (1999), and were subsequently set out in Fulton Hogan Ltd.'s resource consent. The comparatively low suspended solid values measured during this study, even following heavy and prolonged rainfall, indicates that they were implemented effectively onsite.

7.2.2 Pond operation

The Somerset Road pond was very effective at removing suspended solids throughout the sampling period. During the summer months, all runoff remained in the forebay, and did not reach the main pond. Thus all suspended solids were retained onsite within the forebay. Increased rainfall in July and August 2007 resulted in runoff to the forebay. The PAC dosing system (when connected) operated correctly and caused suspended material to rapidly settle out at the entrance to the forebay.

The Somerset Road main pond was characterised by reduced water levels during periods of low rainfall. During March 2007, and between July and August 2007, the retention capacity of the forebay was exceeded, causing it to overflow into the main pond. When this occurred, the major functions of the main pond were to provide dilution and further settlement of suspended solids, as well as to provide additional storage capacity prior to water being discharged to the receiving environment. Catchment stabilisation meant that discharge from the pond only occurred in early April 2007 and between July and August 2007 as the result of prolonged rainfall events. The suspended solids levels recorded in the discharge from the Somerset Road pond were very low (an average of 4.95 ± 0.43 mg/L) compared with other studies in both Auckland and internationally.

In contrast, the continuous groundwater flow and high runoff inputs to the Richardson Road forebay resulted in reduced residence times within the bay. The groundwater input diluted the PAC, and caused the water entering the forebay through the diversion channel to shortcircuit directly into the main pond. Consequently, large volumes of runoff entered the main pond without being dosed with PAC. This reduced the likelihood of these particles settling out of suspension. The lack of dosing was most evident in July and August 2007, where increased rainfall resulted in the generation of substantial runoff to the forebay.

Furthermore, continuous discharge from the main pond decreased residence time and the potential for settlement to be achieved. Consequently, higher levels of suspended solids (an average of 9.42 ± 1.13 mg/L) were discharged from the Richardson Road pond system, compared to Somerset Road. Despite this, the recorded discharge levels were low compared with other studies in Auckland and internationally.

7.2.3 Polyaluminium chloride dosing

The PAC was clearly effective within both the Somerset Road and Richardson Road sediment retention ponds, particularly within the Somerset Road pond where a longitudinal gradient of suspended solids levels developed within the forebay. However, the rainfall-driven dosing system is based on soil characteristics, and largely ignores the management systems in place within the pond’s contributing catchment. The dosing system at Somerset Road was disconnected in May 2007, and then reconnected for several short periods throughout July and August. In terms of site management, it would have been more efficient to have left the system connected and reduced the dose rate by reducing the surface area of the rainfall catchment tray. This would ensure that any large rainfall events, such as those which occurred in July, would still receive treatment without the hoses in the chemical dosing shed having to be manually reconnected.

7.2.4 Assessment of the environmental impact of the discharge

Because of the already degraded nature of the Oakley Creek Tributary, the use of macroinvertebrates to assess the impact of the sediment retention pond discharge had limited effectiveness at this site. The macroinvertebrates present in the stream were tolerant to changes such as increased suspended sediment, and therefore no substantial changes in community composition were observed. This suggests that macroinvertebrate indices such as the MCI are not valuable tools when assessing the impact of environmental changes within Auckland’s already degraded urban streams.

The SEV method was more effective, as it measures a wider range of ecological functions, most of which will show responses to environmental change irrespective of the stream conditions to begin with. The SEV method, while indicating a build up of fine sediment within the Oakley Creek between November 2006 and November 2007, implied that very little environmental harm occurred as a result of the sediment retention pond discharge.

7.3 Further Research

Two key issues that require further research were identified during the course of this investigation, and are presented below.

7.3.1 Winter dosing rates

The results of this study have shown that even stabilised catchments can result in the generation of runoff containing elevated levels of suspended solids during the prolonged rainfall events during the winter months (June – August). It is during these months that the chemical dosing systems are typically disconnected, when stabilisation of the site has been achieved. Therefore, further research is required to determine a dosing rate for stabilised earthworks sites, to ensure that large rainfall events, and the subsequent runoff, receive some level of chemical treatment.

7.3.2 Mixing within the main pond

Further research could be undertaken into the degree of vertical stratification within a sediment retention pond to determine the importance of pond depth to sediment removal efficiency within the pond, and would indicate if convection currents within the water column can resuspend settled particles from the base of the pond if the water level becomes too shallow.

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Appendix A:

Determination of Sample Replicates

Table A.1: Determination of the optimum number of samples required to achieve a given accuracy, based on a 10 replicate sample collected on 24/11/2006

Sample Location	Sus. Slds (mg/L)	Mean (mg/L)	Std Dev	Std Dev (%Mean)	Optimum Sample Replicates (% Accuracy)						
					5	10	20	25	30	40	50
Start	1.8	1.27	0.68	0.54	117	30	8	5	4	2	2
Start	1										
Start	0.7										
Start	1.1										
Start	1										
Start	0.9										
Start	1.4										
Start	2.4										
Start	0.2										
Start	2.2										
Middle	2	1.74	0.72	0.42	70	18	5	3	2	2	1
Middle	1.4										
Middle	2.1										
Middle	1.5										
Middle	1.8										
Middle	0.4										
Middle	2										
Middle	1.4										
Middle	3.1										
End	1.2	1.90	0.69	0.36	54	14	4	3	2	1	1
End	1.5										
End	3.5										
End	1.3										
End	2										
End	2										
End	2.2										
End	1.9										
End	1.5										

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Check Sheet

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2006**
Date	**November 1, 2006**
Project #	

Project task	**Tick when completed**
Macorinvertebrates surveyed (do first)	✓
Fish surveyed (do second)	✓
Site description sheet completed	✓
Visual assessment sheets (3) completed	✓
Cross section sheets (2) completed	✓
Other components assessment sheet completed	✓
Instream Retention datasheet completed	✓
Habitat Assessment datasheet completed	✓
Substrate Assessment datasheet completed	✓
Photos taken	✓

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

These field sheets have been designed to guide the collection of data suitable for assessment of stream reaches using the Stream Ecological Valuation technique (Rowe et al, 200%). A separate set of field sheets should be completed for each site. Where deviation from the listed method is used please provide details in comments section

Site description

Date November 1, 2006

Team Kate & Alison

Stream Name Oakley Creek Tributary

Site Code OT2006

Site location Somerset Road, Mt Roskill

GPS coordinates

Easting 2665725

Northing 6475097

Photo nos

Weather conditions — **Current (tick)**

Clear/sunny	
Cloudy	✓
Rain	

Has there been heavy rain in the past week (circle)?

[✓ Yes] No

Site location map

Comments

Stream is above level it was last time we visited

Water is clear

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 3

Visual assessment component - assess over entire reach length

Stream Name: Oakley Creek Tributary

Site Code: OT2006

Date: November 1, 2006

Ecological Function	Variable	Variable description	Criteria	Data to record (shaded areas)
Natural flow (NFR)	1. Vbed	**Extent of channel bed modification**	**Channel type**	**Proportion of channel affected (0 - 1)**
		See Figure 1 for examples	Natural channel bed with no modification	
			Natural channel bed but with some unnatural fine sediment loading	1
			Channelised with some or no modification (eg gabions)	
			Channelised with total modification (eg concrete lining)	

Natural flow (NFR)	**2. Verosn**	**Proportion of bank length affected by flood flows resulting in erosion (circle appropriate range)**	<5%
			6-30%
			[✓ 31-60%]
			61-100%

Connectivity to flood plain (CFP)	**3. Vfreq**	**Estimate of mean annual frequency of flooding**	**Estimated annual frequency of flood-plain inundation (circle appropriate value)**
		If no data available, estimate using informed judgement. Need to take into account position in catchment, bank height and channel dimensions, presence of debris and/or sediment of floodplain, wet soils, degree of upstream imperviousness, presence of detention ponds, extent of channelisation. Consultation with locals may be useful.	[✓ Rare (<1/yr)]
			Occasional (1-2/yr)
			Often (3-5/yr)
			Frequent (>5/yr)

Connectivity for species migrations (CSM)	**4. Vbarr**	**Identify natural and artificial barriers**	**Barrier types (# in reach)**	**Barriers present (circle appropriate category)**
		See Figure 2 for examples		[✓ None]
				Partial
				Total

SEV (Stream Ecological Valuation) field sheet

Sheet 2 of 3

Visual assessment component - assess over entire reach length

Stream Name Oakley Creek Tributary
Site Code OT2006
Date November 1, 2006

Dissolved oxygen demand (DOM)	**5. Vdod**	**Score DOD as per descriptors in next column**	**Indicators of oxygen reducing processes**	**Status of stream substrate (circle appropriate category)**
			much black anaerobic sediment extensive sediment bubbling when disturbed sulphide odour when disturbed surface scums present abundant sewage fungus	Poor
			small patches of anaerobic sediment some sediment bubbling and sulphide odour when disturbed abundant macrophyte biomass some sewage fungus may be present	[✓ Marginal]
			no anaerobic sediment no sediment bubbling or sulphide odour moderate macrophyte biomass	Sub-optimal
			no anaerobic sediment no bubbling or adours little or no macrophyte biomass	Optimal

Flood-plain particle retention (FPR)	**6. Vrough**	**Measures the thickness of vegetation on the floodplain**	**Proportion of banks covered by any of the following individual or combined vegetation types:**			
		Refer to Figure 3 for examples	**Bare, short grass (grazed, mown)**	**Sedges & long grass**	**Flax, shrubs, thick under-storey**	**Trees & thin under-storey**
			0.5			**0.5**

Habitat for aquatic fauna (HAF)	**7. Vphyshab**	Provides an assessment of instream habitat quality	**Complete \Habitat Assessment Datasheet**

Habitat for aquatic fauna (HAF)	**8. Vwatqual**	**Provides an assessment of the extent of shading upstream of the reach**	**Extent of stream upstream of the reach being assessed that is shaded**	**Tick appropriate category**
		Can estimate this using topographic maps as well as site visit	Well shaded (I.e. >50% of entire stream above site is forested)	
			Partially shaded (I.e. <50% of stream above site is forested)	
			Minimal shade (e.g. mainly pasture, but some riparian cover present)	✓
			No shade (mainly open pasture)	

SEV (Stream Ecological Valuation) field sheet **Sheet 3 of 3**

Visual assessment component - assess over entire reach length

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2006**
Date	**November 1, 2006**

Fish spawning habitat (FSH)	**9. Vgalspwn**	**This provides a measure of area of available spawning habitat for galaxiids**	**Length of spawning habitat (m)**
		Measure the length of near-flat (slope<10^{o}) that would be inundated by floods or high tides. Measure entire bank edge length. Do for entire reach.	**3.9m**

Fish spawning habitat (FSH)	**10. Vgalqual**	**This provides a measure of the quality of spawning habitat for galaxiids**	**Quality of spawning habitat (circle appropriate category)**
		Assess the quality of spawning habitat for galaxiids in terms of substrate vegetation among which eggs are deposited. Refer to Figure 4 for examples.	High
			[✓ Medium]
			Low

Riparian vegetation intact (RVI)	**11. Vripcond**	**Assesses the current condition of riparian vegetation within the stream reach**	**Status of riparian vegetation**	**Tick appropriate category**
			Mature indigenous vegetation, regeneration, diverse canopy and under-storey	
			intact mature canopy but damaged under-storey	
			regenerating bush (e.g. manuka scrub), low diversity, early stage in climax, protected	
			as for above but unprotected (e.g. cattle grazing in understorey)	
			occasional native trees present, non-native trees	
			areas of distuibed soils common (e.g. from animal pugging, herbicide use, cultivation in riparian areas)	
			grazed/short grass	
			long grass	✓

Riparian vegetation intact (RVI)	**12. Vripconn**	**Assesses the connection between riparian trees and streams**	**Proportion of stream channel with linkages intact (0-1)**
		Determine the proportion of stream channel where the connection(s) between riparian trees and the stream channel (eg. Root linkages) are NOT prevented by culverts, concrete linings, gabions, fences etc	**1**

Riparian vegetation intact (RVI)	**13. Vripar**	**Assesses the intactness of the riparian zone**	**Proportion of intact riparian zone (0-1)**
		Measure the proportion of riparian buffer zone (defined as 10m on either side of the stream) that is covered by trees or bush. Measure as horizontal distance from stream.	**0.2**

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 2

Cross section component - assess at each of 10 representative cross-sections along reach

Stream Name Oakley Creek Tributary
Site Code OT2006
Date November 1, 2006

Ecological Function	Variable	Variable description	Criteria	Data to record (shaded areas)	
			Cross-section #	**Floodplain width (m) (A)**	**Wetted channel width (m) (B)**
Connectivity to flood plain (CFP)	**14. Vfpwidth**	**Floodplain width compared to wetted channel width (floodplain extent defined by annual flood level)**	1	0	2.2
			2	0	1.75
			3	0	2
			4	0	2.1
			5	0	1.65
			6	0	2.3
			7	0	2.1
			8	0	3.4
			9	0	2.5
			10	0	1.3
			Mean	0	2.13

				% of channel width/depth (m)				
		Measure depth at selected positions across channel	**Cross-section #**	**0**	**25**	**50**	**75**	**100**
Water temperature control (WTC)	**15. Vdepth**	Water temperature control within a reach may be influenced by water depth, water velocity and the area of stream exposed to both solar radiation and ambient air temperature	1	0.12	0.15	0.14	0.25	0.15
			2	0.02	0.18	0.25	0.27	0.18
			3	0.03	0.16	0.22	0.16	0.1
			4	0.2	0.25	0.25	0.25	0.13
			5	0.13	0.2	0.25	0.15	0.1
			6	0.1	0.3	0.3	0.31	0.28
			7	0.17	0.25	0.27	0.35	0.26
			8	0.13	0.3	0.3	0.35	0.2
			9	0.1	0.3	0.31	0.3	0.15
			10	0.12	0.27	0.3	0.3	0.3
			Mean	0.112	0.236	0.259	0.269	0.185

Determination of pollutants (DOP)	**16. Vsurf**	**Assess bio-surface type and proportional cover** Measure the proportions of biosurface categories for each cross section. Record at same time as substrate assessment	**Complete Substrate Assessment Sheet**

Fish spawning habitat (FSH)	**17. Vgobspwn**	**Assesses the amount of available spawning habitat for bullies**	**Complete Substrate Assessment Sheet**
		Measure the proportions of hard substrate categories (excluding bedrock) for each cross section, as well as medium to large woody debris	

SEV (Stream Ecological Valuation) field sheet

Sheet 2 of 2

Cross section component - assess at each of 10 representative cross-sections along reach

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2006**
Date	**November 1, 2006**

Water temperature control (WTC)	**18. Vshade**	**Proportion of stream channel shaded by vegetation, topographic features and artifical structures**	**Cross-section #**	**Shaded proportion (A) (0 - 1)**
		Assess the proportion of open sky the stream surface is exposed to. Assume trees in full leaf (mid-summer conditions). Refer to Figure 5.	1	**1**
			2	**1**
			3	**0.9**
			4	**1**
			5	**1**
			6	**0.6**
			7	**0.2**
			8	**0.3**
			9	**0**
			10	**0.1**
			Mean	**0.61**

Organic matter input (OMI)	**19. Vcanop**	**Measures the amount of leaf fall likely to be contributed from overhead vegetation.**	**Cross-section #**	**Proportion of stream reach directly covered with overhead vegetation (0 - 1)**
			1	**1**
			2	**1**
			3	**0.9**
			4	**1**
			5	**0.9**
			6	**0.6**
			7	**0.2**
			8	**0.3**
			9	**0**
			10	**0.1**
			Mean	**0.6**

Organic matter input (OMI)	**20. Vdecid**	**Records whether or not overhead vegetation contributes leaf fall year round or only part of the year**	**Cross-section #**	**Proportion of canopy cover over stream that is deciduous (0-1)**
			1	**0.95**
			2	**1**
			3	**0.8**
			4	**1**
			5	**1**
			6	**1**
			7	**0.5**
			8	**1**
			9	**0**
			10	**1**
			Mean	**0.825**

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Other components

Stream Name	
Site Code	**OT2006**
Date	**November 1, 2006**

Water temperature control (WTC)	**21. Vlength**	**Measure length of reach**	**Reach length (m) (L)**
		Standardise survey reach length among sites, if appropriate	**46 m**

Water temperature control (WTC)	**22. Vveloc**	**Calculate mean velocity (Sm)**	**Velocity (m/s)**	**Depth velocity measured at (m)**
		Take gauging at 1 point	**< 1 m/s**	**Surface (0 cm)**

Instream particle retention (IPR)	**23. Vtrans**	**This measure provides an assessment of the capacity of the stream reach to retain material**	**Complete Instream Retention Datasheet**
	24. Vretain		

Invertebrate fauna intact (IFI)	**25. Vmci**	**Provides a species list and community composition of macroinvertebrate fauna**	**Hard (HB) or soft (SB) bottomed sampling protocol applied?**
	26. Vept	Sample using ARC protocols for hard and soft-bottomed streams, as appropriate. 1 composite sample per site to be collected.	**SB**
	27. Vinvert		

Fish fauna intact (FFI)	**28. Vfish**	**Measures the species diversity of fish within the reach**	**Fish species present (list)**	
	29. Vvert	Electrofish with a single pass along the entire length of the stream reach. Also note any other vertebrates or large invertebrates.	**Short-finned Eel**	***Anguilla australis***
			Mosquito Fish	**Gambusia affinis**

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Instream Retention Datasheet

Stream Name

Site Code OT2006

Date November 1, 2006

This needs to be undertaken at 2 sections (runs) within the reach, starting with an upper section and then working downstream. The value is obtained by a: running a measuring tape from top to bottom of the reach section, b: releasing 20 painted plastic paper triangles into the stream at the top of the reach section and 3: recording the distance downstream each triangle travels within the reach section, as well as the structure(s) they are retained on.

Run 1

Distance (m)	# of triangles retained	Structure retained on (choose from list below)
1	5	PL
2	12	AP
7	8	VEGE

Run 2

Distance (m)	# of triangles retained	Structure retained on (choose from list below)
1	6	SW
2	7	PERI
7	10	AP
8	2	VEGE

Structures retaining leaves

Boulders and cobbles	Large wood and tree roots	Rooted aquatic plants/	Periphyton and leaf litter	Small wood	Bankside vegetation	Non-natural debris	Pool
B	LW	AP	PERI	SW	VEGE	NON	PL

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Habitat Assessment Datasheet

Stream Name **Oakley Creek Tributary**

Site Code **OT2006**

Date **November 1, 2006**

These data combined provide an assessment of instream habitat quality. For each habitat parameter, determine the most appropriate condition category for the survey reach, based on the descriptions provide. Within the selected condition category, circle the value which best describes the relative condition.

	Condition Category (circle most relevant value within range for category)			
Habitat Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
1. Aquatic Habitat Abundance - proportion of stream channel occupied by sutable habitat fesatures for instream fauna	> 50% of channel favourable for epifaunal colonisation and fish cover; includes woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat. Also includes macrophyte dominated streams.	30-50% of channel contains stable habitat.	10-30% of channel contains stable habitat.	< 10% of channel contains stable habitat. Note: Algae does not constitute stable habitat.
	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1 0
2. Aquatic Habitat Diversity	Wide variety of stable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris rare or may be smothered by sediment.	Stable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several).
	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Hydrologic Heterogeneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present (pool size relative to size of stream).	Limited variety of hydrologic conditions; deep pools absent (pool size relative to size of stream).	Uniform hydrologic conditions; uniform depth and velocity; pools absent (includes uniformly deep streams).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1 0
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Shade	>80% of water surface shaded. Full canopy.	60 - 80% of water surface shaded; mostly shaded with open patches.	20 - 60% of water surface shaded; mostly open with shaded patches.	<20% of water surface shaded. Fully open; lack of canopy cover.
	20 19 [✓ 18] 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7.Riparian Vegetation Integrity (within 20 meters)	No direct human activity in the last 30 years; mature native tree canopy and intact native understory	Minimal human activity; mature native tree canopy or native scrub; understory shows some impact (e.g. weeds, feral animal grazing).	Extensive human activity affecting canopy and understory; trees exotic (pine, willow, poplar); understory native or exotic.	Extensive human activity; little or no canopy; managed vegetation (e.g. livestock grazing, mowed); permanent structures may be present (e.g. building, roads, carparks).
Left bank	10 9	8 7 6	5 4 3	[✓ 2] 1 0
Right bank	10 9	8 7 6	[✓ 5] 4 3	2 1 0

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Substrate Assessment Datasheet

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2006**
Date	**November 1, 2006**

This assessment addresses spawning habitat for gobies, as well as providing data for assessment of the decontamination capacity of the stream reach based on organic material. The aim is to determine the relative proportion of different substrates and organic material within the reach. This can be acheived either through a broad-scale reach assessment (where diversity of types is low) or by detailed cross-section information(where diversity is of types is high). Where cross-sections are surveyed, divide the stream into 10 equally spaced points. At each point record the predominant substrate categories immediately in front of the mid-line of your boot or similar (1 = present). At the same point also record the organic material below/above the substrate (1=present). Record material only from stream bed.

Substrate category	**SI/SA**	**SG**	**SMG**	**MLG**	**LG**	**SC**	**LC**	**B**	**BR**	**SW**	**MW**	**LW**
Size (mm)/Cross-section #	**<2**	**2-8**	**8-16**	**16-32**	**32-64**	**64-128**	**128-256**	**>256**		**<25**	**25-100**	**>100**
1	**9**								**1**	**5**		
2	**10**									**5**		**1**
3	**10**									**5**		
4	**10**									**10**		**6**
5	**10**									**6**		**3**
6	**10**									**3**		
7	**10**									**4**		
8	**10**									**4**		
9	**10**									**5**	**1**	
10	**10**									**4**		

	Organic material category		
Cross-section #	**Leaf litter**	**Periphyton, submerged macorphytes**	**Wood, roots, plus emergent and floating vegetation**
1	**9**		**4**
2	**10**		**6**
3	**10**		**5**
4	**10**		**6**
5	**10**		**2**
6	**9**		
7	**10**		
8	**5**	**5**	
9	**5**	**10**	
10	**10**		

Substrate category descriptors

SI/SA	Silt/Sand	**MLG**	Medium-large gravel	**LC**	Large cobbles	**SW**	Small wood
SG	Small gravel	**LG**	Large gravel	**B**	Boulders	**MW**	Medium wod
SMG	Small-medium gravel	**SC**	Small cobbles	**Bedrock**		**LW**	Large wood

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Check Sheet

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2007**
Date	**November 2, 2007**
Project #	

Project task	**Tick when completed**
Macorinvertebrates surveyed (do first)	✓
Fish surveyed (do second)	✓
Site description sheet completed	✓
Visual assessment sheets (3) completed	✓
Cross section sheets (2) completed	✓
Other components assessment sheet completed	✓
Instream Retention datasheet completed	✓
Habitat Assessment datasheet completed	✓
Substrate Assessment datasheet completed	✓
Photos taken	✓

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

These field sheets have been designed to guide the collection of data suitable for assessment of stream reaches using the Stream Ecological Valuation technique (Rowe et al, 200%). A separate set of field sheets should be completed for each site. Where deviation from the listed method is used please provide details in comments section

Site description

Date November 2, 2007

Team Kate & Lachlan

Stream Name Oakley Creek Tributary

Site Code OT2007

Site location Somerset Road, Mt Roskill

GPS coordinates

Easting 2665725

Northing 6475097

Photo nos

Weather conditions

	Current (tick)
Clear/sunny	✓
Cloudy	
Rain	

Has there been heavy rain in the past week (circle)?

[✓ Yes]

No

Site location map

Comments

Abundant algal growth in stream

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 3

Visual assessment component - assess over entire reach length

Stream Name Oakley Creek Tributary

Site Code OT2007

Date November 2, 2007

Ecological Function	Variable	Variable description	Criteria	Data to record (shaded areas)
Natural flow (NFR)	1. Vbed	**Extent of channel bed modification**	**Channel type**	**Proportion of channel affected (0 - 1)**
		See Figure 1 for examples	Natural channel bed with no modification	
			Natural channel bed but with some unnatural fine sediment loading	1
			Channelised with some or no modification (eg gabions)	
			Channelised with total modification (eg concrete lining)	

Natural flow (NFR)	2. Verosn	**Proportion of bank length affected by flood flows resulting in erosion (circle appropriate range)**	<5%
			6-30%
			[✓ 31-60%]
			61-100%

Connectivity to flood plain (CFP)	3. Vfreq	**Estimate of mean annual frequency of flooding**	**Estimated annual frequency of flood-plain inundation (circle appropriate value)**
		If no data available, estimate using informed judgement. Need to take into account position in catchment, bank height and channel dimensions, presence of debris and/or sediment of floodplain, wet soils, degree of upstream imperviousness, presence of detention ponds, extent of channelisation. Consultation with locals may be useful.	[✓ Rare (<1/yr)]
			Occasional (1-2/yr)
			Often (3-5/yr)
			Frequent (>5/yr)

Connectivity for species migrations (CSM)	4. Vbarr	**Identify natural and artificial barriers**	**Barrier types (# in reach)**	**Barriers present (circle appropriate category)**
		See Figure 2 for examples		[✓ None]
				Partial
				Total

SEV (Stream Ecological Valuation) field sheet

Sheet 2 of 3

Visual assessment component - assess over entire reach length

Stream Name Oakley Creek Tributary
Site Code OT2007
Date November 2, 2007

			Indicators of oxygen reducing processes	**Status of stream substrate (circle appropriate category)**
Dissolved oxygen demand (DOM)	**5. Vdod**	**Score DOD as per descriptors in next column**	much black anaerobic sediment extensive sediment bubbling when disturbed sulphide odour when disturbed surface scums present abundant sewage fungus	Poor
			small patches of anaerobic sediment some sediment bubbling and sulphide odour when disturbed abundant macrophyte biomass some sewage fungus may be present	[✓ Marginal]
			no anaerobic sediment no sediment bubbling or sulphide odour moderate macrophyte biomass	Sub-optimal
			no anaerobic sediment no bubbling or adours little or no macrophyte biomass	Optimal

Flood-plain particle retention (FPR)	**6. Vrough**	**Measures the thickness of vegetation on the floodplain**	**Proportion of banks covered by any of the following individual or combined vegetation types:**			
		Refer to Figure 3 for examples	**Bare, short grass (grazed, mown)**	**Sedges & long grass**	**Flax, shrubs, thick under-storey**	**Trees & thin under-storey**
			0.5			**0.5**

Habitat for aquatic fauna (HAF)	**7. Vphyshab**	Provides an assessment of instream habitat quality	**Complete \Habitat Assessment Datasheet**

Habitat for aquatic fauna (HAF)	**8. Vwatqual**	**Provides an assessment of the extent of shading upstream of the reach**	**Extent of stream upstream of the reach being assessed that is shaded**	**Tick appropriate category**
		Can estimate this using topographic maps as well as site visit	Well shaded (I.e. >50% of entire stream above site is forested)	
			Partially shaded (I.e. <50% of stream above site is forested)	
			Minimal shade (e.g. mainly pasture, but some riparian cover present)	✓
			No shade (mainly open pasture)	

SEV (Stream Ecological Valuation) field sheet

Sheet 3 of 3

Visual assessment component - assess over entire reach length

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2007**
Date	**Novenber 2, 2007**

		This provides a measure of area of available spawning habitat for galaxiids	**Length of spawning habitat (m)**
Fish spawning habitat (FSH)	**9. Vgalspwn**	Measure the length of near-flat (slope<10^{o}) that would be inundated by floods or high tides. Measure entire bank edge length. Do for entire reach.	**3.9m**

		This provides a measure of the quality of spawning habitat for galaxiids	**Quality of spawning habitat (circle appropriate category)**
Fish spawning habitat (FSH)	**10. Vgalqual**	Assess the quality of spawning habitat for galaxiids in terms of substrate vegetation among which eggs are deposited. Refer to Figure 4 for examples.	High
			[✓ Medium]
			Low

			Status of riparian vegetation	**Tick appropriate category**
Riparian vegetation intact (RVI)	**11. Vripcond**	**Assesses the current condition of riparian vegetation within the stream reach**	Mature indigenous vegetation, regeneration, diverse canopy and under-storey	
			intact mature canopy but damaged under-storey	
			regenerating bush (e.g. manuka scrub), low diversity, early stage in climax, protected	
			as for above but unprotected (e.g. cattle grazing in understorey)	
			occasional native trees present, non-native trees	
			areas of distuibed soils common (e.g. from animal pugging, herbicide use, cultivation in riparian areas)	
			grazed/short grass	
			long grass	✓

		Assesses the connection between riparian trees and streams	**Proportion of stream channel with linkages intact (0-1)**
Riparian vegetation intact (RVI)	**12. Vripconn**	Determine the proportion of stream channel where the connection(s) between riparian trees and the stream channel (eg. Root linkages) are NOT prevented by culverts, concrete linings, gabions, fences etc	**1**

		Assesses the intactness of the riparian zone	**Proportion of intact riparian zone (0-1)**
Riparian vegetation intact (RVI)	**13. Vripar**	Measure the proportion of riparian buffer zone (defined as 10m on either side of the stream) that is covered by trees or bush. Measure as horizontal distance from stream.	**0.2**

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 2

Cross section component - assess at each of 10 representative cross-sections along reach

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2007**
Date	**November 2, 2007**

Ecological Function	Variable	Variable description	Criteria	Data to record (shaded areas)	
			Cross-section #	**Floodplain width (m) (A)**	**Wetted channel width (m) (B)**
Connectivity to flood plain (CFP)	**14. Vfpwidth**	**Floodplain width compared to wetted channel width (floodplain extent defined by annual flood level)**	1	**0**	**2**
			2	**0**	**1.35**
			3	**0**	**2.1**
			4	**0**	**2.25**
			5	**0**	**1.5**
			6	**0**	**2.1**
			7	**0**	**1.9**
			8	**0**	**3.2**
			9	**0**	**2.35**
			10	**0**	**1.1**
			Mean	**0**	**1.985**

Water temperature control (WTC)	**15. Vdepth**	**Measure depth at selected positions across channel**	**Cross-section #**	**% of channel width/depth (m)**				
		Water temperature control within a reach may be influenced by water depth, water velocity and the area of stream exposed to both solar radiation and ambient air temperature		**0**	**25**	**50**	**75**	**100**
			1	**0.1**	**0.13**	**0.11**	**0.2**	**0.13**
			2	**0.01**	**0.16**	**0.24**	**0.22**	**0.17**
			3	**0.02**	**0.16**	**0.2**	**0.13**	**0.08**
			4	**0.12**	**0.24**	**0.23**	**0.24**	**0.11**
			5	**0.1**	**0.17**	**0.25**	**0.13**	**0.1**
			6	**0.15**	**0.28**	**0.31**	**0.28**	**0.27**
			7	**0.11**	**0.22**	**0.27**	**0.3**	**0.25**
			8	**0.09**	**0.28**	**0.29**	**0.3**	**0.18**
			9	**0.1**	**0.29**	**0.29**	**0.3**	**0.11**
			10	**0.13**	**0.23**	**0.25**	**0.28**	**0.27**
			Mean	**0.093**	**0.216**	**0.244**	**0.238**	**0.167**

Determination of pollutants (DOP)	**16. Vsurf**	**Assess bio-surface type and proportional cover** Measure the proportions of biosurface categories for each cross section. Record at same time as substrate assessment	**Complete Substrate Assessment Sheet**

Fish spawning habitat (FSH)	**17. Vgobspwn**	**Assesses the amount of available spawning habitat for bullies**	**Complete Substrate Assessment Sheet**
		Measure the proportions of hard substrate categories (excluding bedrock) for each cross section, as well as medium to large woody debris	

SEV (Stream Ecological Valuation) field sheet

Sheet 2 of 2

Cross section component - assess at each of 10 representative cross-sections along reach

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2007**
Date	**November 2, 2007**

		Proportion of stream channel shaded by vegetation, topographic features and artifical structures	**Cross-section #**	**Shaded proportion (A) (0 - 1)**
Water temperature control (WTC)	**18. Vshade**	Assess the proportion of open sky the stream surface is exposed to. Assume trees in full leaf (mid-summer conditions). Refer to Figure 5.	1	**1**
			2	**0.9**
			3	**1**
			4	**0.6**
			5	**1**
			6	**1**
			7	**0.2**
			8	**0.4**
			9	**0**
			10	**0.1**
			Mean	**0.62**

			Cross-section #	**Proportion of stream reach directly covered with overhead vegetation (0 - 1)**
Organic matter input (OMI)	**19. Vcanop**	**Measures the amount of leaf fall likely to be contributed from overhead vegetation.**	1	**1**
			2	**0.9**
			3	**1**
			4	**1**
			5	**0.9**
			6	**0.5**
			7	**0.1**
			8	**0.2**
			9	**0**
			10	**0**
			Mean	**0.56**

			Cross-section #	**Proportion of canopy cover over stream that is deciduous (0-1)**
Organic matter input (OMI)	**20. Vdecid**	**Records whether or not overhead vegetation contributes leaf fall year round or only part of the year**	1	**0.9**
			2	**1**
			3	**0.8**
			4	**1**
			5	**1**
			6	**1**
			7	**0.5**
			8	**1**
			9	**0**
			10	**0**
			Mean	**0.72**

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Other components

Stream Name	**Oakley Creek Tributary**
Site Code	**OT2007**
Date	**November 2, 2007**

Water temperature control (WTC)	**21. Vlength**	**Measure length of reach**	**Reach length (m) (L)**
		Standardise survey reach length among sites, if appropriate	**46 m**

Water temperature control (WTC)	**22. Vveloc**	**Calculate mean velocity (Sm)**	**Velocity (m/s)**	**Depth velocity measured at (m)**
		Take gauging at 1 point	**< 1 m/s**	**Surface (0 cm)**

Instream particle retention (IPR)	**23. Vtrans** **24. Vretain**	**This measure provides an assessment of the capacity of the stream reach to retain material**	**Complete Instream Retention Datasheet**

Invertebrate fauna intact (IFI)	**25. Vmci**	**Provides a species list and community composition of macroinvertebrate fauna**	**Hard (HB) or soft (SB) bottomed sampling protocol applied?**
	26. Vept	Sample using ARC protocols for hard and soft-bottomed streams, as appropriate. 1 composite sample per site to be collected.	**SB**
	27. Vinvert		

Fish fauna intact (FFI)	**28. Vfish**	**Measures the species diversity of fish within the reach**	**Fish species present (list)**	
	29. Vvert	Electrofish with a single pass along the entire length of the stream reach. Also note any other vertebrates or large invertebrates.	**Short-finned Eel**	***Anguilla australis***
			Mosquito Fish	**Gambusia affinis**

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Instream Retention Datasheet

Stream Name Oakley Creek Tributary
Site Code OT2007
Date November 2, 2007

This needs to be undertaken at 2 sections (runs) within the reach, starting with an upper section and then working downstream. The value is obtained by a: running a measuring tape from top to bottom of the reach section, b: releasing 20 painted plastic paper triangles into the stream at the top of the reach section and 3: recording the distance downstream each triangle travels within the reach section, as well as the structure(s) they are retained on.

Run 1

Distance (m)	# of triangles retained	Structure retained on (choose from list below)
0.01	2	PL
1	4	PL
2	11	PERI
4	5	SW
6	2	AP
9	1	VEGE

Run 2

Distance (m)	# of triangles retained	Structure retained on (choose from list below)
1	5	PL
2	11	PERI
3	2	PERI
4	1	SW
5	3	AP
7	1	AP
9	1	VEGE
10	1	VEGE

Structures retaining leaves							
Boulders and cobbles	Large wood and tree roots	Rooted aquatic plants/	Periphyton and leaf litter	Small wood	Bankside vegetation	Non-natural debris	Pool
B	LW	AP	PERI	SW	VEGE	NON	PL

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Habitat Assessment Datasheet

Stream Name **Oakley Creek Tributary**

Site Code **OT2007**

Date **November 2, 2007**

These data combined provide an assessment of instream habitat quality. For each habitat parameter, determine the most appropriate condition category for the survey reach, based on the descriptions provide. Within the selected condition category, circle the value which best describes the relative condition.

	Condition Category (circle most relevant value within range for category)			
Habitat Parameter	**Optimal**	**Suboptimal**	**Marginal**	**Poor**
1. Aquatic Habitat Abundance - proportion of stream channel occupied by sutable habitat fesatures for instream fauna	> 50% of channel favourable for epifaunal colonisation and fish cover; includes woody debris, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat. Also includes macrophyte dominated streams.	30-50% of channel contains stable habitat.	10-30% of channel contains stable habitat.	< 10% of channel contains stable habitat. Note: Algae does not constitute stable habitat.
	20 19 18 17 16	15 14 13 12 11	[✓ 10] 9 8 7 6	5 4 3 2 1 0
2. Aquatic Habitat Diversity	Wide variety of stable aquatic habitat types present including: woody debris, riffles, undercut banks, root mats, rooted aquatic vegetation, cobble or other stable habitat.	Moderate variety of habitat types; 3-4 habitats present including woody debris.	Habitat diversity limited to 1-2 types; woody debris rare or may be smothered by sediment.	Stable habitats lacking or limited to macrophytes (a few macrophyte species scores lower than several).
	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Hydrologic Heterogeneity	Mixture of hydrologic conditions i.e. pool, riffle, run, chute, waterfalls; variety of pool sizes and depths.	Moderate variety of hydrologic conditions; deep and shallow pools present (pool size relative to size of stream).	Limited variety of hydrologic conditions; deep pools absent (pool size relative to size of stream).	Uniform hydrologic conditions; uniform depth and velocity; pools absent (includes uniformly deep streams).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 3 2 1 0
	Optimal	**Suboptimal**	**Marginal**	**Poor**
6. Channel Shade	>80% of water surface shaded. Full canopy.	60 - 80% of water surface shaded; mostly shaded with open patches.	20 - 60% of water surface shaded; mostly open with shaded patches.	<20% of water surface shaded. Fully open; lack of canopy cover.
	20 19 18 17 16	[✓ 15] 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7.Riparian Vegetation Integrity (within 20 meters)	No direct human activity in the last 30 years; mature native tree canopy and intact native understory	Minimal human activity; mature native tree canopy or native scrub; understory shows some impact (e.g. weeds, feral animal grazing).	Extensive human activity affecting canopy and understory; trees exotic (pine, willow, poplar); understory native or exotic.	Extensive human activity; little or no canopy; managed vegetation (e.g. livestock grazing, mowed); permanent structures may be present (e.g. building, roads, carparks).
Left bank	10 9	8 7 6	5 4 3	[✓ 2] 1 0
Right bank	10 9	8 7 6	5 [✓ 4] 3	2 1 0

SEV (Stream Ecological Valuation) field sheet

Sheet 1 of 1

Substrate Assessment Datasheet

Stream Name Oakley Creek Tributary
Site Code OT2007
Date November 2, 2007

This assessment addresses spawning habitat for gobies, as well as providing data for assessment of the decontamination capacity of the stream reach based on organic material. The aim is to determine the relative proportion of different substrates and organic material within the reach. This can be acheived either through a broad-scale reach assessment (where diversity of types is low) or by detailed cross-section information(where diversity is of types is high). Where cross-sections are surveyed, divide the stream into 10 equally spaced points. At each point record the predominant substrate categories immediately in front of the mid-line of your boot or similar (1 = present). At the same point also record the organic material below/above the substrate (1=present). Record material only from stream bed.

Substrate category	**SI/SA**	**SG**	**SMG**	**MLG**	**LG**	**SC**	**LC**	**B**	**BR**	**SW**	**MW**	**LW**
Size (mm)/Cross-section #	**<2**	**2-8**	**8-16**	**16-32**	**32-64**	**64-128**	**128-256**	**>256**		**<25**	**25-100**	**>100**
1	**10**									**6**		
2	**10**									**5**	**2**	
3	**10**									**4**		
4	**10**									**6**		
5	**10**									**4**	**1**	
6	**10**									**3**		
7	**10**									**7**		
8	**10**									**7**		**4**
9	**10**									**5**		
10	**10**									**6**		

	Organic material category		
Cross-section #	**Leaf litter**	**Periphyton, submerged macorphytes**	**Wood, roots, plus emergent and floating vegetation**
1	**8**		**3**
2	**9**		**4**
3	**10**		
4	**5**		**2**
5	**5**		
6	**10**		
7	**7**		
8	**3**	**4**	
9	**9**	**7**	
10	**8**		

Substrate category descriptors

SI/SA	Silt/Sand	**MLG**	Medium-large gravel	**LC**	Large cobbles	**SW**	Small wood
SG	Small gravel	**LG**	Large gravel	**B**	Boulders	**MW**	Medium wod
SMG	Small-medium gravel	**SC**	Small cobbles	**Bedrock**		**LW**	Large wood

Somerset Road November 2006

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Ave (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
1/11/06	S Main Pond Start	1	1	1	0.1843	0.1878	0.0035	1.00	3.50		3.50	-	-
1/11/06	S Main Pond End	1	1	1	0.1859	0.1908	0.0049	1.00	4.90		4.90	-	-
15/11/06	S Forebay Outflow	1	1	1	0.1866	0.2042	0.0176	0.08	234.67		234.67	-	-
15/11/06	S Main Pond End	1	1	1	0.1844	0.1895	0.0051	1.00	5.10		5.10	-	-
15/11/06	S Main Pond Discharge	1	1	1	0.1868	0.1885	0.0017	1.00	1.70		1.70	-	-
24/11/06	S Main Pond Start	1	1	10	0.1859	0.1877	0.0018	1.00	1.8		1.27	0.68	0.22
		2	1		0.1855	0.1865	0.001	1.00	1				
		3	1		0.1854	0.1861	0.0007	1.00	0.7				
		4	1		0.1861	0.1872	0.0011	1.00	1.1				
		5	1		0.1864	0.1874	0.001	1.00	1				
		6	1		0.1866	0.1875	0.0009	1.00	0.9				
		7	1		0.1861	0.1875	0.0014	1.00	1.4				
		8	1		0.1844	0.1868	0.0024	1.00	2.4				
		9	1		0.1854	0.1856	0.0002	1.00	0.2				
		10	1		0.1846	0.1868	0.0022	1.00	2.2				
24/11/06	S Main Pond Middle	1	1	9	0.1842	0.1862	0.002	1.00	2		1.74	0.72	0.24
		2	1		0.1855	0.1869	0.0014	1.00	1.4				
		3	1		0.1847	0.1868	0.0021	1.00	2.1				
		4	1		0.1837	0.1852	0.0015	1.00	1.5				
		5	1		0.1843	0.1861	0.0018	1.00	1.8				
		6	1		0.1863	0.1867	0.0004	1.00	0.4				
		7	1		0.1848	0.1868	0.002	1.00	2				
		8	1		0.1862	0.1876	0.0014	1.00	1.4				
		9	1		0.1847	0.1878	0.0031	1.00	3.1				
24/11/06	S Main Pond End	1	1	9	0.1847	0.1859	0.0012	1.00	1.2		1.90	0.69	0.23
		2	1		0.1853	0.1868	0.0015	1.00	1.5				
		3	1		0.1849	0.1884	0.0035	1.00	3.5				
		4	1		0.1857	0.187	0.0013	1.00	1.3				
		5	1		0.1852	0.1872	0.002	1.00	2				
		6	1		0.1847	0.1867	0.002	1.00	2				
		7	1		0.186	0.1882	0.0022	1.00	2.2				
		8	1		0.186	0.1879	0.0019	1.00	1.9				
		9	1		0.1848	0.1863	0.0015	1.00	1.5				

Somerset Road December 2006

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Ave (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
8/12/06	S Main Pond Start	1	1	8	0.1858	0.1868	0.001	1	1.00		1.68	0.57	0.20
		2	1		0.1846	0.1859	0.0013	1	1.30				
		3	1		0.1851	0.1875	0.0024	1	2.40				
		4	1		0.1857	0.1874	0.0017	1	1.70				
		5	1		0.1845	0.186	0.0015	1	1.50				
		6	1		0.1851	0.1873	0.0022	1	2.20				
		7	1		0.1848	0.1871	0.0023	1	2.30				
		8	1		0.1852	0.1862	0.001	1	1.00				
8/12/06	S Main Pond Middle	1	1	8	0.1835	0.1844	0.0009	1	0.90		0.92	0.23	0.08
		2	1		0.186	0.1871	0.0011	1	1.10				
		3	1		0.1858	0.1871	0.0013	1	1.30				
		4	1		0.1846	0.1854	0.0008	1	0.80				
		5	1		0.1852	0.1863	0.0011	1	1.10				
		6	1		0.1862	0.187	0.0008	1	0.80				
		7	1		0.185	0.1856	0.0006	1	0.60				
		8	1		0.1839	0.1847	0.0008	1	0.80				
8/12/06	S Main Pond End	1	1	8	0.1839	0.1846	0.0007	1	0.70		0.96	0.32	0.11
		2	1		0.1837	0.185	0.0013	1	1.30				
		3	1		0.1834	0.1846	0.0012	1	1.20				
		4	1		0.1852	0.1865	0.0013	1	1.30				
		5	1		0.1846	0.1854	0.0008	1	0.80				
		6	1		0.1839	0.1843	0.0004	1	0.40				
		7	1		0.1841	0.1851	0.001	1	1.00				
		8	1		0.186	0.187	0.001	1	1.00				
8/12/06	Stream	1	1	1	0.1842	0.1891	0.0049	0.3	16.33	10.00	10.00	-	-
			2		0.185	0.1861	0.0011	0.3	3.67				
14/12/06	S Main Pond Start	1	1	4	0.1848	0.1901	0.0053	0.5	10.6		13.14	3.47	1.74
		2	1		0.1843	0.1923	0.008	0.5	16				
		3	1		0.1851	0.1968	0.0117	0.72	16.25				
		4	1		0.1865	0.1962	0.0097	1	9.7				
14/12/06	S Main Pond Middle	1	1	4	0.1839	0.1849	0.001	1	1		1.23	0.17	0.09
		2	1		0.1858	0.1871	0.0013	1	1.3				
		3	1		0.182	0.1834	0.0014	1	1.4				
		4	1		0.1847	0.1859	0.0012	1	1.2				
14/12/06	S Main Pond End	1	1	4	0.1854	0.1877	0.0023	1	2.3		1.35	0.78	0.39
		2	1		0.1841	0.1854	0.0013	1	1.3				
		3	1		0.1862	0.1876	0.0014	1	1.4				
		4	1		0.1849	0.1853	0.0004	1	0.4				
19/12/06	S Forebay Outflow	1	1	3	0.1869	0.2103	0.0234	0.1	234		263.00	40.29	23.26
		2	1		0.1876	0.2122	0.0246	0.1	246				
		3	1		0.1882	0.2191	0.0309	0.1	309				

Somerset Road December 2006

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Ave (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
19/12/06	S Main Pond Start	1	1	1	0.1886	0.1891	0.0005	1	0.5		0.50	-	-
19/12/06	S Main Pond Middle	1	1	1	0.186	0.1865	0.0005	1	0.5		0.50	-	-
19/12/06	S Main Pond End	1	1	2	0.1856	0.1862	0.0006	1	0.6	0.55	0.55	0.07	0.05
		2	1		0.186	0.1865	0.0005	1	0.5				

Somerset Road January 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
10/01/07	S Main Pond End	1	1	3	0.1847	0.1926	0.0079	0.5	15.8		9.07	5.97	3.45
		2	1		0.1872	0.1907	0.0035	0.5	7				
		3	1		0.1876	0.1898	0.0022	0.5	4.4				
10/01/07	Upstream A	1	1	2	0.1879	0.1886	0.0007	0.2	3.5	4.75	5.38	0.88	0.63
			2		0.1887	0.1899	0.0012	0.2	6				
		2	1		0.1889	0.1902	0.0013	0.2	6.5	6			
			2		0.1873	0.1884	0.0011	0.2	5.5				
10/01/07	Stream	1	1	3	0.1858	0.1864	0.0006	0.2	3	3.25	6.00	3.89	2.25
			2		0.186	0.1867	0.0007	0.2	3.5				
		2	1		0.1847	0.1872	0.0025	0.2	12.5	8.75			
			2		0.1863	0.1873	0.001	0.2	5				
		3	1		0.1872	0.1881	0.0009	0.2	4.5				
17/01/07	S Main Pond Start	1	1	4	0.1858	0.1859	0.0001	1	0.1		0.18	0.15	0.08
		2	1		0.1854	0.1855	1E-04	1	0.4				
		3	1		0.1852	0.1855	0.0003	1	0.1				
		4	1		0.1857	0.1861	0.0004	1	0.1				
17/01/07	S Main Pond Middle	1	1	4	0.1863	0.1865	0.0002	1	0.2		0.27	0.10	0.05
		2	1		0.1863	0.1865	0.0002	1	0.2				
		3	1		0.1857	0.1861	0.0004	1	0.3				
		4	1		0.1861	0.1867	0.0006	1	0.4				
17/01/07	S Main Pond End	1	1	4	0.1879	0.1881	0.0002	1	0.4		0.42	0.17	0.09
		2	1		0.1877	0.1882	0.0005	1	0.6				
		3	1		0.1862	0.1905	0.0043	1	0.2				
		4	1		0.1857	0.1905	0.0048	1	0.5				
17/01/07	Stream	1	1	1	0.1818	0.1819	0.0001	0.5	8.6	9.1	9.10	-	-
			2		0.1858	0.1862	0.0004	0.5	9.6				

Somerset Road February 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
9/02/07	S Main Pond Start	1	1	4	0.1806	0.1825	0.0019	1	1.90		1.48	0.59	0.30
		2	1		0.1861	0.1878	0.0017	1	1.70				
		3	1		0.1848	0.1865	0.0017	1	1.70				
		4	1		0.1852	0.1858	0.0006	1	0.60				
9/02/07	S Main Pond Middle	1	1	4	0.1839	0.1853	0.0014	1	1.40		1.58	0.56	0.28
		2	1		0.1846	0.187	0.0024	1	2.40				
		3	1		0.1786	0.1799	0.0013	1	1.30				
		4	1		0.184	0.1852	0.0012	1	1.20				
9/02/07	S Main Pond End	1	1	4	0.1844	0.1849	0.0005	1	0.50		0.70	0.16	0.08
		2	1		0.1831	0.1838	0.0007	1	0.70				
		3	1		0.1832	0.1841	0.0009	1	0.90				
		4	1		0.1854	0.1861	0.0007	1	0.70				
9/02/07	Stream	1	1		0.1857	0.2028	0.0171	0.2	85.50	74.75	74.75	-	-
			2		0.1848	0.1976	0.0128	0.2	64.00				
17/02/07	S Main Pond Start	1	1	4	0.1837	0.1849	0.0012	1	1.20		1.63	0.39	0.19
		2	1		0.1815	0.1829	0.0014	1	1.40				
		3	1		0.1833	0.1852	0.0019	1	1.90				
		4	1		0.179	0.181	0.002	1	2.00				
17/02/07	S Main Pond Middle	1	1	4	0.1864	0.1875	0.0011	1	1.10		100.61	199.15	99.58
		2	1		0.1865	0.1877	0.0012	1	1.20				
		3	1		0.1841	0.244	0.0599	0.15	399.33				
		4	1		0.1848	0.1856	0.0008	1	0.80				
17/02/07	S Main Pond End	1	1	4	0.1846	0.1851	0.0005	1	0.50		1.00	0.38	0.19
		2	1		0.1839	0.1848	0.0009	1	0.90				
		3	1		0.184	0.1853	0.0013	1	1.30				
		4	1		0.1838	0.1851	0.0013	1	1.30				
17/02/07	Upstream A	1	1	1	0.185	0.1874	0.0024	0.3	8.00	7.83	7.83	-	-
			2		0.1837	0.186	0.0023	0.3	7.67				
17/02/07	Upstream B	1	1	1	0.1843	0.1878	0.0035	0.3	11.67	11.00	11.00	-	-
			2		0.1843	0.1874	0.0031	0.3	10.33				
17/02/07	Stream	1	1	1	0.1817	0.1874	0.0057	0.2	28.50	29.00	29.00	-	-
			2		0.1811	0.187	0.0059	0.2	29.50				
17/02/07	Downstream A	1	1	1	0.1809	0.1846	0.0037	0.3	12.33	13.17	13.17	-	-
			2		0.1804	0.1846	0.0042	0.3	14.00				
17/02/07	Downstream B	1	1	1	0.1827	0.1882	0.0055	0.3	18.33	21.17	21.17	-	-
			2		0.1841	0.1913	0.0072	0.3	24.00				
26/02/07	S Main Pond Start	1	1	4	0.1849	0.1897	0.0048	0.8	6.00		7.20	0.85	0.42
		2	1		0.1861	0.1898	0.0037	0.5	7.40				
		3	1		0.183	0.1867	0.0037	0.5	7.40				
		4	1		0.1829	0.1869	0.004	0.5	8.00				
26/02/07	S Main Pond Middle	1	1	4	0.1826	0.1856	0.003	0.5	6.00		5.63	0.25	0.12

Somerset Road February 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.185	0.1879	0.0029	0.53	5.47				
		3	1		0.1848	0.1876	0.0028	0.51	5.49				
		4	1		0.1827	0.1856	0.0029	0.52	5.58				
26/02/07	S Main Pond End	1	1	4	0.1804	0.1858	0.0054	0.5	10.80		9.85	0.75	0.38
		2	1		0.1865	0.1914	0.0049	0.51	9.61				
		3	1		0.1853	0.1898	0.0045	0.5	9.00				
		4	1		0.1857	0.1907	0.005	0.5	10.00				
26/02/07	Upstream A	1	1	1	0.186	0.2022	0.0162	0.2	81.00	115.75	115.75	-	-
			2		0.1834	0.2135	0.0301	0.2	150.50				
26/02/07	Upstream B	1	1	1	0.1828	0.1876	0.0048	0.3	16.00	16.50	16.50	-	-
			2		0.1835	0.1886	0.0051	0.3	17.00				
26/02/07	Downstream A	1	1	1	0.1851	0.1869	0.0018	0.3	6.00	5.67	5.67	-	-
			2		0.1836	0.1852	0.0016	0.3	5.33				

Somerset Road March 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
5/03/07	Upstream A	1	1	1	0.1876	0.1942	0.0066	0.25	26.40	25.60	25.60	-	-
			2		0.1877	0.1939	0.0062	0.25	24.80				
5/03/07	Upstream B	1	1	1	0.1865	0.19	0.0035	0.6	5.83	9.58	9.58	-	-
			2		0.1883	0.1923	0.004	0.3	13.33				
5/03/07	Downstream A	1	1	1	0.1866	0.1899	0.0033	0.27	12.22	13.29	13.29	-	-
			2		0.1885	0.1918	0.0033	0.23	14.35				
5/03/07	Downstream B	1	1	1	0.1878	0.1903	0.0025	0.215	11.63	11.61	11.61	-	-
			2		0.1856	0.1885	0.0029	0.25	11.60				
16/03/07	Upstream A	1	1	1	0.1867	0.1873	0.0006	0.24	2.50	3.02	3.02	-	-
			2		0.1859	0.187	0.0011	0.31	3.55				
16/03/07	Upstream B	1	1	1	0.1859	0.1885	0.0026	0.31	8.39	8.48	8.48	-	-
			2		0.1867	0.1891	0.0024	0.28	8.57				
16/03/07	Stream	1	1	1	0.187	0.1885	0.0015	0.2	7.50	7.00	7.00	-	-
			2		0.1854	0.1867	0.0013	0.2	6.50				
16/03/07	Downstream A	1	1	1	0.1863	0.1873	0.001	0.2	5.00	5.25	5.25	-	-
			2		0.1862	0.1873	0.0011	0.2	5.50				
16/03/07	Downstream B	1	1	1	0.1854	0.1867	0.0013	0.22	5.91	5.34	5.34	-	-
			2		0.188	0.189	0.001	0.21	4.76				
16/03/07	S Forebay Outflow	1	1	3	0.1875	0.192	0.0045	0.5	9.00	9.50	9.87	0.36	0.21
			2		0.1865	0.1915	0.005	0.5	10.00				
		2	1		0.1868	0.1925	0.0057	0.5	11.40	9.90			
			2		0.1867	0.1909	0.0042	0.5	8.40				
		3	1		0.1866	0.1914	0.0048	0.52	9.23	10.22			
			2		0.1868	0.1924	0.0056	0.5	11.20				
16/03/07	S Main Pond Start	1	1	3	0.1855	0.1987	0.0132	0.3	44.00	57.63	57.27	0.56	0.32
			2		0.1867	0.2095	0.0228	0.32	71.25				
		2	1		0.1855	0.1964	0.0109	0.2	54.50	56.63			
			2		0.1873	0.2014	0.0141	0.24	58.75				
		3	1		0.1877	0.2011	0.0134	0.26	51.54	57.57			
			2		0.1871	0.203	0.0159	0.25	63.60				
16/03/07	S Main Pond Middle	1	1	3	0.1867	0.1959	0.0092	0.2	46.00	53.67	56.53	2.52	1.46
			2		0.1862	0.2046	0.0184	0.3	61.33				
		2	1		0.1878	0.204	0.0162	0.3	54.00	58.43			
			2		0.1878	0.201	0.0132	0.21	62.86				
		3	1		0.1861	0.1971	0.011	0.2	55.00	57.50			
			2		0.1882	0.2002	0.012	0.2	60.00				
16/03/07	S Main Pond End	1	1	3	0.1866	0.2042	0.0176	0.31	56.77	60.56	59.74	1.00	0.58
			2		0.1871	0.2019	0.0148	0.23	64.35				
		2	1		0.1874	0.2047	0.0173	0.3	57.67	58.63			
			2		0.1889	0.2038	0.0149	0.25	59.60				
		3	1		0.1877	0.205	0.0173	0.3	57.67	60.03			

Somerset Road March 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1888	0.2044	0.0156	0.25	62.40				
21/03/07	S Main Pond Start	1	1	3	0.1835	0.1891	0.0056	0.5	11.20	11.20	11.46	1.11	0.64
			2		0.1818	0.1874	0.0056	0.5	11.20				
		2	1		0.1836	0.1896	0.006	0.5	12.00	12.67			
			2		0.182	0.186	0.004	0.3	13.33				
		3	1		0.1822	0.1851	0.0029	0.29	10.00	10.50			
			2		0.1821	0.1854	0.0033	0.3	11.00				
21/03/07	S Main Pond Middle	1	1	3	0.1832	0.1865	0.0033	0.3	11.00	11.50	10.83	0.76	0.44
			2		0.183	0.1866	0.0036	0.3	12.00				
		2	1		0.1824	0.1856	0.0032	0.3	10.67	10.00			
			2		0.1828	0.1856	0.0028	0.3	9.33				
		3	1		0.1831	0.1863	0.0032	0.3	10.67	11.00			
			2		0.1824	0.1858	0.0034	0.3	11.33				
21/03/07	S Main Pond End	1	1	3	0.1837	0.1886	0.0049	0.3	16.33	17.00	13.26	3.27	1.89
			2		0.1819	0.1872	0.0053	0.3	17.67				
		2	1		0.1826	0.186	0.0034	0.3	11.33	11.83			
			2		0.1828	0.1865	0.0037	0.3	12.33				
		3	1		0.1823	0.1855	0.0032	0.3	10.67	10.96			
			2		0.1822	0.1858	0.0036	0.32	11.25				
21/03/07	Downstream A	1	1	1	0.1824	0.1837	0.0013	0.15	8.67	9.67	9.67	-	-
			2		0.1832	0.1848	0.0016	0.15	10.67				
21/03/07	Downstream B	1	1	1	0.1832	0.1845	0.0013	0.15	8.67	10.90	10.90	-	-
			2		0.1826	0.1847	0.0021	0.16	13.12				
28/03/07	S Main Pond Start	1	1	3	0.1826	0.1851	0.0025	0.5	5.00	6.70	7.93	1.20	0.69
			2		0.1839	0.1881	0.0042	0.5	8.40				
		2	1		0.182	0.1856	0.0036	0.5	7.20	8.00			
			2		0.1828	0.1872	0.0044	0.5	8.80				
		3	1		0.1828	0.1872	0.0044	0.5	8.80	9.10			
			2		0.1828	0.1875	0.0047	0.5	9.40				
28/03/07	S Main Pond Middle	1	1	3	0.1824	0.1834	0.001	0.2	5.00	6.25	5.33	0.88	0.51
			2		0.1852	0.1867	0.0015	0.2	7.50				
		2	1		0.1821	0.1826	0.0005	0.2	2.50	5.25			
			2		0.1844	0.1864	0.002	0.25	8.00				
		3	1		0.1835	0.1852	0.0017	0.3	5.67	4.50			
			2		0.1837	0.1843	0.0006	0.18	3.33				
28/03/07	S Main Pond End	1	1	3	0.1831	0.1836	0.0005	0.15	3.33	4.67	5.56	0.77	0.44
			2		0.1827	0.1839	0.0012	0.2	6.00				
		2	1		0.1837	0.1843	0.0006	0.2	3.00	6.00			
			2		0.1828	0.1846	0.0018	0.2	9.00				
		3	1		0.1843	0.185	0.0007	0.2	3.50	6.00			
			2		0.1838	0.1855	0.0017	0.2	8.50				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
28/03/07	Upstream A	1	1	1	0.1881	0.1898	0.0017	0.16	10.63	11.25	11.25	-	-
			2		0.1861	0.188	0.0019	0.16	11.88				
28/03/07	Upstream B	1	1	1	0.1765	0.1771	0.0006	0.14	4.29	5.48	5.48	-	-
			2		0.1863	0.1873	0.001	0.15	6.67				
28/03/07	Stream	1	1	1	0.1867	0.1875	0.0008	0.15	5.33	6.67	6.67	-	-
			2		0.1866	0.1878	0.0012	0.15	8.00				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
5/03/07	R Forebay Inflow	1	1	3	0.1852	0.1905	0.0053	0.2	26.50	32.58	38.74	5.46	3.15
			2		0.1846	0.1962	0.0116	0.3	38.67				
		2	1		0.184	0.1958	0.0118	0.3	39.33	40.63			
			2		0.183	0.196	0.013	0.31	41.94				
		3	1		0.1848	0.197	0.0122	0.3	40.67	43.00			
			2		0.1842	0.1978	0.0136	0.3	45.33				
5/03/07	R Forebay Outflow	1	1	3	0.1792	0.1961	0.0169	0.32	52.81	55.76	52.81	2.58	1.49
			2		0.1819	0.2001	0.0182	0.31	58.71				
		2	1		0.1807	0.1948	0.0141	0.3	47.00	51.00			
			2		0.1812	0.1977	0.0165	0.3	55.00				
		3	1		0.1816	0.1938	0.0122	0.3	40.67	51.67			
			2		0.1854	0.2042	0.0188	0.3	62.67				
5/03/07	R Main Pond Start	1	1	3	0.1794	0.1866	0.0072	0.35	20.57	21.00	19.21	2.10	1.21
			2		0.1873	0.1903	0.003	0.14	21.43				
		2	1		0.1796	0.1817	0.0021	0.16	13.12	16.90			
			2		0.1849	0.188	0.0031	0.15	20.67				
		3	1		0.187	0.1899	0.0029	0.16	18.13	19.73			
			2		0.1872	0.1904	0.0032	0.15	21.33				
5/03/07	R Main Pond Middle	1	1	3	0.1868	0.1896	0.0028	0.16	17.50	17.75	18.52	0.80	0.46
			2		0.1872	0.1908	0.0036	0.2	18.00				
		2	1		0.1886	0.1915	0.0029	0.15	19.33	19.35			
			2		0.1865	0.1896	0.0031	0.16	19.37				
		3	1		0.1874	0.19	0.0026	0.16	16.25	18.46			
			2		0.1859	0.189	0.0031	0.15	20.67				
5/03/07	R Main Pond End	1	1	3	0.1872	0.1902	0.003	0.15	20.00	21.25	19.08	2.13	1.23
			2		0.1851	0.1887	0.0036	0.16	22.50				
		2	1		0.1868	0.1891	0.0023	0.15	15.33	19.00			
			2		0.188	0.1914	0.0034	0.15	22.67				
		3	1		0.1872	0.1885	0.0013	0.15	8.67	17.00			
			2		0.1873	0.1911	0.0038	0.15	25.33				
16/03/07	R Forebay Inflow	1	1	3	0.1872	0.1873	1E-04	1	0.10	0.10	1.48	3.36	1.94
		2	1		0.1881	0.1888	0.0007	1	0.70	0.70			
		3	1		0.1873	0.1875	0.0002	0.5	0.40	0.50			
			2		0.1863	0.1866	0.0003	0.5	0.60	4.60			
16/03/07	R Forebay Outflow	1	1	3	0.1866	0.1909	0.0043	0.5	8.60	7.80	7.43	0.47	0.27
			2		0.1864	0.1899	0.0035	0.5	7.00				
		2	1		0.1857	0.1892	0.0035	0.5	7.00	6.90			
			2		0.1869	0.1903	0.0034	0.5	6.80				
		3	1		0.1871	0.191	0.0039	0.5	7.80	7.60			
			2		0.1881	0.1918	0.0037	0.5	7.40				
16/03/07	R Main Pond Start	1	1	3	0.184	0.1856	0.0016	0.5	3.20	3.10	1.90	1.11	0.64

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1862	0.1877	0.0015	0.5	3.00				
		2	1		0.1882	0.1887	0.0005	0.5	1.00	0.90			
			2		0.1886	0.189	0.0004	0.5	0.80				
		3	1		0.1885	0.1889	0.0004	0.5	0.80	1.70			
			2		0.1857	0.187	0.0013	0.5	2.60				
16/03/07	R Main Pond Middle	1	1	3	0.1859	0.1866	0.0007	0.5	1.40	2.70	2.47	0.21	0.12
			2		0.1891	0.1911	0.002	0.5	4.00				
		2	1		0.186	0.1866	0.0006	0.5	1.20	2.30			
			2		0.1873	0.189	0.0017	0.5	3.40				
		3	1		0.1885	0.1894	0.0009	0.5	1.80	2.40			
			2		0.1879	0.1894	0.0015	0.5	3.00				
16/03/07	R Main Pond End	1	1	3	0.1875	0.1879	0.0004	0.5	0.80	1.90	2.20	0.44	0.25
			2		0.188	0.1895	0.0015	0.5	3.00				
		2	1		0.187	0.1878	0.0008	0.5	1.60	2.00			
			2		0.187	0.1882	0.0012	0.5	2.40				
		3	1		0.1859	0.1868	0.0009	0.5	1.80	2.70			
			2		0.186	0.1878	0.0018	0.5	3.60				
16/03/07	R Main Pond Discharge	1	1	1	0.1867	0.1901	0.0034	0.5	6.80	8.30	8.30	-	-
			2		0.1866	0.1915	0.0049	0.5	9.80				
21/03/07	R Forebay Inflow	1	1	3	0.1827	0.1908	0.0081	0.99	8.18		7.60	5.64	3.25
		2	1		0.1834	0.194	0.0106	0.82	12.93				
		3	1		0.1821	0.1838	0.0017	1	1.70				
21/03/07	R Forebay Outflow	1	1	3	0.1835	0.1914	0.0079	0.32	24.69	27.34	22.64	6.93	4.00
			2		0.1841	0.1931	0.009	0.3	30.00				
		2	1		0.1823	0.1898	0.0075	0.3	25.00	25.89			
			2		0.1823	0.1906	0.0083	0.31	26.77				
		3	1		0.1825	0.1833	0.0008	0.31	2.58	14.68			
			2		0.1826	0.1909	0.0083	0.31	26.77				
21/03/07	R Main Pond Start	1	1	3	0.1822	0.1836	0.0014	0.7	2.00	2.00	2.70	1.04	0.60
		2	1		0.1831	0.1849	0.0018	0.5	3.60	3.90			
			2		0.1825	0.1846	0.0021	0.5	4.20				
		3	1		0.1821	0.1832	0.0011	0.5	2.20	2.20			
			2		0.1834	0.1845	0.0011	0.5	2.20				
21/03/07	R Main Pond Middle	1	1	3	0.1828	0.1838	0.001	0.5	2.00	3.90	3.83	0.12	0.07
			2		0.1826	0.1855	0.0029	0.5	5.80				
		2	1		0.1827	0.1844	0.0017	0.5	3.40	3.70			
			2		0.182	0.184	0.002	0.5	4.00				
		3	1		0.1828	0.1847	0.0019	0.5	3.80	3.90			
			2		0.1842	0.1862	0.002	0.5	4.00				
21/03/07	R Main Pond End	1	1	3	0.1833	0.1847	0.0014	0.5	2.80	3.00	5.03	2.86	1.65
			2		0.1826	0.1842	0.0016	0.5	3.20				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.1843	0.1878	0.0035	0.5	7.00	8.30			
			2		0.1818	0.1866	0.0048	0.5	9.60				
		3	1		0.1832	0.1852	0.002	0.5	4.00	3.80			
			2		0.183	0.1848	0.0018	0.5	3.60				
21/03/07	R Main Pond Discharge	1	1	1	0.1826	0.1875	0.0049	0.5	9.80	8.20	8.20	-	-
			2		0.1828	0.1861	0.0033	0.5	6.60				
28/03/07	R Forebay Inflow	1	1	3	0.1836	0.1858	0.0022	0.2	11.00	12.64	14.46	1.78	1.03
			2		0.1817	0.1847	0.003	0.21	14.29				
		2	1		0.1832	0.1864	0.0032	0.22	14.55	14.52			
			2		0.1824	0.1853	0.0029	0.2	14.50				
		3	1		0.1812	0.1855	0.0043	0.25	17.20	16.21			
			2		0.1863	0.1898	0.0035	0.23	15.22				
28/03/07	R Forebay Outflow	1	1	3	0.1852	0.1885	0.0033	0.2	16.50	17.25	18.59	3.19	1.84
			2		0.1866	0.1902	0.0036	0.2	18.00				
		2	1		0.1862	0.1907	0.0045	0.22	20.45	22.23			
			2		0.1879	0.1927	0.0048	0.2	24.00				
		3	1		0.1862	0.1899	0.0037	0.23	16.09	16.29			
			2		0.1764	0.1797	0.0033	0.2	16.50				
28/03/07	R Main Pond Start	1	1	3	0.1839	0.1844	0.0005	0.2	2.50	2.75	1.93	0.91	0.52
			2		0.1832	0.1841	0.0009	0.3	3.00				
		2	1		0.1838	0.1842	0.0004	0.31	1.29	2.10			
			2		0.1825	0.1834	0.0009	0.31	2.90				
		3	1		0.1847	0.185	0.0003	0.3	1.00	0.95			
			2		0.1836	0.1838	0.0002	0.22	0.91				
28/03/07	R Main Pond Middle	1	1	3	0.1823	0.1826	0.0003	0.32	0.94	1.09	2.40	1.16	0.67
			2		0.1832	0.1836	0.0004	0.32	1.25				
		2	1		0.1833	0.1846	0.0013	0.5	2.60	2.80			
			2		0.1833	0.1848	0.0015	0.5	3.00				
		3	1		0.1821	0.1837	0.0016	0.5	3.20	3.30			
			2		0.1862	0.1879	0.0017	0.5	3.40				
28/03/07	R Main Pond End	1	1	3	0.1826	0.1838	0.0012	0.5	2.40	2.40	2.53	0.15	0.09
			2		0.1835	0.1847	0.0012	0.5	2.40				
		2	1		0.182	0.1829	0.0009	0.5	1.80	2.50			
			2		0.1825	0.1841	0.0016	0.5	3.20				
		3	1		0.1832	0.1846	0.0014	0.5	2.80	2.70			
			2		0.1819	0.1832	0.0013	0.5	2.60				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
2/04/07	S Forebay Outflow	1	1	1	0.188	0.1955	0.0075	0.15	50.00	49.67	49.67	-	-
			2		0.1747	0.1821	0.0074	0.15	49.33				
2/04/07	S Main Pond Start	1	1	3	0.1816	0.184	0.0024	0.3	8.00	8.67	10.00	1.15	0.67
			2		0.1754	0.1782	0.0028	0.3	9.33				
		2	1		0.1749	0.1779	0.003	0.3	10.00	10.67			
			2		0.1746	0.178	0.0034	0.3	11.33				
		3	1		0.1815	0.1846	0.0031	0.3	10.33	10.67			
			2		0.1742	0.1775	0.0033	0.3	11.00				
2/04/07	S Main Pond Middle	1	1	3	0.1817	0.1843	0.0026	0.3	8.67	9.00	8.39	0.54	0.31
			2		0.1828	0.1856	0.0028	0.3	9.33				
		2	1		0.1755	0.1774	0.0019	0.3	6.33	8.17			
			2		0.1797	0.1827	0.003	0.3	10.00				
		3	1		0.1807	0.1828	0.0021	0.3	7.00	8.00			
			2		0.179	0.1817	0.0027	0.3	9.00				
2/04/07	S Main Pond End	1	1	3	0.1801	0.1833	0.0032	0.3	10.67	10.50	8.94	1.39	0.80
			2		0.1809	0.184	0.0031	0.3	10.33				
		2	1		0.1814	0.1841	0.0027	0.3	9.00	8.50			
			2		0.1765	0.1789	0.0024	0.3	8.00				
		3	1		0.181	0.1834	0.0024	0.3	8.00	7.83			
			2		0.1804	0.1827	0.0023	0.3	7.67				
2/04/07	S Main Pond Discharge	1	1	2	0.1869	0.1878	0.0009	0.3	3.00	4.33	4.67	1.41	1.00
			2		0.1828	0.1845	0.0017	0.3	5.67				
		2	1		0.181	0.1822	0.0012	0.3	4.00	5.00			
			2		0.1804	0.1822	0.0018	0.3	6.00				
2/04/07	Upstream A	1	1	1	0.1803	0.1807	0.0004	0.2	2.00	2.50	2.50	-	-
			2		0.1818	0.1824	0.0006	0.2	3.00				
2/04/07	Upstream B	1	1	1	0.1803	0.1811	0.0008	0.23	3.48	2.99	2.99	-	-
			2		0.1793	0.1798	0.0005	0.2	2.50				
2/04/07	Stream	1	1	1	0.1809	0.1821	0.0012	0.15	8.00	9.67	9.67	-	-
			2		0.1807	0.1824	0.0017	0.15	11.33				
2/04/07	Downstream B	1	1	1	0.1796	0.1802	0.0006	0.16	3.75	5.54	5.54	-	-
			2		0.1796	0.1807	0.0011	0.15	7.33				
17/04/07	S Main Pond Start	1	1	3	0.1875	0.1882	0.0007	0.25	2.80	3.40	3.43	0.03	0.02
			2		0.1875	0.1887	0.0012	0.3	4.00				
		2	1		0.1871	0.1881	0.001	0.3	3.33	3.47			
			2		0.1876	0.1885	0.0009	0.25	3.60				
		3	1		0.1883	0.1891	0.0008	0.25	3.20	3.43			
			2		0.1892	0.1903	0.0011	0.3	3.67				
17/04/07	S Main Pond Middle	1	1	3	0.1865	0.1873	0.0008	0.4	2.00	2.71	2.85	0.12	0.07
			2		0.188	0.1892	0.0012	0.35	3.43				
		2	1		0.1868	0.1877	0.0009	0.4	2.25	2.88			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1862	0.1875	0.0013	0.37	3.51				
		3	1		0.1866	0.1873	0.0007	0.3	2.33	2.94			
			2		0.1876	0.1887	0.0011	0.31	3.55				
17/04/07	S Main Pond End	1	1	3	0.1883	0.1902	0.0019	0.36	5.28	6.55	4.47	1.81	1.05
			2		0.1873	0.1898	0.0025	0.32	7.81				
		2	1		0.1881	0.189	0.0009	0.31	2.90	3.71			
			2		0.1878	0.1892	0.0014	0.31	4.52				
		3	1		0.1875	0.1883	0.0008	0.3	2.67	3.17			
			2		0.188	0.1891	0.0011	0.3	3.67				
17/04/07	Upstream A	1	1	1	0.187	0.1877	0.0007	0.25	2.80	2.55	2.55	-	-
			2		0.1893	0.1899	0.0006	0.26	2.31				
17/04/07	Upstream B	1	1	1	0.1877	0.1881	0.0004	0.25	1.60	2.00	2.00	-	-
			2		0.1857	0.1863	0.0006	0.25	2.40				
17/04/07	Stream	1	1	1	0.1871	0.1879	0.0008	0.26	3.08	2.46	2.46	-	-
			2		0.1894	0.1899	0.0005	0.27	1.85				
17/04/07	Downstream A	1	1	1	0.1866	0.1873	0.0007	0.3	2.33	2.90	2.90	-	-
			2		0.1869	0.1878	0.0009	0.26	3.46				
17/04/07	Downstream B	1	1	1	0.1833	0.184	0.0007	0.3	2.33	2.33	2.33	-	-
			2		0.1868	0.1875	0.0007	0.3	2.33				
23/04/07	S Main Pond Start	1	1	3	0.1865	0.1871	0.0006	0.25	2.40	2.80	2.72	0.08	0.05
			2		0.1873	0.1881	0.0008	0.25	3.20				
		2	1		0.1855	0.1862	0.0007	0.27	2.59	2.64			
			2		0.1863	0.187	0.0007	0.26	2.69				
		3	1		0.1867	0.1872	0.0005	0.26	1.92	2.71			
			2		0.1858	0.1865	0.0007	0.2	3.50				
23/04/07	S Main Pond Middle	1	1	3	0.1864	0.1872	0.0008	0.31	2.58	2.62	2.94	0.29	0.17
			2		0.1855	0.1863	0.0008	0.3	2.67				
		2	1		0.1863	0.187	0.0007	0.25	2.80	3.20			
			2		0.1868	0.1877	0.0009	0.25	3.60				
		3	1		0.1868	0.1876	0.0008	0.27	2.96	2.98			
			2		0.1849	0.1858	0.0009	0.3	3.00				
23/04/07	S Main Pond End	1	1	3	0.1864	0.1876	0.0012	0.3	4.00	3.85	3.32	1.19	0.69
			2		0.1861	0.1871	0.001	0.27	3.70				
		2	1		0.1864	0.1873	0.0009	0.21	4.29	4.14			
			2		0.1875	0.1883	0.0008	0.2	4.00				
		3	1		0.1872	0.1879	0.0007	0.25	2.80	1.96			
			2		0.1875	0.1878	0.0003	0.27	1.11				
23/04/07	Upstream A	1	1	1	0.1859	0.1869	0.001	0.27	3.70	4.71	4.71	-	-
			2		0.1853	0.1865	0.0012	0.21	5.71				
23/04/07	Upstream B	1	1	1	0.186	0.1862	0.0002	0.15	1.33	1.33	1.33	-	-
			2		0.1852	0.1854	0.0002	0.15	1.33				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
23/04/07	Stream	1	1	1	0.1845	0.1851	0.0006	0.25	2.40	4.37	4.37	-	-
			2		0.1859	0.1878	0.0019	0.3	6.33				
23/04/07	Downstream A	1	1	1	0.1873	0.1881	0.0008	0.27	2.96	3.88	3.88	-	-
			2		0.1868	0.188	0.0012	0.25	4.80				
30/04/07	S Forebay Outflow	1	1	3	0.1864	0.1903	0.0039	0.27	14.44	18.47	27.54	8.93	5.16
			2		0.1876	0.193	0.0054	0.24	22.50				
		2	1		0.1867	0.1911	0.0044	0.27	16.30	27.81			
			2		0.1876	0.1935	0.0059	0.15	39.33				
		3	1		0.1862	0.1914	0.0052	0.15	34.67	36.33			
			2		0.1867	0.1924	0.0057	0.15	38.00				
30/04/07	S Main Pond Start	1	1	3	0.1861	0.1864	0.0003	0.25	1.20	1.77	2.19	0.45	0.26
			2		0.1867	0.1874	0.0007	0.3	2.33				
		2	1		0.1856	0.1862	0.0006	0.3	2.00	2.67			
			2		0.1872	0.1881	0.0009	0.27	3.33				
		3	1		0.1862	0.1866	0.0004	0.27	1.48	2.14			
			2		0.1859	0.1866	0.0007	0.25	2.80				
30/04/07	S Main Pond Middle	1	1	3	0.1876	0.1881	0.0005	0.25	2.00	1.60	1.88	0.25	0.14
			2		0.1866	0.1869	0.0003	0.25	1.20				
		2	1		0.1861	0.1864	0.0003	0.21	1.43	2.05			
			2		0.186	0.1868	0.0008	0.3	2.67				
		3	1		0.1867	0.1871	0.0004	0.23	1.74	2.01			
			2		0.1865	0.187	0.0005	0.22	2.27				
30/04/07	S Main Pond End	1	1	3	0.1868	0.1873	0.0005	0.35	1.43	2.38	2.00	0.48	0.28
			2		0.1868	0.1875	0.0007	0.21	3.33				
		2	1		0.186	0.1866	0.0006	0.3	2.00	2.15			
			2		0.1871	0.1877	0.0006	0.26	2.31				
		3	1		0.1879	0.1883	0.0004	0.27	1.48	1.46			
			2		0.1873	0.1878	0.0005	0.35	1.43				
30/04/07	Upstream A	1	1	1	0.1861	0.1865	0.0004	0.25	1.60	2.15	2.15	-	-
			2		0.1861	0.1868	0.0007	0.26	2.69				
30/04/07	Upstream B	1	1	1	0.1867	0.1873	0.0006	0.27	2.22	2.65	2.65	-	-
			2		0.1857	0.1865	0.0008	0.26	3.08				
30/04/07	Stream	1	1	1	0.1861	0.1865	0.0004	0.26	1.54	1.32	1.32	-	-
			2		0.1871	0.1874	0.0003	0.27	1.11				
30/04/07	Downstream A	1	1	1	0.1865	0.1872	0.0007	0.3	2.33	3.17	3.17	-	-
			2		0.1869	0.1881	0.0012	0.3	4.00				
30/04/07	Downstream B	1	1	1	0.1864	0.1874	0.001	0.26	3.85	3.78	3.78	-	-
			2		0.1872	0.1885	0.0013	0.35	3.71				

Richardson Road April 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
2/04/07	R Forebay Inflow	1	1	3	0.179	0.1808	0.0018	0.3	6.00	6.50	7.39	0.79	0.45
			2		0.1805	0.1826	0.0021	0.3	7.00				
		2	1		0.1863	0.1887	0.0024	0.3	8.00	8.00			
			2		0.1876	0.19	0.0024	0.3	8.00				
		3	1		0.1803	0.1824	0.0021	0.3	7.00	7.67			
			2		0.176	0.1785	0.0025	0.3	8.33				
2/04/07	R Forebay Outflow	1	1	3	0.1809	0.1822	0.0013	0.3	4.33	6.00	6.83	0.93	0.54
			2		0.1807	0.183	0.0023	0.3	7.67				
		2	1		0.1806	0.183	0.0024	0.3	8.00	7.83			
			2		0.1805	0.1828	0.0023	0.3	7.67				
		3	1		0.1802	0.1819	0.0017	0.3	5.67	6.67			
			2		0.1838	0.1861	0.0023	0.3	7.67				
2/04/07	R Main Pond Start	1	1	3	0.1805	0.1813	0.0008	0.3	2.67	3.33	3.44	0.51	0.29
			2		0.1794	0.1806	0.0012	0.3	4.00				
		2	1		0.1798	0.181	0.0012	0.3	4.00	4.00			
			2		0.1805	0.1817	0.0012	0.3	4.00				
		3	1		0.1812	0.182	0.0008	0.3	2.67	3.00			
			2		0.1793	0.1803	0.001	0.3	3.33				
2/04/07	R Main Pond Middle	1	1	3	0.1804	0.1813	0.0009	0.3	3.00	3.50	3.56	0.25	0.15
			2		0.1822	0.1834	0.0012	0.3	4.00				
		2	1		0.1809	0.1814	0.0005	0.3	1.67	3.33			
			2		0.1855	0.187	0.0015	0.3	5.00				
		3	1		0.186	0.1868	0.0008	0.3	2.67	3.83			
			2		0.1801	0.1816	0.0015	0.3	5.00				
2/04/07	R Main Pond End	1	1	3	0.1803	0.1815	0.0012	0.3	4.00	3.67	3.57	0.16	0.09
			2		0.1809	0.1819	0.001	0.3	3.33				
		2	1		0.1863	0.1874	0.0011	0.3	3.67	3.67			
			2		0.1867	0.1878	0.0011	0.3	3.67				
		3	1		0.1859	0.1869	0.001	0.36	2.78	3.39			
			2		0.1877	0.1889	0.0012	0.3	4.00				
2/04/07	R Main Pond Discharge	1	1	3	0.1869	0.1898	0.0029	0.3	9.67	12.67	7.33	4.63	2.67
			2		0.1801	0.1848	0.0047	0.3	15.67				
		2	1		0.1869	0.1878	0.0009	0.3	3.00	4.33			
			2		0.1828	0.1845	0.0017	0.3	5.67				
		3	1		0.181	0.1822	0.0012	0.3	4.00	5.00			
			2		0.1804	0.1822	0.0018	0.3	6.00				
17/04/07	R Forebay Groundwater Input	1	1	1	0.1847	0.185	0.0003	0.5	0.60	0.60	0.60	-	-
			2		0.1849	0.1852	0.0003	0.5	0.60				
17/04/07	R Forebay Inflow	1	1	3	0.1858	0.1885	0.0027	0.5	5.40	6.37	6.84	0.63	0.36
			2		0.1871	0.1893	0.0022	0.3	7.33				
		2	1		0.1868	0.1889	0.0021	0.5	4.20	6.60			

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1873	0.19	0.0027	0.3	9.00				
		3	1		0.1878	0.1895	0.0017	0.3	5.67	7.55			
			2		0.1872	0.1905	0.0033	0.35	9.43				
17/04/07	R Forebay Outflow	1	1	3	0.187	0.19	0.003	0.4	7.50	7.65	7.85	0.28	0.16
			2		0.1875	0.1914	0.0039	0.5	7.80				
		2	1		0.1851	0.188	0.0029	0.4	7.25	7.73			
			2		0.1868	0.1909	0.0041	0.5	8.20				
		3	1		0.1868	0.1894	0.0026	0.3	8.67	8.17			
			2		0.1868	0.1891	0.0023	0.3	7.67				
17/04/07	R Main Pond Start	1	1	3	0.1878	0.1896	0.0018	0.4	4.50	5.42	5.25	0.22	0.13
			2		0.1876	0.1895	0.0019	0.3	6.33				
		2	1		0.1874	0.1888	0.0014	0.3	4.67	5.00			
			2		0.1871	0.1887	0.0016	0.3	5.33				
		3	1		0.1871	0.1886	0.0015	0.3	5.00	5.33			
			2		0.1879	0.1896	0.0017	0.3	5.67				
17/04/07	R Main Pond Middle	1	1	3	0.1863	0.1883	0.002	0.35	5.71	6.61	6.20	0.48	0.28
			2		0.1864	0.1894	0.003	0.4	7.50				
		2	1		0.1876	0.1891	0.0015	0.3	5.00	6.33			
			2		0.1865	0.1888	0.0023	0.3	7.67				
		3	1		0.1865	0.188	0.0015	0.3	5.00	5.67			
			2		0.1876	0.1895	0.0019	0.3	6.33				
17/04/07	R Main Pond End	1	1	3	0.1854	0.1868	0.0014	0.25	5.60	6.47	5.54	0.80	0.46
			2		0.1872	0.1894	0.0022	0.3	7.33				
		2	1		0.1863	0.1877	0.0014	0.35	4.00	5.00			
			2		0.1869	0.1887	0.0018	0.3	6.00				
		3	1		0.1858	0.1869	0.0011	0.3	3.67	5.17			
			2		0.1857	0.1877	0.002	0.3	6.67				
17/04/07	R Main Pond Discharge	1	1	3	0.1885	0.1903	0.0018	0.3	6.00	6.50	6.89	0.35	0.20
			2		0.187	0.1891	0.0021	0.3	7.00				
		2	1		0.1871	0.1887	0.0016	0.3	5.33	7.00			
			2		0.1877	0.1903	0.0026	0.3	8.67				
		3	1		0.1873	0.189	0.0017	0.3	5.67	7.17			
			2		0.1876	0.1902	0.0026	0.3	8.67				
23/04/07	R Forebay Groundwater Input	1	1	1	0.1802	0.1804	0.0002	0.5	0.40	0.87	0.87	-	-
			2		0.1871	0.1878	0.0007	0.52	1.35				
23/04/07	R Forebay Inflow	1	1	3	0.1865	0.1877	0.0012	0.31	3.87	3.71	3.28	0.44	0.25
			2		0.1858	0.1869	0.0011	0.31	3.55				
		2	1		0.1824	0.1826	0.0002	0.3	0.67	2.83			
			2		0.1823	0.1843	0.002	0.4	5.00				
		3	1		0.187	0.1879	0.0009	0.31	2.90	3.28			
			2		0.1789	0.18	0.0011	0.3	3.67				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
23/04/07	R Forebay Outflow	1	1	3	0.1814	0.1824	0.001	0.5	2.00	2.40	3.36	1.05	0.60
			2		0.176	0.1774	0.0014	0.5	2.80				
		2	1		0.1877	0.1898	0.0021	0.5	4.20	4.47			
			2		0.1869	0.1888	0.0019	0.4	4.75				
		3	1		0.1868	0.1882	0.0014	0.5	2.80	3.20			
			2		0.1878	0.1896	0.0018	0.5	3.60				
23/04/07	R Main Pond Start	1	1	3	0.186	0.1871	0.0011	0.53	2.08	2.54	2.24	0.27	0.16
			2		0.1858	0.187	0.0012	0.4	3.00				
		2	1		0.1865	0.1874	0.0009	0.5	1.80	2.00			
			2		0.1868	0.1879	0.0011	0.5	2.20				
		3	1		0.1874	0.1883	0.0009	0.51	1.76	2.18			
			2		0.1866	0.1879	0.0013	0.5	2.60				
23/04/07	R Main Pond Middle	1	1	3	0.1866	0.1876	0.001	0.51	1.96	2.09	2.09	0.22	0.13
			2		0.1823	0.1831	0.0008	0.36	2.22				
		2	1		0.1867	0.1875	0.0008	0.52	1.54	1.87			
			2		0.1874	0.1885	0.0011	0.5	2.20				
		3	1		0.1861	0.1871	0.001	0.51	1.96	2.31			
			2		0.1863	0.1871	0.0008	0.3	2.67				
23/04/07	R Main Pond End	1	1	3	0.1862	0.1871	0.0009	0.4	2.25	2.37	2.39	0.28	0.16
			2		0.1873	0.1883	0.001	0.4	2.50				
		2	1		0.1862	0.1869	0.0007	0.4	1.75	2.13			
			2		0.1864	0.1874	0.001	0.4	2.50				
		3	1		0.1869	0.1879	0.001	0.35	2.86	2.68			
			2		0.1829	0.1839	0.001	0.4	2.50				
23/04/07	R Main Pond Discharge	1	1	3	0.1861	0.1869	0.0008	0.3	2.67	2.78	13.05	15.29	8.83
			2		0.187	0.1879	0.0009	0.31	2.90				
		2	1		0.186	0.1891	0.0031	0.16	19.37	30.63			
			2		0.1851	0.1918	0.0067	0.16	41.88				
		3	1		0.1868	0.1892	0.0024	0.5	4.80	5.73			
			2		0.186	0.188	0.002	0.3	6.67				
30/04/07	R Forebay Groundwater Input	1	1	1	0.188	0.1888	0.0008	0.51	1.57	2.28	2.28	-	-
			2		0.1868	0.1883	0.0015	0.5	3.00				
30/04/07	R Forebay Inflow	1	1	3	0.1869	0.1897	0.0028	0.16	17.50	19.03	17.84	1.06	0.61
			2		0.1851	0.1888	0.0037	0.18	20.56				
		2	1		0.1856	0.1872	0.0016	0.15	10.67	17.00			
			2		0.1853	0.1888	0.0035	0.15	23.33				
		3	1		0.1856	0.1883	0.0027	0.16	16.88	17.50			
			2		0.1868	0.1897	0.0029	0.16	18.13				
30/04/07	R Forebay Outflow	1	1	3	0.1862	0.1903	0.0041	0.15	27.33	30.67	30.59	1.70	0.98
			2		0.1871	0.1922	0.0051	0.15	34.00				
		2	1		0.1865	0.19	0.0035	0.15	23.33	28.85			

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1874	0.1929	0.0055	0.16	34.37				
		3	1		0.1851	0.1899	0.0048	0.15	32.00	32.25			
			2		0.1863	0.1915	0.0052	0.16	32.50				
30/04/07	R Main Pond Start	1	1	3	0.1866	0.1887	0.0021	0.25	8.40	9.39	8.93	0.41	0.24
			2		0.1874	0.1902	0.0028	0.27	10.37				
		2	1		0.1858	0.1876	0.0018	0.25	7.20	8.60			
			2		0.1868	0.1896	0.0028	0.28	10.00				
		3	1		0.186	0.1879	0.0019	0.25	7.60	8.80			
			2		0.1875	0.19	0.0025	0.25	10.00				
30/04/07	R Main Pond Middle	1	1	3	0.1863	0.1878	0.0015	0.2	7.50	8.37	8.70	0.45	0.26
			2		0.1851	0.1875	0.0024	0.26	9.23				
		2	1		0.1874	0.1892	0.0018	0.27	6.67	8.52			
			2		0.1858	0.1886	0.0028	0.27	10.37				
		3	1		0.1859	0.1879	0.002	0.26	7.69	9.22			
			2		0.1875	0.1904	0.0029	0.27	10.74				
30/04/07	R Main Pond End	1	1	3	0.1861	0.1886	0.0025	0.25	10.00	13.20	10.72	2.26	1.31
			2		0.1868	0.1909	0.0041	0.25	16.40				
		2	1		0.1868	0.1891	0.0023	0.25	9.20	10.20			
			2		0.1864	0.1892	0.0028	0.25	11.20				
		3	1		0.187	0.1895	0.0025	0.3	8.33	8.77			
			2		0.1863	0.1886	0.0023	0.25	9.20				
30/04/07	R Main Pond Discharge	1	1	3	0.1872	0.1895	0.0023	0.27	8.52	10.03	9.17	0.75	0.43
			2		0.1866	0.1896	0.003	0.26	11.54				
		2	1		0.1865	0.1882	0.0017	0.26	6.54	8.82			
			2		0.1868	0.1898	0.003	0.27	11.11				
		3	1		0.1875	0.1895	0.002	0.26	7.69	8.65			
			2		0.1864	0.1889	0.0025	0.26	9.62				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
15/05/07	S Main Pond Start	1	1	3	0.1875	0.188	0.0005	0.3	1.67	2.03	1.87	0.15	0.09
			2		0.1864	0.187	0.0006	0.25	2.40				
		2	1		0.1885	0.1888	0.0003	0.3	1.00	1.83			
			2		0.1872	0.188	0.0008	0.3	2.67				
		3	1		0.1861	0.1867	0.0006	0.31	1.94	1.74			
			2		0.1873	0.1877	0.0004	0.26	1.54				
15/05/07	S Main Pond Middle	1	1	3	0.1861	0.1866	0.0005	0.3	1.67	0.99	1.08	0.46	0.27
			2		0.1869	0.187	0.0001	0.31	0.32				
		2	1		0.1878	0.1882	0.0004	0.3	1.33	0.67			
			2		0.1865	0.1865	0.0000	0.3	0.00				
		3	1		0.1854	0.1858	0.0004	0.3	1.33	1.58			
			2		0.1879	0.1885	0.0006	0.33	1.82				
15/05/07	S Main Pond End	1	1	3	0.1867	0.187	0.0003	0.33	0.91	0.95	1.21	0.52	0.30
			2		0.1872	0.1875	0.0003	0.3	1.00				
		2	1		0.1868	0.1871	0.0003	0.32	0.94	1.80			
			2		0.1859	0.1867	0.0008	0.3	2.67				
		3	1		0.1863	0.1864	0.0001	0.25	0.40	0.87			
			2		0.1868	0.1872	0.0004	0.3	1.33				
15/05/07	Upstream A	1	1	3	0.1856	0.1864	0.0008	0.3	2.67	3.50	2.53	1.16	0.67
			2		0.1856	0.1869	0.0013	0.3	4.33				
		2	1		0.1866	0.187	0.0004	0.32	1.25	1.25			
			2		0.1866	0.187	0.0004	0.32	1.25				
		3	1		0.1862	0.187	0.0008	0.3	2.67	2.83			
			2		0.1872	0.1881	0.0009	0.3	3.00				
15/05/07	Upstream B	1	1	3	0.1864	0.1873	0.0009	0.33	2.73	3.26	2.81	0.57	0.33
			2		0.1865	0.1876	0.0011	0.29	3.79				
		2	1		0.1884	0.1889	0.0005	0.25	2.00	3.00			
			2		0.187	0.188	0.0010	0.25	4.00				
		3	1		0.1878	0.1884	0.0006	0.3	2.00	2.17			
			2		0.1877	0.1884	0.0007	0.3	2.33				
15/05/07	Stream	1	1	3	0.1878	0.1885	0.0007	0.25	2.80	2.90	3.25	0.32	0.19
			2		0.1856	0.1865	0.0009	0.3	3.00				
		2	1		0.1869	0.1877	0.0008	0.26	3.08	3.54			
			2		0.1861	0.1871	0.0010	0.25	4.00				
		3	1		0.1865	0.1874	0.0009	0.25	3.60	3.30			
			2		0.1859	0.1868	0.0009	0.3	3.00				
15/05/07	Downstream B	1	1	3	0.187	0.1876	0.0006	0.25	2.40	3.03	3.98	1.30	0.75
			2		0.1864	0.1875	0.0011	0.3	3.67				
		2	1		0.187	0.1878	0.0008	0.25	3.20	3.45			
			2		0.1877	0.1887	0.0010	0.27	3.70				
		3	1		0.1874	0.189	0.0016	0.27	5.93	5.46			
			2		0.1867	0.1882	0.0015	0.3	5.00				
23/05/07	S Main Pond Start	1	1	3	0.1856	0.186	0.0004	0.23	1.74	2.07	1.74	0.46	0.27
			2		0.1851	0.1857	0.0006	0.25	2.40				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.1866	0.1869	0.0003	0.22	1.36	1.21			
			2		0.1868	0.187	0.0002	0.19	1.05				
		3	1		0.1863	0.1866	0.0003	0.22	1.36	1.93			
			2		0.1877	0.1882	0.0005	0.2	2.50				
23/05/07	S Main Pond Middle	1	1	3	0.1846	0.185	0.0004	0.23	1.74	1.43	0.69	0.65	0.37
			2		0.1863	0.1866	0.0003	0.27	1.11				
		2	1		0.1853	0.1854	0.0001	0.22	0.45	0.44			
			2		0.187	0.1871	0.0001	0.23	0.43				
		3	1		0.1869	0.1869	0.0000	0.27	0.00	0.20			
			2		0.1875	0.1876	0.0001	0.25	0.40				
23/05/07	S Main Pond End	1	1	3	0.1856	0.1858	0.0002	0.22	0.91	0.81	0.61	0.26	0.15
			2		0.1863	0.1865	0.0002	0.28	0.71				
		2	1		0.1862	0.1865	0.0003	0.3	1.00	0.70			
			2		0.1843	0.1844	0.0001	0.25	0.40				
		3	1		0.1857	0.1859	0.0002	0.31	0.65	0.32			
			2		0.1853	0.1853	0.0000	0.29	0.00				
23/05/07	Stream	1	1	3	0.1861	0.1867	0.0006	0.22	2.73	3.15	2.16	0.87	0.50
			2		0.1857	0.1862	0.0005	0.14	3.57				
		2	1		0.187	0.1873	0.0003	0.26	1.15	1.50			
			2		0.187	0.1875	0.0005	0.27	1.85				
		3	1		0.185	0.1852	0.0002	0.15	1.33	1.83			
			2		0.1864	0.1871	0.0007	0.3	2.33				
23/05/07	Upstream A	1	1	3	0.1851	0.1853	0.0002	0.15	1.33	1.92	2.02	1.48	0.85
			2		0.1852	0.1855	0.0003	0.12	2.50				
		2	1		0.185	0.1856	0.0006	0.16	3.75	3.54			
			2		0.1852	0.1857	0.0005	0.15	3.33				
		3	1		0.1863	0.1863	0.0000	0.17	0.00	0.59			
			2		0.1869	0.1871	0.0002	0.17	1.18				
23/05/07	Upstream B	1	1	3	0.1876	0.188	0.0004	0.15	2.67	2.38	2.20	0.15	0.09
			2		0.1871	0.1876	0.0005	0.24	2.08				
		2	1		0.185	0.1852	0.0002	0.18	1.11	2.12			
			2		0.186	0.1865	0.0005	0.16	3.13				
		3	1		0.1871	0.1875	0.0004	0.23	1.74	2.12			
			2		0.1848	0.1852	0.0004	0.16	2.50				
23/05/07	Downstream A	1	1	3	0.186	0.1866	0.0006	0.17	3.53	2.51	1.48	0.96	0.55
			2		0.1853	0.1856	0.0003	0.2	1.50				
		2	1		0.1854	0.1855	0.0001	0.16	0.62	1.31			
			2		0.1858	0.1861	0.0003	0.15	2.00				
		3	1		0.1854	0.1856	0.0002	0.16	1.25	0.62			
			2		0.1869	0.1869	0.0000	0.16	0.00				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
15/05/07	R Forebay Groundwater Input	1	1	3	0.186	0.1865	0.0005	0.5	1.00	1.70	0.77	0.82	0.47
			2		0.1867	0.1879	0.0012	0.5	2.40				
		2	1		0.1873	0.1874	0.0001	0.52	0.19	0.20			
			2		0.1875	0.1876	0.0001	0.5	0.20				
		3	1		0.1875	0.1877	0.0002	0.5	0.40	0.40			
			2		0.1884	0.1886	0.0002	0.5	0.40				
15/05/07	R Forebay Inflow	1	1	3	0.1863	0.1903	0.0040	0.15	26.67	25.21	27.03	3.48	2.01
			2		0.1863	0.1901	0.0038	0.16	23.75				
		2	1		0.1875	0.1935	0.0060	0.18	33.33	31.04			
			2		0.1886	0.1932	0.0046	0.16	28.75				
		3	1		0.1858	0.1897	0.0039	0.16	24.38	24.83			
			2		0.1876	0.1919	0.0043	0.17	25.29				
15/05/07	R Forebay Outflow	1	1	3	0.1866	0.1899	0.0033	0.23	14.35	14.17	15.17	1.88	1.08
			2		0.1875	0.1903	0.0028	0.2	14.00				
		2	1		0.1874	0.1894	0.0020	0.15	13.33	14.00			
			2		0.1866	0.1888	0.0022	0.15	14.67				
		3	1		0.1861	0.1889	0.0028	0.15	18.67	17.33			
			2		0.1869	0.1893	0.0024	0.15	16.00				
15/05/07	R Main Pond Start	1	1	3	0.1871	0.1879	0.0008	0.2	4.00	3.74	4.71	0.86	0.50
			2		0.1877	0.1885	0.0008	0.23	3.48				
		2	1		0.1871	0.1878	0.0007	0.15	4.67	4.98			
			2		0.1863	0.1872	0.0009	0.17	5.29				
		3	1		0.1871	0.1877	0.0006	0.15	4.00	5.40			
			2		0.1869	0.1886	0.0017	0.25	6.80				
15/05/07	R Main Pond Middle	1	1	3	0.1885	0.1894	0.0009	0.21	4.29	4.74	4.48	0.30	0.17
			2		0.1875	0.1888	0.0013	0.25	5.20				
		2	1		0.1869	0.1875	0.0006	0.21	2.86	4.16			
			2		0.187	0.1882	0.0012	0.22	5.45				
		3	1		0.1862	0.1873	0.0011	0.2	5.50	4.55			
			2		0.1871	0.188	0.0009	0.25	3.60				
15/05/07	R Main Pond End	1	1	3	0.1873	0.1879	0.0006	0.25	2.40	3.40	3.34	0.50	0.29
			2		0.1866	0.1877	0.0011	0.25	4.40				
		2	1		0.1858	0.1868	0.0010	0.31	3.23	2.81			
			2		0.187	0.1876	0.0006	0.25	2.40				
		3	1		0.1866	0.1871	0.0005	0.25	2.00	3.80			
			2		0.1867	0.1881	0.0014	0.25	5.60				
15/05/07	R Main Pond Discharge	1	1	3	0.187	0.1872	0.0002	0.21	0.95	1.81	2.72	0.79	0.46
			2		0.1859	0.1867	0.0008	0.3	2.67				
		2	1		0.1858	0.1867	0.0009	0.3	3.00	3.27			
			2		0.1873	0.1884	0.0011	0.31	3.55				
		3	1		0.1859	0.1868	0.0009	0.27	3.33	3.07			
			2		0.1874	0.1881	0.0007	0.25	2.80				
23/05/07	R Forebay Groundwater Input	1	1	3	0.1875	0.1875	0.0000	0.5	0.00	0.30	0.47	0.21	0.12
			2		0.1874	0.1877	0.0003	0.5	0.60				
		2	1		0.1868	0.1868	0.0000	0.5	0.00	0.40			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1879	0.1883	0.0004	0.5	0.80				
		3	1		0.1872	0.1874	0.0002	0.5	0.40	0.70			
			2		0.1876	0.1881	0.0005	0.5	1.00				
23/05/07	R Forebay Inflow	1	1	3	0.1868	0.1924	0.0056	0.13	43.08	43.08	41.24	2.68	1.55
			2		0.1872	0.1928	0.0056	0.13	43.08				
		2	1		0.1868	0.1923	0.0055	0.13	42.31	42.49			
			2		0.1848	0.1912	0.0064	0.15	42.67				
		3	1		0.1863	0.1909	0.0046	0.12	38.33	38.17			
			2		0.1863	0.192	0.0057	0.15	38.00				
23/05/07	R Forebay Outflow	1	1	3	0.1854	0.1911	0.0057	0.15	38.00	36.67	37.51	2.88	1.66
			2		0.1884	0.1937	0.0053	0.15	35.33				
		2	1		0.185	0.1907	0.0057	0.16	35.63	35.15			
			2		0.1855	0.1907	0.0052	0.15	34.67				
		3	1		0.1853	0.1912	0.0059	0.14	42.14	40.71			
			2		0.186	0.1915	0.0055	0.14	39.29				
23/05/07	R Main Pond Start	1	1	3	0.1851	0.1863	0.0012	0.18	6.67	6.58	6.94	0.63	0.36
			2		0.1853	0.1866	0.0013	0.2	6.50				
		2	1		0.1864	0.1877	0.0013	0.22	5.91	6.57			
			2		0.1871	0.1884	0.0013	0.18	7.22				
		3	1		0.1876	0.1885	0.0009	0.15	6.00	7.67			
			2		0.1876	0.189	0.0014	0.15	9.33				
23/05/07	R Main Pond Middle	1	1	3	0.1872	0.1881	0.0009	0.15	6.00	6.21	6.87	0.59	0.34
			2		0.1868	0.1877	0.0009	0.14	6.43				
		2	1		0.1861	0.1869	0.0008	0.11	7.27	7.07			
			2		0.1863	0.1874	0.0011	0.16	6.88				
		3	1		0.1856	0.1867	0.0011	0.15	7.33	7.33			
			2		0.1869	0.188	0.0011	0.15	7.33				
23/05/07	R Main Pond End	1	1	3	0.1873	0.1881	0.0008	0.14	5.71	6.52	6.09	0.67	0.39
			2		0.1848	0.1859	0.0011	0.15	7.33				
		2	1		0.1855	0.1863	0.0008	0.14	5.71	6.43			
			2		0.1848	0.1858	0.0010	0.14	7.14				
		3	1		0.1862	0.1867	0.0005	0.14	3.57	5.32			
			2		0.1866	0.1878	0.0012	0.17	7.06				
23/05/07	R Main Pond Discharge	1	1	3	0.1855	0.1865	0.0010	0.22	4.55	5.80	6.31	0.46	0.27
			2		0.1868	0.188	0.0012	0.17	7.06				
		2	1		0.1854	0.186	0.0006	0.14	4.29	6.43			
			2		0.1859	0.1871	0.0012	0.14	8.57				
		3	1		0.1845	0.1853	0.0008	0.14	5.71	6.70			
			2		0.1846	0.1856	0.0010	0.13	7.69				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
1/06/07	S Main Pond Start	1	1	3	0.1872	0.1877	0.0005	0.25	2.00	2.25	2.35	0.10	0.06
			2		0.1864	0.187	0.0006	0.24	2.50				
		2	1		0.1856	0.1861	0.0005	0.22	2.27	2.34			
			2		0.1863	0.1869	0.0006	0.25	2.40				
		3	1		0.1851	0.1857	0.0006	0.22	2.73	2.45			
			2		0.1868	0.1873	0.0005	0.23	2.17				
1/06/07	S Main Pond Middle	1	1	3	0.1859	0.1863	0.0004	0.22	1.82	1.94	1.77	0.15	0.09
			2		0.1868	0.1874	0.0006	0.29	2.07				
		2	1		0.1868	0.1875	0.0007	0.27	2.59	1.68			
			2		0.1866	0.1868	0.0002	0.26	0.77				
		3	1		0.1866	0.1871	0.0005	0.26	1.92	1.68			
			2		0.1865	0.1869	0.0004	0.28	1.43				
1/06/07	S Main Pond End	1	1	3	0.1868	0.1875	0.0007	0.29	2.41	1.92	1.73	0.42	0.24
			2		0.1875	0.1879	0.0004	0.28	1.43				
		2	1		0.1855	0.1859	0.0004	0.26	1.54	2.02			
			2		0.1862	0.1868	0.0006	0.24	2.50				
		3	1		0.1869	0.1871	0.0002	0.24	0.83	1.25			
			2		0.1873	0.1877	0.0004	0.24	1.67				
1/06/07	Upstream A	1	1	3	0.1867	0.1869	0.0002	0.28	0.71	0.52	0.88	0.59	0.34
			2		0.1872	0.1873	0.0001	0.3	0.33				
		2	1		0.1886	0.1887	0.0001	0.27	0.37	0.56			
			2		0.1872	0.1874	0.0002	0.27	0.74				
		3	1		0.1871	0.1876	0.0005	0.25	2.00	1.56			
			2		0.1878	0.1881	0.0003	0.27	1.11				
1/06/07	Upstream B	1	1	3	0.1864	0.1873	0.0009	0.25	3.60	3.47	6.32	4.58	2.65
			2		0.1877	0.1886	0.0009	0.27	3.33				
		2	1		0.185	0.1857	0.0007	0.27	2.59	3.88			
			2		0.1856	0.1871	0.0015	0.29	5.17				
		3	1		0.1872	0.1903	0.0031	0.27	11.48	11.60			
			2		0.1865	0.1899	0.0034	0.29	11.72				
1/06/07	Stream	1	1	3	0.1848	0.1849	0.0001	0.31	0.32	0.32	1.43	1.35	0.78
			2		0.1874	0.1875	0.0001	0.31	0.32				
		2	1		0.1866	0.1868	0.0002	0.19	1.05	1.04			
			2		0.1866	0.1869	0.0003	0.29	1.03				
		3	1		0.1873	0.1879	0.0006	0.32	1.88	2.94			
			2		0.188	0.1892	0.0012	0.3	4.00				
10/06/07	S Runoff flow into Forebay	1	1	3	0.18	0.1829	0.0029	0.21	13.81	12.62	13.34	1.46	0.84
			2		0.1869	0.1885	0.0016	0.14	11.43				
		2	1		0.1867	0.1888	0.0021	0.16	13.12	15.02			
			2		0.187	0.1892	0.0022	0.13	16.92				
		3	1		0.1868	0.1888	0.0020	0.15	13.33	12.38			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1871	0.1887	0.0016	0.14	11.43				
10/06/07	S Forebay Outflow	1	1	3	0.1863	0.1881	0.0018	0.14	12.86	13.01	12.15	1.01	0.58
			2		0.1872	0.1897	0.0025	0.19	13.16				
		2	1		0.1873	0.1898	0.0025	0.24	10.42	11.04			
			2		0.1872	0.19	0.0028	0.24	11.67				
		3	1		0.1879	0.1901	0.0022	0.2	11.00	12.40			
			2		0.1865	0.1894	0.0029	0.21	13.81				
10/06/07	S Main Pond Start	1	1	3	0.1869	0.1872	0.0003	0.28	1.07	1.37	1.35	0.45	0.26
			2		0.1862	0.1867	0.0005	0.3	1.67				
		2	1		0.1865	0.1868	0.0003	0.28	1.07	0.89			
			2		0.1866	0.1868	0.0002	0.28	0.71				
		3	1		0.1884	0.1889	0.0005	0.3	1.67	1.80			
			2		0.1876	0.1882	0.0006	0.31	1.94				
10/06/07	S Main Pond Middle	1	1	3	0.1871	0.1874	0.0003	0.26	1.15	1.61	1.45	0.31	0.18
			2		0.1866	0.1872	0.0006	0.29	2.07				
		2	1		0.1866	0.1871	0.0005	0.27	1.85	1.64			
			2		0.1859	0.1863	0.0004	0.28	1.43				
		3	1		0.1875	0.1878	0.0003	0.29	1.03	1.09			
			2		0.1862	0.1865	0.0003	0.26	1.15				
10/06/07	S Main Pond End	1	1	3	0.187	0.1872	0.0002	0.27	0.74	1.20	1.28	0.12	0.07
			2		0.1872	0.1877	0.0005	0.3	1.67				
		2	1		0.1877	0.1879	0.0002	0.29	0.69	1.21			
			2		0.1859	0.1863	0.0004	0.23	1.74				
		3	1		0.1864	0.1868	0.0004	0.23	1.74	1.43			
			2		0.188	0.1883	0.0003	0.27	1.11				
10/06/07	Upstream A	1	1	3	0.1877	0.1879	0.0002	0.24	0.83	0.95	1.05	0.12	0.07
			2		0.1881	0.1884	0.0003	0.28	1.07				
		2	1		0.1872	0.1876	0.0004	0.3	1.33	1.18			
			2		0.1869	0.1872	0.0003	0.29	1.03				
		3	1		0.1866	0.1869	0.0003	0.3	1.00	1.02			
			2		0.1871	0.1874	0.0003	0.29	1.03				
10/06/07	Upstream B	1	1	3	0.1863	0.1865	0.0002	0.28	0.71	1.45	0.61	0.75	0.44
			2		0.1862	0.1869	0.0007	0.32	2.19				
		2	1		0.1855	0.1856	0.0001	0.25	0.40	0.37			
			2		0.184	0.1841	0.0001	0.3	0.33				
		3	1		0.1853	0.1853	0.0000	0.3	0.00	0.00			
			2		0.1882	0.1882	0.0000	0.28	0.00				
10/06/07	Stream	1	1	3	0.1866	0.1877	0.0011	0.27	4.07	3.54	2.69	0.74	0.43
			2		0.1855	0.1864	0.0009	0.3	3.00				
		2	1		0.1866	0.1871	0.0005	0.28	1.79	2.14			
			2		0.1869	0.1875	0.0006	0.24	2.50				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		3	1		0.1872	0.1879	0.0007	0.25	2.80	2.40			
			2		0.1862	0.1868	0.0006	0.3	2.00				
10/06/07	Downstream B	1	1	3	0.1869	0.187	0.0001	0.25	0.40	1.03	0.67	0.32	0.19
			2		0.1863	0.1868	0.0005	0.3	1.67				
		2	1		0.1857	0.1859	0.0002	0.24	0.83	0.56			
			2		0.1877	0.1878	0.0001	0.36	0.28				
		3	1		0.1861	0.1862	0.0001	0.23	0.43	0.42			
			2		0.1869	0.187	0.0001	0.25	0.40				
15/06/07	S Main Pond Start	1	1	3	0.186	0.1865	0.0005	0.26	1.92	1.65	1.65	0.42	0.24
			2		0.1857	0.1861	0.0004	0.29	1.38				
		2	1		0.1867	0.1872	0.0005	0.39	1.28	1.24			
			2		0.186	0.1863	0.0003	0.25	1.20				
		3	1		0.1852	0.1858	0.0006	0.27	2.22	2.07			
			2		0.1854	0.1859	0.0005	0.26	1.92				
15/06/07	S Main Pond Middle	1	1	3	0.1854	0.1858	0.0004	0.29	1.38	1.25	1.36	0.10	0.06
			2		0.1856	0.1859	0.0003	0.27	1.11				
		2	1		0.186	0.1866	0.0006	0.28	2.14	1.44			
			2		0.1868	0.187	0.0002	0.27	0.74				
		3	1		0.1848	0.185	0.0002	0.25	0.80	1.40			
			2		0.1861	0.1866	0.0005	0.25	2.00				
15/06/07	S Main Pond End	1	1	3	0.1831	0.1835	0.0004	0.28	1.43	0.94	1.49	0.48	0.28
			2		0.185	0.1851	0.0001	0.22	0.45				
		2	1		0.1804	0.1808	0.0004	0.31	1.29	1.73			
			2		0.1818	0.1823	0.0005	0.23	2.17				
		3	1		0.1845	0.1849	0.0004	0.25	1.60	1.80			
			2		0.1841	0.1846	0.0005	0.25	2.00				
15/06/07	Upstream A	1	1	3	0.1846	0.1851	0.0005	0.31	1.61	1.28	1.20	0.38	0.22
			2		0.185	0.1853	0.0003	0.32	0.94				
		2	1		0.1855	0.1859	0.0004	0.23	1.74	1.54			
			2		0.1844	0.1848	0.0004	0.3	1.33				
		3	1		0.1817	0.1821	0.0004	0.32	1.25	0.79			
			2		0.1847	0.1848	0.0001	0.3	0.33				
15/06/07	Upstream B	1	1	3	0.1843	0.1847	0.0004	0.29	1.38	1.38	0.93	0.40	0.23
			2		0.1825	0.1829	0.0004	0.29	1.38				
		2	1		0.1837	0.184	0.0003	0.33	0.91	0.79			
			2		0.1834	0.1836	0.0002	0.3	0.67				
		3	1		0.1856	0.1857	0.0001	0.32	0.31	0.63			
			2		0.1844	0.1847	0.0003	0.32	0.94				
15/06/07	Stream	1	1	3	0.1846	0.1854	0.0008	0.32	2.50	1.81	1.46	0.31	0.18
			2		0.1845	0.1848	0.0003	0.27	1.11				
		2	1		0.1798	0.1801	0.0003	0.24	1.25	1.37			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1848	0.1852	0.0004	0.27	1.48				
		3	1		0.1843	0.1846	0.0003	0.3	1.00	1.21			
			2		0.1807	0.1811	0.0004	0.28	1.43				
15/06/07	Downstream A	1	1	3	0.184	0.1842	0.0002	0.25	0.80	1.51	1.35	0.15	0.09
			2		0.1839	0.1845	0.0006	0.27	2.22				
		2	1		0.1857	0.1863	0.0006	0.3	2.00	1.33			
			2		0.184	0.1842	0.0002	0.3	0.67				
		3	1		0.1844	0.1848	0.0004	0.29	1.38	1.21			
			2		0.185	0.1853	0.0003	0.29	1.03				
15/06/07	Downstream B	1	1	3	0.1841	0.1842	0.0001	0.27	0.37	0.70	0.96	0.51	0.29
			2		0.1846	0.1849	0.0003	0.29	1.03				
		2	1		0.1845	0.185	0.0005	0.3	1.67	1.55			
			2		0.185	0.1854	0.0004	0.28	1.43				
		3	1		0.1841	0.1844	0.0003	0.32	0.94	0.64			
			2		0.1842	0.1843	0.0001	0.29	0.34				
20/06/07	S Main Pond Start	1	1	3	0.1869	0.1871	0.0002	0.3	0.67	0.79	0.96	0.38	0.22
			2		0.1857	0.1859	0.0002	0.22	0.91				
		2	1		0.1842	0.1844	0.0002	0.25	0.80	0.69			
			2		0.1864	0.1866	0.0002	0.34	0.59				
		3	1		0.1807	0.1812	0.0005	0.3	1.67	1.39			
			2		0.1851	0.1854	0.0003	0.27	1.11				
20/06/07	S Main Pond Middle	1	1	3	0.1802	0.1806	0.0004	0.3	1.33	1.44	1.77	0.38	0.22
			2		0.18	0.1804	0.0004	0.26	1.54				
		2	1		0.1856	0.1859	0.0003	0.24	1.25	1.70			
			2		0.1831	0.1837	0.0006	0.28	2.14				
		3	1		0.1852	0.1858	0.0006	0.27	2.22	2.18			
			2		0.1852	0.1858	0.0006	0.28	2.14				
20/06/07	S Main Pond End	1	1	3	0.1843	0.1847	0.0004	0.27	1.48	1.71	2.10	0.34	0.20
			2		0.1811	0.1817	0.0006	0.31	1.94				
		2	1		0.1841	0.1846	0.0005	0.29	1.72	2.26			
			2		0.1802	0.1809	0.0007	0.25	2.80				
		3	1		0.1799	0.1804	0.0005	0.3	1.67	2.33			
			2		0.1873	0.1882	0.0009	0.3	3.00				
20/06/07	Stream	1	1	3	0.1873	0.1877	0.0004	0.31	1.29	1.31	1.04	0.25	0.14
			2		0.1864	0.1868	0.0004	0.3	1.33				
		2	1		0.1865	0.1868	0.0003	0.3	1.00	0.95			
			2		0.1857	0.186	0.0003	0.33	0.91				
		3	1		0.1885	0.1886	0.0001	0.29	0.34	0.84			
			2		0.1878	0.1882	0.0004	0.3	1.33				
20/06/07	Downstream A	1	1	3	0.1875	0.1883	0.0008	0.31	2.58	2.62	6.06	5.51	3.18
			2		0.1868	0.1876	0.0008	0.3	2.67				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.1869	0.1882	0.0013	0.28	4.64	3.15			
			2		0.1875	0.188	0.0005	0.3	1.67				
		3	1		0.1873	0.19	0.0027	0.27	10.00	12.41			
			2		0.1856	0.1899	0.0043	0.29	14.83				
29/06/07	S Main Pond Start	1	1	3	0.186	0.1869	0.0009	0.29	3.10	3.52	3.40	0.15	0.09
			2		0.1881	0.1892	0.0011	0.28	3.93				
		2	1		0.1862	0.1871	0.0009	0.32	2.81	3.22			
			2		0.1861	0.1873	0.0012	0.33	3.64				
		3	1		0.1869	0.1878	0.0009	0.29	3.10	3.45			
			2		0.188	0.1891	0.0011	0.29	3.79				
29/06/07	S Main Pond Middle	1	1	3	0.1858	0.1865	0.0007	0.36	1.94	2.82	2.40	0.48	0.28
			2		0.1871	0.1881	0.0010	0.27	3.70				
		2	1		0.1861	0.1866	0.0005	0.3	1.67	2.50			
			2		0.1874	0.1884	0.0010	0.3	3.33				
		3	1		0.1871	0.1878	0.0007	0.32	2.19	1.88			
			2		0.1881	0.1886	0.0005	0.32	1.56				
29/06/07	S Main Pond End	1	1	3	0.187	0.1877	0.0007	0.29	2.41	2.87	2.97	0.30	0.17
			2		0.1864	0.1874	0.0010	0.3	3.33				
		2	1		0.1874	0.188	0.0006	0.32	1.87	2.72			
			2		0.1868	0.1878	0.0010	0.28	3.57				
		3	1		0.1859	0.1866	0.0007	0.36	1.94	3.31			
			2		0.1872	0.1886	0.0014	0.3	4.67				
29/06/07	Upstream A	1	1	3	0.1865	0.1866	0.0001	0.29	0.34	0.66	1.12	0.40	0.23
			2		0.1869	0.1872	0.0003	0.31	0.97				
		2	1		0.1869	0.1872	0.0003	0.35	0.86	1.32			
			2		0.1865	0.187	0.0005	0.28	1.79				
		3	1		0.187	0.1875	0.0005	0.4	1.25	1.38			
			2		0.1865	0.187	0.0005	0.33	1.52				
29/06/07	Upstream B	1	1	3	0.187	0.1874	0.0004	0.32	1.25	1.32	1.71	1.01	0.59
			2		0.1865	0.1871	0.0006	0.43	1.40				
		2	1		0.1863	0.1868	0.0005	0.3	1.67	2.86			
			2		0.1864	0.1877	0.0013	0.32	4.06				
		3	1		0.1864	0.1866	0.0002	0.35	0.57	0.95			
			2		0.1866	0.187	0.0004	0.3	1.33				
29/06/07	Stream	1	1	3	0.1864	0.1867	0.0003	0.34	0.88	1.27	1.41	0.21	0.12
			2		0.1868	0.1873	0.0005	0.3	1.67				
		2	1		0.1872	0.1876	0.0004	0.32	1.25	1.29			
			2		0.188	0.1884	0.0004	0.3	1.33				
		3	1		0.1875	0.188	0.0005	0.28	1.79	1.65			
			2		0.1841	0.1846	0.0005	0.33	1.52				
29/06/07	Downstream A	1	1	3	0.1863	0.1867	0.0004	0.31	1.29	1.58	1.44	0.27	0.15

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1871	0.1877	0.0006	0.32	1.88				
		2	1		0.1861	0.1863	0.0002	0.31	0.65	1.13			
			2		0.1868	0.1873	0.0005	0.31	1.61				
		3	1		0.1877	0.1881	0.0004	0.3	1.33	1.60			
			2		0.1874	0.188	0.0006	0.32	1.87				
29/06/07	Downstream B	1	1	3	0.1872	0.1874	0.0002	0.26	0.77	0.97	1.85	1.06	0.61
			2		0.1873	0.1877	0.0004	0.34	1.18				
		2	1		0.1873	0.1877	0.0004	0.27	1.48	1.55			
			2		0.1867	0.1872	0.0005	0.31	1.61				
		3	1		0.1873	0.1878	0.0005	0.32	1.56	3.02			
			2		0.1867	0.188	0.0013	0.29	4.48				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
1/06/07	R Forebay Groundwater Input	1	1	3	0.1868	0.1871	0.0003	0.5	0.60	0.80	0.50	0.30	0.17
			2		0.1866	0.1871	0.0005	0.5	1.00				
		2	1		0.1869	0.1871	0.0002	0.5	0.40	0.50			
			2		0.1877	0.188	0.0003	0.5	0.60				
		3	1		0.1873	0.1874	0.0001	0.5	0.20	0.20			
			2		0.1877	0.1878	0.0001	0.5	0.20				
1/06/07	R Forebay Inflow	1	1	3	0.1861	0.1904	0.0043	0.33	13.03	13.37	12.57	0.76	0.44
			2		0.1856	0.1893	0.0037	0.27	13.70				
		2	1		0.1864	0.1895	0.0031	0.27	11.48	12.46			
			2		0.186	0.1899	0.0039	0.29	13.45				
		3	1		0.1862	0.1894	0.0032	0.29	11.03	11.86			
			2		0.1872	0.1905	0.0033	0.26	12.69				
1/06/07	R Forebay Outflow	1	1	3	0.1858	0.1891	0.0033	0.29	11.38	11.52	9.93	2.74	1.58
			2		0.1868	0.1903	0.0035	0.3	11.67				
		2	1		0.1875	0.191	0.0035	0.3	11.67	11.50			
			2		0.1868	0.1902	0.0034	0.3	11.33				
		3	1		0.1875	0.1889	0.0014	0.31	4.52	6.77			
			2		0.1868	0.1896	0.0028	0.31	9.03				
1/06/07	R Main Pond Start	1	1	3	0.186	0.187	0.0010	0.2	5.00	5.26	6.36	1.45	0.83
			2		0.1864	0.188	0.0016	0.29	5.52				
		2	1		0.187	0.1886	0.0016	0.2	8.00	8.00			
			2		0.1861	0.1877	0.0016	0.2	8.00				
		3	1		0.1864	0.1878	0.0014	0.21	6.67	5.83			
			2		0.1853	0.1867	0.0014	0.28	5.00				
1/06/07	R Main Pond Middle	1	1	3	0.1863	0.1878	0.0015	0.2	7.50	7.66	7.86	0.49	0.28
			2		0.1857	0.1875	0.0018	0.23	7.83				
		2	1		0.1868	0.1886	0.0018	0.19	9.47	8.42			
			2		0.1869	0.1883	0.0014	0.19	7.37				
		3	1		0.1872	0.1894	0.0022	0.25	8.80	7.50			
			2		0.1852	0.1865	0.0013	0.21	6.19				
1/06/07	R Main Pond End	1	1	3	0.1868	0.1884	0.0016	0.2	8.00	8.00	9.07	0.94	0.54
			2		0.1875	0.1887	0.0012	0.15	8.00				
		2	1		0.1878	0.1895	0.0017	0.18	9.44	9.46			
			2		0.1851	0.1869	0.0018	0.19	9.47				
		3	1		0.1876	0.1898	0.0022	0.21	10.48	9.76			
			2		0.1879	0.1898	0.0019	0.21	9.05				
1/06/07	R Main Pond Discharge	1	1	3	0.1866	0.1893	0.0027	0.16	16.88	11.67	9.04	2.61	1.50
			2		0.1869	0.188	0.0011	0.17	6.47				
		2	1		0.1869	0.1885	0.0016	0.19	8.42	6.46			
			2		0.1879	0.1888	0.0009	0.2	4.50				
		3	1		0.1852	0.1869	0.0017	0.2	8.50	9.00			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1857	0.1876	0.0019	0.2	9.50				
10/06/07	R Runoff flow into Forebay	1	1	3	0.1843	0.1896	0.0053	0.26	20.38	22.12	27.06	6.10	3.52
			2		0.1859	0.1921	0.0062	0.26	23.85				
		2	1		0.1842	0.1883	0.0041	0.16	25.63	33.88			
			2		0.1855	0.1914	0.0059	0.14	42.14				
		3	1		0.1853	0.1906	0.0053	0.23	23.04	25.19			
			2		0.186	0.1901	0.0041	0.15	27.33				
10/06/07	R Forebay Groundwater Input	1	1	3	0.1831	0.1834	0.0003	0.52	0.58	0.89	4.76	7.05	4.07
			2		0.1789	0.1795	0.0006	0.5	1.20				
		2	1		0.1855	0.1856	0.0001	0.5	0.20	0.50			
			2		0.1857	0.1861	0.0004	0.5	0.80				
		3	1		0.1872	0.1917	0.0045	0.5	9.00	12.90			
			2		0.1864	0.1948	0.0084	0.5	16.80				
10/06/07	R Forebay Inflow	1	1	3	0.1859	0.1877	0.0018	0.15	12.00	11.67	11.09	0.52	0.30
			2		0.1873	0.189	0.0017	0.15	11.33				
		2	1		0.1869	0.1885	0.0016	0.15	10.67	10.67			
			2		0.1867	0.1883	0.0016	0.15	10.67				
		3	1		0.1865	0.1882	0.0017	0.15	11.33	10.94			
			2		0.1873	0.1892	0.0019	0.18	10.56				
10/06/07	R Forebay Outflow	1	1	3	0.1868	0.189	0.0022	0.17	12.94	14.47	15.05	0.61	0.35
			2		0.1863	0.1887	0.0024	0.15	16.00				
		2	1		0.1866	0.1891	0.0025	0.17	14.71	15.69			
			2		0.1866	0.1891	0.0025	0.15	16.67				
		3	1		0.1869	0.1891	0.0022	0.15	14.67	15.00			
			2		0.1869	0.1892	0.0023	0.15	15.33				
10/06/07	R Main Pond Start	1	1	3	0.1862	0.188	0.0018	0.19	9.47	9.74	10.16	0.52	0.30
			2		0.1875	0.1887	0.0012	0.12	10.00				
		2	1		0.1867	0.188	0.0013	0.14	9.29	10.00			
			2		0.1873	0.1888	0.0015	0.14	10.71				
		3	1		0.1881	0.1895	0.0014	0.15	9.33	10.74			
			2		0.1834	0.1851	0.0017	0.14	12.14				
10/06/07	R Main Pond Middle	1	1	3	0.1827	0.1841	0.0014	0.15	9.33	9.98	9.30	0.88	0.51
			2		0.1838	0.1855	0.0017	0.16	10.63				
		2	1		0.1839	0.185	0.0011	0.14	7.86	8.30			
			2		0.1857	0.1871	0.0014	0.16	8.75				
		3	1		0.1861	0.1873	0.0012	0.14	8.57	9.62			
			2		0.1828	0.1844	0.0016	0.15	10.67				
10/06/07	R Main Pond End	1	1	3	0.1803	0.182	0.0017	0.19	8.95	9.83	9.94	0.72	0.42
			2		0.1813	0.1828	0.0015	0.14	10.71				
		2	1		0.1838	0.185	0.0012	0.14	8.57	9.29			
			2		0.1851	0.1865	0.0014	0.14	10.00				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		3	1		0.1848	0.1863	0.0015	0.15	10.00	10.71			
			2		0.1834	0.185	0.0016	0.14	11.43				
10/06/07	R Main Pond Discharge	1	1	3	0.1845	0.1857	0.0012	0.13	9.23	9.28	10.82	1.63	0.94
			2		0.1855	0.1869	0.0014	0.15	9.33				
		2	1		0.1836	0.1847	0.0011	0.12	9.17	10.65			
			2		0.1797	0.1814	0.0017	0.14	12.14				
		3	1		0.1839	0.1853	0.0014	0.13	10.77	12.53			
			2		0.1845	0.1865	0.0020	0.14	14.29				
15/06/07	R Forebay Groundwater Input	1	1	3	0.1801	0.1801	0.0000	0.51	0.00	0.28	0.22	0.11	0.06
			2		0.1869	0.1872	0.0003	0.53	0.57				
		2	1		0.1851	0.1853	0.0002	0.5	0.40	0.29			
			2		0.1853	0.1854	0.0001	0.54	0.19				
		3	1		0.185	0.185	0.0000	0.51	0.00	0.09			
			2		0.1842	0.1843	0.0001	0.53	0.19				
15/06/07	R Forebay Inflow	1	1	3	0.185	0.1869	0.0019	0.26	7.31	8.48	9.06	0.80	0.46
			2		0.1844	0.1871	0.0027	0.28	9.64				
		2	1		0.1837	0.1861	0.0024	0.26	9.23	9.97			
			2		0.1823	0.1853	0.0030	0.28	10.71				
		3	1		0.1808	0.183	0.0022	0.28	7.86	8.73			
			2		0.1868	0.1892	0.0024	0.25	9.60				
15/06/07	R Forebay Outflow	1	1	3	0.1848	0.1879	0.0031	0.24	12.92	13.07	12.47	0.53	0.30
			2		0.1839	0.1876	0.0037	0.28	13.21				
		2	1		0.1862	0.189	0.0028	0.24	11.67	12.26			
			2		0.1831	0.1858	0.0027	0.21	12.86				
		3	1		0.1856	0.1885	0.0029	0.24	12.08	12.08			
			2		0.1838	0.1873	0.0035	0.29	12.07				
15/06/07	R Main Pond Start	1	1	3	0.1826	0.1837	0.0011	0.2	5.50	5.44	6.24	0.83	0.48
			2		0.1844	0.1858	0.0014	0.26	5.38				
		2	1		0.1831	0.1841	0.0010	0.26	3.85	6.17			
			2		0.1855	0.1872	0.0017	0.2	8.50				
		3	1		0.185	0.1864	0.0014	0.22	6.36	7.09			
			2		0.1844	0.1862	0.0018	0.23	7.83				
15/06/07	R Main Pond Middle	1	1	3	0.1847	0.1864	0.0017	0.25	6.80	8.85	7.66	1.09	0.63
			2		0.1835	0.1859	0.0024	0.22	10.91				
		2	1		0.1844	0.1858	0.0014	0.21	6.67	7.42			
			2		0.1837	0.1855	0.0018	0.22	8.18				
		3	1		0.1836	0.1849	0.0013	0.22	5.91	6.70			
			2		0.1839	0.1854	0.0015	0.2	7.50				
15/06/07	R Main Pond End	1	1	3	0.183	0.1843	0.0013	0.24	5.42	7.03	7.31	0.29	0.17
			2		0.1856	0.1875	0.0019	0.22	8.64				
		2	1		0.1855	0.1868	0.0013	0.23	5.65	7.61			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1854	0.1876	0.0022	0.23	9.57				
		3	1		0.1845	0.1864	0.0019	0.3	6.33	7.28			
			2		0.1856	0.187	0.0014	0.17	8.24				
15/06/07	R Main Pond Discharge	1	1	3	0.1848	0.1858	0.0010	0.25	4.00	6.76	7.37	0.53	0.31
			2		0.1844	0.1864	0.0020	0.21	9.52				
		2	1		0.1839	0.1852	0.0013	0.23	5.65	7.62			
			2		0.1836	0.1859	0.0023	0.24	9.58				
		3	1		0.1811	0.1826	0.0015	0.22	6.82	7.73			
			2		0.1868	0.1887	0.0019	0.22	8.64				
20/06/07	R Forebay Groundwater Input	1	1	3	0.1839	0.1841	0.0002	0.5	0.40	0.89	1.26	0.41	0.24
			2		0.1852	0.1859	0.0007	0.51	1.37				
		2	1		0.1807	0.1808	0.0001	0.51	0.20	1.20			
			2		0.1837	0.1848	0.0011	0.5	2.20				
		3	1		0.1872	0.1881	0.0009	0.5	1.80	1.70			
			2		0.181	0.1818	0.0008	0.5	1.60				
20/06/07	R Forebay Inflow	1	1	3	0.1825	0.1838	0.0013	0.29	4.48	5.07	4.01	1.08	0.62
			2		0.1852	0.1869	0.0017	0.3	5.67				
		2	1		0.186	0.1868	0.0008	0.32	2.50	2.92			
			2		0.1816	0.1826	0.0010	0.3	3.33				
		3	1		0.1847	0.186	0.0013	0.3	4.33	4.04			
			2		0.1846	0.1858	0.0012	0.32	3.75				
20/06/07	R Forebay Outflow	1	1	3	0.181	0.1818	0.0008	0.3	2.67	3.21	3.11	0.25	0.14
			2		0.1852	0.1864	0.0012	0.32	3.75				
		2	1		0.1864	0.1872	0.0008	0.36	2.22	3.30			
			2		0.1811	0.1825	0.0014	0.32	4.37				
		3	1		0.1806	0.1813	0.0007	0.3	2.33	2.83			
			2		0.1853	0.1863	0.0010	0.3	3.33				
20/06/07	R Main Pond Start	1	1	3	0.1862	0.1873	0.0011	0.19	5.79	6.08	5.44	0.65	0.38
			2		0.1797	0.1811	0.0014	0.22	6.36				
		2	1		0.1844	0.1853	0.0009	0.21	4.29	5.48			
			2		0.1852	0.1866	0.0014	0.21	6.67				
		3	1		0.1833	0.1842	0.0009	0.21	4.29	4.77			
			2		0.185	0.186	0.0010	0.19	5.26				
20/06/07	R Main Pond Middle	1	1	3	0.1834	0.1848	0.0014	0.23	6.09	6.23	6.40	0.15	0.09
			2		0.1836	0.185	0.0014	0.22	6.36				
		2	1		0.18	0.1814	0.0014	0.22	6.36	6.52			
			2		0.1841	0.1855	0.0014	0.21	6.67				
		3	1		0.1854	0.1868	0.0014	0.23	6.09	6.45			
			2		0.1794	0.1809	0.0015	0.22	6.82				
20/06/07	R Main Pond End	1	1	3	0.1811	0.1823	0.0012	0.21	5.71	6.61	5.92	0.59	0.34
			2		0.1854	0.1869	0.0015	0.2	7.50				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.1809	0.1821	0.0012	0.22	5.45	5.58			
			2		0.1801	0.1813	0.0012	0.21	5.71				
		3	1		0.1858	0.1867	0.0009	0.2	4.50	5.58			
			2		0.1813	0.1827	0.0014	0.21	6.67				
20/06/07	R Main Pond Discharge	1	1	3	0.1834	0.1846	0.0012	0.24	5.00	5.98	6.61	0.55	0.32
			2		0.1836	0.1852	0.0016	0.23	6.96				
		2	1		0.1842	0.1853	0.0011	0.23	4.78	6.97			
			2		0.1861	0.1883	0.0022	0.24	9.17				
		3	1		0.1829	0.184	0.0011	0.21	5.24	6.87			
			2		0.1804	0.1821	0.0017	0.2	8.50				
29/06/07	R Forebay Groundwater Input	1	1	3	0.1852	0.1858	0.0006	0.53	1.13	1.45	1.60	0.14	0.08
			2		0.187	0.1879	0.0009	0.51	1.76				
		2	1		0.1861	0.1868	0.0007	0.5	1.40	1.72			
			2		0.1879	0.189	0.0011	0.54	2.04				
		3	1		0.1869	0.1878	0.0009	0.51	1.76	1.64			
			2		0.1865	0.1873	0.0008	0.53	1.51				
29/06/07	R Forebay Inflow	1	1	3	0.1876	0.1912	0.0036	0.29	12.41	12.34	12.06	0.24	0.14
			2		0.1861	0.1899	0.0038	0.31	12.26				
		2	1		0.1855	0.1886	0.0031	0.3	10.33	11.94			
			2		0.1862	0.1904	0.0042	0.31	13.55				
		3	1		0.1859	0.1891	0.0032	0.31	10.32	11.89			
			2		0.1867	0.1902	0.0035	0.26	13.46				
29/06/07	R Forebay Outflow	1	1	3	0.1865	0.1892	0.0027	0.3	9.00	11.00	10.60	0.93	0.53
			2		0.1881	0.192	0.0039	0.3	13.00				
		2	1		0.1869	0.1897	0.0028	0.3	9.33	9.54			
			2		0.1863	0.1902	0.0039	0.4	9.75				
		3	1		0.1873	0.1906	0.0033	0.31	10.65	11.26			
			2		0.1864	0.1902	0.0038	0.32	11.88				
29/06/07	R Main Pond Start	1	1	3	0.1862	0.1895	0.0033	0.24	13.75	14.84	14.91	0.45	0.26
			2		0.1867	0.191	0.0043	0.27	15.93				
		2	1		0.1873	0.1899	0.0026	0.25	10.40	15.40			
			2		0.1867	0.1918	0.0051	0.25	20.40				
		3	1		0.1875	0.1901	0.0026	0.2	13.00	14.50			
			2		0.1874	0.1914	0.0040	0.25	16.00				
29/06/07	R Main Pond Middle	1	1	3	0.1877	0.191	0.0033	0.3	11.00	14.10	14.46	0.56	0.32
			2		0.1891	0.1934	0.0043	0.25	17.20				
		2	1		0.1871	0.1906	0.0035	0.3	11.67	14.17			
			2		0.1862	0.1907	0.0045	0.27	16.67				
		3	1		0.187	0.1903	0.0033	0.22	15.00	15.10			
			2		0.1861	0.1899	0.0038	0.25	15.20				
29/06/07	R Main Pond End	1	1	3	0.1867	0.1895	0.0028	0.24	11.67	13.13	14.77	1.83	1.06

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1864	0.1899	0.0035	0.24	14.58				
		2	1		0.1862	0.1903	0.0041	0.3	13.67	14.44			
			2		0.1874	0.1909	0.0035	0.23	15.22				
		3	1		0.1865	0.1905	0.0040	0.26	15.38	16.74			
			2		0.1865	0.1903	0.0038	0.21	18.10				
29/06/07	R Main Pond Discharge	1	1	3	0.1883	0.1916	0.0033	0.24	13.75	14.92	15.55	0.60	0.35
			2		0.1872	0.1909	0.0037	0.23	16.09				
		2	1		0.1854	0.1892	0.0038	0.24	15.83	16.12			
			2		0.1868	0.1909	0.0041	0.25	16.40				
		3	1		0.1858	0.1877	0.0019	0.24	7.92	15.63			
			2		0.1875	0.1931	0.0056	0.24	23.33				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
11/07/07	S Forebay Inflow	1	1	3	0.1878	0.2017	0.0139	0.13	106.92	113.46	104.84	7.98	4.61
			2		0.1877	0.2045	0.0168	0.14	120.00				
		2	1		0.1861	0.1985	0.0124	0.12	103.33	103.33			
			2		0.1852	0.1976	0.0124	0.12	103.33				
		3	1		0.1862	0.1993	0.0131	0.13	100.77	97.72			
			2		0.1862	0.2004	0.0142	0.15	94.67				
11/07/07	S Forebay Outflow	1	1	3	0.1868	0.1908	0.0040	0.15	26.67	28.33	41.51	14.60	8.43
			2		0.1867	0.1912	0.0045	0.15	30.00				
		2	1		0.187	0.1936	0.0066	0.15	44.00	39.00			
			2		0.1864	0.1915	0.0051	0.15	34.00				
		3	1		0.1869	0.1943	0.0074	0.13	56.92	57.21			
			2		0.1859	0.1951	0.0092	0.16	57.50				
11/07/07	S Main Pond Start	1	1	3	0.1862	0.1869	0.0007	0.27	2.59	2.60	2.26	0.30	0.17
			2		0.185	0.1856	0.0006	0.23	2.61				
		2	1		0.1866	0.1872	0.0006	0.26	2.31	2.15			
			2		0.1857	0.1863	0.0006	0.3	2.00				
		3	1		0.1881	0.1886	0.0005	0.27	1.85	2.04			
			2		0.187	0.1876	0.0006	0.27	2.22				
11/07/07	S Main Pond Middle	1	1	3	0.1871	0.1878	0.0007	0.25	2.80	2.33	2.39	0.37	0.21
			2		0.1868	0.1873	0.0005	0.27	1.85				
		2	1		0.1872	0.1876	0.0004	0.19	2.11	2.05			
			2		0.1874	0.188	0.0006	0.3	2.00				
		3	1		0.1861	0.1869	0.0008	0.26	3.08	2.79			
			2		0.1867	0.1875	0.0008	0.32	2.50				
11/07/07	S Main Pond End	1	1	3	0.1868	0.1874	0.0006	0.29	2.07	2.10	2.51	0.40	0.23
			2		0.1855	0.1862	0.0007	0.33	2.12				
		2	1		0.1883	0.189	0.0007	0.29	2.41	2.54			
			2		0.1878	0.1886	0.0008	0.3	2.67				
		3	1		0.1859	0.1867	0.0008	0.3	2.67	2.89			
			2		0.1874	0.1883	0.0009	0.29	3.10				
11/07/07	S Main Pond Discharge	1	1	3	0.1863	0.1873	0.0010	0.31	3.23	2.83	2.29	0.70	0.40
			2		0.1879	0.1887	0.0008	0.33	2.42				
		2	1		0.1868	0.1873	0.0005	0.3	1.67	1.50			
			2		0.1863	0.1867	0.0004	0.3	1.33				
		3	1		0.1866	0.1875	0.0009	0.34	2.65	2.53			
			2		0.1859	0.1866	0.0007	0.29	2.41				
11/07/07	Upstream A	1	1	3	0.1867	0.1876	0.0009	0.28	3.21	4.20	4.99	0.72	0.41
			2		0.1881	0.1895	0.0014	0.27	5.19				
		2	1		0.1858	0.1868	0.0010	0.25	4.00	5.15			
			2		0.1855	0.1872	0.0017	0.27	6.30				
		3	1		0.1852	0.1866	0.0014	0.3	4.67	5.61			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1871	0.189	0.0019	0.29	6.55				
11/07/07	Upstream B	1	1	3	0.1861	0.1874	0.0013	0.33	3.94	4.21	4.04	0.15	0.09
			2		0.1843	0.1856	0.0013	0.29	4.48				
		2	1		0.1801	0.1811	0.0010	0.27	3.70	3.99			
			2		0.1809	0.1821	0.0012	0.28	4.29				
		3	1		0.186	0.187	0.0010	0.26	3.85	3.92			
			2		0.1872	0.1884	0.0012	0.3	4.00				
11/07/07	Stream	1	1	3	0.1837	0.1852	0.0015	0.3	5.00	5.73	5.19	0.48	0.28
			2		0.1881	0.1901	0.0020	0.31	6.45				
		2	1		0.1843	0.1855	0.0012	0.3	4.00	5.08			
			2		0.1871	0.1887	0.0016	0.26	6.15				
		3	1		0.1882	0.1896	0.0014	0.33	4.24	4.78			
			2		0.1823	0.184	0.0017	0.32	5.31				
11/07/07	Downstream A	1	1	3	0.1839	0.1851	0.0012	0.31	3.87	4.08	4.21	0.13	0.08
			2		0.1855	0.187	0.0015	0.35	4.29				
		2	1		0.187	0.1883	0.0013	0.31	4.19	4.19			
			2		0.1862	0.1875	0.0013	0.31	4.19				
		3	1		0.1866	0.1876	0.0010	0.25	4.00	4.34			
			2		0.1839	0.1854	0.0015	0.32	4.69				
17/07/07	S Forebay Inflow	1	1	3	0.1862	0.1923	0.0061	0.25	24.40	24.70	23.37	2.10	1.21
			2		0.1885	0.1925	0.0040	0.16	25.00				
		2	1		0.1865	0.19	0.0035	0.16	21.88	24.47			
			2		0.187	0.1916	0.0046	0.17	27.06				
		3	1		0.1862	0.1888	0.0026	0.14	18.57	20.95			
			2		0.1878	0.1913	0.0035	0.15	23.33				
17/07/07	S Forebay Outflow	1	1	3	0.1883	0.1898	0.0015	0.22	6.82	7.89	7.04	0.92	0.53
			2		0.1863	0.1889	0.0026	0.29	8.97				
		2	1		0.1865	0.1883	0.0018	0.3	6.00	6.06			
			2		0.1876	0.1895	0.0019	0.31	6.13				
		3	1		0.1854	0.1876	0.0022	0.3	7.33	7.17			
			2		0.1883	0.1904	0.0021	0.3	7.00				
17/07/07	S Main Pond Start	1	1	3	0.1864	0.1879	0.0015	0.29	5.17	5.59	5.17	0.65	0.38
			2		0.1863	0.1881	0.0018	0.3	6.00				
		2	1		0.1867	0.1878	0.0011	0.3	3.67	4.42			
			2		0.1869	0.1884	0.0015	0.29	5.17				
		3	1		0.1873	0.1885	0.0012	0.3	4.00	5.50			
			2		0.1872	0.1893	0.0021	0.3	7.00				
17/07/07	S Main Pond Middle	1	1	3	0.187	0.1882	0.0012	0.28	4.29	4.04	4.36	0.28	0.16
			2		0.1867	0.1878	0.0011	0.29	3.79				
		2	1		0.1862	0.1876	0.0014	0.32	4.37	4.53			
			2		0.1822	0.1837	0.0015	0.32	4.69				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		3	1		0.1832	0.1844	0.0012	0.3	4.00	4.50			
			2		0.1871	0.1886	0.0015	0.3	5.00				
17/07/07	S Main Pond End	1	1	3	0.1863	0.1876	0.0013	0.27	4.81	4.81	5.05	0.23	0.13
			2		0.1857	0.187	0.0013	0.27	4.81				
		2	1		0.186	0.1872	0.0012	0.3	4.00	5.28			
			2		0.1863	0.1882	0.0019	0.29	6.55				
		3	1		0.1882	0.1898	0.0016	0.35	4.57	5.04			
			2		0.188	0.1896	0.0016	0.29	5.52				
17/07/07	S Main Pond Discharge	1	1	3	0.1876	0.1887	0.0011	0.3	3.67	4.61	4.80	0.17	0.10
			2		0.1864	0.1879	0.0015	0.27	5.56				
		2	1		0.1869	0.1881	0.0012	0.27	4.44	4.89			
			2		0.1882	0.1898	0.0016	0.3	5.33				
		3	1		0.1883	0.1897	0.0014	0.32	4.38	4.91			
			2		0.1871	0.1889	0.0018	0.33	5.45				
17/07/07	Upstream A	1	1	3	0.1865	0.1876	0.0011	0.31	3.55	4.71	5.53	1.07	0.62
			2		0.1872	0.1889	0.0017	0.29	5.86				
		2	1		0.1872	0.189	0.0018	0.28	6.43	6.73			
			2		0.1874	0.1893	0.0019	0.27	7.04				
		3	1		0.1869	0.188	0.0011	0.26	4.23	5.15			
			2		0.1865	0.1882	0.0017	0.28	6.07				
17/07/07	Upstream B	1	1	3	0.1883	0.1892	0.0009	0.25	3.60	4.13	4.96	0.90	0.52
			2		0.1876	0.189	0.0014	0.3	4.67				
		2	1		0.1884	0.1898	0.0014	0.3	4.67	4.83			
			2		0.1869	0.1883	0.0014	0.28	5.00				
		3	1		0.1862	0.1878	0.0016	0.29	5.52	5.93			
			2		0.1869	0.1888	0.0019	0.3	6.33				
17/07/07	Stream	1	1	3	0.1869	0.1877	0.0008	0.3	2.67	3.61	4.33	0.70	0.40
			2		0.1858	0.1873	0.0015	0.33	4.55				
		2	1		0.1872	0.1886	0.0014	0.3	4.67	5.00			
			2		0.1855	0.1871	0.0016	0.3	5.33				
		3	1		0.1869	0.188	0.0011	0.28	3.93	4.38			
			2		0.1866	0.1881	0.0015	0.31	4.84				
17/07/07	Downstream A	1	1	3	0.1864	0.1874	0.0010	0.28	3.57	3.62	3.52	0.09	0.05
			2		0.1873	0.1884	0.0011	0.3	3.67				
		2	1		0.1877	0.1887	0.0010	0.28	3.57	3.51			
			2		0.187	0.188	0.0010	0.29	3.45				
		3	1		0.188	0.1888	0.0008	0.26	3.08	3.44			
			2		0.1885	0.1896	0.0011	0.29	3.79				
17/07/07	Downstream B	1	1	3	0.1852	0.1861	0.0009	0.29	3.10	3.74	3.54	0.23	0.13
			2		0.1865	0.1879	0.0014	0.32	4.38				
		2	1		0.1809	0.1819	0.0010	0.31	3.23	3.58			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1811	0.1824	0.0013	0.33	3.94				
		3	1		0.1864	0.1874	0.0010	0.29	3.45	3.29			
			2		0.1881	0.1891	0.0010	0.32	3.13				
26/07/07	S Forebay Outflow	1	1	3	0.1841	0.1849	0.0008	0.51	1.57	1.75	2.05	0.31	0.18
			2		0.1829	0.1839	0.0010	0.52	1.92				
		2	1		0.1861	0.1871	0.0010	0.53	1.89	2.04			
			2		0.1873	0.1884	0.0011	0.5	2.20				
		3	1		0.184	0.1851	0.0011	0.52	2.12	2.36			
			2		0.1847	0.186	0.0013	0.5	2.60				
26/07/07	S Main Pond Start	1	1	3	0.1822	0.1833	0.0011	0.28	3.93	3.74	3.85	0.19	0.11
			2		0.183	0.1841	0.0011	0.31	3.55				
		2	1		0.1825	0.1838	0.0013	0.31	4.19	4.07			
			2		0.1839	0.1852	0.0013	0.33	3.94				
		3	1		0.1844	0.1857	0.0013	0.32	4.06	3.75			
			2		0.1859	0.187	0.0011	0.32	3.44				
26/07/07	S Main Pond Middle	1	1	3	0.1851	0.1861	0.0010	0.29	3.45	4.22	3.77	0.42	0.25
			2		0.1849	0.1865	0.0016	0.32	5.00				
		2	1		0.1846	0.1856	0.0010	0.28	3.57	3.72			
			2		0.1835	0.1847	0.0012	0.31	3.87				
		3	1		0.1824	0.1836	0.0012	0.3	4.00	3.38			
			2		0.1861	0.1869	0.0008	0.29	2.76				
26/07/07	S Main Pond End	1	1	3	0.1817	0.1829	0.0012	0.31	3.87	4.27	4.26	0.31	0.18
			2		0.1826	0.184	0.0014	0.3	4.67				
		2	1		0.1845	0.1854	0.0009	0.31	2.90	3.95			
			2		0.1865	0.1881	0.0016	0.32	5.00				
		3	1		0.1849	0.1864	0.0015	0.32	4.69	4.57			
			2		0.1854	0.1866	0.0012	0.27	4.44				
26/07/07	S Main Pond Discharge	1	1	3	0.1862	0.1876	0.0014	0.29	4.83	4.81	4.24	0.71	0.41
			2		0.1807	0.1819	0.0012	0.25	4.80				
		2	1		0.1854	0.1865	0.0011	0.32	3.44	4.46			
			2		0.1848	0.1865	0.0017	0.31	5.48				
		3	1		0.1824	0.1832	0.0008	0.3	2.67	3.45			
			2		0.182	0.1834	0.0014	0.33	4.24				
26/07/07	Stream	1	1	3	0.1812	0.1823	0.0011	0.32	3.44	2.93	3.30	0.70	0.40
			2		0.1817	0.1825	0.0008	0.33	2.42				
		2	1		0.1816	0.1823	0.0007	0.29	2.41	2.87			
			2		0.1816	0.1827	0.0011	0.33	3.33				
		3	1		0.1795	0.1806	0.0011	0.31	3.55	4.11			
			2		0.1804	0.1818	0.0014	0.3	4.67				
26/07/07	Downstream A	1	1	3	0.1813	0.1821	0.0008	0.34	2.35	3.21	3.32	0.15	0.09
			2		0.1806	0.1819	0.0013	0.32	4.06				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.1809	0.1824	0.0015	0.4	3.75	3.26			
			2		0.1815	0.1825	0.0010	0.36	2.78				
		3	1		0.1818	0.1828	0.0010	0.32	3.13	3.50			
			2		0.1808	0.182	0.0012	0.31	3.87				
26/07/07	Downstream B	1	1	3	0.1813	0.1821	0.0008	0.29	2.76	2.35	2.38	0.14	0.08
			2		0.1824	0.183	0.0006	0.31	1.94				
		2	1		0.178	0.1786	0.0006	0.31	1.94	2.26			
			2		0.1782	0.179	0.0008	0.31	2.58				
		3	1		0.1822	0.1829	0.0007	0.31	2.26	2.54			
			2		0.1803	0.1812	0.0009	0.32	2.81				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
11/07/07	R Forebay Groundwater Input	1	1	3	0.1867	0.1894	0.0027	0.32	8.44	9.55	10.98	8.73	5.04
			2		0.1862	0.1894	0.0032	0.3	10.67				
		2	1		0.1867	0.1927	0.0060	0.33	18.18	20.34			
			2		0.1856	0.1928	0.0072	0.32	22.50				
		3	1		0.1871	0.1881	0.0010	0.35	2.86	3.05			
			2		0.1868	0.188	0.0012	0.37	3.24				
11/07/07	R Forebay Diversion Channel	1	1	3	0.1862	0.1985	0.0123	0.16	76.88	80.31	95.54	20.07	11.59
			2		0.1854	0.1988	0.0134	0.16	83.75				
		2	1		0.1863	0.1976	0.0113	0.15	75.33	88.02			
			2		0.1854	0.1995	0.0141	0.14	100.71				
		3	1		0.1874	0.204	0.0166	0.14	118.57	118.29			
			2		0.1883	0.206	0.0177	0.15	118.00				
11/07/07	R Runoff flow into Forebay	1	1	3	0.1874	0.221	0.0336	0.11	305.45	312.73	277.68	42.52	24.55
			2		0.1865	0.2121	0.0256	0.08	320.00				
		2	1		0.1866	0.1942	0.0076	0.13	58.46	230.38			
			2		0.1881	0.2404	0.0523	0.13	402.31				
		3	1		0.1865	0.2183	0.0318	0.11	289.09	289.93			
			2		0.1874	0.2252	0.0378	0.13	290.77				
11/07/07	R Forebay Inflow	1	1	3	0.1864	0.1941	0.0077	0.15	51.33	50.67	50.12	0.50	0.29
			2		0.1855	0.193	0.0075	0.15	50.00				
		2	1		0.1863	0.1942	0.0079	0.16	49.38	49.69			
			2		0.1865	0.1945	0.0080	0.16	50.00				
		3	1		0.1868	0.1957	0.0089	0.16	55.63	50.00			
			2		0.1873	0.1944	0.0071	0.16	44.38				
11/07/07	R Forebay Outflow	1	1	3	0.1859	0.1928	0.0069	0.16	43.12	54.23	54.98	0.94	0.54
			2		0.1875	0.1973	0.0098	0.15	65.33				
		2	1		0.1871	0.1968	0.0097	0.17	57.06	56.03			
			2		0.1859	0.1958	0.0099	0.18	55.00				
		3	1		0.1864	0.1946	0.0082	0.15	54.67	54.67			
			2		0.1862	0.1944	0.0082	0.15	54.67				
11/07/07	R Main Pond Start	1	1	3	0.1865	0.1885	0.0020	0.17	11.76	11.82	12.78	1.25	0.72
			2		0.1857	0.1876	0.0019	0.16	11.87				
		2	1		0.1876	0.1897	0.0021	0.15	14.00	14.19			
			2		0.1862	0.1885	0.0023	0.16	14.38				
		3	1		0.1858	0.1873	0.0015	0.15	10.00	12.33			
			2		0.1865	0.1887	0.0022	0.15	14.67				
11/07/07	R Main Pond Middle	1	1	3	0.1858	0.1884	0.0026	0.22	11.82	12.21	11.68	0.54	0.31
			2		0.1866	0.1895	0.0029	0.23	12.61				
		2	1		0.1868	0.1886	0.0018	0.16	11.25	11.70			
			2		0.1857	0.1874	0.0017	0.14	12.14				
		3	1		0.186	0.1876	0.0016	0.17	9.41	11.13			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.185	0.1868	0.0018	0.14	12.86				
11/07/07	R Main Pond End	1	1	3	0.1874	0.1892	0.0018	0.15	12.00	11.33	10.36	0.85	0.49
			2		0.1862	0.1878	0.0016	0.15	10.67				
		2	1		0.1869	0.1885	0.0016	0.17	9.41	10.02			
			2		0.1864	0.1881	0.0017	0.16	10.62				
		3	1		0.1858	0.1872	0.0014	0.16	8.75	9.73			
			2		0.1861	0.1876	0.0015	0.14	10.71				
11/07/07	R Main Pond Discharge	1	1	3	0.1869	0.1886	0.0017	0.15	11.33	13.17	11.25	1.78	1.03
			2		0.1861	0.1882	0.0021	0.14	15.00				
		2	1		0.1876	0.1896	0.0020	0.2	10.00	10.94			
			2		0.1878	0.1897	0.0019	0.16	11.88				
		3	1		0.1861	0.1872	0.0011	0.14	7.86	9.64			
			2		0.1885	0.1901	0.0016	0.14	11.43				
17/07/07	R Forebay Groundwater Input	1	1	3	0.1868	0.1869	0.0001	0.54	0.19	0.20	0.69	0.70	0.40
			2		0.1861	0.1862	0.0001	0.48	0.21				
		2	1		0.1854	0.1861	0.0007	0.53	1.32	1.49			
			2		0.1863	0.1871	0.0008	0.48	1.67				
		3	1		0.1863	0.1864	0.0001	0.52	0.19	0.39			
			2		0.1857	0.186	0.0003	0.51	0.59				
17/07/07	R Forebay Inflow	1	1	3	0.1871	0.1904	0.0033	0.29	11.38	11.94	12.06	0.12	0.07
			2		0.1853	0.1888	0.0035	0.28	12.50				
		2	1		0.1886	0.1916	0.0030	0.25	12.00	12.07			
			2		0.1874	0.1908	0.0034	0.28	12.14				
		3	1		0.186	0.1892	0.0032	0.27	11.85	12.18			
			2		0.1856	0.1891	0.0035	0.28	12.50				
17/07/07	R Forebay Outflow	1	1	3	0.1878	0.1912	0.0034	0.28	12.14	12.27	11.45	0.77	0.44
			2		0.1854	0.1885	0.0031	0.25	12.40				
		2	1		0.1879	0.1915	0.0036	0.33	10.91	11.35			
			2		0.1865	0.1898	0.0033	0.28	11.79				
		3	1		0.1873	0.1901	0.0028	0.26	10.77	10.74			
			2		0.1816	0.1846	0.0030	0.28	10.71				
17/07/07	R Main Pond Start	1	1	3	0.1857	0.1893	0.0036	0.231	15.58	15.19	14.96	0.25	0.14
			2		0.187	0.1907	0.0037	0.25	14.80				
		2	1		0.1805	0.1845	0.0040	0.29	13.79	14.97			
			2		0.1814	0.1856	0.0042	0.26	16.15				
		3	1		0.1831	0.1867	0.0036	0.25	14.40	14.70			
			2		0.1832	0.1871	0.0039	0.26	15.00				
17/07/07	R Main Pond Middle	1	1	3	0.1824	0.1864	0.0040	0.27	14.81	15.32	14.93	0.46	0.27
			2		0.1795	0.1833	0.0038	0.24	15.83				
		2	1		0.1832	0.1868	0.0036	0.25	14.40	15.03			
			2		0.1798	0.1845	0.0047	0.3	15.67				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		3	1		0.1859	0.1895	0.0036	0.26	13.85	14.42			
			2		0.1865	0.1904	0.0039	0.26	15.00				
17/07/07	R Main Pond End	1	1	3	0.1805	0.1848	0.0043	0.28	15.36	17.08	14.28	3.15	1.82
			2		0.1824	0.1871	0.0047	0.25	18.80				
		2	1		0.1858	0.1876	0.0018	0.26	6.92	10.86			
			2		0.1837	0.1874	0.0037	0.25	14.80				
		3	1		0.1828	0.1865	0.0037	0.25	14.80	14.90			
			2		0.183	0.1869	0.0039	0.26	15.00				
17/07/07	R Main Pond Discharge	1	1	3	0.184	0.1879	0.0039	0.26	15.00	15.10	14.91	0.30	0.17
			2		0.1818	0.1856	0.0038	0.25	15.20				
		2	1		0.1816	0.1857	0.0041	0.29	14.14	14.57			
			2		0.1826	0.1865	0.0039	0.26	15.00				
		3	1		0.1872	0.1907	0.0035	0.26	13.46	15.06			
			2		0.1876	0.1921	0.0045	0.27	16.67				
26/07/07	R Forebay Groundwater Input	1	1	3	0.187	0.1875	0.0005	0.52	0.96	0.67	0.58	0.34	0.20
			2		0.1833	0.1835	0.0002	0.52	0.38				
		2	1		0.189	0.1892	0.0002	0.52	0.38	0.19			
			2		0.1874	0.1874	0.0000	0.53	0.00				
		3	1		0.1875	0.1877	0.0002	0.5	0.40	0.86			
			2		0.1865	0.1872	0.0007	0.53	1.32				
26/07/07	R Forebay Inflow	1	1	3	0.1813	0.1836	0.0023	0.33	6.97	8.30	8.02	1.03	0.59
			2		0.1858	0.1884	0.0026	0.27	9.63				
		2	1		0.1856	0.1876	0.0020	0.34	5.88	6.88			
			2		0.1804	0.183	0.0026	0.33	7.88				
		3	1		0.1868	0.1894	0.0026	0.35	7.43	8.88			
			2		0.1843	0.1875	0.0032	0.31	10.32				
26/07/07	R Forebay Outflow	1	1	3	0.1867	0.1881	0.0014	0.29	4.83	6.16	7.07	0.81	0.47
			2		0.1876	0.19	0.0024	0.32	7.50				
		2	1		0.1856	0.1874	0.0018	0.31	5.81	7.72			
			2		0.1865	0.1892	0.0027	0.28	9.64				
		3	1		0.1839	0.1856	0.0017	0.32	5.31	7.32			
			2		0.1799	0.1827	0.0028	0.3	9.33				
26/07/07	R Main Pond Start	1	1	3	0.1809	0.1827	0.0018	0.33	5.45	6.48	6.39	0.66	0.38
			2		0.184	0.1864	0.0024	0.32	7.50				
		2	1		0.1846	0.1858	0.0012	0.29	4.14	5.69			
			2		0.1794	0.1815	0.0021	0.29	7.24				
		3	1		0.1866	0.1882	0.0016	0.3	5.33	7.00			
			2		0.1851	0.1877	0.0026	0.3	8.67				
26/07/07	R Main Pond Middle	1	1	3	0.1869	0.189	0.0021	0.31	6.77	7.46	6.78	0.61	0.35
			2		0.1868	0.189	0.0022	0.27	8.15				
		2	1		0.1862	0.1879	0.0017	0.33	5.15	6.29			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1848	0.1871	0.0023	0.31	7.42				
		3	1		0.1859	0.1873	0.0014	0.29	4.83	6.58			
			2		0.1833	0.1858	0.0025	0.3	8.33				
26/07/07	R Main Pond End	1	1	3	0.1878	0.1893	0.0015	0.28	5.36	6.57	6.63	0.61	0.35
			2		0.1867	0.1888	0.0021	0.27	7.78				
		2	1		0.1867	0.1879	0.0012	0.27	4.44	6.06			
			2		0.1856	0.1879	0.0023	0.3	7.67				
		3	1		0.1844	0.1861	0.0017	0.28	6.07	7.27			
			2		0.1868	0.189	0.0022	0.26	8.46				
26/07/07	R Main Pond Discharge	1	1	3	0.1852	0.1864	0.0012	0.27	4.44	5.44	6.37	0.81	0.46
			2		0.184	0.1858	0.0018	0.28	6.43				
		2	1		0.1863	0.188	0.0017	0.28	6.07	6.83			
			2		0.1853	0.1875	0.0022	0.29	7.59				
		3	1		0.183	0.1846	0.0016	0.27	5.93	6.83			
			2		0.184	0.1864	0.0024	0.31	7.74				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
1/08/07	S Forebay Inflow	1	1	3	0.1808	0.1834	0.0026	0.32	8.13	9.26	6.45	2.52	1.46
			2		0.1801	0.1827	0.0026	0.25	10.40				
		2	1		0.1799	0.1812	0.0013	0.27	4.81	5.68			
			2		0.1789	0.1808	0.0019	0.29	6.55				
		3	1		0.1812	0.1823	0.0011	0.29	3.79	4.40			
			2		0.1817	0.1832	0.0015	0.3	5.00				
1/08/07	S Forebay Outflow	1	1	3	0.1891	0.1904	0.0013	0.27	4.81	5.24	4.79	0.39	0.23
			2		0.1906	0.1923	0.0017	0.3	5.67				
		2	1		0.1886	0.1897	0.0011	0.25	4.40	4.53			
			2		0.1898	0.1912	0.0014	0.3	4.67				
		3	1		0.1907	0.1922	0.0015	0.32	4.69	4.59			
			2		0.1908	0.1921	0.0013	0.29	4.48				
1/08/07	S Main Pond Start	1	1	3	0.1893	0.1929	0.0036	0.25	14.40	14.03	16.58	2.29	1.32
			2		0.189	0.1931	0.0041	0.3	13.67				
		2	1		0.1889	0.1931	0.0042	0.27	15.56	17.24			
			2		0.1803	0.1856	0.0053	0.28	18.93				
		3	1		0.1807	0.1853	0.0046	0.29	15.86	18.47			
			2		0.1806	0.1865	0.0059	0.28	21.07				
1/08/07	S Main Pond Middle	1	1	3	0.1804	0.1839	0.0035	0.27	12.96	14.81	15.51	0.65	0.37
			2		0.1821	0.1866	0.0045	0.27	16.67				
		2	1		0.1799	0.1845	0.0046	0.29	15.86	16.10			
			2		0.1796	0.1845	0.0049	0.3	16.33				
		3	1		0.1804	0.1852	0.0048	0.32	15.00	15.60			
			2		0.1819	0.1866	0.0047	0.29	16.21				
1/08/07	S Main Pond End	1	1	3	0.1804	0.1843	0.0039	0.29	13.45	15.47	14.82	0.57	0.33
			2		0.1793	0.1842	0.0049	0.28	17.50				
		2	1		0.1781	0.1818	0.0037	0.3	12.33	14.57			
			2		0.1816	0.1858	0.0042	0.25	16.80				
		3	1		0.1787	0.1823	0.0036	0.28	12.86	14.43			
			2		0.1809	0.1857	0.0048	0.3	16.00				
1/08/07	S Main Pond Discharge	1	1	3	0.1786	0.1819	0.0033	0.27	12.22	14.90	14.61	1.17	0.67
			2		0.1817	0.1868	0.0051	0.29	17.59				
		2	1		0.1823	0.1855	0.0032	0.26	12.31	15.60			
			2		0.1787	0.1838	0.0051	0.27	18.89				
		3	1		0.1817	0.1852	0.0035	0.31	11.29	13.32			
			2		0.1767	0.181	0.0043	0.28	15.36				
1/08/07	Upstream A	1	1	3	0.1866	0.1889	0.0023	0.29	7.93	6.63	4.41	1.95	1.13
			2		0.189	0.1906	0.0016	0.3	5.33				
		2	1		0.1817	0.1826	0.0009	0.25	3.60	3.59			
			2		0.187	0.188	0.0010	0.28	3.57				
		3	1		0.1842	0.1853	0.0011	0.33	3.33	3.00			
			2		0.1855	0.1863	0.0008	0.3	2.67				
1/08/07	Upstream B	1	1	3	0.1865	0.1884	0.0019	0.26	7.31	7.58	4.71	2.49	1.44
			2		0.189	0.1912	0.0022	0.28	7.86				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		2	1		0.1872	0.1881	0.0009	0.27	3.33	3.33			
			2		0.1868	0.1879	0.0011	0.33	3.33				
		3	1		0.1852	0.1861	0.0009	0.29	3.10	3.22			
			2		0.1834	0.1844	0.0010	0.3	3.33				
1/08/07	Stream	1	1	3	0.1832	0.184	0.0008	0.3	2.67	2.83	2.43	0.43	0.25
			2		0.1838	0.1847	0.0009	0.3	3.00				
		2	1		0.1875	0.1885	0.0010	0.3	3.33	2.47			
			2		0.1889	0.1894	0.0005	0.31	1.61				
		3	1		0.1822	0.183	0.0008	0.3	2.67	1.98			
			2		0.1869	0.1873	0.0004	0.31	1.29				
1/08/07	Downstream A	1	1	3	0.1851	0.1861	0.0010	0.27	3.70	3.85	3.68	0.80	0.46
			2		0.1853	0.1865	0.0012	0.3	4.00				
		2	1		0.1849	0.1863	0.0014	0.29	4.83	4.38			
			2		0.183	0.1841	0.0011	0.28	3.93				
		3	1		0.1845	0.1851	0.0006	0.25	2.40	2.81			
			2		0.1843	0.1853	0.0010	0.31	3.23				
12/08/07	S Forebay Inflow	1	1	3	0.1834	0.2018	0.0184	0.13	141.54	141.13	137.10	4.15	2.40
			2		0.1897	0.2094	0.0197	0.14	140.71				
		2	1		0.1893	0.2086	0.0193	0.17	113.53	132.84			
			2		0.1904	0.2117	0.0213	0.14	152.14				
		3	1		0.1896	0.2095	0.0199	0.15	132.67	137.33			
			2		0.1897	0.211	0.0213	0.15	142.00				
12/08/07	S Forebay Outflow	1	1	3	0.1869	0.2067	0.0198	0.16	123.75	151.21	153.16	7.07	4.08
			2		0.1878	0.2146	0.0268	0.15	178.67				
		2	1		0.1874	0.2013	0.0139	0.15	92.67	161.00			
			2		0.1856	0.22	0.0344	0.15	229.33				
		3	1		0.1866	0.208	0.0214	0.15	142.67	147.27			
			2		0.1876	0.2119	0.0243	0.16	151.88				
12/08/07	S Main Pond Start	1	1	3	0.1866	0.1884	0.0018	0.31	5.81	5.50	5.15	0.58	0.33
			2		0.1856	0.187	0.0014	0.27	5.19				
		2	1		0.1865	0.1877	0.0012	0.26	4.62	5.47			
			2		0.1868	0.1887	0.0019	0.3	6.33				
		3	1		0.1876	0.1888	0.0012	0.29	4.14	4.49			
			2		0.1875	0.189	0.0015	0.31	4.84				
12/08/07	S Main Pond Middle	1	1	3	0.1873	0.1887	0.0014	0.31	4.52	4.59	4.72	0.11	0.07
			2		0.1855	0.1869	0.0014	0.3	4.67				
		2	1		0.1871	0.1885	0.0014	0.33	4.24	4.78			
			2		0.1868	0.1885	0.0017	0.32	5.31				
		3	1		0.188	0.1892	0.0012	0.28	4.29	4.80			
			2		0.1885	0.1902	0.0017	0.32	5.31				
12/08/07	S Main Pond End	1	1	3	0.1875	0.1889	0.0014	0.33	4.24	4.95	5.04	0.11	0.07
			2		0.1866	0.1883	0.0017	0.3	5.67				
		2	1		0.1872	0.1885	0.0013	0.28	4.64	4.99			
			2		0.1864	0.188	0.0016	0.3	5.33				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		3	1		0.1873	0.1886	0.0013	0.27	4.81	5.17			
			2		0.187	0.1886	0.0016	0.29	5.52				
12/08/07	S Main Pond Discharge	1	1	3	0.1885	0.1896	0.0011	0.28	3.93	4.72	4.66	0.14	0.08
			2		0.1879	0.1895	0.0016	0.29	5.52				
		2	1		0.1876	0.1889	0.0013	0.31	4.19	4.76			
			2		0.187	0.1886	0.0016	0.3	5.33				
		3	1		0.187	0.188	0.0010	0.25	4.00	4.50			
			2		0.1867	0.1882	0.0015	0.3	5.00				
12/08/07	Upstream A	1	1	3	0.1866	0.1873	0.0007	0.26	2.69	3.35	8.91	4.89	2.83
			2		0.1865	0.1877	0.0012	0.3	4.00				
		2	1		0.187	0.1896	0.0026	0.24	10.83	10.83			
			2		0.1865	0.1904	0.0039	0.36	10.83				
		3	1		0.1854	0.1881	0.0027	0.24	11.25	12.55			
			2		0.1856	0.1892	0.0036	0.26	13.85				
12/08/07	Upstream B	1	1	3	0.1862	0.1872	0.0010	0.27	3.70	3.82	6.19	3.88	2.24
			2		0.1878	0.1889	0.0011	0.28	3.93				
		2	1		0.1869	0.19	0.0031	0.3	10.33	10.67			
			2		0.1875	0.1908	0.0033	0.3	11.00				
		3	1		0.1873	0.1886	0.0013	0.31	4.19	4.10			
			2		0.1876	0.1888	0.0012	0.3	4.00				
12/08/07	Stream	1	1	3	0.1879	0.1888	0.0009	0.34	2.65	3.05	3.16	0.15	0.09
			2		0.1878	0.1888	0.0010	0.29	3.45				
		2	1		0.1857	0.1867	0.0010	0.31	3.23	3.11			
			2		0.1876	0.1885	0.0009	0.3	3.00				
		3	1		0.1874	0.1884	0.0010	0.25	4.00	3.33			
			2		0.1873	0.1881	0.0008	0.3	2.67				
12/08/07	Downstream A	1	1	3	0.1868	0.1879	0.0011	0.29	3.79	3.01	2.94	0.10	0.06
			2		0.1872	0.1878	0.0006	0.27	2.22				
		2	1		0.1891	0.1899	0.0008	0.26	3.08	2.99			
			2		0.1893	0.1902	0.0009	0.31	2.90				
		3	1		0.1902	0.1911	0.0009	0.31	2.90	2.83			
			2		0.1895	0.1903	0.0008	0.29	2.76				
12/08/07	Downstream B	1	1	3	0.1888	0.1894	0.0006	0.26	2.31	3.41	4.00	0.95	0.55
			2		0.1886	0.19	0.0014	0.31	4.52				
		2	1		0.1848	0.1856	0.0008	0.25	3.20	3.50			
			2		0.1871	0.1882	0.0011	0.29	3.79				
		3	1		0.187	0.1885	0.0015	0.28	5.36	5.10			
			2		0.1856	0.1871	0.0015	0.31	4.84				

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
1/08/07	R Forebay Groundwater Input	1	1	3	0.1816	0.1825	0.0009	0.51	1.76	1.36	1.83	1.08	0.62
			2		0.1827	0.1832	0.0005	0.52	0.96				
		2	1		0.1818	0.1824	0.0006	0.51	1.18	1.06			
			2		0.1824	0.1829	0.0005	0.53	0.94				
		3	1		0.1816	0.1824	0.0008	0.5	1.60	3.06			
			2		0.1806	0.183	0.0024	0.53	4.53				
1/08/07	R Forebay Diversion Channel	1	1	3	0.1825	0.1853	0.0028	0.27	10.37	10.74	24.05	17.49	10.10
			2		0.1778	0.1808	0.0030	0.27	11.11				
		2	1		0.1782	0.1886	0.0104	0.24	43.33	43.87			
			2		0.1809	0.192	0.0111	0.25	44.40				
		3	1		0.1816	0.1855	0.0039	0.24	16.25	17.55			
			2		0.1815	0.1864	0.0049	0.26	18.85				
1/08/07	R Runoff flow into Forebay	1	1	3	0.1812	0.1877	0.0065	0.25	26.00	25.95	26.89	5.83	3.37
			2		0.1811	0.1868	0.0057	0.22	25.91				
		2	1		0.1807	0.1853	0.0046	0.21	21.90	21.58			
			2		0.1799	0.185	0.0051	0.24	21.25				
		3	1		0.1802	0.19	0.0098	0.3	32.67	33.13			
			2		0.1813	0.1897	0.0084	0.25	33.60				
1/08/07	R Forebay Inflow	1	1	3	0.1816	0.1846	0.0030	0.27	11.11	13.06	12.65	0.51	0.30
			2		0.1803	0.1842	0.0039	0.26	15.00				
		2	1		0.1799	0.183	0.0031	0.26	11.92	12.81			
			2		0.1815	0.1852	0.0037	0.27	13.70				
		3	1		0.1798	0.1826	0.0028	0.29	9.66	12.07			
			2		0.1803	0.1845	0.0042	0.29	14.48				
1/08/07	R Forebay Outflow	1	1	3	0.1805	0.1854	0.0049	0.25	19.60	21.80	22.45	2.65	1.53
			2		0.1816	0.1876	0.0060	0.25	24.00				
		2	1		0.1777	0.1825	0.0048	0.25	19.20	20.18			
			2		0.1777	0.1832	0.0055	0.26	21.15				
		3	1		0.1812	0.1874	0.0062	0.25	24.80	25.36			
			2		0.1801	0.1864	0.0063	0.243	25.93				
1/08/07	R Main Pond Start	1	1	3	0.1813	0.1846	0.0033	0.28	11.79	12.06	12.13	0.18	0.10
			2		0.1796	0.1833	0.0037	0.3	12.33				
		2	1		0.1788	0.182	0.0032	0.3	10.67	12.00			
			2		0.1813	0.1853	0.0040	0.3	13.33				
		3	1		0.179	0.1824	0.0034	0.3	11.33	12.33			
			2		0.181	0.1846	0.0036	0.27	13.33				
1/08/07	R Main Pond Middle	1	1	3	0.178	0.1818	0.0038	0.3	12.67	15.53	14.47	1.24	0.72
			2		0.1774	0.182	0.0046	0.25	18.40				
		2	1		0.1821	0.1853	0.0032	0.29	11.03	14.78			
			2		0.1828	0.1878	0.0050	0.27	18.52				
		3	1		0.1813	0.1836	0.0023	0.27	8.52	13.11			

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Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
			2		0.1774	0.182	0.0046	0.26	17.69				
1/08/07	R Main Pond End	1	1	3	0.1799	0.1831	0.0032	0.27	11.85	12.00	12.84	0.73	0.42
			2		0.1815	0.1849	0.0034	0.28	12.14				
		2	1		0.1809	0.184	0.0031	0.27	11.48	13.24			
			2		0.1807	0.1852	0.0045	0.3	15.00				
		3	1		0.1807	0.1834	0.0027	0.29	9.31	13.28			
			2		0.1801	0.1851	0.0050	0.29	17.24				
1/08/07	R Main Pond Discharge	1	1	3	0.1811	0.1834	0.0023	0.27	8.52	9.78	13.81	4.65	2.68
			2		0.1819	0.1851	0.0032	0.29	11.03				
		2	1		0.1804	0.1834	0.0030	0.27	11.11	18.89			
			2		0.1792	0.1856	0.0064	0.24	26.67				
		3	1		0.1796	0.1826	0.0030	0.29	10.34	12.77			
			2		0.1815	0.1856	0.0041	0.27	15.19				
12/08/07	R Forebay Groundwater Input	1	1	3	0.1843	0.1847	0.0004	0.51	0.78	1.55	1.76	0.30	0.18
			2		0.1876	0.1888	0.0012	0.52	2.31				
		2	1		0.185	0.1861	0.0011	0.52	2.12	1.63			
			2		0.1876	0.1882	0.0006	0.52	1.15				
		3	1		0.1892	0.1904	0.0012	0.53	2.26	2.11			
			2		0.1864	0.1874	0.0010	0.51	1.96				
12/08/07	R Forebay Diversion Channel	1	1	3	0.1878	0.1935	0.0057	0.15	38.00	44.67	31.61	11.91	6.88
			2		0.1853	0.193	0.0077	0.15	51.33				
		2	1		0.1868	0.1903	0.0035	0.16	21.88	21.34			
			2		0.188	0.1932	0.0052	0.25	20.80				
		3	1		0.182	0.1873	0.0053	0.17	31.18	28.82			
			2		0.1857	0.1902	0.0045	0.17	26.47				
12/08/07	R Runoff flow into Forebay	1	1	3	0.1854	0.1907	0.0053	0.18	29.44	31.28	30.46	1.76	1.01
			2		0.1859	0.1912	0.0053	0.16	33.13				
		2	1		0.1879	0.1928	0.0049	0.16	30.62	31.65			
			2		0.1868	0.1917	0.0049	0.15	32.67				
		3	1		0.1862	0.1907	0.0045	0.16	28.13	28.44			
			2		0.1841	0.1887	0.0046	0.16	28.75				
12/08/07	R Forebay Inflow	1	1	3	0.186	0.19	0.0040	0.22	18.18	16.80	18.09	1.69	0.98
			2		0.1872	0.1909	0.0037	0.24	15.42				
		2	1		0.1826	0.1866	0.0040	0.25	16.00	17.46			
			2		0.1816	0.1869	0.0053	0.28	18.93				
		3	1		0.1823	0.1863	0.0040	0.2	20.00	20.00			
			2		0.1814	0.186	0.0046	0.23	20.00				
12/08/07	R Forebay Outflow	1	1	3	0.1847	0.1902	0.0055	0.27	20.37	22.79	24.81	2.86	1.65
			2		0.1866	0.1929	0.0063	0.25	25.20				
		2	1		0.1865	0.1936	0.0071	0.28	25.36	28.08			
			2		0.1866	0.1943	0.0077	0.25	30.80				

Richardson Road August 2007

Date	Sample Location	Sample No.	Run No.	Replicates	Filter Paper Weight (g)	Filter Paper & Sediment (g)	Sediment Weight (g)	Vol. Water Used (L)	Suspended Solids (mg/L)	Run Average (mg/L)	Sample Location Ave (mg/L)	Standard Deviation	Standard Error
		3	1		0.186	0.1922	0.0062	0.28	22.14	23.57			
			2		0.1816	0.1881	0.0065	0.26	25.00				
12/08/07	R Main Pond Start	1	1	3	0.1871	0.1896	0.0025	0.3	8.33	10.83	11.36	0.46	0.27
			2		0.1865	0.1905	0.0040	0.3	13.33				
		2	1		0.1867	0.1894	0.0027	0.32	8.44	11.56			
			2		0.1892	0.1939	0.0047	0.32	14.69				
		3	1		0.1865	0.1892	0.0027	0.3	9.00	11.69			
			2		0.188	0.1926	0.0046	0.32	14.38				
12/08/07	R Main Pond Middle	1	1	3	0.1847	0.1865	0.0018	0.27	6.67	10.00	10.41	1.20	0.69
			2		0.1855	0.1887	0.0032	0.24	13.33				
		2	1		0.1867	0.1891	0.0024	0.29	8.28	9.47			
			2		0.1863	0.1895	0.0032	0.3	10.67				
		3	1		0.1839	0.1867	0.0028	0.29	9.66	11.76			
			2		0.1809	0.1852	0.0043	0.31	13.87				
12/08/07	R Main Pond End	1	1	3	0.1834	0.1858	0.0024	0.24	10.00	11.48	11.39	0.48	0.28
			2		0.1816	0.1851	0.0035	0.27	12.96				
		2	1		0.1847	0.1879	0.0032	0.3	10.67	11.81			
			2		0.1857	0.1892	0.0035	0.27	12.96				
		3	1		0.1867	0.1887	0.0020	0.27	7.41	10.87			
			2		0.1881	0.1924	0.0043	0.3	14.33				
12/08/07	R Main Pond Discharge	1	1	3	0.1843	0.1872	0.0029	0.25	11.60	12.92	12.29	0.62	0.36
			2		0.1857	0.1894	0.0037	0.26	14.23				
		2	1		0.1848	0.188	0.0032	0.3	10.67	12.30			
			2		0.1883	0.1922	0.0039	0.28	13.93				
		3	1		0.1885	0.1914	0.0029	0.29	10.00	11.67			
			2		0.1892	0.1932	0.0040	0.3	13.33				

SEV scores for stream reaches

This worksheet calculates the final scores for each function, the sum of all scores (ranging between 0 and 16), and the overall mean SEV score (ranging between 0 and 1), for each site. The final scores are located at the bottom of the table. Reference site values derived from other studies are also presented.

Instructions: Enter the site number or name into the tan cells. **No other data entry is required on this worksheet.**

HAVE YOU ENTERED DATA IN ALL WORKSHEETS?

					Test sites										Reference sites			Mean values for reference sites	Reference sites (Papakura) (from Phillips et al, 2006)				Reference sites (Albany) (from Rowe et al		
					Site name/number										Site name/number				Hays Stream	Hays Stream	Symmonds Stream	Mean values for reference sites	West Hoe	Nukumea	Otanerua
Function category	Report section*	Function	Worksheet #	Variable (code)	utary 2006	utary 2006													7	9	23				
			1	Vbed	0.70	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.93	0.93	0.93	1.00	1.00	1.00
			2	Verosn	0.20	0.20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			30	Vimper	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	1.00	1.00	0.90	1.00	1.00	1.00
Hydraulic	**5.1**	**NFR**		**=**	**0.45**	**0.45**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.68**	**0.97**	**0.97**	**0.87**	**1.00**	**1.00**	**1.00**
			14	Vfpwidth	0.40	0.40	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.40	0.40	1.00	0.60	1.00	1.00	1.00
			3	Vfreq	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.40	0.80	0.53	0.81	0.81	0.81
Hydraulic	**5.2**	**CFP**		**=**	**0.25**	**0.25**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.40**	**0.40**	**0.90**	**0.57**	**0.91**	**0.91**	**0.91**
			4	Vbarr	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			31	Vcatch	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Hydraulic	**5.3**	**CSM**		**=**	**1.00**	**1.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
			1	Vbed	0.70	0.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.93	0.93	0.93	1.00	1.00	1.00
Hydraulic	**5.4**	**CGW**		**=**	**0.70**	**0.70**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.00	**0.94**	**0.93**	**0.93**	0.93	**1.00**	**1.00**	**1.00**
				Hydraulic function mean score	**0.60**	**0.60**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.75**	**0.82**	**0.95**	**0.84**	**0.98**	**0.98**	**0.98**
			18	Vshade	0.61	0.62	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.93	0.84	0.85	0.87	0.80	0.70	0.76
			15	Vdepth	0.80	0.70	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.80	0.70	0.70	0.73	0.80	0.70	0.70
			22	Vveloc	0.70	0.70	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.70	0.80	1.00	0.83	1.00	0.80	0.90
			21	Vlength	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00
biogeochemical	**5.5**	**WTC**		**=**	**0.62**	**0.61**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.88**	**0.84**	**0.88**	**0.86**	**0.87**	**0.77**	**0.81**
			5	Vdod	0.59	0.58	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.00	1.00	1.00	1.00	1.00	1.00	1.00
biogeochemical	**5.6**	**DOM**		**=**	**0.59**	**0.58**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
			19	Vcanop	0.60	0.56	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.83	0.78	0.88	0.83	0.80	0.70	0.76
			20	Vdecid	0.83	0.72	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.00	0.00	0.00	0.00	0.00	0.00	0.00
biogeochemical	**5.7**	**OMI**		**=**	**0.35**	**0.36**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	#DIV/0!	**0.83**	**0.78**	**0.88**	0.83	**0.80**	**0.70**	**0.76**
			23	Vtrans	0.70	1.00	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			24	Vretain	0.76	0.81	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.00	1.00	0.93	0.98	0.78	1.00	0.86
biogeochemical	**5.8**	**IPR**		**=**	**0.53**	**0.81**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**#NUM!**	**1.00**	**1.00**	**0.93**	**0.98**	**0.78**	**1.00**	**0.86**
			16	Vsurf	1.00	1.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.00	0.86	1.00	0.95	1.00	0.92	1.00
biogeochemical	**5.9**	**DOP**		**=**	**1.00**	**1.00**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**1.00**	**0.86**	**1.00**	**0.95**	**1.00**	**0.92**	**1.00**
			14	Vfpwidth	0.40	0.40	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.40	0.40	1.00	0.60	1.00	1.00	1.00
			6	Vrough	0.25	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.84	0.87	0.86	0.70	1.00	1.00
			3	Vfreq	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.80	0.80	0.67	0.81	0.81	0.81
biogeochemical	**5.10**	**FPR**		**=**	**0.25**	**0.25**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.56**	**0.68**	**0.89**	**0.71**	**0.84**	**0.94**	**0.94**
				Biogeochemical function mean score	**0.56**	**0.60**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.88**	**0.86**	**0.93**	**0.89**	**0.88**	**0.89**	**0.90**
			9	Vgalspwn	0.25	0.25	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			10	Vgalqual	0.75	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.25	0.75	0.58	1.00	1.00	1.00
			17	Vgobspwn	0.80	0.20	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.00	1.00	1.00	1.00	1.00	1.00	1.00
habitat provision	**5.11**	**FSH**		**=**	**0.49**	**0.19**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	#DIV/0!	**0.88**	**0.63**	**0.88**	**0.79**	**1.00**	**1.00**	**1.00**
			7	Vphyshab	0.64	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.75	0.92	0.90
			8	Vwatqual	0.24	0.24	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.97	0.92	0.93	0.94	0.90	0.85	0.88
			30	Vimper	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	1.00	1.00		1.00	1.00	1.00
habitat provision	**5.12**	**HAF**		**=**	**0.63**	**0.58**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.92**	**0.98**	**0.98**	**0.96**	**0.85**	**0.92**	**0.92**
				Habitat provision function mean score	**0.56**	**0.39**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.90**	**0.80**	**0.93**	**0.88**	**0.93**	**0.96**	**0.96**
			28	Vfish	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.95	0.95	0.95	0.97	1.00	0.97
Biodiversity	**5.13**	**FFI**		**=**	**0.17**	**0.17**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.95**	**0.95**	**0.95**	**0.95**	**0.97**	**1.00**	**0.97**
			25	Vmci	0.00	0.00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	1.00	1.00	1.00	1.00	1.00	0.96	1.00
			26	Vept	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.75
Biodiversity	**5.14**	**IFI**		**=**	**0.03**	**0.03**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**0.98**	**0.88**
			29	Vvert	0.17	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	0.95	0.95	0.95	1.00	1.00	1.00
			27	Vinvert	0.47	0.34	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.98	0.93	0.93	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biodiversity	**5.15**	**ABI**		**=**	**0.32**	**0.26**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.49**	**0.46**	**0.46**	**0.47**	**0.98**	**0.98**	**0.98**	**0.98**	**1.00**	**1.00**	**1.00**
			11	Vripcond	0.30	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			12	Vripconn	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
			13	Vripar	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Biodiversity	**5.16**	**RVI**		**=**	**0.50**	**0.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
				Biodiversity function mean score	**0.25**	**0.24**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.98**	**0.98**	**0.98**	**0.98**	**0.99**	**1.00**	**0.96**
Sum of scores (maximum value 16)					**7.88**	**7.73**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**14.00**	**13.98**	**15.15**	**14.38**	**15.01**	**15.13**	**15.04**
Overall mean SEV score (maximum value 1)					**0.493**	**0.483**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**0.875**	**0.874**	**0.947**	**0.90**	**0.938**	**0.946**	**0.940**

HAVE YOU ENTERED DATA IN ALL WORKSHEETS?

*** see Rowe et al (2006) for further details**

Rowe D, Quinn J, Parkyn S, Collier K, Hatton C, Joy M, Maxted J, Moore S (2006) Stream Ecological Value (SEV): a method for scoring the ecological performance of Auckland streams and for quantifying mitigation. ARC06226. Hamilton, NIWA. 85p.

Black bold = Function scores calculated using variable values

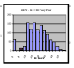
Red bold = Mean function scores for each category of function

l, 2006)

Mean values for reference sites
1.00
1.00
1.00
1.00
1.00
0.81
0.91
1.00
1.00
1.00
1.00
1.00
0.98
0.75
0.73
0.90
1.00
0.82
1.00
1.00
0.75
0.00
0.75
1.00
0.88
0.88
0.97
0.97
1.00
0.90
0.81
0.90
0.89
1.00
1.00
1.00
1.00
0.86
0.88
1.00
0.90
0.95
0.98
0.98
0.99
0.92
0.95
1.00
1.00
1.00
1.00
1.00
1.00
1.00
0.98
15.06
0.94

Index of Biological Integrity - Auckland Region

Centre for Freshwater Ecosystem Modelling and Management, Massey University



Batch notes																					
Site code or name		Oakley Tr	19673	19674	19675	19701	19702	19703	19704	19705	19726	19727	19728	e	f	t	y	g	f	m	t
Altitude (metres)		56	40	10	10	25	25	18	18	20	20	40	18								
Distance from coast (k		6						2	3	3	3	1	4								
Scientific name	**Common name**																				
Aldrichetta forsteri	Yelloweye																2				
Ameiurus nebulosus	Catfish																				
Anguilla australis	Shortfin eel	1										2									
Anguilla	Longfin eel							2		2											
Carassius auratus	Goldfish																				
Cheimarrichthys	Torrentfish																				
Ctenopharyngodon	Grass carp																				4
Cyprinus carpio	Koi carp																				
Galaxias argenteus	Giant kokopu																				
Galaxias brevipinnis	Koaro																				
Galaxias fasciatus	Banded		3				4		1	1	53	3	20								
Galaxias maculatus	Inanga				3		34		6		28										
Galaxias postvectis	Shortjaw																				
Gambusia affinis	Mosquitofish	1									10										
Geotria australis	Lamprey													2		2			2		
Gobiomorphus basalis	Crans bully																				
Gobiomorphus	Common bully								1						1						
Gobiomorphus	Giant bully																	3			
Gobiomorphus hubbsi	Bluegill bully																				
Gobiomorphus huttoni	Redfin bully				4		12		12		3		14								
Gobiomorphus spp.	Bullies																				
Mugil spp.	Mullet																				
Neochanna diversus	Black mudfish																				
Neochanna heleios	Northland																				
Oncorhynchus mykiss	Rainbow trout																				
Perca fluviatilis	Perch																				
Retropinna	Common smelt																				
Salmo trutta	Brown trout																				
Scardinius	Rudd																				
Tinca tinca	Tench																				

TOA5	KateCR200	CR2xx		v04	KateJ.CR2	35559	Table1
TIMESTAMP	RECORD	Batt_Volt_Avg	Rain_mm_Tot				
TS	RN	Volts	mm				
		Avg	Tot				
2/2/2007 11:30	0	12.99063	0.2				
2/2/2007 12:00	1	12.99552	0				
2/2/2007 12:30	2	12.99772	0				
2/2/2007 13:00	3	12.99842	0				
2/2/2007 13:30	4	12.99897	0				
2/2/2007 14:00	5	12.9994	0				
2/2/2007 14:30	6	12.99939	0				
2/2/2007 15:00	7	12.99967	0				
2/2/2007 15:30	8	12.99938	0				
2/2/2007 16:00	9	13.00016	0				
2/2/2007 16:30	10	13.00083	0				
2/2/2007 17:00	11	13.00087	0				
2/2/2007 17:30	12	13.00066	0				
2/2/2007 18:00	13	13.00092	0				
2/2/2007 18:30	14	13.00091	0				
2/2/2007 19:00	15	13.00113	0				
2/2/2007 19:30	16	13.00096	0				
2/2/2007 20:00	17	13.00077	0				
2/2/2007 20:30	18	13.0007	0				
2/2/2007 21:00	19	13.00096	0				
2/2/2007 21:30	20	13.00017	0				
2/2/2007 22:00	21	13.0006	0				
2/2/2007 22:30	22	13.00041	0				
2/2/2007 23:00	23	13.00014	0				
2/2/2007 23:30	24	13.00031	0				
2/3/2007 0:00	25	13.0001	0				
2/3/2007 0:30	26	12.99989	0				
2/3/2007 1:00	27	12.9999	0				
2/3/2007 1:30	28	13.00035	0				
2/3/2007 2:00	29	12.99989	0				
2/3/2007 2:30	30	12.99985	0				
2/3/2007 3:00	31	12.99988	0				
2/3/2007 3:30	32	12.99923	0				
2/3/2007 4:00	33	12.99947	0				
2/3/2007 4:30	34	12.99925	0				
2/3/2007 5:00	35	12.99899	0				
2/3/2007 5:30	36	12.99877	0				
2/3/2007 6:00	37	12.9998	0				
2/3/2007 6:30	38	12.99898	0				
2/3/2007 7:00	39	12.99918	0				
2/3/2007 7:30	40	12.99846	0				
2/3/2007 8:00	41	12.99905	0				
2/3/2007 8:30	42	12.99857	0				
2/3/2007 9:00	43	12.99894	0				
2/3/2007 9:30	44	12.99842	0				
2/3/2007 10:00	45	12.99913	0				
2/3/2007 10:30	46	12.9993	0				
2/3/2007 11:00	47	12.99892	0				

2/3/2007 11:30	48	12.99853	0
2/3/2007 12:00	49	12.99828	0
2/3/2007 12:30	50	12.99905	0
2/3/2007 13:00	51	12.99853	0
2/3/2007 13:30	52	12.99844	0
2/3/2007 14:00	53	12.99891	0
2/3/2007 14:30	54	12.99856	0
2/3/2007 15:00	55	12.99923	0
2/3/2007 15:30	56	12.99906	0
2/3/2007 16:00	57	12.99917	0
2/3/2007 16:30	58	12.99936	0
2/3/2007 17:00	59	12.99906	0
2/3/2007 17:30	60	12.99893	0
2/3/2007 18:00	61	12.99946	0
2/3/2007 18:30	62	12.99967	0
2/3/2007 19:00	63	12.99944	0
2/3/2007 19:30	64	12.99944	0
2/3/2007 20:00	65	12.99891	0
2/3/2007 20:30	66	12.99879	0
2/3/2007 21:00	67	12.99889	0
2/3/2007 21:30	68	12.99919	0
2/3/2007 22:00	69	12.9986	0
2/3/2007 22:30	70	12.99848	0
2/3/2007 23:00	71	12.99812	0
2/3/2007 23:30	72	12.99857	0
2/4/2007 0:00	73	12.9985	0
2/4/2007 0:30	74	12.99824	0
2/4/2007 1:00	75	12.99796	0
2/4/2007 1:30	76	12.99774	0
2/4/2007 2:00	77	12.99816	0
2/4/2007 2:30	78	12.99775	0
2/4/2007 3:00	79	12.99691	0
2/4/2007 3:30	80	12.99778	0
2/4/2007 4:00	81	12.99739	0
2/4/2007 4:30	82	12.99701	0
2/4/2007 5:00	83	12.99714	0
2/4/2007 5:30	84	12.99687	0
2/4/2007 6:00	85	12.99673	0
2/4/2007 6:30	86	12.99721	0
2/4/2007 7:00	87	12.99707	0
2/4/2007 7:30	88	12.99664	0
2/4/2007 8:00	89	12.99718	0
2/4/2007 8:30	90	12.99618	0
2/4/2007 9:00	91	12.99607	0
2/4/2007 9:30	92	12.99696	0
2/4/2007 10:00	93	12.99651	0
2/4/2007 10:30	94	12.99633	0
2/4/2007 11:00	95	12.99682	0
2/4/2007 11:30	96	12.99672	0
2/4/2007 12:00	97	12.99656	0
2/4/2007 12:30	98	12.99669	0
2/4/2007 13:00	99	12.99685	0

2/4/2007 13:30	100	12.99668	0
2/4/2007 14:00	101	12.99615	0
2/4/2007 14:30	102	12.99661	0
2/4/2007 15:00	103	12.99645	0
2/4/2007 15:30	104	12.9962	0
2/4/2007 16:00	105	12.99667	0
2/4/2007 16:30	106	12.99645	0
2/4/2007 17:00	107	12.99658	0
2/4/2007 17:30	108	12.99627	0
2/4/2007 18:00	109	12.99602	0
2/4/2007 18:30	110	12.99635	0
2/4/2007 19:00	111	12.99674	0
2/4/2007 19:30	112	12.99652	0
2/4/2007 20:00	113	12.99652	0
2/4/2007 20:30	114	12.99639	0
2/4/2007 21:00	115	12.99626	0
2/4/2007 21:30	116	12.99628	0
2/4/2007 22:00	117	12.99557	0
2/4/2007 22:30	118	12.99634	0
2/4/2007 23:00	119	12.99574	0
2/4/2007 23:30	120	12.99544	0
2/5/2007 0:00	121	12.99574	0
2/5/2007 0:30	122	12.9957	0
2/5/2007 1:00	123	12.99632	0
2/5/2007 1:30	124	12.99548	0
2/5/2007 2:00	125	12.99616	0
2/5/2007 2:30	126	12.99607	0
2/5/2007 3:00	127	12.99567	0
2/5/2007 3:30	128	12.99547	0
2/5/2007 4:00	129	12.99587	0
2/5/2007 4:30	130	12.99487	0
2/5/2007 5:00	131	12.99547	0
2/5/2007 5:30	132	12.99484	0
2/5/2007 6:00	133	12.99574	0
2/5/2007 6:30	134	12.99508	0
2/5/2007 7:00	135	12.99499	0
2/5/2007 7:30	136	12.9951	0
2/5/2007 8:00	137	12.9949	0
2/5/2007 8:30	138	12.99469	0
2/5/2007 9:00	139	12.99519	0
2/5/2007 9:30	140	12.9948	0
2/5/2007 10:00	141	12.99505	0
2/5/2007 10:30	142	12.99491	0
2/5/2007 11:00	143	12.99492	0
2/5/2007 11:30	144	12.99503	0
2/5/2007 12:00	145	12.99433	0
2/5/2007 12:30	146	12.99479	0
2/5/2007 13:00	147	12.99474	0
2/5/2007 13:30	148	12.99548	0
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2/5/2007 15:00	151	12.99578	0

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2/5/2007 16:00	153	12.99538	0
2/5/2007 16:30	154	12.99559	0
2/5/2007 17:00	155	12.99554	0
2/5/2007 17:30	156	12.99579	0
2/5/2007 18:00	157	12.99553	0
2/5/2007 18:30	158	12.99506	0
2/5/2007 19:00	159	12.9955	0
2/5/2007 19:30	160	12.99518	0
2/5/2007 20:00	161	12.99575	0
2/5/2007 20:30	162	12.99606	0
2/5/2007 21:00	163	12.99556	0
2/5/2007 21:30	164	12.99514	0
2/5/2007 22:00	165	12.99562	0
2/5/2007 22:30	166	12.9953	0
2/5/2007 23:00	167	12.99539	0
2/5/2007 23:30	168	12.99486	0
2/6/2007 0:00	169	12.99558	0
2/6/2007 0:30	170	12.99507	0
2/6/2007 1:00	171	12.99548	0
2/6/2007 1:30	172	12.99482	0
2/6/2007 2:00	173	12.99548	0
2/6/2007 2:30	174	12.99501	0
2/6/2007 3:00	175	12.99481	0
2/6/2007 3:30	176	12.99451	0
2/6/2007 4:00	177	12.9948	0
2/6/2007 4:30	178	12.99478	0
2/6/2007 5:00	179	12.99461	0
2/6/2007 5:30	180	12.99473	0
2/6/2007 6:00	181	12.99456	0
2/6/2007 6:30	182	12.99441	0
2/6/2007 7:00	183	12.99413	0
2/6/2007 7:30	184	12.99407	0
2/6/2007 8:00	185	12.99417	0
2/6/2007 8:30	186	12.99398	0
2/6/2007 9:00	187	12.9939	0
2/6/2007 9:30	188	12.99402	0
2/6/2007 10:00	189	12.99413	0
2/6/2007 10:30	190	12.99393	0
2/6/2007 11:00	191	12.99409	0
2/6/2007 11:30	192	12.99375	0
2/6/2007 12:00	193	12.99391	0
2/6/2007 12:30	194	12.99367	0
2/6/2007 13:00	195	12.99374	0
2/6/2007 13:30	196	12.99412	0
2/6/2007 14:00	197	12.99425	0
2/6/2007 14:30	198	12.9947	0
2/6/2007 15:00	199	12.99445	0
2/6/2007 15:30	200	12.99451	0
2/6/2007 16:00	201	12.99447	0
2/6/2007 16:30	202	12.99481	0
2/6/2007 17:00	203	12.99442	0

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2/6/2007 18:00	205	12.99524	0
2/6/2007 18:30	206	12.9959	0
2/6/2007 19:00	207	12.99546	0
2/6/2007 19:30	208	12.99527	0
2/6/2007 20:00	209	12.99514	0
2/6/2007 20:30	210	12.99555	0
2/6/2007 21:00	211	12.99542	0
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2/6/2007 22:00	213	12.99521	0
2/6/2007 22:30	214	12.99493	0
2/6/2007 23:00	215	12.99496	0
2/6/2007 23:30	216	12.99505	0
2/7/2007 0:00	217	12.99503	0
2/7/2007 0:30	218	12.99485	0
2/7/2007 1:00	219	12.99503	0
2/7/2007 1:30	220	12.9951	0
2/7/2007 2:00	221	12.99488	0
2/7/2007 2:30	222	12.99496	0
2/7/2007 3:00	223	12.99488	0
2/7/2007 3:30	224	12.99441	0
2/7/2007 4:00	225	12.99422	0
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2/7/2007 6:00	229	12.99446	0
2/7/2007 6:30	230	12.99457	0
2/7/2007 7:00	231	12.99412	0
2/7/2007 7:30	232	12.99372	0
2/7/2007 8:00	233	12.99449	0
2/7/2007 8:30	234	12.99424	0
2/7/2007 9:00	235	12.99423	0
2/7/2007 9:30	236	12.99402	0
2/7/2007 10:00	237	12.99433	0
2/7/2007 10:30	238	12.99488	0
2/7/2007 11:00	239	12.99463	0
2/7/2007 11:30	240	12.99453	0
2/7/2007 12:00	241	12.99432	0
2/7/2007 12:30	242	12.99446	0
2/7/2007 13:00	243	12.9948	0
2/7/2007 13:30	244	12.99526	0
2/7/2007 14:00	245	12.99502	0
2/7/2007 14:30	246	12.99495	0
2/7/2007 15:00	247	12.99505	0
2/7/2007 15:30	248	12.9949	0
2/7/2007 16:00	249	12.99587	0
2/7/2007 16:30	250	12.99517	0
2/7/2007 17:00	251	12.9959	0
2/7/2007 17:30	252	12.99608	0
2/7/2007 18:00	253	12.99546	0
2/7/2007 18:30	254	12.99597	0
2/7/2007 19:00	255	12.99601	0

2/7/2007 19:30	256	12.99568	0
2/7/2007 20:00	257	12.99623	0
2/7/2007 20:30	258	12.99593	0
2/7/2007 21:00	259	12.99562	0
2/7/2007 21:30	260	12.99564	0
2/7/2007 22:00	261	12.99575	0
2/7/2007 22:30	262	12.99512	0
2/7/2007 23:00	263	12.99527	0
2/7/2007 23:30	264	12.99492	0
2/8/2007 0:00	265	12.99486	0
2/8/2007 0:30	266	12.99433	0
2/8/2007 1:00	267	12.99461	0
2/8/2007 1:30	268	12.99503	0
2/8/2007 2:00	269	12.99454	0
2/8/2007 2:30	270	12.99479	0
2/8/2007 3:00	271	12.99438	0
2/8/2007 3:30	272	12.99419	0
2/8/2007 4:00	273	12.99468	0
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2/8/2007 5:00	275	12.99428	0
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2/25/2007 22:00	1119	12.23253	0
2/25/2007 22:30	1120	12.23076	0
2/25/2007 23:00	1121	12.23062	0
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2/26/2007 14:30	1152	12.23166	0
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3/6/2007 10:00	1527	12.2093	0
3/6/2007 10:30	1528	12.20951	0
3/6/2007 11:00	1529	12.21017	0
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3/6/2007 13:00	1533	12.2135	0
3/6/2007 13:30	1534	12.21494	0
3/6/2007 14:00	1535	12.217	0
3/6/2007 14:30	1536	12.21821	0
3/6/2007 15:00	1537	12.21947	0
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3/6/2007 16:00	1539	12.22149	0
3/6/2007 16:30	1540	12.22257	0
3/6/2007 17:00	1541	12.22388	0
3/6/2007 17:30	1542	12.22401	0
3/6/2007 18:00	1543	12.22538	0
3/6/2007 18:30	1544	12.22432	0
3/6/2007 19:00	1545	12.22516	0
3/6/2007 19:30	1546	12.22349	0
3/6/2007 20:00	1547	12.22252	0
3/6/2007 20:30	1548	12.22142	0
3/6/2007 21:00	1549	12.21954	0
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3/6/2007 22:00	1551	12.21776	0
3/6/2007 22:30	1552	12.21611	0
3/6/2007 23:00	1553	12.21514	0
3/6/2007 23:30	1554	12.21374	0
3/7/2007 0:00	1555	12.21328	0

3/7/2007 0:30	1556	12.2129	0
3/7/2007 1:00	1557	12.21126	0
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3/7/2007 3:00	1561	12.2103	0
3/7/2007 3:30	1562	12.21029	0
3/7/2007 4:00	1563	12.2097	0
3/7/2007 4:30	1564	12.21004	0
3/7/2007 5:00	1565	12.2097	0
3/7/2007 5:30	1566	12.20903	0.4
3/7/2007 6:00	1567	12.20942	0
3/7/2007 6:30	1568	12.20887	0.2
3/7/2007 7:00	1569	12.20845	0
3/7/2007 7:30	1570	12.20913	0
3/7/2007 8:00	1571	12.20864	0
3/7/2007 8:30	1572	12.2088	0
3/7/2007 9:00	1573	12.2092	0
3/7/2007 9:30	1574	12.20916	0
3/7/2007 10:00	1575	12.20994	0
3/7/2007 10:30	1576	12.20991	0
3/7/2007 11:00	1577	12.21126	0
3/7/2007 11:30	1578	12.21154	0
3/7/2007 12:00	1579	12.21246	0.2
3/7/2007 12:30	1580	12.2134	0
3/7/2007 13:00	1581	12.21429	0
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3/7/2007 14:00	1583	12.21583	0
3/7/2007 14:30	1584	12.21664	0
3/7/2007 15:00	1585	12.21756	0
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3/7/2007 16:00	1587	12.21734	1.2
3/7/2007 16:30	1588	12.21746	0
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3/7/2007 18:00	1591	12.21641	0
3/7/2007 18:30	1592	12.21556	0
3/7/2007 19:00	1593	12.21514	0.2
3/7/2007 19:30	1594	12.21445	1.6
3/7/2007 20:00	1595	12.21374	0
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3/7/2007 22:00	1599	12.21069	0
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3/8/2007 0:30	1604	12.20845	0
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3/8/2007 1:30	1606	12.20753	0
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3/8/2007 5:30	1614	12.20528	0
3/8/2007 6:00	1615	12.20462	0
3/8/2007 6:30	1616	12.20464	0
3/8/2007 7:00	1617	12.20436	0
3/8/2007 7:30	1618	12.20415	0.2
3/8/2007 8:00	1619	12.20378	0
3/8/2007 8:30	1620	12.2042	0
3/8/2007 9:00	1621	12.20453	0
3/8/2007 9:30	1622	12.20496	0
3/8/2007 10:00	1623	12.20536	0
3/8/2007 10:30	1624	12.20603	0
3/8/2007 11:00	1625	12.206	0
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3/8/2007 12:00	1627	12.20747	0
3/8/2007 12:30	1628	12.20844	0
3/8/2007 13:00	1629	12.20987	0
3/8/2007 13:30	1630	12.21018	0
3/8/2007 14:00	1631	12.21064	0
3/8/2007 14:30	1632	12.21175	0
3/8/2007 15:00	1633	12.21295	0
3/8/2007 15:30	1634	12.2122	0
3/8/2007 16:00	1635	12.21377	0
3/8/2007 16:30	1636	12.21424	0
3/8/2007 17:00	1637	12.21542	0
3/8/2007 17:30	1638	12.21601	0
3/8/2007 18:00	1639	12.21725	0
3/8/2007 18:30	1640	12.21732	0
3/8/2007 19:00	1641	12.21725	0
3/8/2007 19:30	1642	12.21673	0
3/8/2007 20:00	1643	12.2149	0
3/8/2007 20:30	1644	12.21415	0
3/8/2007 21:00	1645	12.2127	0
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3/8/2007 22:00	1647	12.2105	0
3/8/2007 22:30	1648	12.20985	0
3/8/2007 23:00	1649	12.2087	0
3/8/2007 23:30	1650	12.20749	0
3/9/2007 0:00	1651	12.20695	0
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3/9/2007 1:00	1653	12.20432	0
3/9/2007 1:30	1654	12.20506	0
3/9/2007 2:00	1655	12.20446	0
3/9/2007 2:30	1656	12.20348	0
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3/9/2007 5:30	1662	12.20072	0
3/9/2007 6:00	1663	12.20029	0
3/9/2007 6:30	1664	12.19976	0
3/9/2007 7:00	1665	12.19906	0
3/9/2007 7:30	1666	12.19891	0
3/9/2007 8:00	1667	12.19809	0
3/9/2007 8:30	1668	12.19832	0
3/9/2007 9:00	1669	12.19868	0
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3/9/2007 10:00	1671	12.19897	0
3/9/2007 10:30	1672	12.19932	0
3/9/2007 11:00	1673	12.19976	0
3/9/2007 11:30	1674	12.20028	0
3/9/2007 12:00	1675	12.20064	0
3/9/2007 12:30	1676	12.20238	0
3/9/2007 13:00	1677	12.20361	0
3/9/2007 13:30	1678	12.20535	0
3/9/2007 14:00	1679	12.20744	0
3/9/2007 14:30	1680	12.20959	0
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3/9/2007 16:00	1683	12.2144	0
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3/9/2007 17:00	1685	12.21709	0
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3/9/2007 23:00	1697	12.21055	0
3/9/2007 23:30	1698	12.20988	0
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3/10/2007 7:30	1714	12.20074	0
3/10/2007 8:00	1715	12.20168	0
3/10/2007 8:30	1716	12.2012	0
3/10/2007 9:00	1717	12.20253	0
3/10/2007 9:30	1718	12.20318	0
3/10/2007 10:00	1719	12.20313	0
3/10/2007 10:30	1720	12.20393	0
3/10/2007 11:00	1721	12.20455	0
3/10/2007 11:30	1722	12.20539	0
3/10/2007 12:00	1723	12.20659	0
3/10/2007 12:30	1724	12.20734	0
3/10/2007 13:00	1725	12.2084	0
3/10/2007 13:30	1726	12.21069	0
3/10/2007 14:00	1727	12.21175	0
3/10/2007 14:30	1728	12.21269	0
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3/10/2007 18:00	1735	12.21751	0
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3/10/2007 20:00	1739	12.21373	0
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3/10/2007 21:00	1741	12.21159	0
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3/10/2007 23:00	1745	12.20804	0
3/10/2007 23:30	1746	12.20777	0
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3/11/2007 3:00	1753	12.20151	0
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3/11/2007 7:30	1762	12.19761	0
3/11/2007 8:00	1763	12.19729	0

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3/11/2007 11:30	1770	12.20224	0
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3/11/2007 13:30	1774	12.20726	0
3/11/2007 14:00	1775	12.20804	0
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3/11/2007 23:00	1793	12.20747	0
3/11/2007 23:30	1794	12.20596	0
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3/12/2007 7:30	1810	12.2012	0
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3/12/2007 9:00	1813	12.20147	0
3/12/2007 9:30	1814	12.20259	0
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3/12/2007 17:00	1829	12.20953	0
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3/12/2007 18:30	1832	12.20823	0
3/12/2007 19:00	1833	12.20751	0.4
3/12/2007 19:30	1834	12.20722	2
3/12/2007 20:00	1835	12.20692	0.2
3/12/2007 20:30	1836	12.20644	2.4
3/12/2007 21:00	1837	12.20617	13.19999
3/12/2007 21:30	1838	12.20481	18.8
3/12/2007 22:00	1839	12.20372	8.199997
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3/13/2007 13:00	1869	12.19865	0
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3/13/2007 19:00	1881	12.1964	0
3/13/2007 19:30	1882	12.19552	0
3/13/2007 20:00	1883	12.19492	0.2
3/13/2007 20:30	1884	12.19465	0.6
3/13/2007 21:00	1885	12.19344	0
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3/13/2007 22:00	1887	12.1918	0.8
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3/13/2007 23:30	1890	12.1895	0
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3/14/2007 1:30	1894	12.18717	0
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3/14/2007 3:30	1898	12.1857	0
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3/14/2007 6:30	1904	12.18445	0
3/14/2007 7:00	1905	12.18491	0
3/14/2007 7:30	1906	12.18451	0
3/14/2007 8:00	1907	12.18509	0
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3/14/2007 9:00	1909	12.18539	0
3/14/2007 9:30	1910	12.18592	0
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3/14/2007 11:30	1914	12.18851	0.2
3/14/2007 12:00	1915	12.18867	0
3/14/2007 12:30	1916	12.18899	0.2
3/14/2007 13:00	1917	12.18908	0.8
3/14/2007 13:30	1918	12.18977	0
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3/14/2007 14:30	1920	12.19125	0.4
3/14/2007 15:00	1921	12.19106	0
3/14/2007 15:30	1922	12.1915	2.2
3/14/2007 16:00	1923	12.19157	0.2
3/14/2007 16:30	1924	12.19148	2.8
3/14/2007 17:00	1925	12.19174	4
3/14/2007 17:30	1926	12.19134	1.2
3/14/2007 18:00	1927	12.19149	1.6
3/14/2007 18:30	1928	12.19053	0.2
3/14/2007 19:00	1929	12.19081	0.6
3/14/2007 19:30	1930	12.18988	0.2
3/14/2007 20:00	1931	12.18947	0.4
3/14/2007 20:30	1932	12.18865	0
3/14/2007 21:00	1933	12.18804	0
3/14/2007 21:30	1934	12.18726	0
3/14/2007 22:00	1935	12.18656	0
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3/14/2007 23:00	1937	12.18478	0
3/14/2007 23:30	1938	12.18408	0.4
3/15/2007 0:00	1939	12.1837	0
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3/15/2007 1:00	1941	12.18281	0
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3/15/2007 2:00	1943	12.18213	0
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3/15/2007 3:00	1945	12.1808	0
3/15/2007 3:30	1946	12.18076	0
3/15/2007 4:00	1947	12.18065	0
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3/15/2007 5:00	1949	12.17956	0.4
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3/15/2007 6:30	1952	12.17874	0
3/15/2007 7:00	1953	12.17832	0
3/15/2007 7:30	1954	12.17784	0
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3/15/2007 8:30	1956	12.17863	0
3/15/2007 9:00	1957	12.17857	0
3/15/2007 9:30	1958	12.17922	0
3/15/2007 10:00	1959	12.17909	0
3/15/2007 10:30	1960	12.17905	0
3/15/2007 11:00	1961	12.18039	0
3/15/2007 11:30	1962	12.18072	0
3/15/2007 12:00	1963	12.18169	0
3/15/2007 12:30	1964	12.18251	0
3/15/2007 13:00	1965	12.18261	0
3/15/2007 13:30	1966	12.18364	0
3/15/2007 14:00	1967	12.18382	0
3/15/2007 14:30	1968	12.18475	0
3/15/2007 15:00	1969	12.18633	0
3/15/2007 15:30	1970	12.18754	0
3/15/2007 16:00	1971	12.18782	0

3/15/2007 16:30	1972	12.18895	0
3/15/2007 17:00	1973	12.1893	0
3/15/2007 17:30	1974	12.19008	0
3/15/2007 18:00	1975	12.19024	0
3/15/2007 18:30	1976	12.18968	0
3/15/2007 19:00	1977	12.1888	0
3/15/2007 19:30	1978	12.18908	0
3/15/2007 20:00	1979	12.18883	0
3/15/2007 20:30	1980	12.18848	0
3/15/2007 21:00	1981	12.18777	0
3/15/2007 21:30	1982	12.18764	0
3/15/2007 22:00	1983	12.18712	0
3/15/2007 22:30	1984	12.18771	0
3/15/2007 23:00	1985	12.18683	0
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3/16/2007 1:00	1989	12.18596	0
3/16/2007 1:30	1990	12.18561	0
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3/16/2007 14:00	2015	12.18972	0
3/16/2007 14:30	2016	12.19013	0
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3/16/2007 15:30	2018	12.19237	0
3/16/2007 16:00	2019	12.19263	0
3/16/2007 16:30	2020	12.1937	0
3/16/2007 17:00	2021	12.19374	0
3/16/2007 17:30	2022	12.19413	0.6
3/16/2007 18:00	2023	12.19353	0

3/16/2007 18:30	2024	12.19287	0
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3/16/2007 19:30	2026	12.19131	0
3/16/2007 20:00	2027	12.1911	0
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3/16/2007 21:30	2030	12.18978	0
3/16/2007 22:00	2031	12.18958	0
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3/16/2007 23:00	2033	12.18883	0
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3/17/2007 21:30	2078	12.18978	0
3/17/2007 22:00	2079	12.18901	0
3/17/2007 22:30	2080	12.18948	0
3/17/2007 23:00	2081	12.1888	0
3/17/2007 23:30	2082	12.18838	0
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3/18/2007 0:30	2084	12.18835	0
3/18/2007 1:00	2085	12.18791	0
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3/18/2007 2:30	2088	12.1871	0
3/18/2007 3:00	2089	12.18747	0
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3/18/2007 4:00	2091	12.18695	0
3/18/2007 4:30	2092	12.18707	0
3/18/2007 5:00	2093	12.18674	0
3/18/2007 5:30	2094	12.18598	0
3/18/2007 6:00	2095	12.18598	0
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3/18/2007 12:00	2107	12.18972	0
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3/19/2007 5:00	2141	12.18089	0
3/19/2007 5:30	2142	12.18104	0
3/19/2007 6:00	2143	12.18065	0
3/19/2007 6:30	2144	12.18053	0
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3/23/2007 8:30	2340	12.17497	0
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3/23/2007 9:30	2342	12.17515	0
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3/23/2007 13:00	2349	12.17814	0
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3/23/2007 16:00	2355	12.18789	0
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3/24/2007 1:30	2374	12.18048	0
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3/24/2007 6:00	2383	12.17509	0
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3/24/2007 7:30	2386	12.17443	0
3/24/2007 8:00	2387	12.17496	0

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3/26/2007 14:30	2496	12.18606	0
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3/26/2007 23:00	2513	12.183	0
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3/28/2007 18:30	2600	12.17759	0.2
3/28/2007 19:00	2601	12.17757	0.8
3/28/2007 19:30	2602	12.17618	0.6
3/28/2007 20:00	2603	12.17711	0.2
3/28/2007 20:30	2604	12.17715	0.6
3/28/2007 21:00	2605	12.17688	0.8
3/28/2007 21:30	2606	12.17646	0.8
3/28/2007 22:00	2607	12.17596	0.2
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3/29/2007 0:30	2612	12.17634	0
3/29/2007 1:00	2613	12.17591	0.2
3/29/2007 1:30	2614	12.17544	0
3/29/2007 2:00	2615	12.17605	0
3/29/2007 2:30	2616	12.17516	0.4
3/29/2007 3:00	2617	12.17545	0.8
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3/29/2007 4:00	2619	12.17508	0
3/29/2007 4:30	2620	12.17531	0
3/29/2007 5:00	2621	12.17577	0.2
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3/29/2007 6:00	2623	12.17511	0.2
3/29/2007 6:30	2624	12.17561	0.6
3/29/2007 7:00	2625	12.17538	0.6
3/29/2007 7:30	2626	12.17531	0.6
3/29/2007 8:00	2627	12.17524	1.6
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3/29/2007 10:30	2632	12.17551	1.6
3/29/2007 11:00	2633	12.17588	0.8
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3/29/2007 12:30	2636	12.17515	0.2
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3/29/2007 20:00	2651	12.1749	0.2
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3/29/2007 21:00	2653	12.17468	1
3/29/2007 21:30	2654	12.17447	0.8
3/29/2007 22:00	2655	12.17423	0.4
3/29/2007 22:30	2656	12.17357	0.8
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3/30/2007 22:30	2704	12.17572	0
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3/31/2007 14:30	2736	12.17241	0
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3/31/2007 16:00	2739	12.17445	0
3/31/2007 16:30	2740	12.17454	0
3/31/2007 17:00	2741	12.17507	0
3/31/2007 17:30	2742	12.17568	0
3/31/2007 18:00	2743	12.17631	0
3/31/2007 18:30	2744	12.17678	0
3/31/2007 19:00	2745	12.17652	0
3/31/2007 19:30	2746	12.17534	0
3/31/2007 20:00	2747	12.17497	0
3/31/2007 20:30	2748	12.17381	0
3/31/2007 21:00	2749	12.17358	0
3/31/2007 21:30	2750	12.1734	0
3/31/2007 22:00	2751	12.17227	0

3/31/2007 22:30	2752	12.17228	0
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4/1/2007 10:30	2776	12.16889	0
4/1/2007 11:00	2777	12.16926	0
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4/1/2007 15:00	2785	12.17536	0
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4/2/2007 4:30	2812	12.16538	0.2
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4/2/2007 5:30	2814	12.16461	0
4/2/2007 6:00	2815	12.16494	0
4/2/2007 6:30	2816	12.16424	0
4/2/2007 7:00	2817	12.16382	0.2
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4/2/2007 11:00	2825	12.16491	0
4/2/2007 11:30	2826	12.16564	0
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4/2/2007 14:00	2831	12.16829	0
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4/2/2007 17:30	2838	12.17331	0
4/2/2007 18:00	2839	12.17372	0
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4/3/2007 1:00	2853	12.16561	0
4/3/2007 1:30	2854	12.16492	0
4/3/2007 2:00	2855	12.16435	0

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4/3/2007 23:00	2897	12.16461	0
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4/4/2007 2:30	2904	12.15951	0
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4/5/2007 6:00	2959	12.15534	0

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4/9/2007 3:30	3146	12.15222	0
4/9/2007 4:00	3147	12.1519	0
4/9/2007 4:30	3148	12.15138	0
4/9/2007 5:00	3149	12.15079	0
4/9/2007 5:30	3150	12.15023	0
4/9/2007 6:00	3151	12.14918	0
4/9/2007 6:30	3152	12.14817	0
4/9/2007 7:00	3153	12.14807	0
4/9/2007 7:30	3154	12.14766	0
4/9/2007 8:00	3155	12.14824	0
4/9/2007 8:30	3156	12.1478	0
4/9/2007 9:00	3157	12.14784	0
4/9/2007 9:30	3158	12.1484	0
4/9/2007 10:00	3159	12.14908	0
4/9/2007 10:30	3160	12.15014	0
4/9/2007 11:00	3161	12.14997	0
4/9/2007 11:30	3162	12.15086	0
4/9/2007 12:00	3163	12.15158	0
4/9/2007 12:30	3164	12.15289	0
4/9/2007 13:00	3165	12.15393	0
4/9/2007 13:30	3166	12.15582	0
4/9/2007 14:00	3167	12.15752	0

4/9/2007 14:30	3168	12.15941	0
4/9/2007 15:00	3169	12.16113	0
4/9/2007 15:30	3170	12.1622	0
4/9/2007 16:00	3171	12.16348	0
4/9/2007 16:30	3172	12.16505	0
4/9/2007 17:00	3173	12.16641	0
4/9/2007 17:30	3174	12.16713	0
4/9/2007 18:00	3175	12.16798	0
4/9/2007 18:30	3176	12.16771	0
4/9/2007 19:00	3177	12.16757	0
4/9/2007 19:30	3178	12.16585	0
4/9/2007 20:00	3179	12.16487	0
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4/9/2007 21:00	3181	12.16299	0
4/9/2007 21:30	3182	12.16196	0
4/9/2007 22:00	3183	12.16103	0
4/9/2007 22:30	3184	12.16105	0
4/9/2007 23:00	3185	12.15964	0
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4/10/2007 4:30	3196	12.15134	0
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4/10/2007 14:00	3215	12.15915	0
4/10/2007 14:30	3216	12.161	0.2
4/10/2007 15:00	3217	12.16236	2.2
4/10/2007 15:30	3218	12.16175	0
4/10/2007 16:00	3219	12.1624	0

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4/10/2007 17:00	3221	12.16292	0
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4/10/2007 18:00	3223	12.16216	0
4/10/2007 18:30	3224	12.16217	0
4/10/2007 19:00	3225	12.16139	0
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4/10/2007 22:00	3231	12.15733	0
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4/11/2007 7:30	3250	12.14745	0
4/11/2007 8:00	3251	12.14697	0
4/11/2007 8:30	3252	12.14709	0
4/11/2007 9:00	3253	12.14666	0.2
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4/11/2007 10:00	3255	12.14814	0
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4/11/2007 16:00	3267	12.15586	0
4/11/2007 16:30	3268	12.15753	0
4/11/2007 17:00	3269	12.15898	0
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4/11/2007 18:00	3271	12.15963	0

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4/11/2007 19:00	3273	12.159	0
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4/11/2007 20:00	3275	12.158	0
4/11/2007 20:30	3276	12.15699	0
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4/11/2007 21:30	3278	12.15553	0
4/11/2007 22:00	3279	12.1555	0
4/11/2007 22:30	3280	12.15456	0
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4/11/2007 23:30	3282	12.15393	0
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4/12/2007 3:00	3289	12.14904	0
4/12/2007 3:30	3290	12.14829	0
4/12/2007 4:00	3291	12.14799	0
4/12/2007 4:30	3292	12.1479	0.6
4/12/2007 5:00	3293	12.14745	0
4/12/2007 5:30	3294	12.14657	0
4/12/2007 6:00	3295	12.14625	0
4/12/2007 6:30	3296	12.14624	0.2
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4/12/2007 7:30	3298	12.14648	0.2
4/12/2007 8:00	3299	12.1458	0.8
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4/12/2007 9:00	3301	12.14507	0.2
4/12/2007 9:30	3302	12.14453	0.2
4/12/2007 10:00	3303	12.14511	0
4/12/2007 10:30	3304	12.14552	0
4/12/2007 11:00	3305	12.14505	0
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4/12/2007 12:30	3308	12.14487	0
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4/12/2007 13:30	3310	12.14566	0.2
4/12/2007 14:00	3311	12.14526	0
4/12/2007 14:30	3312	12.14623	0.2
4/12/2007 15:00	3313	12.14607	0
4/12/2007 15:30	3314	12.14582	1.2
4/12/2007 16:00	3315	12.14553	0.6
4/12/2007 16:30	3316	12.14469	0.2
4/12/2007 17:00	3317	12.14429	0
4/12/2007 17:30	3318	12.14334	0.4
4/12/2007 18:00	3319	12.14301	0.6
4/12/2007 18:30	3320	12.14259	0
4/12/2007 19:00	3321	12.14197	0.8
4/12/2007 19:30	3322	12.14202	1.4
4/12/2007 20:00	3323	12.14146	0

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4/12/2007 22:00	3327	12.14063	0
4/12/2007 22:30	3328	12.14047	0
4/12/2007 23:00	3329	12.14025	0
4/12/2007 23:30	3330	12.14036	0
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4/13/2007 3:00	3337	12.13983	0
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4/13/2007 4:30	3340	12.13996	0
4/13/2007 5:00	3341	12.14038	1.4
4/13/2007 5:30	3342	12.14053	0.8
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4/13/2007 7:30	3346	12.14188	0
4/13/2007 8:00	3347	12.14142	0
4/13/2007 8:30	3348	12.14225	0.2
4/13/2007 9:00	3349	12.14214	0
4/13/2007 9:30	3350	12.14286	1
4/13/2007 10:00	3351	12.14301	0
4/13/2007 10:30	3352	12.14341	0.4
4/13/2007 11:00	3353	12.14321	0
4/13/2007 11:30	3354	12.1441	0.2
4/13/2007 12:00	3355	12.14406	0
4/13/2007 12:30	3356	12.14441	0
4/13/2007 13:00	3357	12.14468	0
4/13/2007 13:30	3358	12.14484	0
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4/13/2007 14:30	3360	12.14492	0
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4/13/2007 17:00	3365	12.14539	0
4/13/2007 17:30	3366	12.14607	0
4/13/2007 18:00	3367	12.14608	2.4
4/13/2007 18:30	3368	12.14545	0.2
4/13/2007 19:00	3369	12.14497	0
4/13/2007 19:30	3370	12.14423	0
4/13/2007 20:00	3371	12.14405	0
4/13/2007 20:30	3372	12.1434	0
4/13/2007 21:00	3373	12.14332	0
4/13/2007 21:30	3374	12.14252	0
4/13/2007 22:00	3375	12.14239	0

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4/13/2007 23:00	3377	12.14201	0
4/13/2007 23:30	3378	12.14189	0
4/14/2007 0:00	3379	12.14122	0
4/14/2007 0:30	3380	12.14085	0
4/14/2007 1:00	3381	12.14099	0
4/14/2007 1:30	3382	12.14118	0.2
4/14/2007 2:00	3383	12.14143	0
4/14/2007 2:30	3384	12.14048	0
4/14/2007 3:00	3385	12.14032	0.4
4/14/2007 3:30	3386	12.14028	0
4/14/2007 4:00	3387	12.14041	0.2
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4/14/2007 5:00	3389	12.13926	0
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4/14/2007 6:00	3391	12.13918	0
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4/14/2007 7:30	3394	12.1397	0
4/14/2007 8:00	3395	12.13998	0
4/14/2007 8:30	3396	12.13955	0.2
4/14/2007 9:00	3397	12.13965	0
4/14/2007 9:30	3398	12.14078	0
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4/14/2007 19:00	3417	12.14635	0
4/14/2007 19:30	3418	12.14569	0.2
4/14/2007 20:00	3419	12.14555	0
4/14/2007 20:30	3420	12.14547	0
4/14/2007 21:00	3421	12.14492	0
4/14/2007 21:30	3422	12.14422	0
4/14/2007 22:00	3423	12.14413	0
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4/14/2007 23:30	3426	12.14346	0
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4/15/2007 2:00	3431	12.14304	0
4/15/2007 2:30	3432	12.14257	0.4
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4/15/2007 5:00	3437	12.14216	0.4
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4/15/2007 7:30	3442	12.14078	0
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4/16/2007 8:00	3491	12.13791	0
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4/16/2007 9:00	3493	12.13864	0
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4/16/2007 10:00	3495	12.13978	0
4/16/2007 10:30	3496	12.1402	0
4/16/2007 11:00	3497	12.14092	0.8
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4/16/2007 12:00	3499	12.14193	0
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4/16/2007 13:00	3501	12.14321	0
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4/17/2007 8:30	3540	12.13798	0
4/17/2007 9:00	3541	12.13833	0
4/17/2007 9:30	3542	12.16825	0.2
4/17/2007 10:00	3543	12.38146	0
4/17/2007 10:30	3544	12.38528	0
4/17/2007 11:00	3545	12.38494	0
4/17/2007 11:30	3546	12.38475	0
4/17/2007 12:00	3547	12.38478	0
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4/26/2007 1:30	3958	12.36498	0
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4/26/2007 3:30	3962	12.36237	0
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4/26/2007 5:00	3965	12.36062	0
4/26/2007 5:30	3966	12.36037	0
4/26/2007 6:00	3967	12.35901	0
4/26/2007 6:30	3968	12.35849	0
4/26/2007 7:00	3969	12.35733	0
4/26/2007 7:30	3970	12.35759	0
4/26/2007 8:00	3971	12.35744	0
4/26/2007 8:30	3972	12.35675	0
4/26/2007 9:00	3973	12.35637	0
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4/26/2007 14:30	3984	12.36849	0
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4/27/2007 14:30	4032	12.36618	0
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4/28/2007 21:30	4094	12.3651	0
4/28/2007 22:00	4095	12.36448	0.8
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4/28/2007 23:30	4098	12.36352	0
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4/29/2007 3:30	4106	12.3623	0
4/29/2007 4:00	4107	12.36203	0
4/29/2007 4:30	4108	12.36147	0.2
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4/29/2007 5:30	4110	12.36202	0
4/29/2007 6:00	4111	12.36174	0
4/29/2007 6:30	4112	12.36091	0
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4/29/2007 8:00	4115	12.36043	0
4/29/2007 8:30	4116	12.36035	0.2
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4/29/2007 9:30	4118	12.36106	0.2
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4/29/2007 11:00	4121	12.36166	0
4/29/2007 11:30	4122	12.36176	0
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4/29/2007 20:00	4139	12.36552	0
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4/29/2007 22:00	4143	12.36392	0
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4/30/2007 0:30	4148	12.36318	0
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4/30/2007 6:30	4160	12.36155	0
4/30/2007 7:00	4161	12.36229	0
4/30/2007 7:30	4162	12.36206	0.2
4/30/2007 8:00	4163	12.36257	0
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4/30/2007 9:00	4165	12.36192	0.2
4/30/2007 9:30	4166	12.36252	0.4
4/30/2007 10:00	4167	12.36253	0.2
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4/30/2007 14:00	4175	12.36241	0
4/30/2007 14:30	4176	12.36237	0.2
4/30/2007 15:00	4177	12.36351	0.8
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4/30/2007 16:00	4179	12.36229	0.4
4/30/2007 16:30	4180	12.36251	0.2
4/30/2007 17:00	4181	12.36319	0
4/30/2007 17:30	4182	12.36376	0
4/30/2007 18:00	4183	12.36342	0.2
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4/30/2007 19:00	4185	12.36364	0
4/30/2007 19:30	4186	12.3636	0
4/30/2007 20:00	4187	12.36291	0
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4/30/2007 21:00	4189	12.36336	2.2
4/30/2007 21:30	4190	12.36346	0.2
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4/30/2007 22:30	4192	12.36408	0.2
4/30/2007 23:00	4193	12.3637	0.6
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5/2/2007 12:00	4267	12.35784	0
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5/2/2007 20:00	4283	12.36028	0
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5/2/2007 23:00	4289	12.35633	0
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5/3/2007 2:00	4295	12.35403	0
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5/3/2007 7:30	4306	12.35306	0
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5/4/2007 7:30	4354	12.34246	0
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5/20/2007 3:00	5113	12.32155	0
5/20/2007 3:30	5114	12.32148	0.2
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5/20/2007 4:30	5116	12.32073	0.2
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5/21/2007 6:30	5168	12.32391	0
5/21/2007 7:00	5169	12.32369	0.2
5/21/2007 7:30	5170	12.3235	0
5/21/2007 8:00	5171	12.32344	0
5/21/2007 8:30	5172	12.32337	0
5/21/2007 9:00	5173	12.32349	0
5/21/2007 9:30	5174	12.32294	0
5/21/2007 10:00	5175	12.32329	0
5/21/2007 10:30	5176	12.32406	0.2
5/21/2007 11:00	5177	12.32373	0.2
5/21/2007 11:30	5178	12.32432	0
5/21/2007 12:00	5179	12.32424	0
5/21/2007 12:30	5180	12.32497	0
5/21/2007 13:00	5181	12.32636	0
5/21/2007 13:30	5182	12.32706	0
5/21/2007 14:00	5183	12.32768	0
5/21/2007 14:30	5184	12.32856	0
5/21/2007 15:00	5185	12.32827	0
5/21/2007 15:30	5186	12.32903	0
5/21/2007 16:00	5187	12.32985	0
5/21/2007 16:30	5188	12.32994	0
5/21/2007 17:00	5189	12.32926	0.4
5/21/2007 17:30	5190	12.32946	0
5/21/2007 18:00	5191	12.32824	0
5/21/2007 18:30	5192	12.3285	0.4
5/21/2007 19:00	5193	12.32853	0
5/21/2007 19:30	5194	12.32872	0
5/21/2007 20:00	5195	12.32789	0

5/21/2007 20:30	5196	12.32727	0
5/21/2007 21:00	5197	12.32651	0
5/21/2007 21:30	5198	12.32604	0
5/21/2007 22:00	5199	12.32588	0
5/21/2007 22:30	5200	12.32533	0
5/21/2007 23:00	5201	12.32477	0
5/21/2007 23:30	5202	12.32436	0
5/22/2007 0:00	5203	12.324	0
5/22/2007 0:30	5204	12.32314	0
5/22/2007 1:00	5205	12.32243	0
5/22/2007 1:30	5206	12.32249	0
5/22/2007 2:00	5207	12.3224	0
5/22/2007 2:30	5208	12.32193	0
5/22/2007 3:00	5209	12.32203	0
5/22/2007 3:30	5210	12.32193	0
5/22/2007 4:00	5211	12.32176	0
5/22/2007 4:30	5212	12.32177	0
5/22/2007 5:00	5213	12.32156	0.2
5/22/2007 5:30	5214	12.32176	0
5/22/2007 6:00	5215	12.32133	0
5/22/2007 6:30	5216	12.32148	0
5/22/2007 7:00	5217	12.32125	0
5/22/2007 7:30	5218	12.32104	0
5/22/2007 8:00	5219	12.32086	0
5/22/2007 8:30	5220	12.32147	0
5/22/2007 9:00	5221	12.32111	0
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5/22/2007 10:00	5223	12.32122	0
5/22/2007 10:30	5224	12.32164	0
5/22/2007 11:00	5225	12.32252	0
5/22/2007 11:30	5226	12.32269	0
5/22/2007 12:00	5227	12.32343	0
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5/22/2007 13:00	5229	12.32491	0
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5/22/2007 14:00	5231	12.32509	0
5/22/2007 14:30	5232	12.32679	0
5/22/2007 15:00	5233	12.32777	0
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5/22/2007 16:00	5235	12.32801	0
5/22/2007 16:30	5236	12.32843	0
5/22/2007 17:00	5237	12.32818	0
5/22/2007 17:30	5238	12.32747	0
5/22/2007 18:00	5239	12.32812	0
5/22/2007 18:30	5240	12.32767	0
5/22/2007 19:00	5241	12.32713	0
5/22/2007 19:30	5242	12.32707	0
5/22/2007 20:00	5243	12.32676	0
5/22/2007 20:30	5244	12.32643	0
5/22/2007 21:00	5245	12.32597	0
5/22/2007 21:30	5246	12.32568	0
5/22/2007 22:00	5247	12.32578	0

5/22/2007 22:30	5248	12.32527	0
5/22/2007 23:00	5249	12.32437	0
5/22/2007 23:30	5250	12.32398	0
5/23/2007 0:00	5251	12.32448	0
5/23/2007 0:30	5252	12.32414	0
5/23/2007 1:00	5253	12.32329	0
5/23/2007 1:30	5254	12.32421	0
5/23/2007 2:00	5255	12.32456	0
5/23/2007 2:30	5256	12.32336	0
5/23/2007 3:00	5257	12.32473	0
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5/23/2007 4:00	5259	12.32402	0
5/23/2007 4:30	5260	12.32357	0
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5/23/2007 5:30	5262	12.32368	0
5/23/2007 6:00	5263	12.32337	0
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5/23/2007 7:00	5265	12.3238	0
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5/23/2007 8:00	5267	12.3238	0
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5/23/2007 9:00	5269	12.32285	0
5/23/2007 9:30	5270	12.32334	0
5/23/2007 10:00	5271	12.32397	0
5/23/2007 10:30	5272	12.32302	0.2
5/23/2007 11:00	5273	12.32399	0.4
5/23/2007 11:30	5274	12.32337	0.4
5/23/2007 12:00	5275	12.32363	0.4
5/23/2007 12:30	5276	12.32314	0.2
5/23/2007 13:00	5277	12.32342	0
5/23/2007 13:30	5278	12.32397	0.6
5/23/2007 14:00	5279	12.3234	1
5/23/2007 14:30	5280	12.3233	0
5/23/2007 15:00	5281	12.32257	0
5/23/2007 15:30	5282	12.32355	0.2
5/23/2007 16:00	5283	12.323	0
5/23/2007 16:30	5284	12.32363	0.4
5/23/2007 17:00	5285	12.32275	0.2
5/23/2007 17:30	5286	12.32281	0
5/23/2007 18:00	5287	12.3219	0
5/23/2007 18:30	5288	12.32188	0
5/23/2007 19:00	5289	12.3218	0
5/23/2007 19:30	5290	12.32077	0
5/23/2007 20:00	5291	12.32053	0
5/23/2007 20:30	5292	12.31961	0
5/23/2007 21:00	5293	12.31842	0
5/23/2007 21:30	5294	12.31759	0
5/23/2007 22:00	5295	12.31697	0
5/23/2007 22:30	5296	12.31652	0
5/23/2007 23:00	5297	12.3156	0
5/23/2007 23:30	5298	12.31585	0
5/24/2007 0:00	5299	12.31548	0

5/24/2007 0:30	5300	12.31555	0
5/24/2007 1:00	5301	12.31532	0
5/24/2007 1:30	5302	12.31546	0
5/24/2007 2:00	5303	12.31553	0
5/24/2007 2:30	5304	12.315	0
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5/24/2007 5:30	5310	12.31176	0
5/24/2007 6:00	5311	12.31107	0
5/24/2007 6:30	5312	12.31131	0
5/24/2007 7:00	5313	12.31086	0.2
5/24/2007 7:30	5314	12.31037	0
5/24/2007 8:00	5315	12.31061	0
5/24/2007 8:30	5316	12.31047	0
5/24/2007 9:00	5317	12.31037	0
5/24/2007 9:30	5318	12.30994	0
5/24/2007 10:00	5319	12.31115	0
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5/24/2007 11:30	5322	12.3119	0
5/24/2007 12:00	5323	12.31383	0
5/24/2007 12:30	5324	12.31531	0
5/24/2007 13:00	5325	12.3156	0
5/24/2007 13:30	5326	12.31677	0
5/24/2007 14:00	5327	12.31687	0
5/24/2007 14:30	5328	12.31895	0
5/24/2007 15:00	5329	12.31971	0
5/24/2007 15:30	5330	12.32094	0
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5/24/2007 17:00	5333	12.32266	0
5/24/2007 17:30	5334	12.32189	0
5/24/2007 18:00	5335	12.32129	0
5/24/2007 18:30	5336	12.32172	0
5/24/2007 19:00	5337	12.32123	0
5/24/2007 19:30	5338	12.32056	0
5/24/2007 20:00	5339	12.31927	0
5/24/2007 20:30	5340	12.31752	0
5/24/2007 21:00	5341	12.31679	0
5/24/2007 21:30	5342	12.31642	0
5/24/2007 22:00	5343	12.3152	0
5/24/2007 22:30	5344	12.31424	0
5/24/2007 23:00	5345	12.31362	0
5/24/2007 23:30	5346	12.31234	0
5/25/2007 0:00	5347	12.31079	0
5/25/2007 0:30	5348	12.30991	0
5/25/2007 1:00	5349	12.30909	0
5/25/2007 1:30	5350	12.30786	0
5/25/2007 2:00	5351	12.30767	0

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5/25/2007 4:30	5356	12.30448	0
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5/25/2007 9:00	5365	12.30257	0
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5/25/2007 11:00	5369	12.30542	0
5/25/2007 11:30	5370	12.30713	0
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5/25/2007 13:30	5374	12.312	0
5/25/2007 14:00	5375	12.31319	0
5/25/2007 14:30	5376	12.31398	0
5/25/2007 15:00	5377	12.31555	0
5/25/2007 15:30	5378	12.31618	0
5/25/2007 16:00	5379	12.3161	0
5/25/2007 16:30	5380	12.31758	0
5/25/2007 17:00	5381	12.31717	0
5/25/2007 17:30	5382	12.31722	0
5/25/2007 18:00	5383	12.31781	0
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5/25/2007 23:30	5394	12.31038	0
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5/26/2007 1:00	5397	12.30966	0
5/26/2007 1:30	5398	12.30906	0
5/26/2007 2:00	5399	12.30922	0
5/26/2007 2:30	5400	12.30892	0
5/26/2007 3:00	5401	12.30908	0
5/26/2007 3:30	5402	12.30859	0
5/26/2007 4:00	5403	12.3084	0

5/26/2007 4:30	5404	12.30803	0
5/26/2007 5:00	5405	12.30804	0
5/26/2007 5:30	5406	12.30808	0
5/26/2007 6:00	5407	12.30872	0
5/26/2007 6:30	5408	12.30876	0
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5/26/2007 17:00	5429	12.31629	0
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5/27/2007 2:00	5447	12.30817	0
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5/27/2007 5:00	5453	12.30804	0
5/27/2007 5:30	5454	12.30875	0
5/27/2007 6:00	5455	12.30878	0

5/27/2007 6:30	5456	12.30901	0
5/27/2007 7:00	5457	12.30852	0
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5/27/2007 20:30	5484	12.31328	0
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5/28/2007 8:00	5507	12.30378	0

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5/29/2007 12:30	5564	12.29217	0
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5/29/2007 17:00	5573	12.30822	0
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6/15/2007 15:30	6386	12.27503	0
6/15/2007 16:00	6387	12.27459	0
6/15/2007 16:30	6388	12.27522	0
6/15/2007 17:00	6389	12.27548	0
6/15/2007 17:30	6390	12.27617	0
6/15/2007 18:00	6391	12.27569	0

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6/15/2007 20:30	6396	12.27262	0
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6/16/2007 14:00	6431	12.2639	0
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6/16/2007 20:00	6443	12.26621	0

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6/17/2007 21:00	6493	12.26391	0
6/17/2007 21:30	6494	12.26344	0
6/17/2007 22:00	6495	12.26274	0

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6/20/2007 13:00	6621	12.25887	0.4
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6/21/2007 2:30	6648	12.26958	0
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6/21/2007 5:30	6654	12.26819	0
6/21/2007 6:00	6655	12.2682	0
6/21/2007 6:30	6656	12.26735	0
6/21/2007 7:00	6657	12.2675	0
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6/21/2007 14:30	6672	12.27257	0
6/21/2007 15:00	6673	12.27319	0
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6/22/2007 2:00	6695	12.26629	0
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6/22/2007 3:00	6697	12.26552	0.2
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6/22/2007 10:00	6711	12.26354	4.6
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6/22/2007 12:00	6715	12.2633	0
6/22/2007 12:30	6716	12.26379	0
6/22/2007 13:00	6717	12.26494	2.6
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6/22/2007 14:30	6720	12.26659	0
6/22/2007 15:00	6721	12.26661	0.4
6/22/2007 15:30	6722	12.26639	0.2
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6/22/2007 17:00	6725	12.26722	0
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6/22/2007 18:00	6727	12.26571	0
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6/22/2007 20:00	6731	12.26311	0
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6/23/2007 1:30	6742	12.26199	0
6/23/2007 2:00	6743	12.26123	0
6/23/2007 2:30	6744	12.26206	0.2
6/23/2007 3:00	6745	12.2626	1
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6/23/2007 18:30	6776	12.26457	1
6/23/2007 19:00	6777	12.26452	0
6/23/2007 19:30	6778	12.26336	0.2
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6/23/2007 21:00	6781	12.26227	0.2
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6/23/2007 22:00	6783	12.26133	0.2
6/23/2007 22:30	6784	12.26137	0
6/23/2007 23:00	6785	12.26075	0.2
6/23/2007 23:30	6786	12.26116	0
6/24/2007 0:00	6787	12.26045	0
6/24/2007 0:30	6788	12.26021	0
6/24/2007 1:00	6789	12.25932	0
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6/24/2007 2:30	6792	12.25935	0
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6/24/2007 9:30	6806	12.25834	0
6/24/2007 10:00	6807	12.25863	0

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6/24/2007 14:00	6815	12.26362	0
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6/25/2007 17:00	6869	12.26117	0
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6/25/2007 18:00	6871	12.26083	0.4
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6/25/2007 19:00	6873	12.25995	0.8
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6/25/2007 21:30	6878	12.25682	0
6/25/2007 22:00	6879	12.25679	0.8
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6/25/2007 23:00	6881	12.25568	1.2
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6/29/2007 14:00	7055	12.25758	0.4
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6/29/2007 22:00	7071	12.2562	0
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6/30/2007 2:30	7080	12.25706	0.2
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6/30/2007 10:00	7095	12.26014	2.2
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7/1/2007 0:30	7124	12.25736	0
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7/1/2007 9:30	7142	12.25585	0.6
7/1/2007 10:00	7143	12.25568	0.2
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7/1/2007 15:30	7154	12.258	0
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7/1/2007 21:00	7165	12.25636	1
7/1/2007 21:30	7166	12.25573	0
7/1/2007 22:00	7167	12.2558	0
7/1/2007 22:30	7168	12.2551	0
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7/2/2007 0:30	7172	12.25342	1.2
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7/2/2007 3:00	7177	12.25158	0
7/2/2007 3:30	7178	12.25095	0
7/2/2007 4:00	7179	12.25129	0.4
7/2/2007 4:30	7180	12.25107	0.6
7/2/2007 5:00	7181	12.25033	0.2
7/2/2007 5:30	7182	12.25064	0
7/2/2007 6:00	7183	12.24976	0
7/2/2007 6:30	7184	12.24963	0
7/2/2007 7:00	7185	12.24946	0.2
7/2/2007 7:30	7186	12.24941	1
7/2/2007 8:00	7187	12.24859	1.8
7/2/2007 8:30	7188	12.24883	0.2
7/2/2007 9:00	7189	12.24917	0
7/2/2007 9:30	7190	12.24944	0
7/2/2007 10:00	7191	12.24924	0
7/2/2007 10:30	7192	12.24867	0
7/2/2007 11:00	7193	12.24909	0
7/2/2007 11:30	7194	12.24957	0
7/2/2007 12:00	7195	12.24987	0.2
7/2/2007 12:30	7196	12.25099	0
7/2/2007 13:00	7197	12.25165	0
7/2/2007 13:30	7198	12.25176	0
7/2/2007 14:00	7199	12.25201	0.2
7/2/2007 14:30	7200	12.25174	0.8
7/2/2007 15:00	7201	12.25178	0
7/2/2007 15:30	7202	12.25142	0
7/2/2007 16:00	7203	12.25125	0
7/2/2007 16:30	7204	12.25163	0
7/2/2007 17:00	7205	12.25111	0
7/2/2007 17:30	7206	12.25136	0
7/2/2007 18:00	7207	12.2508	0
7/2/2007 18:30	7208	12.25017	0
7/2/2007 19:00	7209	12.25016	0.4
7/2/2007 19:30	7210	12.24948	0
7/2/2007 20:00	7211	12.2493	0
7/2/2007 20:30	7212	12.2486	0
7/2/2007 21:00	7213	12.24835	0
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7/2/2007 22:00	7215	12.24818	0
7/2/2007 22:30	7216	12.24727	0
7/2/2007 23:00	7217	12.24738	0
7/2/2007 23:30	7218	12.24671	0
7/3/2007 0:00	7219	12.24655	0
7/3/2007 0:30	7220	12.24633	0
7/3/2007 1:00	7221	12.24669	0.2
7/3/2007 1:30	7222	12.24665	0.4
7/3/2007 2:00	7223	12.24636	0

7/3/2007 2:30	7224	12.24662	0
7/3/2007 3:00	7225	12.24619	0
7/3/2007 3:30	7226	12.24602	0
7/3/2007 4:00	7227	12.24558	0
7/3/2007 4:30	7228	12.24512	0.2
7/3/2007 5:00	7229	12.24523	0
7/3/2007 5:30	7230	12.24432	0
7/3/2007 6:00	7231	12.24373	0
7/3/2007 6:30	7232	12.24457	0
7/3/2007 7:00	7233	12.2444	0
7/3/2007 7:30	7234	12.24453	0
7/3/2007 8:00	7235	12.24463	0
7/3/2007 8:30	7236	12.2447	0
7/3/2007 9:00	7237	12.24396	0
7/3/2007 9:30	7238	12.24466	0
7/3/2007 10:00	7239	12.24526	0
7/3/2007 10:30	7240	12.2452	0
7/3/2007 11:00	7241	12.24551	0
7/3/2007 11:30	7242	12.24674	0
7/3/2007 12:00	7243	12.2468	0
7/3/2007 12:30	7244	12.24744	0
7/3/2007 13:00	7245	12.24852	0
7/3/2007 13:30	7246	12.24977	0
7/3/2007 14:00	7247	12.25064	0
7/3/2007 14:30	7248	12.25126	0
7/3/2007 15:00	7249	12.25205	0
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7/3/2007 16:00	7251	12.25275	0
7/3/2007 16:30	7252	12.25324	0
7/3/2007 17:00	7253	12.25271	0
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7/3/2007 18:00	7255	12.25338	0
7/3/2007 18:30	7256	12.25194	0
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7/4/2007 3:00	7273	12.2387	0
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7/4/2007 5:00	7277	12.23732	0.2
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7/4/2007 6:00	7279	12.23637	0
7/4/2007 6:30	7280	12.23665	0
7/4/2007 7:00	7281	12.23692	0
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7/4/2007 8:00	7283	12.23679	0
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7/4/2007 10:00	7287	12.23936	0
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7/4/2007 11:30	7290	12.24169	0
7/4/2007 12:00	7291	12.24372	0
7/4/2007 12:30	7292	12.2449	0
7/4/2007 13:00	7293	12.24585	0
7/4/2007 13:30	7294	12.2474	0
7/4/2007 14:00	7295	12.24814	1
7/4/2007 14:30	7296	12.24837	0
7/4/2007 15:00	7297	12.24888	0
7/4/2007 15:30	7298	12.24934	4.2
7/4/2007 16:00	7299	12.24876	1
7/4/2007 16:30	7300	12.24779	0.8
7/4/2007 17:00	7301	12.24751	0.6
7/4/2007 17:30	7302	12.24671	0.2
7/4/2007 18:00	7303	12.24658	0.2
7/4/2007 18:30	7304	12.24519	0
7/4/2007 19:00	7305	12.24481	0
7/4/2007 19:30	7306	12.2448	0
7/4/2007 20:00	7307	12.24373	1.4
7/4/2007 20:30	7308	12.24347	0.4
7/4/2007 21:00	7309	12.24303	0
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7/4/2007 23:00	7313	12.24212	1
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7/5/2007 1:00	7317	12.24226	0.2
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7/5/2007 2:30	7320	12.24255	0.4
7/5/2007 3:00	7321	12.24315	0.2
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7/5/2007 4:00	7323	12.24343	0.6
7/5/2007 4:30	7324	12.24287	0.2
7/5/2007 5:00	7325	12.24262	0
7/5/2007 5:30	7326	12.24334	0
7/5/2007 6:00	7327	12.24263	0

7/5/2007 6:30	7328	12.24316	0
7/5/2007 7:00	7329	12.24293	0
7/5/2007 7:30	7330	12.24293	0
7/5/2007 8:00	7331	12.24275	0
7/5/2007 8:30	7332	12.24169	0
7/5/2007 9:00	7333	12.24269	0
7/5/2007 9:30	7334	12.24259	0
7/5/2007 10:00	7335	12.24293	0
7/5/2007 10:30	7336	12.24333	0
7/5/2007 11:00	7337	12.24347	0
7/5/2007 11:30	7338	12.2447	0
7/5/2007 12:00	7339	12.24499	0
7/5/2007 12:30	7340	12.24471	0
7/5/2007 13:00	7341	12.24546	0
7/5/2007 13:30	7342	12.24634	0
7/5/2007 14:00	7343	12.24731	0
7/5/2007 14:30	7344	12.2481	0
7/5/2007 15:00	7345	12.24804	0
7/5/2007 15:30	7346	12.24823	0
7/5/2007 16:00	7347	12.24888	0
7/5/2007 16:30	7348	12.24905	0
7/5/2007 17:00	7349	12.24887	0
7/5/2007 17:30	7350	12.24925	0
7/5/2007 18:00	7351	12.24886	0
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7/5/2007 19:00	7353	12.24828	0
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7/5/2007 20:00	7355	12.24787	0
7/5/2007 20:30	7356	12.24833	0
7/5/2007 21:00	7357	12.2476	0
7/5/2007 21:30	7358	12.24777	0
7/5/2007 22:00	7359	12.24785	0
7/5/2007 22:30	7360	12.24775	0
7/5/2007 23:00	7361	12.24733	0
7/5/2007 23:30	7362	12.24763	0
7/6/2007 0:00	7363	12.24748	2.8
7/6/2007 0:30	7364	12.24685	0.4
7/6/2007 1:00	7365	12.24686	0.4
7/6/2007 1:30	7366	12.2469	0.2
7/6/2007 2:00	7367	12.24636	0
7/6/2007 2:30	7368	12.24506	0
7/6/2007 3:00	7369	12.2451	0
7/6/2007 3:30	7370	12.24479	0
7/6/2007 4:00	7371	12.24455	0
7/6/2007 4:30	7372	12.24447	0
7/6/2007 5:00	7373	12.24478	0
7/6/2007 5:30	7374	12.24439	0
7/6/2007 6:00	7375	12.24474	0
7/6/2007 6:30	7376	12.24492	0
7/6/2007 7:00	7377	12.24461	0.4
7/6/2007 7:30	7378	12.24462	1.2
7/6/2007 8:00	7379	12.24535	2.2

7/6/2007 8:30	7380	12.24543	0.4
7/6/2007 9:00	7381	12.24453	0.8
7/6/2007 9:30	7382	12.24508	0.2
7/6/2007 10:00	7383	12.24579	0
7/6/2007 10:30	7384	12.24526	0
7/6/2007 11:00	7385	12.24487	0
7/6/2007 11:30	7386	12.24489	0
7/6/2007 12:00	7387	12.24613	2.8
7/6/2007 12:30	7388	12.24591	2
7/6/2007 13:00	7389	12.24551	0.6
7/6/2007 13:30	7390	12.24563	1
7/6/2007 14:00	7391	12.24562	2.2
7/6/2007 14:30	7392	12.24557	0.6
7/6/2007 15:00	7393	12.24527	0.4
7/6/2007 15:30	7394	12.24391	0.2
7/6/2007 16:00	7395	12.24417	0
7/6/2007 16:30	7396	12.24404	0.2
7/6/2007 17:00	7397	12.24436	0
7/6/2007 17:30	7398	12.24457	0.6
7/6/2007 18:00	7399	12.24428	0.6
7/6/2007 18:30	7400	12.24401	0
7/6/2007 19:00	7401	12.24366	4
7/6/2007 19:30	7402	12.24354	0.6
7/6/2007 20:00	7403	12.24399	0
7/6/2007 20:30	7404	12.24298	0
7/6/2007 21:00	7405	12.24286	0
7/6/2007 21:30	7406	12.242	1
7/6/2007 22:00	7407	12.24171	0.8
7/6/2007 22:30	7408	12.24141	2
7/6/2007 23:00	7409	12.24147	0.6
7/6/2007 23:30	7410	12.24102	0.2
7/7/2007 0:00	7411	12.24166	0.4
7/7/2007 0:30	7412	12.24124	0.6
7/7/2007 1:00	7413	12.24145	1.2
7/7/2007 1:30	7414	12.24123	0.2
7/7/2007 2:00	7415	12.24138	3.600001
7/7/2007 2:30	7416	12.24043	2.6
7/7/2007 3:00	7417	12.24021	1.2
7/7/2007 3:30	7418	12.23845	0
7/7/2007 4:00	7419	12.23876	0
7/7/2007 4:30	7420	12.23817	0
7/7/2007 5:00	7421	12.23749	0.2
7/7/2007 5:30	7422	12.2371	0
7/7/2007 6:00	7423	12.23735	0
7/7/2007 6:30	7424	12.23713	0
7/7/2007 7:00	7425	12.23684	0
7/7/2007 7:30	7426	12.23623	0
7/7/2007 8:00	7427	12.23564	0
7/7/2007 8:30	7428	12.23589	0
7/7/2007 9:00	7429	12.23509	0
7/7/2007 9:30	7430	12.23617	0
7/7/2007 10:00	7431	12.2358	0

7/7/2007 10:30	7432	12.23562	0
7/7/2007 11:00	7433	12.23517	0
7/7/2007 11:30	7434	12.23566	0
7/7/2007 12:00	7435	12.23583	0
7/7/2007 12:30	7436	12.23608	0
7/7/2007 13:00	7437	12.2363	0
7/7/2007 13:30	7438	12.23617	0
7/7/2007 14:00	7439	12.23695	0
7/7/2007 14:30	7440	12.23715	0
7/7/2007 15:00	7441	12.23751	0
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7/7/2007 16:00	7443	12.23862	0
7/7/2007 16:30	7444	12.23795	0
7/7/2007 17:00	7445	12.23819	0
7/7/2007 17:30	7446	12.23832	0
7/7/2007 18:00	7447	12.23754	0
7/7/2007 18:30	7448	12.2372	0
7/7/2007 19:00	7449	12.23705	0
7/7/2007 19:30	7450	12.23683	0
7/7/2007 20:00	7451	12.23638	0
7/7/2007 20:30	7452	12.23584	0.6
7/7/2007 21:00	7453	12.23536	0.4
7/7/2007 21:30	7454	12.2359	0.4
7/7/2007 22:00	7455	12.2352	0
7/7/2007 22:30	7456	12.23447	0
7/7/2007 23:00	7457	12.23459	0
7/7/2007 23:30	7458	12.23476	0.2
7/8/2007 0:00	7459	12.23434	0.2
7/8/2007 0:30	7460	12.23394	0.2
7/8/2007 1:00	7461	12.23452	0
7/8/2007 1:30	7462	12.23394	0.2
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7/8/2007 2:30	7464	12.23376	0
7/8/2007 3:00	7465	12.23329	0.8
7/8/2007 3:30	7466	12.23289	0.8
7/8/2007 4:00	7467	12.23319	0.2
7/8/2007 4:30	7468	12.23277	0
7/8/2007 5:00	7469	12.23264	0.2
7/8/2007 5:30	7470	12.2313	0
7/8/2007 6:00	7471	12.23164	0
7/8/2007 6:30	7472	12.23085	0
7/8/2007 7:00	7473	12.23157	0
7/8/2007 7:30	7474	12.23117	0
7/8/2007 8:00	7475	12.23027	0
7/8/2007 8:30	7476	12.23038	0
7/8/2007 9:00	7477	12.23014	0
7/8/2007 9:30	7478	12.2295	0
7/8/2007 10:00	7479	12.22984	0
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7/8/2007 11:00	7481	12.22953	0
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7/8/2007 12:00	7483	12.23049	0

7/8/2007 12:30	7484	12.2318	0
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7/8/2007 13:30	7486	12.23468	0
7/8/2007 14:00	7487	12.23573	0
7/8/2007 14:30	7488	12.23649	0
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7/8/2007 17:00	7493	12.24109	0
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7/8/2007 19:00	7497	12.23909	0
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7/8/2007 20:00	7499	12.23742	0
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7/8/2007 23:00	7505	12.23527	0
7/8/2007 23:30	7506	12.23558	0
7/9/2007 0:00	7507	12.23523	0
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7/9/2007 9:30	7526	12.23184	0
7/9/2007 10:00	7527	12.23292	0
7/9/2007 10:30	7528	12.23307	0.2
7/9/2007 11:00	7529	12.23374	0
7/9/2007 11:30	7530	12.23462	0
7/9/2007 12:00	7531	12.23479	0
7/9/2007 12:30	7532	12.23567	0
7/9/2007 13:00	7533	12.23603	0
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7/9/2007 14:00	7535	12.23755	0.4

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7/9/2007 17:00	7541	12.24145	0
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7/9/2007 18:00	7543	12.24045	0
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7/9/2007 23:30	7554	12.23812	0
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7/10/2007 5:00	7565	12.2371	0
7/10/2007 5:30	7566	12.23656	0.2
7/10/2007 6:00	7567	12.23603	0.2
7/10/2007 6:30	7568	12.23656	0
7/10/2007 7:00	7569	12.23609	0.6
7/10/2007 7:30	7570	12.23606	1
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7/10/2007 9:00	7573	12.23542	0.4
7/10/2007 9:30	7574	12.23542	0.2
7/10/2007 10:00	7575	12.23514	0.4
7/10/2007 10:30	7576	12.23533	0.4
7/10/2007 11:00	7577	12.23499	0.4
7/10/2007 11:30	7578	12.23499	0.6
7/10/2007 12:00	7579	12.23467	0.6
7/10/2007 12:30	7580	12.23431	0.4
7/10/2007 13:00	7581	12.23518	0
7/10/2007 13:30	7582	12.23466	0
7/10/2007 14:00	7583	12.23557	0.2
7/10/2007 14:30	7584	12.23427	0
7/10/2007 15:00	7585	12.23486	0.2
7/10/2007 15:30	7586	12.23435	0.2
7/10/2007 16:00	7587	12.23405	0.2

7/10/2007 16:30	7588	12.235	0.2
7/10/2007 17:00	7589	12.2338	0.8
7/10/2007 17:30	7590	12.23401	0.4
7/10/2007 18:00	7591	12.23404	0
7/10/2007 18:30	7592	12.23355	0
7/10/2007 19:00	7593	12.23268	0
7/10/2007 19:30	7594	12.23172	0
7/10/2007 20:00	7595	12.23308	0
7/10/2007 20:30	7596	12.23268	0
7/10/2007 21:00	7597	12.23248	0
7/10/2007 21:30	7598	12.23201	0
7/10/2007 22:00	7599	12.23178	0
7/10/2007 22:30	7600	12.2314	0
7/10/2007 23:00	7601	12.23119	0
7/10/2007 23:30	7602	12.23055	0
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7/11/2007 1:00	7605	12.2317	0.6
7/11/2007 1:30	7606	12.2308	0.4
7/11/2007 2:00	7607	12.23078	0.2
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7/11/2007 4:00	7611	12.22964	0.2
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7/11/2007 5:00	7613	12.22949	0
7/11/2007 5:30	7614	12.22882	0.2
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7/11/2007 7:30	7618	12.22786	0
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7/11/2007 10:00	7623	12.22637	0
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7/11/2007 14:00	7631	12.22816	0
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7/11/2007 16:00	7635	12.22874	0
7/11/2007 16:30	7636	12.22889	0
7/11/2007 17:00	7637	12.22953	0
7/11/2007 17:30	7638	12.22858	0
7/11/2007 18:00	7639	12.22982	0

7/11/2007 18:30	7640	12.23001	0
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7/11/2007 20:30	7644	12.22953	0
7/11/2007 21:00	7645	12.22892	0
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7/12/2007 19:00	7689	12.23184	0
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7/12/2007 20:00	7691	12.23087	0

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7/12/2007 22:00	7695	12.22777	0
7/12/2007 22:30	7696	12.22676	0
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7/13/2007 17:00	7733	12.23383	0
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7/13/2007 18:00	7735	12.23392	0
7/13/2007 18:30	7736	12.23323	0
7/13/2007 19:00	7737	12.232	0
7/13/2007 19:30	7738	12.23053	0
7/13/2007 20:00	7739	12.22951	0
7/13/2007 20:30	7740	12.22903	0
7/13/2007 21:00	7741	12.22769	0
7/13/2007 21:30	7742	12.22602	0
7/13/2007 22:00	7743	12.22441	0

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7/13/2007 23:00	7745	12.22197	0
7/13/2007 23:30	7746	12.22159	0
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7/14/2007 6:30	7760	12.21264	0
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7/14/2007 22:30	7792	12.22421	0
7/14/2007 23:00	7793	12.22376	0
7/14/2007 23:30	7794	12.22348	0
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7/15/2007 7:00	7809	12.21735	0
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7/16/2007 0:30	7844	12.22578	0
7/16/2007 1:00	7845	12.22587	0.2
7/16/2007 1:30	7846	12.22563	0.2
7/16/2007 2:00	7847	12.22589	0.4

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7/16/2007 6:00	7855	12.22397	0
7/16/2007 6:30	7856	12.22382	0
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7/16/2007 9:00	7861	12.22348	0.6
7/16/2007 9:30	7862	12.22365	0.8
7/16/2007 10:00	7863	12.22312	1.8
7/16/2007 10:30	7864	12.22306	1
7/16/2007 11:00	7865	12.22286	0.8
7/16/2007 11:30	7866	12.22348	0.6
7/16/2007 12:00	7867	12.22384	0.4
7/16/2007 12:30	7868	12.22305	2.2
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7/16/2007 14:00	7871	12.22372	4.2
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7/16/2007 15:00	7873	12.22448	0
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7/16/2007 17:00	7877	12.22545	0
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7/16/2007 23:00	7889	12.2247	0
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7/17/2007 0:30	7892	12.22438	0
7/17/2007 1:00	7893	12.22428	0.4
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7/17/2007 3:00	7897	12.22422	0
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7/17/2007 6:00	7903	12.22387	0.2
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7/17/2007 8:00	7907	12.22468	0
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7/17/2007 15:00	7921	12.23291	0
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7/17/2007 16:00	7923	12.23338	0
7/17/2007 16:30	7924	12.23378	0
7/17/2007 17:00	7925	12.23322	0
7/17/2007 17:30	7926	12.23334	0
7/17/2007 18:00	7927	12.23291	0
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7/17/2007 20:00	7931	12.2317	0
7/17/2007 20:30	7932	12.23034	0
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7/18/2007 2:00	7943	12.22625	0
7/18/2007 2:30	7944	12.22491	0
7/18/2007 3:00	7945	12.22427	0.2
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7/18/2007 7:30	7954	12.22146	0
7/18/2007 8:00	7955	12.22191	0
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7/18/2007 9:00	7957	12.22118	0
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7/18/2007 12:00	7963	12.22316	0
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7/18/2007 13:00	7965	12.22529	0
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7/18/2007 18:30	7976	12.2322	0
7/18/2007 19:00	7977	12.2311	0
7/18/2007 19:30	7978	12.22995	0
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7/18/2007 20:30	7980	12.2286	0
7/18/2007 21:00	7981	12.22734	0
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7/18/2007 22:00	7983	12.22513	0
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7/18/2007 23:00	7985	12.22295	0
7/18/2007 23:30	7986	12.22256	0
7/19/2007 0:00	7987	12.22194	0
7/19/2007 0:30	7988	12.22136	0
7/19/2007 1:00	7989	12.22121	0
7/19/2007 1:30	7990	12.21989	0
7/19/2007 2:00	7991	12.22054	0
7/19/2007 2:30	7992	12.22047	0
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7/21/2007 10:00	8103	12.21063	0
7/21/2007 10:30	8104	12.21266	0.6
7/21/2007 11:00	8105	12.21283	4.2
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7/21/2007 14:00	8111	12.21802	0
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7/21/2007 16:30	8116	12.22032	0
7/21/2007 17:00	8117	12.22119	0
7/21/2007 17:30	8118	12.22138	0.8
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7/22/2007 7:00	8145	12.21428	0
7/22/2007 7:30	8146	12.21432	0
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7/22/2007 13:30	8158	12.21223	0
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7/23/2007 14:00	8207	12.20899	0
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7/24/2007 7:30	8242	12.20646	0
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7/24/2007 18:00	8263	12.21661	0

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7/25/2007 3:00	8281	12.20726	0
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7/25/2007 6:00	8287	12.20379	0
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7/25/2007 15:00	8305	12.21599	0.2
7/25/2007 15:30	8306	12.21615	0
7/25/2007 16:00	8307	12.21605	0
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7/25/2007 17:00	8309	12.21688	0
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7/25/2007 19:00	8313	12.21602	0
7/25/2007 19:30	8314	12.21509	0
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7/26/2007 2:00	8327	12.20847	0
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7/26/2007 4:00	8331	12.20793	0
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7/26/2007 5:00	8333	12.20693	0
7/26/2007 5:30	8334	12.20702	0
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7/26/2007 7:00	8337	12.20513	0
7/26/2007 7:30	8338	12.20479	0
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7/26/2007 16:00	8355	12.21477	0
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7/26/2007 21:30	8366	12.21176	0
7/26/2007 22:00	8367	12.21142	0

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7/26/2007 23:00	8369	12.21107	0
7/26/2007 23:30	8370	12.21073	0
7/27/2007 0:00	8371	12.20999	0
7/27/2007 0:30	8372	12.21058	0.2
7/27/2007 1:00	8373	12.21075	0
7/27/2007 1:30	8374	12.21061	0
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7/27/2007 2:30	8376	12.20933	0
7/27/2007 3:00	8377	12.20942	0
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7/27/2007 9:30	8390	12.2097	0
7/27/2007 10:00	8391	12.20971	0
7/27/2007 10:30	8392	12.21104	0
7/27/2007 11:00	8393	12.21133	0
7/27/2007 11:30	8394	12.21266	0
7/27/2007 12:00	8395	12.2139	0
7/27/2007 12:30	8396	12.21461	1.8
7/27/2007 13:00	8397	12.21478	0
7/27/2007 13:30	8398	12.21563	0
7/27/2007 14:00	8399	12.21562	0
7/27/2007 14:30	8400	12.21659	0
7/27/2007 15:00	8401	12.21721	0
7/27/2007 15:30	8402	12.21893	0
7/27/2007 16:00	8403	12.21913	0
7/27/2007 16:30	8404	12.21931	0
7/27/2007 17:00	8405	12.21979	0
7/27/2007 17:30	8406	12.21965	0
7/27/2007 18:00	8407	12.21963	0
7/27/2007 18:30	8408	12.21976	0
7/27/2007 19:00	8409	12.21904	0
7/27/2007 19:30	8410	12.21784	0
7/27/2007 20:00	8411	12.21764	0
7/27/2007 20:30	8412	12.21744	0
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7/27/2007 21:30	8414	12.21562	0
7/27/2007 22:00	8415	12.2154	0
7/27/2007 22:30	8416	12.21435	0
7/27/2007 23:00	8417	12.21323	0
7/27/2007 23:30	8418	12.2124	0
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7/28/2007 1:00	8421	12.21016	0
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7/28/2007 2:30	8424	12.20916	0
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7/28/2007 3:30	8426	12.20798	0
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7/28/2007 4:30	8428	12.20865	0
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7/28/2007 5:30	8430	12.20758	0
7/28/2007 6:00	8431	12.20715	0
7/28/2007 6:30	8432	12.20661	0
7/28/2007 7:00	8433	12.20614	0
7/28/2007 7:30	8434	12.20616	0
7/28/2007 8:00	8435	12.20589	0
7/28/2007 8:30	8436	12.2046	0
7/28/2007 9:00	8437	12.20509	0
7/28/2007 9:30	8438	12.20563	0
7/28/2007 10:00	8439	12.20553	0
7/28/2007 10:30	8440	12.2066	0
7/28/2007 11:00	8441	12.20654	0
7/28/2007 11:30	8442	12.2073	0
7/28/2007 12:00	8443	12.20825	0
7/28/2007 12:30	8444	12.20899	0
7/28/2007 13:00	8445	12.20984	0
7/28/2007 13:30	8446	12.21084	0
7/28/2007 14:00	8447	12.21233	0
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7/28/2007 15:00	8449	12.2143	0
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7/28/2007 16:00	8451	12.21569	0
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7/28/2007 17:00	8453	12.21623	0
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7/28/2007 18:00	8455	12.21602	0
7/28/2007 18:30	8456	12.2161	0
7/28/2007 19:00	8457	12.21459	0
7/28/2007 19:30	8458	12.21441	0
7/28/2007 20:00	8459	12.21437	0
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7/28/2007 23:00	8465	12.21123	0
7/28/2007 23:30	8466	12.21079	0
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7/29/2007 0:30	8468	12.21058	0
7/29/2007 1:00	8469	12.21057	0
7/29/2007 1:30	8470	12.21058	0
7/29/2007 2:00	8471	12.20973	0

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7/29/2007 3:00	8473	12.20919	0
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7/29/2007 4:00	8475	12.20886	0
7/29/2007 4:30	8476	12.20949	0
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7/29/2007 5:30	8478	12.21016	1.8
7/29/2007 6:00	8479	12.21035	1.6
7/29/2007 6:30	8480	12.21055	0.6
7/29/2007 7:00	8481	12.21002	1
7/29/2007 7:30	8482	12.21105	1
7/29/2007 8:00	8483	12.21084	2.4
7/29/2007 8:30	8484	12.2111	0.4
7/29/2007 9:00	8485	12.21117	1.4
7/29/2007 9:30	8486	12.21208	4.2
7/29/2007 10:00	8487	12.21265	2.2
7/29/2007 10:30	8488	12.21264	2.2
7/29/2007 11:00	8489	12.21312	4.4
7/29/2007 11:30	8490	12.21308	1.2
7/29/2007 12:00	8491	12.21328	1
7/29/2007 12:30	8492	12.21328	0.2
7/29/2007 13:00	8493	12.2137	0.4
7/29/2007 13:30	8494	12.21377	0
7/29/2007 14:00	8495	12.21434	0
7/29/2007 14:30	8496	12.21525	0
7/29/2007 15:00	8497	12.21474	0
7/29/2007 15:30	8498	12.21542	0
7/29/2007 16:00	8499	12.21548	0
7/29/2007 16:30	8500	12.2157	0
7/29/2007 17:00	8501	12.21579	0
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7/29/2007 18:00	8503	12.21549	0
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7/29/2007 19:00	8505	12.21503	0
7/29/2007 19:30	8506	12.21495	0
7/29/2007 20:00	8507	12.21422	0
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7/30/2007 1:00	8517	12.21247	0
7/30/2007 1:30	8518	12.21185	0
7/30/2007 2:00	8519	12.21177	0
7/30/2007 2:30	8520	12.21113	0
7/30/2007 3:00	8521	12.2106	0
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7/30/2007 7:30	8530	12.2076	0
7/30/2007 8:00	8531	12.20765	0
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7/30/2007 9:30	8534	12.20788	0
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7/30/2007 14:00	8543	12.21352	0
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7/30/2007 15:00	8545	12.2137	2.6
7/30/2007 15:30	8546	12.21325	0
7/30/2007 16:00	8547	12.21222	0
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7/30/2007 17:00	8549	12.21152	0
7/30/2007 17:30	8550	12.21117	0
7/30/2007 18:00	8551	12.21092	0.4
7/30/2007 18:30	8552	12.20992	0.6
7/30/2007 19:00	8553	12.20961	0
7/30/2007 19:30	8554	12.20922	0
7/30/2007 20:00	8555	12.20888	0
7/30/2007 20:30	8556	12.20897	0.2
7/30/2007 21:00	8557	12.20844	0
7/30/2007 21:30	8558	12.2078	0
7/30/2007 22:00	8559	12.20781	0
7/30/2007 22:30	8560	12.20706	0
7/30/2007 23:00	8561	12.2067	0
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7/31/2007 1:00	8565	12.20571	0
7/31/2007 1:30	8566	12.20498	0
7/31/2007 2:00	8567	12.20511	0
7/31/2007 2:30	8568	12.20407	0
7/31/2007 3:00	8569	12.20407	0
7/31/2007 3:30	8570	12.20332	0
7/31/2007 4:00	8571	12.20368	0
7/31/2007 4:30	8572	12.20352	0
7/31/2007 5:00	8573	12.20306	0
7/31/2007 5:30	8574	12.20362	0
7/31/2007 6:00	8575	12.20335	0

7/31/2007 6:30	8576	12.20335	0
7/31/2007 7:00	8577	12.20326	0
7/31/2007 7:30	8578	12.20232	0
7/31/2007 8:00	8579	12.20229	0
7/31/2007 8:30	8580	12.20222	0
7/31/2007 9:00	8581	12.20341	0
7/31/2007 9:30	8582	12.20334	0
7/31/2007 10:00	8583	12.20379	0
7/31/2007 10:30	8584	12.20472	0
7/31/2007 11:00	8585	12.20584	0
7/31/2007 11:30	8586	12.20679	0
7/31/2007 12:00	8587	12.20745	0
7/31/2007 12:30	8588	12.2082	0
7/31/2007 13:00	8589	12.20882	0
7/31/2007 13:30	8590	12.2093	0.2
7/31/2007 14:00	8591	12.21059	0
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7/31/2007 15:00	8593	12.21151	0
7/31/2007 15:30	8594	12.21261	0
7/31/2007 16:00	8595	12.21285	0
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7/31/2007 17:00	8597	12.21272	0
7/31/2007 17:30	8598	12.21331	0
7/31/2007 18:00	8599	12.21275	0.6
7/31/2007 18:30	8600	12.21304	0.6
7/31/2007 19:00	8601	12.21223	0
7/31/2007 19:30	8602	12.21094	0
7/31/2007 20:00	8603	12.21091	0
7/31/2007 20:30	8604	12.21027	1.8
7/31/2007 21:00	8605	12.21048	0
7/31/2007 21:30	8606	12.20979	0
7/31/2007 22:00	8607	12.20925	0
7/31/2007 22:30	8608	12.20903	0
7/31/2007 23:00	8609	12.20816	0
7/31/2007 23:30	8610	12.20818	0
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8/1/2007 5:30	8622	12.20216	0
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8/1/2007 7:00	8625	12.20055	0
8/1/2007 7:30	8626	12.20039	0
8/1/2007 8:00	8627	12.19994	0

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8/1/2007 10:30	8632	12.19909	0
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8/1/2007 12:30	8636	12.20286	0
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8/1/2007 14:00	8639	12.20669	0
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8/1/2007 15:00	8641	12.2084	0.4
8/1/2007 15:30	8642	12.20926	0
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8/1/2007 16:30	8644	12.20885	0
8/1/2007 17:00	8645	12.20911	0
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8/1/2007 18:00	8647	12.20868	0
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8/1/2007 19:00	8649	12.20778	0.2
8/1/2007 19:30	8650	12.20799	0
8/1/2007 20:00	8651	12.20698	0.4
8/1/2007 20:30	8652	12.20603	0
8/1/2007 21:00	8653	12.20539	0.4
8/1/2007 21:30	8654	12.20447	0
8/1/2007 22:00	8655	12.20362	0
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8/1/2007 23:00	8657	12.20284	0
8/1/2007 23:30	8658	12.20234	0
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8/2/2007 6:30	8672	12.19668	0
8/2/2007 7:00	8673	12.19707	0.4
8/2/2007 7:30	8674	12.19713	0
8/2/2007 8:00	8675	12.19641	0
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8/2/2007 9:00	8677	12.19721	0
8/2/2007 9:30	8678	12.19611	0
8/2/2007 10:00	8679	12.19704	0

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8/2/2007 11:00	8681	12.19791	0
8/2/2007 11:30	8682	12.19892	0
8/2/2007 12:00	8683	12.19923	0
8/2/2007 12:30	8684	12.20005	0
8/2/2007 13:00	8685	12.20099	0
8/2/2007 13:30	8686	12.20169	0
8/2/2007 14:00	8687	12.2024	0
8/2/2007 14:30	8688	12.20328	0
8/2/2007 15:00	8689	12.2039	0
8/2/2007 15:30	8690	12.20354	0
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8/2/2007 18:00	8695	12.20459	0
8/2/2007 18:30	8696	12.20526	0
8/2/2007 19:00	8697	12.20491	0
8/2/2007 19:30	8698	12.20356	0
8/2/2007 20:00	8699	12.20435	0
8/2/2007 20:30	8700	12.20409	0
8/2/2007 21:00	8701	12.20362	1.2
8/2/2007 21:30	8702	12.20321	1
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8/2/2007 22:30	8704	12.2035	1.6
8/2/2007 23:00	8705	12.20296	0.2
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8/3/2007 2:30	8712	12.20259	0
8/3/2007 3:00	8713	12.20242	0
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8/3/2007 6:30	8720	12.20151	0
8/3/2007 7:00	8721	12.20002	0
8/3/2007 7:30	8722	12.20127	0
8/3/2007 8:00	8723	12.20151	0.2
8/3/2007 8:30	8724	12.20143	0
8/3/2007 9:00	8725	12.20068	0
8/3/2007 9:30	8726	12.20133	0
8/3/2007 10:00	8727	12.20173	0
8/3/2007 10:30	8728	12.20157	0.2
8/3/2007 11:00	8729	12.20226	0
8/3/2007 11:30	8730	12.20245	0
8/3/2007 12:00	8731	12.20287	0

8/3/2007 12:30	8732	12.20244	0
8/3/2007 13:00	8733	12.20357	0
8/3/2007 13:30	8734	12.20443	0
8/3/2007 14:00	8735	12.20498	0
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8/3/2007 23:00	8753	12.20148	0
8/3/2007 23:30	8754	12.20002	0
8/4/2007 0:00	8755	12.19946	0
8/4/2007 0:30	8756	12.19857	0
8/4/2007 1:00	8757	12.19842	0
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8/4/2007 5:00	8765	12.19581	0
8/4/2007 5:30	8766	12.1957	0
8/4/2007 6:00	8767	12.19548	0.4
8/4/2007 6:30	8768	12.19577	0.4
8/4/2007 7:00	8769	12.19541	0.8
8/4/2007 7:30	8770	12.19614	1.4
8/4/2007 8:00	8771	12.19594	3.600001
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8/4/2007 9:00	8773	12.1965	0.4
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8/4/2007 11:30	8778	12.19935	0
8/4/2007 12:00	8779	12.1997	0
8/4/2007 12:30	8780	12.20052	0
8/4/2007 13:00	8781	12.20153	0
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8/4/2007 14:30	8784	12.20333	0
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8/4/2007 16:30	8788	12.20536	0
8/4/2007 17:00	8789	12.20519	0
8/4/2007 17:30	8790	12.20602	0.2
8/4/2007 18:00	8791	12.2058	0.6
8/4/2007 18:30	8792	12.20556	1.2
8/4/2007 19:00	8793	12.20574	0
8/4/2007 19:30	8794	12.20522	0
8/4/2007 20:00	8795	12.20511	0
8/4/2007 20:30	8796	12.20506	0
8/4/2007 21:00	8797	12.20425	0.4
8/4/2007 21:30	8798	12.20417	0
8/4/2007 22:00	8799	12.20368	0
8/4/2007 22:30	8800	12.20396	0
8/4/2007 23:00	8801	12.20305	0
8/4/2007 23:30	8802	12.2027	0
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8/5/2007 0:30	8804	12.20221	0
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8/5/2007 2:30	8808	12.19966	0
8/5/2007 3:00	8809	12.19865	0
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8/5/2007 4:30	8812	12.19713	0
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8/5/2007 5:30	8814	12.19651	0
8/5/2007 6:00	8815	12.19609	0
8/5/2007 6:30	8816	12.19576	0
8/5/2007 7:00	8817	12.19482	0
8/5/2007 7:30	8818	12.19578	0
8/5/2007 8:00	8819	12.19492	0
8/5/2007 8:30	8820	12.19405	0
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8/5/2007 9:30	8822	12.19414	0
8/5/2007 10:00	8823	12.19453	0
8/5/2007 10:30	8824	12.19504	0
8/5/2007 11:00	8825	12.19585	0.4
8/5/2007 11:30	8826	12.19641	0
8/5/2007 12:00	8827	12.19683	0
8/5/2007 12:30	8828	12.19663	0
8/5/2007 13:00	8829	12.19791	0
8/5/2007 13:30	8830	12.19814	0
8/5/2007 14:00	8831	12.19857	0
8/5/2007 14:30	8832	12.19971	0
8/5/2007 15:00	8833	12.20017	0
8/5/2007 15:30	8834	12.20127	0
8/5/2007 16:00	8835	12.20148	0

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8/5/2007 18:30	8840	12.20178	0
8/5/2007 19:00	8841	12.20086	0
8/5/2007 19:30	8842	12.20045	0
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8/5/2007 20:30	8844	12.19932	0
8/5/2007 21:00	8845	12.19837	0
8/5/2007 21:30	8846	12.19753	0
8/5/2007 22:00	8847	12.1966	0
8/5/2007 22:30	8848	12.19608	0
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8/6/2007 1:00	8853	12.1927	0
8/6/2007 1:30	8854	12.19243	0
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8/6/2007 2:30	8856	12.19126	0
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8/6/2007 16:00	8883	12.19751	0
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8/6/2007 17:00	8885	12.19871	0
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8/6/2007 19:00	8889	12.19719	0
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8/6/2007 21:30	8894	12.1948	0
8/6/2007 22:00	8895	12.19415	0
8/6/2007 22:30	8896	12.19239	0.2
8/6/2007 23:00	8897	12.1926	0.8
8/6/2007 23:30	8898	12.19245	0
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8/7/2007 1:00	8901	12.19093	0
8/7/2007 1:30	8902	12.19088	0
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8/7/2007 2:30	8904	12.1894	0
8/7/2007 3:00	8905	12.18907	0.4
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8/7/2007 4:30	8908	12.18965	0
8/7/2007 5:00	8909	12.18872	0
8/7/2007 5:30	8910	12.18753	0
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8/7/2007 8:00	8915	12.18681	0
8/7/2007 8:30	8916	12.1864	0
8/7/2007 9:00	8917	12.18677	0
8/7/2007 9:30	8918	12.18664	2.6
8/7/2007 10:00	8919	12.18695	1.4
8/7/2007 10:30	8920	12.18728	0
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8/7/2007 14:00	8927	12.19036	0
8/7/2007 14:30	8928	12.19009	2.6
8/7/2007 15:00	8929	12.19073	0.2
8/7/2007 15:30	8930	12.19123	0
8/7/2007 16:00	8931	12.19077	0
8/7/2007 16:30	8932	12.19055	0.2
8/7/2007 17:00	8933	12.19032	0
8/7/2007 17:30	8934	12.19044	0
8/7/2007 18:00	8935	12.191	0
8/7/2007 18:30	8936	12.19085	0
8/7/2007 19:00	8937	12.19004	0.8
8/7/2007 19:30	8938	12.18958	0.2
8/7/2007 20:00	8939	12.18966	0

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8/7/2007 21:00	8941	12.18791	0.4
8/7/2007 21:30	8942	12.18763	0.2
8/7/2007 22:00	8943	12.18707	0
8/7/2007 22:30	8944	12.18738	0
8/7/2007 23:00	8945	12.18643	0
8/7/2007 23:30	8946	12.18673	0
8/8/2007 0:00	8947	12.18613	0.2
8/8/2007 0:30	8948	12.18587	0.2
8/8/2007 1:00	8949	12.18519	0.2
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8/8/2007 2:00	8951	12.1849	0
8/8/2007 2:30	8952	12.18479	0
8/8/2007 3:00	8953	12.18428	0
8/8/2007 3:30	8954	12.18302	0
8/8/2007 4:00	8955	12.18262	0
8/8/2007 4:30	8956	12.18252	0
8/8/2007 5:00	8957	12.18209	0
8/8/2007 5:30	8958	12.18158	0
8/8/2007 6:00	8959	12.18162	0
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8/8/2007 7:00	8961	12.18037	0
8/8/2007 7:30	8962	12.17978	0
8/8/2007 8:00	8963	12.17872	0
8/8/2007 8:30	8964	12.17923	0
8/8/2007 9:00	8965	12.17948	0
8/8/2007 9:30	8966	12.17973	0
8/8/2007 10:00	8967	12.18119	0
8/8/2007 10:30	8968	12.18185	0
8/8/2007 11:00	8969	12.18267	0
8/8/2007 11:30	8970	12.18344	0
8/8/2007 12:00	8971	12.18439	0
8/8/2007 12:30	8972	12.18576	0
8/8/2007 13:00	8973	12.18688	0
8/8/2007 13:30	8974	12.18898	0
8/8/2007 14:00	8975	12.18937	0
8/8/2007 14:30	8976	12.19209	0
8/8/2007 15:00	8977	12.19322	0
8/8/2007 15:30	8978	12.19318	0
8/8/2007 16:00	8979	12.19438	0
8/8/2007 16:30	8980	12.1951	0
8/8/2007 17:00	8981	12.19535	0
8/8/2007 17:30	8982	12.195	0
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8/8/2007 20:30	8988	12.19209	0
8/8/2007 21:00	8989	12.19149	0
8/8/2007 21:30	8990	12.19122	0
8/8/2007 22:00	8991	12.19053	0

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8/8/2007 23:30	8994	12.18937	0
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8/9/2007 0:30	8996	12.1886	0
8/9/2007 1:00	8997	12.1875	0
8/9/2007 1:30	8998	12.18649	0
8/9/2007 2:00	8999	12.18655	0
8/9/2007 2:30	9000	12.18648	0
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8/9/2007 3:30	9002	12.18634	0
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8/9/2007 5:30	9006	12.18602	0
8/9/2007 6:00	9007	12.18526	0
8/9/2007 6:30	9008	12.1859	0
8/9/2007 7:00	9009	12.1855	0
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8/9/2007 9:30	9014	12.18543	0
8/9/2007 10:00	9015	12.18656	0
8/9/2007 10:30	9016	12.18695	0
8/9/2007 11:00	9017	12.18744	0
8/9/2007 11:30	9018	12.18848	0
8/9/2007 12:00	9019	12.18886	0
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8/9/2007 18:00	9031	12.198	0
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8/9/2007 20:00	9035	12.19641	0
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8/9/2007 22:00	9039	12.19309	0
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8/9/2007 23:00	9041	12.19239	0
8/9/2007 23:30	9042	12.19327	0
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8/10/2007 2:00	9047	12.19244	0.2
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8/10/2007 6:00	9055	12.19263	0
8/10/2007 6:30	9056	12.192	0
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8/10/2007 10:00	9063	12.19185	0
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8/11/2007 0:30	9092	12.19549	0
8/11/2007 1:00	9093	12.1949	0
8/11/2007 1:30	9094	12.19422	0
8/11/2007 2:00	9095	12.19446	0

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8/11/2007 8:00	9107	12.1882	0
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8/11/2007 11:00	9113	12.19031	0
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8/11/2007 12:30	9116	12.19287	0
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8/11/2007 15:30	9122	12.19841	0
8/11/2007 16:00	9123	12.1983	0
8/11/2007 16:30	9124	12.19936	0
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8/11/2007 18:00	9127	12.19911	0
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8/11/2007 22:00	9135	12.19696	0
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8/11/2007 23:00	9137	12.19611	0
8/11/2007 23:30	9138	12.19615	0
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8/12/2007 8:00	9155	12.19443	0
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8/12/2007 10:00	9159	12.19368	0
8/12/2007 10:30	9160	12.19384	2.2
8/12/2007 11:00	9161	12.19407	2.4
8/12/2007 11:30	9162	12.19361	0.2
8/12/2007 12:00	9163	12.19343	0
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8/12/2007 13:00	9165	12.19302	0
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8/12/2007 17:00	9173	12.19378	0
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8/12/2007 18:00	9175	12.19366	0
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8/12/2007 20:30	9180	12.19031	0
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8/13/2007 1:30	9190	12.18375	0
8/13/2007 2:00	9191	12.18274	0
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8/13/2007 7:30	9202	12.17895	0
8/13/2007 8:00	9203	12.17898	0
8/13/2007 8:30	9204	12.17807	0
8/13/2007 9:00	9205	12.17818	0
8/13/2007 9:30	9206	12.17839	0
8/13/2007 10:00	9207	12.17854	0
8/13/2007 10:30	9208	12.17935	0
8/13/2007 11:00	9209	12.18036	0
8/13/2007 11:30	9210	12.18083	0
8/13/2007 12:00	9211	12.18045	0
8/13/2007 12:30	9212	12.182	0
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8/13/2007 13:30	9214	12.18439	0
8/13/2007 14:00	9215	12.18578	0
8/13/2007 14:30	9216	12.18696	0
8/13/2007 15:00	9217	12.18772	0
8/13/2007 15:30	9218	12.18873	0
8/13/2007 16:00	9219	12.18897	0
8/13/2007 16:30	9220	12.18969	0
8/13/2007 17:00	9221	12.1903	0
8/13/2007 17:30	9222	12.19021	0
8/13/2007 18:00	9223	12.19068	0
8/13/2007 18:30	9224	12.18974	0
8/13/2007 19:00	9225	12.18935	0
8/13/2007 19:30	9226	12.18841	0
8/13/2007 20:00	9227	12.18705	0
8/13/2007 20:30	9228	12.18602	0
8/13/2007 21:00	9229	12.18579	0
8/13/2007 21:30	9230	12.18427	0
8/13/2007 22:00	9231	12.18316	0
8/13/2007 22:30	9232	12.18176	0
8/13/2007 23:00	9233	12.18216	0
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8/14/2007 1:00	9237	12.17901	0
8/14/2007 1:30	9238	12.17726	0
8/14/2007 2:00	9239	12.17713	0
8/14/2007 2:30	9240	12.17623	0
8/14/2007 3:00	9241	12.17579	0.2
8/14/2007 3:30	9242	12.17632	0
8/14/2007 4:00	9243	12.17528	0
8/14/2007 4:30	9244	12.17495	0
8/14/2007 5:00	9245	12.17408	0
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8/14/2007 7:00	9249	12.17281	0
8/14/2007 7:30	9250	12.17196	0
8/14/2007 8:00	9251	12.17074	0

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8/14/2007 11:00	9257	12.17406	0
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8/14/2007 16:00	9267	12.18573	0
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8/14/2007 17:00	9269	12.18674	0
8/14/2007 17:30	9270	12.18734	0
8/14/2007 18:00	9271	12.18645	0
8/14/2007 18:30	9272	12.18542	0
8/14/2007 19:00	9273	12.18588	0
8/14/2007 19:30	9274	12.18447	0
8/14/2007 20:00	9275	12.18355	0
8/14/2007 20:30	9276	12.18402	0
8/14/2007 21:00	9277	12.18312	0
8/14/2007 21:30	9278	12.18202	0
8/14/2007 22:00	9279	12.18201	0
8/14/2007 22:30	9280	12.18093	0
8/14/2007 23:00	9281	12.18057	0
8/14/2007 23:30	9282	12.18099	0
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8/15/2007 1:30	9286	12.17853	0
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8/15/2007 3:00	9289	12.17868	0
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8/15/2007 4:00	9291	12.17746	0
8/15/2007 4:30	9292	12.17719	0
8/15/2007 5:00	9293	12.17636	0
8/15/2007 5:30	9294	12.17731	0
8/15/2007 6:00	9295	12.17701	0
8/15/2007 6:30	9296	12.17617	0
8/15/2007 7:00	9297	12.17623	0
8/15/2007 7:30	9298	12.17613	0
8/15/2007 8:00	9299	12.17548	0
8/15/2007 8:30	9300	12.17579	0
8/15/2007 9:00	9301	12.17583	0
8/15/2007 9:30	9302	12.17629	0
8/15/2007 10:00	9303	12.17574	0

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8/15/2007 11:00	9305	12.17722	0
8/15/2007 11:30	9306	12.17744	0
8/15/2007 12:00	9307	12.17857	0
8/15/2007 12:30	9308	12.17972	0
8/15/2007 13:00	9309	12.18068	0
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8/15/2007 14:00	9311	12.18269	0
8/15/2007 14:30	9312	12.18272	0
8/15/2007 15:00	9313	12.18381	0
8/15/2007 15:30	9314	12.18306	0
8/15/2007 16:00	9315	12.18404	0
8/15/2007 16:30	9316	12.18402	0
8/15/2007 17:00	9317	12.18461	0
8/15/2007 17:30	9318	12.18408	0
8/15/2007 18:00	9319	12.18446	0
8/15/2007 18:30	9320	12.18303	0
8/15/2007 19:00	9321	12.18291	0
8/15/2007 19:30	9322	12.18217	0
8/15/2007 20:00	9323	12.18209	0
8/15/2007 20:30	9324	12.18244	0
8/15/2007 21:00	9325	12.18222	0
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8/15/2007 23:00	9329	12.18098	0
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8/16/2007 1:00	9333	12.1799	0
8/16/2007 1:30	9334	12.17983	0
8/16/2007 2:00	9335	12.17943	0
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8/16/2007 4:00	9339	12.17967	0
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8/16/2007 5:30	9342	12.1782	0
8/16/2007 6:00	9343	12.17903	0
8/16/2007 6:30	9344	12.17924	0
8/16/2007 7:00	9345	12.17951	0
8/16/2007 7:30	9346	12.17966	0
8/16/2007 8:00	9347	12.17981	0
8/16/2007 8:30	9348	12.17985	0
8/16/2007 9:00	9349	12.17938	0
8/16/2007 9:30	9350	12.17934	0
8/16/2007 10:00	9351	12.17988	0
8/16/2007 10:30	9352	12.17949	0
8/16/2007 11:00	9353	12.1801	0
8/16/2007 11:30	9354	12.18078	0
8/16/2007 12:00	9355	12.18029	0

8/16/2007 12:30	9356	12.18159	0
8/16/2007 13:00	9357	12.18168	0
8/16/2007 13:30	9358	12.18209	0
8/16/2007 14:00	9359	12.18206	0.4
8/16/2007 14:30	9360	12.18215	0.4
8/16/2007 15:00	9361	12.18236	0.4
8/16/2007 15:30	9362	12.18226	0.6
8/16/2007 16:00	9363	12.18203	0.6
8/16/2007 16:30	9364	12.18215	0.4
8/16/2007 17:00	9365	12.18179	0.2
8/16/2007 17:30	9366	12.18185	0.2
8/16/2007 18:00	9367	12.18145	0
8/16/2007 18:30	9368	12.18141	0.2
8/16/2007 19:00	9369	12.18103	0
8/16/2007 19:30	9370	12.18181	0
8/16/2007 20:00	9371	12.18196	0.2
8/16/2007 20:30	9372	12.18169	0.8
8/16/2007 21:00	9373	12.18169	0.6
8/16/2007 21:30	9374	12.18225	0.4
8/16/2007 22:00	9375	12.18144	0.4
8/16/2007 22:30	9376	12.1818	0.2
8/16/2007 23:00	9377	12.18136	0.6
8/16/2007 23:30	9378	12.18163	1.2
8/17/2007 0:00	9379	12.18166	0.4
8/17/2007 0:30	9380	12.18153	0.4
8/17/2007 1:00	9381	12.18204	1
8/17/2007 1:30	9382	12.18165	10.8
8/17/2007 2:00	9383	12.18165	1.2
8/17/2007 2:30	9384	12.18172	0.2
8/17/2007 3:00	9385	12.18105	0
8/17/2007 3:30	9386	12.18166	0
8/17/2007 4:00	9387	12.18129	0
8/17/2007 4:30	9388	12.18064	0
8/17/2007 5:00	9389	12.18045	0
8/17/2007 5:30	9390	12.1793	0
8/17/2007 6:00	9391	12.17884	0
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8/17/2007 7:30	9394	12.1762	0
8/17/2007 8:00	9395	12.1748	0
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8/17/2007 9:00	9397	12.17425	0
8/17/2007 9:30	9398	12.1748	0
8/17/2007 10:00	9399	12.17542	0.2
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8/17/2007 11:00	9401	12.17611	0
8/17/2007 11:30	9402	12.17643	0
8/17/2007 12:00	9403	12.17746	0
8/17/2007 12:30	9404	12.17897	0.2
8/17/2007 13:00	9405	12.17984	0
8/17/2007 13:30	9406	12.18062	0
8/17/2007 14:00	9407	12.1815	0

8/17/2007 14:30	9408	12.1817	0
8/17/2007 15:00	9409	12.1823	0
8/17/2007 15:30	9410	12.18271	0
8/17/2007 16:00	9411	12.18322	0
8/17/2007 16:30	9412	12.18328	0
8/17/2007 17:00	9413	12.18432	0
8/17/2007 17:30	9414	12.18463	0
8/17/2007 18:00	9415	12.18492	0
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8/17/2007 22:00	9423	12.18172	0
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8/17/2007 23:00	9425	12.18139	0
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8/18/2007 4:30	9436	12.17981	0
8/18/2007 5:00	9437	12.1795	0
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8/18/2007 6:00	9439	12.18008	0.4
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8/18/2007 10:00	9447	12.17998	0.2
8/18/2007 10:30	9448	12.17989	0
8/18/2007 11:00	9449	12.18096	0.2
8/18/2007 11:30	9450	12.18055	0
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8/18/2007 12:30	9452	12.18195	0
8/18/2007 13:00	9453	12.1822	1.2
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8/18/2007 14:00	9455	12.18208	0
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8/18/2007 18:00	9463	12.18254	0
8/18/2007 18:30	9464	12.18234	0.2
8/18/2007 19:00	9465	12.18251	0
8/18/2007 19:30	9466	12.182	0
8/18/2007 20:00	9467	12.18195	0.8
8/18/2007 20:30	9468	12.18258	0.2
8/18/2007 21:00	9469	12.18244	0.2
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8/18/2007 23:00	9473	12.18204	0
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8/19/2007 1:00	9477	12.18104	0
8/19/2007 1:30	9478	12.18074	0.4
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8/19/2007 7:00	9489	12.17865	0
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8/19/2007 20:30	9516	12.18176	0
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8/20/2007 8:00	9539	12.16911	0
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8/20/2007 9:00	9541	12.16856	0.4
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8/20/2007 10:00	9543	12.16837	0
8/20/2007 10:30	9544	12.1694	0
8/20/2007 11:00	9545	12.16942	0.2
8/20/2007 11:30	9546	12.16941	0.2
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8/20/2007 12:30	9548	12.1711	0
8/20/2007 13:00	9549	12.17195	0
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8/20/2007 20:00	9563	12.17675	0

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8/21/2007 12:00	9595	12.16562	0
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8/21/2007 14:30	9600	12.17138	0
8/21/2007 15:00	9601	12.17371	0
8/21/2007 15:30	9602	12.17437	0
8/21/2007 16:00	9603	12.175	0
8/21/2007 16:30	9604	12.17507	0
8/21/2007 17:00	9605	12.17547	0
8/21/2007 17:30	9606	12.17522	0
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8/21/2007 18:30	9608	12.17499	0
8/21/2007 19:00	9609	12.1738	0
8/21/2007 19:30	9610	12.17434	0
8/21/2007 20:00	9611	12.17271	0
8/21/2007 20:30	9612	12.1731	0
8/21/2007 21:00	9613	12.17209	0
8/21/2007 21:30	9614	12.17145	0
8/21/2007 22:00	9615	12.17039	0

8/21/2007 22:30	9616	12.17081	0
8/21/2007 23:00	9617	12.16921	0
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8/28/2007 23:00	9953	12.16268	0
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9/4/2007 22:00	10287	12.15912	0
9/4/2007 22:30	10288	12.15859	0
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9/7/2007 13:30	10414	12.14356	0
9/7/2007 14:00	10415	12.14519	0
9/7/2007 14:30	10416	12.1461	0
9/7/2007 15:00	10417	12.14813	0
9/7/2007 15:30	10418	12.1488	0
9/7/2007 16:00	10419	12.15005	0
9/7/2007 16:30	10420	12.15094	0
9/7/2007 17:00	10421	12.15132	0
9/7/2007 17:30	10422	12.1519	0
9/7/2007 18:00	10423	12.15177	0
9/7/2007 18:30	10424	12.15084	0
9/7/2007 19:00	10425	12.15029	0
9/7/2007 19:30	10426	12.15001	0
9/7/2007 20:00	10427	12.14892	0
9/7/2007 20:30	10428	12.14866	0
9/7/2007 21:00	10429	12.14772	0
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9/7/2007 22:30	10432	12.14562	0
9/7/2007 23:00	10433	12.14429	0
9/7/2007 23:30	10434	12.14437	0
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9/8/2007 1:00	10437	12.14338	0
9/8/2007 1:30	10438	12.14235	0
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9/8/2007 3:00	10441	12.14165	0
9/8/2007 3:30	10442	12.14108	0
9/8/2007 4:00	10443	12.14093	0
9/8/2007 4:30	10444	12.13985	0
9/8/2007 5:00	10445	12.13965	0
9/8/2007 5:30	10446	12.13997	0
9/8/2007 6:00	10447	12.13971	0

9/8/2007 6:30	10448	12.13915	0
9/8/2007 7:00	10449	12.13888	0
9/8/2007 7:30	10450	12.13893	0
9/8/2007 8:00	10451	12.13849	0
9/8/2007 8:30	10452	12.13865	0
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9/8/2007 10:00	10455	12.14005	0
9/8/2007 10:30	10456	12.14067	0
9/8/2007 11:00	10457	12.14198	0
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9/8/2007 12:30	10460	12.14497	0
9/8/2007 13:00	10461	12.14698	0
9/8/2007 13:30	10462	12.14844	0
9/8/2007 14:00	10463	12.1486	0
9/8/2007 14:30	10464	12.14991	0
9/8/2007 15:00	10465	12.15051	0
9/8/2007 15:30	10466	12.15174	0
9/8/2007 16:00	10467	12.15168	0
9/8/2007 16:30	10468	12.15281	0
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9/9/2007 3:00	10489	12.14271	0
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9/9/2007 6:30	10496	12.14115	0
9/9/2007 7:00	10497	12.14077	0
9/9/2007 7:30	10498	12.1407	0
9/9/2007 8:00	10499	12.14033	0

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9/9/2007 9:00	10501	12.14071	0
9/9/2007 9:30	10502	12.14004	0
9/9/2007 10:00	10503	12.14051	0
9/9/2007 10:30	10504	12.14027	0
9/9/2007 11:00	10505	12.14113	0
9/9/2007 11:30	10506	12.14155	0.4
9/9/2007 12:00	10507	12.14103	0.8
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9/9/2007 13:00	10509	12.14086	0.6
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9/9/2007 14:00	10511	12.14094	0.8
9/9/2007 14:30	10512	12.14129	0.6
9/9/2007 15:00	10513	12.14101	0.4
9/9/2007 15:30	10514	12.14199	0
9/9/2007 16:00	10515	12.14258	0
9/9/2007 16:30	10516	12.1427	0
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9/10/2007 0:30	10532	12.14023	1.6
9/10/2007 1:00	10533	12.14093	1.6
9/10/2007 1:30	10534	12.14032	0.4
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9/10/2007 19:30	10570	12.14868	0
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9/11/2007 10:30	10600	12.1373	0
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9/11/2007 13:30	10606	12.14237	0
9/11/2007 14:00	10607	12.14314	0.4
9/11/2007 14:30	10608	12.14455	0
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9/12/2007 11:00	10649	12.12848	0
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9/12/2007 12:00	10651	12.13313	0
9/12/2007 12:30	10652	12.13462	0
9/12/2007 13:00	10653	12.13623	0
9/12/2007 13:30	10654	12.13809	0
9/12/2007 14:00	10655	12.13993	0

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9/12/2007 15:30	10658	12.14322	0
9/12/2007 16:00	10659	12.14316	0
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9/15/2007 23:00	10817	12.14361	0
9/15/2007 23:30	10818	12.14321	0
9/16/2007 0:00	10819	12.14298	0
9/16/2007 0:30	10820	12.14239	0
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9/16/2007 1:30	10822	12.14093	0
9/16/2007 2:00	10823	12.14109	0
9/16/2007 2:30	10824	12.14099	0.8
9/16/2007 3:00	10825	12.14147	0
9/16/2007 3:30	10826	12.14021	0
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9/16/2007 4:30	10828	12.14053	0.6
9/16/2007 5:00	10829	12.14006	0
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9/16/2007 6:00	10831	12.14006	0
9/16/2007 6:30	10832	12.13958	0
9/16/2007 7:00	10833	12.13926	0.8
9/16/2007 7:30	10834	12.13925	1.4
9/16/2007 8:00	10835	12.13967	0.2
9/16/2007 8:30	10836	12.14007	0
9/16/2007 9:00	10837	12.14001	0
9/16/2007 9:30	10838	12.13969	0
9/16/2007 10:00	10839	12.13996	0
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9/16/2007 11:00	10841	12.14062	0
9/16/2007 11:30	10842	12.14092	0
9/16/2007 12:00	10843	12.14151	0
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9/16/2007 13:00	10845	12.14245	4
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9/16/2007 14:00	10847	12.14275	0
9/16/2007 14:30	10848	12.14348	0
9/16/2007 15:00	10849	12.14387	0
9/16/2007 15:30	10850	12.14394	0
9/16/2007 16:00	10851	12.14372	0
9/16/2007 16:30	10852	12.14413	0
9/16/2007 17:00	10853	12.14364	0
9/16/2007 17:30	10854	12.14345	0
9/16/2007 18:00	10855	12.14371	0
9/16/2007 18:30	10856	12.1438	0
9/16/2007 19:00	10857	12.14353	0
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9/16/2007 20:30	10860	12.14221	0
9/16/2007 21:00	10861	12.14103	0
9/16/2007 21:30	10862	12.14063	0
9/16/2007 22:00	10863	12.13897	0

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9/16/2007 23:00	10865	12.13808	0
9/16/2007 23:30	10866	12.13607	0
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9/17/2007 1:00	10869	12.13444	0
9/17/2007 1:30	10870	12.13441	0
9/17/2007 2:00	10871	12.13274	0
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9/17/2007 13:00	10893	12.1359	0
9/17/2007 13:30	10894	12.13781	0
9/17/2007 14:00	10895	12.13876	0
9/17/2007 14:30	10896	12.13855	0
9/17/2007 15:00	10897	12.13942	0
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9/17/2007 17:00	10901	12.14131	0
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9/17/2007 19:00	10905	12.14203	0
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9/18/2007 7:00	10929	12.13029	0
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9/18/2007 10:00	10935	12.13198	0
9/18/2007 10:30	10936	12.13256	0
9/18/2007 11:00	10937	12.13327	0
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9/18/2007 12:00	10939	12.13478	0
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9/18/2007 14:00	10943	12.13811	0
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9/18/2007 15:00	10945	12.13853	0
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9/18/2007 20:00	10955	12.13938	0
9/18/2007 20:30	10956	12.13858	0
9/18/2007 21:00	10957	12.13692	0
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9/19/2007 1:00	10965	12.12853	0
9/19/2007 1:30	10966	12.12826	0
9/19/2007 2:00	10967	12.12793	0

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9/19/2007 4:30	10972	12.12701	0
9/19/2007 5:00	10973	12.12689	0
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9/19/2007 6:30	10976	12.12671	0
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9/19/2007 9:00	10981	12.12863	0
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9/20/2007 1:00	11013	12.13391	0
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9/20/2007 13:00	11037	12.13385	0.2
9/20/2007 13:30	11038	12.13339	0.2
9/20/2007 14:00	11039	12.13392	0
9/20/2007 14:30	11040	12.13371	0
9/20/2007 15:00	11041	12.13419	0
9/20/2007 15:30	11042	12.13375	0
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9/20/2007 20:00	11051	12.13303	0
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9/22/2007 19:00	11145	12.13761	0
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9/22/2007 20:00	11147	12.13599	0
9/22/2007 20:30	11148	12.13424	0
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9/23/2007 10:00	11175	12.12736	0

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9/23/2007 11:00	11177	12.12843	0
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9/23/2007 14:00	11183	12.13154	0
9/23/2007 14:30	11184	12.13207	0
9/23/2007 15:00	11185	12.13341	0
9/23/2007 15:30	11186	12.13307	0.2
9/23/2007 16:00	11187	12.13273	1
9/23/2007 16:30	11188	12.13362	0.8
9/23/2007 17:00	11189	12.13263	2.6
9/23/2007 17:30	11190	12.13187	1.6
9/23/2007 18:00	11191	12.13164	0
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9/23/2007 19:00	11193	12.1306	9.399996
9/23/2007 19:30	11194	12.13043	0
9/23/2007 20:00	11195	12.12982	0
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9/24/2007 10:30	11224	12.12125	0
9/24/2007 11:00	11225	12.12161	0
9/24/2007 11:30	11226	12.12218	0
9/24/2007 12:00	11227	12.12247	0

9/24/2007 12:30	11228	12.12306	0
9/24/2007 13:00	11229	12.12333	0
9/24/2007 13:30	11230	12.12469	0
9/24/2007 14:00	11231	12.12538	0
9/24/2007 14:30	11232	12.12573	0
9/24/2007 15:00	11233	12.12704	0
9/24/2007 15:30	11234	12.12707	0
9/24/2007 16:00	11235	12.12719	0
9/24/2007 16:30	11236	12.12727	1.6
9/24/2007 17:00	11237	12.12795	1.6
9/24/2007 17:30	11238	12.12775	0
9/24/2007 18:00	11239	12.12766	0
9/24/2007 18:30	11240	12.128	0
9/24/2007 19:00	11241	12.1268	0
9/24/2007 19:30	11242	12.12598	0
9/24/2007 20:00	11243	12.12523	0
9/24/2007 20:30	11244	12.12447	0
9/24/2007 21:00	11245	12.12385	0
9/24/2007 21:30	11246	12.12286	2.6
9/24/2007 22:00	11247	12.12227	0.4
9/24/2007 22:30	11248	12.12145	0.2
9/24/2007 23:00	11249	12.12103	0
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9/25/2007 0:00	11251	12.11892	0
9/25/2007 0:30	11252	12.11812	0
9/25/2007 1:00	11253	12.11766	0
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9/25/2007 2:30	11256	12.11661	0
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9/25/2007 4:00	11259	12.1159	0
9/25/2007 4:30	11260	12.11559	0
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9/25/2007 5:30	11262	12.11509	0
9/25/2007 6:00	11263	12.11383	0
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9/25/2007 7:30	11266	12.11394	0
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9/25/2007 9:30	11270	12.11355	0
9/25/2007 10:00	11271	12.11374	0
9/25/2007 10:30	11272	12.11458	0
9/25/2007 11:00	11273	12.11491	0
9/25/2007 11:30	11274	12.11543	0
9/25/2007 12:00	11275	12.11627	0
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9/25/2007 13:00	11277	12.11771	0
9/25/2007 13:30	11278	12.1179	0
9/25/2007 14:00	11279	12.11805	0

9/25/2007 14:30	11280	12.11966	0
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9/25/2007 16:00	11283	12.12201	0
9/25/2007 16:30	11284	12.12257	0
9/25/2007 17:00	11285	12.12348	0
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9/25/2007 20:30	11292	12.1243	0
9/25/2007 21:00	11293	12.12412	0
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9/25/2007 22:00	11295	12.12235	0
9/25/2007 22:30	11296	12.12192	0
9/25/2007 23:00	11297	12.12131	0
9/25/2007 23:30	11298	12.12021	0
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9/26/2007 1:30	11302	12.11824	0
9/26/2007 2:00	11303	12.11724	0
9/26/2007 2:30	11304	12.11673	0
9/26/2007 3:00	11305	12.11581	0
9/26/2007 3:30	11306	12.11537	0
9/26/2007 4:00	11307	12.11483	0
9/26/2007 4:30	11308	12.11341	0
9/26/2007 5:00	11309	12.11429	0
9/26/2007 5:30	11310	12.11334	0
9/26/2007 6:00	11311	12.11216	0
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9/26/2007 7:00	11313	12.11292	0
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9/26/2007 8:00	11315	12.11185	0
9/26/2007 8:30	11316	12.11176	0
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9/26/2007 9:30	11318	12.11178	0
9/26/2007 10:00	11319	12.11241	0
9/26/2007 10:30	11320	12.11269	0
9/26/2007 11:00	11321	12.1129	0
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9/26/2007 12:30	11324	12.11402	0
9/26/2007 13:00	11325	12.11445	0
9/26/2007 13:30	11326	12.11576	0
9/26/2007 14:00	11327	12.11702	0
9/26/2007 14:30	11328	12.11804	0
9/26/2007 15:00	11329	12.11909	0
9/26/2007 15:30	11330	12.11984	0
9/26/2007 16:00	11331	12.12105	0

9/26/2007 16:30	11332	12.12231	0
9/26/2007 17:00	11333	12.12273	0
9/26/2007 17:30	11334	12.12315	0
9/26/2007 18:00	11335	12.12413	0
9/26/2007 18:30	11336	12.12463	0
9/26/2007 19:00	11337	12.1249	0
9/26/2007 19:30	11338	12.12439	0
9/26/2007 20:00	11339	12.12317	0
9/26/2007 20:30	11340	12.12208	0
9/26/2007 21:00	11341	12.12175	0
9/26/2007 21:30	11342	12.11904	0
9/26/2007 22:00	11343	12.11869	0
9/26/2007 22:30	11344	12.1188	0
9/26/2007 23:00	11345	12.11757	0
9/26/2007 23:30	11346	12.11709	0
9/27/2007 0:00	11347	12.11651	0
9/27/2007 0:30	11348	12.11561	0
9/27/2007 1:00	11349	12.11435	0
9/27/2007 1:30	11350	12.11458	0
9/27/2007 2:00	11351	12.11353	0
9/27/2007 2:30	11352	12.11322	0
9/27/2007 3:00	11353	12.11291	0
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9/27/2007 4:00	11355	12.11144	0
9/27/2007 4:30	11356	12.11149	0
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9/27/2007 5:30	11358	12.10961	0
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9/27/2007 8:00	11363	12.10675	0
9/27/2007 8:30	11364	12.10685	0
9/27/2007 9:00	11365	12.10651	0
9/27/2007 9:30	11366	12.10683	0
9/27/2007 10:00	11367	12.10644	0
9/27/2007 10:30	11368	12.10707	0
9/27/2007 11:00	11369	12.10705	0
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9/27/2007 12:00	11371	12.10696	0
9/27/2007 12:30	11372	12.10801	0
9/27/2007 13:00	11373	12.10877	0
9/27/2007 13:30	11374	12.1096	0
9/27/2007 14:00	11375	12.11131	0
9/27/2007 14:30	11376	12.11286	0
9/27/2007 15:00	11377	12.11337	0
9/27/2007 15:30	11378	12.11492	0
9/27/2007 16:00	11379	12.11619	0
9/27/2007 16:30	11380	12.11709	0
9/27/2007 17:00	11381	12.11822	0
9/27/2007 17:30	11382	12.11945	0
9/27/2007 18:00	11383	12.12016	0

9/27/2007 18:30	11384	12.11975	0
9/27/2007 19:00	11385	12.12068	0
9/27/2007 19:30	11386	12.12067	0
9/27/2007 20:00	11387	12.12021	0
9/27/2007 20:30	11388	12.11856	0
9/27/2007 21:00	11389	12.11671	0
9/27/2007 21:30	11390	12.1155	0
9/27/2007 22:00	11391	12.11467	0
9/27/2007 22:30	11392	12.11367	0
9/27/2007 23:00	11393	12.11251	0
9/27/2007 23:30	11394	12.11081	0
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9/28/2007 1:00	11397	12.10734	0
9/28/2007 1:30	11398	12.10644	0
9/28/2007 2:00	11399	12.10584	0
9/28/2007 2:30	11400	12.10491	0
9/28/2007 3:00	11401	12.10412	0
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9/28/2007 4:00	11403	12.10252	0
9/28/2007 4:30	11404	12.10104	0
9/28/2007 5:00	11405	12.10145	0
9/28/2007 5:30	11406	12.10054	0
9/28/2007 6:00	11407	12.09997	0
9/28/2007 6:30	11408	12.09913	0
9/28/2007 7:00	11409	12.09877	0
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9/28/2007 8:00	11411	12.09813	0
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9/28/2007 9:00	11413	12.09869	0
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9/28/2007 10:00	11415	12.09912	0
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9/28/2007 12:00	11419	12.10201	0
9/28/2007 12:30	11420	12.10401	0
9/28/2007 13:00	11421	12.10562	0
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9/28/2007 14:00	11423	12.10897	0
9/28/2007 14:30	11424	12.10995	0
9/28/2007 15:00	11425	12.11152	0
9/28/2007 15:30	11426	12.11305	0
9/28/2007 16:00	11427	12.11329	0
9/28/2007 16:30	11428	12.11474	0
9/28/2007 17:00	11429	12.115	0
9/28/2007 17:30	11430	12.11556	0
9/28/2007 18:00	11431	12.11681	0
9/28/2007 18:30	11432	12.11765	0
9/28/2007 19:00	11433	12.11803	0
9/28/2007 19:30	11434	12.1174	0
9/28/2007 20:00	11435	12.11655	0

9/28/2007 20:30	11436	12.11572	0
9/28/2007 21:00	11437	12.11494	0
9/28/2007 21:30	11438	12.11397	0
9/28/2007 22:00	11439	12.11307	0
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9/28/2007 23:00	11441	12.1119	0
9/28/2007 23:30	11442	12.11106	0
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9/29/2007 0:30	11444	12.10958	0
9/29/2007 1:00	11445	12.10814	0
9/29/2007 1:30	11446	12.10689	0
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9/29/2007 2:30	11448	12.10574	0
9/29/2007 3:00	11449	12.10439	0
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9/29/2007 5:30	11454	12.10169	0
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9/29/2007 7:30	11458	12.10018	0
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9/29/2007 8:30	11460	12.10003	0
9/29/2007 9:00	11461	12.10034	0
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9/29/2007 15:00	11473	12.11373	0
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9/29/2007 16:30	11476	12.1165	0
9/29/2007 17:00	11477	12.1171	0
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9/29/2007 18:30	11480	12.1194	0
9/29/2007 19:00	11481	12.11933	0
9/29/2007 19:30	11482	12.11842	0
9/29/2007 20:00	11483	12.11689	0
9/29/2007 20:30	11484	12.1173	0
9/29/2007 21:00	11485	12.11615	0
9/29/2007 21:30	11486	12.11499	0
9/29/2007 22:00	11487	12.11464	0

9/29/2007 22:30	11488	12.11409	0
9/29/2007 23:00	11489	12.11413	0
9/29/2007 23:30	11490	12.11333	0
9/30/2007 0:00	11491	12.1127	0.2
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9/30/2007 1:00	11493	12.11206	0
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9/30/2007 11:00	11513	12.11107	0
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9/30/2007 12:00	11515	12.11246	0
9/30/2007 12:30	11516	12.11337	0
9/30/2007 13:00	11517	12.1133	0
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9/30/2007 15:00	11521	12.11491	0
9/30/2007 15:30	11522	12.11615	0
9/30/2007 16:00	11523	12.11566	0.2
9/30/2007 16:30	11524	12.11562	0.4
9/30/2007 17:00	11525	12.11528	1
9/30/2007 17:30	11526	12.11488	1.8
9/30/2007 18:00	11527	12.11497	1.4
9/30/2007 18:30	11528	12.11517	3.200001
9/30/2007 19:00	11529	12.11464	0.4
9/30/2007 19:30	11530	12.11417	0.6
9/30/2007 20:00	11531	12.11462	0.4
9/30/2007 20:30	11532	12.11324	0
9/30/2007 21:00	11533	12.11376	0
9/30/2007 21:30	11534	12.11363	0
9/30/2007 22:00	11535	12.11347	0
9/30/2007 22:30	11536	12.11341	0
9/30/2007 23:00	11537	12.11352	0
9/30/2007 23:30	11538	12.11278	0
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10/1/2007 12:30	11564	12.11124	0
10/1/2007 13:00	11565	12.11216	0
10/1/2007 13:30	11566	12.11251	0
10/1/2007 14:00	11567	12.11378	2
10/1/2007 14:30	11568	12.11379	7.399998
10/1/2007 15:00	11569	12.11384	5
10/1/2007 15:30	11570	12.11432	0.2
10/1/2007 16:00	11571	12.11399	5.599999
10/1/2007 16:30	11572	12.11354	1
10/1/2007 17:00	11573	12.11316	0.8
10/1/2007 17:30	11574	12.11394	0.6
10/1/2007 18:00	11575	12.11416	0.4
10/1/2007 18:30	11576	12.11423	0
10/1/2007 19:00	11577	12.11282	0.4
10/1/2007 19:30	11578	12.11364	0.2
10/1/2007 20:00	11579	12.11335	0
10/1/2007 20:30	11580	12.11256	0.2
10/1/2007 21:00	11581	12.11264	0.4
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10/1/2007 22:00	11583	12.1116	0.2
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10/2/2007 4:00	11595	12.10572	0
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10/2/2007 12:30	11612	12.10625	0
10/2/2007 13:00	11613	12.10664	0
10/2/2007 13:30	11614	12.10741	0
10/2/2007 14:00	11615	12.10799	0
10/2/2007 14:30	11616	12.10909	0
10/2/2007 15:00	11617	12.1098	0
10/2/2007 15:30	11618	12.11	0.4
10/2/2007 16:00	11619	12.10957	3.400001
10/2/2007 16:30	11620	12.11027	2
10/2/2007 17:00	11621	12.11004	1.4
10/2/2007 17:30	11622	12.10927	0.4
10/2/2007 18:00	11623	12.10857	0
10/2/2007 18:30	11624	12.1087	0
10/2/2007 19:00	11625	12.10739	0
10/2/2007 19:30	11626	12.1074	0
10/2/2007 20:00	11627	12.10641	0
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10/2/2007 21:00	11629	12.10588	0
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10/2/2007 23:00	11633	12.10397	0
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10/3/2007 2:30	11640	12.10042	0.6
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10/3/2007 10:30	11656	12.09519	0
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10/11/2007 7:00	12033	12.09268	0
10/11/2007 7:30	12034	12.09208	0
10/11/2007 8:00	12035	12.09186	0
10/11/2007 8:30	12036	12.09118	0
10/11/2007 9:00	12037	12.09153	0
10/11/2007 9:30	12038	12.09097	0
10/11/2007 10:00	12039	12.09172	0
10/11/2007 10:30	12040	12.09223	0
10/11/2007 11:00	12041	12.0932	0