3

Northern Suburbs

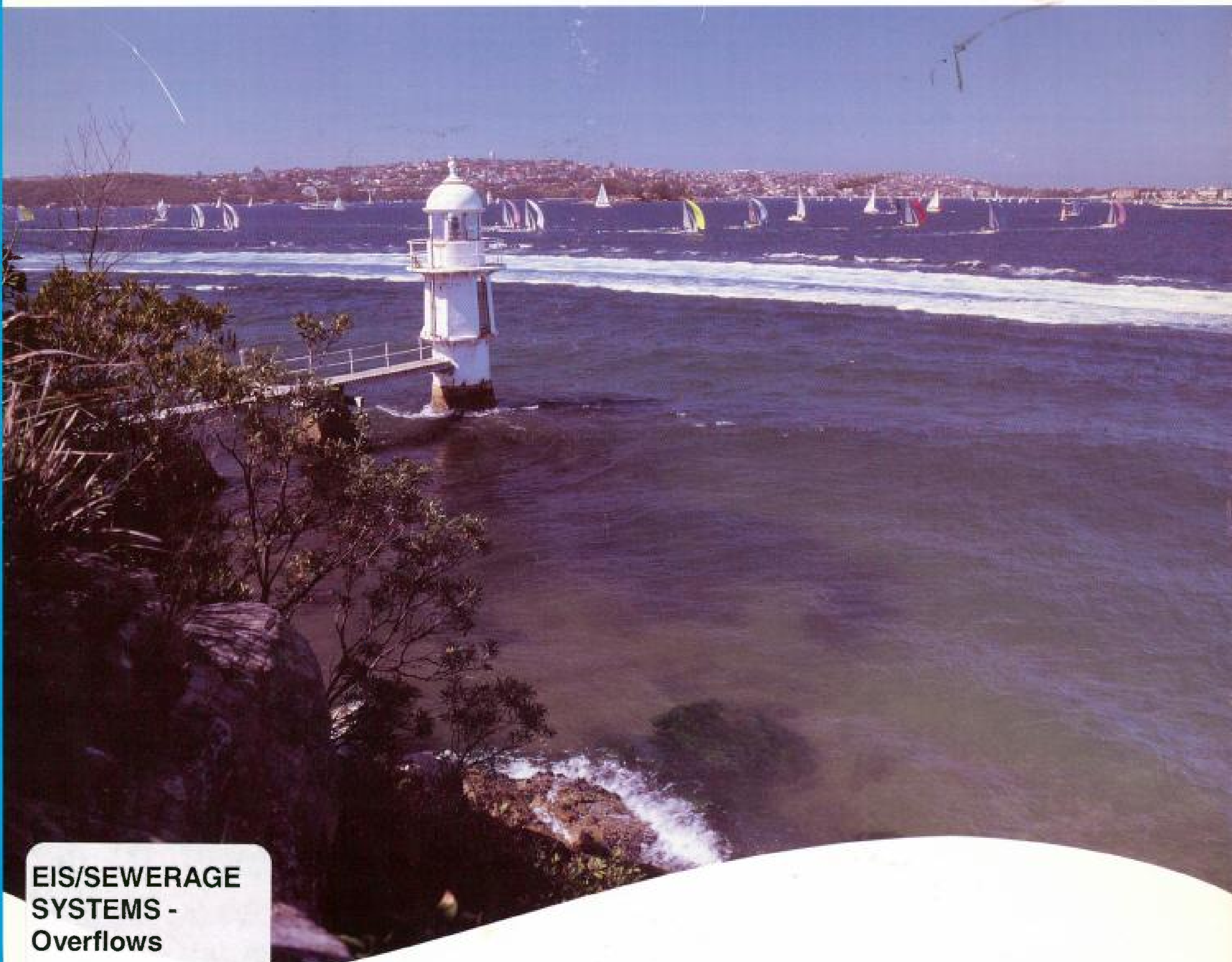
Licensing Sewerage Overflows

ENVIRONMENTAL IMPACT STATEMENT – JUNE 1998

Volume 3

Sydney Harbour and Northern Beaches Geographic Area

Northern Suburbs



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Licensing Sewerage Overflows – Environmental Impact Statements

Document Hierarchy

Sewerage Overflows Licensing Project
Environmental Impact Statement

Volume 3

Northern Suburbs Ocean Outfall Sewer System

JUNE 1998

AWT Australian Water Technologies

Sydney WATER

Hyder Consulting

Sewerage Overflows Licensing Project
Environmental Impact Statement

Volume 3: Northern Suburbs Ocean Outfall Sewer System Overflows

Volume 3 : NSOOS

Volume Summary

1. Introduction

Overflows are defined for the purposes of the EISs as all liquid and odour discharges from the sewerage system and partially treated wet weather sewage treatment plant (STP) discharges. The EPA currently licenses fully treated discharges from STPs.

Volume 1 of this EIS focuses on the Sydney-wide overflow abatement program and provides the generic considerations, inputs and methodology that form part of the licensing project. It also sets out the priorities and process of implementation of the abatement strategy. Volume 2 describes the overflows in the Sydney Coastal GA, including the extent of the overflow problem, the environmental impacts, proposed solutions and environmental benefits resulting from the preferred solution for the GA.

Volume 3 describes the specific solutions developed for each sewerage system located within the Sydney Coastal GA. There are three sewerage systems in the Sydney Coastal GA; Warriewood Sewerage System, Bondi Sewerage System and Northern Suburbs Sewerage System.

This document (Volume 3) assesses overflows from the Northern Suburbs Ocean Outfall Sewer System (referred to as the NSOOS). The NSOOS system catchment consists of all the areas from which sewage flows via the reticulations system and trunk sewers to the North Head STP. The NSOOS lies within the catchments of the Parramatta River and its tributaries, Lane Cove River and tributaries, Middle Harbour and Middle Harbour Creek, North Harbour and Port Jackson. The system also serves the catchments of Manly, Curl Curl, Dee Why and Narrabeen Lagoons. Some suburbs on the northern boundary of the NSOOS system, are located within the Cowan Creek receiving environment zone, which is part of the Lower Hawkesbury GA. Environmental objectives for this GA are discussed in Volume 2, Lower Hawkesbury GA.

2. System performance

The NSOOS system, which serves a population of approximately one million, transfers, treats and discharges an ADWF of 316 ML/d of sewage. The system includes 87 sewage pumping stations, over 5000 km of reticulation sewer, over 500 km of sewer main and is connected to about 6000 km of private sewer. North Head STP provides preliminary and high rate primary treatment, before treated sewage is discharged 3.5km offshore, via a long sea outfall.

The size of the NSOOS system trunkline sewers is sufficient to prevent dry weather discharges due to inadequate hydraulic capacity. However, there are sections capable of transferring less than 1.33 times PDWF (<5%). Five to ten percent of the NSOOS only has capacity to transfer between 1.33 PDWF and 2.0 PDWF, 50% of the system can transfer 2 to 4 times PDWF and the remaining 40% can transfer more than 4 PDWF. Rainfall inflow and ingress into the NSOOS exceeds 10% in about half of the catchment (rainfall ingress is measured as the percentage of the total volume of rain falling within a certain catchment that enter the sewer). This inflow and ingress, combined with limited hydraulic capacity of some parts of the system results in relatively frequent overflow events during wet weather. Forty percent of rainfall events cause overflows from the system. Time series modelling of the sewers using ten years rainfall data indicates that 237 rainfall events result in overflows in a ten year period (roughly twice a month). The estimated volume of sewage discharge was 181 791 ML over 10 years from 160 modelled overflows. Over 35% of this volume comes from five major overflow structures which discharge to Lane Cove and Middle Harbour.

The volume of sewage transferred to North Head STP is currently limited by the hydraulic capacity of the NSOOS. The treatment plant has capacity to treat the peak flow rates from the sewerage system. Consequently, there are no partially treated STP discharges from the NSOOS.

Other causes of overflows from the system include surcharges which result from chokes, SPS failures and exfiltration. Of the 128 suburbs served or partially served by the NSOOS, only 16 are considered to experience a “high” frequency of chokes. A further 74 suburbs experience a “medium” choke frequency. However, more than 99% of Sydney Water’s customers served by the NSOOS are not effected by surcharges. There are six sub-catchments within the NSOOS where the potential exfiltration (leakage of sewage from the sewer) is classed as "high" and 14 where exfiltration is considered "moderate". From over 600 SPS failures, only 20 overflows resulted in a year from 1996 to 1997. There are a number of SPSs (15) where the detection time is below the response time available to correct a fault.

It has been predicted that the population served by the NSOOS will grow by 9% by the year 2021. The addition sewage flows produced (an extra 28 ML/d) will exacerbate the overflow problem from the NSOOS, unless overflow abatement strategies are introduced.

Sydney Water already has programs in place to detect and prevent overflows and minimise their impact. These programs, which are subject to continual improvement, include ingress, inflow, infiltration and exfiltration detection through smoke testing, flow gauging and water quality monitoring. The corporation has been undertaking preventative and reactive inspection and maintenance of the system, managed using objective risk analysis tools to concentrate efforts on the most critical features of the system. An interim I/E program has been under way for a number of years aimed at improving detection of exfiltration and developing cost effective means to reduce I/E. The impacts of overflows, particularly from chokes and SPS failures are minimised through Sydney Water's rapid response, containment and clean-up procedures.

3. Environmental impacts of overflows

The environmental assessment is focused primarily on issues that effect large areas of a catchment, or are of catchment-wide concern. Localised impacts are considered only where they affect areas which have been identified as 'sensitive' because of their ecological status, human uses, or cultural values. Overflows are considered to have negligible impact on noise, traffic and landuse zoning, although impacts which may be incurred by the implementation of overflow control options will be considered in the second stage EIA documents prior to any construction.

Impacts on the environment from overflows from the NSOOS system can be highly localised or have relatively widespread impacts across a REZ (such as the high volume overflows impacting on Middle Harbour and Lane Cove River, which impacts on the Sydney Harbour REZ). Direct discharge of overflows impacts on the upper and estuarine Lane Cove River, the upper and estuarine Parramatta River, Port Jackson and Middle Harbour. These areas are used extensively for primary and secondary contact recreation and have a high visual amenity. Overflows effect the suitability of these areas for water based activities and tourism.

The aquatic impacts due to overflows predicted by modelling are significant. The combined wet weather overflow volumes from the SWOOS, BOOS and NSOOS contribute 53 percent of the total phosphorus load and 55 percent of the total nitrogen load to Port Jackson, indicating that sewerage overflows contribute approximately half of the total nutrient loads to Port Jackson. Of the sewerage overflow derived nutrient loads, approximately 90 percent is contributed by the NSOOS. The NSOOS is the main contributor of faecal coliform contamination of Middle Harbour and the Lane Cove River estuary. The contribution of the NSOOS to nutrient and faecal coliform loads received by Manly Lagoon are also significant.

The terrestrial impacts due to overflows are relatively minor since the majority of overflows drain to the aquatic environment, either directly or via the stormwater system. Chokes and exfiltration within terrestrial areas may cause weed growth through soil nutrient enrichment, disturbance of the soil surface and addition of non-native plant seeds. However, these effects are likely to be localised and the impacted areas small in comparison to habitat ranges for native flora and fauna impacted.

Sensitive areas with high biodiversity and community value have been identified to determine if greater overflow containment is warranted to protect their ecological status and value. High potential impact areas form overflows are expected at sensitive areas of North Ryde, Lane Cove River, Blue Gum Creek, Duck Creek, Haslams Creek, Middle Harbour, Park Gate Estate, Scotts Creek, Moores Creek and Buffalo Creek, Dee Why, Curl Curl and Manly Lagoons, Manly Reservoir and Manly Creek.

Overflows are one of several sources of pollution in the Sydney Coastal GA. In some parts of the receiving environment such as Dee Why, Curl Curl and Narabeem Lagoons stormwater is a major source of contamination and overflow elimination processes recover only a small number of days when water quality is unsuitable for recreation or ecosystem protection. Other factors such as conversion of land for housing and erosion caused by flood flows, are likely to have far greater impacts on terrestrial ecosystems than those caused by sewerage overflows.

4. Overflow management strategy

A combination of three distinctive sets of requirements define the overflow abatement objectives for the NSOOS. These requirements are; long term performance targets, covering the whole of Sydney Water's service area; minimum performance standards and environmental objectives for the REZs, as discussed in Volume 2. These requirements were applied to each type of overflow, and the most stringent requirements were adopted as abatement objectives for the NSOOS.

Environmental and overflow abatement objectives have been identified for the Sydney Harbour, and Northern and Eastern Sydney Beaches REZ in Volume 2. The benefits and costs of additional overflow abatement levels (above the minimum performance standard) have been evaluated and the most appropriate overflow abatement strategy selected. A variety of containment options have been selected for the REZs impacted by the NSOOS (refer to volume 2 for full details). A three month containment option has been selected for the majority of the areas impacted including Upper Lane Cove River REZ, Upper Parramatta River REZ and two areas within the Sydney Harbour REZ, namely the Parramatta River Estuary and Lane Cove River Estuary. Six month containment levels have been adopted for the remainder of the Sydney Harbour REZ (Port Jackson and Middle Harbour), the Northern and Eastern Beaches REZ and for Manly Lagoon. For Curl Curl, Dee Why and Narrabeen Lagoons minimum performance standard containments have been selected.

The Northside Storage Tunnel project, currently being progressed by Sydney Water, will extend from Lane Cove to North Head, intercepting sewage overflows at Lane Cove, Tunks Park, Quakers Hat Bay and Scotts Creek (the overflow from Scotts Creek Carrier and the overflow from Scotts Creek Aqueduct). These are the largest wet weather overflows in the GA. The overflow ranking completely as part of this EIS, ranks these overflows as numbers 1, 2, 3, 4 and 7 from the sewerage system. In other words, these overflows are deemed to be the most significant based on discharge quantity, frequency and the sensitivity of the receiving environment. The objective of the tunnel project is therefore to achieve a substantial improvement in water quality in Sydney Harbour to improve the amenity value of the waterway (both in terms of appearance and odour), to improve the aquatic environment and reduce perceived risks to public health.

Actions to achieve the minimum performance standard, three month and six month containments for the NSOOS will include further sewer rehabilitation (I/I reduction), reticulation amplification, trunk main amplification and provision of storage capacity (such as the Northside Storage Tunnel). Wet weather abatement actions range from preventing additional rainfall dependent infiltration and inflow components entering in to the sewer system, reticulation and main carriers amplifications, provision of on line or off line storage, and to upgrade the existing capacity of the STP. A combination of these actions will be used to develop sewerage system management strategies to transport wet weather flows to the STP, thereby minimising overflows from the system. System failure abatement actions include measures to reduce the potential for and/or mitigate the impact of chokes, SPS failures, exfiltration and odours.

The I/E programme currently being undertaken by Sydney Water is targeted to eliminate both dry and wet weather overflows in the form of exfiltration and infiltration from the sewerage system. The elimination of exfiltration and infiltration problems will improve the overall performance of the sewerage system and reduce the possible dry and wet weather sewage related impacts to the receiving environment zones.

Actions will be implemented through a structured plan which integrates the timetable for improvements, funding requirements, researching, system maintenance, training and standardised operating and emergency response procedures. Components of the management plan have been selected to achieve a balance between non-structural and structural options that can be implemented progressively over the next 25 years. The proposed management plan will form part of Sydney Water's total quality assurance system. The total estimated cost for the NSOOS System over the next 23 years is $ 964.5 million (based on 1996 costs). This will be funded from Sydney Water's existing rates, rates from new customers and developer charges for new infrastructure.

5. Benefits of the preferred strategy

An integrated management plan for overflow abatement in the NSOOS Sewerage Catchment has been proposed to help achieve the environmental objectives set for each REZ (as outlined in Volume 2). This plan will contribute towards achieving the Sydney Water's long term performance targets and will; i) reduce faecal coliform inputs to receiving waters, resulting in an increase in the number of days suitable for primary and secondary contact recreation in most of the receiving waters; ii) reduce nutrient inputs to receiving waters, with resulting reduction in eutrophication and an increase in the number of days when the water quality meets ANZEEC guidelines for ecosystem protection; iii) reduce input of chemicals into receiving waters; iv) reduce release of visible pollutants such as sewage solids and grease to receiving environments, helping protect ecosystems and improving visual amenity; and v) reduce odour nuisance arising from surcharges and overflows from designed structures.

The likely outcome from failing to provide addition capacity for the increasing population and from letting the system deteriorate would be a greater impact to aquatic, terrestrial and socio-economic environments. Impacts on the receiving environments would be evident from: increased levels of nutrients, leading to further eutrophication and possibly resulting in excessive weed and algal growth; increased levels of faecal coliforms; reduced suitability of the waterways for primary and secondary recreational uses; reduced compliance with water quality guidelines for ecosystem protection and consequently, reduced biodiversity; reduced visual amenity of the receiving waterways; and Increased human health risks. The major impact which could result from failing to implement the preferred option would be on the general amenity of the environment in an area where the amenity value, to resident and tourist alike, is very high and should preserved.

It is important to note, however, that unless all pollution sources are identified and quantified, it is difficult to determine the level of impacts which may occur if the preferred strategy is not implemented. The water quality modelling results show that removing all overflows will result in the recovery of the majority of unsuitable swimming and boating days in Port Jackson, particularly Lane Cove River and Middle Harbour, where the levels of faecal coliforms are greatest and quality of the stormwater runoff is generally good. The main evidence of impacts increasing due to not implementing the strategy would be from reduced recreational activities and general amenity of the environment.

6. Conclusion

The NSOOS has significant impacts on some of the REZs effected by overflows from the system, particularly with respect to the aquatic environment during wet weather.

To mitigate these impacts, an overflow management plan has been proposed. The plan is justified as it aims to achieve the environmental objectives established for each REZ and Sydney-wide long term performance targets in a cost effective manner. The plan will also protect sensitive areas and minimised the impacts of overflows when they do occur.

Some components of the management plan are already being progressed by Sydney Water. The remaining components will be implemented over a period of 23 years. Where major structural works are required for specific components of the plan, a second stage EIA will be necessary.

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Volume 3: Northern Suburbs Ocean Outfall Sewer System Overflows

Chapter 1

Introduction

Synopsis

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Volume 1 of this EIS focuses on the Sydney wide overflow abatement program and provides the generic considerations, inputs and methodology that form part of the licensing project. It also sets out the priorities and process of implementation of the abatement strategy. Volume 2 describes the overflows in the Sydney Coastal GA, including the extent of the overflow problem, the environmental impacts, proposed solutions and environmental benefits resulting from the preferred solution for the GA.

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1. Introduction

1.1 Sydney Water objectives

The Sydney Water Corporation (Sydney Water) has three equal objectives:

1. to be a successful business
2. to protect the environment
3. to protect public health.

Sewerage overflows are just one element of Sydney Water's wastewater system, however, they have the potential to affect the environment and public health. By assessing these impacts, options can be developed to prevent or reduce their effects. The costs and benefits of the proposed option can then be considered to ensure Sydney Water's objectives are achieved.

1.2 The EIS objectives

Sydney Water has other business objectives which are relevant to this assessment process:

1. to maintain the current level of performance as a minimum standard and not permit any deterioration of the sewerage system performance, with consideration of population growth, in the future
2. to conduct operations in compliance with the principles of Ecologically Sustainable Development (ESD) as outlined in the *Protection of the Environment Administration Act (1991)*
3. to conduct overflow licensing operations within the objectives of other Sydney Water strategies including WaterPlan 21.

These objectives are considered when the preferred sewerage overflow option is selected.

The objectives of this Environmental Impact Statement (EIS) are to identify potential adverse impacts of overflows on the environment and public health and to prioritise those actions required to prevent or reduce them. By determining potential impacts and a list of actions that may minimise adverse effects, a licence with an improvement program attached can be issued by the Environmental Protection Authority. Relevant Acts and Regulations, policies and community concerns should be considered when determining the most suitable options. To ensure Sydney Water will spend their available funds effectively, the costs and benefits of the proposed options are considered.

This volume is the third in the set making up the EIS for the Northern Suburbs Ocean Outfall Sewer System (NSOOS):

1. Volume 1 contains the Sydney wide overflow abatement program and provides information on generic considerations and the methodology that provide the basis for this assessment. It summarises the performance, impacts, proposed solutions, costs and benefits for all 27 sewerage systems in Sydney Water's area of operations and outlines the prioritisation process for implementation of the programme.
2. Volume 2 describes and assesses the environmental impacts of overflows in the Sydney Coastal Geographic Area (GA). It also contains information regarding cumulative environmental impacts of overflows in the GA and proposes overflow abatement strategies on a Receiving Environment Zone (REZ) basis according to the contribution of overflows to total catchment pollution. There are six REZs in the Sydney Coastal GA, these are Sydney Harbour, Upper Parramatta River, Upper Lane Cove River, Pittwater, Northern Lagoons and Northern and Eastern Sydney Beaches.
3. Volume 3 (this volume) addresses the NSOOS system in detail. It describes the known problems within the system, identifies sensitive areas within the REZs and determines the potential impact of overflows on these sensitive areas. Actions to minimise or prevent adverse effects from overflows are proposed and the benefits and costs of the abatement options are considered.

1.3 The purpose and content of this volume

This volume provides an assessment of overflows from the NSOOS system. Six types of overflow are assessed:

1. wet weather overflows
2. partially treated sewage treatment plant (STP) discharges
3. overflows caused by chokes
4. overflows caused by exfiltration
5. overflows caused by sewerage pumping station (SPS) failures
6. odours.

Specific objectives to alleviate overflows listed above are set out in Chapter 4. System specific options are developed to meet the REZ overflow abatement strategy set out in Volume 2. Actions which make up the options are prioritised depending on the performance of the system, sensitive areas of the environment likely to be impacted by overflows and currently proposed capital works programs. This volume is set out as follows:

1. Chapter 2 describes the NSOOS and the extent of the overflow problem related to the system.
2. Chapter 3 describes the environmental impacts from overflows in the system and ranks the overflows based on the severity of impact.
3. Chapter 4 provides a prioritised list of the problems in the system that require action to meet the performance strategy proposed in Volume 2. It lists the Sydney Water objectives to address each overflow type and presents actions to achieve these.
4. Chapter 5 discusses the environmental costs and benefits of the preferred option.
5. Chapter 6 presents the justification of the preferred option.

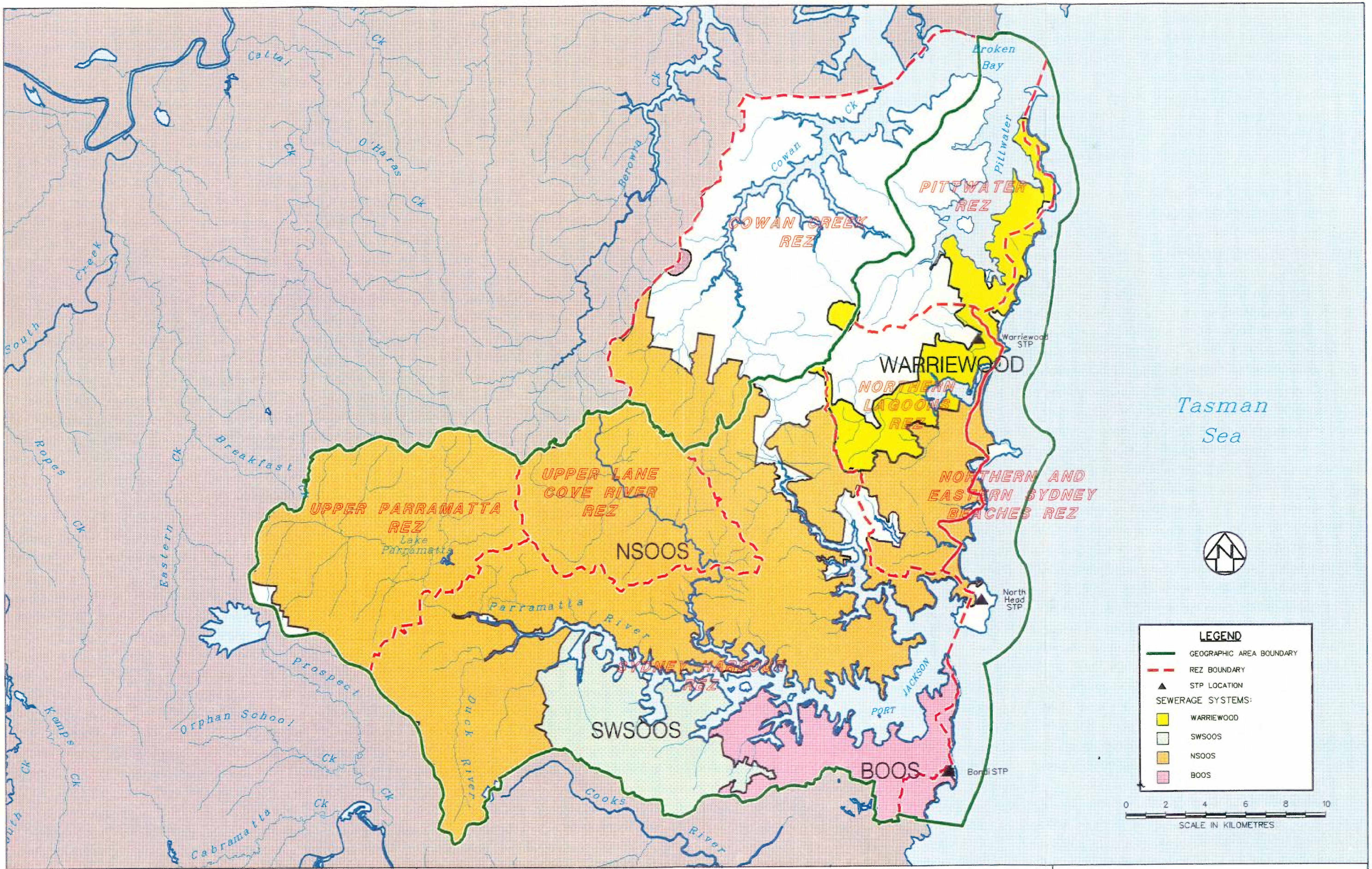
1.4 Introduction to the NSOOS system

The NSOOS system catchment consists of all the areas from which sewage flows via the reticulation system and trunk sewers to the North Head STP. The NSOOS system lies within the catchments of the Parramatta River and its tributaries, Lane Cover River and tributaries, Middle Harbour and Middle Harbour Creek, North Harbour and Port Jackson. The system also serves the catchments of the Manly, Curl Curl, Dee Why and Narrabeen Lagoons. Some suburbs on the northern boundary of the NSOOS system, are located within the Cowan Creek catchment.

The system serves residential and industrial areas extending from North Head STP to Prospect, running parallel to the northern shore of Port Jackson and the Parramatta River. The catchment is bounded to the north by Narrabeen Lagoon, St Ives and Hornsby, and to the south by Port Jackson and the Parramatta River. The NSOOS system serves some areas south and west of the Parramatta River, namely Auburn, Strathfield and Greystanes (refer to Figure 1.1). The majority of the 416 km^2 served by the system is fully developed for residential, commercial and industrial uses. The population served is approximately one million.

The receiving environments for overflows from the NSOOS system have been defined as:-

1. Upper Parramatta River (upstream of the Parramatta Weir)
2. Upper Lane Cove River (Upstream of Lane Cover Weir)
3. Sydney Harbour (including the Parramatta River downstream of the weir, Lane Cove River downstream of the weir, Middle Harbour)



Sydney WATER

SYDNEY WATER CORPORATION LIMITED
ACN 063 279 649

SEWERAGE OVERFLOWS LICENSING PROJECT
SYDNEY HARBOUR AND NORTHERN BEACHES
GEOGRAPHIC AREA

FIGURE 1-1
THE STUDY AREA

4. Northern Lagoons (including Narrabeen Lagoon, Manly Lagoon, Curl Curl and Dee Why Lagoons)
5. Northern and Eastern Sydney Beaches (Barrenjoey to Clovelly Bay)
6. Cowan Creek and tributaries (discussed in the EIS covering the Lower Hawkesbury GA).

There are a number of sensitive areas containing a range of environments within this catchment including remnant bushland habitats, recreational areas, cultural heritage items and aquatic habitat values. The options assessment considers the requirements of these sensitive areas.

Sewerage Overflow Licensing Project
Environmental Impact Statement

Volume 3: Northern Suburbs Ocean Outfall Sewer System Overflows

Chapter 2

System Performance

Synopsis

The NSOOS system which serves a population of approximately one million, transfers, treats and discharges an ADWF of 316 ML/day of sewage. The system includes 87 sewage pumping stations, over 5000 kilometres of reticulation sewer, over 500 kilometres of sewer main and is connected to about 6000 kilometres of private sewer. North Head STP provides preliminary and high rate primary treatment, before treated sewage is discharged 3.5 kilometres offshore, via a deep ocean outfall.

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It has been predicted that the population served by the NSOOS will grow by nine per cent by the year 2021. The addition sewage flows produced (an extra 28 ML/day) will increase dry weather flow but not wet weather flow as the development is largely infill.

Sydney Water already has programs in place to detect and prevent overflows and minimise their impact. These programs, which are subject to continual improvement, include ingress, inflow, infiltration and exfiltration detection through smoke testing, flow gauging and water quality monitoring. The company has been undertaking preventative and reactive inspection and maintenance of the system, managed using objective risk analysis tools to concentrate efforts on the most critical features of the system. An interim I/E program has been under way for a number of years aimed at improving detection of exfiltration and developing cost effective means to reduce I/E. The impacts of overflows, particularly from chokes and SPS failures are minimised through Sydney Water's rapid response, containment and clean-up procedures.

2. System performance

2.1 Overflow definition

Overflow problems in the sewerage system have been divided into six categories:

1. wet weather overflows
2. partially treated STP discharges
3. overflows caused by chokes
4. overflows caused by exfiltration
5. overflows caused by sewage pumping stations (SPS failures)
6. odours.

Overflows occur because of capacity problems within the system or a failure of the system integrity or performance. They can occur in wet or dry weather. The final destination for overflows can be:

1. waterways (including stormwater and groundwater, as well as creeks, rivers, lakes and the ocean)
2. land (including public and private properties)
3. air (in the case of odours).

Table 2.1 identifies the types of overflow and the final destinations of their discharge. For a full description of overflows and types refer to Volume 1.

Table 2.1 Overflow types and final destinations

Overflow type	Receiving environment			Occurrence		Cause	
	Aquatic	Terrestrial	Air	Wet weather	Dry weather	Capacity	System failure
Wet weather	✓	✓	✓	✓		✓	✓
Partially treated STP discharges	✓			✓	✓	✓	✓
Chokes	✓	✓	✓	✓	✓		✓
Exfiltration	✓	✓		✓	✓		✓
SPS failure	✓	✓	✓	✓	✓	✓	✓
Odours			✓	✓	✓		✓

All overflow types can occur in wet weather. It should be noted that a wet weather overflow is one caused by excess infiltration/inflow (I/I) to the system during wet weather only. The computer models developed by Sydney Water to predict system performance and construct a capital works programme have used wet weather information such as rainfall data, sewer flow and wet weather overflow monitoring.

Sewage which does not receive the full treatment available at the STP is termed a partially treated STP discharge. The quantity of this bypass can vary between STPs depending on the level of treatment received before the bypass occurs. As a minimum, bypassed flows are usually screened and grit is removed before discharge.

2.2 Current system overview

The NSOOS system is the second largest sewerage system operated by Sydney Water. It serves an area of 416 km^2 which extends westward from the North Head STP to near Blacktown. The catchment is bounded to the north by the Narrabeen Lagoon, St. Ives and Hornsby, and to the south by Port Jackson, Lidcombe, Yagoona, Guildford and Greystanes. The majority of the catchment, is fully developed. The system and its catchment area is shown on Figure 2.1.

Sewage is collected and transported to the STP via 5414 kilometres of reticulation sewers, 563 kilometres of main sewers and an estimated 6000 kilometres of private sewer. The NSOOS trunk sewer is divided into 13 major sections, each section being serviced by an associated tributary area and consisting of a system of sewer sub-mains and carriers (Section 1-7: from North Head to Dundas, Section 8-13 : From Dundas to Blacktown). The NSOOS trunk sewer is approximately 44 kilometres in length. Along its route, the NSOOS trunk sewer receives flow from 53 principal sewers, 11 pumping stations and to a lesser extent, direct connections to smaller local sewers (Sydney Water 1997c).

A comparison of the NSOOS system with the GA and with Sydney Water's overall wastewater systems is given in Table 2.2.

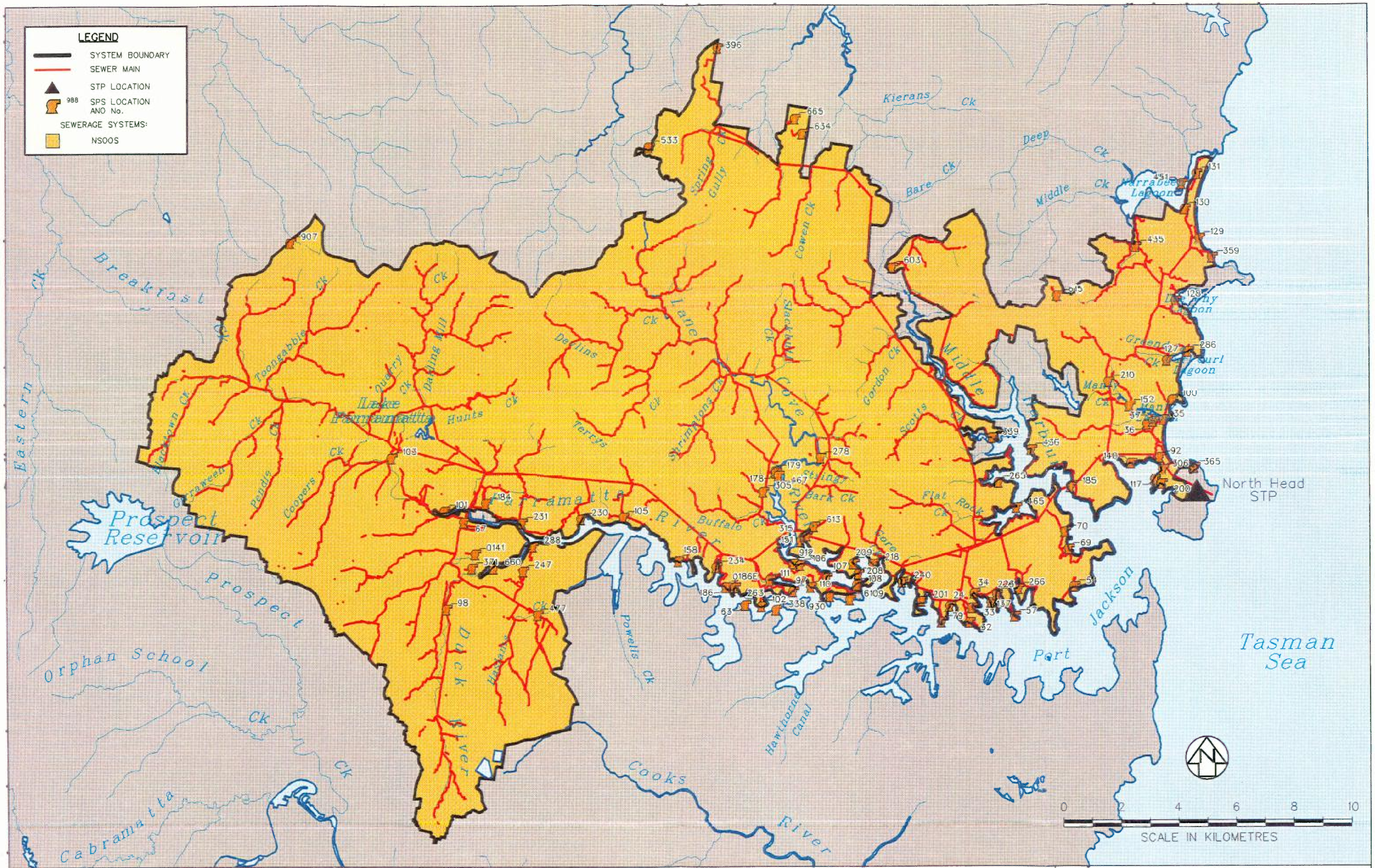
Table 2.2 - Comparison of the NSOOS system to the Sydney Coastal and Sydney Water wastewater system

System	NSOOS	Total GA	Total Sydney Water	% NSOOS	
Description				Total GA	Total Sydney Water
Area (ha)	42 000	55 634	187,121	75	22
Population served (1991)	1 000 000	1 264 000	3,884,212	79	27
Length main sewers ≥ 300 mm (km)	563	695	2,497	81	22
Length reticulation sewers < 300 mm (km)	5414	6528	18,966	83	29
Total length sewers (km)	5 971	7 223	21,463	83	28
Number of SPSs	87	177	642	49	13
Number of designed overflows	1042	1335	3109	78	31

Source: Sydney Water

There are 87 SPSs in the NSOOS sewerage system catchment. The majority of these pumping stations service small catchment areas less than 25 ha on the northern shores of Port Jackson and Parramatta River. The three largest pumping stations in the system are SPS 67, SPS 103 and SPS 98 which service areas south of Parramatta River and west of Homebush Bay. All but one of the SPSs in the NSOOS have on-line telemetry. Telemetry systems are important as they activate alarms in the regional operations centre when there is a pump malfunction, power failure, overflow or other failure at a pumping station.

Sewerage systems all have the potential to experience capacity and/or blockage problems, and therefore a large network of overflow structures is incorporated into them. Such structures serve as emergency relief points and ensure that overflow impacts on private property are minimised. When the volume of sewage exceeds the capacity of a sewerage pipe, the system is designed to divert sewage through the overflow structure to a nearby stormwater system or directly to a receiving watercourse. This can occur in heavy rain, when large volumes of stormwater find their way into the sewerage system. During dry weather, blockages in the system or failures at the SPSs can also cause overflows.



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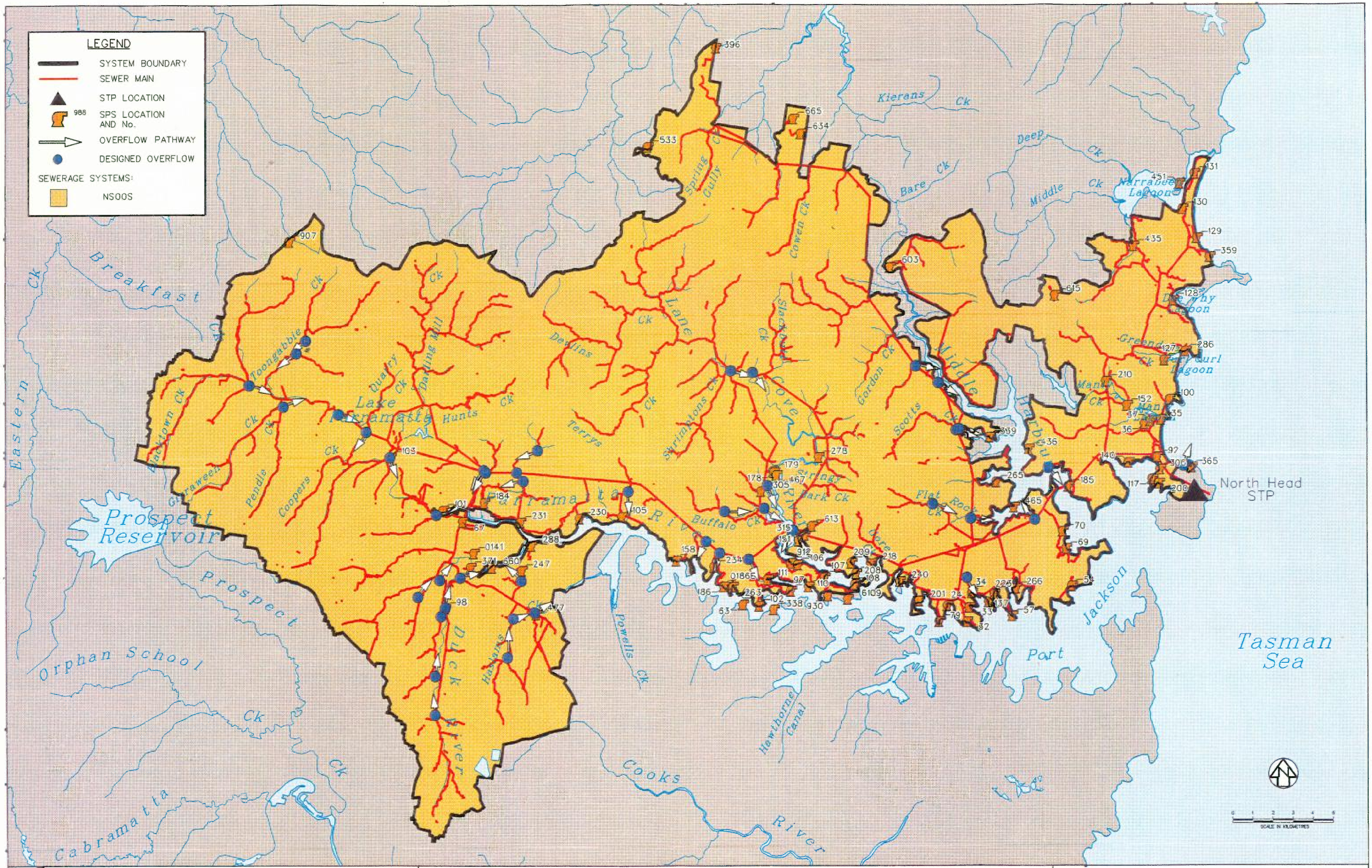
SEWERAGE OVERFLOWS LICENSING PROJECT
NSOOS SEWERAGE SYSTEM

FIGURE 2-1
NSOOS SEWERAGE SYSTEM



Sydney WATER SYDNEY WATER CORPORATION LIMITED ACN 063 279 649	SEWERAGE OVERFLOWS LICENSING PROJECT NSOOS SEWERAGE SYSTEM	FIGURE 2-2 MAJOR DESIGNED OVERFLOW PATHWAYS

Sewerage Overflows from the NSOOS system are not limited to overflows from designed overflow structures. Examples of overflows from non-designed locations include sewage discharge from access chambers, leakage of sewage through cracks in pipes and joints (exfiltration) and odour emission via liquid overflow discharges. An SPS may overflow in dry weather due to power loss, sequential operational failure (an SPS will automatically stop operating when a downstream SPS fails) or, in wet weather, due to insufficient capacity to deal with volumes resulting from infiltration (stormwater flow into the sewers), despite storage available in SPS wet wells and gravity sewers.

2.3 Condition of the NSOOS system

2.3.1 Pipes and access chambers

Much of the NSOOS is over 60 years old and the oldest sections are over 100 years old. The reticulation system feeding to the trunk mains, along with the private sewers feeding into it, form the majority of the sewer pipe network. The reticulation pipes are mainly constructed of brittle materials such as vitreous clay (VC), concrete and brick and are mostly joined by mortar. These materials are potentially problematic during the operation of the sewerage system as they can crack relatively easily and allow infiltration of groundwater and rainwater and exfiltration of sewage. Cracking of pipes and joints due to age, poor pipe bedding for older sewers and poorly maintained private sewers is partly responsible for infiltration and exfiltration from the reticulation sewers. Poorly sealed access chambers also contribute to inflow of rainwater. For the purposes of hydraulic modelling of the NSOOS system, Sydney Water subdivided the system into 167 inflow catchments. The percentage of rainfall ingress into these inflow catchments ranged from 2.4% to 38.9% (Sydney Water 1997a).

Until the mid 1960s, the majority of reticulation pipes installed were joined with mortar joints which are brittle, have low structural strength and tend to crack to allow infiltration and tree root intrusion into the system. Rubber ring joints are now being used in VC and UPVC pipes and solvent welded joints in smaller UPVC pipes which have resulted in improved quality of the joints and the reduced occurrence of infiltration problems.

Within the NSOOS, seven gauged catchments experience hydraulic loading rates greater than twice the estimated water consumption in the area and are classified as having high infiltration. A further five catchments experience moderate infiltration (sewage production is 1.5 to 2.0 times the water consumption in the area) and 11 gauged catchments were classified as low infiltration (sewage production is 1.0 to 1.5 times water consumption). Twenty-two gauged catchments were classed as likely areas for exfiltration.

With respect to the NSOOS trunk system, age, high wet weather flows, inadequate ventilation (producing high hydrogen sulphide levels and damp conditions which speed up corrosion of the sewers) and structural inadequacies can all combine to cause structural deterioration. However, effective asset management for the NSOOS systems means that despite its age, the NSOOS trunk sewer is in good operating and structural condition.

2.3.2 System hydraulic capacity

Sydney Water aim to design sewers for areas with population densities greater than 75 EP/ha with sufficient capacity to transfer up to four PDWF. Sydney Water has analysed the existing performance of the sewerage catchment using the hydraulic MOUSE model representing the NSOOS system (description of the MOUSE modelling tool is given in the Methods volume of this EIS). The results of the hydraulic analysis of this sewerage catchment indicated that all of the sewers have adequate capacity to convey peak dry weather flow. No section of the sewers is found to be associated with dry weather surcharge problems (Sydney Water, 1997a). However, there are extensive sections of the NSOOS trunk sewer which are capable of transferring less than four PDWF. Much of the trunk sewer from Parramatta running eastward to North Head has a capacity between two and four PDWF. There are notable sections of the trunk sewer with a hydraulic capacity of between 1.33 and 2 PDWF. These include a section in West Ryde, a section running parallel to Middle Harbour from Sailors Bay to Long Bay and the final section from Manly to North Head. There are a limited number of trunk sections where the capacity is less than 1.33 PDWF. These include the Lane Cove River crossing, and a section running parallel to Middle Harbour from Castle Cove to Sailors Bay (Refer to Figure 2.3). Overall, 90% of the NSOOS has a capacity greater than 2 PDWF with:

1. 40% > 4 PDWF
2. 50% 2 to 4 PDWF
3. 5 to 10% 1.33 to 2 PDWF
4. <5% 1.33 PDWF.

2.3.3 Sewage pumping stations

Because SPSs were built as an integral component of the NSOOS system they also range in age from early 1920s to the present day. Structurally, most of the SPSs are in good condition except for minor irregularities caused by minor gas attack to wet wells and corrosion of steelwork. Mechanical and electrical equipment in some of the SPSs, however, is not in good condition with some of the electrical equipment lacking functionality. SPSs are being upgraded on a priority basis. Regular maintenance has ensured that pumping stations continue to operate.

Pumping stations tend to be located in low lying areas adjacent to waterways, and thus overflows of raw sewage would directly impact on receiving waters. Failure of SPSs are a high priority and as such receive prompt attention as they are monitored by Sydney Water's telemetry system. During 1996/1997, 655 failures occurred in the NSOOS pump stations, as a result of unplanned power loss, sequential pump operation failure and level control failure. Twenty-two of these failures resulted in overflows from 8 of the SPSs.

Sydney Water conducted an operational performance assessment to determine the reliability, serviceability, suitability and physical/operational condition of SPS equipment including pumps, motors, valves, power supply, telemetry, unit control and procedural control instructions and overflows (Water Board 1994a). Both mechanical and electrical components of SPSs are important as failures may lead to the occurrence of overflows. Telemetry system performance is important as it activates alarms in the regional operations centre when a failure occurs at a pumping station.

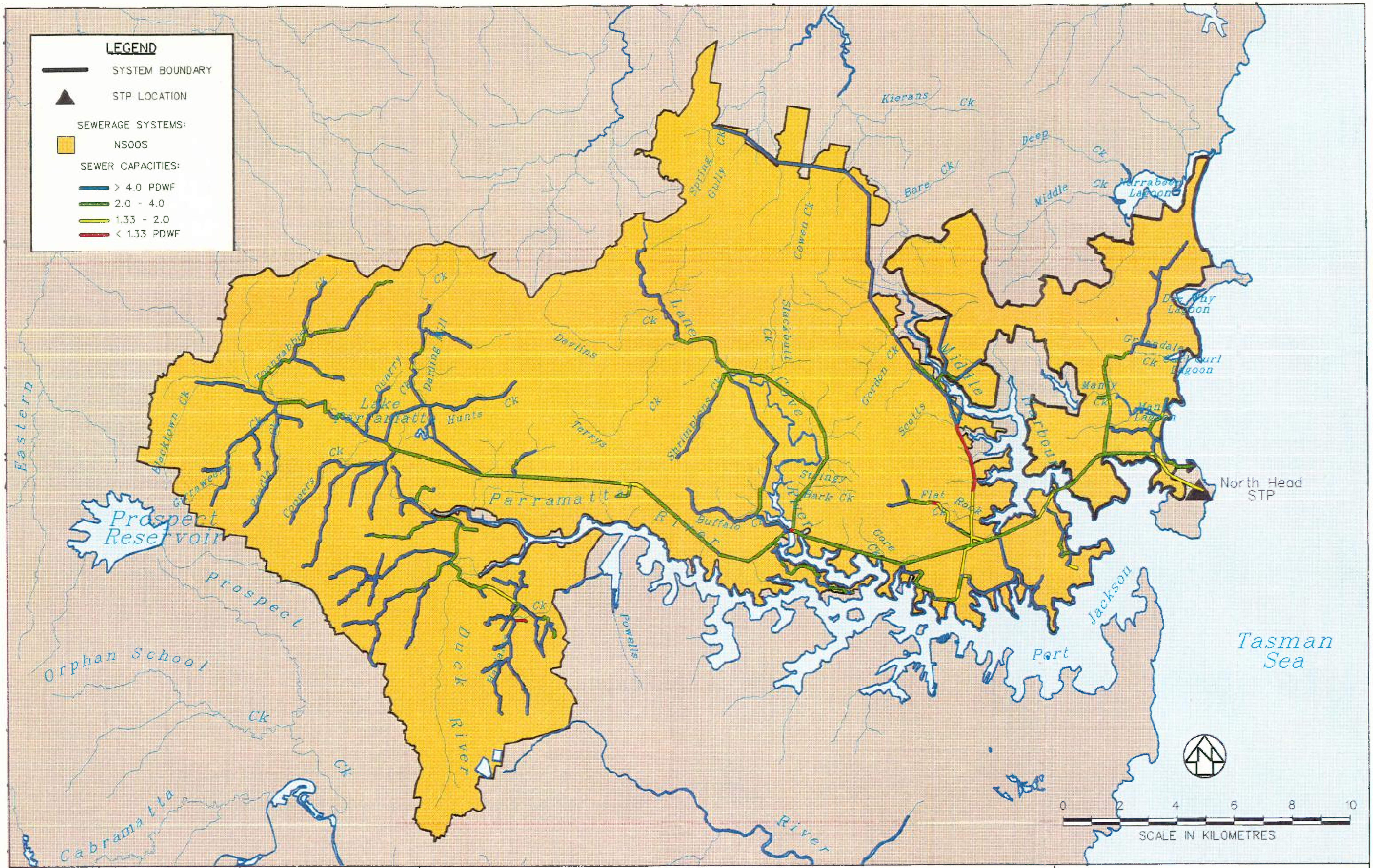
Common faults detected by the performance assessment of sewerage systems included unsatisfactory telemetry, unit control and procedural control, motor starters, pumps, and power supply at some pumping stations. Yearly performance reports are compiled by Sydney Water on SPS failures in the NSOOS system.

2.4 Sewage characteristics

2.4.1 Dry weather sewage characteristics

Raw sewage consists of the combined discharges from industry, commerce and domestic residences. In addition, sewage may contain groundwater and stormwater which can infiltrate into the sewerage system. Generally, sewage contains about 99.9% water and 0.1% solids.

To characterise the magnitude and variability of chemicals in sewage discharges, data from existing effluent sampling programs for Operating Licence compliance purposes have been used (Sydney Water 1995a). In November 1989, Sydney Water implemented the sewer catchment sampling program to assist in the assessment of the effectiveness of the then newly developed trade waste policy. This sampling program is ongoing.



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NSOOS SEWERAGE SYSTEM

FIGURE 2-3
DRY WEATHER
TRUNKLINE CAPABILITY INDICATOR

The wastewater source control data has been considered to be representative of dry weather flow water quality in the sewer system since the sampling was conducted over days of dry or almost dry weather to minimise the diluting effect of inflow/infiltration.

There are six sampling locations where sewage data was collected for the NSOOS, namely:

1. Burns Bay sewer at the sewer aqueduct, Kooyong Road, Lane Cove
2. Camelia sewage pumping station No 67 at Grand Avenue, Camelia
3. Clontarf sewer at Amiens Road, Clontarf
4. Dundas sewer at Kissing Point near Robertson Park, Dundas
5. Lane Cove sewer at Burns Bay Road, Lane Cove
6. North Head sewage treatment plant inlet at Bluefish Drive, Manly.

The dry weather 10, 50 and 90 percentiles for conventional sewage parameters are presented in Table 2.3.

Table 2.3 - NSOOS conventional sewage parameters

	10 percentile (mg/L)	50 percentile (mg/L)	90 percentile (mg/L)
Ammonia	17.3	28	33.6
Total Phosphorus	4.9	8.3	10.3
BOD	111.9	239	499.2
Total Kjel. Nitrogen	30.5	42.2	50.4
Suspended Solids	120	200	295

Note: Sewage samples collected at STP inlet twice a year in May and August (1993 to 1995). Refer to Appendix H for sewage characteristics summary.

Source: Sydney Water, 1996.

Chemicals in sewage

Sewage in the NSOOS system contains a wide range of chemical compounds. The substances typically found in sewage effluent are from commercial, industrial and household sources. They include: polyaromatic hydrocarbons (PAHs), monocyclic aromatic compounds, metals, organochlorine pesticides, halogenated aliphatic compounds, organophosphate pesticides, herbicides, conventional and other organics (Sydney Water, 1995a).

The chemicals that have been analysed in the sewage samples cover a wide range of pollutants with the number of parameters measured being approximately 70. Some parameters were measured intensively at some locations but not at others, reflecting anticipated differences in effluent quality because of the presence of certain industry types. The statistical analysis of the results has focused on chemicals of concern which were above detection limits and which were measured at most sampling points. The selection process of influent parameters to be analysed was divided into two steps.

The first step eliminated the parameters which had a considerable number of samples below detection limits. After eliminating non-detectable parameters, the number of parameters was reduced to approximately 40 analytes. The second step selected the chemicals of concern as identified in the *"Preliminary assessment of chemicals in sewer overflows and stormwater, December 1995"* report prepared by Sydney Water. The chemicals of concern were those which had a high percentage of recorded concentrations above acute toxicity criteria for either human health or for aquatic life.

This selection process identified 12 parameters for which a simple statistical analysis was carried out to estimate the variation in sewage composition within the sewer catchment and also to determine the variation in sewer water quality at each sampling point. The selected parameters were: ammonia, delta BHC, total aluminium, total arsenic, total chlordanes, total copper, total iron, total lead, total mercury, total nickel, total silver and total zinc.

Although not calculated from the available data, domestic sewage normally has a total nitrogen of about 40 mg/L, total phosphorus of 8 mg/L and a BOD of about 220 mg/L.

Microbiological quality

The microbiological components of sewage generally comprise bacteria, viruses and parasites such as protozoa. Bacteria include faecal coliforms (often used as indicators of the presence of sewage in receiving waters), faecal enterococci and *Clostridium perfringens* (the spores of which are sometimes suggested as an alternative indicator of faecal pollution).

Viruses such as enteroviruses, hepatitis, adenoviruses, rotaviruses and calciviruses have been associated with swimming related illnesses. Protozoan parasites such as *Cryptosporidium pravum* and *Giardia lamblia* can also affect persons having primary contact with the waters.

A study of the microbiological quality of the raw sewage entering Sydney Water's STPs was undertaken by Long and Ashbolt (1994). The results are summarised in Table 2.4.

Table 2.4 - Bacteriological sewage parameters

	Raw Sewage (cfu/100 mL) - 50%ile
Faecal coliforms	2.5×10^7
Giardia	30,000 cysts/L
Cyrptosporidium	32.2 cysts/L
Clostridium perfringens	1.3×10^5

Source: Long & Ashbolt, 1994

Trade wastes

Chemicals in sewage can be derived from non-point sources, such as the use of pesticides within the sewerage system catchment, or from point sources such as discharges of industrial effluent to the sewer. Sydney Water cannot directly control the quantities of chemicals entering the sewer through non-point sources. However, Sydney Water controls point sources of chemicals through a Wastewater Source Control Policy, which is based on a system of trade waste agreements with commercial and industrial customers who discharge effluent to the sewerage system. These trade waste agreements specify volume, concentration and mass of different substances in commercial and industrial effluent that may legally be discharged to the sewer.

Trade waste dischargers are divided into four categories for the purpose of licence agreements:

1. Category One - commercial establishments producing residential-type substances in their trade wastewater streams
2. Category Two - operating small businesses producing low annual mass loads of residential type substances and low daily mass loads of non-residential-type substances
3. Category Three - all customers whose discharge cannot comply with the conditions relating to Categories 1 or 2, and whose trade wastewater is treated at an STP at which Sydney Water provides the equivalent of primary or advanced primary sewage treatment

4. Category Four - all customers whose discharge cannot comply with the conditions relating to Categories 1 or 2, and whose trade wastewater is treated at an STP at which Sydney Water provides the equivalent of secondary or tertiary sewage treatment.

Sydney Water's Source Control Policy has traditionally been focused on the loads and concentrations of particular substances entering STPs and the ability of the STP to reduce these loads to acceptable levels before discharge to receiving waters. It therefore requires the dischargers to treat their waste streams to an acceptable level prior to discharge to the sewers. However, the concentrations of trade waste substances at the STP have been diluted by all of the wastewater flowing through the system. Concentrations at particular points in the wastewater system, corresponding to industrial areas or major trade waste dischargers, will be significantly higher than the concentrations received at the STP. Sydney Water's Source Control Policy does not specifically consider the spatial variation in sewage characteristics and the potential risks associated with overflows immediately downstream of industrial areas or major trade waste dischargers.

Trade waste dischargers in the NSOOS area include Category 1 to 3 dischargers. There are numerous commercial properties ranging from small dischargers producing less than five kL/day to medium sized dischargers producing more than 25 kL/day. The main concern with respect to small commercial dischargers is oil and grease, especially from food processing or supplying companies. There are a number of industrial areas in the NSOOS catchment where Category 3 dischargers are concentrated. These areas included the parts of Blacktown catered for by the NSOOS and Auburn. A summary of the Category 3 dischargers to the NSOOS system is given below in Table 2.5.

Table 2.5 - Major Trade Waste Dischargers - NSOOS

System	Category	Number of licenses	Average trade waste kL/d
NSOOS	3	139	18 008

Source: (Sydney Water 1996b).

2.4.2 Wet weather sewage characteristics

The existing wet weather containment standard varies across different parts of the extensive NSOOS system. As the NSOOS impacts on a number of different REZs, the average containment standard in each REZ affected is different. The REZs and the modelled average containment standards for parts of the NSOOS impacting on each REZ is summarised below.

1. Upper Lane Cove River, 200 events in ten years (< one month containment)
2. Upper Parramatta River, 78 events in ten years (< two month containment)
3. Sydney Harbour, 186 events in ten years (< one month containment)
4. Northern Lagoons, 71 events in ten years (< two month containment)
5. Northern Beaches, 35 events in ten years (three month containment)

Even within the REZs, the containment standards can differ markedly. Notably, the containment standards for the Northern Lagoons and within the Sydney Harbour REZ differ markedly. Containment standards for the Northern Lagoons and for area within the Sydney Harbour REZ are given below.

North lagoon containment standards:

1. Manly Lagoon, 71 events in ten years (< two month containment)
2. Curl Curl Lagoon, 20 events in ten years (six month containment)
3. Dee Why Lagoon, 13 events in ten years (nine month containment)
4. Narrabeen Lagoon, 13 events in ten years (nine month containment)

Sydney Harbour containment standards:

1. Lane Cove River estuary, 116 events in ten years (one month containment)
2. Parramatta River estuary, 186 events in ten years (< one month containment)
3. Middle Harbour, 161 events in ten years (< one month containment)
4. Port Jackson, 157 events in ten years (< one month containment)

As part of the Corporatisation requirements of Sydney Water, an ecological and human health risk assessment of sewer overflow has been undertaken by the company. The findings of this study are found in the report. Ecological and Human Health Risk Assessment of Chemicals in wet weather sewage overflow in the Sydney Illawarra - Blue Mountains Regions (Sydney Water 1998a).

As part of the risk assessment, overflow sampling and analysis was conducted at several locations on the Sydney sewer system. Four of these locations were on the NSOOS.

Table 2.6 gives the location of the overflow sampling points and the period for which data was collected at all sites in the NSOOS system.

Table 2.6 - Location of sewer overflow sites and period of sampling for the NSOOS system

Location	Sampling period	Description
Gloucester Ave	April 1994 to March 1995	NSOOS East Lane Cove Submain at Gloucester Ave (freshwater)
Lane Cove Siphon	March 1995 to May 1995	NSOOS at Lane Cove Siphon, Gladesville (Marine)
Quakers Hat Bay	July 1993 to March 1995	NSOOS at Quakers Hat Bay (Marine)
Tunks Park/Long Bay	January 1995	NSOOS West Middle Harbour Submain at Tunks Park (Marine)

The wet weather overflow discharge characteristics of the 11 urban sewerage overflow sites sampled in Sydney Water's ecological and human health risk assessment study (ERA) for sewerage overflows, together with the average dry weather sewage characteristics in the NSOOS catchment and the range of wet weather sewage characteristics for the NSOOS catchment are shown in Table 2.7.

Table 2.7 - Wet weather sewage quality

Parameter	Concentrations Average dry weather sewage characteristics in NSOOS catchment	Range of wet weather overflow characteristics for 11 urban sewerage overflow sites*	Range of wet weather sewage characteristics identified for the NSOOS system.
Conventional parameters			
Ammonia (mg/L)	28.0	3-5	0.7 - 1.5
BOD (mg/L)	239	-	-
Suspended Solids (mg/L)	200	40-200	20 - 200
Total Phosphorus (mg/L)	8.3	0.8-5	0.7 - 5.0
Metals			
Total Aluminium (μg/L)	0.9	0.5-5	0.2 - 3.0
Total Arsenic (μg/L)	0.003	0.001-0.004	0.001 - 0.002
Total Chromium (μg/L)	-	0.002-0.03	-
Total Copper (μg/L)	0.17	0.02-0.2	0.01 - 0.1
Total Iron (μg/L)	1.1	1-3	0.3 - 3.0
Total Lead (μg/L)	0.02	0.007-0.05	0.004 - 0.04
Total Mercury (μg/L)	0.004	0.0001-0.001	0.0001 - 0.0006
Total Zinc (μg/L)	0.17	0.1-0.3	0.04 - 0.3

Note: *Sites sampled as part of the Ecological and Human Health Risk Assessment project

Samples are taken from receiving waters

Source: Sydney Water 1995a; Sydney Water 1996.

As shown in Table 2.7, the wet weather concentrations for total phosphorus is approximately half the average dry weather concentrations. The ammonia concentration is substantially decreased during wet weather. In wet weather, most metal concentrations are lower than the average concentrations in dry weather. This is likely to be as a result of dilution effects when the sewage enters the water body, although, the degree of dilution varies significantly for each compound.

2.5 Extent of the overflow problem

The extent of the overflow problem in the NSOOS system has been determined largely from the results of sewer modelling and gauging data. Historical records of overflow events have also been examined for the most recent information.

Sewer flow model simulation of the NSOOS system for the existing population predicts that all components of the system have sufficient capacity to contain dry weather flows under ideal operating conditions but that sewerage overflow discharges will occur as a result of hydraulic overload during wet weather. The incidence and magnitude of all types of sewerage overflows in the NSOOS system are discussed in the following sections.

2.5.1 Wet weather overflows

As discussed previously, wet weather overflows have been defined, for the purposes of this EIS, as those overflows caused by excess infiltration/inflow to the sewerage system and include partially treated STP discharges. This definition of wet weather overflows is compatible with the assumptions of the hydraulic sewer model. Other factors influencing the wet weather overflows include; loss of pipe capacity due to siltation or blockage, and downstream backwater effects and poor hydraulic conditions.

Studies of performance during wet weather of Sydney Water wastewater systems indicate that up to 39 per cent of rainfall can enter the sewerage system in some areas. The actual percentage is dependent upon a number of catchment variables including age and extent of deterioration of the sewerage system, soil and strata types, catchment size and the rainfall-runoff relationship of the catchment (based on vegetative cover, catchment wetness, soil type etc.) and rainfall intensities. The overflow is also dependent upon capacity trunk sewers and carriers.

The performance of the NSOOS system during wet weather conditions, including the frequency and volume of wet weather overflows and the percentage of rainfall ingress to the sewers, was estimated using the time series hydrologic and hydraulic analysis (using MOUSE modelling tool) of the system which are detailed in Appendix A. A description of the modelling methodology is given in the Method Volume of this EIS. For the NSOOS system, 160 overflow points were modelled. These modelled overflow points fall into two categories, designed overflow structures and reticulation overflows. A designed overflow is an actual physical structure in the sewer system that is designed to direct the sewer overflow discharge to a known location. A modelled reticulation overflow is a point in the sewer model which represents a catchment area. The discharge can occur anywhere within the catchment from both designed overflow structures or other location such as undirected discharges from access chambers. In the NSOOS system, 41 designed and 119 reticulation overflows were modelled.

The wet weather sewerage system performance is defined by rainfall events over a ten year period (January 1985 to December 1994). The calculated overflows are summarised in Table 2.8 for the ten largest overflows (in terms of volume discharged). During this period a total of 602 discrete rainfall events were run through the model to determine the frequency, volume and duration of overflows from the 160 modelled overflow points. All the modelled overflow points were activated during the ten year period.

The overflow which discharges the most frequently is modelled overflow node EJ1, at Gloucester Avenue, West Pymble and located in the East Lane Cove Sub-main, discharging into Lane Cove River. The total volume discharged from this overflow is approximately four per cent of the total system discharge. Therefore, EJ1 dominates the system performance in terms of the number of events in the modelled period. However the modelling suggests that there are overflows which discharge a greater volume than EJ1. Overflows at the Lane Cove River Siphon (3120), at Tunks Park (WM1-17) and Quakers Hat Bay (820052U) were predicted to discharge between 11 412 and 20 788 ML over ten years. The performance of the individual overflows is summarised in Figure 2.4.

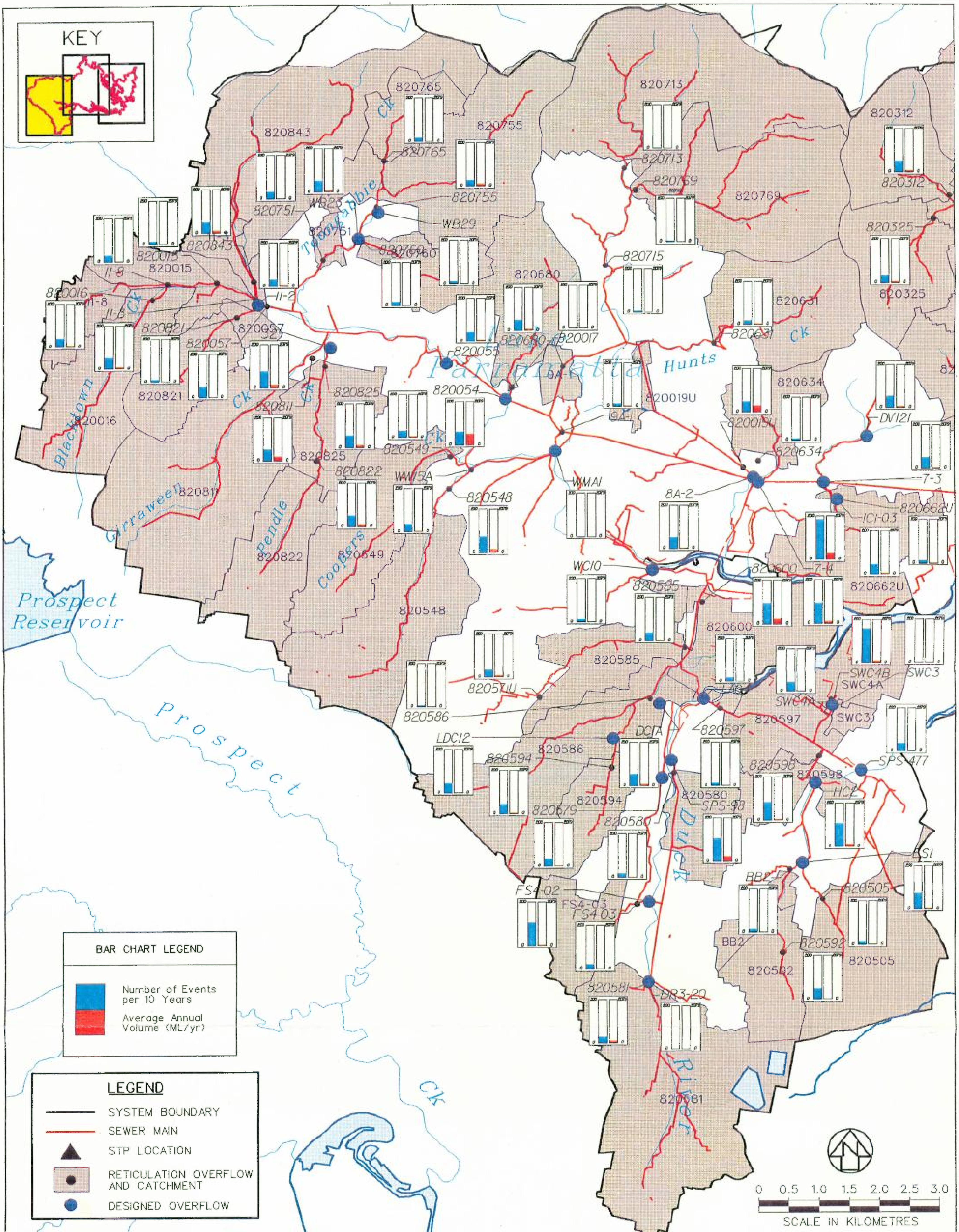

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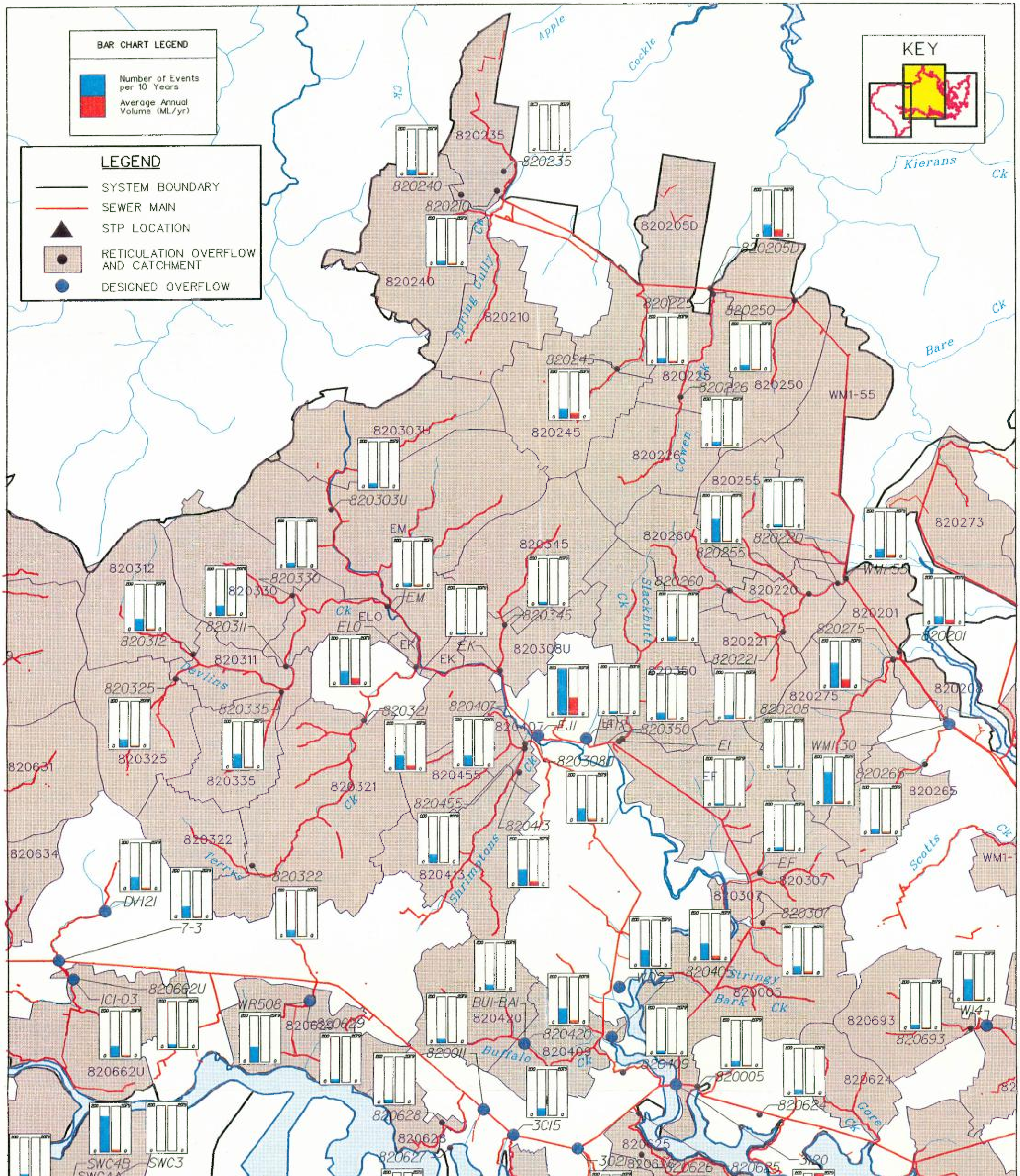
FIGURE 2-4a
SUMMARY OF
OVERFLOW EVENTS



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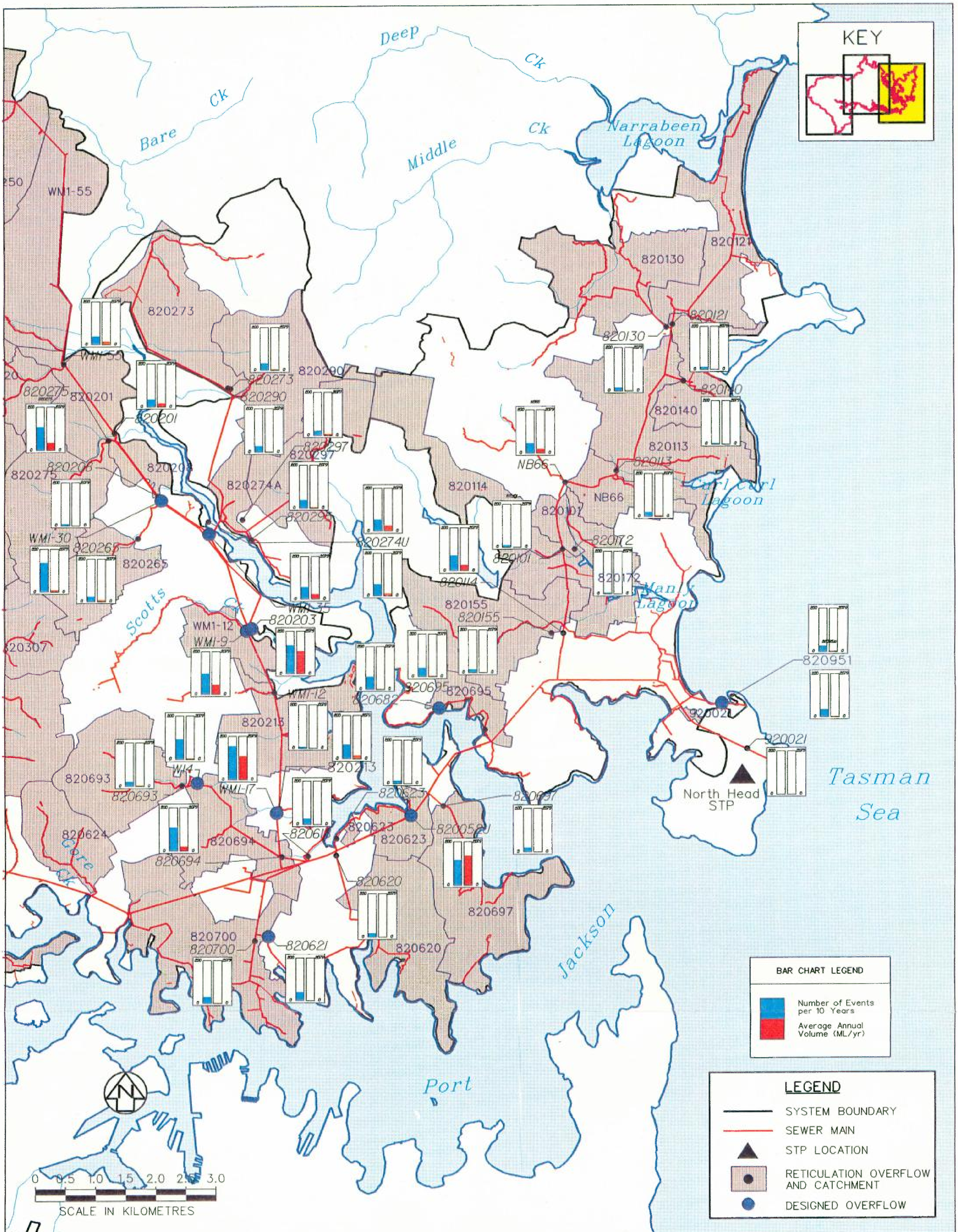
SEWERAGE OVERFLOWS LICENSING PROJECT
NSOOS SEWERAGE SYSTEM

FIGURE 2-4b
SUMMARY OF
OVERFLOW EVENTS



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SEWERAGE OVERFLOWS LICENSING PROJECT
NSOOS SEWERAGE SYSTEM

FIGURE 2-4c
SUMMARY OF
OVERFLOW EVENTS

Table 2.8 - Individual wet weather overflow summary for the 10 year time series NSOOS system - existing condition

Location	Modelled overflow node	Asset No.	Type of overflow	No. of events	Total duration (hr)	Total volume (ML)
Bums Bay Rd, Lane Cove	3120	NS083	Designed	114	2567.5	20788
Quakers Hat Bay O/F, Mosman	820052U	NS502	Designed	116	3219.5	14239
Tunks Park O/F, Northbridge	WM1-17	NS049	Designed	154	4216.0	11412
Glenroy/Greenfield Ave, Castle Cove	820203	NS034	Designed	134	4207.5	11337
Gloucester Av, West Pymble	EJ1	H503	Designed	200	5159.5	7897
Hood St, Toongabbie	820054	NS3OF012	Designed	61	1657.5	5363
Glenroy Ave, Middlecove	WM1-9	NS040	Designed	95	2159.0	4587
West Middle Harbour Sub-main	820275	-	Reticulation	109	2092.0	3761
NSOOS Trunk Main	820019U	-	Reticulation	53	725.0	3273
West Middle Harbour Sub-main	820205D	-	Reticulation	54	913.5	3203
Off Kissing Point Rd, Dundas	7-4A	NS3OF001	Designed	185	3515.5	3022
Carlye Ave, East Lindfield	WM1-30	NS004	Designed	137	2857.5	1029

A maximum of 237 overflow events (an event is a period of rainfall that leads to at least one individual overflow discharging) were predicted over the ten year period, discharging an estimated volume of 181,791 ML in ten years (Sydney Water, 1997a). The system performance was also assessed over the modelled ten year period to determine the yearly variation in overflow performance. Table 2.9 provides a summary of these results from the ten year time series modelling for all modelled overflows. Table 2.17, which presents results of the modelling data based on future conditions, lists overflow volumes from all the individual overflows modelled.

The overflow volume from five highest rank (based on volume) events comprised approximately 50% of the total overflows discharged to receiving environment zones. The largest overflow event from the NSOOS system occurred during a storm in August, 1986. The overflow volume discharged from this event was approximately 19 191 ML. This overflow volume comprised approximately 10% of the total overflows discharged to the environment in the ten year time series modelling run.

Table 2.9 - Yearly wet weather overflow summary for the NSOOS system - existing conditions

Year	No. of rainfall events	No. of overflow events	Total duration (hr)	Total volume (ML)
1985	56	27	692.0	10 110
1986	51	18	474.5	24 660
1987	54	27	584.0	13 776
1988	54	28	1 004.0	41 295
1989	63	32	1 004.5	14 956
1990	78	27	1 134.0	44 627
1991	59	17	378.5	16 280
1992	70	25	515.0	12 940
1993	63	17	191.0	1 117
1994	55	19	272.5	2 030
Total	**602**	**237**	**6 250.0**	**181 791**

2.5.2 Partially treated STP discharge

During heavy rain, sewage treatment plants have to handle much larger flows than in dry weather and can sometimes only partially treat the wastewater before discharging it. Studies have shown that pathogens and visible floating debris are the only pollutant types from overflows which significantly contribute to waterway pollution in wet weather. Accordingly, a partially treated sewage treatment plant discharge is deemed to be a sewerage overflow if it discharges floating debris or if its faecal coliform density exceeds 150 cfu per 100 millilitres because then the objective of maintaining recreational water quality criteria may be compromised. The deep ocean outfall performance is the equivalent of full treatment.

STPs are designed to receive flows from small storms and still fully treat wastewater within the limits imposed by their discharge licences. Flows above these levels are experienced for about two to six per cent of the time, or about eight to 20 days per year, when STPs are less able to provide full treatment or full disinfection. Disinfection and effluent fine screening have historically not been design requirements under such wet weather flow conditions. Disinfection and effluent screening, as currently designed, are less effective at such high flow rates, and faecal coliform levels rise sharply above the acceptable limit of 150 faecal coliform units per 100 millilitres, and often reach 1,000,000 faecal coliform units per 100 millilitres or more.

For current containment performance (refer to Chapter 2), all events where less than full treatment occurs are given in Table 2.17. This may considerably overstate the actual number of events when partially treated discharges are deemed to be sewerage overflows (that is when they exceed 150 cfu per 100 millilitre).

Sydney Water has decided that partially treated sewerage treatment plant discharges should receive at least fine screening and disinfection to less than 150 cfu per 100 millilitres up until the first system overflow discharges. This is the adopted base case abatement level which may be improved upon should environmental or other requirements deem it necessary. The base case for all other overflow types is to maintain the current performance.

Future containment performance goal (refer to Chapter 4), requires that only those events which will exceed 150 faecal coliforms per 100 millilitres will be considered as overflows from STPs. It is accepted that the future containment performance may be achieved by either storage or disinfection which are considered to be equivalent in terms of pathogens.

Sewage collected in the NSOOS receives preliminary and primary treatment at the North Head STP, prior to being discharged into the ocean. Between 1926 and 1970 raw sewage was discharged directly to the ocean at the cliff face adjacent to the plant. Following the commissioning of the influent screens in 1971, the plant has been progressively expanded and upgraded to the present high rate primary treatment plant. Following the commissioning of a 3.5 kilometre long deep ocean outfall in 1990, use of the cliff face discharge has been limited to emergency situations.

The North Head STP currently provides treatment for a population of approximately 1,000,000 treating a mean daily dry weather flow of approximately 316 ML/day (Sydney Water 1997a). The maximum dry weather flow to this STP is 423 ML/day. The maximum wet weather flow to the STP from existing catchment conditions is 1038 ML/day, which is limited by the capacity of NSOOS. The predicted mean dry weather flow to the treatment plant in the year 2021 conditions will be approximately 344 ML/day from a predicted population in 2021 of 1 070 000 (Sydney Water 1997a).

The existing preliminary and primary treatment plant at North Head has sufficient hydraulic capacity to treat up to 1050 ML/day. The ocean outfall was designed for an ultimate hydraulic capacity of 2400 ML/day (Sydney Water 1997b). Table 2.10 summarises the existing plant performance with respect to overall levels of treatment.

The continuum of operations within the plant is as follows:

1. low flows (< 260 ML/day) no partially treated discharge to the cliff face
2. medium flows (< PDWF 423 ML/day) produces no partially treated discharge to the environment
3. high flows (< Plant Capacity 1050 ML/day) produces no partially treated discharge to the environment. As the capacity of the NSOOS is limited to 950 ML/day, there is no record of a partially treated STP discharge to the cliff face due to extreme wet weather events. The full treatment train is available at full plant capacity.

Table 2.10 -Summary of existing treatment levels for North Head STP

Level of treatment	Flow able to receive level of treatment	Comments
Raw sewage pumping to treatment	flow up to 1050 ML/ day	The hydraulic capacity of the lower NSOOS is limited to about 950 ML/ day. During extreme storm events flow can back-up in the system causing the NSOOS to become pressurised. On such occasions, the flow to the plant can reach 1050 ML/day for brief periods.
Fine Screens	flow up to 1040 ML/day	Connected to emergency diesel generators so that in situations where total loss of power supply occurs, a screened STP discharge to the cliff face is possible for extended periods. Coarse screens can be used in emergency situations.
Grit removal and primary sedimentation	flow up to 1050 ML/ day	The hydraulic capacity of the existing plant matches current peak wet weather flow.
Ocean Outfall	flow up to 1650 ML/ day	Recent modelling shows that the current outfall diffuser configuration and drop shaft will carry up to 1650 ML/day. The outfall hydraulic capacity is 2400 ML/day with a modified diffuser configuration.

Note : *The flow coming from the ocean outfall discharge into the sea through a special hydraulic arrangement of nozzles diffuses the flow effectively during low and high flow conditions. To operate the outfall efficiently for the low flows currently being passed through it, the outfall has a configuration which uses only about half of the nozzles fitted

Source: Sydney Water 1997b

Sewage effluent quality from the NSOOS system is monitored at the outlet of the North Head STP. The 1996/97 licence conditions for the North Head STP effluent, together with the 50 and 90 percentile values for effluent quality from the plant are shown in Table 2.11.

Table 2.11 - North Head licence conditions and STP effluent quality

Parameter	1996/97 licence conditions		STP plant effluent quality 1996/97	
	50 percentile (mg/L)	90 percentile (mg/L)	50 percentile (mg/L)	90 percentile (mg/L)
NFR	200	250	177	203
Grease and oil	45	70	24	31

Note: NFR = Non Filterable Residue

Source: EPA 1997

The existing capacity of the deep water ocean outfall means that flows received during wet weather are all discharged through the ocean outfall and not through the cliff face outfall.

There are no partially treated STP discharges from the North Head STP under the existing conditions. At present the hydraulic capacity of the STP matches the hydraulic capacity of the NSOOS sewerage system.

2.5.3 Choke related overflows

The NSOOS sewerage system has sufficient hydraulic capacity to transport both existing and future dry weather flows to the STP so there will be no overflows due to hydraulic bottlenecks in the system. Chokes are due to partial or complete pipe blockages caused by tree roots, collapsed pipes, siltation, grease build up or similar restrictions.

Sydney Water records customer complaints of overflows relating to chokes on a database. The number of chokes recorded in this database has remained relatively steady recently in the NSOOS, although there was a notable drop in numbers recorded after 1994/95. No data is available on the actual volume, duration or environmental impacts of discharges associated with sewer chokes.

In order to allow identification of the areas worst affected by chokes, the number of chokes has been calculated on a per suburb basis. In addition, to allow a reasonable comparison between suburbs, the number of chokes has been "normalised" into chokes per 100 kilometres of sewer as a measure of choke density.

At present, Sydney Water aims to contain chokes to 60 per 100 kilometres of sewer as per the NSW Annual Water Supply and Sewerage Reporting System. Sydney Water considers that a high level of chokes per suburb is three times this benchmark limit. Suburbs have been ranked in order of choke density on a system basis, and have then been grouped into one of three categories:

1. Suburbs with a "high" choke density (>180 chokes per 100 kilometres)
2. Suburbs with a "medium" choke density (60 - 180 chokes 100 kilometres)
3. Suburbs with a "low" choke density (<60 chokes per 100 kilometres)

The choke density in each suburb will be used in conjunction with other information to prioritise sub-sections of the sewerage system for rehabilitation.

The suburbs in the NSOOS considered to have a high overflow ranking include:- Henly, North Curl Curl, Cheltenham, Turramurra, Castle Cove, West Pymble, Killara, Putney, St Ives, Warrawee, Castlecrag, Middle Cove, Old Toongabbie, Lindfield, Pymble and Balgowlah (16 suburbs). A further 74 suburbs have a medium choke frequency and 38 suburbs served by the system have a low frequency of chokes. A full list of suburbs in the NSOOS and their choke category is included in Appendix B and is presented graphically in Figure 2.5.

Across the entire Sydney sewerage system, 53 per cent of sewered suburbs are considered to have a low choke density, 40 per cent have a medium choke density and seven per cent have a high choke density. Within the NSOOS system, 16 out of the 128 suburbs served are considered to have a "high" choke density. This is slightly worse than the Sydney wide situation, possibly reflecting the age of infrastructure or the large number of trees in the area.

Recurring choke problems

Sydney Water considers prevention and rectification of repeat chokes to be a priority in customer satisfaction. Areas prone to recurring choke problems are identified by Sydney Water's on-going repeat choke program. A repeat choke is considered to have occurred when two chokes occur at the same location in the space of six months, or three chokes occur at the same location in the space of two years.

Sydney Water has management systems in place to identify and rectify problems resulting in repeat chokes. Repeat chokes are used as an indicator of potential problems in the sewerage system which need to be addressed. When a repeat choke occurs, Sydney Water conducts a site assessment, rectifies the immediate problem and determines whether any rehabilitation or pro-active maintenance is required. In many cases, the sewer in which the repeat choke occurred will be added to the CCTV inspection program (described previously) to identify the cause of the repeat chokes.

2.5.4 Exfiltration

Sewerage system sub-catchments where infiltration or exfiltration may be occurring were identified by comparing average dry weather sewer flow (ADWF) data to expected sewer flows based on water consumption (WC) data. The quarterly sewer ADWF is calculated from recorded sewer flow data for each gauged sub-catchment while the expected sewer flow is calculated from metered WC per property. This method was also used to identify candidates for the I/E rehabilitation program (Table 2.12).

Twenty-two (22) sub-catchments have been identified as a candidates having exfiltration potential requiring further investigation of potential I/E rehabilitation. The exfiltration potential exists mainly in the areas of Manly, Narrabeen - Brookvale, East Lindfield - Castle Cove - Middle Cove, Northbridge - Cammeray - Spit Junction, St Ives - Turramurra - Wahroonga, Epping - Pennant Hills - Castle Hill, Strathfield - Chullora, Greystanes - Parramatta - Harris Park (refer to Figure 2.6, showing identified I/E areas in this catchment). There are 24 sub-catchments in the NSOOS system for which the infiltration/exfiltration potential is unknown.

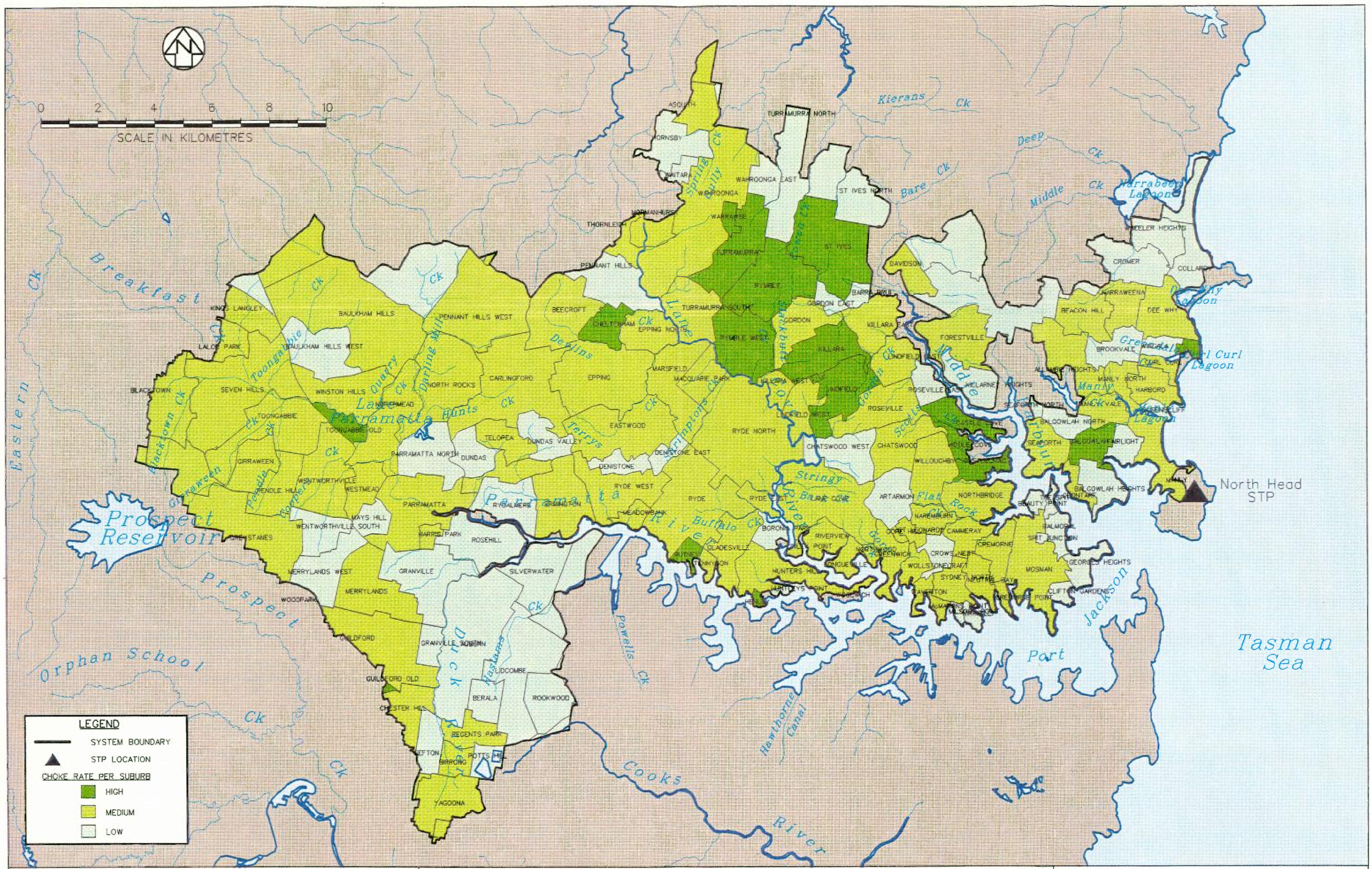
Areas with exfiltration problems may also be identified by examining water quality monitoring data. Median concentrations of faecal coliforms in receiving waters in dry weather greater than 1000 cfu/100 mL which can not be attributed to point source discharges including conventional overflows or rural run-off indicate that exfiltration of sewage into the receiving waters may be occurring and requires further investigation (Sydney Water, 1997d).

Dry weather monitoring of faecal coliforms in receiving water indicates potential sewage pollution in the Upper Parramatta REZ, where the water was only suitable for primary contact 10% of the time. Moderate potential for dry weather sewage pollution exists in the Upper Lane Cove River REZ, where 41% of days were suitable for primary contact; Sydney Harbour REZ, with more than 70%, (except Duck River - 65% and Long Bay 65%); and Northern Lagoons REZ, with more than 64% (except Upper Manly 29% and Curl Curl 57%).

Sydney Water does not monitor groundwater for faecal coliforms in the vicinity of sewer mains.

Table 2.12 - Infiltration/exfiltration (I/E) candidates

Leakage	Gauged sub-catchments	Inflow sub-catchments	Suburb	REZ
Exfiltration (high)	820210	820210	Wahroonga/Hornsby	Cowan Creek
	820203	820203	Roseville Chase/Castle Cove	
			Castlecrag/Northbridge	Sydney Harbour
	820207A	820213		Sydney Harbour
	820752		Northbridge	
	820202	WM1-17	Collaroy/Narrabeen	Sydney Harbour
	820131	820121		Northern Lagoons
Exfiltration (medium)	820542	820548	Graystanes/Pendle Hill/Girraween	Upper Parramatta River
			South Wentworthville	Sydney Harbour
	820585	820585	North Rocks	Upper Parramatta River
	820715	820715		Upper Parramatta River
			Chullora	Upper Parramatta River
	820561	820581		Upper Parramatta River
			West Pennant Hills/Beecroft	Upper Lane Cove River
	820769	820769		Upper Lane Cove River
			Rockwood/Lidcombe	Upper Lane Cove River
	820592	820592		Cowan Creek
			Pennant Hills/Beecroft	Sydney Harbour
	820313	820312		Sydney Harbour
			Epping	Northern Lagoons
	820321	820321		Northern Lagoons
			South Turramurra	Sydney Harbour
	820226	820226		
			Wahroonga/N.Turramurra	
	820250	820250	North Cremorne/Cammeray	
		820052U	North Cremorne/Mosman	
	820623	820623	Dee Why/Curl Curl/	
	820113	820113	Narraweena	
			Beacon Hill	
	820113	NB114	Manly	
	820696	820696		
Infiltration (high)	820054	820054	Wentworthville	Upper Parramatta River
		9A-3		Sydney Harbour
	820700	820700	North Sydney/Waverton	Sydney Harbour
	820265	820265	Lindfield/Killara	Sydney Harbour
	820340	EM	Epping North	
	820209			Northern Lagoons
	820121		Dee Why	Northern Lagoons
	820957U		Manly	
Infiltration (medium)	820627	820627	Gladesville	Sydney Harbour
	820694	820694	Naremburn, Crows Nest	Sydney Harbour
		W14	St Leonards	
	820155	820155	North Balgowlah	Sydney Harbour
	820548	WW15A	Pendle Hill, Wentworthville	Upper Parramatta River
	820053			



Sydney WATER

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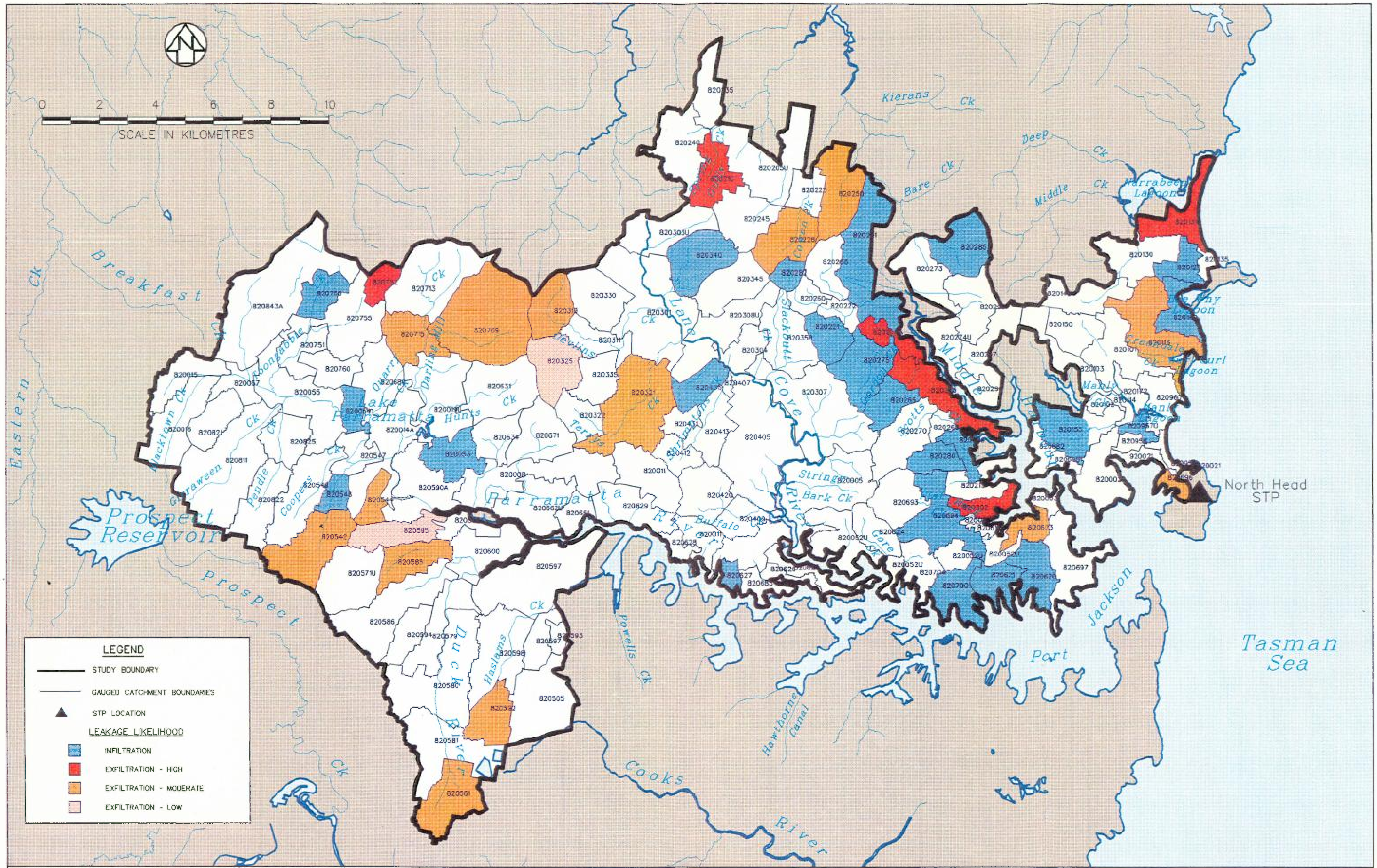
SEWERAGE OVERFLOWS LICENSING PROJECT
NSOOS SEWERAGE SYSTEM

FIGURE 2-5
CHOKE AREAS



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SEWERAGE OVERFLOWS LICENSING PROJECT
NSOOS SEWERAGE SYSTEM

FIGURE 2-6
POTENTIAL INFILTRATION/
EXFILTRATION AREAS

2.5.5 Overflows from SPSs

The pumping and storage capacities for the SPSs with detention time less than response time of the 87 SPSs in the NSOOS system are summarised in Table 2.13. Storage capacity is a measure of the time available (during peak dry weather flow) after a failure and before overflows occur. All SPSs (except SPS 1016) have on-line telemetry which activates an alarm in the regional operations centre when a pump fails or other faults occur. All the pump stations have standby pump capacity at PDWF, except SPS 201, 208 and 240. Twenty-four of the SPSs have a manual stand-by pump, although the remaining stations have automatically started stand-bys.

SPS pumping capacity for the NSOOS is summarised below.

1. 13.1% have a capacity <two times PDWF
2. 71.4% have a capacity two to four times PDWF
3. 15.5% have a capacity >four times PDWF
4. 15 of the pump stations have a detention time lower than the response time.

Table 2.13 - Pumping capacity and detention times for SPSs with detention time less than the response time

SPS No. and location	Detention time (hrs)	Pumping capacity (L/s)	Peak dry flow (L/s)
SPS 0117 (Manly)	4	11	4.52
SPS 0365 (Manly)	3	235	90
SPS 0487 (Ryde)	1.5	5.60	1.70
SPS 0159 (Tennyson)	3.5	49.2	19.1
SPS 0240 (Wollstonecraft)	2.5	3.7	2.2
SPS 0184 (Rydalmere)	3.8	181.6	75.0
SPS 0230 (Ermington)	3.8	85.0	23.0
SPS 0231 (Rydalmere)	3.2	174.0	57.0
SPS 0103 (Northmead)	0.4	600.0	N/A
SPS 0067 (Camellia)	2.8	1600 - 2400	1480.0
SPS 0098 (Auburn)	1.3	879	269.0
SPS 0141 (Rosehill)	2.3	30.3	15.0
SPS 0477 (Lidcombe)	1.1	280.0	70.0
SPS 0265 (Northbridge)	1	6.5	1.9
SPS 0615 (Frenchs Forest)	4..1	19.5	4.5

Source: Sydney Water

During 1996/1997, 655 failures occurred at the 87 SPSs in the NSOOS system as a result of unplanned power loss, sequential pump operation failure and level control failure. The four worst performing stations, each with more than 30 failures, were SPS 263, 140, 365 and 240. Sixteen (16) of the failures resulted in overflows from seven SPSs. The base case target is for the response time to each SPS failure to be less than the detention time for the SPS. The detention time is a measure of the storage time in an SPS before an overflow occurs when the pumps have failed , during peak dry weather flow (PDWF). Fifteen SPSs have a detention time less than the response time.

SPSs are typically constructed in low areas, close to foreshore or creeks. Overflows from SPSs therefore have the potential to enter waterways.

2.5.6 Odour emissions

During the period from July 1996 to June 1997, a total of 152 complaints were received regarding odours in the NSOOS catchment. A list of the suburbs in the NSOOS catchment with odour complaints (excluding the STP as the source of odour), are contained in Appendix B. The NSOOS system in the Mosman area was subject of the most odour complaints with 13. Suburbs with five or more complaints include Manly, Dee Why, Castle Cove, Balgowlah, North Turramurra and Cremorne.

2.6 Existing overflow management practices

Volume 1 of this EIS includes a description of minimum requirements for operation of sewerage overflows as laid out by the USEPA (1994). These requirements have been adopted as a benchmark against which to measure Sydney Water's current management techniques.

Management practices used in the NSOOS system are similar to those used in other sewerage systems operated by Sydney Water, as described in Chapter 2, Volume 1. New technologies and methods are constantly being investigated to improve and update the systems to current standards.

Specific practices and activities used in the NSOOS system include:

1. periodical inspection of trunk sewers
2. relining of pipes that deteriorated (more than 100 kilometres of pipes are scheduled to be relined in the 1997/1998 period
3. upgrade of SPSs to improve reliability, increase capacity and reduce odours
4. minimising the impact on the environment and the public by containing overflows where possible and cleaning after the event
5. compilation of data (asset database, database of overflow nodes and frequency of overflows and response, response to public complaints/problems). Expanded data collection (contingency plans for overflow tracking, response and operation) is required
6. long term rehabilitation plans being developed.

The operational management framework used by Sydney Water focuses on a system management approach. This management philosophy not only considers the individual pipes and pumps, but also the overall performance of the systems of pipes and pumps which deliver services to the required standards.

Some key elements of the existing system management approach involve:

1. gaining a better understanding of customers' and regulators' requirements at a systems level
2. obtaining a quantifiable understanding of the capability of the sewerage systems
3. interpreting system performance (such as reliability, integrity, utilisation and outputs)
4. developing and implementing a sound maintenance planning process
5. enhancing system performance and capability to meet business market demands
6. considering non-asset solutions, such as demand management, sewer mining, source control and changed operational practices, to achieve the required system performance
7. minimising life cycle costs of assets
8. ensuring environmental due diligence
9. managing business risks

10. ensuring a good incident management capability

11. improving the efficiency and effectiveness of the delivery of services to the required standards.

Important system management techniques to minimise the incidence and impact of sewage overflow include:

1. designing sewerage systems with sufficient hydraulic capacity to meet identified future requirements
2. implementing effective Wastewater Source Control activities to improve the quality of commercial industrial and residential wastewater discharged to the sewerage system
3. developing a better understanding of current system performance and environmental impact
4. effective operation and maintenance of assets to minimise equipment breakdowns and failures which may cause overflows
5. effective response to problems and incidents to minimise environmental impact.

Design philosophy

Sydney Water's current sewer design philosophy is to size sewers to cope with peak dry weather flows together with an allowance for infiltration and some stormwater inflow. For gravity sewers, an air space is also provided to help keep sewage aerobic and minimise the potential odour problems. In abnormal wet weather conditions, this air space is filled with sewage diluted by stormwater.

Depending on the density of development in a catchment or sub-catchment, Sydney Water's current design philosophy provides sewers with the capacity to handle the design wet weather flow which is between 1.7 and four times the peak dry weather flow. The higher ratio applies to areas with lower density development and for smaller systems.

If the storm inflow and infiltration exceeds the design allowance provided, the system is designed to divert excess flow from the sewerage system in a controlled manner via designed overflow points. This averts uncontrolled discharge of diluted sewage from access chambers and private sewers. Sydney Water's current practice is to generally design SPSs to have a pumping capacity equal to the design wet weather flow rate. This helps reduce the likelihood of overflows from SPSs.

For new urban developments, one of Sydney Water's key servicing requirements is that the provision of water and sewerage services must be appropriate and in accordance with Sydney Water design standards. This helps ensure new sewers do not contain the faults that exist in some of the older sewers and minimises the amount of infiltration and exfiltration occurring from new sewers.

Understanding and monitoring system performance

Sydney Water's information on the performance of its sewers is being constantly refined and updated. Since 1991, almost 400 sewer flow gauges have been installed in trunk sewers to gauge reticulation sub-catchments serving approximately 10,000 people. Flow data obtained from the gauges has been used to develop and calibrate computer based hydraulic models. This allows the performance of the system to be predicted and the identification of problems such as high inflow and infiltration, siltation, lack of hydraulic capacity, active major designed overflows and exfiltration. Results from the models are used extensively in developing strategic options for the future development and improvement of the sewerage systems.

Sydney Water currently monitors the frequency of overflows at 25 representative overflow sites. This monitoring records the start and finish time of the overflow operation and the associated rainfall recorded at a nearby rain gauge. The monitoring is currently provided to the EPAs Beachwatch and Harbourwatch branch.

In addition, Sydney Water is carrying out two major monitoring programs to assess the impact of sewage overflows: the Ecological Risk Assessment (ERA) program and the Environmental Indicators Program (EIP). Results from both of these programs have been published.

System operation and maintenance

Sydney Water has developed interim maintenance guidelines to identify the frequency of system inspection based on how critical an asset is in the operation of a system. Table 2.14 summarises Sydney Water's current asset maintenance practices.

The physical condition of the sewers are managed using a reliability centred maintenance framework. This determines the critically of asset operation and identifies what can be done to prevent, predict or delay asset failure. A key part of the approach is planned inspection. Inspections, which are carried out in accordance with the Australian Conduit Condition Evaluation Manual, are carried out either physically or through closed circuit television (CCTV).

The trunk sewers greater than or equal to 900 mm in diameter have been subject to regular internal inspection since the early 1970s and this has detected potential problems at an early stage and allowed remedial action to be taken before failure can occur. Minor (non-traversable) trunk sewers (less than 900 mm diameter) have not previously been the subject of regular inspection. Since 1991 however, Sydney Water have established an inspection program to establish the structural and service conditions of the trunk sewerage system with a view to developing a comprehensive renewal and rehabilitation program to minimise the potential for collapse. This program, developed as part of the Clean Waterways Program is still continuing. Sewers deemed to be critical and larger than 900 mm in diameter, other than unlined drill and blasted rock tunnels are inspected every ten years. Unlined drill and blasted rock sewers are inspected every five years. Critical sewers smaller than 900 mm are inspected by CCTV every ten years.

Service reliability and structural integrity assessments for the NSOOS trunk sewer is initially carried out by visual inspection. Because of the age of the NSOOS trunk sewer, the importance that its structural integrity is preserved and an increasing potential for gas attack to concrete with increased service life, many sections of the NSOOS trunk are now inspected every five years. The entire NSOOS trunk sewer was last inspected in 1993. Most of the critical sewers in the tributary sewers were inspected between 1992 and 1996 and a further 45 kilometres of critical sewer inspection by CCTV will have been completed by the end of 1998. Analysis of the CCTV inspection results generates an ongoing sewer relining and rehabilitation programme.

Aqueducts and siphons on the NSOOS trunk sewer are generally inspected at intervals of five years. Where problems of asset deterioration are identified the inspection intervals are more frequent. The siphon pipework under middle harbour and Lane Cove River is inspected every ten years. Most aqueducts and syphons were last inspected between 1993 and 1996. Siphon pipework was last inspected between 1988 and 1990. Analysis of the inspection results generates refurbishment projects to protect the assets from failure.

Over 80% of the NSOOS trunk sewer is concrete lined rock tunnel and is in reasonable condition requiring no major work. The ongoing programme of asset inspections reveal that renovation work is required for a number of major concrete structures and an ongoing refurbishment programme is addressing the identified problems.

In 1994 a Hazard Identification Analysis (HIA) was undertaken by Sydney Water for the NSOOS trunk sewer using the results of the 1993 asset inspection. The HIA considered the risk of asset failure occurring, the resultant risk of environmental harm and the likely degree of environmental harm. The 1994 HIA was only confined to the impact of the environmental consequences of failure such as asset repair costs, effect on public health and loss of service continuity to customers were not considered. Based on this risk analysis a ten year rehabilitation programme and refurbishment work was commenced immediately on assets with the highest risk of failure.

Table 2.14 - System monitoring, operation and maintenance procedures

Activity	Asset type	Procedure	Frequency
Overflows	All SPSs	Respond to overflow alarms/station failures. Contain and minimise overflow volume, dilute any overflow reaching the receiving environment, clear up visible solids. Record and report site conditions.	As necessary
	Overflow structures and access chambers	Identified from customer complaints. Respond as above.	As necessary
Surcharges	Sewer carriers, sewer reticulation	Identified from customer complaints and inspections by operations personnel. Respond as above.	As necessary
Odour	SPSs	Identified from customer complaints or inspections by operations personnel. Flush SPS to remove any grit or solid deposits	As necessary
	Sewer carriers and sewer reticulation	Manual inspection following customer complaint. Flush low-flow sections of pipe to remove siltation	As necessary
Asset condition and investigation	>900 mm diameter critical sewers other than unlined drill and blasted rock tunnels	Transversable - manually inspected	ten years
	Unlined drill and blasted rock tunnels	Inspection and reporting in accordance with Australian Standards	5 years
	Critical sewers <900 mm diameter	Inspection and reporting in accordance with Australian Standards	ten years
	Critical sewers deteriorated	Inspection and reporting in accordance with Australian Standards	As determined based on condition
	Rehabilitated sewers	Inspection and reporting in accordance with Australian Standards	5 years
	Non critical sewers with specific problems/repeat chokes	Inspection of sewers where a customer or property is affected for the third time in two years or twice in six months, followed by corrective maintenance and further monitoring if required.	As determined based on condition and corrective maintenance reports
	Overflow structures	Manual inspection to ensure performance of gas-check valve, ensure overflow pipe clear	1 year
	Access chambers	Manual inspection	As determined
	SPSs	Inspection of telemetry/instrumentation	4 months
		Check operation of valves and penstocks	4 months
		Mechanical and electrical inspection performance	6 months or 1 year
		Test pumps for capacity	As determined based on historic performance
		Measurement of overflow time	1 year
Dry/wet weather flow	At strategic locations in the system	Measurement of flow by depth and/or velocity flow gauges	Continuous
	In areas with suspected inflow/infiltration or exfiltration	Measurement of flow by depth and/or velocity flow gauges	Continuous over specific period of time

Since 1996, Sydney Water has been using a standardised Business Risk Assessment and Control (BRAC) evaluation following detailed condition assessment of the assets targeted by the HIA programme. The BRAC process considers the probability of asset failure, the resultant impact on health, safety, the environment, customer service and financial performance. Since the BRAC assessments a revised condition inspection and rehabilitation programme has been developed and implemented (summarised in table 2.15).

The NSOOS trunk sewer is generally in reasonable operating condition. It exhibits symptoms of its age but structurally is better than would be expected because of the continual inspections and repairs that are undertaken. There are no locations on the trunk sewer that are known to be structurally unsound.

Table 2.15 - NSOOS trunk sewer refurbishment plans and inspection dates

NSOOS structure	Refurbishment planned	Inspection program
Box section under Manly CBD (stage 1)	Refurbished 1997	2000
Box section under Manly CBD (stage 2, 3)	January to July '99	1996
Sewer at King Avenue, Fairlight	November '98 to March '99	1996
Clontarf Aqueduct	December '97 to May '98	1996
Spit Siphon "Down Leg" Chamber	Refurbished 1994	1998
Quakers Hat Bay Aqueduct	March '97 to December '97	1997
Brightmore Reserve Aqueduct	Refurbished 1996	1996
Alfred Street Junction Chamber, Cammeray	Not required	1996
Sewer beneath Berrys Creek, Greenwich	Not required	1996
Core Creek Aqueduct, Riverview	Refurbished 1995	2001
Sewer near Woodford Bay, Northwood	Not required	1996
Bums Bay Aqueduct, Riverview	Refurbished 1995	2001
Lane Cove Siphon "up leg" chamber	November '97 to June '98	1997
Lane Cove Siphon pipework under river	-	2000
Lane Cove Siphon "down leg" chamber	Refurbished '96	2001
Sewer near Peel Park, Gladesville	Not required	1996
Sewer near Bremner Park, Gladesville	Not required	1996
Morrison Creek Aqueduct, Ryde	April '98 to December '98	1996
Sewer near Hermitage Road, West Ryde	Not required	1996
Sewer near Herbert Street, West Ryde	May '97 to November '97	1995
Kissing Point Road junction chamber, Dundas	April '97 to June '98	1995
Vineyard Creek Aqueduct, Dundas	Refurbished '97	1995
Vineyard Creek pipe crossing, Dundas	Refurbished '97	1995
Darling Mills Creek Aqueduct, North Parramatta	Not required	1995
Toongabbie Creek Aqueduct, Northmead	Not required	1993
NSOOS Tunnels from Middle Harbour to Ermington	Depends on inspection	1998
Sewer near Chatham Road, West Ryde	Not required	1996

Interim infiltration/exfiltration programme

Over the past seven years, Sydney Water has conducted an extensive inflow defect detection and repair compliance program. Inflow is due to faults in private sewers. Smoke-testing of half of the properties in Sydney Water's area of operations (more than 526,000 properties) identified low-lying surface gullies in privates sewers, illegal roof water connections to private sewers and other faulty components. More than 129,000 properties were found to have faulty private sewers, about 85% of which could be fixed relatively quickly.

In addition, Sydney Water has been investigating and developing methods to undertake an ongoing I/E correction program. Several prototype studies of increasing size and complexity have enabled Sydney Water to assess the efficacy and cost effectiveness of various techniques for a variety areas with different drainage characteristics, pipe types and ages.

The results of early investigations into I/E control techniques has been used to develop an interim control program. Indicative expenditure on this control program from 1996/97 to 2000/2001 is $68 million for the NSOOS system.

2.7 Effects of growth

The previous section described the extent of the NSOOS sewerage system overflows for existing conditions (based on modelling results carried out for 1994/95 conditions). As the population of the catchment increases, the frequency and volume of overflows is likely to increase, particularly in the case of overflows influenced by system capacity if no abatement measures are implemented. This section describes the effect of catchment growth over the next 24 years on the NSOOS sewerage system overflows in terms of predicted system performance for the year 2021.

Development in the NSOOS catchment over the next 24 years will be associated with a mixture of new residential growth from the Urban Release Areas and residential redevelopment near the major centres. As the Urban Release Areas at Hornsby, Baulkham Hills and Blacktown are almost completely developed, the new residential growth is likely to be limited in scale. Both resident and transient populations will continue to grow in the major commercial centres including Chatswood, Ryde, Parramatta and North Sydney.

The most likely development scenario for the NSOOS catchment is presented in Table 2.16.

Table 2.16 - Estimated population for the NSOOS sewerage system catchment 1991-2021

Sub-Catchment	Area (ha)	Population (year)	
		1993/94	2021
NSOOS System	42 971.9	984 955	1 069 781

Future wet weather overflow performance

The 2021 performance of wet weather overflows has been modelled using the above population growth estimates. The Average Dry Weather Flow (ADWF) from existing conditions (1994) to the future developed conditions (2021) will be increased from 316 ML/day to 344 ML/day. Most of the population increase will result from infill development and wet weather flow is not predicted to increase. The wet weather system performance has been determined for both existing catchment conditions and future conditions with some system improvements to limit the number of overflow events to 40/ten years and 20/ten years. The predicted number of overflow events for three month and six month containment plans is 72 and 37 respectively over ten years. This compares with 237 events predicted based on the existing system with no modifications. The 2021 system performance, with three and six month containment options, is summarised in Table 2.17.

The 2021 system performance with no modification to the system was not modelled. Note that the containment options seek to limit the number of overflow events to 40 or 20 in ten years (three or six months containment) on a REZ by REZ basis. As the catchment is so large, some rainfall events are restricted to parts of the catchment. This results in the number of overflow events for the entire system being greater than the number of overflow events in any one REZ (72 across the system as opposed to 40 per REZ per ten years for the three month standard).

Table 2.17 - Wet weather overflow performance for existing and future (2021) conditions(40 events/10 years and 20 events/10 years) - NSOOS system

		Existing condition/10 years		40 events/10 years		20 events/10 years	
Location	Modelled overflow node	No. of events/10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume(ML/ 10 years)
Gloucester Av, West Pymble	EJ1	200	7897	39	1220	19	878
Off Kissing Point Rd, Dundas	7-4A	185	3022	38	395	10	40
Private Prop. Derby St, Auburn	SWC4B	158	1158	26	228	18	126
Tunks Park O/F, Northbridge	WM1-17	154	11412	11	535	8	403
52, Carlye Ave, East Lindfield	WM1-30	137	1029	26	140	18	193
Glenroy/Greenfield Ave, Castle Cove	820203	134	11337	19	8328	16	8313
Quakers Hat Bay O/F, Mosman	820052U	116	14239	12	1484	10	1022
Bums Bay Rd, Lane Cove	3120	114	20788	19	5284	15	4919
Tooheys Nyrang St, Lidcombe	HC2	109	1103	17	164	6	42
West Middle Harbour Sub-main	820275	109	3761	21	800	12	1405
Auburn Golf Course, Auburn	FS4-02	107	481	17	95	13	37
Shepherd St, Auburn	SPS-98	107	2400	7	28	8	38
Willoughby Sub-main	820694	107	2311	36	780	20	547
West Middle Harbour Sub-main	820255	104	550	14	125	10	45
SPS-67 System	820600	98	2791	20	1063	17	1005
Off Kissing Point Rd, Dundas	7-4B	96	1129	38	361	10	50
Glenroy Ave, Middlecove	WM1-9	95	4587	3	6	1	0.1
Gaza St End, Willoughby	W14	92	542	13	163	12	128
Tarban Creek O/F, Hunters Hill	3021	89	2088	38	426	16	320
SPS-67 System	820598	84	525	7	31	1	5
29, Woodlawn Drive, Toongabbie	32	78	1501	15	110	14	43
SPS-103 System	820548	76	1738	19	329	14	235
Wyatt Park Olympic, Lidcombe	ES1	75	372	21	106	19	69
Jeanette St, Lane Cove	WD2	73	492	37	252	15	133
Narrabeen Sub-main	820114	71	2909	39	1039	21	419

		Existing condition/10 years		40 events/10 years		20 events/10 years	
Location	Modelled overflow node	No. of events/10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume(ML/ 10 years)
Lane Cove Sub-main	820405	71	1623	40	931	16	450
Lane Cove Sub-main	820413	69	1777	28	739	16	596
22, Station Rd, West Ryde	WR508	67	144	19	64	11	43
West Middle Harbour Sub-main	820213	66	1699	12	850	10	359
Lane Cove Sub-main	820420	66	1403	14	189	14	188
Lane Cove Sub-main	820321	64	2122	18	421	15	338
5, Hood St, Toongabbie	820054	61	5363	14	1865	19	1633
Lane Cove Sub-main	820335	61	491	23	143	13	67
Lane Cove Sub-main	EL0	59	3067	12	324	11	208
Seaforth Sub-main	820682	57	238	29	82	17	61
Toongabbie and Pendle Hill Carrier	820825	57	1255	14	265	15	288
Rumsey Cr.-Quarry Rd, Dundas	DV121	56	772	31	645	16	209
Kissing Point Rd, Dundas	8A-2	56	405	28	152	15	116
Babbage Rd-End, East Roseville	WM1-35	56	2476	12	109	11	128
NSOOS Trunk Main	11-3	55	820	17	151	15	139
Lane Cove Sub-main	820308U	55	1051	2	12	3	18
Toongabbie and Pendle Hill Carrier	820811	55	2003	13	278	13	268
East St End, Granville	DC1A	54	838	17	229	14	185
West Middle Harbour Sub-main	820205D	54	3203	26	1436	11	370
West Middle Harbour Sub-main	820274A	54	2875	15	580	11	305
West Middle Harbour Sub-main	820274B	54	1150	0	0	0	0
NSOOS Trunk Main	820019U	53	3273	26	1155	15	901
Lalor Park Carrier	820843	53	1308	21	471	17	489
15, Sierra Place, W.Baulkham Hills	WB23	52	710	21	299	17	242
SPS-67 System	820592	52	202	19	29	10	16
Toongabbie and Pendle Hill Carrier	820822	52	1103	21	398	17	351
Lane Cove Sub-main	820312	51	746	27	338	14	138
NSOOS Trunk Main	7-3	50	315	11	50	10	32
NSOOS Trunk Main	820057	50	120	14	233	11	13

		Existing condition/10 years		**40 events/10 years**		**20 events/10 years**	
Location	Modelled overflow node	No. of events/10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume(ML/ 10 years)
3, Jillong St, Rydalmere	IC1-03	49	641	23	291	18	256
Stone Quarry Creek Carrier	820680	49	853	37	722	12	216
32, Louise St, Granville	LDC12	46	32	16	9	16	28
Lane Cove Sub-main	820407	46	201	18	32	0	0
Opp.44 Peter Pde, Toongabbie	820055	45	546	35	1183	11	255
SPS-67 System	820594	45	325	20	82	16	61
Narrabeen Sub-main	NB66	45	2169	31	899	18	538
SPS-67 System	SWC4A	44	134	19	25	6	4
West Middle Harbour Sub-main	820245	43	2227	15	444	12	284
Lane Cove Sub-main	820311	43	344	0	0	0	0
NSOOS Trunk Main	820016	40	635	17	235	15	48
Seaforth Sub-main	820695	40	414	9	36	10	114
Mosman Sub-main	820621	39	216	26	141	5	12
SPS-67 System	820585	38	316	14	55	3	7
West Middle Harbour Sub-main	WM1-55	38	1500	16	434	10	187
203-205 Pitt St, Merrylands	820571U	37	768	35	750	9	78
West Middle Harbour Sub-main	820295	37	495	25	183	12	98
SPS-103 System	WW15A	37	414	16	217	11	72
SPS477 Hill Rd, Lidcombe	SPS-477	36	149	12	29	9	17
Lane Cove Sub-main	820455	36	279	15	65	18	104
133, Monna St, Granville	820579	35	229	18	124	7	11
West Middle Harbour Sub-main	820201	35	1925	23	1155	12	1295
Manly System	820951b	35	422	24	330	15	89
NSOOS Trunk Main	3015	34	193	10	33	13	93
Lane Cove Sub-main	820307	34	1178	18	1016	10	199
Lane Cove Sub-main	820325	34	653	18	232	10	110
West Baulkham Hills Sub-main	820751	34	136	7	6	7	4
SPS-103 System	820549	33	572	14	186	9	126
98-100 Station Rd, Seven hills	11-2	32	533	15	380	15	308
NSOOS Trunk Main	11-8	32	363	14	122	13	91
Lane Cove Sub-main	820350	32	439	16	212	11	117

		Existing condition/10 years		40 events/10 years		20 events/10 years	
Location	Modelled overflow node	No. of events/10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume(ML/ 10 years)
West Middle Harbour Sub-main	820273	31	544	9	216	3	16
SPS-98 System	820581	30	1240	16	381	12	257
Lane Cove Sub-main	820322	29	242	14	78	9	31
Woolwich Sub-main	820625	29	421	10	65	12	165
Mosman Sub-main	820700	29	349	18	130	3	7
West Baulkham Hills Sub-main	820755	29	1070	14	419	13	278
West Middle Harbour Sub-main	820290	27	343	25	365	12	118
NSOOS Trunk Main	820005	26	623	21	1480	18	2210
Alfred St, Willoughby & Long Bay Sub-main	820618	26	27	19	27	4	1
Manly System	820951a	26	346	9	9	7	22
West Middle Harbour Sub-main	820240	25	1308	17	668	8	223
West Middle Harbour Sub-main	820225	24	735	11	217	2	3
Higginbottom Rd, Ryde	BU1-BA1	23	76	4	6	3	5
West Middle Harbour Sub-main	820297	23	850	23	850	8	106
West Middle Harbour Sub-main	820250	22	538	22	539	10	114
West Middle Harbour Sub-main	820265	22	843	4	20	12	689
Lane Cove Sub-main	820303U	21	142	21	142	13	67
Gores Creek Sub-main	820624	21	200	14	132	11	108
SPS-98 System	FS4-03	21	92	7	14	1	3
Narrabeen Sub-main	820113	20	692	20	575	13	256
West Middle Harbour Sub-main	820221	20	576	12	297	10	87
Willoughby Sub-main	820693	20	483	8	119	9	124
West Middle Harbour Sub-main	820226	19	336	19	337	8	19
SPS-98 System	820580	19	218	1	1	0	0
Balmoral Slopes Sub-main	820697	19	141	16	141	16	134
Morrison O/F, Northbridge	820011	18	75	8	15	8	19
Parramatta Rd, Clyde	LAG4	18	46	6	4	0	0
West Middle Harbour Sub-main	820210	18	656	13	617	10	196
Lane Cove Sub-main	820330	18	220	12	137	9	63
Hunts Creek Sub-main	820631	18	413	11	135	16	430

		Existing condition/10 years		40 events/10 years		20 events/10 years	
Location	Modelled overflow node	No. of events/10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume(ML/ 10 years)
West Baulkham Hills Sub-main	820765	18	274	9	80	9	66
West Middle Harbour Sub-main	820260	17	411	16	362	10	120
Lane Cove Sub-main	EM	17	843	10	265	8	188
Opp.153 George St, Parramatta	WC10	16	271	16	227	7	49
SPS-67 System	820505	16	46	16	46	16	43
Mosman Sub-main	820620	16	93	8	27	4	3
West Baulkham Hills Sub-main	820760	16	95	7	15	7	16
SPS-67 System	BB2	16	27	4	2	1	0.5
SPS-67 System	820597	15	46	1	1	0	0
Putney Carrier	820628	15	123	11	73	9	36
West Ryde Sub-main	820629	15	177	2	2	0	0
Lane Cove Sub-main	EF	15	430	2	2	2	8
Lane Cove Sub-main	820409	14	268	3	20	9	68
Iona Creek Sub-main	820662U	14	328	13	299	13	299
Off Marina Road, W.Baulkham Hills	WB29	13	15	6	4	17	242
NSOOS Trunk Main	820015	13	164	5	35	5	48
Narrabeen Sub-main	820130	13	257	12	254	7	71
Narrabeen Sub-main	820155	13	77	13	77	2	3
Lane Cove Sub-main	820345	13	100	11	79	11	82
Tarban Creek Sub-main	820626	13	109	8	35	9	36
NSOOS Trunk Main	9A-1	13	415	11	261	18	458
West Middle Harbour Sub-main	820220	12	196	12	192	10	57
Middle Harbour Slopes Main Sewer	820623	12	39	12	40	6	6
Seven Hills Carrier	820821	12	105	12	105	12	106
Glades Bay Sub-main	820627	11	51	3	8	3	7
National Park, Ryde Rd, Northbridge	EI2	10	52	2	4	7	26
Narrabeen Sub-main	820121	10	50	10	50	7	27
Lane Cove Sub-main	EI	10	22	2	13	7	16
Vineyard Creek High Level Carrier	820634	9	150	9	91	9	151

		Existing condition/10 years		**40 events/10 years**		**20 events/10 years**	
Location	Modelled overflow node	No. of events/10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume (ML/10 years)	No. of events/ 10 years	Total volume(ML/ 10 years)
Baulkham Hills Sub-main	820715	8	57	8	58	8	63
Narrabeen Sub-main	820101	7	70	9	80	5	16
West Middle Harbour Sub-main	820208	7	73	0	0	3	2
SPS-67 System	820586	7	164	1	7	1	5
Lane Cove Sub-main	EK	7	15	0	0	0	0
West Middle Harbour Sub-main	WM1-12	6	93	0	0	0	0
Baulkham Hills Sub-main	820713	5	68	6	70	6	79
Baulkham Hills Sub-main	820769	5	94	6	94	5	108
Narrabeen Sub-main	820140	4	11	4	11	1	0.3
Narrabeen Sub-main	820172	4	3	4	2	1	0.1
Collecting M.H. SPS103	WMA1	3	13	4	13	0	0
Private Prop. Chisholm Rd, Sefton	DR3-20	3	4	0	0	1	0.1
West Middle Harbour Sub-main	820235	3	21	3	21	1	0.2
NSOOS Trunk Main	820017	2	2	2	2	3	9
North Head STP	920021	1	4	1	0.5	0	0
SPS-67 System	SWC3	1	264	0	0	0	0
SPS-103	103-S	N.R.	N.R.			17	545
SPS-67	67-S	N.R.	N.R.			17	1203
SPS-98	98-S	N.R.	N.R.			15	773
'Number of Overflow Events for the system		**237**		**71**		**40**	
Maximum number of overflows during at any one event.		**200**		**40**		**21**	

Note: Because of the large size of the catchment, rainfall events may be restricted to part of the catchment. This results in the number of overflow events for the system being greater than the maximum number of overflows at any one points.

2.8 Summary

For convenience, discussion of the overflows is subdivided into "dry weather" overflows and "wet weather" overflows. Dry weather overflows are caused by problems with SPSs, chokes and exfiltration, and these problems also can and do occur during wet weather. Weather overflows are caused by hydraulic overloading of the system, which in turn results from infiltration and rainwater ingress. For the NSOOS, wet weather overflows are believed to discharge by far the greatest volume of sewage. Hydraulic modelling of the existing system predicts that 18,179 ML/year is discharged as a result of wet weather overflows. This volume of sewage is discharged during a predicted average of 23.7 wet weather overflow events each year.

Of the wet weather overflows, the modelled overflow node, EJ1, located at Gloucester Avenue, West Pymble is the most frequently active. Overflows from this structure, which drain into Lane Cove River, are predicted to occur 200 times over an average ten year period. However this overflow alone only accounts for 4.3% of total volume discharged. There are overflows which discharge less frequently, but which contribute a much greater proportion of the total discharge volume. These overflows include the Lane Cove Siphonic overflow (modelled node 3120) which discharges 11.4% of the total predicted wet weather overflows, Tunks Park (modelled node WM1-17) discharging 6.3%, Quakers Hat Bay (node 820052U) discharging 7.8%, Scotts Creek overflows (820203) discharging 6.2%. Between them these overflows account for approximately 6,600 ML/year of wet weather overflow.

Dry weather overflows resulting from SPS failure are a minor problem relative to wet weather overflows. Although there were 655 SPS failures during the last full year of data, only 20 of these failures resulted in an overflow. Of these, seven were from a single SPS (which is on Sydney Water's upgrade program). The odours resulting from overflows also appear to be a relatively minor problem. The vast majority of suburbs served by the NSOOS recorded only two or less odour complaints. For the whole system the number of complaints averaged one every 6600 people served.

Chokes represent the most common cause of overflow resulting from system failure. Sixteen suburbs in the NSOOS are deemed to have a high choke frequency, and a further 74 have a medium choke frequency and 30% have a low frequency. Across Sydney Water, an average of 40% of suburbs served have a low choke frequency and seven per cent have a high frequency. The fact that NSOOS performs below the Sydney Water average reflects the age of the existing infrastructure. Twenty-four sub-catchments within the NSOOS system have been identified as having potential exfiltration problems. Further assessment of exfiltration is required to confirm the extent of the problem and associated impacts.

Table 2.18 - Summary of existing NSOOS performance

Overflow Category	Measure	Performance
Wet Weather Modelled Overflows	% Rainfall events resulting in wet weather overflows	42%
	% inflow catchment with rainfall ingress > 10%	52%
	Number of overflow events in 10 years	237
	Total number of modelled overflows (designed and reticulation) activated in 10 years	160
	Modelled overflow volume in 10 years	181 791 ML in 10 years
	Most frequently activated designed overflow node	Model node no. EJ1, Gloucester Av, W Pymble (200 in 10 years)
	Most frequently activated reticulation overflow node	Model node no. 820275, West Middle Harbour sub (109 in 10yrs)
	Highest risk ranked designed overflow (against all Sydney wide)*	Model node no. WM1-17 (Tunks Park, Northbridge)
	Highest risk ranked reticulation overflow (against all Sydney wide)*	Model node no. 820694
	Number of STPs in NSOOS catchment	1
	Frequency of most frequent untreated or partially treated STP bypass	0
	Volume of partially treated STP bypass	0
Surcharges (chokes and dry weather overflows)	Number and proportion of suburbs in "high" category	16 (12.5%)
	Number and proportion of suburbs in "medium" category	74 (58%)
	Number and proportion of suburbs in "low" category	38 (29.5%)
	% of properties not affected by surcharges	99%
	Any trunk sewer capacity < 2 x PDWF (Yes or No)	Yes
	SPS pump capacity: % with capacity < 2 X PDWF % with capacity 2 - 4 X PDWF % with capacity > 4 X PDWF	 13.1% 71.4% 15.5%
SPS failure	Total number of overflows from SPSs (96/97)	20
	Number of SPSs with detention time < response time	15
	Number of SPSs without alternative power supply and standby pumps	12/3
	Highest risk ranked SPS	SPS 0117
Exfiltration	Number and proportion of potential "high" exfiltration sub-catchments	6 (4%)
	Number and proportion of potential "medium" exfiltration sub-catchments	14 (10%)
	Number and proportion of potential "low" exfiltration sub-catchments	2 (1.4%)
	Number and proportion of sub-catchments where exfiltration potential is unknown	24 (14%)*
Odours	Total number of odour events leading to complaints (96/97)	152

Note: * refer to page 2-15

Chapter 3

Environmental Impacts of Overflows

Synopsis

The environmental assessment is focused primarily on issues that effect large areas of a catchment, or are of catchment-wide concern. Localised impacts are considered only where they affect areas which have been identified as 'sensitive' because of their ecological status, human uses, or cultural values. Overflows are considered to have negligible impact on noise, traffic and land-use zoning, although impacts which may be incurred by the implementation of overflow control options will be considered in the second stage EIA documents prior to any construction.

Impacts on the environment from overflows from the NSOOS system can be highly localised or have relatively widespread impacts across a REZ (such as the high volume overflows impacting on Middle Harbour and Lane Cove River, which impact on the Sydney Harbour REZ). Direct discharge of overflows impacts on the upper and estuarine Lane Cove River, the upper and estuarine Parramatta River, Port Jackson and Middle Harbour. These areas are used extensively for primary and secondary contact recreation and have a high visual amenity. Overflows effect the suitability of these areas for water based activities and tourism.

The aquatic impacts due to overflows predicted by modelling are very significant. The combined wet weather overflow volumes from the SWOOS, BOOS and NSOOS contribute 53 percent of the total phosphorus load and 55 percent of the total nitrogen load to Port Jackson, indicating that sewerage overflows contribute approximately half of the total nutrient loads to Port Jackson. Of the sewerage overflow derived nutrient loads, approximately 90 percent is contributed by the NSOOS. The NSOOS is the main contributor of faecal coliform contamination of Middle Harbour and the Lane Cove River estuary. The contribution of the NSOOS to nutrient and faecal coliform loads received by Manly Lagoon are also significant.

The terrestrial impacts due to overflows are relatively minor since the majority of overflows drain to the aquatic environment, either directly or via the stormwater system. Chokes and exfiltration within terrestrial areas may cause weed growth through soil nutrient enrichment, disturbance of the soil surface and addition of non-native plant seeds. However, these effects are likely to be localised and the impacted areas small in comparison to habitat ranges for native flora and fauna impacted.

Sensitive areas with high biodiversity and community value have been identified to determine if greater overflow containment is warranted to protect their ecological status and value. High potential impact areas form overflows are expected at sensitive areas of North Ryde, Lane Cove River, Blue Gum Creek, Duck Creek, Haslams Creek, Middle Harbour, Park Gate Estate, Scotts Creek, Moores Creek and Buffalo Creek, Dee Why, Curl Curl and Manly Lagoons, Manly Reservoir and Manly Creek.

Overflows are one of several sources of pollution in the Sydney Coastal GA. In some parts of the receiving environment such as Dee Why, Curl Curl and Narrabeen Lagoons stormwater is a major source of contamination and overflow elimination processes recover only a small number of days when water quality is unsuitable for recreation or ecosystem protection. Other factors such as conversion of land for housing and erosion caused by flood flows, are likely to have far greater impacts on terrestrial ecosystems than those caused by sewerage overflows.

3. Environmental Impacts of Overflows

3.1 The sewerage system catchment and receiving environment

Overflows from the NSOOS system impact on the following Receiving Environment Zones. These receiving environments are also effected by overflows from other sewerage systems (given in brackets). The impacts of overflows within the REZs are described in Volume 2 of this EIS. This volume identifies the key impacts of sewerage overflows within the various REZs, and attempts to define the relative contribution of overflows from the NSOOS system.

1. Upper Parramatta River REZ
2. Upper Lane Cove River REZ
3. Sydney Harbour REZ (BOOS, SWSOOS)
4. Cowan Creek REZ (Hornsby Heights)
5. Northern Lagoons REZ (Warriewood)
6. Northern and Eastern Sydney Beaches REZ (BOOS, Warriewood).

The location of the REZs related to the NSOOS system are shown in Figure 1.1.

The NSOOS system serves the following Local Government Areas (LGA): Blacktown, Parramatta, Baulkham Hills, Hornsby, Ryde, Willoughby, Lane Cove, Hunters Hill, North Sydney, Ku-ring-gai, Warringah, Mosman, Manly, Holroyd, Bankstown and Auburn. The predominant land use with the NSOOS catchment is urban development, being either residential, commercial or industrial. To a lesser degree, there are areas used for recreational and conservation purposes such as Lane Cove National Park and Sydney Harbour National Park.

The major receiving waterways include the Parramatta River, Lane Cove River, Middle Harbour, Port Jackson, Northern Lagoons and the Tasman Sea. The Parramatta River has a largely urbanised catchment. Water Quality is better in the lower estuarine sections and deteriorates in the poorly flushed upper estuary of the fresh water section. Water quality deteriorates markedly during wet weather.

Lane Cove River runs through a bushland corridor that winds through an otherwise urban landscape. For part of its length, the river runs through a National Park and large areas of native vegetation. The river is estuarine up to a weir near Fullers Bridge in the Lane Cove National Park and is lined with mangroves in parts. The river is a scenic area and popular for recreational activities including boating and fishing. The water quality is good in dry weather but deteriorates markedly during wet weather, largely as a result of the Lane Cove overflow, other overflows further upstream and stormwater runoff. Overflows to Lane Cove ultimately impact on the Sydney Harbour REZ.

The Middle Harbour estuary is a tributary of the Sydney Harbour REZ. Middle Harbour is used for a variety of water-based recreational activities. The major sewerage system overflows at Scotts Creek, Tunks Park and Quakers Bay discharge directly or indirectly to Middle Harbour. Consequently, water quality deteriorates markedly in wet weather due to these overflows, upstream overflows and stormwater runoff.

Port Jackson is the central feature of the city of Sydney and is of national significance. It is an important tourist attraction with high aesthetic values, but is also used extensively for recreation, including sailing, boating, fishing, diving and swimming. Water quality in Port Jackson is generally good, although there are high levels of nutrients and pathogens during and after wet weather (AWT 1994).

In addition to monitoring by Sydney Water and the EPA, the water bodies effected by overflows from the NSOOS are monitored by a number of independent bodies, namely the Sydney Northern Beaches, Middle Harbour and Lane Cove Catchment Management Committees and the Upper Parramatta River Catchment Trust.

The environmental values of the area served by the NSOOS include: protection of aquatic ecosystems, primary contact recreation, secondary contact recreation, visual amenity and human consumers of fish and shellfish for human consumption.

3.2 Overflow impacts

A full description of existing conditions and overflow impacts within the Upper Parramatta River REZ, the Upper Lane Cove River REZ, the Sydney Harbour REZ, the Northern Lagoons REZ, and the Northern and Eastern Sydney Beaches REZ are provided in Volume 2 of this EIS. The key impacts, and the relative contribution of NSOOS system overflows to these impacts are described below. Sensitive components of aquatic, terrestrial, and socio-economic environments have been given special consideration and are discussed in Section 3.2.5. The methods by which environmental impacts were identified, and the limitations of these methods, are presented in the Methods volume of this EIS.

3.2.1 Impacts on the aquatic environment

Waterways affected by the direct discharge of overflows from the NSOOS include Port Jackson (which covers the freshwater and estuarine sections of Parramatta and Lane Cove rivers, Duck River, Middle Harbour and Sydney Harbour), the Northern Lagoons and Eastern and Northern and Eastern Beaches. None of these waterways have been classified under the Clean Waters Act 1970.

Overflow impacts were difficult to identify from existing water quality data (refer to Volume 2). To assist with the assessment of overflow impacts, water quality modelling was performed to determine the contribution of overflows to receiving water nutrient loads. For the estuarine sections of Parramatta River and Lane Cove River, Middle Harbour and Sydney Harbour, water quality modelling was also undertaken to assess the impact of overflows on the achievement of water quality objectives for chlorophyll-a, an indicator of algal levels. Water quality modelling results indicated that sewerage overflows make a significant contribution to high levels of algal growth (refer to Volume 2). The contribution of NSOOS overflows to receiving water nutrient loads, and the effect of these overflows on the achievement of water quality objectives, is discussed below.

There was little data available for aquatic sediments, aquatic flora, or aquatic fauna within the waterways affected by the NSOOS, although the contribution of overflows to impacts on these components of the environment is likely to reflect the contribution of overflows to impacts on water quality. The risks to aquatic life and human health were also investigated through Sydney Water's Ecological and Human Health Risk Assessment (ERA) study (Sydney Water, 1998a).

Contribution of overflows to receiving water nutrient loads

Water quality modelling indicates that the combined wet weather overflow volumes from the NSOOS, BOOS and SWSOOS contribute 53 % of total phosphorus loads and 55 % of total nitrogen loads to Port Jackson. The data indicate that sewerage overflows contribute similar loads to stormwater runoff.

Manly Lagoon, Dee Why Lagoon and Curl Curl Lagoon receive overflows from the NSOOS only, while Narrabeen Lagoon receives overflows from the NSOOS and Warriewood System. Sewerage overflows contribute 35 percent of total phosphorus loads and 31 percent of total nitrogen loads to Manly Lagoon and 20 and 17 percent of loads respectively to Curl Curl Lagoon. The contribution from sewerage overflows to total phosphorus and total nitrogen loads was much lower in Dee Why Lagoon (seven and six per cent respectively) and Narrabeen Lagoon (one percent for both).

Nutrient loads contributed by sewerage overflows were not determined for the Northern and Eastern Beaches. Hydraulic modelling of the system only predicted overflows into this REZ from modelled nodes at Shelly Beach, Manly.

Estimates of the receiving water nutrient loads from wet weather overflows from the NSOOS are listed in Table 3.1 for Port Jackson, Manly Lagoon, Curl Curl Lagoon, Dee Why Lagoon and Narrabeen Lagoon. Of the total nutrient loads from wet weather overflows discharged to Port Jackson, the NSOOS is estimated to contribute approximately 92% of total phosphorus and total nitrogen. Manly Lagoon, Curl Curl Lagoon and Dee Why Lagoon receive overflows from only the NSOOS, therefore this system contributes all of the nutrient load derived from sewerage overflows. As the model predicted no sewerage overflows from the Warriewood System to Narrabeen Lagoon, the NSOOS also contributed all of the nutrient loads from sewerage overflows to this waterway.

Table 3.1 - Current annual total nitrogen and total phosphorus loads from wet weather overflows from the NSOOS.

Waterway (Receiving)	Annual average wet weather overflow volume (ML)	Total nitrogen load (t/yr)	Total phosphorus load (t/yr)
Port Jackson	16173	260.0	35.6
Manly Lagoon	523	8.4	1.11
Curl Curl Lagoon	69	1.1	0.15
Dee Why Lagoon	32	0.5	0.07
Narrabeen Lagoon	26	0.4	0.06

Sewerage overflows contribute approximately half of the total nutrient loads to the Port Jackson waterway, with the majority of this load (greater than 90 percent) derived from the NSOOS. The NSOOS therefore makes a significant contribution to the total loads of total phosphorus and total nitrogen entering Port Jackson. This contribution is made largely from a small number of key overflows that are located on the main and sub-main which frequently discharge large volumes (Tunks Park, Quakers Hat, Gloucester Avenue, Lane Cove Siphon and two nodes which discharge to Scotts Creek (AWT 1997a)).

In Manly Lagoon and Curl Curl Lagoon sewerage overflows contribute 20 to 30 percent of the nutrient load, with all of this derived from the NSOOS. The NSOOS therefore makes a substantial contribution to nutrient loads entering these waterways. In contrast, sewerage overflows contribute less than eight per cent of the total nutrient loads to Dee Why Lagoon and only one percent of nutrient loads to Narrabeen Lagoon, with all overflow contributed loads originating from the NSOOS.

Effect of overflows on meeting water quality objectives

Water quality modelling was used to compare the existing conditions with predicted conditions and other three to six months containment standards that have been implemented. Predicted water quality was compared with guideline values for primary and secondary contact recreation and for ecosystem protection (ANZECC, 1992). The modelling indicated that the impact of sewerage overflows from the NSOOS, BOOS and SWSOOS on faecal coliform levels in Port Jackson was greatest in Lane Cove River and Middle Harbour. This impact resulted from the fact that these areas receive overflows from several major overflow nodes (located in NSOOS) and the quality of stormwater runoff is generally good. The elimination of overflows in these areas results in the recovery of most unsuitable swimming and boating days. In contrast, overflows have only a minor impact on faecal coliform levels in Parramatta River and in bays on the southern side of the Harbour. In these areas stormwater runoff is a major source of contamination and overflow elimination recovers only a minor number of unsuitable days. In lower Port Jackson, while dilution from marine waters greatly reduces the impact of stormwater and sewerage overflow discharges, overflow elimination recovers almost all of the unsuitable recreation days. Sewerage overflows make a significant contribution to levels of chlorophyll-a throughout Port Jackson (AWT, 1997a). Overflow elimination recovers approximately 50 percent of unsuitable days in well flushed areas of Port Jackson and has negligible effect in the upper Parramatta River and Duck River. (refer to Table 3.2)

For the Northern Lagoons, water quality modelling (AWT 1997a) indicated that overflow elimination does not increase the number of days suitable for primary and secondary contact recreation, indicating poor quality stormwater runoff in this receiving environment.

It should be noted, that the water quality modelling results are indicative only of catchment-wide impacts within the major receiving waterways. Impacts not identified by the modelling may occur within localised areas, particularly within minor tributary streams. The main impact of overflows at the localised level is likely to be a temporary reduction in bacteriological water quality immediately following an overflow event. For this reason, it is important that overflow control strategies take into consideration the total number of overflow points during any one overflow event.

Table 3.2 - Suitable days in the NSOOS catchment and additional days achieved with various overflow containments

Modelled site	Activity	Existing suitable days	Additional suitable days	
			40 events/year	20 events/year
Balmoral Beach	Swimming (primary contact)	346 (95%)	10 (3%)	13 (4%)
	Boating (secondary contact)	355 (97%)	6 (2%)	7 (2%)
	Chlorophyll a (aquatic ecosystem protection)	321 (88%)	17 (5%)	21 (6%)
Spit Bridge	Swimming (primary contact)	328 (90%)	26 (7%)	30 (8%)
	Boating (secondary contact)	343 (94%)	15 (4%)	18 (5%)
	Chlorophyll a (aquatic ecosystem protection)	319 (87%)	17 (5%)	22 (6%)
Long Bay	Swimming (primary contact)	316 (87%)	37 (10%)	42 (12%)
	Boating (secondary contact)	327 (90%)	29 (8%)	34 (9%)
	Chlorophyll a (aquatic ecosystem protection)	318 (87%)	19 (5%)	23 (6%)
Roseville Bridge	Swimming (primary contact)	341 (93%)	13 (4%)	15 (4%)
	Boating (secondary contact)	351 (96%)	7 (2%)	8 (2%)
	Chlorophyll a (aquatic ecosystem protection)	315 (86%)	19 (5%)	23 (6%)
Estuary Mouth	Swimming (primary contact)	336 (92%)	21 (6%)	23 (6%)
	Boating (secondary contact)	348 (95%)	14 (4%)	15 (4%)
	Chlorophyll a (aquatic ecosystem protection)	267 (73%)	33 (9%)	38 (10%)
Gloucester Street	Swimming (primary contact)	303 (83%)	34 (9%)	35 (10%)
	Boating (secondary contact)	326 (89%)	37 (10%)	39 (10%)
	Chlorophyll a (aquatic ecosystem protection)	290 (79%)	29 (8%)	34 (9%)
Lane Cove River	Swimming (primary contact)	323 (88%)	35 (10%)	39 (10%)
Bridge	Boating (secondary contact)	337 (92%)	24 (7%)	27 (7%)
	Chlorophyll a (aquatic ecosystem	269 (74%)	35 (10%)	40 (11%)

Modelled site	Activity	Existing suitable days	Additional suitable days	
			40 events/year	20 events/year
	protection)			
Gladesville Bridge	Swimming (primary contact)	346 (95%)	7 (2%)	8 (2%)
	Boating (secondary contact)	354 (97%)	6 (2%)	7 (2%)
	Chlorophyll a (aquatic ecosystem protection)	263 (72%)	33 (9%)	38 (10%)
Ryde Bridge	Swimming (primary contact)	322 (88%)	9 (2%)	11 (3%)
	Boating (secondary contact)	343 (94%)	9 (2%)	11 (3%)
	Chlorophyll a (aquatic ecosystem protection)	248 (68%)	17 (5%)	23 (6%)
Homebush Bay	Swimming (primary contact)	305 (84%)	6 (2%)	6 (2%)
	Boating (secondary contact)	340 (93%)	8 (2%)	9 (2%)
	Chlorophyll a (aquatic ecosystem protection)	250 (68%)	17 (5%)	23 (6%)
Duck River	Swimming (primary contact)	292 (80%)	9 (2%)	10 (3%)
	Boating (secondary contact)	329 (90%)	14 (4%)	16 (4%)
	Chlorophyll a (aquatic ecosystem protection)	202 (55%)	9 (2%)	11 (3%)
James Ruse Drive	Swimming (primary contact)	292 (80%)	9 (2%)	10 (3%)
	Boating (secondary contact)	304 (83%)	3 (1%)	3 (1%)
	Chlorophyll a (aquatic ecosystem protection)	191 (52%)	8 (2%)	10 (3%)

Note: The modelling assumes three or six month containment for all systems discharging into Sydney Harbour

Additionally, the water quality modelling data provides no information on the impacts of overflows caused by system failures including chokes, SPS failures, and exfiltration. The absence of information for choke-related overflows and SPS failures is not a major concern, since the volumes of these overflows are likely to be small in relation to wet weather overflows. The occurrence and associated impacts of exfiltration require further investigation, however, since discharge volumes and associated pollutant pathways are currently unknown. Prototype projects aimed at identifying areas where exfiltration is occurring and quantifying the impact of exfiltration on surface water quality are currently under way.

Ecological and human health risk assessment

A risk assessment has been undertaken for 37 sites across areas potentially impacted by the operation of Sydney Water's sewerage systems. Representative sites have been selected for each geographic area in order to evaluate the potential impacts of chemical and non-chemical stressors to aquatic life and human health, from wet weather overflows. In order to assess the contribution of overflow discharge to wet weather receiving water quality, potential impacts from stormwater discharge were also evaluated. In addition the possible benefits of overflow abatement were also assessed. The following sites in the NSOOS catchment were evaluated:

1. No. 15. Toongabbie Creek at Toongabbie Creek overflow
2. No. 16. Lane Cove River at Gloucester Avenue overflow
3. No. 17. Parramatta River near Silverwater Bridge

4. No. 18. Lane Cove River at Lane Cove Siphon Overflow
5. No. 19. Long Bay
6. No. 22 Narrabeen Lagoon
7. No. 23 Upper Manly Lagoon (Brookvale overflow)
8. No. 24. Shelly Beach, Manly.

All sites were subject to a risk evaluation, which identified potential risks to aquatic life and human health under current conditions and for each abatement option. Five of the sites (15, 16, 18, 19 and 23) were selected for a more detailed analysis (called a detailed risk evaluation) to assess how accurate the risk evaluation predictions were.

Details of the risk assessment methodology can be found in Appendix C of Volume 2 of this EIS.

Aquatic life

Overall, for aquatic life, the acute chemicals of potential concern (COPC) vary extensively among the eight sites. Acute COPCs that are common to all sites are chlorpyrifos, copper, and zinc (aluminium was also found as a COPC, but because aluminium is ubiquitous in the soils of this region and occurs naturally at high concentrations, it cannot be considered a true COPC). There are a number of chronic COPCs (22) common to all sites including chlorphyrifos, chlordane and copper. At the estuarine sites (the Parramatta River near Silverwater Bridge, the Lane Cove River at Lane Cove Siphon and Long Bay) a freshwater upper layer and a lower saline layer forms during severe storm events. For these sites, the number of COPCs in the lower layer can vary greatly from site to site. In general, most of the potential risks from chemicals are attributable to stormwater, with minimal potential risks from sewer overflow alone. However, potential risks from a few chemicals (ammonia, nitrite, and PAHs) were often associated with sewer overflows only.

The detailed risk evaluations conducted at five sites in the region indicated that due to the settling of particle-bound chemicals and/or accounting for the bioavailable form of a chemical, risks from the COPCs was reduced and in some cases eliminated. Copper and chlorpyrifos remained as acute COCs (chemicals of concern) at all sites. However, the duration of exceedance of the criteria was substantially reduced. Ammonia, chlordane, chlorpyrifos, copper, diazinon, hydrogen sulphide, TSS and zinc remained as chronic COCs. Almost all the acute and chronic risk resulted from the stormwater discharge.

Samples of both undiluted sewer overflow discharge and receiving water taken upstream of overflow discharge points during storm conditions exhibited some toxicity to laboratory test organisms (bioassays), indicating potential risk. Sediment bioassays and surveys of sediment dwelling organisms conducted upstream and downstream of some sites in the region sometimes indicated toxicity and/or stressed aquatic communities. Sediment bioassays and surveys of sediment organisms did not indicate any greater stress in aquatic communities downstream of overflows than upstream or when compared to an urban reference site. Both water and sediment results suggest that sources upstream of overflows are contributing to the majority of any observable risks to aquatic organisms. Since potential risks from stormwater are not eliminated by abatement, long term recovery of these ecosystems would not be expected from sewer overflow abatement options alone. The methodology used to determine the downstream receiving water toxicity produced inconclusive results. However, as both the water upstream of the overflow discharge points and the undiluted overflow exhibited some toxicity it is likely that the downstream waters may also be toxic to some sensitive aquatic species.

Total suspended solids (TSS) were identified as a chronic COPC for all of the eight sites. Where TSS was identified as a COPC, it was entirely or largely due to stormwater rather than sewer overflows. Because of this, the three and six month abatement options have little or no effect on reducing TSS risk potential.

Overall, salinity, dissolved oxygen, and scouring/sedimentation risks are similar for sites with similar physical characteristics and hydrology. During large storms, stormwater can cause an upper freshwater layer to form at estuarine sites. However, these conditions occur naturally and additional potential risks from sewer overflow would not be expected. In general, it is unlikely that dissolved oxygen deficits caused by sewer overflows occur for sufficiently long periods of time to detrimentally affect aquatic life at most of these sites. At several of the sites, past monitoring has indicated that dissolved oxygen depressions can occur and sewer overflows may increase the frequency or intensity of these dissolved oxygen depressions. In these cases, abatement options would be expected to reduce the frequency and/or intensity of these depressions. For sites with relatively deep waters, scouring is unlikely to occur; however, local scouring where the sewer overflow enters the waterway may be possible at some sites. Although sedimentation could become of concern for areas of slower moving water, TSS inputs from stormwater, rather than sewer overflows, appear to be the predominant source. Thus, potential risks from sewer overflow sedimentation are likely to be small. For the one beach site in this region (Shelly Beach), which has a dynamic coastal hydrology, effects from overflows are not expected for any of the non-chemical stressors.

Effect of flooding on sewerage system operation and overflows

It is important to note that flooding may affect the operation of sewerage systems and sewage overflows. The NSOOS System may be adversely affected by:

1. overbank flooding above Old Windsor Road (Toongabbie Creek and Darling Mills Creek catchments) during a 1 in 20 year flood, although a 1 in 50 year flood is required to produce widespread flooding (Water Resources, 1989)
2. overbank flooding downstream of Old Windsor Road at the confluence with Coopers and Finlaysons Creeks, at Oakes Road and at Church St Parramatta where Lennox Bridge severely constricts flood flow
3. overbank flooding in the Upper Lane Cove River catchment during a 1 in 20 year flood, although a 1 in 50 year flood is required to produce widespread flooding
4. flooding around Mullet and Narrabeen Creeks on the northern side of Narrabeen Lagoon and where a number of sewage overflows and SPS 451 are located in the 1% AEP flood risk area in the Narrabeen Lagoon Catchment
5. flooding in the Manly Lagoon catchment.

The number of overflow structures located in the above flood prone areas is as yet undefined as there are limited flood maps available. Inundation of design overflow structures during flooding may reduce the efficiency of their operation and cause an overflow to occur elsewhere in the system.

Flooding may also alter pollutant dispersal pathways following an overflow event. In general, the relative impact of sewerage overflows is likely to be reduced during flooding as a result of the dilution and dispersion of pollutants (EPA, 1994).

but not for sediment

3.2.2 Impacts on the terrestrial environment

Little data is available to accurately assess the impacts of overflows on terrestrial ecosystems within the REZs effected by NSOOS overflows (refer to Volume 2). Nevertheless, the majority of overflows from the NSOOS discharge either directly to receiving watercourses or indirectly to watercourses via the stormwater system. Consequently impacts on terrestrial environments are likely to be minor relative to impacts on the aquatic environment. Overflows which may effect terrestrial ecosystems are limited to chokes and exfiltration, although the occurrence of the latter is yet to be quantified.

The majority of the Sydney Metropolitan Area is highly urbanised and as a consequence, relatively few extensive areas of natural or undisturbed ecosystems remain. Owing to their proximity to the modified urban environment these remnant areas of bushland are potentially subject to impacts from many sources of which the discharge of sewage from overflows is only one. Others include stormwater, direct physical disturbance by human populations, introduction of non-native species and air pollution. For overflows which generally occur infrequently (such as chokes) or are difficult to quantify (such as exfiltration) it is difficult to definitively separate the impact of overflows from other potential impacts.

The native terrestrial fauna which are most likely to be affected by sewage overflow events are those which inhabit wetland habitats found in areas such as drainage lines, reservoirs and coastal foreshore areas immediately downhill of discharge points. Sewage overflows to land are likely to be confined to small areas within drainage channels and wetlands. Therefore, the impact on terrestrial fauna that are not habitat specialists of wetlands and which have relatively large home ranges are considered to be low.

Choke-related overflows and exfiltration within terrestrial areas may cause weed growth through soil nutrient enrichment, disturbance of the soil surface, and addition of non-native plant seeds. These affects are likely to be localised, however, and the impacted areas are likely to be small in comparison to habitat ranges for native flora and fauna. Furthermore, other factors such as urban stormwater runoff, conversion of land for housing, and erosion caused by flood flows, are likely to have far greater impacts on terrestrial ecosystems in the NSOOS catchment than those caused by sewerage overflows.

3.2.3 Impacts on the socio-economic environment

Sewerage overflows may affect socio-economic environments indirectly through the adverse affects on the biophysical environment or through direct exposure of human populations to overflow discharges. The main impacts on socio-economic environments in the NSOOS catchment are as follows:

1. risks to human health as a result of exposure to toxicants or pathogens through water-based or terrestrial recreation
2. potential impacts on recreational values
3. potential impacts on visual amenity of waterways and terrestrial areas
4. potential impacts on community amenity as a result of odour discharges.

Risks to human health

Details of the risk assessment for human health are contained in Section 3.5.4 Public Health in Volume 2 and Appendix C. Potential risks to human health due to Schedule 10 chemicals were not found for incidental water ingestion while swimming at any of the sites chosen for the risk assessment. Potential risks were found for some chemicals at most of the sites where fish consumption was estimated (assumes six to 36 meals of fish per year for 30 years). However, most of these potential risks from fish consumption appeared to be due to stormwater, not sewer overflows. For human health, potential risks from fish consumption were not reduced by abatement options, again because stormwater contributes most of the potential risk.

Impacts on recreational values

Impacts on recreational values include temporary loss of visual amenity, loss of the use of recreational infrastructure/facilities, unpleasant odours, disturbances to recreational fishing grounds and health problems.

Concern over impacts on water-based recreation are related largely to human health risks from faecal contamination. However, where the risks were assessed in detail for some selected sites, it was concluded that there was little risk that public health would be adversely affected. Nutrient pollution may also decrease the recreational value of a water body through promotion of nuisance plant and algal growths and eutrophication. Other impacts on the recreational environment may occur where overflows result in solids or debris floating in the water or lying over the ground in a park or reserve. These impacts diminish the visual amenity value of the waterway or area, making it undesirable for recreational purposes.

People undertaking primary recreation activities (such as swimming and surfing) can be affected by sewage overflows through the reduction in the water quality of the areas where these activities are undertaken. Places such as the swimming baths at Quakers Hat Bay have previously been closed (permanently) as a result of poor water quality. Swimming is actively discouraged in Lane Cove River in the Lane Cove National Park, partly as a result of poor water quality. Recreational fishing remains a significant activity downstream of the major Lane Cove Siphon overflow.

Predicted faecal coliform levels at points throughout the NSOOS overflow receiving waters have been compared against ANZECC (1992) water quality guidelines for primary and secondary recreation. The number of days per year when the water quality was unsuitable for swimming at some key points ranges between 42 (Lane Cove River) to 19 (Middle Harbour, Balmoral). The number of days per year for these same sites when the water quality was unsuitable for boating was 28 and ten respectively.

The period of time after an overflow event during which water quality is unsuitable for recreation varies considerably. The recovery time depends on flushing within the waterway (river flows, tidal currents), salinity levels, the extent of the contamination from the overflow and other sources, especially stormwater. Water Quality modelling, backed up with verification through monitoring has been used to estimate recovery times (Port Jackson Water Quality Modelling Report, AWT 1997 a). Generally, recovery times are between one and three days. However, there are examples of confined water bodies where background contamination levels, stormwater contamination, lack of flushing and the frequency of overflow events into the water body, all contribute to very long recovery periods or water quality which never meets the ANZECC guidelines (ANZECC 1992). Such receiving waters include Manly Lagoon.

The impacts of overflows on the terrestrial recreational values are considered to be minor and localised as the majority of overflows drain to waterways. Localised impacts may occur as a result of odour emissions or temporary reductions in the water quality of adjacent creek lines.

Impacts on visual amenity of waterways and terrestrial areas

The visual amenity of the study area is high owing to the variety of landforms, water bodies and built environments (eg. Parramatta River, Sydney Harbour and the adjoining National Park, the Lane Cove River and National Park and Middle Harbour). The Sydney Harbour National Park protects a significant portion of the scenic backdrop to Sydney Harbour by retaining key natural elements of the landscape. The park includes a varied landscape of outstanding scenic value, such as spectacular sandstone cliffs and headlands, small sandy beaches and rocky foreshores, natural vegetation, grassed clearings and historic structures and planting (NPWS, 1996).

Middle Harbour is flanked by numerous foreshore parks and reserves, as well as Garigal National Park, which provide a visual buffer and aesthetic relief to the residential developments found above the reserves. The Northern Lagoons have a high visual amenity as they provide a natural setting between the stark contrast of the coastline and residential development along the northern beaches of Sydney. Narrabeen and Dee Why Lagoons are also surrounded by bushland, reducing the urban character of their locations. Cowan Creek has a high visual amenity as it is surrounded by Ku-ring-gai Chase National Park, with natural bushland, steep slopes, and sandstone outcropping.

Lane Cove River is predominantly of moderate visual quality. Some areas of remnant mangroves and mature eucalyptus growing immediate by the river provide areas of high visual quality. Visual amenity in the Lane Cove National Park is high. However, there are disturbed areas of both sides of the river including access tracks, cuttings bushland clearing, and weed growth.

Sewer overflows impair the visual quality of the environment by depositing debris, grease and other objectionable matter, both on land and in receiving waterways. Overflows also produce undesirable water colours, odours and foaming. Indirectly, overflows impair the visual environment by contributing weed infestation or algal growth around outlet points.

The visual impact of overflows onto land, primarily caused by surcharges resulting from chokes, are generally localised. Visual impacts include gross solid contamination of surrounding ground, and standing areas of sewage if the surcharge drains to a natural depression. Not only are visual impacts on land from chokes localised, the majority are short-lived. Sydney Water's operational practices for dealing with chokes include effective clean-up of visible contamination of an area.

Visual impacts of discharges to receiving waterways, either via stormwater systems or directly also causes localised problems, however more widely spread problems can result. These include excessive algal growth following eutrophication contributed to by sewerage overflows. Localised problems include discolouration, particularly during wet weather events near major overflows. Examples include the discharge at Tunks Park which is located close to frequently used playing fields and the major Lane Cove Siphon overflow. Overflows from well flushed areas may not have protracted impacts on the visual amenity of water bodies. However, overflows into confined, poorly flushed water bodies may result in longer term visual impacts.

Impacts on community amenity as a result of odours

Odour releases, when detected, have the potential to reduce the amenity of the surrounding area for human use and occupation and thereby affect a range of human uses. There is very little data available concerning the concentration and rate of odour emissions from sewerage overflows and vents. Odour complaints received by Sydney Water provide some indication of the impact of odours on community amenity within the NSOOS catchments.

During the period from July 1996 to June 1997, a total of 152 complaints were received regarding odours in the NSOOS catchment. These odour complaints were spread fairly evenly within the NSOOS catchment. The complaints were distributed through approximately 70 suburban areas in the catchment with the highest incidence of complaint being experienced in Mosman and Cremorne (refer to Appendix B for details).

3.2.4 Impacts on sensitive areas

Sensitive areas are sites or components of the environment which are considered to be of particular importance because of their ecological, conservation, cultural heritage, recreational, social or commercial values. Examples of areas which may be classified as sensitive are listed in the Methods document. Briefly though, areas deemed to be sensitive contain one or more of the following characteristics; high biodiversity, a habitat for a rare or threatened species, important for breeding or nursery animals and birds, important for public usage and recreation and hence public health, important for commercial or economic development or recognised as a protected area by legislation.

Sensitive areas which have the potential to be impacted by overflows from the NSOOS system are summarised in Figure 3.1 and Table 3.3 below. Each sensitive area has been assigned an identification code within the table (eg. NS1). For the purposes of this EIS, where there is no sewerage overflow impact, the environment is not considered sensitive regardless of the intrinsic ecological or other values it contains.

Overflow points in the NSOOS are located in a wide range of areas including reserves, national parks or parks, private residential property, industrial estates, and within roads and footpaths. Most, however, drain either directly or via stormwater channels into receiving waters. Waterways potentially affected by the operation of overflows which are connected to the NSOOS have not been classified under the Clean Waters Act 1970 (SPCC 1980). Overflows from the NSOOS therefore do not impact on classified waters.

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A large number of sensitive areas are present within the NSOOS system catchment. Those which may be impacted by the overflows include, the southern foreshore of Narrabeen Lagoon, Manly Lagoon, Manly Reservoir and their catchments, most of the beaches and foreshores in the area, remnant bushland of Ku-ring-gai Chase and Garigal National Parks and the urban bushland in the residential areas and some of the recreation areas, including Bayview golf course. It is important to note that

Sydney WATER

SYDNEY WATER CORPORATION LIMITED
ACN 063 279 649

SEWERAGE OVERFLOWS LICENSING PROJECT
NSOOS SEWERAGE SYSTEM

FIGURE 3-1
SENSITIVE AREAS

repeat overflows (eg. from designed structures) are impacting on sensitive areas and have been doing so for a relatively long time (measurable in tens of years for a mature system such as the NSOOS). The species, habitats and other values identified as sensitive are co-existing with overflows at the present time. The objectives of the overflow abatement programme in relation to these sensitive areas will, therefore, be to safeguard the environment and, where possible, to improve the environment by reducing overflow volumes, frequencies and impacts.

The extent to which overflows from the NSOOS contribute to the degradation of sensitive native vegetation communities and terrestrial fauna habitats is considered to be minor. The majority drain either directly or via stormwater channels into receiving waters and the main impacts on terrestrial communities comes from chokes, exfiltration and SPS failures. The exception to this is the impacts from overflows from the reticulation nodes.

Areas of possible exfiltration include the catchment areas of Mosman, Lidcombe, Lane Cove, East Killara and North Rocks. Exfiltration would occur into the groundwater and may eventually move to the adjacent waterways of Port Jackson and its tributaries, predominantly foreshore bays of the Lane Cove River, Middle Harbour, Toongabbie Creek and Upper Parramatta River. There is evidence of sewage overflow impacts in these receiving waters in dry weather periods especially in the Upper Parramatta River, and Manly Lagoon suggesting that the exfiltration is having a direct effect on these waterways. However, impacts on terrestrial and aquatic environments from dry weather overflows are hard to quantify. It is difficult even to attribute any relationship between evidence of dry weather overflows and a clear response in the environment, other than immediate and local impacts on amenity which may result from chokes and blockages, odours or pumping station failures. The effects of these events on sensitive environments are not predictable, and such events would need to be considered on an individual occurrence basis for impacts assessment. There is no direct evidence available that sensitive environments have been affected by such events.

Table 3.3 lists the areas deemed to be sensitive to impacts from sewerage system overflows. The table gives approximate location, nature of sensitivity, and the potential sources of the impact (ie. large wet weather overflow or chokes etc.). Supplementary information on some of the sensitive areas is given below to support the table.

Lake Paramatta Reserve, NS-1a

Rowing, power boating, canoeing and Scout and Guide water-based activities are undertaken in the upper reaches of Parramatta River. Lake Parramatta Reserve is predominantly used for passive recreational activities and Homebush Bay receives little recreational usage owing to the industrial nature of the area (Macdonald Wagner, 1985).

Scotts Creek/Willis Reserve, Willoughby, NS-1b

This wetland, located downstream of a major sewerage discharge point, 820203, may receive significant quantities of sewerage under certain circumstances from Scotts Creek. The impacts of the overflows could be detrimental to the ecosystem and particularly to the birds which utilise the resources of the wetland. The discharge could also contribute to alterations in native vegetation communities in adjacent bushland.

Moores Creek, Roseville, NS-1c

This mangrove community could potentially be affected by the major overflow, WM1-35 that drains into Moores Creek.

Buffalo Creek, North Ryde, NS-1d

This area is considered to be of conservation importance as it provides habitat for the threatened Red-Crowned Toadlet (*Pseudophryne australis*), which has been recorded at Sugarloaf Hill, at the mouth of Buffalo Creek (NP&WS 1996). This particular species could potentially be affected by discharges into the Creek. The wetland is located upstream of a major sewerage overflow, 3120 which may receive significant quantities of sewage under certain circumstances from Buffalo Creek.

Tarban Creek Wetland, Hunters Hill, NS-1e

This wetland is considered to be of conservation importance as it has been identified as having particular habitat value for wading birds and it supports the threatened plant species *Darwinia biflora* (Dept of Planning 1986). It may be impacted upon by modelled overflow no. 3021.

Lane Cove National Park & Lane Cove River, NS-2

Lane Cove National Park, which incorporates the Lane Cove River, is a popular recreation area. It has been estimated by the NPWS that the Park receives over one million visits per annum, with picnicking and bushwalking cited as the most popular activities (A. Ramsay, NPWS, *pers comm*). The natural flow regime of the Upper Lane Cove River has been altered by a weir above which the river suffers elevated water levels and elevated nutrient concentrations after heavy rainfall. These, in combination have resulted in weed infestation along the banks of the river and general degradation of the aquatic environment. Nevertheless, some areas are considered to be sensitive.

Links, Falls and Blackbutt Creeks, NS-2

The aspects of NS15 which have the greatest potential to be impacted by the overflows identified in Table 3.3 are natural aquatic ecosystems, recreational values, and visual amenity.

Northern Beaches, NS 4

Sydney's northern beaches and headlands are an important recreational and tourist resource. Shelly Beach at Manly is utilised by groups learning to scuba dive, and hang-gliding and windsurfing are popular at Long Reef.

Dee Why Lagoon, NS-6

Dee Why Lagoon has limited scope for water based recreation owing to its small area and shallow depth. Aesthetic enjoyment of the lagoon's features, particularly the foreshore wildlife refuge and reserves, is the main recreational activity. Dee Why is listed as a sensitive area primarily because of the presence of a number of bird species (refer to Table 3.2).

Toongabbie Creek, Old Toongabbie NS-19

Remnant vegetation exists as small patches and as long narrow strips in a number of locations along Toongabbie Creek. Forest and woodland of the sandstone soils is found in the sheltered gullies consisting of *Eucalyptus deanei, Angophora floribunda, Syncarpia glomulifera*. The vegetation contains many species found on the Hawkesbury sandstone soils (Benson and Howell 1994). A significant sewerage overflow discharges directly into the Creek which may contribute significantly to alterations in native vegetation communities along the creek line.

Numerous parks and reserves are scattered throughout the NSOOS catchment. Among the main areas of open space are: the Castle Hill Country Club and Golf Course, Excelsior Reserve, Fox Hills golf course, Lake Parramatta Reserve and the linear parks and reserves located adjacent to the Quarry Branch and Darling Mills Creeks. Coastal areas contain major open space and special uses within the area include the New South Wales Academy of Sport, the Cromer and Long Reef Golf Courses, the substantial area of the Garigal National Park and the Dee Why Lagoon and Wildlife Refuge. Most of the remaining land use is open space and bushland predominantly within the Lane Cove National Park and Lane Cove State Recreation Area. Numerous parks and reserves are located throughout the catchment including the Pennant Hills Recreation Reserve, Pennant Hills Golf Course and the substantial open space network adjacent to the Lane Cove River, Devlins Creek and Scout Creek.

Impacts of overflows on the terrestrial recreation areas within the Northern Lagoons area are generally considered to be minor since most overflows drain to waterways. Impacts on terrestrial recreational values are most likely to occur on the foreshore of the lagoons, lakes and other sensitive areas which are important to the attractive image of the catchment. Impacts of overflows on terrestrial recreation in the upper Parramatta River area are generally considered to be minor since most overflows drain to waterways. Impacts on terrestrial recreational values are most likely to occur within the reserves adjacent to the waterways which are of high importance to the local community. Impacts of overflows on the terrestrial environment within the upper Lane Cove area are generally considered to be moderate since most overflows drain to waterways and adjoining parklands. There is major weed infestation in most parks owing to both urban run-off and sewerage overflows.

Impacts on terrestrial recreational values are most likely to occur within the Lane Cove National Park, the adjoining Recreation Reserve and other waterside parks in the vicinity where the levels of visual and recreational amenity are affected by weed infestation and odours. People undertaking land-based recreational activities have the use of numerous foreshore parks and reserves and walking tracks. Sydney Harbour National Park which encompasses the harbour foreshore to include Bradleys Head, Middle Head, and North Head has walking tracks, picnic facilities and amenities. Garigal National Park has a large area designated for recreation purposes and provides picnic areas and barbecues (Gregory's, 1992). Other major foreshore parks are located at Middle Cove, Castle Cove, Northbridge and Cremorne. Impacts of overflows on the terrestrial within the Sydney Harbour REZ are generally considered to be minor since most overflows drain to waterways. Impacts on terrestrial recreational values are most likely to occur within the Sydney Harbour National Park and in other foreshore parks, which are of high importance to the local community.

Parks and reserves on the headlands and frontal dunes of beaches provide passive recreational opportunities. Walking trails, such as the Dee Why Head Bicentennial Walking Track, and the Manly Beach trail are also important. Other important waterside recreational resources include the Mona Vale Golf Course, Mona Vale Beach and Headland Recreation Reserve, Long Reef Golf Course, Manly Beach board walk, the Sydney Harbour National Park and numerous Surf Life Saving Clubs. The North Head STP, which is the primary sewerage outlet for the north Sydney sewerage system is located at the southern end of the catchment.

The potential for overflow impacts on the majority of listed sensitive areas is therefore likely to be low, with the possible occurrence of repeat chokes presenting the main overflow problem. Discharges resulting from these chokes are likely to vary, however, the majority drain to waterways, resulting in very little impact on native vegetation. The exceptions to this are NS12, NS24, Lane Cove River, Powell Creek, lower Parramatta River and Tarban Creek Wetland which are considered to have high potential impacts from chokes and other dry weather flows.

The following High risk threatened species (refer to Volume 2), is considered to be potentially affected by overflows from the NSOOS:

1. *Deyeuxia appressa*
2. Red-crowned Toadlet
3. Giant Burrowing Frog
4. Green and Golden Bell Frog
5. Australasian Bittern
6. Eastern Bristlebird
7. Broad-billed Sandpiper
8. Black-tailed Godwit
9. Freckled Duck.

As all these species are considered to be high risk the impact of overflows on these species is potentially significant.

Table 3.3 - Sensitive area potentially impacted by overflows from the NSOOS system

Sensitive area	Nature of sensitivity	Impact potential	Impacting system	Potential sources of impact
NS-1 Port Jackson/ Middle Harbour/Parramatta River				
NS-1a Lake Parramatta	Remnant bushland (ie. Blackbutt Forest) Macrophytes, Invertebrates	High	NSOOS	SPS 0222E, Chokes
NS1- b Scotts Creek /Willis Reserve, Willoughby	Wetland and bird habitat	High	NSOOS	Impacted by 820203.
NS1-c Moores Creek, Roseville	Mangrove wetland and saltmarsh	High	NSOOS	Impacted by major overflow WM-35 that drains into Moores Creek
NS1-d Buffalo Creek, North Ryde.	Small remnant wetland. Habitat of Red-crowned toadlet	High	NSOOS	Upstream of major overflow 3120.
NS1-e Tarban Creek Wetland, Hunters Hill	Wetland with habitat for wading birds. Supports threatened species Darwinia biflora.	Medium	NSOOS	Chokes and Overflow 3021 potentially impacts on this area.
Parramatta River	Macrophytes, Invertebrates	Low	NSOOS	SPS 103, Chokes
Middle Head (Sydney Harbour National Park)	Presence of Red-Crowned Toadlet	Low	NSOOS	Chokes
Duck Creek	Presence of wetlands	High	NSOOS	SPS Chokes
Adjacent to Haslams Creek	Presence of Green and Golden Bell Frog	High	NSOOS/ SWSOOS	SPS 42, 477, 1029, Chokes
Powell Creek	Presence of Black-tailed Goodwit, Broad-billed Sandpiper, Greater Sand Plover, Freckled Duck	High		SPS 41, 91, 980, Chokes
Lower Parramatta River (below weir)	Mangrove	Low	NSOOS	Chokes from "high" choke areas of Putney & Henley
Lower Lane Cove River	Mangrove	Low	NSOOS	Chokes, major overflow at Bums Bay Road.
Middle Harbour	Mangrove, Kelp Habitat, Seagrass	High	NSOOS	Exfiltration from inflow sub-catchment 820203, 820213 & WM1-17. Major wet weather overflows at Scotts Creek, Quakers Hat Bay and Tunks Park. Chokes from "high" choke areas in Middle Cove, Catlecrag & Castle Cove.
Bates Creek	Garigal National Park, Presence of Red-crowned Toadlet, Tiger Quoll.	Low	NSOOS	Chokes
South Creek	Presence of Red-crowned Toadlet, Giant Burrowing Frog, Estuarine Complex	High	NSOOS	SPS 615 Chokes
Sydney Harbour National Park	Remnant vegetation, sensitive fauna, very high amenity value (terrestrial and water based amenity)	Medium	NSOOS	Chokes, major wet weather overflows to Lane Cove River and Middle Harbour.

Sensitive area	Nature of sensitivity	Impact potential	Impacting system	Potential sources of impact
North Harbour Aquatic Park	Aquatic habitats, amenity value (terrestrial and water-based amenity)	Low	NSOOS	Chokes
NS 2 Lane Cove National Park	Blue Gum High Forest, Remnant vegetation, threatened flora & fauna.	Low	NSOOS	SPS 278, high choke area of Turramurra, Killara, West Pymble. Major designed overflow at Gloucester Acer Vaughan., West Pymble.
Near junction Shrimptons Creek and Lane Cove River	Presence of Red-crowned Toadlet Macrophytes, Aquatic Invertebrate Community	High	NSOOS	Chokes Reticulation node sub-catchment no. 820321 bordered by Agincourt Rd, North Rd, Kings Rd, Trelawney St, Marsden Rd, Lawson St, Epping Rd, Beecroft Rd, Oxford St. Aquatic boundary- Terrys Creek to Lane Cove River at De Burghs Bridge
Links, Falls and Blackbutt Creeks	Presence of Red-crowned Toadlet* and *Deyeuxia appressa* Macrophytes, Aquatic Invertebrate Community	Low	NSOOS	Chokes
Near junction Lane Cove River and Little Blue Gum Creek	Presence of Red-crowned Toadlet	High	NSOOS	Chokes
Blue Gum Creek	Presence of Giant Burrowing Frog* Macrophytes, Aquatic Invertebrate Community	High	NSOOS	Chokes
NS-3 Manly Creek	Presence of Red-crowned Toadlet habitat.	High	NSOOS	SPS 0210E
Manly Lagoon	Presence of Red-crowned Toadlet habitat.	High	NSOOS	SPS 0210E, 152, 35, 36, 37, Chokes
Manly Reservoir	Presence of Red-crowned Toadlet and *Tetratheca glandulosa, Acacia terminalis*[3]	High	NSOOS	Chokes
NS-4 Beaches	Beach Fauna	High	NSOOS	
NS-5Curl Curl Lagoon	Coastal Sandstone Heath	High	NSOOS	Chokes
NS-6 Dee Why Lagoon	Estuarine Complex. Presence of Sanderling, Pied Oystercatcher, Great Knot.	High	NSOOS	SPS 307, 128 Chokes
NS-7 Garigal National Park	Remnant vegetation, threatened flora and fauna	Low	NSOOS	Chokes from high choke area of St Ives
Ku-ring-gai National Park	Remnant vegetation threatened flora and fauna	Low	NSOOS	Chokes, exfiltration from inflow catchment 820210
NS-8 Brown Field	Rainforest	Low	NSOOS	Chokes
Twin Creek Reserve	Blue Gum High Forest Macrophytes, Aquatic Invertebrate Community	Low	NSOOS	Chokes
NS 9 Coups Creek	Blue Gum High Forest Macrophytes, Aquatic Invertebrate Community	Low	NSOOS	Chokes

Sensitive area	Nature of sensitivity	Impact potential	Impacting system	Potential sources of impact
NS-10 Devlins Creek	Blue Gum High Forest	Low	NSOOS	Chokes
	Macrophytes, Aquatic Invertebrate Community			Reticulation node sub-catchment no. EL0 bordered by Kissing Point Rd, Lane Cove River, Malton Rd, The Cres, Devlins Creek and Cannon Rd. Aquatic boundary- Devlins Creek and Lane Cove River to De Burghs Bridge.
NS-11 Brush Farm Park and Lambert Park	Blue Gum High Forest	Low	NSOOS	Chokes
NS-12 North Ryde	Presence of Green and Golden Bell Frog habitat	High	NSOOS	Chokes
NS 13 Denistone Park	Blue Gum High Forest	Low	NSOOS	Chokes
NS 14 Crown Reserve (between Darvall and Denistone Parks)	Blue Gum High Forest	Low	NSOOS	Chokes
NS-15 Darvall Park	Blue Gum High Forest	Low	NSOOS	Chokes
NS-16 Sir Thomas Mitchell Reserve	Blue Gum High Forest	Low	NSOOS	Chokes
NS-17 Cumberland State Forest (east of Darling Mills Creek)	Blue Gum High Forest	Low	NSOOS	Chokes
NS-18 Darling Mills Creek	Blue Gum High Forest Macrophytes	Low	NSOOS	Chokes
NS19-Toongabbie Creek	narrow strips of remnant vegetation	Low	NSOOS	Reticulation node sub-catchment no. 82548 bordered by Toongabbie Creek Branch, to Toongabbie Creek to confluence with Parramatta River. Reticulation node sub-catchment-no. 820680 bordered by Quarry Branch Creek and Toongabbie Creek (high choke area of old Toongabbie).
NS 20 Small Creek	Macrophytes, Invertebrates	Low	NSOOS	SPS 907, Chokes
NS-21 Girraween Creek	Presence of *Meridolum corneovirens* Macrophytes, Invertebrates	Low	NSOOS	Chokes
NS-22 North Head	Coastal Dune Heath[2], Presence of Long-nosed Bandicoot, Little Penguin and Potential presence of Red-crowned Toadlet, *Eucalyptus camfieldii*, Interkdal rock platforms, kelp habitat	High	NSOOS	SPS North Head STP, Chokes
NS-23 Wallumatta National Park (Near Kitty Creek)	Remnant vegetation.	Low	NSOOS	Chokes
NS24 98 Kissing Point Road, Dundas	a Victorian		NSOOS	Heritage item in the vicinity of three overflows
272 Kissing Point Road, Dundas	Army Hall		NSOOS	Heritage item in the vicinity of three overflows

Sensitive area	Nature of sensitivity	Impact potential	Impacting system	Potential sources of impact
37 311 Kissing Point Road, Dundas	Spanish Mission		NSOOS	Heritage item in the vicinity of three overflows
NS25 Original Road Park Gate Estate	Heritage item and presence of Green and Golden Bell Frog, Australian Bittern, Freckled Duck, Broad-billed Sandpiper.	Low for heritage item, high for fauna	NSOOS	Heritage item in the vicinity of overflow Model Node No. 820052U
NS 26 Park Gate Estate	Heritage item	Low	NSOOS	Heritage item in the vicinity of overflow Model Node No. 820052U
Harstone House 15-17 Carrington Ave Mosman	Heritage item	Low	NSOOS	Heritage item in the vicinity of overflow Model Node No. 820052U
NS 27 Glenaeon School 5A Glenroy Ave Middle Cove	Heritage item	Low	NSOOS	Heritage item in the vicinity of overflow Model Node No. 820203

3.3 Overflow ranking

A number of methods have been developed by Sydney Water to rank or prioritise the overflow problems identified in Chapter 2. Ranking methodologies were devised for wet weather overflows, SPS overflows, leakage (exfiltration/infiltration and chokes) and for odours. The ranking procedures have been used to target and prioritise abatement efforts and to allow comparison of overflow problems across Sydney Water's area of operation.

For wet weather overflows, a ranking method was developed based on the combined assessment of the magnitude of the overflow problem and the sensitivity of the potentially impacted environments. This method, referred to as the 'wet weather overflow ranking method', was used to calculate ranking scores for three categories of modelled wet weather overflow, wet weather overflows from designed overflow structures, from reticulation areas and from partially treated STP discharges. However, as the NSOOS system leads to no partially treated STP discharges, this part of the methodology was not relevant in this instance.

The ranking for assessment of overflows caused by SPS failure was similar to the wet weather overflow ranking. The method calculates ranking scores for individual SPSs based on a combined assessment of the asset quality, the magnitude of the overflow problem, and the sensitivity of the potentially impacted environment.

To address the problems of choke related overflows and exfiltration, a method was developed for the prioritisation of sewer inflow catchments. This method involved the determination of remediation priority ranks for inflow catchments based on a combined assessment of choke frequency, net infiltration / exfiltration (I/E), percentage rainfall ingress and the presence of sensitive areas. Finally, odour releases were ranked by classification of the sewerage suburbs in terms of odour complaint frequency.

Further details of each overflow ranking method are given below. Full details are included in the Methods volume of this EIS. The results of the ranking assessments for the NSOOS system are presented below and these have been used to help develop overflow management strategies and to prioritise remedial action, as outlined in Chapter 4 of this document.

3.3.1 Wet weather overflow ranking

The wet weather overflow ranking method calculates ranking scores for modelled wet weather overflow nodes and ranks the overflows in descending order of these scores. There are three discrete categories of overflow nodes, which exhibit distinctly different characteristics, and therefore comparisons of ranking scores can not be made. These are designed structure nodes, reticulation nodes and partially treated STP discharges.

Designed structure nodes represent untreated wet weather discharges from single known locations. In the event of an overflow, these structures generally discharge directly into the waterway, or stormwater system that then enters the waterway.

Reticulation nodes represent a modelled inflow catchment for a sewer reticulation area and discharge information from a reticulation node represents the sum of untreated wet weather discharges, which may occur anywhere within the inflow catchment.

Partially treated STP discharges represent STP discharges, which bypass the full treatment usually received, although may receive some form of treatment.

The wet weather overflow ranking scores are calculated as the sum of an overflow score (based on the assessment of overflow discharge volume and activation frequency) and an environmental sensitivity score (based on the potentially impacted environment). The environmental sensitivity score is determined via the assessment and scoring of three component environmental dimensions and is taken as the highest score obtained for any one dimension. These dimensions are aquatic ecosystems, terrestrial ecosystems and human health. Full details of the wet weather overflow ranking method are provided in Section (insert section number) of the Methods document.

Some overflows have the potential to impact on areas where threatened species, populations or communities (under the Threatened Species Conservation Act 1995) have been recorded. Individual threatened species were assessed on the potential impact from overflows and categorised into:

1. threatened species has the potential to be adversely affected by overflows (TSCA1) or
2. threatened species has no potential to be adversely affected by overflows (TSCA2).

The complete results for the wet weather overflow ranking for the Port Jackson geographical area, including score sheets and reasonings, are presented in Appendix C. A summary of the Sydney wide wet weather ranking results is provided in Volume 1 and Appendix G. Below is a summary of key wet weather overflow ranking results from designed structures and reticulation nodes within the NSOOS sewerage system. There are no partially treated STP discharges in the NSOOS sewerage system. These wet weather overflow ranking results have been used to assist with the overflow problem definition for the Port Jackson and Northern and Eastern Sydney Beaches geographical area

Designed Structures

There are 45 designed structure overflows within the NSOOS (Appendix C). The scores of the nine highest ranked designed structure overflows in the NSOOS system largely reflect the high activation frequencies and high average annual discharge volumes (Table 3.4). Eight out of ten of the highest ranked structures are predicted to overflow in excess of 100 times in a ten year period. Five of highest ranked designed overflow structures have predicted average annual wet weather discharge volumes greater than 1000 ML, three have predicted annual average wet weather discharge volumes of between 250 ML and 1000 ML, with the remaining two between 50 ML and 250 ML.

The environmental sensitivity scores were most strongly influenced by the sensitivity of human environmental uses and the number of people affected in terms of human health. Generally, scores obtained for the human health dimension were higher than those obtained for the aquatic ecosystem dimension and the terrestrial ecosystem dimensions (Appendix C). Whilst most of these designed structures have the potential to impact on sensitive biophysical aquatic areas (aquatic habitat, seagrass beds and mangroves) and some discharge onto the terrestrial environment (within a national park), the potential threat to human health scored higher. The impact on human health due to the high frequency of primary contact (swimming and canoeing) of the affected waterways was found to be the most important of the environmentally sensitive criteria with the exception of the fourth and tenth highest ranked overflows.

The fourth highest ranked overflows scored a very high aquatic ecosystem dimension score due to the presence of threatened population (fairy penguins) listed under the *Threatened Species Conservation Act, 1995.* The tenth highest ranked overflow score a very high terrestrial ecosystem dimension score due to the presence of a threatened species (Red Crowned Toadlet) as listed under the *Threatened Species Conservation Act, 1995.* The presence of the threatened population and species are scored and are flagged differently (Table 3.4). Fairy penguins have the potential to be adversely affected by potential discharges, although the frequency and volume of discharge are low, whereas Red Crowned Toadlets are unlikely to be adversely affected by potential discharges.

The four highest ranking overflows in the NSOOS are also the four highest in the geographical area and are ranked in the 15 highest ranking designed structures Sydney wide. The ranking of these NSOOS overflows reflects the significance of the high volume and frequency of overflows discharging into high usage recreational areas in Middle Harbour (Tunks Park, Castle Cove and Quakers Hat Bay) and presence of threatened species at Manly (Shelly Beach).

In summary, the greatest problem relating to designed structure wet weather overflows in the NSOOS is the predicted average activation frequency and average annual wet weather discharge volume of the overflows into the receiving environment, largely primary contact recreational areas.

Table 3.4 - Summary of wet weather overflow ranking results for modelled designed overflow structures in the NSOOS sewerage system

Designed Structure		Impacted REZs	Overflow Rank			Scores			Overflow Flags[2]	Potential to Impact Sensitive Area (Y/N)
Model Node No.	Location		System	GA	Sydney wide	Overflow discharge	Environmental sensitivity	Overflow ranking score[1]		
WM1-17	Tunks Park, Northbridge	Sydney Harbour	1	1	7	32	16	48	N/A	Y
820203	Glenroy/Greenfield Ave, Castle Cove	Sydney Harbour	2	2	13	32	10	42	N/A	Y
820052U	Bay St, Mosman	Sydney Harbour	3	3	15	24	16	40	N/A	Y
820951b	Shelly Beach, Manly	N/E Sydney Beaches	4	4	14*	6	32.5	38.5	TSCA1	Y
820951a	Shelly Beach, Manly	N/E Sydney Beaches	4	4	14	6	32.5	38.5	TSCA1	Y
3120	Burns Bay Rd, Lane Cove	Sydney Harbour	6	6	32	24	12	36	N/A	Y
EJ1	Gloucester Ave, West Pymble	Upper Lane Cove River	6	6	32	24	12	36	N/A	Y
WM1-30	52 Carlyle Ave, East Lindfield	Sydney Harbour	8	8	40	20	12	32	N/A	Y
7-4a	Kissing Point Rd, Dundas	Sydney Harbour	9	9	41	24	6	30	N/A	N
820405	McCallum Ave, East Ryde	Sydney Harbour	10	11	48	12	17	29	TSCA2	Y

Notes:

1. Wet weather overflow ranking score = overflow score + environmental sensitivity score
2. Species protected under the *Threatened Species Conservation Act, 1995* lie within the estimate boundaries of impact

TSCA1 Discharge from designed structure has potential to adversely affect the species

TSCA2 Discharge from designed structure has no potential to adversely affect the species

* In the Sydney-wide ranking, the Shelly Beach overflows were considered as one, which changed the ranking

Reticulation Nodes

There are 105 reticulation nodes in NSOOS sewerage system of the Port Jackson and Northern and Eastern Sydney Beaches geographical area. A summary of the highest ranking reticulation nodes is presented below (Table 3.5).

Seven of these overflows are in the Sydney Harbour REZ, two in the Upper Lane Cove River REZ and the remaining one in the Northern Lagoons REZ. The environmental sensitivity scores primarily determined the top positions.

For nine of these overflows the terrestrial ecosystem scores were higher than both aquatic ecosystem and human health scores, and therefore determined the environmental sensitivity score. The high scores for terrestrial ecosystems reflected the presence of threatened species within the boundaries of the reticulation catchments. The threatened species identified are considered unlikely to be impacted by wet weather overflows, however, and the subject reticulation catchments have therefore been flagged TSCA2 (see Table 3.5) The exception was the reticulation node in North Parramatta (820019U) which ranked highly in the aquatic ecosystem dimension due to Lake Parramatta being in the catchment area. Under small rainfall events Lake Parramatta does not undergo any flushing. Flushing will only occur under large storm conditions when the Lake will utilise the siphon system to maintain water levels at one metre below the top of the wall (pers. comm. Gary Jenson, 1997).

The overflow discharge score did not have a significant impact on the overall ranking positions, except for the third reticulation node overflow in Mosman, which had a discharge frequency of less than 40 times over a ten year period, had a discharge frequency of greater than 40 times over a ten year period.

Whilst not significant in determining the overall ranking the majority of the top ranking reticulation nodes have the potential to impact on sensitive areas. The reticulation overflows in Cammeray (820694), Clontarf (820695), East Killara and Lindfield (820275), Northbridge (820213) and Killarney Heights (820274a) have the potential to impact on sensitive areas in Middle Harbour (aquatic habitat, seagrass beds and mangroves). The reticulation overflow in North Parramatta (820019u) has the potential to impact on sensitive areas in Middle Creek (aquatic habitat).

The greatest potential problem associated with wet weather overflows from reticulation nodes, in the NSOOS is the presence of threatened species within a modelled inflow catchment. The highest ranked reticulation nodes received a high score because of the presence of threatened species within the catchment. The four highest ranked reticulation nodes in NSOOS are also the four highest ranked in the geographical area. However they are ranked between 26th and 44th Sydney wide.

Table 3.5 Summary of wet weather overflow ranking results for modelled reticulation areas in the NSOOS sewerage system.

Reticulation Area/ Inflow Catchment		Impacted REZs	Overflow Rank		Scores				Overflow Flags[2]	Potential to Impact Sensitive Area (Y/N)
Model Node No.	Location		System	GA	Sydney Wide	Overflow Discharge	Environmental Sensitivity	Overflow Ranking Score[1]		
820694	Cammeray	Sydney Harbour	1	1	26	12	32	44	TSCA2	Y
820695	Clontarf	Sydney Harbour	2	2	27	10	32	42	TSCA2	Y
820620	Mosman	Sydney Harbour	3	3	40	5	32	37	TSCA2	N
820114	Allambie Heights	Northern Lagoons	4	4	44	16	20	36	TSCA2	N
ELO	South Turramurra	Upper Lane Cove River	4	4	44	16	20	36	TSCA2	N
820019U	North Parramatta	Sydney Harbour	4	4	44	16	20	36		Y
820275	East Killara and Lindfield	Sydney Harbour	7	7	56	16	17	33	TSCA2	Y
820274a	Killarney Heights	Sydney Harbour	7	7	56	16	17	33	TSCA2	Y
820213	Northbridge	Sydney Harbour	9	9	59	12	20	32	TSCA2	Y
820321	Epping, Eastwood and Marsfield	Upper Lane Cove River	9	9	59	12	20	32	TSCA2	N

1. Wet weather overflow ranking score = overflow score + environmental sensitivity score

2. TSCA2 species protected under the *Threatened Species Conservation Act, 1995* lie within the estimate boundaries of impact but are unlikely to be adversely affected by wet weather overflows

3.3.2 SPS ranking

The 'SPS ranking method' is designed to reflect the magnitude of the problem relating to overflows caused by SPS failure. This method calculates ranking scores for individual SPSs, then ranks the SPSs in descending order of these scores. For SPSs where operational failures are predicted to result in overflow, the individual SPS ranking score is calculated as the sum of three scores - an asset score (based on assessment of asset quality and the likelihood of operational failure and overflow), an overflow score (based on assessment of overflow volume and frequency) and an environmental sensitivity score (which is determined as described for wet weather overflows section 3.6.1).

For SPSs where operational failures are not predicted to result in an overflow, the individual SPS ranking score is calculated as the sum of the asset score and overflow score only. Full details on the SPS ranking method are provided in the Methods document.

Some overflows have the potential to impact on areas where threatened species, populations or communities (under the Threatened Species Conservation Act 1995) have been recorded. Individual threatened species were assessed on the potential impact from overflows and categorised into:

1. threatened species has the potential to be adversely affected by overflows (TSCA1)
2. threatened species has no potential to be adversely affected by overflows (TSCA2).

A 'flagging' system was also used to highlight critical problems which may otherwise not be considered in the assessment of final results. The items flagged include:

1. SPSs with no telemetry (T1);
2. SPSs without fail safe 'Above Top Water Level' (AWTL) alarm activation (A1)
3. SPSs with an ineffective contingency plan (C1)
4. There were no SPSs in the NSOOS with 'T1' or 'A1' flags.

The complete set of results, including score sheets and corresponding reasoning, of SPS rankings in the NSOOS sewerage system of the Port Jackson and Northern and Eastern Sydney Beaches geographic area are presented in Appendix C. A summary of the Sydney wide SPS ranking results are presented in Appendix G of Volume 1. This section presents a summary of key individual SPS ranking results for the NSOOS sewerage system. These SPS ranking results have been used to assist with the overflow problem definition for the Port Jackson and Northern and Eastern Sydney Beaches geographic area

There are 87 SPSs ranked within the NSOOS sewerage system (Appendix C). Summary results for the ten highest ranked SPSs are present in Table 3.6. These discharge into the Sydney Harbour REZ, Northern and Eastern Sydney Beaches REZ and Upper Parramatta River REZs.

As shown in Table 3.6 the asset scores and overflow discharge scores are variable. The overflow discharge score for SPS 67 is significantly higher any other SPSs in the NSOOS. This reflects the potential for an overflow volume, greater than 100 000 kL per failure, to be discharged, however none of these SPSs have reported operational failures during the last year of record. Only three out of ten SPSs, (103, 365 and 240) reported overflows caused by operational failure in the last year of record. These ranged from one overflow from SPS 103 with a volume up to 10 000 kL to seven overflows from SPS 240 with a volume up to 100 kL per failure, in the year.

The environmental sensitivity score has a greater impact on the overall SPS ranking score than the asset or overflow discharge score. SPS 117 and SPS 365, at Manly, were the two highest ranked SPSs, because a threatened population of fairy penguins, as listed under the *Threatened Species Conservation Act, 1995*, is reported to forage within the potentially impacted area of discharge from the SPSs. These two SPSs also received an asset flag, the only other SPS to receive an asset flag was SPS 240.

Whilst eight out of ten of the highest ranked SPSs in the NSOOS discharged to sensitive biophysical areas, potential impacts on the human health dimension had the greatest influence on environmental sensitivity scores. Human health was significant to all the SPSs, with the exception of SPS 98 at Auburn, because in the event of failure they have the potential to discharge into waterways where medium to high usage primary and/or secondary contact recreational activities take place. Recreational activities include diving, swimming, rowing, boating and recreational fishing. Facilities found within the vicinity of these SPSs that encourage these activities include rowing clubs, boat ramps and baths.

Flushing times of potentially impacted waterways were generally less than five days due to tidal influence. The exception was SPS 103 at Northmead. This SPS discharges into the freshwater section of the Parramatta River above the weir. Due to the impoundment by the weir, flushing significantly decreases and the potential impact of sewerage discharges therefore increases. As a result, the aquatic ecosystem dimension was the highest scoring environmental dimension for SPS 103 and therefore determined its environmental sensitivity score. The terrestrial ecosystem dimension was not included in the ranking process for the SPSs as all the SPSs discharged directly into waterways.

Overall, the human health impacts are the greatest problem associated with potential SPS overflows resulting from operational failures in the NSOOS.

The Sydney wide scores showed that, with the exception of SPS 117 and SPS 365 at Manly, the NSOOS SPSs were not highly ranked. SPS 117 and SPS 365 were highly ranked because of the presence of the threatened population, the fairy penguins. Whilst fairy penguins are a threatened population, the potential of impact is low. SPS 365 has reported overflows of less than 1000 kL and less than four overflows caused by operational failure occurred during the last year of record and no overflows caused by operational failure have occurred in the last year of record from SPS 117.

Table 3.6: Summary of SPS ranking results for the NSOOS system.

			SPS Rank			Scores				Asset score flags[2]	SPS flags[3]	Potential to impact sensitive
SPS	Location	Impacted REZs	System	GA	Sydney wide	Asset	Overflow discharge	Environmental sensitivity	SPS ranking score[1]			Area (Y/N)
0117	Stuart Street, Manly	Sydney Harbour	1	1	20	28	3	65	96	C1	TSCA1	Y
0365	Bower Street, Manly	N/E Sydney Beaches	2	2	27	16	8	65	89	C1	TSCA1	Y
103	Balfour Street, Northmead	Upper Parramatta River	3	6	56	18	10	36	64	N/A	N/A	N
67	Grand Ave, Granville	Sydney Harbour	4	9	71	11	33	12	56	N/A	N/A	N
0240	Shirley Road, Wollstonecraft	Sydney Harbour	5	10	80	30	10	12	52	C1	N/A	Y
0159	Teemer Street, Tennyson	Sydney Harbour	6	18	99	18	3	24	45	N/A	N/A	Y
477	Off Hills Road, Lidcombe	Sydney Harbour	6	18	99	12	9	24	45	N/A	N/A	Y
0265	Off Minimbah Road, Northbridge	Sydney Harbour	8	24	105	21	3	20	44	N/A	N/A	Y
98	Sheffield Street, Auburn	Sydney Harbour	9	27	118	22	9	10	41	N/A	N/A	Y
0467	Magdala Road, Ryde	Sydney Harbour	10	32	127	17	3	20	40	N/A	N/A	Y

Note:
1. SPS ranking score = asset score + overflow score + environmental sensitivity score
2. Species protected under the *Threatened Species Conservation Act, 1995.* Discharge from SPS has the potential to adversely affect the species.
3. SPSs with an ineffective contingency plan are flagged 'C1'

3.3.3 Inflow catchment ranking

This ranking methodology aimed to prioritise sewerage system sub-catchments in terms of choke frequency and pipe leakage problems. The methodology involved determination of the inflow catchment classification for leakage severity based on the combined consideration of percentage rainfall ingress and the net infiltration / exfiltration. Following inflow catchment classification, initial rankings were determined based on leakage severity and choke frequency. Inflow catchments (Figure 4.1) were ranked on a scale ranging from a rank of one, which represents a high investigation priority, down to a rank of five, which represents a low investigation priority. Finally, initial rankings were modified based on the presence of a sensitive area.

The inflow catchment priority ranks are designed to provide an indication of the need for remedial action and to assist with the allocation of investigation priorities. Full details of the ranking method can be found in the Methods volume of this EIS.

The complete results of the inflow catchment ranking across all the Sydney Water sewerage systems are presented in Appendix G of Volume 1 of this EIS. This section provides a summary of the key inflow catchment prioritisation results for the NSOOS system (a full set of results is presented in Appendix C). These results have been used to assist with the overflow problem definition for the Sydney Coastal GA (refer to Volume 2 of this EIS).

Table 3.7 provides a list of all inflow catchments in the NSOOS system ranked as a priority 1. Thirty five inflow sub-catchments (of the 167 in the NSOOS system) have been ranked as priority 1.

Table 3.7. - Prioritisation of inflow catchments in terms of choke and pipe leakage problems - summary of results for the NSOOS (only those inflow catchments with a priority "1" are shown, a complete table showing priority of all inflow catchments in the NSOOS is shown in Appendix C).

Inflow	Location (REZ)	Problem classification				Priority rankings		
Catchment		Net I/E	Rainfall ingress	Leakage severity	Choke frequency	Initial priority	Presence of sensitive areas	Priority
9A-3	Upper Parramatta River	ih	ll	l	h	1	y	1
820581	Upper Parramatta River	em	h	h	m	1	n	1
820312	Upper Lane Cove River	em	m	h	m	1	n	1
820321	Upper Lane Cove River	em	m	h	m	1	y	1
EM	Upper Lane Cove River	un	m	h	m	1	y	1
ELO	Upper Lane Cove River	un	m	h	m	1	y	1
820301	Upper Lane Cove River	un	m	h	m	1	y	1
EK	Upper Lane Cove River	un	m	h	m	1	y	1
820308U	Upper Lane Cove River	un	m	h	h	1	y	1
820345	Upper Lane Cove River	ok	ll	ll	h	1	n	1
820409	Upper Lane Cove River	un	m	h	m	1	y	1
E12	Upper Lane Cove River	un	h	h	h	1	y	1
820226	Sydney Harbour	em	m	h	h	1	n	1
E1	Upper Lane Cove River	un	h	h	h	1	n	1
EF	Upper Lane Cove River	un	h	h	m	1	y	1
820260	Sydney Harbour	un	h	h	h	1	n	1
820221	Sydney Harbour	il	h	m	h	1	n	1
820255	Sydney Harbour	ok	m	l	h	1	n	1
820275	Sydney Harbour	il	h	m	h	1	y	1

Inflow Catchment	Location (REZ)	Problem classification				Priority rankings		
		Net I/E	Rainfall ingress	Leakage severity	Choke frequency	Initial priority	Presence of sensitive areas	Priority
820265	Sydney Harbour	ih	h	h	m	1	y	1
820700	Sydney Harbour	ih	m	h	h	1	y	1
WM1-12	Sydney Harbour	ih	h	h	h	1	y	1
820274	Sydney Harbour	un	h	h	m	1	y	1
820618	Sydney Harbour	un	m	h	m	1	y	1
820695	Sydney Harbour	un	h	h	m	1	y	1
820172	Northern Lagoons	un	h	h	m	1	y	1
820843	Upper Parramatta River	ok	h	m	m	2	y	1
820627	Sydney Harbour	im	m	m	m	2	y	1
820407	Upper Lane Cove River	il	h	m	m	2	y	1
820307	Upper Lane Cove River	un	h	h	l	2	y	1
820201	Sydney Harbour	il	h	m	h	2	y	1
820203	Sydney Harbour	eh	h	h	l	2	y	1
820297	Sydney Harbour	ok	h	m	m	2	y	1
WM1-17	Sydney Harbour	eh	l	m	m	2	y	1
820213	Sydney Harbour	eh	h	m	m	2	y	1

3.3.4 Odour ranking

Odours could not be ranked based on environmental impacts, as these are highly variable, largely subjective and are not recorded in detail. They have therefore been ranked by suburb according to the number of odour complaints per year. The NSOOS system serves 128 suburbs. The full odour ranking is presented in Appendix C. Only the top ten ranked suburbs are shown in Table 3.8.

Table 3.8. - Summary of odour problem assessment results for the NSOOS (only the suburbs with the ten highest number of complaints are shown).

Suburb	Location (REZ)	Rank (NSOOS)	Rank (Sydney wide)	Number of complaints in 96/97
Mosman	Sydney Harbour	1	1	13
Cremorne	Sydney Harbour	2	6	8
Hornsby	Upper Lane Cove River	3	12	7
North Turramurra	Sydney Harbour	4	15	6
Balgowlah	Sydney Harbour	8	28	5
Castle Cove	Sydney Harbour	8	28	5
Dee Why	Northern Lagoons	8	28	5
Manly	Northern Lagoons	8	28	5
Hunters hill	Sydney Harbour	10	51	4
Strathfield	Upper Parramatta River	10	51	4

Odour complaint data (table 3.8) indicates that the NSOOS system is significant in terms of odour complaints, in comparison with other areas of Sydney

3.4 Conclusions

The environmental impact of each type of overflow can be assessed by considering their impact on water quality, terrestrial habitats, public health and public amenity. The impact of overflows from the NSOOS system has been assessed quantitatively (if sufficient data was available) or qualitatively (where limited data could be obtained). Methods have been developed and used to objectively rank each overflow source for each type of overflow. The impact assessment and results of the ranking have been used to develop overflow abatement strategies for the system (discussed in Chapter 4). Major impacts from each type of overflow for the NSOOS system are summarised below.

Wet weather overflows

Overflows have a significant impact on water quality during and immediately after storm events in freshwater and estuarine sections of Lane Cove and Parramatta Rivers, Middle Harbour, Port Jackson, Shelly Beach and Manly Lagoon. Improving overflow containment standards increases the number of days per year during which water quality meets ANZECC guidelines for ecosystem protection and recreation in most of these areas. The improvements that can be realised through overflow containment in the Upper Parramatta River, Shelly Beach and in the Northern Lagoons (except Manly Lagoon) are limited, reflecting the relatively high contribution of pollutant loads derived from stormwater in these areas. Wet weather overflows also result in localised loss of amenity value.

Partially treated STP discharges

There are no partially treated STP discharges from the NSOOS. The capacity of North Head STP matches the maximum capacity of the sewerage system.

Infiltration, Exfiltration and chokes

Twenty gauged catchments in the system are classed as having high or moderate exfiltration potential. The infiltration / exfiltration potential of a further 24 inflow catchments is unknown. Although the extent of exfiltration and the resulting impacts are difficult to quantify, there is some evidence to suggest that exfiltration is contributing toward high faecal coliform concentrations (and presumably, associated water quality deterioration) during dry weather in some receiving waters.

The NSOOS serves 16 suburbs where the frequency of chokes is classed as “high”. Some of these high choke areas coincide with sensitive areas. A further 78 suburbs are classed as “medium” in terms of chokes. The inflow catchment ranking, has been used to prioritise areas for leakage control (I/E and choke reduction). Thirty-five inflow catchments in NSOOS have been identified as high priority areas.

Overflows from SPSs

Only 20 overflows resulted from the 87 SPSs in the NSOOS system during the period (96/97). Impacts are generally on the aquatic environment and highly localised. The SPS ranking methodology suggests that overflows from SPSs in the NSOOS are not a major problem compared with overflows on a Sydney wide basis.

Chapter 4

System Overflow Management Strategy

Synopsis

A combination of three distinctive sets of requirements define the overflow abatement objectives for the NSOOS. These requirements are; long term performance targets, covering the whole of Sydney Water's service area; minimum performance standards and environmental objectives for the REZs, as discussed in Volume 2. These requirements were applied to each type of overflow, and the most stringent requirements were adopted as abatement objectives for the NSOOS.

Environmental and overflow abatement objectives have been identified for the Sydney Harbour, and Northern and Eastern Sydney Beaches REZ in Volume 2. The benefits and costs of additional overflow abatement levels (above the minimum performance standard) have been evaluated and the most appropriate overflow abatement strategy selected. A variety of containment options have been selected for the REZs impacted by the NSOOS (refer to Volume 2 for full details). A 40 overflows in ten years containment option has been selected for the majority of the areas impacted including Upper Lane Cove River REZ, Upper Parramatta River REZ and two areas within the Sydney Harbour REZ, namely the Parramatta River Estuary and Lane Cove River Estuary. Twenty overflows in ten years containment levels have been adopted for the remainder of the Sydney Harbour REZ (Port Jackson and Middle Harbour) and for Manly Lagoon. For the Northern Beaches REZ and for Curl Curl, Dee Why and Narrabeen Lagoons and Cowan Creek minimum performance standard containments have been selected.

The Northside Storage Tunnel project, currently being progressed by Sydney Water, will extend from Lane Cove to North Head, intercepting sewage overflows at Lane Cove, Tunks Park, Quakers Hat Bay and Scotts Creek (the overflow from Scotts Creek Carrier and the overflow from Scotts Creek Aqueduct). These are the largest wet weather overflows in the GA. The overflow ranking completely as part of this EIS, ranks these overflows as numbers 1, 2, 3, 4 and 7 from the sewerage system. In other words, these overflows are deemed to be the most significant based on discharge quantity, frequency and the sensitivity of the receiving environment. The objective of the tunnel project is therefore to achieve a substantial improvement in water quality in Sydney Harbour to improve the amenity value of the waterway (both in terms of appearance and odour), to improve the aquatic environment and reduce perceived risks to public health.

Actions to achieve the proposed strategy, 40 overflows in ten years and 20 overflows in ten years containments for the NSOOS will include further sewer rehabilitation (I/I reduction), reticulation amplification, trunk main amplification and provision of storage capacity (such as the Northside Storage Tunnel). Wet weather abatement actions range from preventing additional rainfall dependent infiltration and inflow components entering in to the sewer system, reticulation and main carriers amplifications, provision of on line or off line storage, treat and discharge and to upgrade the existing capacity of the STP. A combination of these actions will be used to develop sewerage system management strategies to transport wet weather flows to the STP, thereby minimising overflows from the system. System failure abatement actions include measures to reduce the potential for and/or mitigate the impact of chokes, SPS failures, exfiltration and odours.

The I/E programme currently being undertaken by Sydney Water is targeted to eliminate both dry and wet weather overflows in the form of exfiltration and infiltration from the sewerage system. The elimination of exfiltration and infiltration problems will improve the overall performance of the sewerage system and reduce the possible dry and wet weather sewage related impacts to the receiving environment zones.

Actions will be implemented through a structured plan which integrates the timetable for improvements, funding requirements, researching, system maintenance, training and standardised operating and emergency response procedures. Components of the management plan have been selected to achieve a balance between non-structural and structural options that can be implemented progressively over the next 25 years. The proposed management plan will form part of Sydney Water's total quality assurance system. The total estimated cost for the NSOOS System over the next 23 years is $ 964.5 million (based on 1996 costs). This will be funded from Sydney Water's existing rates, rates from new customers and developer charges for new infrastructure.

4. System overflow management strategy

4.1 Overflow abatement objectives

A combination of three distinctive sets of requirements define the overflow abatement objectives for the NSOOS. These requirements are:

1. long term performance targets, covering the whole of Sydney Water's service area
2. minimum performance standards
3. environmental objectives for the REZs, as discussed in Volume 2.

These requirements were applied to each type of overflow, and the most stringent requirements were adopted as abatement objectives for the NSOOS. The contribution of the NSOOS to the achievement of Sydney Water's long term performance targets is also discussed.

4.1.2 Sydney Water long term performance targets

Sydney Water has adopted Sydney wide long term performance targets, as in Table 4.1.

Table 4.1 - Sydney wide long term performance targets

Overflow type	Long term performance target
Discharges through overflow structures	80 - 90% reduction in events per ten years average across Sydney in wet weather
	15 discharges* per year across Sydney in dry weather
Surcharges (including chokes)	No internal surcharges due to Sydney Water capacity in wet weather
	Less than ten internal surcharges per year due to Sydney Water across Sydney in dry weather
	96% of customers with no surcharges
	Individual customers experiencing less than two events per six months guarantee no repeat for two years
Partially treated STP discharge	STP discharge will not cause receiving water to exceed swimming criteria in wet weather
Exfiltration	Will not cause dry weather failure of swimming / boating water quality criteria
Odour	Less than three verified events per year for an individual asset (eg. ventshaft or SPS)

Note: * Mainly from SPSs

4.1.3 Minimum performance standard

Sydney Water has defined the minimum performance standard for each overflow type as maintaining the current system performance in the year 2021. This requires that population growth in the sewerage catchment will not cause deterioration to the system performance resulting in additional overflows. The proposed Sydney Water minimum performance standard and the current performance of the NSOOS is shown in Table 4.2.

Table 4.2 - Sydney Water minimum performance

Overflow type	Performance indicator	Current NSOOS performance
Wet weather overflows	Number of overflow events per ten years	237 (modelled)
Surcharges (due to chokes)	Number of high choke complaint suburbs	16
	Number of medium choke complaint suburbs	74
SPS failure	Number of individual SPS overflow events	20
Exfiltration	Number of gauging catchments with high likelihood of exfiltration	6
	Number of gauging catchments with medium likelihood of exfiltration	14
Odour	Number of events leading to complaints per sewerage system	152
Partially treated STP discharges	Number of STP untreated or partially treated events per ten years	0

The first stage of the overflow abatement programme is to ensure that the NSOOS system meets the minimum performance standard requirements. In addition, Sydney Water has initiated programs to investigate the impacts of overflows from SPS failures and exfiltration. Outcomes from these programs will result in improved system performance. All SPSs have been ranked as part of the SPS risk reduction programme and works have been identified to reduce the risk of SPS failures.

An interim I/E programme is already under way to investigate and reduce the impacts of infiltration and exfiltration. The sewer mini-catchments experiencing exfiltration have been evaluated from sewer flow and water use data, and these mini-catchments are ranked based on and adopted criteria for exfiltration. Other potential exfiltration sewer sub-catchments identified in this EIS will be added to the program.

4.1.4 Environmental objectives

Environmental and overflow abatement objectives have been identified for the Sydney Harbour, and Northern and Eastern Sydney Beaches REZ in Volume 2. The benefits and costs of additional overflow abatement levels (above the minimum performance standard) have been evaluated and the most appropriate overflow abatement strategy selected. Additional overflow containment has also been recommended for sensitive areas within the NSOOS catchment.

4.2 Strategies for the NSOOS

This section defines the overflow abatement strategy for each overflow category as required by the Sydney long term performance targets, the minimum performance standards, the outcomes of the REZs assessment in Volume 2, the protection of sensitive areas, the SPS risk reduction program and the interim I/E program.

The overall strategy for the NSOOS includes a combination of the following:

1. Improving containment standards to 20 overflow events in ten years or 40 events in ten years (six or three month containment) depending on receiving environment. A varying containment standard has been selected for the NSOOS system, reflecting the range of different existing containment standards across this extensive system and the range of different receiving environment values. The actions which will achieve additional containment include sewer sub-catchment rehabilitation, main sewer and/or reticulation amplification and storage.

2. Continue the current interim I/E program for Port Jackson. Extend this program to areas identified as having high and moderate exfiltration and investigate unknown sub-catchments.
3. The Northside Storage Tunnel Project.
4. Sewer rehabilitation for those areas with high chokes which are not addressed as part of the wet weather containment work or as part of the I/E program.
5. SPS upgrades for high ranking pumping stations.

The Northside Storage Tunnel

Sydney Water are currently progressing a project designed to significantly reduce the frequency of the largest volume wet weather overflows into the Sydney Harbour REZ. The project, known as the "Northside Storage Tunnel", is an integral part of Sydney Water's wastewater strategy, WaterPlan 21, and is in accordance with the NSW Government's Waterways Package.

The Northside Storage Tunnel will extend from Lane Cove to North Head, intercepting sewage overflows at Lane Cove (3120), Tunks Park (WM1-17), Quakers Hat Bay (820052U)and Scotts Creek (the overflow from Scotts Creek Carrier, WM1-9 and the overflow from Scotts Creek Aqueduct, 820203). These are the largest wet weather overflows in the GA. In terms of volume, these overflows are ranked 1, 2, 3, 4 and 7 in the sewerage system (refer to Table 2.8). In other words, these overflows are deemed to be the most significant based on discharge quantity, frequency and the sensitivity of the receiving environment. The objective of the tunnel project is therefore to achieve a substantial improvement in water quality in Sydney Harbour to improve the amenity value of the waterway (both in terms of appearance and odour), to improve the aquatic environment and reduce perceived risks to public health.

The project will include construction of a 15.8 km-long, 6 m diameter main storage tunnel, running from 65m to 90m below sea level and a 3.5 km-long, 4 m diameter branch tunnel from Tunks Park to Scotts Creek. A dry well pumping station adjacent to the storage tunnel at North Head STP will be built to transfer sewage to the STP for treatment before discharge via the long sea outfall. During wet weather, the tunnel will store about 510 ML of sewage. Pumps will lift the sewage from the storage tunnel to North Head STP. These pumps will be controlled by computers at the STP to maximise the capture of overflows while ensuring the combined tunnel and NSOOS flows will be within the capacity of the STP. This will allow treatment and discharge of all flows through the ocean outfall.

Once constructed the tunnel, which is sized to improve the containment level for the five major overflows listed to once every six months, will deliver the following environmental benefits:

1. reduce nutrient inputs to receiving waters, with potential reduction in eutrophication
2. reduce faecal coliform inputs to receiving waters, with resultant increase in swimmable days and days suitable for secondary contact recreation
3. reduce inputs of chemicals to receiving waterways, with reduction in magnitude or risk to human health
4. reduced visible evidence of overflows in receiving waters.

An EIS for the tunnel was published in September 1997 and the project was approved by the Department of Urban Affairs and Planning in December 1997. A contract for the design and construction of the tunnel and associated works has been awarded and the project detailed design work is underway. Construction is expected to start this year.

4.2.2 Wet weather overflows

A variety of containment options have been selected for the REZs impacted by the NSOOS (refer to Volume 2 for full details). A 40 overflows per ten years containment option has been selected for the majority of the areas impacted including Upper Lane Cove River REZ, Upper Parramatta River REZ and two areas within the Sydney Harbour REZ, namely the Parramatta River Estuary and Lane Cove River Estuary. 20 overflows per ten years containment levels have been adopted for the remainder of the Sydney Harbour REZ (Port Jackson and Middle Harbour) and for Manly Lagoon. For the Northern Beaches REZ and for Curl Curl, Dee Why and Narrabeen Lagoons the minimum performance standard has been selected. These REZs already have containment levels of 20 overflows per ten years. The containment standard selected for the Cowan Creek REZ in the lower Hawkesbury GA is also current performance standard (now 54 events per ten years).

The Northern and Eastern Beaches REZ currently has a containment standard of 35 overflow events in ten years. The Northside Storage Tunnel will reduce the number of overflows from the Shelly Beach overflow (the only one modelled to discharge) to 20 overflows in ten years. The remainder of the overflows in this REZ have current containment standards of 20 events in ten years or better. This standard will be maintained.

The Northside storage tunnel will help deliver the selected containment standard of 40 events/ten years for Middle Harbour by delivering the selected containment standards for the two Scotts Creek overflows and the overflows to Quakers Hat Bay and Tunks Park. However, the containment of 20 events/ten years selected for the Lane Cove River Estuary will be improved upon as a result of the tunnel project. The containment standard for the major Lane Cove Siphon overflow will be 40 events/ten years.

Modelling results indicate that, although most of the NSOOS system has a capacity of two to four times PDWF, the system is currently operating at an average overflow frequency of two events in a month. This is due to high levels of inflow and infiltration problems during wet weather. Cost benefit studies for alternative containment standards have been undertaken based on SEEKER runs. The modelling indicated that the cost effectiveness of overflow containment below 20 events in ten years decreases dramatically. Beyond a containment of between 20 and 40 events in ten years, the high additional costs cannot be justified on the basis of relatively minor environmental gains (refer to Volume 2 for more detail).

Strategies to achieve the minimum performance standard, 40 events in ten years and 60 events in ten years containments for the NSOOS will include further sewer rehabilitation (I/I reduction), reticulation amplification, trunk main amplification and provision of storage capacity (specifically the Northside Storage Tunnel).

Components of the preferred option are shown graphically in Figure 4.1. The costs presented were developed using SEEKER results for 20 events per ten years and 40 events per ten years containment standards to estimate costs associated with the variable containment standard.

Sensitive areas which are potentially impacted by wet weather overflows include Lane Cove National Park, Lane Cove River Estuary, Middle Harbour, Toongabbie Creek, Manly Lagoon and the Northern and Eastern Beaches. The risk and severity of overflow impacts on sensitive areas in the will be significantly reduced as the preferred containment options are implemented. Although the containment standard for the Beaches REZ remains as the base case standard, containment of the major modelled overflow (at Shelly Beach) will be improved as part of the Northside Storage Tunnel project.

4.2.3 Partially treated STP discharges

Currently there are no STP partially treated discharges (refer to Section 2.5.2) due to wet weather from North Head STP. The only partially treated discharges that can occur are as a result of equipment or process failure. As part of the construction of the Northside Storage Tunnel, the maximum throughput of the North Head STP will increase from 1050 ML/day to 1400 ML/day. All flows will be treated and discharged via a deep ocean outfall.

The risk of partially treated discharges due to equipment failure is expected to be reduced because the two new pumps at the inlet to be installed as part of the storage tunnel will provide additional standby and maintenance capacity. The tunnel may also be able to be used to store sewage in the event of a major failure at the plant during dry weather (Sydney Water, 1997c).

The additional wet weather sewage flows that will be treated at the STP will effectively extend the duration of wet weather operation. The proposed modifications to the STP will increase capacity of parts of the plant to cater for the higher wet weather flows predicted. The STP is expected to continue to meet its licence conditions, with the exception of the maximum discharge. Sydney Water expects that the EPA will amend this condition in a new licence incorporating tunnel operations (Sydney Water, 1997c).

The wet weather containment options developed using SEEKER and proposed for the NSOOS will limit flows to 1400 ML/day. Consequently, increases in flows due to the long term abatement program will not exceed the capacity of North Head, once modifications as part of the Northside Storage Tunnel project have been completed and no modifications to the treatment plant are proposed as part of the SOLP project. During wet weather, all flow transferred to North Head will continue to receive treatment and will be discharged through the deepwater ocean outfall. This will help achieve Sydney Water's long term objective of not impacting on swimming water quality criteria during wet weather.

4.2.4 Chokes

Currently, 99.1% of the NSOOS customers are not effected by surcharges, which is above the Sydney Water long term performance target of 96%. However, information relating to occurrences of internal surcharges and individual customers experiencing less than two surcharge events per six months with a guarantee of no repeat chokes for five years is unknown.

Sixteen (16) suburbs within the system require work to reduce their choke frequency to "low" from "high". A number of suburbs require choke frequency to be reduced from medium to low, reflecting the presence of sensitive areas potentially impacted by chokes. Strategies to reduce choke frequency will include:

1. better reporting of the occurrence of chokes and their associated impacts
2. pro-active sewer clearing and root removal
3. education of the public relating to tree placement
4. improved sewer design and installation.

In addition, repeat choke areas should be investigated to identify the cause, and remedial action taken where further chokes are likely to occur due to damaged pipes, root infestation or other causes. Choke frequency should be regularly reviewed as part of the continuous improvement process. Response to chokes resulting in discharges to sensitive areas must be prioritised to minimise impacts. A number of sensitive areas have been identified as being potentially impacted by chokes (refer to Section 3.3).

4.2.5 Exfiltration

Twenty-two (22) out of the 146 gauging sub-catchments in the NSOOS system have been identified as high or moderate exfiltration candidates requiring further investigation, (refer to Chapter 2). High exfiltration potential was estimated for six sub-catchments: three on West Middle Harbour, one in the Castle Hill area (Quarry Creek catchment), one in the Hornsby-Wahroonga area and on in the Narrabeen area (draining to both Narrabeen Lakes and the Tasman Sea). There are also 2 sub-catchments with low exfiltration (refer to Figure 2.6).

The strategies for dealing with potential exfiltration areas include investigation of high faecal coliform levels in water bodies during dry weather to determine whether the sewerage system may be contributing to the problem. Where sewer gauging indicates relative low flows, undertaking routine dry weather sampling of nearby watercourses to identify whether sewage contamination is occurring. If investigations indicate that exfiltration is likely, the catchment may be added to Sydney Waters ongoing I/E program.

4.2.6 SPS failures

The required minimum performance standard is to maintain the present number of overflows, which is 20. Strategies should be assessed for SPSs that do not comply with current design standards (stand-by pump, generator connection, detention time and telemetry) to be upgraded to current standard in order to reduce the risk of overflow. Overflows caused by SPS failures will be reduced with the eventual target of no dry weather overflows except under circumstances beyond Sydney Water's control (such as extreme weather, blocked road access to SPSs etc.). An alternative means of power supply needs to be assessed for SPSs in particularly those impacting on sensitive areas. Priority should also be given to those SPSs identified in the SPS ranking as presenting the greatest environmental risk. These include SPS 0117, 0103, 0365, 0067, 0240, 0159, 0477, 0265, 0098 and 0467.

4.2.7 Odours

Generally within the NSOOS catchment odour complaints received during 1996/7 were spread fairly evenly geographically. However, there were a limited number of suburbs which were notably exceptions to this including Mosman and Cremorne. As the odour complaint data did not specify complaints associated with particular assets, compliance with the Sydney long term performance target of less than three events per asset per year for individual assets could not be determined. However it is possible to speculate that the concentration of odour complaints in Mosman relates to the presence of the Quaker Hat Bay overflow.

Management practices and response to complaints will ensure that any inconvenience caused by odour emissions should be minimised. In addition, the requirement of the minimum performance objective is not to increase the present number of odour complaints in the future. Strategies designed to reduce the frequency of overflows, overflow volume, to improve SPS reliability, reduce the numbers of surcharges and reduce exfiltration should all help reduce the number of odour complaints.

4.3 Actions to achieve the overflow abatement objectives

The abatement of the impacts of wet and dry weather sewer overflows can be accomplished in many ways. For this project, each of these ways has been termed an action. The selected actions make up the preferred strategy, as described in the following Section. One of the main objectives of the overflow licences will be to set overflow performance requirements. Actions will need to be implemented by Sydney Water to meet the requirements of the licences.

It is important to note that these EISs only set out the preferred options and general strategies and actions required to deliver the preferred options. Second generation EIA will be required to detail and assess the actions and works required to deliver the preferred option. This second stage EIA is required by the approval process defined in the Environmental Planning and Assessment Act 1990 for any works recommended in these EISs.

Actions fall into three general categories:

1. detection - improve information on prediction of overflows, impacts of overflows and identifying and recording overflows and their impacts
2. prevention - prevent or reduce frequency of overflows
3. minimisation of impact - reduce the impact of overflows once they occur.

4.3.1 Actions for wet weather overflow abatement objectives

Actions to achieve the wet weather overflow abatement strategy include the following and are summarised in Table 4.3.

Detect Overflow

1. conduct more comprehensive sewer and water quality modelling
2. record overflows in the appropriate database. Predictions of overflows from the sewer modelling need to be corroborated by recording actual overflow events. Additionally the actual recording of overflow events is required to measure the performance of the system against the adopted strategy
3. continue monitoring of receiving waters to confirm predictions of water quality modelling
4. improve water quality monitoring in sensitive areas of REZs impacted by the NSOOS (refer to Table 3.3 of Chapter 3).

Prevent overflow

1. I/I reduction in Sydney Water sewer pipes and private sewers up to the boundary trap (property line). Rehabilitation of Sydney Water sewers and private sewers to the property line will help to meet the objectives of a I/I and I/E correction program (a reduction in infiltration of approximately 23% is estimated). However, rehabilitation of the private sewers would contribute to I/I reductions (50% of the sewer lines are privately owned). The introduction of incentives to encourage private rehabilitation of private sewers or enforcement through legislation is a potential way to further reduce I/I.
2. provision of storage for flows beyond the capacity of the sewers. The Northside Storage tunnel will store excess flows from five of the top ten ranked wet weather overflows in the NSOOS. Similar projects, to store excess flow, then return it to the system when the flow rate drops may be beneficial for other parts of the system, although they are likely to be of a far smaller scale. Storage is necessary in parts of the NSOOS as the I/E program and I/I reduction alone cannot achieve the target containment levels for some areas.
3. the effectiveness of the interim I/E program and the I/I reduction work will be investigated and reviewed. Results of this review will determine the need for further investigation and implementation of other actions such as further storage, treat and discharge, sewer mining and reuse. In particular, options of storage, treat and discharge may be required at sensitive areas
4. Trunk main amplification. Where hydraulic capacity is limiting, increase the sewer size or duplicate the sewer to allow the transfer of additional flow.
5. modification to reticulation pipes to allow the transfer of greater flows and limit overflows from non-designed reticulation overflows. Actions to achieve this include sewer duplication, cross connections to other sewers, and increasing reticulation sewer size.

Minimise impact of overflows

1. continue with current procedure of rapid response to overflow complaints
2. continue with current procedure of containing overflows by bunding the area, and returning sewage to the sewer
3. continue current procedure of cleaning the site after the overflow, including removal of visual solids and flushing the area with fresh water.
4. Treat ad discharge technologies for overflows are being investigated by Sydney Water and this is a potential action at selected overflows.

Table 4.3 - Summary of actions to detect, prevent and minimise the impact of wet weather overflows

Category	Actions	Benefits	Relevant USEPA requirements
Detect overflow	Additional sewer and water quality modelling	More accurate prediction of overflows and their impact	You must have a process for identifying overflows
	Record overflows	Confirm modelling results and compliance with strategy	A summary description of known overflow events occurring in the last 24 months
	Continue monitoring receiving waters	Confirm predictions of water quality modelling	Monitoring to effectively characterise overflow impacts and efficiency of overflow controls
	Improve and continue monitoring of potential exfiltration sub-catchments	Identify volume discharged, receiving environments and impacts	You must have a process for identifying overflows
	Improve water quality monitoring in sensitive areas	Identify overflows and impacts	You must have a process for identifying overflows
Prevent overflow	Interim I/E program and I/I reduction	Reduce flow in sewers during wet weather to help achieve the adopted containment.	Pro-active maintenance to known problem areas including - regular maintenance of deteriorating sewers - remediation of poorly constructed sewers - a long term replacement or rehabilitation program
	Provision of storage for flow in excess of the system capacity during wet weather eg. Northside Storage Tunnel	Reduces wet weather overflows (frequency and volume) to help achieve adopted containment standards	As above
	Investigate effectiveness of interim I/E program and I/I reduction work	Review containment level achieved and so determine appropriate follow - up actions	As above
	Trunk main amplification	Increases hydraulic capacity of system and so can help reduce overflows	As above
	Reticulation sewer amplification, duplication or cross connections	Increases hydraulic capacity of system and so can help reduce overflows	As above
Minimise impact	Continue rapid response to overflows	Minimise amounts of sewage entering water courses	Pollution prevention
	Continue containment of overflows	Minimise amounts of sewage entering water courses	Pollution prevention
	Continue cleaning after overflow	Reduce visual impact and risk to public health	You must have procedures to stop and respond to overflow events

4.3.2 Partially treated STP discharges

Under the existing conditions, the North Head STP has the hydraulic capacity to discharge the PWWF of 1050 ML/day without discharges to the cliff face. However, under the selected overflow containment standard including the Northside storage tunnel, the PWWF to the STP will increase to 1400 ML/day. As part of the Northside Storage Tunnel project, modifications will be made to the STP to enable it to accept 1400 ML/day, as proposed by the Pollution Reduction Program (PRP) for the STP. As a result, no modifications will be required at North Head as a result of the long term abatement options.

4.3.3 Choke

Actions to achieve the choke related overflow strategy include the following and are summarised in table 4.4.

Detect chokes

1. Record chokes in the appropriate database. This database will provide an indication of the environmental impact of choke related overflows and enable Sydney Water to monitor the performance of the system against the adopted strategy.
2. Develop methodology for identifying internal surcharges and repeat chokes to allow monitoring of compliance with the Sydney wide long term objectives.
3. Improve water quality data, especially in sensitive areas, to gauge impact on chokes.
4. Sydney Water relies on public reporting almost exclusively to identify chokes. It is possible to improve this aspect by encouraging the public to report chokes, and to carry out inspection of pipes in bush areas, where public reporting may not be effective.

Prevent chokes

Ninety suburbs (16 with a "high" frequency and 74 with a "medium" frequency) require actions to reduce choke frequency. These actions can include:

1. Continuing Sydney Water's regular maintenance and inspection of sewers. In 1997/98, the inspection program for the NSOOS system will cover approximately 120 km of sewers. As part of the inspection, sewers are cleaned and the potential for chokes is reduced. Generally these inspections are only carried out on critical assets (sewers larger than 300 mm diameter). This program could be extended to smaller sewers in suburbs with high numbers of chokes.
2. Proactive cleaning and root removal.
3. Education of the public, local council and developers relating to tree placement.
4. Improved sewer design and installation.
5. Undertake modelling to identify accurate cost benefits for the alternative actions, as the estimates used in this EIS process are only preliminary.

Minimise impact of chokes

1. Improve public reporting of chokes. Sydney Water relies heavily on public reporting of chokes, but it is possible that overflows in roads or other public areas may not be reported promptly. An education campaign to encourage the public to report overflows will improve reporting, reduce Sydney Water response time and reduce the impact of overflows.
2. Continue with current procedure of rapid response to overflow complaints.
3. Continue with current procedures of containing overflows by bunding area, returning sewage to the sewer, and/or pumping the sewage to road tanker and transporting to other parts of the system until choke is cleared.
4. Continue with current procedure of cleaning the site after the overflow, including removal of visual solids and flushing the area with fresh water.

Table 4.4 - Options to detect, prevent and minimise the impact of chokes

Category	Options	Benefits	Relevant USEPA requirement
Detect chokes	Develop methodology to quantify volume and impact of choke related overflows[1]	Enable assessment of the impact of chokes	You must have a process for identifying overflows. Monitoring to effectively characterise overflow impacts.
	Improve methodology for identifying internal surcharges and repeat chokes	Consistency across Sydney Water	A summary description of known overflows.
	Develop model for assessing the cost benefits of options[1]	Enable Sydney Water to budget choke reduction targets	Monitoring to effectively characterise the efficiency of overflow controls.
Prevention of chokes	Proactive root cutting in reticulation pipes in areas of high choke incidents	Reduction in choke incidents	Regular maintenance of deteriorating sewer lines. Remediation of poor construction. Proactive maintenance in known problem areas.
	Sydney Water maintenance and inspection of sewers	Minimise choke frequency	Measures to stop and reduce the impact of overflow events
	Public education for appropriate tree planting (including Councils and developers) [1]	Long term reduction in root intrusion	
Minimise impacts	Improve public reporting[1]	Prompt reporting will reduce the duration and impact of overflows	You must have a process for identifying overflows
	Inspect non-urban pipe routes	Identify overflows that are not reported by the public	Measures to stop and mitigate the impact of overflow events
	Continue rapid response and containment of overflow	Minimise amount of sewage released to the environment	Pollution prevention
	Continue clean-up site after overflow	Reduce impact on the environment	Measures to stop and mitigate the impact of overflow events

4.3.4 Exfiltration

Two parameters have been used to assess the performance of the system with respect to exfiltration, leakage and dry weather water quality data where available. Table 4.5 shows the process for identifying and developing actions for exfiltration.

Table 4.5 - Action matrix for exfiltration

Leakage indicator **Environmental indicator**	**Leakage OK**	**Leakage analysis indicates exfiltration**
Indicator OK	(1) No action required - routine review of leakage indicator only	(2) Undertake routine dry weather sampling if no water quality data available. No further action required if dry weather water quality data complies with water quality objectives
Indicator above trigger level (ie. median > 1000 cfu/ 100 ml - secondary recreation median > 150 cfu/100 ml - primary recreation)	(3) Investigation as to source of contamination - Catchment to I/E Programme if no other major sources are identified.	(4) Catchment to I/E Programme for initial investigation at mini-catchment gauging level

From the limited water quality monitoring data, and the leakage analysis, it is possible to indicate some general areas in accordance with Action Matrix in Table 4.5.

Category (2): Narrabeen - Brookvale, St Ives - Turramurra - Wahroonga, Epping - Pennant Hills - Castle Hill, Strathfield - Chullora Upper Manly - Curl Curl.

Category (3): Toongabbie - Wentworthville (impact on Pendle Creek and Toongabbie Creek), Auburn - Silverwater (moderate impact on Duck River).

Category (4): East Lindfield - Castle Cove - Middle Cove (impact on Upper Lane Cove River), Northbridge - Cammeray - Spit Junction (moderate impact on Long Bay).

Routine dry weather faecal coliforms sampling will be initiated for sub-catchments, mainly in Category (2). No further action will be taken if no localised high levels of faecal coliforms are identified. If high faecal coliforms concentrations are detected, the sub-catchments will be added to the I/E programme for investigation at the mini-catchment gauging level.

Rehabilitation works to reduce exfiltration can also reduce infiltration and will therefore contribute to reducing wet weather overflows. Therefore, I/I reduction works as part of the wet weather options in these catchments are likely to result in reducing the exfiltration potential.

Actions to achieve the exfiltration strategy include the following and area summarised in Table 4.6.

Detect exfiltration

1. Record exfiltration data in the appropriate database. This database will provide an indication of the exfiltration observed and relevant environmental data (such as water quality) relevant to exfiltration.
2. Investigate any sources of dry weather contamination to identify if it can be caused by sources other than exfiltration from the sewerage system.

3. Improve water quality data to determine impacts from exfiltration and assess the effectiveness of reduction actions. This is particularly important for sensitive areas.
4. Prevent exfiltration
5. When exfiltration is identified from dry weather water quality monitoring, the relevant sub-catchment is included in the Sydney Water interim I/E program. As part of the program, pipes are rehabilitated by grouting and/or relining activities which reduce exfiltration and infiltration. I/I reduction work done to reduce wet weather flow will also help reduce exfiltration potential.

Minimise impact of exfiltration

1. No actions are relevant for minimising the impact apart from undertaking the previously mentioned preventative measures.

Table 4.6 - Summary of actions to detect, prevent and minimise the impact of exfiltration

Category	Actions	Benefits	Relevant USEPA requirements
Detect exfiltration	Record exfiltration data	Enable assessment of the impact	A summary description of known overflow events occurring in the last 24 months
	Investigate any sources of dry weather pollution	Determine source of pollution and/or exfiltration	Monitoring to effectively characterise overflow impacts and the efficiency of overflow controls
	Monitor water quality	Protect water quality and sensitive areas	Monitoring to effectively characterise overflow impacts and the efficiency of controls
Prevent exfiltration	Sydney Water interim I/E programme	Sewer rehabilitation to prevent sewage leakage from the system	Pro-active maintenance to known problem areas including: regular maintenance of deteriorating sewers - remediation of poorly constructed sewers - a long term replacement or rehabilitation program
Minimise impact	None relevant		

4.3.5 SPS failures

Actions to achieve the SPS failure overflow strategy include the following and are summarised in Table 4.7.

Detect overflows

1. Record overflows caused by SPS failures in the appropriate database. This database will provide an indication of the environmental impact of SPS failures and enable Sydney Water to monitor performance of the system.
2. Regularly review the pumping capacity and storage capacity of SPSs, to ensure their capacity complies with the requirement, as loading increases.

Prevent overflows

1. Continue regular maintenance (including telemetry upgrades) of all SPSs to ensure reliability and reduce failures.
2. A number of SPSs (15) have less a storage time that is less than the response time. Sydney Water should investigate the comparative costs of increasing the storage capacity and reducing response time (or a combination of the two) and adopt the most effective action. For this EIS, it was assumed that these SPSs will be upgraded to increase their storage capacity.

3. Three SPSs do not have a stand-by pump, to prevent overflow in case of pump failure. These stations to be provided with a stand-by pump. Further 24 stations have a manually controlled stand-by pumps. These stations should be provided with automatic starting of the stand-by pumps.
4. Twelve stations have no provision for a plug in generator. It is proposed to install sockets in these stations to enable Sydney Water to operate the stations with a portable generator in case of a prolonged power interruption.

Minimise impacts of SPS failures

1. One SPS does not have an overflow structures, to direct the overflow to a location where it will cause least impact. It is proposed to install an overflow pipe and structure for that SPS.
2. Continue with current procedure of rapid response to overflow complaints.
3. Continue with current procedure of containing overflows by bunding area, returning the sewage to the sewer, and/or pumping the sewage to a road tanker and transporting it to other parts of the system until choke is cleared.
4. Continue with current procedure of cleaning the site after the overflow, including removal of visual solids and flushing the area with fresh water.
5. Regularly update contingency plans for SPSs.

Table 4.7 - Options to detect, prevent and minimise the impact of SPS failures

Category	Options	Benefits	Relevant USEPA requirement
Detection of SPS failures before they cause an overflow	Improve database to provide easy accessible data on SPS overflows numbers, quantity and impact[1]	Will enable Sydney Water to quantify impact and report on performance	You must have a process for identifying overflows. A summary description of known overflow events.
	Upgrade telemetry[2]	Reduce the risk of overflow in case of equipment failure	You must have a process for identifying overflows.
Prevention of SPS overflows	Install provision for connecting a portable generator for all stations	Reduce the risk of overflow in case of equipment failure	Measures to stop and mitigate the impact of overflows.
	Install stand-by pump and provide automatic starting of stand-by pump where required	Improve reliability	Remediation of poor construction
	Investigate storage requirements for stations with less than response time	Enable maintenance personnel to arrive on site before overflow occurs	Remediation of poor construction. Maximum use of collection system for storage.
	Investigate reduction in the number of SPSs, and providing gravity backup by cross connection of SPSs	Improve reliability	
Minimisation of SPS overflow impacts	Install overflow structure for 1 SPS	Direct overflow to a point of less impact	Measures to mitigate the impact of overflow events.
	Continue rapid response to failure, overflow containment and clean-up	Minimise the amount of sewage released to the environment	You must have procedures to stop and respond to overflow events
	Complete contingency plans for all SPSs and regularly update them.	Improve response in case of failure	You must have procedures to stop and respond to overflow events

Notes: These options are likely to be part of a Sydney Water wide project

The installation of full SCADA system is being considered as part of a current Sydney Water project

4.3.6 Odour

Actions to achieve the odour strategy include the following and are summarised in Table 4.8.

Detect odours

1. Record odour complaints in the appropriate database. This database will provide an indication of odours relating to non-liquid overflows and their environment impact. This will enable Sydney Water to monitor the performance of the system against the adopted strategy.

Prevent odours

1. Continue Sydney Water maintenance activities.

Minimise impact of odours

1. Continue responding to odour complaints by the public with reactive maintenance as required.

Table 4.8 - Summary of actions to detect, prevent and minimise the impact of odours

Category	Actions	Benefits	Relevant USEPA requirements
Detect odours	Record odour complaint data	Enable assessment of the impact of odours	A summary description of known overflow events occurring in the last 24 months
		Ensure that the strategy is met	
Prevent odours	Continue Sydney Water maintenance activities	Prevent odour releases from the system	Pro-active maintenance to known problem areas including: - regular maintenance of deteriorating sewers - remediation of poorly constructed sewers - a long term replacement or rehabilitation program
Minimise impact	Continue responding to odour complaints	Minimise odour releases	Measures to stop and mitigate the impact of overflow events

4.4 The proposed management plan

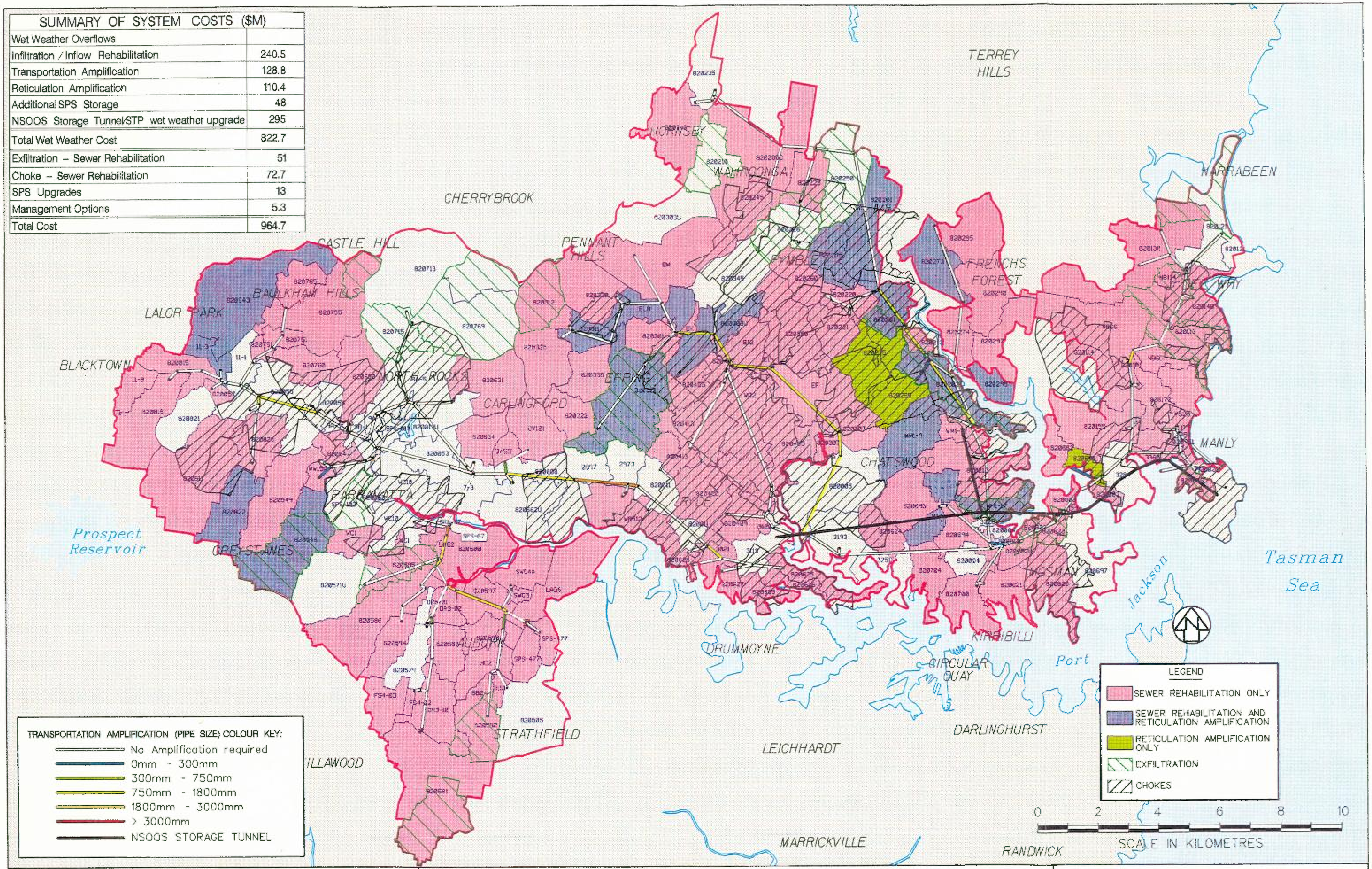
4.4.2 Existing overflow abatement program

Sydney Water is conducting an interim Infiltration/Exfiltration (I/E) programme on 31 project areas which have exhibited high faecal bacteria levels and constitute identifiable public health risks. All projects in the Interim I/E Programme have been selected to minimise environmental and health risks based on the following criteria:

1. high recorded faecal coliforms counts in dry weather
2. gauging of sewage flows confirming potential exfiltration
3. high environmental sensitivity, public use or profile of the area
4. improvements following rehabilitation can be measured
5. focus on the Sydney Harbour catchments.

There are 16 I/E project areas in the NSOOS sewerage catchment. Only Hornsby, Lalor Park and Manly project areas have been completed fully. Eight project areas are under design phase while the rest is

SUMMARY OF SYSTEM COSTS ($M)	
Wet Weather Overflows	
Infiltration / Inflow Rehabilitation	240.5
Transportation Amplification	128.8
Reticulation Amplification	110.4
Additional SPS Storage	48
NSOOS Storage Tunnel/STP wet weather upgrade	295
Total Wet Weather Cost	822.7
Exfiltration – Sewer Rehabilitation	51
Choke – Sewer Rehabilitation	72.7
SPS Upgrades	13
Management Options	5.3
Total Cost	964.7



TRANSPORTATION AMPLIFICATION (PIPE SIZE) COLOUR KEY:

- No Amplification required
- 0mm - 300mm
- 300mm - 750mm
- 750mm - 1800mm
- 1800mm - 3000mm
- > 3000mm
- NSOOS STORAGE TUNNEL

LEGEND

- SEWER REHABILITATION ONLY
- SEWER REHABILITATION AND RETICULATION AMPLIFICATION
- RETICULATION AMPLIFICATION ONLY
- EXFILTRATION
- CHOKES

Sydney WATER

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SEWERAGE OVERFLOWS LICENSING PROJECT NSOOS SEWERAGE SYSTEM

FIGURE 4-1
COMPONENTS OF THE PREFERED UPGRADE

still under define phase which include gauging, analysis and source detection investigation. The current I/E programme on NSOOS catchment will continue up to the year 2000.

Sydney Water has also initiated an SPS risk reduction program to investigate potential impacts of overflows from SPS failures. The risk assessment included estimated overflow volume, environmental factors, telemetry, power supply, pump availability, control/redundancy and history of failure. All of Sydney Water's SPSs have been ranked as part of the program and works have been identified to reduce the risk of SPS failures. The overflow ranking scores of the highly ranked SPSs in the NSOOS are generally dominated by high overflow discharge scores.

Investigations are proceeding into a number of innovative "treat/discharge" technologies which are available from private sector technology providers for localised overflow abatement. Potential improvements could be obtained locally, particularly with respect to sensitive areas. These technologies will be evaluated following assessment of their performances for treatment of overflows.

A five year capital works program has been developed for all sewerage systems. The program is designed to maintain and upgrade the NSOOS system assets and is updated annually. The program includes projects which reduce overflows, such as replacement of old or under-capacity pipes, SPS pump upgrades and installation of telemetry. Overflow abatement works recommended as part of this process will be integrated into the rolling five year programs over the next 23 years according to their priority.

The Northside Storage Tunnel Project, which is due to enter the construction phase in 1998, will significantly reduce overflows from five of the largest wet weather overflows in the NSOOS. These five overflows include the top four highest volume overflows in the system

4.4.3 Summary of preferred options for the NSOOS

The preferred option is a combination of different containment standards selected to meet the environmental objectives of the individual areas impacted by the NSOOS system.

Wet weather options range from preventing additional rainfall dependent infiltration and inflow components entering in to the sewer system, reticulation and main carriers amplifications, provision of on line or off line storage, and to upgrade the existing capacity of the STP. A combination of these options will be used to develop sewerage system management strategies to transport wet weather flows to the STP minimising overflows from the system. System failure options include measures to reduce the potential for and/or mitigate the impact of chokes, SPS failures, exfiltration and odours. Figure 4.1 shows the components of the preferred upgrade.

Demand management can reduce the dry weather sewage flow by reducing people's average water consumption. Sewer mining also reduces sewer flows locally by removing and treating sewage for reuse applications. This means that sewers have greater available storage capacity which can be used to accommodate both dry and wet weather flow before overflowing out of the system. However, demand management only results in relatively small reductions to sewage volume and the reuse applications for sewer mining are predominantly for irrigation in dry weather. These options are therefore more effective in reducing the volume of choke and SPS overflows in dry weather. The benefits in reducing the wet weather overflows by implementing these options may be insignificant.

Source control is an important component in reducing the impacts of all overflows. Control of trade waste discharges to the domestic sewerage systems can reduce some of the sewage components which are known to be harmful to the environment. Sydney Water currently has an extensive trade waste policy as discussed in Chapter 2. The I/E programme currently being undertaken by Sydney Water is targeted to reduce both dry and wet weather overflows in the form of exfiltration and infiltration from the sewerage system. The elimination of exfiltration and infiltration problems will improve the overall performance of the sewerage system and reduce the possible dry and wet weather sewage related impacts to the receiving environment zones.

4.5 The proposed management plan

Actions will be implemented through a structured plan which integrates the timetable for improvements, funding requirements, researching, system maintenance, training and standardised operating and emergency response procedures. This is called the management plan.

The management plan for NSOOS will be designed to deliver the system output performance which meets the overflow abatement objectives for Upper Parramatta River, Upper Lane Cove River, Sydney Harbour Cowan Creek, Northern Lagoons and Northern and Eastern Beaches REZs.

Components of the management plan have been selected to achieve a balance between non-structural and structural options that can be implemented progressively over the next 25 years. The proposed management plan will form part of Sydney Water's total quality assurance system.

The components of the management plan can be divided into two groups - actions which address individual overflow types and recommended management practices for overflows in general. Table 4.9 provides a summary of the actions making up the strategy for the NSOOS.

Table 4.9 - Preferred options for NSOOS by overflow type

Overflow type	Options
Chokes	Reduce chokes in areas of high cokes (immediate priority - 16 suburbs) and medium chokes suburbs with identified sensitive areas.
SPS failures	Upgrade SPSs to current design standards.
Exfiltration	Initiate routine dry weather faecal coliforms sampling for sub-catchments identified as exfiltration candidates. Sub-catchments identified as having exfiltration problem to be added to the I/E Programme for investigation at the mini-catchment gauging level.
Wet weather overflows	Implement three month containment strategy for Upper Lane Cove River, Upper Parramatta River, Lane Cove River Estuary and Parramatta River Estuary area of NSOOS, six month containment strategy for Port Jackson, Middle Harbour and Manly Lagoon area of NSOOS and minimum performance standard containment strategy for all other lagoons and northern beaches area. The options include: sewer sub-catchment rehabilitation, main sewers amplifications, rehabilitation of reticulation up to boundary trap to minimise disturbance to private properties. The private sewers which are suspected of possessing leaking sewers may also need to be rehabilitated as part of I/E correction program and house service policy such as Pipe Check and pursuing defect notices issued as part of a rehabilitation project. The Northside Storage Tunnel project is a major abatement action already being progressed by Sydney Water.
	Ensure that all SPSs are sized to accommodate additional flows for future population growth
	Investigate low-cost options for additional protection of sensitive areas during detailed EIA process
Odours	Maintain register of odours and implement public education to encourage public reporting of odours; investigate odour complaints to identify cause and possible remediation.
Partially treated STP discharges	It is planned, as part of the Pollution Reduction Programme (PRP) for North Head STP and as part of the Northside Storage Tunnel Project, to provide facilities to allow the STP to accept 1400 ML/day. No further modifications are required as a result of the preferred option.

Management actions for overflows are being implemented by Sydney Water across all systems through system management planning process and will continue to be used as part of Sydney Water's continuous improvement process. These are an integral part of recommended management practice and are in line with the USEPA's methods for controlling overflows (USEPA, 1996).

Table 4.10 shows the recommended management practices (including continuation of existing programs) to reduce the potential for sewerage overflows and to minimise the impacts of overflows when they do occur.

Table 4.10 - Recommended management practices for NSOOS system

Management option	Description
Data improvements	
Choke Management Information System (MIS)	Develop a choke management information system to record chokes, their impact and to identify repeat chokes.
SPS failure MIS	
Overflow prevention	
	Develop a management information system to record SPS overflows and their impact.
Interim I/E program	Limit wet weather flows within the system.
I/I reduction	Limit wet weather flows within the system.
Partially treated STP discharge	Carry out modifications to accept additional flows resulting from overflow abatement program.
Chokes reduction	90 suburbs require work to reduce chokes to "low" frequency.
Exfiltration	Continue I/E program.
SPS failures	Continue maintenance activities and provide adequate storage, alternative power source and stand-by pumps where required.
Odours	Continue maintenance activities.
Overflow impact minimisation	
Rapid response to overflow events	Continue rapid responses to minimise amounts of sewage entering water courses.
Clearing of blockages	Prompt clearing of blockages as they occur to minimise overflow quantity. Repeat chokes will be investigated to detect and remedy any pipe faults.
Clean-up of site after overflow	Where necessary, dilute sewage overflows by flushing, monitor impacts of overflow on receiving water and clean away any visible solids.
Public reporting of major overflows	Make public aware of major overflows affecting primary and secondary contact recreation areas through TV, radio and newspaper reports. Reports should include severity of problem and estimate of time until normal conditions return.
Improve reporting of overflow by the community	Encourage the community to report events of overflows.
Dry weather chokes	Inform public on appropriate tree planting near sewers. Clean siltation from sewers prone to blockage. Continue repeat choke programme.
Odour complaint response	Investigate site to determine source of odour where possible. Flush pumping stations and section of sewer as necessary. Inform customer of actions taken to remedy problem.
System maintenance	
Programme for maintenance	Continue routine maintenance programme for all sewers, overflows, pumps, including regular checks on pump start sequences and flushing of SPS to reduce grease build-up. Ongoing programme to reduce the volume of I/E as part of overflows strategy.
System management	
Periodic audits of system	Audit the system and update system management planning at regular intervals to determine the effect of previous strategies, modify them and develop new strategies.
QA principles	Use QA principles to keep system in control and allow incremental improvement. Update and maintain Standard Operating Procedures for all aspects of the system operation and emergency responses. Update and maintain the system management plan.
Domestic and industrial source reduction	Reduce the base sewer flow by encouraging water conservation and reuse of treated effluent. Focus on high water usage industries, particularly food processing, chemical and metal processing. Increases available capacity in the sewer. Reduce oil & grease and phosphorus in sewage through a public education campaign.

4.5.2 System inspection, operation and maintenance

The existing Sydney Water system inspection, operation and maintenance programmes are designed to monitor the performance and reliability of the SPSs and maintain the capacity and condition of the infrastructure. These programme will continue to be used and updated as part of the continuous improvement process, incorporating the recommended management practices discussed in Table 4.10.

Particular attention will be given to response procedures used in emergency situations that may lead to sewerage overflows reaching the receiving environment. The emergency response procedures will be standardised and set out as part of the system management planning process in accordance with Sydney Water's quality assurance system and incident management policy. Relevant government authorities will be notified of major overflow events due to system failures, including the extent of environmental impacts where measurable and the response process conducted. A 24 hour telephone service line is currently maintained by Sydney Water to enable the public to report overflows. This will feature as part of Sydney Water community education efforts.

The proposed management plan will also require additional monitoring of known overflow points to determine the frequency of overflows and any resulting environmental impacts.

4.5.3 Implementation

The components of the proposed management plan will be implemented over the next 23 year planning period. Many of the recommended management practices have already been adopted by Sydney Water to minimise the frequency and impacts of overflows during dry and wet weather. Some structural works will also be implemented in the short to medium term to bring the SPS storage capacities and pump rates up to the recommended levels. Major structural works to abate wet weather overflows will be implemented in the short, medium and long term, depending on the receiving environment. Based on the rollup of system performance outlined in Volume 1 and on the environmental impacts detailed in Volume 2, the following implementation program has been proposed for the NSOOS overflows management plan (Table 4.11).

Table 4.11 - Delivery timetable for proposed management plan components

Components of management plan	Delivery timetable			
	1998 to 2005	By 2010	By 2015	By 2020
Wet weather overflow containment				
Sydney Harbour REZ	✓			
Upper Lane Cove River REZ		✓		
Upper Parramatta River REZ			✓	
North & Eastern Beaches REZ[1]			✓	
Northern Lagoons REZ			✓	
SPS	✓			
Exfiltration				
Conduct I/E investigations and remediation of high and moderate sub-catchments	✓	✓		
Conduct I/E investigations and remediation of medium and low sub-catchments		✓	✓	✓
Chokes				
Conduct rehabilitation work on high choke frequency suburbs	✓	✓		
Conduct rehabilitation work on medium choke frequency suburbs potentially impacting sensitive areas	✓	✓		

Notes
1. The major overflow in the Northern and Eastern Beaches REZ will be addressed by the Northside Storage Tunnel Project, due to be completed before the year 2000.
2. Sensitive areas - where abatement is proposed as part of wet weather solutions, the solutions will be implemented on the same timeframe as the wet weather overflow option.
3. Abatement prioritisation will be subject of on-going reviews with consideration of population growth

4.5.4 Costing and funding

Table 4.12 identifies the estimated cost for components of the preferred strategy. The total estimated cost for the NSOOS System over the next 23 years is $ 964.5million (based on 1996 costs, to be verified). This will be funded from Sydney Water's existing rates, rates from new customers and developer charges for new infrastructure.

Sydney Water had undertaken a survey to determine the community's willingness to pay for abatement works. Although the costs of the proposed options will primarily be covered by existing rates, the community's acceptance is critical to the successful implementation of the proposed management plan. The community must remain involved in the process so that the significant costs associated with the abatement strategies are justified by the value placed on the receiving environment by the community.

Preferred strategy	Basis of costing	Total estimated cost in year 2021 $M
Management practices to prevent overflows		
Regular wet weather inspection	Estimated for routine inspection of major overflow structures after rainfall events	0.525
Regular inspection of sewers in sensitive areas.	Two persons full time	4.00
Maintain and expand the monitoring of overflows impacts and develop better reporting procedures	Aquatic monitoring:	0.57
	Terrestrial monitoring: (Estimated costs, program to be confirmed)	0.175
Reduce system failure overflows		
Reduce exfiltration		
6 catchments from high to low	$3.25M/catchment	19.5
14 catchments from moderate to low (subject to confirmation by further investigation)	$2.25M/catchment	31.5
Upgrade SPSs		
Increase storage at 15 SPSs	$600k/SPS	10.2
Add standby pumps in two SPSs (the third SPS requiring standby, SPS 0240 is already on the upgrade program)	$600k/SPS	1.2
Generator connections for 12 SPSs	$100k/SPS	1.2
Upgrade SPS pump capacity	Included in SEEKER estimates of wet weather abatement costs	-
Reduce chokes		
16 suburbs from high to low	$2.2M/suburb	35.2
25 suburbs with sensitive areas from medium to low	$1.5M/suburb	37.5
	Sub-total dry weather overflow reduction	141.5
Reduce wet weather overflows		
	I/I reduction	240.5
	Reticulation amplification	110.4
	Trunk amplification	128.8
	Additional SPS storage	48.4
	Northside Storage Tunnel & STP modifications	295
	Sub-total wet weather overflow reduction	823
	Total dry & wet weather	964.5 million

Note: Costs in dollars at June 1996

The preferred strategy will be incorporated into the consolidated findings of the sewerage overflow licensing EIS outcomes of all Sydney Water's sewerage systems and be consistent with the Environmental Indicators Monitoring Programme required by the Operating Licence

Cost of Sydney Water management system (such as choke MIS) not included

Note: This estimate of costs is inherently conservative for the following reasons:

1. The estimate assumes that all potential exfiltration areas investigated will required I/E reduction work

2. Work carried out to reduce I/I or the reduce I/E may negate the need for work to reduce chokes in some areas however the cost estimate assumes that all I/I or I/E work will have no effect on high choke areas. The cost estimates for choke reduction may be too high

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Chapter 5

Assessment of Environmental Benefits of the Proposed Strategy

Synopsis

An integrated management plan for overflow abatement in the NSOOS Sewerage Catchment has been proposed to help achieve the environmental objectives set for each REZ (as outlined in Volume 2). This plan will contribute towards achieving the Sydney Water's long term performance targets and will:

1. reduce faecal coliform inputs to receiving waters, resulting in an increase in the number of days suitable for primary and secondary contact recreation in most of the receiving waters
2. reduce nutrient inputs to receiving waters, with resulting reduction in eutrophication and an increase in the number of days when the water quality meets ANZECC guidelines for ecosystem protection
3. reduce input of chemicals into receiving waters
4. reduce release of visible pollutants such as sewage solids and grease to receiving environments, helping protect ecosystems and improving visual amenity
5. reduce odour nuisance arising from surcharges and overflows from designed structures.

The likely outcome from failing to provide addition capacity for the increasing population and from letting the system deteriorate would be a greater impact to aquatic, terrestrial and socio-economic environments. Impacts on the receiving environments would be evident from: increased levels of nutrients, leading to further eutrophication and possibly resulting in excessive weed and algal growth; increased levels of faecal coliforms; reduced suitability of the waterways for primary and secondary recreational uses; reduced compliance with water quality guidelines for ecosystem protection and consequently, reduced biodiversity; reduced visual amenity of the receiving waterways; and Increased human health risks. The major impact which could result from failing to implement the preferred option would be on the general amenity of the environment in an area where the amenity value, to residents and tourists alike, is very high and should be preserved.

It is important to note, however, that unless all pollution sources are identified and quantified, it is difficult to determine the level of impacts which may occur if the preferred strategy is not implemented. The water quality modelling results show that removing all overflows will result in the recovery of the majority of unsuitable swimming and boating days in Port Jackson, particularly Lane Cove River and Middle Harbour, where the levels of faecal coliforms are greatest and quality of the stormwater runoff is generally good.

5. Assessment of environmental benefits of preferred strategy

5.1 Benefits of the preferred strategy

The preferred strategy for overflow abatement in the NSOOS Sewerage Catchment has been selected to help achieve the environmental objectives set for each REZ (as outlined in Volume 2, Chapter 3). This strategy will contribute towards achieving the Sydney Water's long term performance targets and will:

1. reduce faecal coliform inputs to receiving waters, resulting in an increase in the number of days suitable for primary and secondary contact recreation in most of the receiving waters
2. reduced nutrient inputs to receiving waters, with resulting reduction in eutrophication and a resultant increase in the number of days when the water quality meets ANZECC guidelines for ecosystem protection
3. reduced input of chemicals into receiving waters
4. reduced release of visible pollutants such as sewage solids and grease to receiving environments, helping protect ecosystems and improving visual amenity in a catchment which serves a number of areas with very high amenity values
5. reduced odour nuisance arising from surcharges and overflows from designed structures.

However, control of pollutants from other point sources is also required before a significant improvement in water quality can be achieved. Stormwater contribution toward pollutant loads are of key concern for some receiving environments.

The preferred option for the NSOOS system will be a combination of minimum performance standard, 40 events/ten years and 20 events/ten years, depending on the receiving environment. The selected containment level has been chosen based on the individual environmental objectives of the REZs impacted by the NSOOS. In the case of the Sydney Harbour REZ, the containment level has been selected on the basis of environmental values of areas within the REZ. For the Northern Lagoons REZ (with the exception of Manly Lagoon), the minimum performance standard containment has been selected. This reflects the limited impact of the NSOOS on receiving water bodies within these areas. For the Upper Parramatta River REZ, the Upper Lane Cove REZ, the Northern and Eastern Beaches REZ and two areas within the Sydney Harbour REZ (Lower Lane Cove River and Parramatta River Estuary) a containment of 20 events/ten years was selected. A containment level of 40 events/ten years has been selected for Port Jackson and Middle Harbour (consistent with the Northside Storage Tunnel containment level) and for Manly Lagoon.

Sydney Water has prepared an economic evaluation of the costs and benefits of overflow abatement alternatives for each REZ. The economic evaluation involves a full assessment of cost and benefits of a project and aims to provide an indication of whether or not a proposal represents a desirable course of action for a community. The assessment includes mechanisms for incorporating environmental costs and benefits into the decision making process. The selected strategy is broadly consistent with Sydney Water's Economic Evaluation for the Sewerage Overflows Licensing Project (Sydney Water 1998 b). The containment standards selected as part of the EIS are the preferred options from this economic evaluation report except for the Port Jackson and Middle Harbour areas of the Sydney Harbour REZ. For these two areas all containment options have negative net benefits. The three month option has the least negative net benefit of $93.7m. Sensitivity analysis of the economic evaluation calculations show that the three month standard could be viable if a tourist component is included. Justification of the containment standards for Port Jackson and Middle Harbour is therefore important on the basis of ecosystem protection, protection of water based recreation and, importantly, protection of the very high amenity value of these areas.

5.2 Benefits to the aquatic environment

Implementation of the preferred strategy will result in localised benefits to Sydney Harbour and its associated waterways (Upper and Lower Lane Cove and Parramatta River) which receive overflow discharges from the NSOOS system. The benefits to Sydney Harbour are discussed in detail in Volume 2 of this EIS, where the discussion also includes benefits from improvements to other Sydney Water sewerage systems discharging to this waterway.

The overall volume of overflows will be reduced due to the improvement in system performance. The Northside Storage Tunnel will address the four largest designed overflows within the NSOOS. These are 3120, Burns Bay Road, Lane Cove; 820052U, Quakers Hat Bay, Lane Cove, WMI-17 Tunks Park, O/F Northbridge and WMI-9, Glenroy (Scots Creek) Castle Cove. The preferred strategy will reduce the number of overflow events from approximately 24 per year (whole system average) to approximately four for the Upper Lane Cove and Upper Parramatta River REZ, four for Lower Lane Cove and the Parramatta River Estuary, two for Port Jackson and Middle Harbour and two for Manly Lagoon.

The benefits to the aquatic environment will add value to the aesthetic and community amenity of waterways. Reducing the level of pollutants being discharged into the waterway from overflows, will improve the aquatic ecosystem so that the likelihood of environmental problems such as algal blooms, toxicity to aquatic life forms, and human health impacts will be reduced. The number of days during which water quality does not comply with ANZECC guidelines for primary and secondary recreation will be reduced. Similarly, the number of days during which guidelines for ecosystem protection are not met will be reduced (Table 3.2).

Wet weather overflows are having a significant impact on a number of sensitive areas and these areas have been identified for further more detailed consideration of localised abatement options. Benefits will also be derived from reducing impacts from chokes occurring in the sensitive areas. The nature of the sensitivity of these areas and a description of the level of impact is provided in Table 3.2. It is noted that several of these areas also contain sensitive terrestrial habitat values or potentially provide habitat for special status species.

5.3 Benefits to the terrestrial environment

Overflows can potentially impact on the terrestrial environment via direct or indirect pathways. For example overflows may result in an increase in nutrient levels in soils which in turn leads to increased weed growth. Alternatively, overflows may contain plant toxins or components that affect growth rates. There is little evidence of overflow impacts from wet weather overflows on the terrestrial environment in the NSOOS catchment, as these overflows generally discharge into stormwater drains or directly to waterways. The extent to which other overflows contribute to degradation of the terrestrial environment is considered to be minor.

A reduction in exfiltration and chokes could have a beneficial effect on terrestrial flora. Many native plants are tolerant of or adapted to phosphorus-poor environments. Removing or reducing the impact of phosphorus to the ground water and soils by reducing exfiltration would be a benefit to terrestrial ecosystems. It is necessary, however, to identify exfiltration locations and processes before such a benefit can be properly assessed. That knowledge is not yet available. In general, a reduction in exfiltration as part of the system improvement would be of benefit to terrestrial flora.

The interim I/E program which is under way is involved with repairing sewers which have been detected as having cracks or damaged sections of pipe. This will reduce exfiltration and some surcharges from chokes in the sewers, and in doing so will reduce any potential impacts associated with exfiltration such as nutrient enrichment of soils which would induce weed infestation

Sensitive terrestrial environments have also been identified in Table 3.3. Since the majority of overflows from the NSOOS sewerage system drain to aquatic areas, the potential for impacts on most terrestrial environments from overflows are considered to be relatively minor, however, some sensitive areas are at high risk from overflow events

The Preferred Strategy has the potential to improve the NSOOS sewerage system overall thereby reducing the risk of overflow and choke events, thus limiting the impact of pollution in sensitive terrestrial environments. However, it is extremely difficult in most situations to measure the impact of reduced overflows on the terrestrial environment, so it is impossible to quantify the effect. The sensitive terrestrial environments identified in the NSOOS catchment may also warrant higher levels of wet weather overflow containment which will be investigated in future studies.

Overall the implementation of the Preferred Strategy is expected to have a some beneficial effect on the sensitive terrestrial environments by reducing the existing level of impact due to sewage overflows.

5.4 Benefits to the socio-economic environment

The NSOOS serves an extremely important socio-economic area within Sydney. The main socio-economic benefits which will be achieved through implementing the proposed strategy include increasing the visual and recreational value of the environment. The very high amenity values of Port Jackson, Middle Harbour and Lane Cove River and the Parramatta River will be improved. These areas currently are not only important amenities for local residents, but also have a very important tourist value. The amenity values of the Northern Beaches will be preserved by maintaining current wet weather containment standards.

5.5 Consequences of not implementing the preferred strategy

If the measures outlined in the preferred strategy are not implemented, all types of overflows would increase in number of events and in total volume discharged due to increases in population and the aging of the sewerage system. The existing population of the catchment is approximately 1,000,000 which is expected to increase to about 1,070,000 by 2021. It is estimated that the ADWF will increase from the current 316 ML/day to 344 ML/day by 2021. This represents a 9% increase in ADWF.

The outcome from failing to provide addition capacity for the increasing population and from letting the system deteriorate would be a greater impact to aquatic, terrestrial and socio-economic environments. Impacts on the receiving environments would be evident from:

1. increased levels of nutrients, leading to further eutrophication and possibly resulting in excessive weed and algal growth
2. increased levels of faecal coliforms
3. reduced suitability of the waterways for primary and secondary recreational uses
4. reduced compliance with water quality guidelines for ecosystem protection and consequently, reduced biodiversity
5. reduced visual amenity of the receiving waterways
6. Increased human health risks.

Terrestrial environments may also be affected by the increase in number of surcharges due to chokes and exfiltration. This may eventuate in greater nutrient enrichment of the soil, encouraging weed growth and limiting growth of native species which are adapted to low soil nutrient levels. Further, increases in discharges of sewage on land would promote odours, again, decreasing community values for the NSOOS area.

It is important to note, however, that unless all pollution sources are identified and quantified, it is difficult to determine the level of impacts which may occur if the preferred strategy is not implemented. The water quality modelling results show that removing all overflows will result in the recovery of the majority of unsuitable swimming and boating days in Port Jackson, particularly Lane Cove River and Middle Harbour, where the levels of faecal coliforms are greatest and quality of the stormwater runoff is generally good. The main evidence of impacts increasing due to not implementing the strategy would be from reduced recreational activities and general amenity of the environment.

5.6 Justification of NSOOS overflows management plan

The NSOOS overflows management plan has been developed to meet the targets identified for overflows as part of the overall strategy for the Port Jackson, Pittwater, Northern and North Eastern Beaches Geographic Area. The targets have been set based on the environmental values and uses of the waterways in this geographic area.

Justification of overflow management plans for individual REZs in this geographic area is discussed in Volume 2, Chapter 6.

The management plan includes a combination of structural and non-structural options designed to:

1. meet legal requirements and Sydney Water's Operating Licence and Environment Plan
2. reduce overflows in a cost-effective manner
3. protect sensitive areas
4. minimise the impacts of overflows when they do occur
5. aim to meet the principles of Ecologically Sustainable Development (ESD).

The area covered by the NSOOS system contains some highly sensitive areas with the potential to be impacted by overflow events. The overflow management plan for the NSOOS area is therefore based upon the protection of these highly sensitive areas, achieving the environmental objectives for the individual REZs impacted by the NSOOS and helping to achieve Sydney Water's long term performance targets.

Alternative structural actions that could be taken to achieve the selected containment standards will be further refined and improved during the second stage EIA process prior to construction. Non-structural options are focussed on recommended management practices in accordance with USEPA guidelines (USEPA,1996) and are part of the continuous improvement process.

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Chapter 6

Conclusion

Synopsis

The NSOOS has significant impacts on some of the REZs effected by overflows from the system, particularly with respect to the aquatic environment during wet weather.

To mitigate these impacts, an overflow management plan has been proposed. The plan is justified as it aims to achieve the environmental objectives established for each REZ and Sydney wide long term performance targets in a cost effective manner. The plan will also protect sensitive areas and minimise the impacts of overflows when they do occur.

Some components of the management plan are already being progressed by Sydney Water. The remaining components will be implemented over a period of 23 years. Where major structural works are required for specific components of the plan, a second stage EIA will be necessary.

6. Conclusion

Assessment of the environmental impacts of overflows on the NSOOS catchment has shown that the main overflows of concern are wet weather discharges, wet weather surcharges into residential areas, dry weather overflows from chokes and, possibly exfiltration.

Modelling results indicate that there are currently an average of 24 wet weather events per year which lead to overflows from the NSOOS system. The estimated overflow volume from these 24 events is 18,179 ML/year. There were 20 overflows from pump stations in the system during the recording period from 1996 to 1997. Of the 128 suburbs served or partly served by the NSOOS, 16 experience a "high" frequency of chokes and a further 74 experience "medium" choke frequency. However, 99% of Sydney Water's customers served by the system are not effected by surcharges. There are six sub-catchments in the NSOOS with suspected high exfiltration rates and a further 14 sub-catchments with moderate exfiltration.

The impacts on aquatic, terrestrial and socio-economic environments were assessed. The data collected as part of this EIS indicate that sewerage overflows from the NSOOS have a significant impact on some receiving environments. It was concluded that impacts on the terrestrial environment are difficult to quantify, largely because of the lack of data. However, terrestrial impacts are likely to be minor and localised. There is far more data available to allow an assessment of the impacts of sewerage overflows on the aquatic environment. The impacts include deterioration in water quality due to wet weather and dry weather overflow events. Overflows from the NSOOS contribute high proportions of the faecal coliform contamination measured in areas such as Lane Cove River estuary, Middle Harbour, Manly Lagoon and the Upper Parramatta River. Overflows from the NSOOS also contribute a significant proportion of the nutrients to Sydney Harbour. Overflows from all sewerage systems impacting on the Sydney Harbour REZ contribute 50% of the total nutrient load. Of the nutrient contribution from sewerage overflows to Sydney Harbour, 90% is contributed by overflows from the NSOOS. Impacts on the socio-economic environment include 152 odour complaints in relation to the system in the year from 1996 to 1997, a reduced number of days suitable for primary and secondary contact recreation and a reduction in the amenity value.

Sewerage overflows are not the sole cause of nutrient contamination in some of the waterbodies in the REZs. Stormwater contributions are significant in the Upper Parramatta River REZ and in some of the northern lagoons (Curl Curl, Dee Why and Narrabeen). Consequently, measures to achieve guideline water quality for ecosystem protection and primary and secondary recreation in these areas can only be achieved through an integrated catchment management approach.

A preferred overflow abatement option has been selected based on the environmental values identified for each of the REZs impacted by the NSOOS. The abatement option (summarised in Table 6.1) includes a number of different wet weather overflow containment standards, depending on the receiving environment. The selected standards range from maintenance of the existing containment through to six month containment. The existing performance standard has been adopted for the Northern Beaches REZ and the Northern Lagoons REZ (except Manly Lagoon). For the Upper Parramatta River REZ, Upper Lane Cove REZ, Parramatta River estuary and Lane Cove Estuary a three month containment has been selected. For Port Jackson, Middle Harbour and Manly Lagoon, six month containment has been adopted. The variable containment standard selected reflects the wide range of existing performance across this extensive sewerage system and the wide range of receiving environments and receiving environment values. By adopting a variable containment standard for wet weather overflows, the available funds can be targeted to achieve maximum benefit for the catchment.

Other components of the proposed management plan include reducing choke frequencies upgrading SPSs to reduce failures that lead to overflows and reducing exfiltration in the 20 sub-catchments identified as having high or medium potential for exfiltration (refer to Table 6.1). The proposed plan will help achieve Sydney Water's long term performance targets detailed in Table 4.1.

A number of alternative actions to deliver the proposed management plan are being reviewed by Sydney Water. The actions broadly fit into the category of detection, prevention and minimisation of impact. Actions to prevent overflows will include continuation of the interim I/E program, I/I reduction, reticulation sewer amplification, duplication or cross connection, trunk sewer amplification, storage and localised treat and discharge techniques. The Northside Storage Tunnel project, designed to reduce frequency and volume of sewage discharges from five of the most significant overflows in the NSOOS system is already underway (a design and construct contract has been let and the project detailed design has commenced).

The estimated cost for implementing the preferred strategy will be approximately $964.5 million, over the 23 year planning period. This figure includes a cost of $295 million for the Northside Storage Tunnel and the associated STP upgrades that are required as part of the tunnel project.

The benefits of implementing the preferred option for the NSOOS system will be to reduce the level of pollutants being discharged into the waterways of the area. Specific benefits would include increased compliance with guideline water quality for aquatic ecosystem protection and primary and secondary contact recreation. Reducing the number of chokes will have benefits for Sydney Water customers and for the receiving environments.

Actions will be implemented through a structured plan, which integrates the timetable for improvements, funding requirements, researching, system maintenance, training and standardised operating and emergency response procedures. Components of the management plan have been selected to achieve a balance between non-structural and structural options that can be implemented progressively over the next 23 years. The proposed management plan is to form part of Sydney Water's total quality assurance system. The immediate focus of the plan is on best management practises to reduce overflows, particularly due to system failures in dry weather.

Many of the recommended management practices have already been adopted by Sydney Water to minimise the frequency and impacts of dry weather overflows. Continuous improvement of these management practices will further reduce dry weather overflows at minimal expense. The delivery timetable for the proposed management plan is outlined in Chapter 4, Table 4.11.

Table 6.1 - Preferred strategies for NSOOS by overflow type

Overflow type	Options
Chokes	Reduce chokes in areas of high chokes (immediate priority - 16 suburbs) and medium chokes (next priority - 74 suburbs).
SPS failures	Upgrade SPSs to current design standards.
Exfiltration	Initiate routine dry weather faecal coliforms sampling for sub-catchments identified as exfiltration candidates. Sub-catchments identified as having exfiltration problem to be added to the I/E Programme for investigation at the mini-catchment gauging level.
Wet weather overflows	Implement three month containment strategy for Upper Lane Cove River, Upper Parramatta River, Lane Cove River Estuary and Parramatta River Estuary area of NSOOS, six month containment strategy for Port Jackson, Middle Harbour and Manly Lagoon area of NSOOS and minimum performance standard containment strategy for all other lagoons and northern beaches area. The options include: sewer sub-catchment rehabilitation, main sewers amplifications, rehabilitation of reticulation up to boundary trap to minimise disturbance to private properties. The private sewers which are suspected of possessing leaking sewers may also need to be rehabilitated as part of I/E correction program and house service policy such as Pipe Check and pursuing defect notices issued as part of a rehabilitation project. The Northside Storage Tunnel project which is currently out to tender is a major abatement action already being progressed by Sydney Water.
	Ensure that all SPSs are sized to accommodate additional flows for future population growth
	Investigate low-cost options for additional protection of sensitive areas during detailed EIA process
Odours	Maintain register of odours and implement public education to encourage public reporting of odours; investigate odour complaints to identify cause and possible remediation.
Partially treated STP discharges	Treatment plant capacity will be upgraded as part of the Northside Storage Tunnel project and as outlined in the North Head STP PRP to treat 1400 ML/day. No further upgrade will be required as part of the SOLP project. All flows through North Head will be discharged through the deepwater ocean outfall and there will be no partially treated discharges.

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