3 West Camden

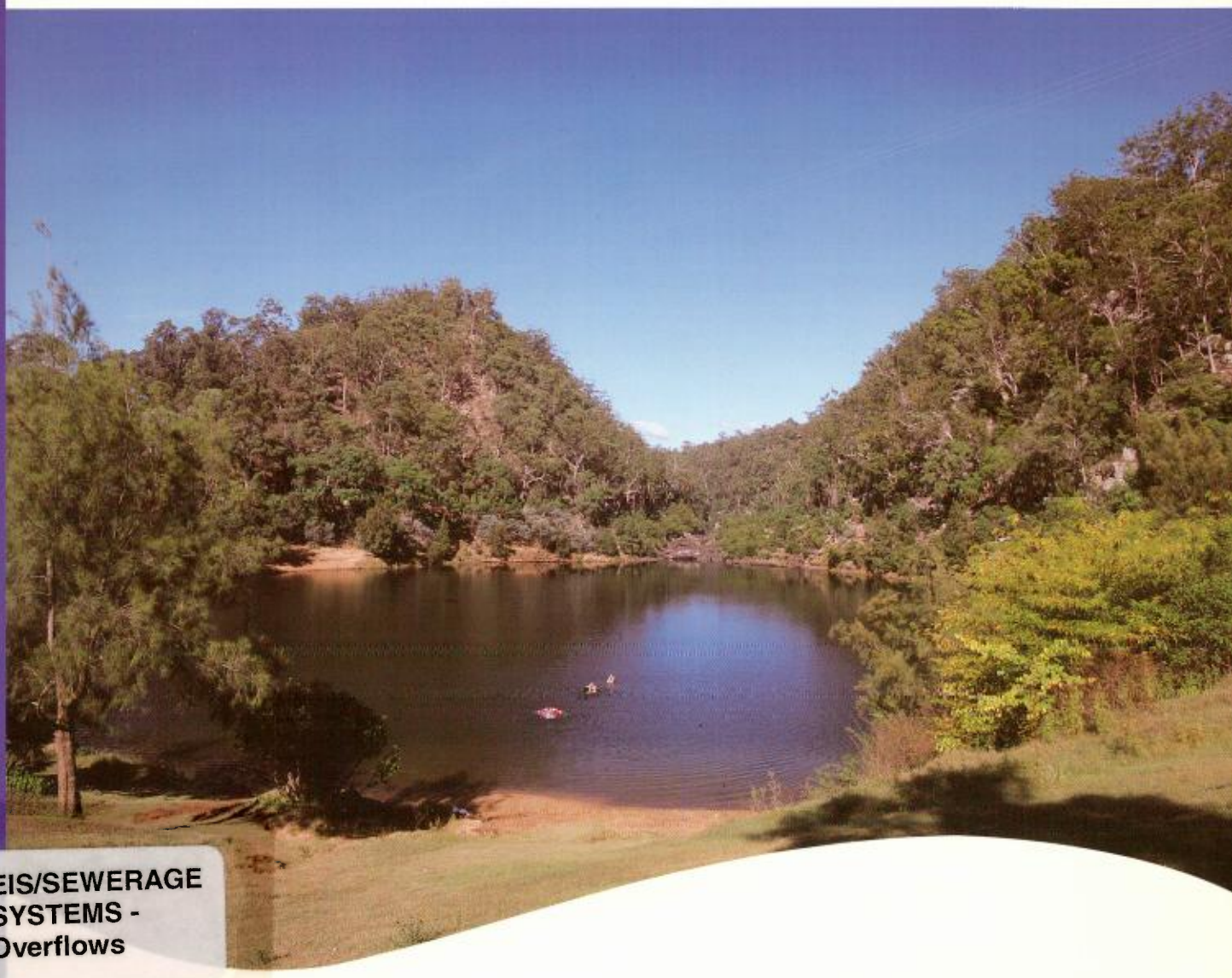
Licensing Sewerage Overflows

ENVIRONMENTAL IMPACT STATEMENT – JUNE 1998

Upper Nepean Geographic Area

Volume 3

West Camden



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Licensing Sewerage Overflows – Environmental Impact Statements

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JUNE 1998

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Volume Summary

1. Introduction

The West Camden sewerage system consists of all the areas from which sewerage flows to the West Camden sewerage treatment plant (STP). Overflows from this area flow into the Upper Nepean River receiving environment zone (REZ). Several sensitive areas were identified within the catchment, including the receiving waters of the Nepean River and its tributaries, areas of remnant vegetation, sites of rare or threatened plant species and wetland areas which provide habitat for rare and endangered frogs.

Overflows are defined for the purpose of the Environment Impact Statement as all liquid and odour discharges from the sewerage system and partially treated wet weather sewage treatment plant (STP) discharges.

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 the process of implementation of the strategies.

Volume 2 describes the overflows in the Upper Nepean Geographic Area (GA), including the extent of the overflow problem, the environmental impacts, proposed solutions and environmental benefits resulting from the proposed strategy for the GA.

Volume 3 describes the overflows and the specific solutions developed for the West Camden system which is located within the Upper Nepean GA.

2. System performance

The components of the West Camden sewerage system's performance which have been identified as potentially causing overflows to the surrounding environment include wet weather overflows, partially treated sewage treatment plant discharges, chokes, sewerage pumping station (SPS) failures, exfiltration and odours.

On average 11% of the rainfall falling on the West Camden sewerage system catchment enters the sewer. This is high when compared to other sewerage systems on the Hawkesbury-Nepean River. However, all of the main sewers in the West Camden sewerage system have capacities of greater than four times peak dry weather flow (PDWF), and all of the SPSs have a pumping capacity of at least three times PDWF. The present capacity of the West Camden system is adequate to prevent most wet weather overflows except during larger storm events. On average, about 5% of all rainfall events in the West Camden catchment result in an overflow.

Wet weather overflows were modelled for the West Camden system. The model estimates that there are 18 wet weather overflow events every 10 years in the West Camden system, discharging a total volume of 564 ML/10 years. This is a relatively small volume compared to other systems around Sydney.

West Camden STP provides some treatment of all flows that reach it, although partially treated discharges start occurring when the flow exceeds 15.5 ML/d. The capacity of the plant is currently limited by the disinfection capacity which is exceeded approximately 70 times in 10 years, resulting in discharges with only partial disinfection. Partially treated STP discharges are four times more frequent and have double the total discharge volume compared to the rest of the sewerage system over the same period.

Overflows also occur in dry and wet weather due to blockages or chokes in the sewerage system caused by roots, broken pipes and other obstructions. Sixty per cent of the suburbs in the West Camden sewerage system have a low choke density and forty per cent have a medium choke density,

which is comparable to the overall performance Sydney-wide. In 1996/97, nine repeat chokes were recorded in the West Camden sewerage system. The timing and location of repeat chokes were random.

About one third of the main sewers in the West Camden system have definite siltation problems. However, these do not cause overflows as they are flushed out during wet weather. It is expected that when further development occurs in the area, the increased flow in the sewers will reduce the siltation problems.

Three of the six sub-catchments in the West Camden sewerage system were identified as having potential moderate exfiltration problems. A further sub-catchment was classified as unknown, requiring further investigation. The exfiltration sub-catchments will be investigated as part of the ongoing infiltration/exfiltration (I/E) program.

Three of the six SPSs in the West Camden system are at risk of overflowing during an SPS failure, because their detention times (time between SPS failure and the start of overflow from the SPS) are currently lower than their response times (expected time to respond to and rectify an average failure at an SPS). Thirty failures occurred at SPSs in the West Camden system in 1996/97, however none of these failures resulted in overflows.

Six odour complaints were received in 1996/97 for the West Camden sewerage system, most of which occurred at private residences and emanated from sewer vents. Some complaints have been received associated with the Narellan Carrier and Sydney Water is already addressing this problem. Odour generation is expected to decrease as development of the catchment leads to increased sewage flows and shortens detention times.

The population served by the West Camden system is expected to be five times greater in 2021 than in 1997. The West Camden system will therefore require significant augmentation to allow 2021 sewage flows to be transported and treated to avoid future increases in overflows.

3. Environmental assessment

This environment assessment is focused primarily on issues that affect 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.

Sewerage overflows are considered to have negligible impact on noise, traffic and landuse zoning and these environmental aspects have not been considered further in this EIS. However, construction of overflow control measures may affect noise, traffic and landuse zoning and such aspects will therefore be considered in the second stage EIA documents.

The assessment of overflow impacts has been carried out in consideration of environmental objectives recommended by Catchment Management Committees (CMCs) and Community Reference Groups. These objectives include water quality suitable for swimming for most waterways in the Upper Nepean River REZ, except for Narellan Creek Urban Zone, where protection of aquatic ecosystems, visual amenity and secondary contact recreation are desired.

The impacts on the environment of overflows from the West Camden sewerage system are localised and minor in extent. Three sensitive areas have been identified. The section of the Nepean River extending from Macarthur Bridge to Cowpastures Bridge in Camden is impacted by overflows located at several sites near the bank. Overflows may cause localised impacts on this area because it is used extensively for swimming during the warmer months. Swimming criteria for water quality are met 80-90% of the time in the Upper Nepean River REZ downstream of Camden.

Overflows into Narellan Creek in the Smeaton Grange area may cause increases in nutrients that promote and sustain weed infestations of remnant River-flat Forest adjoining the Creek in this area.

The terrestrial impacts due to overflows are minor except for potential weed infestation of remnant riparian vegetation as most of the overflows discharge directly to waterways.

Wetland No. 159, which is listed under SEPP 14 as a legally protected wetland may also be potentially impacted by overflows.

Overflows from modelled overflow nodes in the West Camden sewerage system generally have a low ranking compared to other overflows across Sydney. Modelled designed overflow structures are ranked in the bottom 35% and modelled reticulation areas are ranked in the bottom 39%. Wet weather overflow abatement in West Camden therefore has a relatively low priority compared to other systems across Sydney. Wet weather STP overflow for the West Camden STP is ranked in the bottom 48%. However, overflows from SPSs in the event of SPS failures had a moderately high Sydney-wide ranking, and should be given priority for remediation in the West Camden system. Three SPSs were ranked in the top 17% and two SPSs were ranked in the bottom 60%.

Overflows are not the major source of water pollution in the Upper Nepean River REZ although a small improvement in the recreational suitability of the Nepean River would be achieved if all overflows were eliminated. Water quality is mainly influenced by dry weather STP discharges from West Camden STP. Stormwater runoff exerts far greater influence on water quality during wet weather.

4. Overflow abatement options

Strategies for overflow abatement were developed for each sewerage system in the Upper Nepean GA in Volume 2 of this EIS based on the magnitude of the identified overflow problem. A standardised level of overflows, known as the base case, was adopted as the starting point for evaluation of overflow abatement options. The base case for each overflow type is not to allow current overflow performance to deteriorate in 2021, irrespective of population growth. The base case is required to meet Sydney Water's obligations under its Operating Licence and Environment Plan. Further options have then been considered to reduce the impacts of overflows in line with Sydney Water's longterm objectives. The main overflow problems are partially treated wet weather STP discharges and exfiltration.

Environmental objectives have been identified for each of the systems based on current and desired values and uses. Water quality suitable for swimming is a desired outcome for most of the major waterways in the West Camden sewerage system. Water quality modelling of the Nepean River has identified that the major sources of pollution are from stormwater (urban and rural runoff) and STP discharges and that overflows contribute less than one per cent of nutrient loads in the Upper Nepean GA.

From the overflow abatement strategies, actions have been developed to focus in detail on the methods of implementing the strategies. These actions were optimised to meet the targets for all overflow categories. The main components are I/E rehabilitation, trunk main amplification, SPS upgrades and additional STP wet weather treatment. Actions have also been identified for additional protection of the Nepean River corridor sensitive area and Wetland No. 159.

The base case of a 18 overflow events per 10 years overflow abatement is proposed for the majority of the West Camden sewerage system. The sub-catchments overflowing to the Nepean River corridor sensitive area are proposed to have a 5 overflow event per 10 year overflow abatement. This will provide improved protection for this swimming area and is supported by an economic analysis which shows a small incremental cost for moving to this abatement level (see Table 4.10 for summary of cost estimates).

To reduce partially treated STP bypasses, it is proposed to install a 1 ML storage basin at West Camden STP and to upgrade the disinfection system to match the wet weather abatement level of the sewerage

system. The storage basin will return the stored flow back to the treatment process in the STP once the flow levels have returned to normal levels.

Three of the sub-catchments in the West Camden system have potential moderate exfiltration problems. These three sub-catchments will be considered for further investigation. The $0.32m proposed to be spent on I/I works for wet weather, the $0.8m proposed to be spent on the protection of the Nepean River sensitive area and the additional $6.8m allocated to reducing system leakage will reduce exfiltration from these three subcatchments and also reduce chokes in these areas. This work will simultaneously reduce wet weather inflow to the system.

Three of the SPSs in West Camden (SPS 440, 484 and 614) will be upgraded to meet the higher wet weather flow levels when the proposed actions are implemented. A further two SPS (SPS 120 and 453) have been identified as having a high overall overflow ranking and will be compared with other high ranking SPS throughout Sydney to determine a priority for remediation.

Odour problems are currently occurring at SPS 614 due to septic sewage. At present this is being chemically treated and will be naturally corrected when flows increase due to housing and commercial development in the system.

The actions are integrated to form a management plan for the West Camden sewerage system. Management practices will be updated as part of the continuous improvement program. The total cost of the management plan for West Camden is estimated to be $24.2m over the next 25 years. Components of the plan have been prioritised with the aid of overflow ranking results across the whole of Sydney Water, and will be progressively implemented over the 25 year period in a rolling 5 year capital works program. Most of the expenditure will occur in the next 5-15 years mainly on wet weather overflow abatement, STP upgrades and SPS upgrades. The immediate focus of the plan will be on best management practices, particularly due to system failures in dry weather.

5. Benefits

The impacts of overflows to the aquatic environment in the Upper Nepean River REZ have been shown to be minor when compared to other point sources contributing pollutants to receiving waters. The proposed strategies will result in some improvement in water quality, mostly due to the improved treatment of previously partially treated wet weather discharges from West Camden STP. The number of days suitable for swimming and boating however will increase by up to eight per year.

The impacts of overflows on the terrestrial environment are minor since there are no significant discharges to this zone and none are associated with an identified sensitive area.

The impact of overflow abatement on the socio-economic environment affects recreational use with the minor increase in the number of days available for swimming and boating enumerated above.

The proposed strategy meets the requirements of ecologically sustainable development, the goals of Sydney Water's Environment Plan and other environmental initiatives and the desires of the community by taking actions to prevent overflows from increasing in frequency and to reduce overflow volumes.

6. Conclusions

The main overflows of concern are partially treated wet weather STP discharges and exfiltration draining to the Nepean River at Camden, a sensitive area used for swimming. The volume and frequency of wet weather overflows from the West Camden system is small compared to the rest of Sydney Water's area of operations. The relative contributions of stormwater and dry weather STP discharges are much greater than wet weather overflows.

The base case of 18 wet weather overflow events per 10 years is therefore proposed for the West Camden System. Wet weather treatment at the STP will be upgraded and actions taken to reduce exfiltration and potential for SPS failures. The proposed strategy for the West Camden system is estimated to cost $24.2 million. The benefits of the strategy include a reduction in the level of pollutants being discharged into the waterways and a reduction in exfiltration volumes. A minor increase up to eight in the number of days suitable for swimming and boating will be achieved in the main river, including the sensitive Nepean River corridor at Camden.

The management plan for the system balances structural and non-structural actions that can be implemented progressively over the next 25 years and will form part of Sydney Water's total quality assurance system. The plan focuses on best management practices and continuous improvement to reduce overflows, particularly those due to system failures in dry weather.

Sewerage Overflows Licensing Project
Environmental Impact Statement

Volume 3: West Camden Sewerage System

Chapter 1

Introduction

Synopsis for Chapter 1

The West Camden sewerage system consists of all the areas from which sewerage flows to the West Camden sewerage treatment plant (STP). Overflows from this area flow into the Upper Nepean River receiving environment zone (REZ). There are several identified sensitive areas within the catchment, including the receiving waters of the Nepean River and its tributaries, areas of remnant vegetation, sites of rare or threatened plant species and wetland areas which provide habitat for rare and endangered frogs.

Overflows are defined for the purpose of the Environment Impact Statement as all liquid and odour discharges from the sewerage system and partially treated wet weather sewage treatment plant (STP) discharges.

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 the process of implementation of the strategies.

Volume 2 describes the overflows in the Upper Nepean Geographic Area (GA), including the extent of the overflow problem, the environmental impacts, proposed solutions and environmental benefits resulting from the preferred solution for the GA.

This volume (Volume 3) describes the overflows and the specific solutions developed for the West Camden system which is located within the Upper Nepean GA. This chapter of Volume 3 provides details on the study area, background and the purpose of the volume.

1. Introduction

1.1 Background

The Sydney Water Corporation (SWC) has three equal objectives; to be a successful business, to protect the environment and to protect public health. An outcome of these Sewerage Overflow Environmental Impact Statements (EISs) will be licences with improvement programs attached. Capital components of these programs will require second stage Environmental Impact Assessment (EIA) and will be subject to project-specific impact assessment at the time of their implementation as appropriate.

This volume is the third volume in this EIS. Volume 1 contains the Sydney-wide overflow abatement program and provides information on the generic considerations and methodology that form the licensing project. It summarises the performance, impacts, proposed solutions, costs and benefits for the whole 27 systems and outlines the prioritisation process for implementation of the plan.

Volume 2 describes and assesses the environmental impacts of overflows in the Upper Nepean geographic area (GA). Volume 2 also contains information regarding the cumulative environmental impacts of overflows in the GA. It proposes overflow abatement strategies on a receiving environment zone (REZ) basis according to the contribution of overflows to total catchment pollution.

1.2 Purpose and content of this volume

This volume assesses overflows from the West Camden sewerage system. System-specific actions are developed to meet the Upper Nepean River REZ overflow abatement objectives selected in Volume 2. The purpose of identifying system actions is to demonstrate that the abatement objectives are realistic and achievable. It is important to note that overflow performance is the main focus of the EIS, not how the performance is achieved.

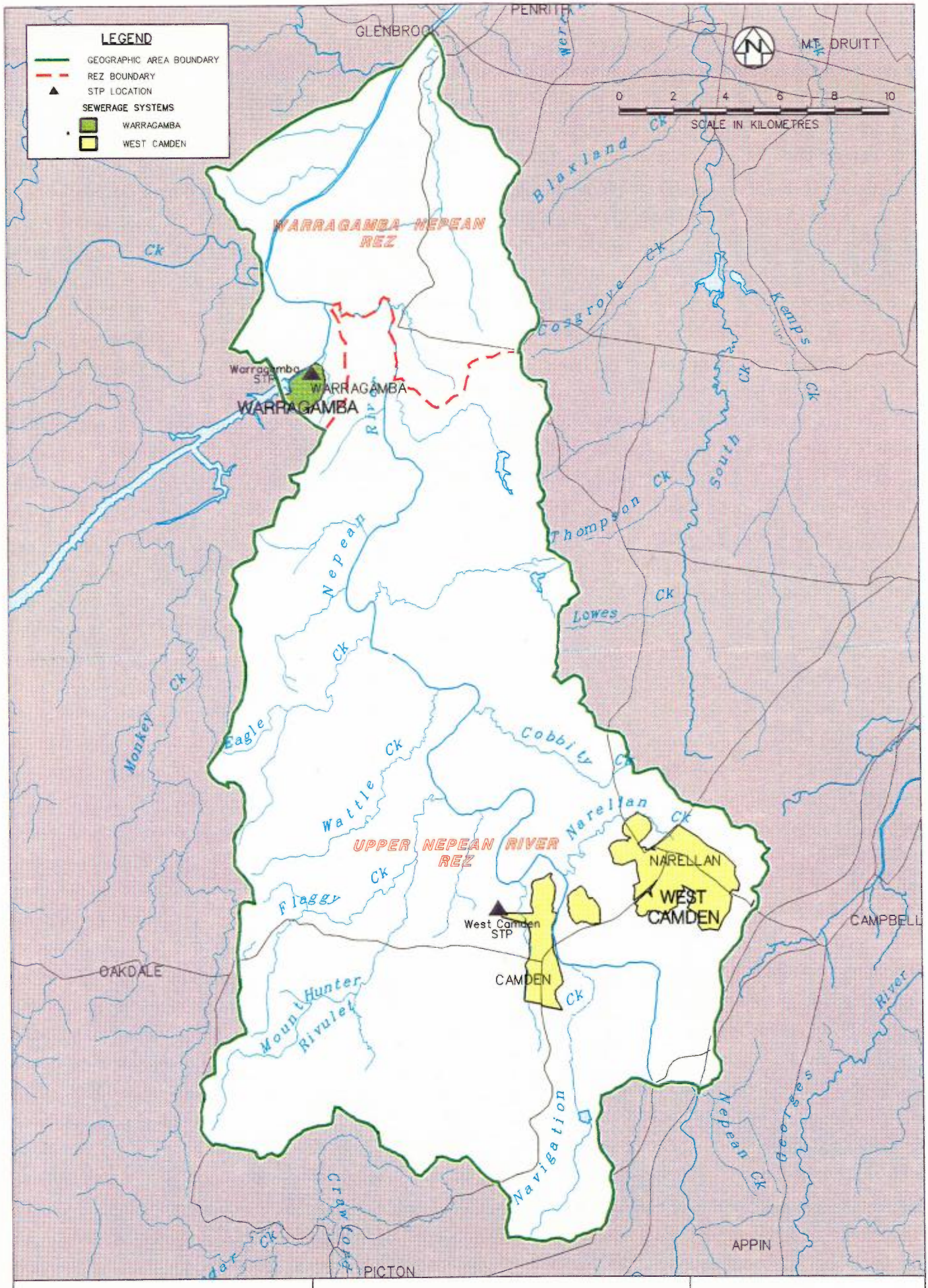
This volume includes:

1. a description of the West Camden sewerage system
2. a description of the extent of the overflow problem related to the West Camden sewerage system
3. a description of the environmental impacts from overflows in the West Camden sewerage system
4. an analysis of actions and strategies to meet the performance standards of solutions proposed in Volume 2 and
5. a description of the environmental benefits of the proposed strategy.

1.3 The study area

The West Camden sewerage system catchment consists of all the areas from which sewerage flows via the reticulation system and trunk sewers to the West Camden sewage treatment plant (STP). The West Camden system lies within the catchment of the Upper Nepean River and serves existing and developing residential, commercial and industrial areas in the township of Camden and the surrounding suburbs of Camden South, Elderslie, Harrington Park, Narellan, Narellan East, Narellan Vale, Mount Annan and Currans Hill. The Upper Nepean catchment is a zone of the Hawkesbury-Nepean catchment. The Hawkesbury-Nepean catchment has a catchment area of approximately 22,000 square kilometres. Over 60% of the catchment is forested, 30% is agricultural land and less than 10% is developed for urban and industrial use. The population served by the West Camden system is estimated at 21,500 with an existing service area of 645 hectares (Refer to Figure 1.1).

The receiving environment for overflows from the West Camden sewerage system has been defined as the Upper Nepean River REZ. There are several identified sensitive areas within the catchment, including the receiving waters of the Nepean River and its tributaries, areas of remnant vegetation, sites of rare or threatened plant species and wetland areas which provide habitat for rare and endangered frogs. The requirements of these sensitive areas are discussed in the options assessment.



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SEWERAGE OVERFLOWS LICENSING PROJECT
UPPER NEPEAN GEOGRAPHIC AREA

FIGURE 1-1
LOCATION OF SEWERAGE SYSTEMS

Chapter 2

System Performance

Synopsis for Chapter 2

The components of the West Camden sewerage system's performance which have been identified as potentially causing overflows to the surrounding environment include wet weather overflows, partially treated sewage treatment plant (STP) discharges, chokes, sewerage pumping station (SPS) failures, exfiltration and odours.

On average 11% of the rainfall falling on the West Camden sewerage system catchment enters the sewer. This is high when compared to other sewerage systems on the Hawkesbury-Nepean River. However, all of the main sewers in the West Camden sewerage system have capacities of greater than four times peak dry weather flow (PDWF), and all of the SPSs have a pumping capacity of at least three times PDWF. The present capacity of the West Camden system is adequate to prevent the majority of wet weather overflows except during larger storm events. On average, about 5% of all rainfall events in the West Camden catchment result in an overflow.

Wet weather overflows were modelled for the West Camden system. The model predicts that there are 18 wet weather overflow events every 10 years in the West Camden system, discharging a total volume of 564 ML/10 years. This is a relatively small volume compared to other systems around Sydney. West Camden STP provides some treatment of all flows that reach it, although partially treated discharges start occurring when the flow exceeds 15.5 ML/d. The capacity of the plant is currently limited by the disinfection capacity which is exceeded approximately 70 times in 10 years, resulting in discharges with only partial disinfection. Partially treated STP discharges are four times more frequent and have double the total discharge volume compared to the rest of the sewerage system over the same period.

Overflows also occur in dry and wet weather due to blockages or chokes in the sewerage system caused by roots, broken pipes and other obstructions. Sixty per cent of the suburbs in the West Camden sewerage system have a low choke density and forty per cent have a medium choke density, which is comparable to the overall performance Sydney-wide. In 1996/97, nine repeat chokes were recorded in the West Camden sewerage system. The timing and location of repeat chokes were random. About one third of the main sewers in the West Camden system have definite siltation problems. However, these do not cause overflows as they are flushed out during wet weather. It is expected that when further development occurs in the area, the increased flow in the sewers will reduce the siltation problems.

Three of the six sub-catchments in the West Camden sewerage system were identified as having potential moderate exfiltration problems. A further sub-catchment was classified as unknown, requiring further investigation. The exfiltration sub-catchments will be investigated as part of the ongoing infiltration/exfiltration (I/E) program. Three of the six SPSs in the West Camden system are at risk of overflowing during an SPS failure, because their detention times (time between SPS failure and the start of overflow from the SPS) are currently lower than their response times (expected time to respond to and rectify an average failure at an SPS). Thirty failures occurred at SPSs in the West Camden system in 1996/97, however none of these failures resulted in overflows.

Six odour complaints were received in 1996/97 for the West Camden sewerage system, most of which occurred at private residences and emanated from sewer vents. Some complaints have been received associated with the Narellan Carrier and Sydney Water is already addressing this problem. Odour generation is expected to decrease as development of the catchment leads to increased sewage flows and shortens detention times.

The population served by the West Camden system is expected to be five times greater in 2021 than in 1997. The West Camden system will therefore require significant augmentation to allow 2021 sewage flows to be transported and treated to avoid future increases in overflows.

2. System performance

2.1 Current system overview

The West Camden sewerage system collects mostly domestic sewage within the Camden Municipality and transports it to the West Camden sewage treatment plant for tertiary treatment prior to discharge into the Nepean River via Matahil Creek.

The system services an area of 645 hectares, comprising the more established suburbs of Camden, Camden South and Elderslie and the newer suburbs of Narellan, Narellan Vale, Harrington Park, Smeaton Grange, Currans Hill and Mt Annan. The system services a population of about 21,500.

Sewage is collected and transported to the STP via approximately 204 km of gravity reticulation sewers (with a diameter of less than 300 mm) and 28 km of gravity main sewers (which have a diameter of 300 mm or larger). The area served by the West Camden system is divided into thirteen sub-catchments, each with a dedicated carrier or submain. The locations of the mains, SPSs, STPs, and suburbs in the West Camden sewerage system are shown in Figure 2.1.

The system incorporates five sewage pumping stations and about seven kilometres of rising mains. There is an additional SPS at the STP (SPS 440), which impacts on the system immediately upstream of the station. SPS 120 and SPS 484 discharge to the Camden submain, SPS 673 and SPS 614 discharge to the Narellan Submain and SPS 453 discharges to the Camden South Low Level Carrier via the Ulmarra Street Carrier. Details of the SPSs in the West Camden system are provided in Section 2.4.

A comparison of the infrastructure of the West Camden sewerage system with the total infrastructure of the Upper Nepean GA and the total SWC wastewater system, is shown in Table 2.1.

Table 2.1 Comparison of West Camden system to Upper Nepean GA and SWC wastewater system

Description	West Camden Sewerage System	Total Upper Nepean GA	Total Sydney Water System
Sewered area (ha)	645	789	187,121
Population Served	21,500	24,900 plus 4000 visitors	3,884,121
Length of Main Sewers > 300 mm (km)	28	34	2,497
Length of Reticulation Sewers < 300 mm (km)	204	217	18,966
Total Length of Sewers (km)	232	251	21,463
No. of SPS	6 (5 in the sewerage system, 1 at STP)	7	642
No. of Designed Overflows	21	22	3109

Note:

There are 21 known designed overflow structures in the West Camden system, 15 in the reticulation system and 1 at each of the 6 SPSs.

As explained in Volume 1, overflows may be described as either designed overflow point or a reticulation overflow. A designed overflow is an physical structure in the sewer system that is designed to direct the overflow to a known location, usually a nearby waterway. A modelled reticulation overflow is a point in the sewer model (described further in Section 2.4.1) which represents a catchment area. The overflow discharge can occur anywhere in the catchment from both designed overflow structures or other locations, such as undirected discharges from access chambers. In addition, to the above overflow types, there may be additional unknown overflows, that is, overflows from the system that could be occurring, but have yet to be detected and evaluated. Unknown overflows may have an impact on the receiving environment. Sydney Water will develop programs to identify unknown overflows and their causes, so that abatement actions can be identified.

Designed overflow structures in the West Camden system either discharge directly onto cleared rural land/recreational areas or discharge near tributaries of the Nepean River, including Matahil Creek, Narellan Creek and Navigation Creek. The receiving water for all overflows in the West Camden system is the Nepean River. The location of major designed overflow structures that are predicted to discharge at least once in ten years by the sewer model and their discharge pathways are shown in Figure 2.2. The figure also shows the location of the SPSs.

Records of overflow discharges from designed overflow structures in the West Camden sewerage system and results of the sewer modelling are presented in Section 2.4 below. Sewer vents are also classed as designed overflows but are not modelled. The effect of overflows from vents is covered in the section on odours, Section 2.4.7.

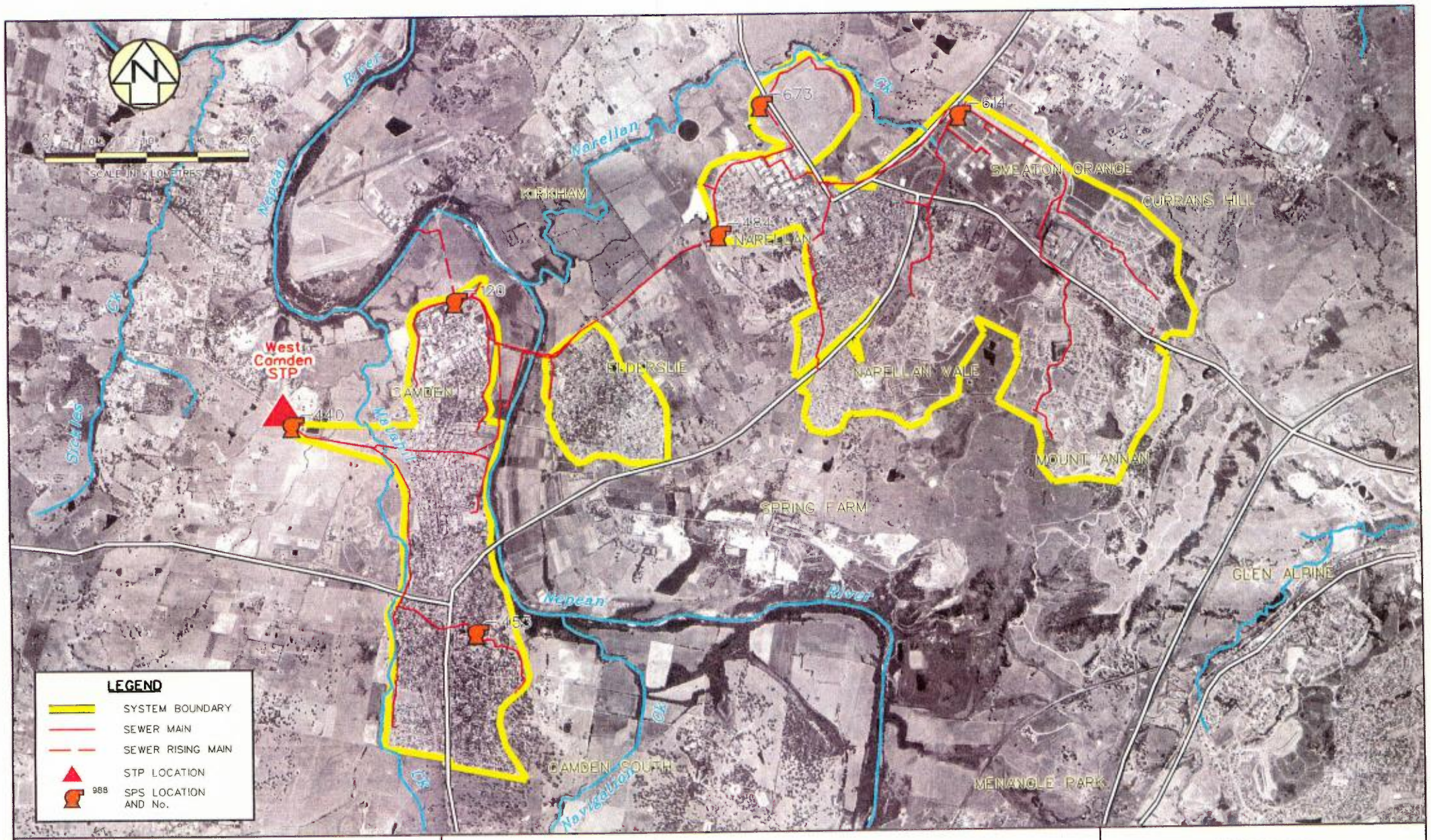
Overflows from non-design locations can occur anywhere in sewerage systems in dry or wet weather conditions. Examples of overflows from non-design locations include sewage discharges from access chambers, leakage of sewage through cracks in sewer pipes and joints (exfiltration), and odour emissions via liquid overflow discharges. Modelled and actual records of overflow discharges from non-design locations in the West Camden sewerage system are presented in Section 2.4 below.

West Camden STP currently provides tertiary treatment of sewage and treated wastewater (effluent) from the STP is discharged to an unnamed creek which flows into Matahil Creek. Matahil Creek is a tributary of the Nepean River located on the western boundary of Camden township. The Nepean River is 1.5 km downstream of the discharge point.

Operation of the West Camden STP is governed by EPA Licence No 001675 (EPA, 1995). The licence allows for discharge of up to 42.7 ML/d of effluent from a total of two discharge points. The plant is a small flow contributor of all the STPs discharging into the Hawkesbury-Nepean river system, contributing around four per cent of the total effluent flow entering the river system. The West Camden STP currently provides treatment for a population of approximately 21,500. The average daily dry weather flow to the STP is 4.8 ML/d.

Based on the current treatment capacities, tertiary treatment is provided for flows up to 30 ML/d although full disinfection is only be provided for flows up to 15.5 ML/d. As flows increase beyond 15.5 ML/d, disinfection efficiency drops leading to reduced effluent quality. These partially treated STP discharges are discussed in more detail in Section 2.4.2.

West Camden STP has two authorised discharge points from the plant. Discharge Point 1 is located at the plant outfall and flows into an unnamed creek and then flows one kilometre to the Nepean River. Discharge Point 2 is located at the overflow drain from the oxidation ponds to an unnamed creek and then flows 1.1 km to the Nepean River. This discharge point is not currently in use, however the oxidation ponds are being considered as a possible stormwater storage facility for SPS 440. Flows exceeding treatment plant capacity are being addressed in this EIS to ensure impacts to the surrounding environment caused from these discharges are identified and appropriate action is taken to rectify any significant problems.



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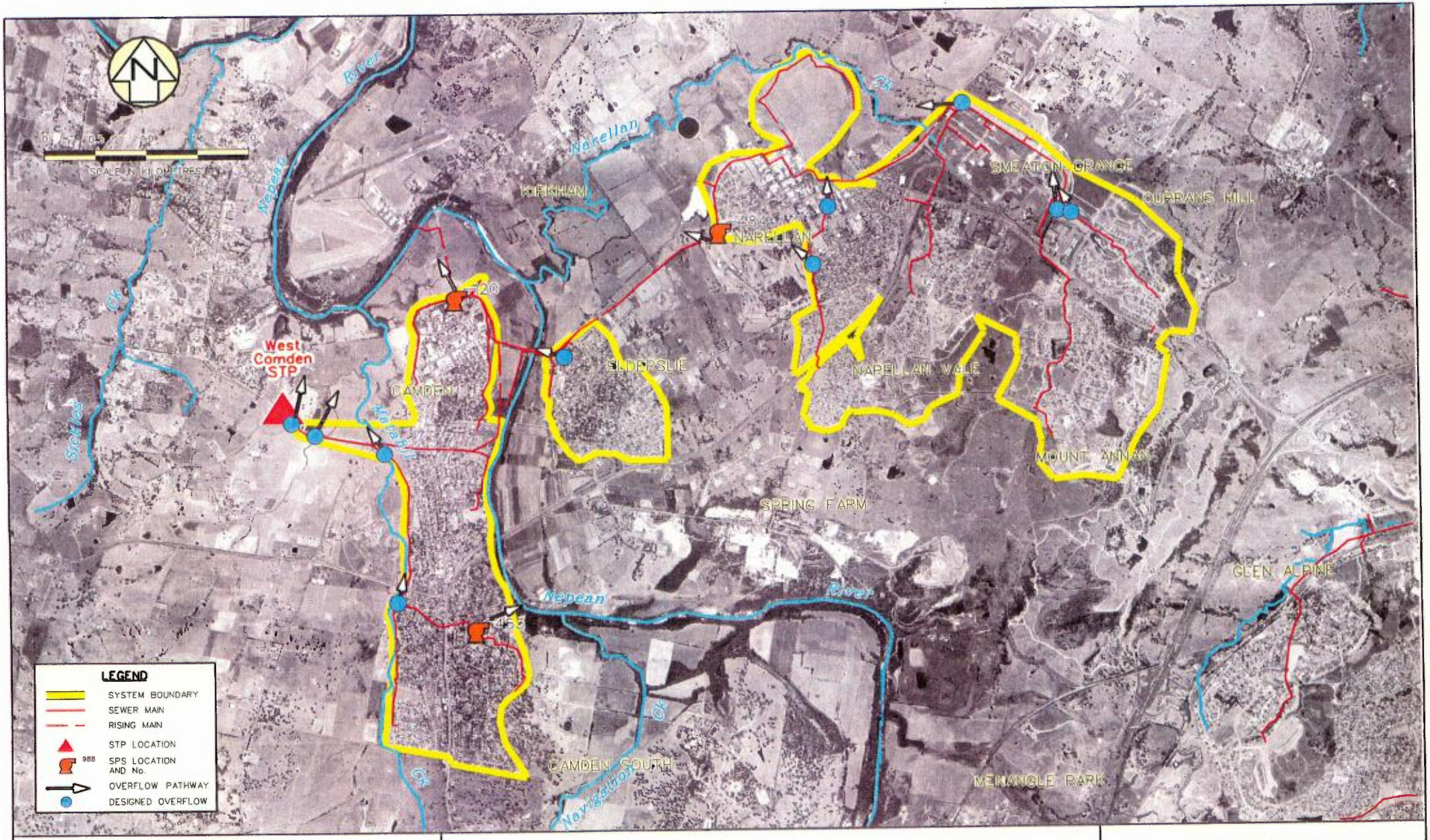
SEWERAGE OVERFLOWS LICENSING PROJECT
WEST CAMDEN SEWERAGE SYSTEM

FIGURE 2-1
WEST CAMDEN SEWERAGE SYSTEM



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SEWERAGE OVERFLOWS LICENSING PROJECT
WEST CAMDEN SEWERAGE SYSTEM

FIGURE 2-2
MAJOR OVERFLOWS
AND DISCHARGE PATHWAYS

2.2 Condition of the West Camden sewerage system

Trunk carriers in the West Camden system are generally in good operational condition. Part of the Camden submain near the STP carrier has surcharge and siltation problems, however the remainder of the carrier is generally in good condition. There is some evidence of pipe corrosion caused by sewage gases (produced as a by-product of sewage septicity) in the first two sections of the Camden submain. Corrective action is required on the first section of the main, due within the next three years. The second section will require inspection within five years and possible corrective action within nine years.

In 1991 the Clean Waterways Program established a five year Closed Circuit Television (CCTV) inspection program to determine the structural conditions of the minor trunk sewers with a view to developing a comprehensive renewal and rehabilitation program.

The traversable trunk sewers (sewers greater than or equal to 900 mm diameter) have been regularly inspected since the early 1970s. Traversable sewers in the West Camden sewerage system were inspected in 1993 and 1995. This has allowed early detection of potential problems and allowed timely remedial investigations. Corrosion problems in the first two sections of the Camden submain are being closely monitored.

Sewer condition assessment is based on criticality, with sewers greater than or equal to 450 mm diameter classified as critical. Sewers less than 450 mm diameter may be critical depending on consequences of failure. All critical sewers in the West Camden sewerage system have been inspected by Closed Circuit Television (CCTV) and a rehabilitation program initiated. Inspections carried out to date on 28 km of trunk mains 300 mm or larger indicate that 20% of the total length requires service or repair (SWC, 1997).

The results of the CCTV inspection program showed that inflow and infiltration (I/I) sources were not a major issue in West Camden. However, computer modelling predicted significant rainfall ingress into the system as described in Section 2.4. Faults such as cracked, fractured and broken pipes and pipe joints, and obstructions to flow by roots, rocks and other debris were found to be minimal. No major blockages of the pipe area were found.

There are a number of sections within the West Camden sewerage system requiring attention to reduce infiltration and exfiltration (I/E) to the sewer. Problem I/E sub-catchments have been identified (in Section 2.4 below) for further investigation to determine the extent of the problem.

Sydney Water conducted an operational performance assessment of SPS equipment including pumps, motors, valves, power supply, telemetry, unit control, procedural control instructions and overflows (Water Board, 1994b). 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. The SPS audit indicated that the peak dry weather overflow detention times for all SPSs were satisfactory (Water Board, 1994b). Yearly performance reports are compiled by SWC on SPS failures in the West Camden system. SPS failures are discussed further in Section 2.4 below.

2.3 Sewage characteristics

2.3.1 Dry weather sewage characteristics

Sydney Water conducts regular analysis of the chemical composition of the sewage flowing into the STP. The dry weather 10, 50 and 90 percentiles for conventional sewage parameters are presented in Table 2.2.

Table 2.2 West Camden conventional sewage parameters

	10 Percentile (mg/L)	50 Percentile (mg/L)	90 Percentile (mg/L)
Ammonia	35.0	39.5	56.6
Total Phosphorus	6.96	9.44	10.66
Biological Oxygen Demand	105	140	246
Total Kjeldahl. Nitrogen	46.6	54.0	60.2
Suspended Solids	117	161	228

Source: SWC, West Camden raw sewage sampling 1990 to 1995.

Sewage in the West Camden catchment contains a wide range of chemical compounds. The concentrations of conventional parameters are typical for the Hawkesbury-Nepean STPs. Appendix B (Volume 3) provides summary statistics for sewage samples for all dry weather flows.

Bacteriological properties of sewage are commonly measured by densities of faecal coliforms. Monthly sewage samples were collected from the inlet at Penrith STP. The median and 90 percentile concentrations were 1.2 x 107 and 1.6 x 108 respectively. Since the concentration of faecal coliforms will be similar for all sewage in the Hawkesbury-Nepean catchment (Water Board, 1994a), the bacteriological properties of Penrith sewage is considered to be representative of the sewage in the Hawkesbury-Nepean catchment.

Trade waste

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 wastewater 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 wastewater to the sewerage system. These trade waste agreements specify the volume, concentration and mass of different substances in commercial and industrial wastewater that may legally be discharged to the sewer.

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

Category 1 - commercial establishments producing residential type substances in their trade wastewater streams.

Category 2 - operating small businesses producing low annual mass loads of residential type substances and low daily mass loads of non-residential type substances.

Category 3 - 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.

Category 4 - 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 Wastewater Source Control Policy has traditionally 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. However, the concentration of trade waste substances at the STP is diluted by the wastewater flowing through the system. The concentration at particular points in the wastewater system, corresponding to industrial areas or major trade waste dischargers, is expected to be higher than the concentration received at the STP. Sydney Water's Wastewater Source Control Policy does not specifically consider this spatial variation in sewage characteristics and the potential risks associated with overflows immediately downstream of industrial areas or major trade waste dischargers.

The main industrial areas in the West Camden sewerage system catchment are in the suburb of Narellan along Camden Valley Way and Narellan Road. All of these industries are classed as Category 1 or 2 and include hospitals, fast food outlets and motor vehicle service workshops. Therefore there would not be a significant variation in the quality of sewage throughout the West Camden sewerage system.

2.3.2 Wet weather sewage characteristics

Sydney Water conducted an ecological and human health risk assessment study (ERA) for sewerage overflows by detailed investigations at eleven wet weather overflow sites. None of these sites are located in the Hawkesbury-Nepean catchment. Study results have indicated, however, that concentrations of most of the chemicals analysed varied little between the monitoring sites. It is therefore reasonable to expect that the quality of wet weather overflow discharges in the West Camden catchment would be similar to that of the 11 sewerage overflow monitoring sites. The wet weather overflow discharge characteristics at these sites are shown in Table 2.3

Table 2.3 Wet weather overflow quality - selected parameters

Parameter	No. of counts	Minimum concentration (mg/L)	Maximum concentration (mg/L)
Ammonia (mg/L)	1238	0.003	15.5
BOD (mg/L)	59	0	141
Suspended Solids (mg/L)	1933	2	1570
Phosphorus (mg/L)	3495	0	6.9
Aluminium	1416	0.005	84.6
Arsenic	1387	0.00067	0.16
Chromium	695	0.002	0.043
Copper	1410	0.0004	2.956
Iron	1414	0.005	41.7
Lead	1410	0.0003	2.16
Mercury	784	0.00005	0.0087
Zinc	1401	0.005	2.281

Source: SWC, ERA Database, 1995b.

The data demonstrates a fairly wide range of concentrations due to differing degrees of dilution. At maximum dilution in heavy storms, the concentrations of the sewage components approach zero where as for low dilution conditions in light rainfall the concentrations start to approach dry weather sewage quality.

2.4 Extent of the overflow problem

The extent of the overflow problem in the West Camden sewerage 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. Sydney Water records customer complaints of overflows in its RECOS database. The RECOS database was designed as a job record and not to generate performance statistics and as such is not a comprehensive record. The extent of data available across different sewerage systems varies and is not necessarily collected and recorded in a similar manner. However, the database is currently the best record of overflows available.

This section discusses the occurrence and magnitude of all types of sewerage overflows in the West Camden sewerage system. The effect of population growth and future loading to the system is discussed in Section 2.6.

2.4.1 Wet weather overflows

Water entering the sewer through illegal stormwater connections or through poorly sealed access chamber covers is termed inflow. Water entering the sewer through cradled pipes and faulty joins is called infiltration. Wet weather overflows occur when the combined inflow and infiltration (I/I) and normal dry weather sewage flow exceed the system capacity. Inflow and infiltration (I/I) to the sewerage system are the major causes of wet weather overflows. Studies of system performance in SWC wastewater systems indicate that up to 15% of rainfall can enter the sewerage system. The actual percentage is dependent upon a number of catchment variables including age and extent of

deterioration of the sewerage system, catchment size and the catchment's response to rainfall (based on vegetative cover, catchment wetness, soil type etc.). The system overflows are dependent upon many factors, including rainfall intensity, catchment wetness, STP capacity and the capacity of trunk sewers and carriers.

A computer model, MOUSE, was used to estimate

- % rainfall ingress to the sewerage
- the capacity of the trunk mains
- the volume, frequency and duration of overflows during wet weather for the ten years from 1985 to 1994.

Further information on the MOUSE model can be found in the Methods document and Appendix A (Volume 3). The model uses one or more nodes for each sewerage system depending on the size of the system, where each node represents a designed overflow structure or an area of reticulation.

The percentage rainfall ingress in West Camden's catchments is in the range 1% to 14% with an average of 11%. That is, on average 11% of the rainfall falling on the catchment enters the sewer. This is high when compared to other sewerage systems on the Hawkesbury Nepean River.

The modelling shows that all of the main sewers in the West Camden sewerage system have capacities of greater than four times peak dry weather flow (PDWF). That is, the system is able to transport up to four times the maximum flow normally encountered during dry weather. This is due to the system being designed and installed to cater for future expansion of the Camden area. The present capacity of the West Camden system is adequate to prevent the majority of wet weather overflows except during larger storm events. The capacities of the SPSs are shown in Table 2.4.

Table 2.4 SPS pumping capacity

SPS No.	Pumping capacity (L/s)	Peak dry weather flow, PDWF (L/s)	Capacity as multiple of PDWF	Location
120	185	48	3.9	Macquarie Grove, Camden
440	1225	201	6.1	Camden STP - off Shooters Lane, Camden
453	74	25	3.0	Brigalow Ave, Camden
484	335	110	3.0	Hume Hwy & Wilson Cres, Narellan
614	250	70	3.6	Hume Hwy, Narellan
673	53	13	4.1	Harrington Park,

Source: SWC, 1997

All of the SPSs in this system have a pumping capacity of three times PDWF or greater. SPS 440 is constrained by the capacity of the treatment plant it pumps to, although the pumping station itself is capable of pumping flows up to six times PDWF.

For the West Camden sewerage system, 13 of the most significant overflow points in terms of overflow frequency and volume were modelled using the MOUSE model. Of these, six overflow points were from the reticulation system and seven were designed overflow structures.

The wet weather sewerage system performance is defined by overflow events over a 10 year period (January 1985 to December 1994). During this period a total of 393 discrete rainfall events were run through the model to determine the frequency, volume and duration of overflows from the 13 modelled overflow points. All of these modelled overflows were predicted to discharge at least twice during the 10 year period, with 18 overflow events predicted to occur at the most frequently activated overflow. The number, duration and volume of events at each overflow location are shown in Table 2.5. Table 2.6 provides a summary of the yearly variation in overflow events. On average, about 5% of all rainfall events result in an overflow.

The most frequent and highest volume overflow is modelled node SPS 440, which pumps to the STP. The overflow discharges to an unnamed creek which flows into Matahil Creek. The total volume discharged from this overflow is approximately 31% of the total system discharge. The next most frequent overflow is CA2-01 which is an overflow on the western edge of Camden, also overflowing into Matahil Creek. The total volume discharged from this overflow is approximately 22% of the total system discharge. Therefore, these two overflows dominate the system performance in terms of the volume, producing a combined flow equal to 53% of the total wet weather overflows from the system upstream of the STP. The performance of the individual overflows is summarised in Figure 2.3. Three of the 18 overflow events contributed approximately 55% of the total overflow volume, which were generated by 3 of the largest storm events in the Sydney area over the last 83 years.

Table 2.5 Individual wet weather overflow summary as predicted by the 10 year time series modelling.

Location	Modelled overflow node	SWC asset No.	Type of overflow	No. of overflow events	Total duration (hrs)	Total volume (ML)
At Sewage Treatment Plant	SP440	SPS440	Design	18	439.0	173.8
Camden	CA2-01	-	Reticulation	17	319.5	122.1
Access chamber at 13 Sheathers Rd. Camden	CS3-01	SMCA2OF1	Design	17	337.5	77.4
Cawdor	CA2-07	-	Reticulation	17	258.0	66.5
Camden Valley Way, Smeaton Grange	EN1-01	SN614OF1	Design	12	128.5	17.5
Narellan	SP484A	SPS484	Reticulation	10	137.5	66.1
Camden Road, Camden	CS3-03	SMCS3OF1	Design	5	68.5	15.8
Macarthur Rd. Elderslie	EC11-05	SMEL3OF1	Design	5	41.5	6.5
Wilton & Richardson Rds. Narellan	RR3-04	SNRS403OF1	Reticulation	5	26.5	4.4
Clutha Park, Queens St. Narellan	RR3-02	SMRS4OF1	Design	5	34.0	4.0
59A Bligh Avenue. Belkinnie	CS3-06	SMCS3OF2	Design	4	25.0	8.5
Narellan Vale	HR-02	-	Reticulation	2	7.5	0.9
Narellan Vale	HR-01	-	Reticulation	2	7.0	0.6

Source: Time Series Model for Separate Sewer (UPS, 1997a)

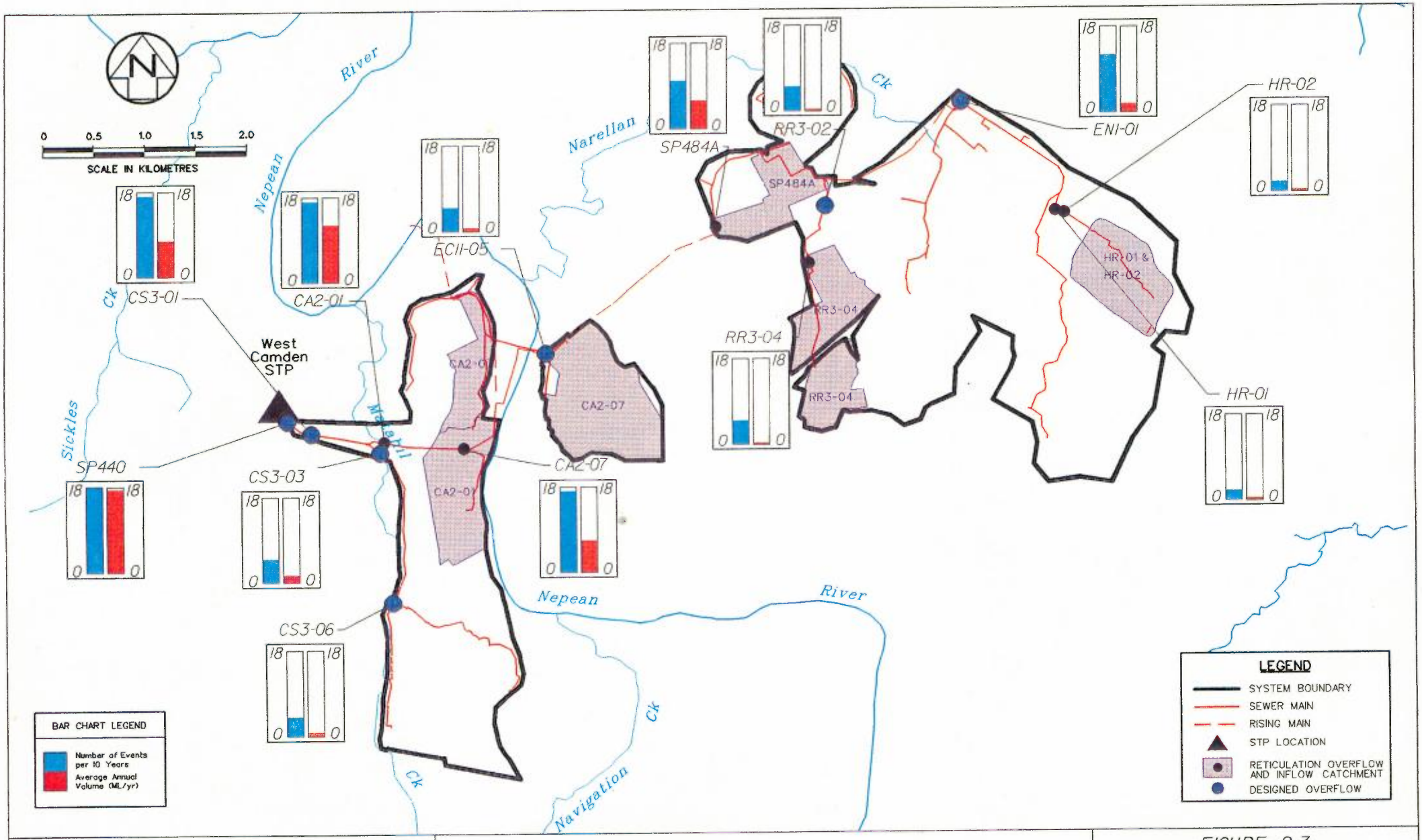

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FIGURE 2-3
SUMMARY OF MODELLED WET WEATHER OVERFLOW EVENTS

Table 2.6 Yearly wet weather overflow summary for the West Camden sewerage system

Year	No. of rainfall events	No. of overflow events	Total duration (Hrs)	Total volume (ML)
1985	39	0	0	0
1986	37	1	38	51.1
1987	44	2	46	63.4
1988	36	4	82	97.7
1989	44	2	28	16.9
1990	47	5	142	140.7
1991	34	2	71	138.4
1992	44	2	36	55.4
1993	47	0	0	0
1994	21	0	0	0
Total	**393**	**18**	**443**	**563.6**

Source: Time Series Model for Separate Sewer (UPS,1997a)

2.4.2 Partially treated STP discharges

West Camden STP receives a wide range of sewage flows depending on the local weather conditions. 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. At such times pathogens are the only pollutant types from overflows which significantly contribute to waterway pollution. Accordingly, a partially treated sewage treatment plant discharge is defined to be a sewerage overflow if its faecal coliform density exceeds 150 cfu per 100 millilitres because then the objective of maintaining recreational water quality criteria may be compromised. Disinfection to 150 cfu per 100 millilitres can be termed "full disinfection".

Sewage treatment plants are designed to receive flows from small storms and still treat and disinfect wastewater within the limits imposed by their discharge licences. Flows above these levels occur for about two to six per cent of the time, or about 8 to 20 days per year. Disinfection, as currently designed, is 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. Summary of the existing treatment levels for the Hornsby Heights STP is given in Table 2.7.

Table 2.7 Summary of existing treatment levels for West Camden STP.

Level of treatment	Flow able to receive level of treatment	Comments
Preliminary	71 ML/d	Limited by pumping station capacity.
Primary	60 ML/d	There is a bypass at the end of the primary treatment which operates above 30ML/d.
Secondary	30 ML/d	Limited by aeration tank capacity.
Tertiary	30 ML/d	Limited by secondary facilities; tertiary filters have capacity for 43 ML/d.
Disinfection	15.5 ML/d	Full flow will go through chlorination chamber although disinfection efficiency is reduced above 15.5 ML/d.

Source: Corporate Services, 1997.

As shown in Table 2.7, all flows up to 30 ML/d receive tertiary treatment, although only partial disinfection is achieved above 15.5 ML/d. The gauging and modelling data indicates that less than full treatment occurs approximately 70 times over 10 years, and a volume of 990 ML is discharged for 1150 hours over the 10 years. 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). This is four times more frequent and double the total discharge volume from the collection system over the same period. The capacity of the plant is currently limited by the disinfection. The capacity of the secondary and tertiary processes are not currently exceeded.

2.4.3 Choke-related overflows

Sydney Water records customer complaints of overflows relating to chokes in its RECOS database, which shows details of each job undertaken by SWC in repairing faults in the sewerage system. The number of chokes recorded in the RECOS database, has shown a steady and significant decrease over the past three years in the West Camden sewerage system, although there is uncertainty in the data because of the way chokes are recorded. The decrease can be at least partially attributed to Sydney Water's ongoing program of sewer inspection and rehabilitation. No data is available on the actual volume, duration or environmental impacts of discharges associated with sewer chokes. Many choke related overflows are small, only affecting the area directly near the overflow point and do not flow outside the immediate area. The duration of a choke is highly variable, and will depend on the nature and cause of the choke and the time taken to respond to and clear the choke. Since Sydney Water responds to chokes as a high priority, most chokes are cleared within a few hours of being reported, or at worst within a day.

Choke density

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.

Suburbs have been ranked in order of choke density on a system basis, and have then been grouped into one of three categories:

- suburbs with a high choke density (greater than 180 chokes per 100 kilometres of sewer)
- suburbs with a medium choke density (between 60 and 180 chokes per 100 kilometres of sewer)
- suburbs with a low choke density (less than 60 chokes per 100 kilometres of sewer).

The choke density in each suburb can be used in conjunction with other information to prioritise sub-catchments of the sewerage system for rehabilitation. Table 2.8 shows the choke density ranking and categories determined for each of the suburbs in the West Camden sewerage system. Figure 2.4 presents the data graphically for the West Camden sewerage system.

Table 2.8 West Camden choke density

Ranking	Suburb	Choke density
1	Camden	Medium
2	Elderslie	Medium
3	Camden South	Low
4	Narellan	Low
5	Narellan Vale	Low

Across all of Sydney's sewerage systems, 53% of sewered suburbs are considered to have a low choke density, 40% have a medium choke density and 7% have a high choke density. As can be seen from Table 2.8, 60% of the suburbs in the West Camden sewerage system have a low choke density and 40% have a medium choke density, which is comparable to the overall performance Sydney-wide.

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 proactive maintenance is required. In many cases, the sewer in which the repeat choke occurred will be added to the CCTV inspection program described in Section 2.2 above to identify the cause of the problem.

In 1996/97 nine repeat chokes were recorded in the West Camden sewerage system. These were generally caused by tree root intrusion into the sewers. Of the total chokes (single occurrence plus repeat chokes) found in the West Camden sewerage system, 98% are caused by tree root intrusion into the pipes. The timing and location of repeat chokes were random.

Dry weather overflows due to lack of capacity

All of the main sewers in the West Camden system have a capacity of greater than four times PDWF and all of the SPSs have capacities at least three times PDWF. There are therefore no dry weather overflows due to lack of design capacity in the sewerage system.

Siltation problems

Siltation occurs when pipe flow is much lower than the designed pipe capacity. Siltation can lead to septicity and odour problems when the solids have a long detention time in the pipes. It can also increase the volume of wet weather overflows by reducing the hydraulic capacity of the pipes, although siltation is often washed through during the initial flushing period. The modelling of trunkline siltation for the West Camden catchment shown in Figure 2.5 reveals that siltation problems are occurring in

many sections of the catchment and particularly in the upstream portions of the system. About one third of the main sewers in the West Camden system have definite siltation problems. These do not cause overflows as they are flushed out during wet weather. The modelling showed only a very small part of the system as having no siltation problems. However, System Management has advised that siltation is not a significant problem in the West Camden system. Further modelling may be required to verify the modelling results. However, if some areas are prone to siltation, it is likely that future development in the area will reduce the problem. Since West Camden is a developing area, pipe capacity is generally much higher than PDWF and when further development occurs, the increased flow will reduce the siltation problems (SWC, 1995a).

2.4.4 Exfiltration

The West Camden sewerage system was divided into six sub-catchments which have been classified as exfiltration, infiltration, acceptable or unknown sub-catchments. Sub-catchments with a classification of exfiltration or infiltration were then ranked for leakage likelihood. The method is described in the Methods document. Three sub-catchments (806000, 828001 and 828005) have been classified as potential exfiltration sub-catchments as shown on Figure 2.5, (Sewer Leakage Analysis Project, UPS, 1997b). The likelihood of exfiltration in the three sub-catchments was described as moderate. A further sub-catchment (928010) was classified as unknown, requiring further investigation including testing in local streams for faecal bacteria and checks on the gauging.

Areas with potential exfiltration problems may also be identified by undertaking further water quality monitoring. Median concentrations of faecal coliform bacteria in receiving waters in dry weather greater than 1000 cfu/100 mL, which can not be attributed to point source discharges including designed overflows or rural runoff, indicate that exfiltration of sewage into the receiving waters may be occurring (Water Board, 1994a). The existing water quality data is not sufficiently differentiated between wet and dry weather to form any conclusions.

Sydney Water does not monitor groundwater for faecal coliforms in the vicinity of sewer mains. However, some monitoring of receiving water zones is performed. At West Camden there has been no evidence of exfiltration problems and a monitoring program has not been established. Section 4.3 discusses the link between water quality monitoring results and exfiltration in more detail.

2.4.5 Overflows caused by SPS failures

The current detention times, telemetry, power supplies and back-up pumping of the six SPSs in the West Camden system are summarised in Table 2.9.

Table 2.9 SPS detention times, power supply and back-up pumps

SPS No.	Detention time (hrs) @ PDWF	Telemetry available	Alternative power supply	Back-up pump available
120	2.17	Yes	Twin feed from single source with generator connection	Yes
440	2.09	Yes	Twin feed from single source	Yes
453	3.45	Yes	Twin feed from single source	Yes
484	2.36	Yes	Twin feed from single source with generator connection	Yes
614	4.28	Yes	Twin feed from single source	Yes
673	8	Yes	Twin feed from single source with generator connection	Yes

Source: SPS risk reduction program (SWC, 1997)

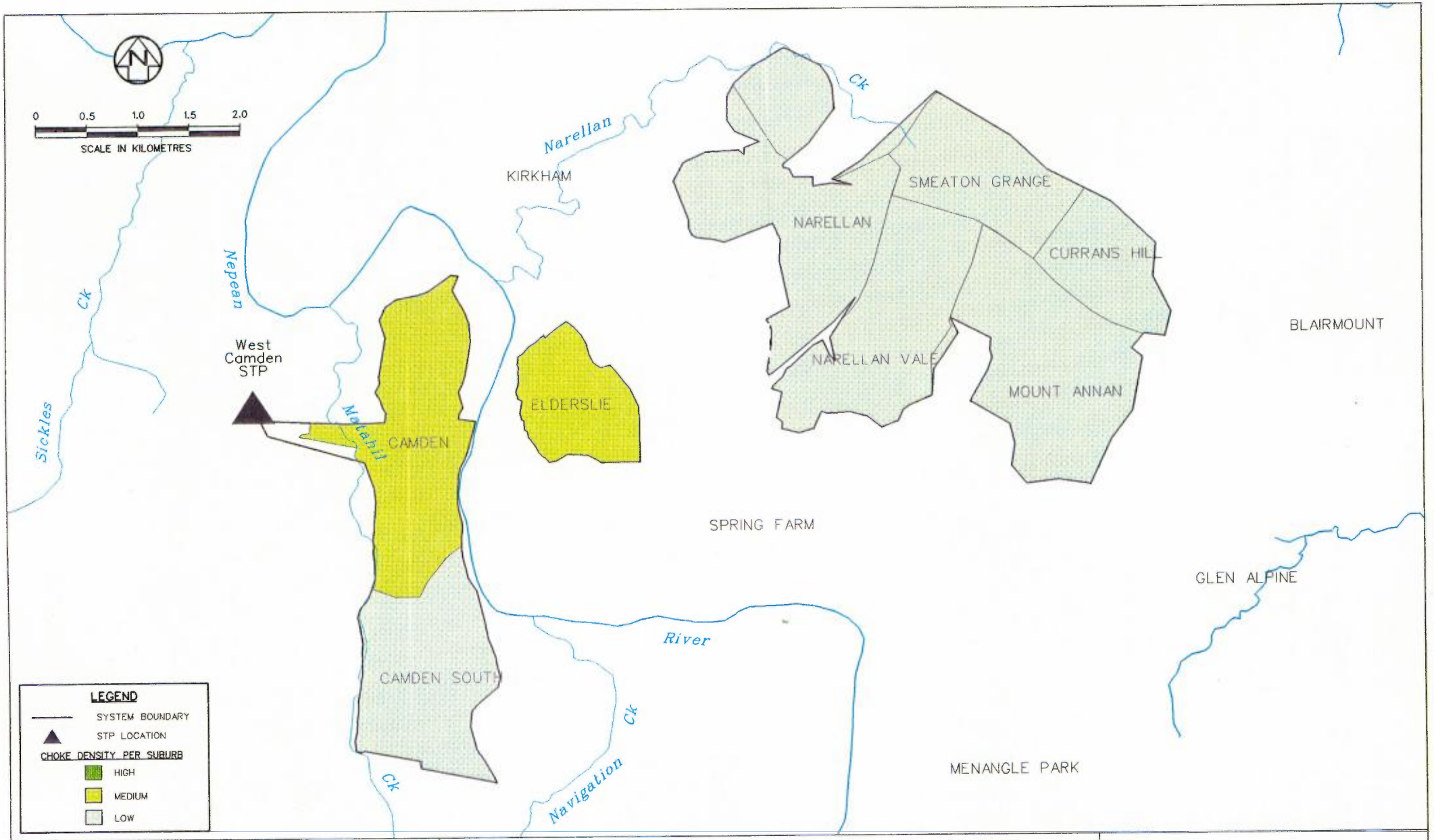

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FIGURE 2-4
CHOKE DENSITY

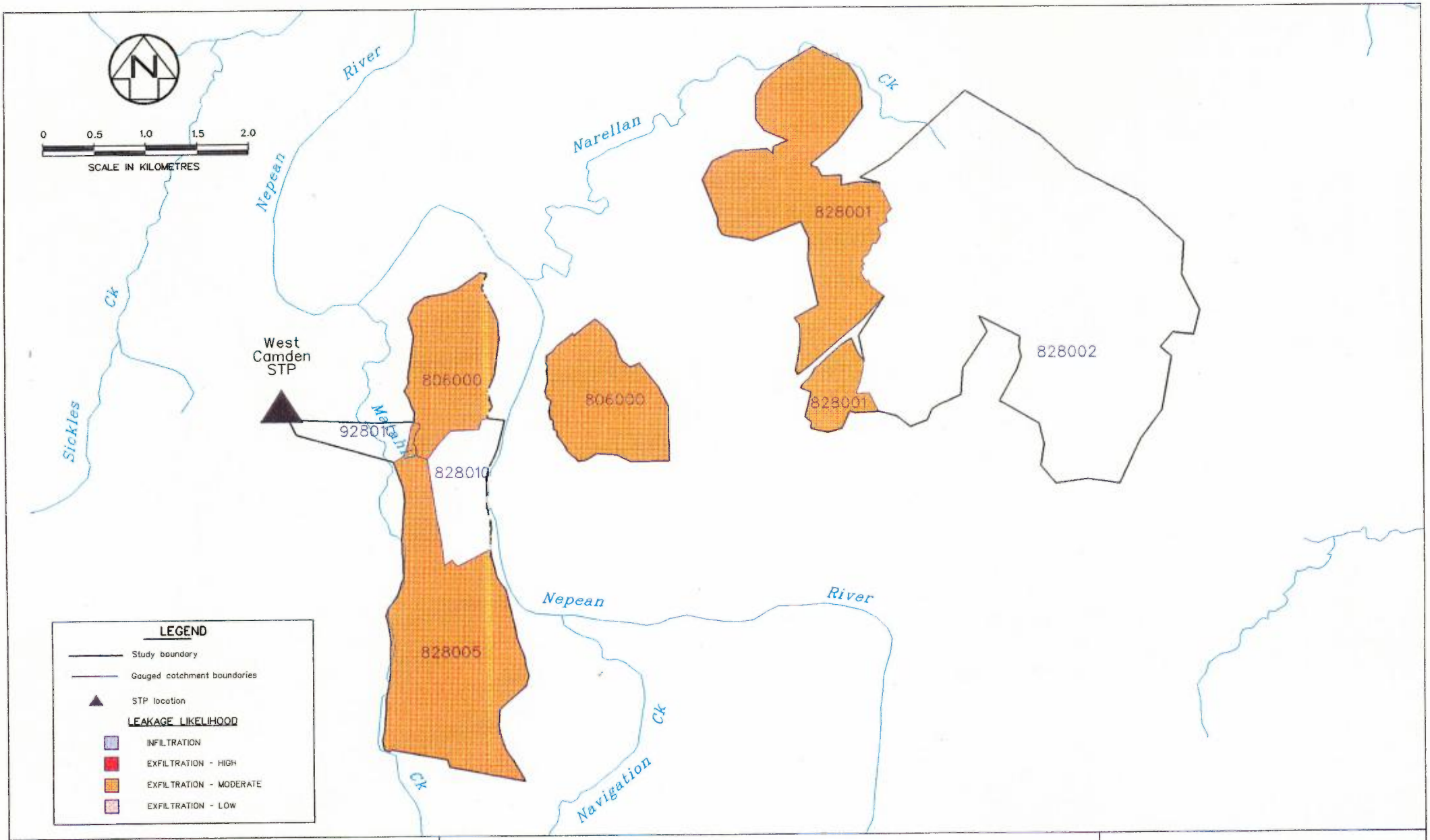

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FIGURE 2-5
POTENTIAL INFILTRATION/
EXFILTRATION AREAS

The adequacy of the detention time of an SPS depends on the time taken to respond to a failure. The detention time (time between SPS failure and the start of overflow from the SPS) may need to be increased, or the response time (expected time to respond to and rectify an average failure at an SPS) decreased to reduce the overflow potential. Based on the worst case scenario of a failure occurring at the peak dry weather flow, SPS 120, SPS 453 and SPS 484 have the highest risk of overflowing because their detention times are currently lower than their response times. The environmental effects of these SPS overflows are discussed in Chapter 3.

All SPSs in the West Camden system 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. IICATS (integrated instrumentation, control and telemetry system) is not connected to any of the West Camden SPSs as yet. The advantage of IICATS over telemetry is that remote control of the station can be undertaken through IICATS, whilst telemetry only allows data to be sent from the SPS and requires someone to go to the site to change the SPS operation. IICATS installation priority at present is for SPSs without telemetry, new SPSs and SPSs undergoing modifications. It is expected that all of West Camden's SPSs will be converted to IICATS over the next eight years. Three of the West Camden SPSs have remote terminal units fitted which allows the station to be turned on and off remotely, giving some control of the pumping. A remote terminal unit is a communications device that will be used at each SPS to "talk" to IICATS. They are progressively being placed in the SPSs to replace faulty telemetry and to prepare for IICATS connection.

All SPSs have two electrical power feeder systems (two different power supplies entering the SPS but from the same electrical sub station) for the pumping station but none have a dual power supply (a power supply from two different electrical sub stations). Three of the SPSs (SPS 120, 484 and 673) have a generator connection facility for emergency operation. Each SPS has a back up pump installed which will start automatically in the case that the normally operating pump fails.

During 1996/97 there were 30 component failures at five of the SPSs in the West Camden sewerage system. The cause of failures were:

- Electrical Faults 15
- Mechanical Faults 3
- Telemetry Failure 7
- Power Failure 1
- Other 4

The sewage treatment plant personnel indicated that data is not available for failures at SPS 440 which is located within the treatment plant grounds. Although the System Manager indicated that none of the 30 failures resulted in an overflow, the SPS ranking (See Appendix C, Volume 3) identified at least six SPS overflows in 1996/97.

2.4.6 Odour emissions

Sydney Water records odour complaints in its RECOS database. Six complaints were received in 1996/97 for the West Camden sewerage system, most of which occurred at private residences and emanated from sewer vents.

The main odour problem area in the West Camden sewerage system is from the Narellan Carrier which feeds SPS 484. This is located in the suburb of Narellan which is in the top 50 suburbs of Sydney in terms of the number of odour complaints. This odour problem is due to septic sewage being pumped from SPS 614. SPS 614 and its rising main were designed for a higher flow than is currently entering the

station which results in long detention times. This in turn generates high levels of hydrogen sulphide. In the long term, the increase in flow due to development of the catchment which will increase flows to the design flows and eliminate the problem of long detention times causing septicity in the sewage. The short term solution is to dose sewage at SPS 614 with an odour control chemical ("Odourlock") which will prevent the formation of hydrogen sulphide. Trials of alternative chemicals have been conducted and the dosing is currently being implemented.

The second major odour problem is from the treatment plant which is being addressed by treatment plant staff.

The other suburbs in the West Camden sewerage system have low levels of odour complaints and therefore do not require action to overcome odour issues.

2.5 Existing overflow management practices

Management practices used in the West Camden system are similar to those used in other sewerage systems operated by Sydney Water, as described in Chapter 2, Volume 1.

A gauging program has recently been initiated in critical locations in the West Camden sewerage system to determine actual flows. The three month program will run over the summer and aims to include a representative number of wet weather events. Some gauging was done in 1996 to determine the best points for ongoing monitoring.

Data loggers have been connected to each of the SPSs in the West Camden system to record data on capacity and flow rates. The information will be used to adjust the operation of the stations and to predict future problems. The System Manager reports that regular wet weather overflows and siltation problems are occurring in the carrier directly before SPS 440 which is located in the STP grounds. The data from SPS 440 will be analysed to see if a change in the operating mode will reduce overflows and siltation. However, the SPS operation is important to the treatment plant operation as it is used to smooth out the peaks in flow and improve treatment performance. Changing the pumping characteristics may adversely affect the operation of the treatment plant and the best outcome for these conflicting requirements will have to be determined.

Corrosion in the Camden submain is being monitored and will be repaired in the medium to long-term (five years or more). The "Repeat Customers Issues" process developed and used throughout the Greater Western region of Sydney Water has led to a focus on those customer complaints which can lead to the greatest improvement in service.

2.6 Effects of growth

As the population of the West Camden sewerage system catchment increases, the frequency and volume of wet weather overflows will eventually increase in the long term if no abatement measures are implemented. This effect will be delayed in most areas of the West Camden system as the sewers are currently operating well below their design capacities due to being designed for ultimate development in the area. The exception are SPSs 440, 484 and 614 and the last kilometre of the submain flowing to the STP which will require upgrading to handle future flows.

The West Camden system is one of the more dynamic systems where urban growth is likely to have a significant impact on population growth. This system contains the established townships of Camden and Narellan. Incremental new and infill development is occurring in both areas but at a relatively slow rate. The system encompasses a portion of the rapidly growing south west sector of Sydney and contains several major urban release areas including the older areas of Elderslie, Narellan and Harrington Park and the future release areas of Harrington Park, Currans Hill, Mount Annan, Narellan, East Narellan, Spring Farm and Elderslie. Progressive development of these areas has been occurring since 1984. Whilst the principal development is residential there is also retail, commercial and

industrial development on a small scale. This system is expected to continue to service steady growth over at least the next 20 years.

The population estimates demonstrate a strong growth pattern up to 2011 as release areas are fully developed. The slight gradual decrease following 2011 is as a result of reduced occupancy rates for the developed areas as the population ages and fewer children remain at home.

Table 2.10 presents the population and wastewater flow projections for the West Camden system used as the basis for system modelling, starting in 1994. Most of the projected growth is within new release areas.

Table 2.10 Population and ADWF projections for West Camden sewerage system

Year	Population	ADWF
1994	21,500	4.8 ML/d
2021	101,200	22.9 ML/d

Source: UPS (1997c)

Growth of the system may increase the area subject to potential overflow impacts. There are a number of waterways, particularly in the zone west of Camden along Burragorang Road, which are not currently impacted by overflows, or other sewage discharges, but may be impacted in the future. These waterways include Spring Creek, Sickles Creek, Mt Hunter Rivulet, Splitters Gully, Tabers Creek and Flaggy Creek. Extension of the sewerage system to these new areas will be subject to ongoing environmental assessment processes to minimise environmental impacts.

2.7 Summary of system performance

Table 2.11 provides a summary of the West Camden overflow performance and includes the highest ranking overflows for each category. The overflow ranking methodology and results are discussed in detail at the end of Chapter 3.

Table 2.11 Summary of the West Camden sewerage system overflow performance

Overflow category	Parameter	Performance
Wet weather modelled overflows (existing conditions)	% rainfall events resulting in wet weather overflows	5 %
	% inflow catchment with rainfall ingress > 10%	49%
	No. of modelled overflow events in 10 yrs	18
	Total no. of modelled overflows (designed and reticulation) activated in 10 yrs	13
	Modelled overflow volume over 10 yrs	564 ML
	Most frequently activated designed overflow node (frequency)	SPS 440 (18 events /10 yrs)
	Most frequently activated reticulation overflow node (frequency)	CA2-01 (17 events/10 yrs)
	Number of modelled overflows discharging to sensitive areas in 10 yrs	3
	Highest risk ranked designed overflow (against all Sydney-wide)	EN1-01 and SP440
	Highest risk ranked reticulation overflow (against all Sydney-wide)	CA2-01
	Number of STPs in geographic area	2
	Number and proportion of infiltration sub-catchments (from I/E modelling)	None (0%)
Partially treated STP discharges	Frequency of most frequent untreated or partially treated STP bypass in 10 yrs	70
	Volume of partially treated STP discharges per 10 yrs	990 ML
	Total number of partially treated STP discharges in 10 yrs	70
Surcharges (chokes and dry weather overflows)	Number and proportion of suburbs with high choke density	None (0%)
	Number and proportion of suburbs with medium choke density	2 (40%)
	Number and proportion of suburbs with low choke density	3 (60%)
	% properties not affected by surcharges	99.37%
	Any trunk sewer capacity < 2 ×PDWF (Yes/No)	No
	Number and proportion of SPSs with pump capacity < 2 × PDWF	0 (0%)
	Number and proportion of SPSs with pump capacity 2-4 × PDWF	5 (83%)
	Number and proportion of SPSs with pump capacity > 4 times PDWF	1 (17%)
SPS Failures	Total number of overflows from SPSs (96/97) as a result of SPS failures	At least 6
	No. of SPSs with detention time less than response time	3
	No. SPSs without telemetry/ alternative power supply/standby pumps	0/2/0
	Highest ranked SPS	SPS 120
Exfiltration	Number and proportion of potential 'high' exfiltration sub-catchments	none (0%)
	Number and proportion of potential 'moderate' exfiltration sub-catchments	3 (50%)
	Number and proportion of potential 'low' exfiltration sub-catchments	none (0%)
	Number and proportion of sub-catchments where exfiltration is unknown	1 (17%)
Odours	Total number of odour events leading to complaints (1996/97)	6
	Asset with highest number of odour complaints	Narellan Carrier

In summary, the main overflow problems in the West Camden system are partially treated STP discharges, wet weather overflows from four of the modelled overflows, particularly EN1-01 and SPS 440, and medium levels of exfiltration from a large part of the system. Chokes and odours are not a major problem in this system, except for odours caused by septicity in the Narellan Carrier.

Chapter 3

Environmental Impacts of Overflows

Synopsis of Chapter 3

This chapter shows how system performance described in Chapter 2 may affect the environment. The environmental assessment is focused primarily on issues that affect 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 of this kind which may be incurred by the implementation of overflow control options will be considered in the second stage EIA documents prior to any construction.

The assessment of overflow impacts has been carried out in consideration of environmental objectives recommended by Catchment Management Committees (CMCs) and Community Reference Groups. The Upper Nepean CMC (UNCMC) has divided the Upper Nepean catchment into five zones, each with specific environmental objectives and preferred waterways uses. These objectives include water quality safe for swimming in most waterways in the Upper Nepean River REZ, except for Narellan Creek Urban Zone, where protection of aquatic ecosystems, visual amenity and secondary recreation are desired.

The impacts on the aquatic environment of overflows from the West Camden sewerage system are localised and minor in extent. Three sensitive areas which may be impacted by overflows have been identified, namely the Nepean River corridor at Camden, the Narellan Creek corridor and Wetland No. 159 at Camden. The Nepean River corridor from Macarthur Bridge to Cowpastures Bridge in Camden is impacted by overflows located at several sites near the bank. As this area is used extensively for swimming during the warmer months, overflows may cause localised impacts on the suitability of this area for this activity. Overflows into Narellan Creek in the Smeaton Grange area may cause increases in nutrients that promote and sustain weed infestations of remnant River-flat Forest that adjoins the Creek in this area. Wetland No. 159, which is listed under SEPP 14 as a legally protected wetland, contains sensitive aquatic ecosystems and habitats which may be adversely affected by nutrient loads in sewerage overflows.

A small improvement in the recreational suitability of the Nepean River (in terms of faecal coliform levels) would be achieved if all wet weather overflows were eliminated. However, improvements in the percentage of time meeting ecosystem protection guidelines will be minor, as overflows are not a significant source of nutrient loads in the Upper Nepean River REZ. Nutrient loads in dry weather are mainly influenced by dry weather discharges from West Camden STP, while stormwater runoff exerts the greatest influence on water quality during wet weather. Dry weather water quality deterioration which may be associated with exfiltration has been observed in the West Camden system.

The terrestrial impacts of overflows are minor as most wet weather overflows discharge directly to waterways. The main terrestrial impacts are local impacts associated with dry weather overflows or potential impacts from weed infestation of riparian areas. Socio-economic impacts of overflows are also relatively minor, and are mainly associated with loss of recreational and visual amenity of the waterways.

Overflows from nodes in the West Camden sewerage system generally have a low ranking compared to other overflows across Sydney. Wet weather overflow abatement in West Camden therefore has a relatively low priority compared to other systems across Sydney. However, overflows from SPSs in the event of SPS failures had a moderately high Sydney-wide ranking, and should be given priority for remediation in the West Camden system. Exfiltration also appears to be a locally significant problem in the West Camden system.

3. Environmental impacts of overflows

Overflows from the West Camden sewerage system drain to the Upper Nepean River Receiving Environment Zone (REZ) which is within the Upper Nepean Geographic Area (GA). The location of the West Camden sewerage system within the Upper Nepean River REZ is shown in Figure 3.1.

The impacts of overflows within the Upper Nepean River REZ are described in Volume 2 of this EIS. This volume identifies the key impacts of sewerage overflows within the Upper Nepean River REZ, and defines the relative contribution of overflows from the West Camden sewerage system.

3.1 The sewerage system catchment and receiving environment

The area served by the West Camden sewerage system covers an area of approximately 645 hectares (compared with a total of 42,000 hectares for the Upper Nepean River REZ). The system serves the township of Camden and surrounding suburbs of Camden South, Harrington Park, Narellan, Narellan East, Narellan Vale, Mount Annan, Elderslie and Currans Hill. The main water courses which drain from the West Camden sewerage system catchment are the upper Nepean River and tributaries including Matahil Creek, Narellan Creek and Navigation Creek). West Camden STP discharges into Matahil Creek, which is a tributary of the Nepean River.

Overflows from the West Camden sewerage system may potentially impact on the Nepean River and a number of creeks in the Camden area. During wet weather, impacts can include partially treated STP discharges, discharges from designed overflow structures, overflows at SPSs and surcharges from unintended overflows at West Camden sewerage system. During dry weather, overflows from the sewerage system can occur as a result of operational failure such as restrictions to wastewater flow or chokes.

The value of each of the waterways within the catchment for recreational, agricultural, educational uses and as aquatic habitat is dependent upon the depth of water, accessibility, cleanliness, velocity of flow and adjacent landuses. In terms of the impact of an overflow and overflow points, it is generally water quality which is most affected. Odour may also be a problem, particularly in dry weather. These waterways have the potential to provide recreational and educational opportunities such as fishing, swimming, canoeing, kayaking, bird watching, irrigation (rural activities), provision of a scenic feature within recreational areas and provision of wildlife habitats. The Upper Nepean Catchment Management Committee (CMC) has divided the catchment into five zones and developed objectives for waterway use in each of these zones. These objectives include water quality suitable for swimming in most waterways in the Upper Nepean River REZ, except for Narellan Creek Urban Zone, where protection of aquatic ecosystems, visual amenity and secondary recreation are desired. The objectives developed by the Upper Nepean CMC have been considered in developing management strategies and water quality objectives.

3.2 Sewerage overflow impacts

A full description of existing conditions and overflow impacts within the Upper Nepean River REZ is provided in Volume 2 of this EIS. The key impacts, and the relative contribution of West Camden sewerage 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. The methods by which environmental impacts were identified, and the limitations of these methods, are discussed in the Methods document.

3.2.1 The extent of the overflow problem

Problems relating to SPS failures, exfiltration, and odours in the West Camden sewerage system catchment appear to be relatively minor, with chokes representing the most common cause of system

failure related overflows. The choke-related overflow volume likely to reach receiving waters is relatively low however, and adverse effects are likely to be limited to localised impacts in the vicinity of discharge points. Three sub-catchments within the West Camden sewerage system (806000, 828001, 828005) have been identified as having a moderate likelihood of exfiltration problems. Further assessment of exfiltration is required to confirm the extent of the problem and associated impacts.

The West Camden sewerage system provides all of the wet weather sewerage overflows discharging into the Upper Nepean River. However, the River flows through large areas of farmland, National Parks and open countryside. Therefore the rate of dilution of overflows by non-urban stormwater from these areas will be high, resulting in minimal impact to the river from West Camden overflows.

The overflow with the largest overflow volume and highest activation frequency is designed overflow structure SP440 located at the pumping station which pumps to the sewage treatment plant. The overflow discharges to an unnamed creek which flows into Matahil Creek. Overflows from this structure are predicted to occur 18 times in an average 10 year period (based on long term rainfall data). The total volume discharged from this overflow is approximately 31% of the total system discharge. The overflow with the next highest activation frequency is the reticulation node CA2-01 which is on the western edge of Camden and also overflows into Matahil Creek. Overflows from this reticulation area are predicted to occur 17 times in an average 10 year period (based on long term rainfall data). The total volume discharged from this overflow is approximately 22% of the total system discharge. Therefore, these two overflows dominate the system performance in terms of volume, producing a combined flow equal to 53% of the total liquid overflows from the system.

The main odour problem area in the West Camden sewerage system is from the Narellan Carrier which feeds SPS 484. This odour problem has been long standing and is due to septic sewage being pumped from SPS 614. The solutions to this odour problem are twofold, being short-term and long-term. The long-term solution will be the increase in flow due to development of the catchment which will increase flows to meet design flows. The short-term solution will be to dose an odour control chemical at SPS 614 to prevent the formation of hydrogen sulphide. Trials of chemicals have been conducted and the short-term solution is currently being implemented.

The West Camden sewerage system is one of the more dynamic systems where urban growth is likely to have a significant impact on population growth. As the population of the West Camden sewerage system catchment increases, the frequency and volume of wet weather overflows will eventually increase if no abatement measures are implemented. This effect will be delayed in many areas as the sewers are currently operating well below their capacities since they were designed for ultimate development in the area.

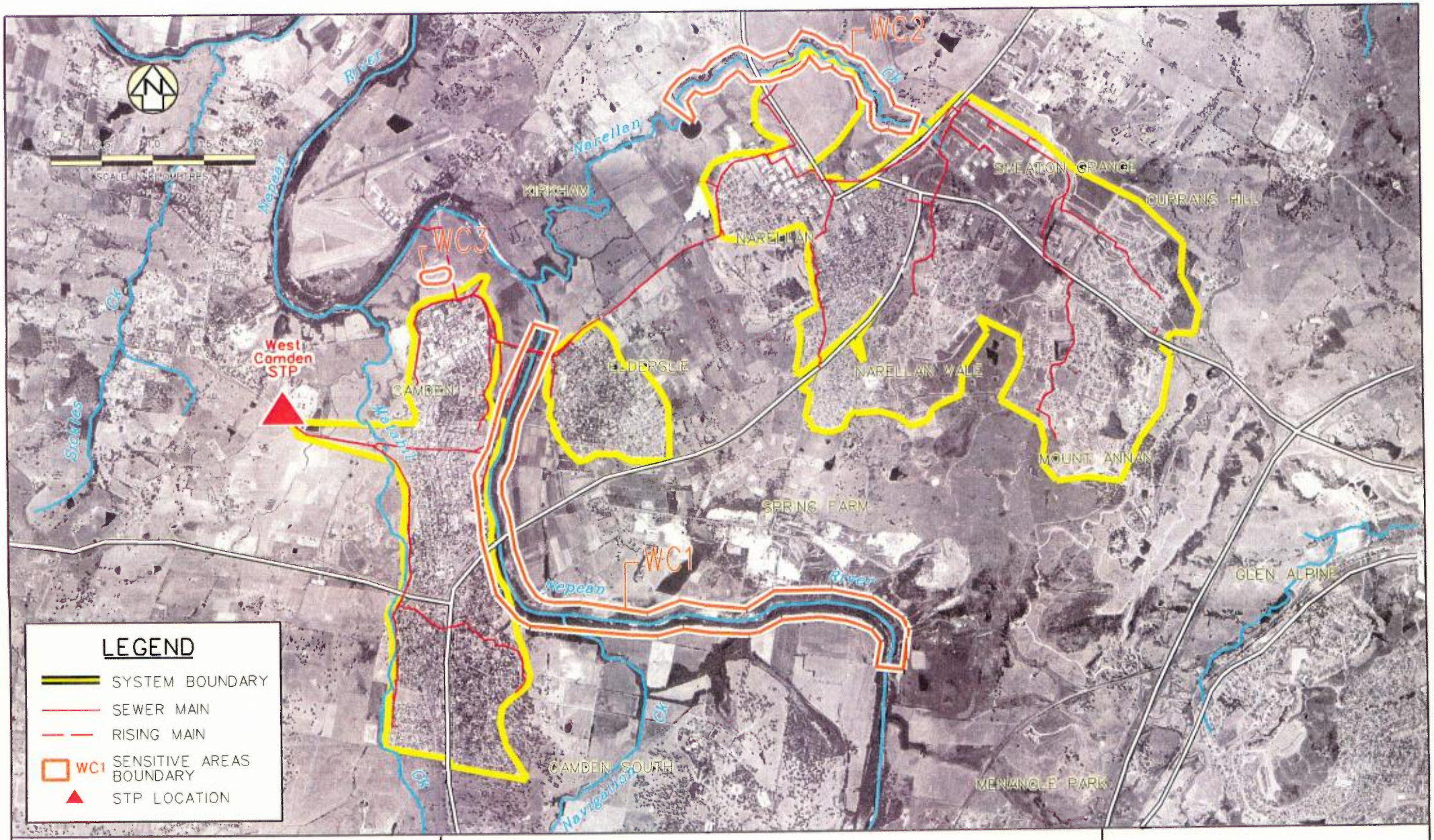
The majority of overflows from the West Camden sewerage system either discharge directly or drain to aquatic environments. Some flow across fields and then into the aquatic environment. Sewerage overflows are therefore likely to mainly impact aquatic ecosystems and human waterway uses close to the source of the overflow.

The impacts of individual overflows are considered in detail in Section 3.3 (Overflow Ranking).

3.2.2 Impacts on the aquatic environment

The *Clean Waters Act,* 1970, makes provision for the classification of waters in NSW. The Nepean River is classified as Class P (Protected Waters) from its confluence with the Warragamba River upstream to Sharpes Weir (downstream of Camden), and then upstream of Bergins Weir (upstream of Camden) to the boundary of the Sydney Water protected water catchment area at Pheasants Nest Weir.

The waters and tributaries of the Nepean River between Bergins Weir and Sharpes Weir, including the Municipality of Camden, are Class C (Controlled Waters). Figure 3.1 in Volume 2 shows the boundaries of the classification of waterways presently in place on the Nepean River. The impacts on sensitive areas is discussed in Section 3.2.5.



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SEWERAGE OVERFLOWS LICENSING PROJECT
WEST CAMDEN SEWERAGE SYSTEM

FIGURE 3-1
SENSITIVE AREAS

The West Camden system overflows could impact most on streams unaffected by effluent discharge, i.e., on upper sections of Matahil Creek as well as Narellan and Navigation Creeks. Limited monitoring data is only available for Matahil Creek, upstream and downstream of West Camden STP, Lake Annan (in the headwaters of the Narellan Creek system) and Narellan Creek.

To assist with the assessment of overflow impacts, water quality modelling was performed to determine the contribution of overflows to receiving water nutrient loads, and the effect of overflows on the achievement of water quality objectives. Water quality modelling results indicated that sewerage overflows in wet weather make an insignificant contribution to the degradation of water quality in the Upper Nepean River REZ (see Volume 2), although there was some contribution indicated for faecal coliforms below Matahil Creek, presumably largely as a result of partially treated STP discharges. The contribution of West Camden sewerage system overflows to receiving water quality, and the effect of these overflows on the achievement of water quality objectives, is discussed in the following sections.

Modelling undertaken by Sydney Water indicates that it is presently safe to boat on the Nepean River 96% of the time, and that this would only improve slightly with wet weather overflow abatement. By comparison, urban runoff abatement would increase safe boating time to 99%. This analysis is based on the ANZECC (1992) faecal coliform limit of 1000 cfu/100mL. In addition, proposed management strategies for overflow abatement would not improve the proportion of time the Nepean River at West Camden is considered suitable for swimming (currently at 75%), as the principal source of faecal coliform pollution is diffuse runoff. However, the reduction in dry weather overflows to smaller tributaries will improve the amenity of these areas.

Contribution of overflows to receiving water nutrient loads

The major contributors to the Upper Nepean River REZ nutrient loads appear to be dry weather STP effluent and diffuse runoff. Water quality modelling indicates that the wet weather overflow volume from West Camden sewerage system contributes 0.5 per cent of total nitrogen load and approximately 1.0 per cent of total phosphorus loads to the Upper Nepean GA (Volume 2). This represents 0.96 tonnes per year of nitrogen and 0.23 tonnes per year of phosphorus.

Effect of overflows on water quality

Water quality objectives are discussed in Volume 2. Modelling indicates that although there would be a minor decrease in pollutant concentrations in the Nepean River if all wet weather overflows and wet weather STP discharges were removed, there would be little or no improvement in the percentage of time that nutrient concentrations comply with criteria for the protection of aquatic ecosystems. The model indicated that there would be a small improvement in the percentage of time that faecal coliform concentrations meet the guideline. In the Nepean River below Matahil Creek, the number of days suitable for swimming would increase from 313 to 323 if all overflows were eliminated. Seven days suitable for boating would also be gained. Similarly, in the Nepean River at Wallacia, the number of days where criteria for swimming are predicted to be met increases from 296 to 297 per year and days suitable for boating improves from 345 to 346 per year.

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 wet weather 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 events at individual overflow points.

Actual monitoring data is available for Matahil Creek upstream of West Camden STP (AWT, 1997), and gives some indication of overflow contribution as well as catchment runoff impact from the areas of Cawdor, South Camden and Camden. This data met ANZECC guidelines for phosphorus but some exceedence of nitrogen criteria, which may relate to sewerage overflows, was observed. However, there was no other evidence of sewerage overflow in wet or dry weather, such as high ammonia, filtrable phosphorus or high faecal coliform levels.

Narellan Creek monitoring by Camden Council in 1995/1996 showed impacts which may be related to overflows. Approximately 80% of samples complied with ANZECC guidelines for nutrients. Dissolved oxygen data for Narellan Creek were regularly below ecosystem protection guidelines. Approximately 70% of samples taken in Narellan Creek in 1995/1996 complied with primary contact criteria for the pathogen indicators faecal coliforms and enterococci. A recreational survey (HNCMT/DLWC, 1997) also showed that criteria for swimming were being met in only 10% of samples from Lake Annan in the Narellan Creek system. At all sites except Cobbity Bridge, the mean faecal coliform concentrations have increased since 1992, suggesting that sources other than STP effluent are contributing to this bacterial contamination.

The water quality modelling data provides no information on the impacts of overflows caused by system failures including chokes, SPS failures and exfiltration. The occurrence and associated impacts of exfiltration require further investigation, since discharge volumes and associated pollutant pathways are currently unknown. Available water quality data suggests that exfiltration may potentially impact on water quality since dry weather faecal coliforms concentrations have measurably increased since 1992 at Macquarie Road Bridge, immediately downstream of the confluence of the Nepean River and Narellan Creek. The exfiltration problems may lie within new housing estates in the catchment of Narellan Creek. This problem requires further investigation to clarify the cause of the elevated faecal coliforms.

Ecological and human health risk assessment

There was little data available for aquatic sediments, aquatic flora or aquatic fauna within the West Camden catchment. The risks to aquatic life and human health were investigated through Sydney Water's Ecological and Human Health Risk Assessment (ERA) study discussed below.

An ERA 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 GA in order to evaluate the potential impacts of toxicants from wet weather sewerage overflows and to evaluate benefits of overflow abatement. One site was evaluated as representative of the West Camden sewerage system. Full details of the ERA are provided in Appendix C (Volume 2).

This site representing the West Camden sewerage system is located in the Nepean River at the junction with Matahil Creek. The Nepean River is approximately 25m wide at this location with steep banks and sandy/gravel bed deposits. West Camden STP discharges into Matahil Creek. Sewerage overflows also discharge from urban areas into Matahil creek, the Nepean River and other tributaries such as Narellan Creek. Some places in the Nepean River are used for fishing and swimming.

The risk evaluation showed that there is only minimal potential risk to aquatic life from sewerage overflows. However, a potential risk to aquatic life from exposure to chemicals in stormwater and STP discharges was identified. The dilution modelling identified 16 chemicals of potential concern (COPCs) associated with chronic exposures and nine COPCs for acute exposures (refer to Appendix C, Volume 2). Overall, the analysis indicated the majority of the potential risks are from exposures to stormwater. However, a few COPCs (i.e., ammonia, cadmium and chloroform) appear to be associated with STP discharges. The detailed risk assessment for Hawkesbury-Nepean STPs (SWC, 1996) did not, however, identify these three chemicals as COPCs from West Camden STP.

The risk evaluation found no potential risk to aquatic life from the stress of suspended particles brought in by sewerage overflow, stormwater, or STP discharges. Low dissolved oxygen concentrations have been measured twice downstream of this site following wet weather events. However, sewerage overflows are relatively infrequent and long-term impacts to the aquatic community from low dissolved oxygen would not be expected. Localised scouring of benthic habitat from overflows is possible at this site, but this scour is likely to be minor in comparison to scour caused by stormwater. Substantial sedimentation from overflows is not likely to occur at this site due to periodic high flows of stormwater, which tend to remove sediment. Therefore, sedimentation risks are not likely from overflows.

The analysis of existing conditions indicates that overflows make a negligible contribution to the potential risk to aquatic life and human health. There are potential risks from stormwater and STP discharges, however, higher overflow abatement standards above the current system performance would not appear to change this level of potential risk.

Effect of flooding on sewerage system operation and overflows

Within the West Camden sewerage system some of the sewerage mains in the catchment and SPS 120 are prone to inundation during flooding. A sewer main and SPS 120 are located near Wetland 159 (listed under SEPP 14). During a flood event, the impact of inundation of the system on this wetland and other sensitive areas is unknown as no studies to date have examined this problem. During floods, large concentrations of nutrients are flushed down the Nepean River and its tributaries and transported downstream. The impacts from inundation and overflows of the system need to be offset against the dilution and dispersion effects that occur during flood events.

Eight of the twenty-one designed overflows in the West Camden sewerage system are located at or below the 1 in 100 year flood level including CS3A 0002, SFCS3A 0003, SFCA2A 0001, SFCE1A 0001, SFNV1A 0003, SFCS3A 000A, SFEL3A 0002 and SFCA2A 0002.

Designed overflows discharge a very small volume relative to flows from stormwater runoff and STP effluent and would have a negligible impact on the hydrology or flooding of the Nepean River and associated tributaries. Flooding may have an impact on the rate of sewerage overflow. If an overflow event occurs concurrently with a flood event, and the overflow discharge is below the flood level, the discharge of sewage from the overflow may be reduced or stopped. If the overflow discharge rate is significantly reduced, overflows upstream of the restricted overflow are more likely to occur.

Backflow of stormwater into the sewers via designed overflows is possible under flood conditions. Designed overflows prone to this problem usually have a backflow prevention valve installed to prevent backflow occurring. These backflow prevention valves require maintenance to ensure their correct operation.

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).

3.2.3 Impacts on the terrestrial environment

Little data is available to assess the impacts of overflows on terrestrial ecosystems within the West Camden sewerage system (see Volume 2).

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 effects are likely to be localised, however, and the impacted areas are likely to be small in comparison to the 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 West Camden catchment than those caused by sewerage overflows.

3.2.4 Impacts on the socio-economic environment

Sewerage overflows may affect socio-economic environments through direct exposure of human populations to overflow discharges, or indirectly through their adverse effects on the biophysical environment. The main impacts on socio-economic environments in the Upper Nepean River REZ were identified in Volume 2 and included:

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 and
4. potential impacts on community amenity as a result of odour discharges.

Risks to human health

Risks from exposure to toxicants in sewerage overflows were investigated as part of the ERA study. The risk evaluation found no human health risks from the incidental ingestion of water while swimming or wading in the river. However, seven COPCs were identified as posing potential carcinogenic risk and four for non-cancer risks to people who might catch and eat fish from the Nepean River downstream of West Camden STP. This result assumes people eat approximately nine meals per month of fish from this area (SWC, 1996) over a period of thirty years. The evaluation indicated that stormwater is responsible for most of the potential risk to human health. The COPCs included organochlorine compounds (e.g., dieldrin) that have been banned for use in Australia, a few polycyclic aromatic hydrocarbons and three metals (lead, manganese and mercury).

Recreational suitability of the waterways was also investigated via the faecal coliform modelling described above. In summary, the results of this modelling indicated that although overflows contributed to faecal coliform pollution in Nepean River, their contribution was moderate relative to other sources, such as stormwater runoff. The modelling also indicated that removal of all wet weather overflows and partially treated STP discharges from catchment inputs would only improve the number of days per year meeting water quality criteria for swimming from 296 to 297 and the number of days per year meeting boating criteria from 345 to 346, indicating that overflows and partially treated STP discharges are not major contributors to poor water quality.

As discussed above, the monitoring data in the Nepean River, particularly downstream of Narellan Creek, suggests that urban runoff (possibly including sewerage overflows) have increased faecal coliforms in the River. Similarly the failure of water quality in both Lake Annan and Narellan Creek to meet guidelines for swimming and boating may also reflect contributions from sewerage overflows. The poor water quality may also be a result of local fauna, including duck populations.

It is recognised that localised bacteriological impacts on waterways may occur, particularly immediately following a wet weather overflow event, or in the event of sewage reaching waterways as a result of a choke, SPS failure or exfiltration.

Impacts on recreational values

Impacts on waterbased recreational values are related largely to human health risks from faecal contamination. Nutrient pollution may also decrease the recreational value of a water body through promotion of nuisance plant and algal growths and eutrophication.

The results of water quality modelling indicate that the effects of overflows from the West Camden sewerage system on both water-based recreational values and the potential for eutrophication in the Nepean River, are minor. Other factors such as stormwater runoff, STP discharges, degradation of riparian environments through urban catchment development, poor river access and shallow water levels are likely to have far greater adverse impacts on the recreational value of the Nepean River. It is considered however, that overflows may contribute to temporary localised reductions in bacteriological water quality and recreation potential in the immediate vicinity of discharge points. As discussed previously, overflow control strategies must therefore consider the total number of overflow events.

The impacts of overflows from the West Camden system on terrestrial recreational values are considered to be minor as the majority of overflows drain to waterways. Localised impacts may occur however as a result of odour emissions or temporary reduction in the water quality of adjacent creek lines.

Impacts on visual amenity of waterways and terrestrial areas

Sewer overflows may impair the visual quality of the environment by depositing debris and solids within areas frequented by humans such as residential areas, recreation reserves, waterways and tourist sites. They may also impair the visual quality of the environment indirectly by contributing to weed infestation or algal growth around outlet points. The visual impacts of overflows are generally localised.

Impacts on community amenity as a result of odours

There is very little data available concerning the strength of odour emissions from sewerage overflows but odour complaints received by Sydney Water provide an indication of the impact of odours on community amenity within sewerage system catchments.

There have been five complaints about sewer odours in the Narellan catchment area in 1996/97. As far as can be determined from existing information, the source of the impact in the Narellan submain appears to be the septicity of sewage from SPS614 which is related to a low flow rate. Odorous emissions do not appear to be associated particularly with liquid overflows but with gaseous odour escaping from the system. No other significant odours have been recorded for the West Camden area.

3.2.5 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.

Sensitive areas which have the potential to be impacted by overflows from the West Camden sewerage system are summarised in Table 3.1 below. Each sensitive area has been assigned an identification code within the table (e.g. WC1). The table describes the nature of the sensitivity and the potential impacts on the sensitive area. The locations of sensitive areas are shown in Figure 3.1. Sensitive areas are discussed in more detail in Volume 2.

The Nepean River corridor (WC1) contains important remnant aquatic and terrestrial habitats and is highly valued for both terrestrial and aquatic recreation activities. The potential for overflow impacts on the Nepean River corridor is considered to be moderate. Impacts from reticulation node overflows, partially treated STP discharges, chokes and exfiltration are all possible. There is potential for overflows to impact on human health within this sensitive area, since good water depth, easy water access, and moderate water quality combine to make the waterways generally attractive for swimming.

The Narellan Creek corridor (WC2) also contains important aquatic and terrestrial habitats, and has some recreational value, although the Creek is not used for primary contact recreation. The potential for overflow impacts on the Narellan Creek corridor is considered to be moderate, with the main impacts resulting from overflows from the designed structure EN1-01.

Wetland No. 159 (WC3) is a legally protected wetland listed under SEPP 14. The potential for overflow impacts on Wetland No. 159 (WC3) is considered to be moderate, with the main impacts resulting from overflows from SPS 120 in the event of SPS failure, chokes and exfiltration.

Table 3.1 Sensitive areas potentially impacted by overflows within the West Camden sewerage system

Sensitive area	Nature of sensitivity	Impact potential	Potential sources of impact
WC1. Nepean River corridor (includes Chellaston Street Reserve and Belgenny Reserve).	Important aquatic ecosystem Important recreation area Classified waterway Riverflat forest/wetlands Riparian vegetation Primary contact recreation	Medium	Modelling predicts potential impact from reticulation nodes CA2-01 (17 events and 122 ML per 10 years) and CA2-07 (17 events and 67 ML per 10 years) Modelling predicts impact from West Camden STP partially treated discharges (70 discharges and 990 ML per 10 years) Low to medium choke density in 1996/97 Moderate likelihood of exfiltration impacts
WC2. Narellan Creek Corridor	Important aquatic ecosystem Important recreation area Riverflat forest/wetlands Riparian vegetation Secondary contact recreation	Medium	Modelling predicts potential impact from designed overflow node EN1-01 (12 events and 17ML/10 yrs)
WC3. Wetland No. 159	Important aquatic ecosystem Legally protected wetland - SEPP 14 Educational and visual amenity values, aquatic habitat.	Medium	Overflows from SPS 120 in the event of SPS failure Medium choke density in 1996/97 Moderate likelihood of exfiltration impacts

3.3 Overflow ranking

Methods to rank or prioritise overflow problems were developed to address each of the overflow types identified in Chapter 2. 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 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 structures, wet weather overflows from reticulation areas and wet weather partially treated STP discharges.

A similar ranking tool was developed for the assessment of overflows caused by SPS failures. Referred to as the 'SPS ranking method', it was designed to calculate ranking scores for individual SPSs based on the combined assessment of the asset quality of the SPS, the magnitude of the potential overflow problem and the sensitivity of the potentially impacted environments.

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 the combined assessment of choke frequency, net infiltration/exfiltration (I/E), percentage rainfall ingress and the presence of sensitive areas.

The assessment of odour problems involved the ranking of sewered suburbs in terms of the frequency of odour complaints relating to sewerage system emissions.

Each of the overflow ranking methods is described further below. Full details of the methodology used for each overflow type are provided in the Methods document. The results of the ranking methods have been used to identify which of Sydney Water's assets are most in need of remedial works to reduce sewerage overflows. A staged overflow abatement program has been developed so as to achieve the greatest reductions in the environmental impacts of sewerage overflows with the least cost to the community. The prioritisation of remedial actions is described in detail in Chapter 4, in particular in Section 4.4 (Wet Weather Overflows), Section 4.5 (Dry Weather Overflows) and Section 4.6 (Integrated Overflow Strategy). This section presents the results of overflow ranking and assessment processes for the West Camden sewerage system.

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, within three discrete categories - designed overflow structure nodes, reticulation nodes and wet weather partially treated STP discharge nodes.

Comparisons of ranking scores should not be made between overflows in the three different wet weather overflow categories because of the distinctly different characteristics of the overflow nodes in each category. Modelled overflow nodes in the designed overflow structure category represent untreated wet weather discharges from single known locations. Reticulation nodes comprise a modelled inflow catchment within a sewer reticulation area. Overflow discharge data for a reticulation node represents the sum of all untreated wet weather discharges which may occur anywhere within the defined inflow catchment.

Modelled nodes in the wet weather partially treated STP discharge category represent wet weather STP discharges which receive some form of treatment, but not full treatment, before discharge.

Wet weather overflow ranks are designed to reflect the magnitude of environmental impacts which could result from a wet weather overflow event. Wet weather overflow ranking scores are calculated as the sum of an overflow score (based on assessment of overflow volume and activation frequency) and an environmental sensitivity score (based on the assessed sensitivity of the potentially impacted environment). The environmental sensitivity score is determined via the assessment and scoring of three component environmental dimensions - aquatic ecosystems, terrestrial ecosystems and human health - and is taken as the highest score obtained for any one dimension. Overflows which discharge to particularly sensitive environments, such as Class P waters or threatened species habitats, are flagged to ensure that these critical problems are addressed. Full details of the wet weather overflow ranking method are provided in the Methods document.

The complete results of wet weather overflow ranking for the Sydney region are presented in Appendix G in Volume 1. This section presents a summary of key wet weather overflow ranking results for the West Camden sewerage system. These wet weather overflow ranking results have been used to assist with the overflow problem definition for the Upper Nepean GA (see Volume 2, Section 3.7).

In the West Camden sewerage system, seven designed overflow structure nodes, six reticulation nodes and the single wet weather partially treated discharge from West Camden STP were modelled. The complete results of wet weather overflow ranking for the West Camden sewerage system, including all scores and reasoning, are provided in Appendix C (Volume 3). The results are summarised in Table 3.2a (designed overflow structure nodes) and Table 3.2b (reticulation nodes). In addition, Figure 2.3 shows the locations of modelled overflow nodes within the West Camden sewerage system, while Figure 3.1 shows any sensitive areas which may be impacted by overflows from these nodes.

As shown in Table 3.2a, the highest ranked designed overflow structure nodes are EN1-01 and SP 440, closely followed by CS3-01. All three nodes have relatively high activation frequencies (12 events, 18 events and 17 events per 10 years respectively) compared to other designed overflow structure nodes in the West Camden sewerage system. SP 440 has a moderate discharge volume (174 ML per 10 years) while CS3-01 and EN1-01 have low discharge volumes (77 ML and 17.5 ML per 10 years respectively). The most sensitive components of the potentially impacted environments are aquatic ecosystems (for EN1-01) and human health (for SP 440 and CS3-01). Overflows from EN1-01 may potentially impact on remnant habitat for the creeper *Glycine microphylla* in the Narellan Creek corridor, which is considered to be a sensitive area. This creeper is poorly conserved in Western Sydney although it is abundant elsewhere. Overflows from SP 440 and CS3-01 may impact on tributaries of Matahil Creek used for stockwatering, and hence may impact directly or indirectly on the human health dimension. As no designed overflow structure nodes were modelled in the other sewerage system within the Upper Nepean GA (Warragamba), the GA overflow ranks are identical to those for the West Camden sewerage system.

The designed overflow structure nodes in the West Camden system have relatively low rankings on a Sydney-wide basis. The highest ranked nodes are ranked 141 of the 216 designed overflow structure nodes across Sydney. The lowest is ranked 207, one of the lowest rankings in Sydney. Most of the overflows have relatively small overflow discharge scores and do not impact on environmentally sensitive areas.

As shown in Table 3.2b, the highest ranked overflows from reticulation nodes are from nodes CA2-01 and CA2-07. Wet weather overflows from the reticulation catchments represented by nodes CA2-01 and CA2-07 have relatively high activation frequencies (17 events per 10 years) and low to moderate discharge volumes (67 ML per 10 years for CA2-07 and 122 ML per 10 years for CA2-01). Human health is the most sensitive component of the potentially impacted environment in both reticulation catchments since wet weather reticulation overflows may impact on the Nepean River at Camden - a sensitive recreation area which is commonly used for swimming and picnicking. The top three ranked reticulation nodes in the West Camden system are also the top three ranked reticulation nodes in the Upper Nepean GA. The only modelled reticulation node in the Upper Nepean GA which is not part of the West Camden system is located at Warragamba, and is ranked equal third in the GA.

Reticulation nodes in the West Camden sewerage system are also ranked very low on a Sydney-wide basis. The rankings range from 167 to 260 of the 272 reticulation nodes across Sydney. Again, most of the overflows have relatively small overflow discharge scores and do not impact on environmentally sensitive areas.

Wet weather partially treated discharges from West Camden STP have an overflow discharge score of 12, an environmental sensitivity score of nine (based on human health impacts) and an overflow ranking score of 21. This makes partially treated STP discharges from West Camden STP the highest ranked in the Upper Nepean GA (ahead of Warragamba STP). The relatively high overflow discharge score is due to the high activation frequency (70 events per 10 years) and overflow volume (990 ML per 10 years) for partially treated discharges from West Camden STP. The environmental sensitivity score is based on the fact that the partially treated discharges potentially impact on the Nepean River at Camden, a sensitive area where primary contact recreation has been reported. As such, there are potential human health impacts associated with wet weather partially treated STP discharges in West Camden. Partially treated discharges from West Camden STP are ranked 12 of 23 partially treated STP discharges across Sydney.

The wet weather overflow ranking results for the West Camden sewerage system indicate that this system is the major contributor to overflows in the Upper Nepean GA and that any remedial works to reduce overflow impacts in this GA should focus on the West Camden system. Two reticulation nodes (CA2-01 and CA2-07) and the West Camden STP partially treated discharge node potentially impact on the Nepean River at Camden, a sensitive primary contact recreation area. Actions to reduce these impacts should be the first priority in the West Camden system. Overflows from the reticulation nodes may be reduced by reducing inflow and infiltration in the inflow catchments through sewer rehabilitation. Impacts from West Camden STP partially treated discharges may be reduced by

upgrading the treatment capacity at the STP. Actions to reduce overflow impacts from designed overflow structure EN1-01 should also be considered so as to avoid impacts on sensitive areas in Narellan Creek.

However, overflows from the West Camden system have relatively low rankings on a Sydney-wide basis, which indicates that overflow abatement in the Upper Nepean River REZ is a relatively low priority. The West Camden sewerage system was built to service a higher future level of demand, and as such overflows from the system are not currently severe.

Table 3.2a Summary of wet weather overflow ranking results for modelled designed overflow structures in the West Camden sewerage system.

Designed structure		Impacted REZs	Overflow rank			Scores			Overflow flags	Potential to impact sensitive Area (Y/N)
Model node No.	Location		System	GA	Sydney wide	Overflow discharge	Environmental sensitivity	Overflow ranking score[1]		
EN1-01	Camden Valley Way, Smeaton Grange	Upper Nepean River	1	1	141	5	6	11	None	Y
SP 440	Sheathers Rd, Camden	Upper Nepean River	1	1	141	6	5	11	None	N
CS3-01	M/H 13 Sheathers Rd, Camden	Upper Nepean River	3	3	149	5	5	10	None	N
CS3-03	Camden Rd, Camden	Upper Nepean River	4	4	176	3	5	8	None	N
EC11-05	Macarthur Rd, Elderslie	Upper Nepean River	5	5	191	2.5	4	6.5	None	N
CS3-06	59A Bligh Ave, Benkennie	Upper Nepean River	6	6	205	1.5	3	4.5	None	N
RR3-02	Clutha Pk, Queen St, Narellan	Upper Nepean River	7	7	207	2.5	1.5	4	None	N

Wet weather overflow ranking score = overflow discharge score + environmental sensitivity score

Table 3.2b Summary of wet weather overflow ranking results for modelled reticulation areas in the West Camden sewerage system.

Reticulation area / inflow catchment		Impacted REZs	Overflow rank			Scores			Overflow flags	Potential to impact sensitive Area (Y/N)
Model node No.	Location		System	GA	Sydney wide	Overflow discharge	Environmental sensitivity	Overflow ranking score[1]		
CA2-01	Camden, between Old Hume Hwy and Nepean River	Upper Nepean River	1	1	167	6	10	16	None	Y
CA2-07	Elderslie and NE Camden, between Camden Valley Way and Camden Bypass	Upper Nepean River	2	2	181	5	10	15	None	Y
SP484A	Narellan, NW of Camden Golf Course	Upper Nepean River	3	3	221	5	6	11	None	N
RR3-04	Area enclosed within inflow catchment No RR3-04, Narellan	Upper Nepean River	4	5	255	2.5	5	7.5	None	N
HR0-01	Currans Hill, NE of Camden Rd and SE of transmission line	Upper Nepean River	5	6	260	1.5	5	6.5	None	N
HR0-02	Currans Hill, NE of Camden Rd and SE of transmission line	Upper Nepean River	5	6	260	1.5	5	6.5	None	N

Wet weather overflow ranking score = overflow discharge score + environmental sensitivity score

3.3.2 SPS ranking

The SPS ranking method calculates ranking scores for individual SPSs then ranks the SPSs in descending order of these scores. SPS ranks are designed to reflect the magnitude of the problem relating to overflows caused by SPS failure. 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 in the previous section). For SPSs where operational failures are not predicted to result in overflow, the individual SPS ranking score is calculated as the sum of the asset score and overflow score only. SPSs with critical problems (such as a lack of telemetry) or critical environmental impacts (such as discharges to habitat for threatened species) are flagged to ensure that these critical problems are highlighted and addressed.

Full details of the SPS ranking method are provided in the Methods document. The complete results of SPS ranking for the Sydney region are presented in Appendix G in Volume 1. This section presents a summary of key individual SPS ranking results for the West Camden sewerage system. These SPS ranking results have been used to assist with the overflow problem definition for the Upper Nepean GA (see Volume 2, Section 3.7).

There are six SPSs in the West Camden sewerage system. Only five of these SPSs have been ranked, as insufficient information was available to allow ranking of SPS 440. The complete results of SPS ranking for the West Camden sewerage system, including all scores and reasoning, are provided in Appendix C (Volume 3). The results are summarised in Table 3.3. In addition, Figure 3.1 shows the locations of SPSs within the West Camden sewerage system as well as any sensitive areas which may be impacted by overflows from these SPSs.

The highest ranking SPSs in the West Camden system, in order, are SPS 120, SPS 484 and SPS 453. These are also the three highest ranking SPSs in the Upper Nepean GA. SPS 614 and SPS 673 are not predicted to overflow. As discussed previously, SPS 440 has not been ranked. SPS 120 has an asset score of 11, due to the absence of both a dual power supply and redundancy in the system controls. The overflow score of 6 is based on a predicted overflow volume between 100 and 1,000 kL in the event of SPS failure, and a single recorded overflow during 1996/97. However, the main reason for the high system ranking for SPS 120 is the potential for impacts on aquatic ecosystems. Overflows discharge into a creek which flows to Wetland No. 159, which is a sensitive biophysical area listed under SEPP 14. As the wetland is flushed infrequently, impacts from SPS overflows can linger for several weeks.

SPS 484 has similar ranking scores to SPS 120, but does not impact on sensitive aquatic ecosystems. The asset score of 10 is again due to the absence of both a dual power supply and redundancy in the system controls. The overflow score of 8 is based on a predicted overflow volume between 100 and 1,000 kL in the event of SPS failure and a recorded number of overflows between 2 and 4 in 1996/97. Discharges from SPS 484 flow to an artificial impoundment in Narellan Creek, so impacts on aquatic ecosystems may linger for several weeks, however the impacted environment is not a sensitive area.

SPS 453 has a higher likelihood of failure than the two top-ranked SPSs but potential environmental impacts are less severe than those for SPS 120 and SPS 484. The asset score of 20 is due to the presence of Mk 7-RCA telemetry, the absence of any backup power supply and redundancy in the system controls. The overflow score of 4 is based on a predicted overflow volume in the event of SPS failure between 0 and 100 kL and a single recorded overflow in 1996/97. The most sensitive component of the potentially impacted environment for SPS 453 is human health. SPS 453 impacts on a section of the Nepean River which is occasionally used for swimming and as such, overflows may impact on the health of swimmers.

The three top-ranked SPSs will be given priority for remedial works within the West Camden system and will be considered further in Chapter 4. A number of SPSs also have specific critical problems which have been flagged during the SPS ranking process. SPS 120, SPS 484 and SPS 673 do not have a fail safe 'Above Top Water Level' alarm installed to warn of overflows. SPS 614 lacks an effective contingency plan. These critical problems will be addressed with a priority based on the SPS rankings.

On a Sydney-wide basis, SPS 120, SPS 484 and SPS 673 are ranked 70, 80 and 112 respectively of the 662 SPSs across Sydney. These rankings are moderately high, indicating that overflows resulting from SPS failures represent one of the major overflow problems in the West Camden system. This is largely due to the potential for these SPSs to impact on identified sensitive areas.

The overflow volume at both SPS 614 and SPS 673 is predicted (theoretically) to be less than or equal to zero. As such, neither SPS should overflow as a result of SPS failures. However, a single overflow resulting from an SPS failure was recorded at each SPS in 1996/97. As the theoretical assessment is inconsistent with actual data, both SPSs will be reassessed and their overflow ranking will be adjusted if required. This means that SPS 614 and SPS 673 may be ranked higher than they are currently ranked.

Table 3.3 Summary of SPS ranking results for the West Camden sewerage system.

			SPS Rank			Scores				SPS flags[2]	Potential to impact sensitive
SPS	Location	Impacted REZs	System	GA	Sydney wide	Asset	Overflow discharge	Environmental sensitivity	SPS ranking score[1]		Area (Y/N)
120	Macquarie Grove, Camden	Upper Nepean River	1	1	70	11	6	40	57	A1	Y
484	Hume Hwy & Wilson Cres, Narellan	Upper Nepean River	2	2	80	10	8	34	52	A1	N
453	Brigalow Ave, Camden	Upper Nepean River	3	3	112	20	4	18	42	na	Y
614	Hume Hwy, Narellan	Upper Nepean River	4	4	270	21	3	na	24	C1	N
673	Harrington Park	Upper Nepean River	5	5	553	10	3	na	13	A1	N
440[3]	West Camden STP - off Shooters Lane, Camden	Upper Nepean River	na	na	na	na	na	na	na	na	na

1. SPS ranking score = asset score + overflow score + environmental sensitivity score
2. An SPS flag of T1 indicates that the SPS lacks telemetry, A1 indicates that the SPS lacks a fail safe 'Above Top Water Level' (ATWL) alarm and C1 indicates that the SPS has an ineffective contingency plan.
3. Data is not available to allow ranking of SPS 440

3.3.3 Prioritisation of sewer inflow catchments in terms of choke and leakage problems

The gauged sewerage system sub-catchments discussed in Chapter 2 (with respect to the likelihood of exfiltration or infiltration) can be further divided into sewer inflow catchments, which are used in sewer system modelling. Each of the sewer inflow catchments within the West Camden sewerage system (refer to Figure 4.1) have been prioritised based on the severity of choke and pipe leakage problems in the catchment.

The first step in the prioritisation process involves the determination of inflow catchment classifications for leakage severity based on the combined consideration of percentage rainfall ingress and net infiltration/exfiltration. The second step in the process involves the determination of initial inflow catchment rankings based on the combined consideration of leakage severity and choke frequency. The final step in the process involves the modification of initial rankings based on the presence of sensitive areas.

The inflow catchment priority ranks are designed to provide an indication of the need for remediation and to assist with the allocation of investigation priorities over the next 25 years. Catchments with a priority of one will be investigated and, if necessary, remediated in the next five years. Catchments with a priority of two will be addressed in the subsequent five year period, and so on for successive priorities. Full details of the inflow catchment prioritisation process for choke and pipe leakage problems are provided in the Methods document.

The complete results of inflow catchment prioritisation for choke and pipe leakage problems across the Sydney region are presented in Appendix G of Volume 1. This section presents a summary of key inflow catchment prioritisation results for the West Camden sewerage system. These results have been used to assist with the overflow problem definition for the Upper Nepean GA (see Volume 2, Section 3.7).

There are 29 defined inflow catchments in the West Camden sewerage system. Of these, eight were assigned an initial priority of one, nine were assigned an initial priority of two, one had an initial priority of four and eleven had an initial priority of five. After consideration of the potential impacts on sensitive areas, one catchment (CS3-06) was upgraded to a priority of one. Table 3.4 summarises the results for the nine catchments with a final priority of one. Full details of inflow catchment priority ranking results for all inflow catchments in the West Camden sewerage system are provided in Appendix C (Volume 3).

All of the catchments with an initial priority of one had moderate exfiltration and a rainfall ingress of between 10 and 15%, resulting in a high leakage severity classification (see Table 3.4). The catchments also had medium choke frequency. Although all of the catchments have a priority of one, five of the catchments drain to the Nepean River corridor sensitive area (WE4-01, EC1-02, EC11-06, EC11-07 and EC11-08) and may therefore impact on areas used for primary contact recreation. Any remedial works should therefore focus on these five catchments before addressing the remaining catchments with a priority of one. Possible overflow abatement actions for all of the inflow catchments with a priority of one, particularly those draining to sensitive areas, will be considered in Chapter 4.

Table 3.4 Prioritisation of inflow catchments in terms of choke and pipe leakage problems - catchments with priority of 1 in the West Camden sewerage system.

		Problem classification				Priority Rankings		
Inflow catchment	Location (REZ)	Net infiltration/ exfiltration (I/E)[1]	Percentage rainfall ingress[2]	Leakage severity[3]	Choke frequency[4]	Initial priority	Presence of sensitive area	Priority
WE4-01	Upper Nepean River	Moderate Exfiltration	Medium	High	Medium	1	Yes. Drains to the Nepean River sensitive area and Wetland No. 159	1
EC1-02	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	Yes. Drains to the Nepean River sensitive area	1
EC11-06	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	Yes. Drains to the Nepean River sensitive area	1
EC11-07	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	Yes. Drains to the Nepean River sensitive area	1
EC11-08	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	Yes. Drains to the Nepean River sensitive area	1
CS3-04A	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	No	1
CS3-04	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	No	1
WE4-03	Upper Nepean River	Moderate exfiltration	Medium	High	Medium	1	No	1
CS3-06	Upper Nepean River	Moderate exfiltration	Medium	High	Low	2	Yes. Drains to the Nepean River sensitive area.	1

Note:

1. I/E has been determined using ratio of Average Dry Weather Flow to Indoor Water Consumption. Ratio > 1 indicates infiltration - 1.0 to 1.5 (low), 1.5 to 2 (moderate) and > 2 (high). Ratio <0.8 indicates exfiltration - 0.8 to 0.7 (low), 0.7 to 0.5 (moderate) and < 0.5 (high).
2. The categories used for rainfall ingress are High (>15%), Medium (10-15%), Low (5-10%) and Very Low (<5%).
3. Leakage severity depends on I/E and rainfall ingress. See Methods document for description of how categories are determined.
4. Choke density is measured on a suburb basis rather than an inflow catchment basis. The suburb at the centre of each inflow catchment has been used to determine priorities

3.3.4 Odour problem assessment

The number of odour complaints relating to sewerage system emissions has been determined for each suburb in the Sydney region based on information recorded in Sydney Water's RECOS database. The RECOS database is used to keep track of all complaints received and work conducted by Sydney Water. As the number of odour complaints received in each system was generally small, no formal ranking of odour problems has been conducted across the Sydney region. However, sewered suburbs within each system have been ranked in order of the number of odour complaints received in 1996/97 to give an indication of the location of odour problems within each system.

The complete listing of odour complaints by system across the Sydney region is provided in Appendix F of Volume 1. Where odour problems have not already been addressed, the ranking of suburbs on the basis of odour complaints has been used to identify the location and likely source of odour problems. This section presents a summary of odour complaints by suburb for the West Camden sewerage system. These results have been used to assist with the overflow problem definition for the Upper Nepean GA (see Volume 2, Section 3.7).

As shown in Table 3.5, a total of six odour complaints were recorded in the West Camden system in 1996/97, comprising four complaints from Narellan and one each from Camden and Narellan Vale. As discussed in Chapter 2, the odour complaints from Narellan and Narellan Vale are associated with the Narellan Carrier which feeds SPS 484. The single odour complaint from Camden may be associated with the West Camden STP rather than the sewerage system itself. Odours associated with the Narellan Carrier are already being addressed as discussed in Chapter 4.

Table 3.5 Summary of odour problem assessment results for the West Camden system

Suburb	Location (REZ)	Odour complaint frequency
Narellan	Upper Nepean River	4
Camden	Upper Nepean River	1
Narellan Vale	Upper Nepean River	1
Elderslie	Upper Nepean River	0
Camden South	Upper Nepean River	0
TOTAL		6

Chapter 4

System Overflow Management Strategy

Synopsis of Chapter 4

Strategies for overflow abatement for each sewerage system in the Upper Nepean GA are described in Volume 2 of this EIS based on the magnitude of the identified overflow problem. A standardised level of overflows, known as the base case, has been adopted as the starting point for evaluation of overflow abatement options. The base case is required to meet Sydney Water's obligations under its Operating Licence and Environment Plan. Further options have then been considered to reduce the impacts of overflows in line with Sydney Water's long-term objectives. The main overflow problems are partially treated wet weather STP discharges and exfiltration.

Environmental objectives have been identified for each of the systems based on current and desired values and uses. Water quality high enough for swimming is a desired outcome for most of the major waterways in the West Camden sewerage system. Water quality modelling of the Nepean River has identified that the major sources of pollution are from stormwater (urban and rural runoff) and STP discharges.

From the overflow abatement strategies, actions have been developed to focus in detail on the methods of implementing the strategies. These actions were optimised to meet the targets for all overflow categories. The main components are I/E rehabilitation, trunk main amplification, SPS upgrades and additional STP wet weather treatment. Actions have also been identified for additional protection of the Nepean River corridor sensitive area.

The base case of a 18 overflow events per 10 years overflow abatement is proposed for the majority of the West Camden sewerage system. The sub-catchments overflowing to the Nepean River corridor sensitive area are proposed to have a 5 overflow event per 10 year overflow abatement standard applied to them. This will provide improved protection for this swimming area and is supported by an economic analysis which provides the highest net present value for this abatement level.

To reduce partially treated STP bypasses it is proposed to install a 1 ML storage basin at West Camden STP and to upgrade the disinfection system to match the wet weather abatement level of the sewerage system. The storage basin will return the stored flow back to the treatment process in the STP once the flow levels have returned to normal levels.

Three of the sub-catchments in the West Camden system have potential moderate exfiltration problems. These three sub-catchments will be considered for further investigation and appropriate I/I reduction works. This work will simultaneously reduce wet weather inflow to the system.

Three of the SPSs in West Camden (SPS 440, 484 and 614) will be upgraded to meet the higher wet weather flow levels when the proposed actions are implemented. A further two SPS (SPS 120 and 453) have been identified as having a high overall overflow ranking and will be compared with other high ranking SPS throughout Sydney to determine a priority for remediation.

Odour problems are currently occurring at SPS 614 due to septic sewage. At present this is being chemically treated and will be naturally corrected when flows increase due to housing and commercial development in the system.

The actions are integrated to form a management plan for the West Camden sewerage system. Management practices will be updated and implemented as part of the continuous improvement program. The total cost of the management plan for West Camden is estimated to be $24.2m over the next 25 years. Components of the plan have been prioritised with the aid of overflow ranking results across the whole of Sydney Water, and will be progressively implemented over the 25 year planning period in a rolling 5 year capital works program. The immediate focus of the plan will be on best management practices, particularly due to system failures in dry weather.

4. System overflow management strategy

4.1 Overflow abatement objectives

Overflow abatement objectives must be considered for all six categories of overflows. The base case overflow performance for the West Camden system is required to maintain the system in line with legal requirements and corporate objectives specified in legislation and SWC's Operating Licence (1996b), Environment Plan (1997b) and ESD Policy Statement (1996a). The base case for each overflow type, as shown in Table 4.1, is not to allow current performance to deteriorate in 2021 with respect to the following performance indicators, irrespective of population growth. Wet weather treatment at the STP will also be upgraded as part of the base case such that STP discharges will receive at least disinfection to less than 150 cfu per 100 millilitres for all flows until the first overflow occurs in the system.

Table 4.1 Base case performance targets

Overflow Type	Base case performance target
Wet weather overflows	maintain the number of modelled overflow events per 10 years
Partially treated STP discharges	STP wet weather discharges will receive at least disinfection to less than 150 cfu per 100 millilitres for all flows until the first overflow occurs in the system.
Surcharges (due to chokes)	maintain the number of high choke complaint suburbs maintain the number of medium choke complaint suburbs
SPS failure	maintain the number of individual SPS overflow events
Exfiltration	maintain the number of gauging catchments with high likelihood of exfiltration maintain the number of gauging catchments with medium likelihood of exfiltration
Odour	maintain the number of events leading to complaints per sewerage system

Sydney Water has developed long-term objectives for overflows based on the Government Waterways package and SWC Corporate direction. These long-term objectives are detailed in Table 4.1 of Volume 2, Chapter 4 for the Upper Nepean Geographic Area.

The first stage in developing the overflow abatement program is to ensure that the West Camden sewerage system meets the base case requirements. In addition to the base case, Sydney Water has initiated specific programs to investigate the impacts of overflows from exfiltration and SPS failures. Outcomes from these programs will result in improved system performance, at or above the base case. An interim I/E program is already under way to investigate and reduce the impacts of identified exfiltration sub-catchments. Other potential exfiltration sub-catchments will be added to this program on the basis of the priorities developed in Chapter 3 of this EIS (see Section 3.3). All SPSs have been ranked (see Section 3.3) as part of the SPS risk reduction program and actions have been identified to reduce the risk of SPS failures. Both programs are discussed further in Section 4.2.

The second stage in developing the program is to determine whether additional levels of overflow abatement are required to protect the environment. Environmental and overflow abatement objectives have been identified for the Upper Nepean River REZ in Volume 2, Chapter 4, of this EIS. The results of overflow ranking, presented in Chapter 3, were used to assist in the development of these objectives. The benefits and costs of additional overflow abatement levels (above the base case) have been evaluated and the most appropriate overflow abatement strategy selected using two computer models, SEEKER (UPS, 1997) and MOST (Corporate Services - Product Planning, 1997).. These models are

discussed in detail in the Methods document. Briefly, SEEKER is a model which evaluates entire sewerage systems to develop combinations of remediation strategies for wet weather overflow abatement. MOST is a model which analyses the costs of remedial actions for individual sewerage treatment plants. An extract from the MOST modelling report is included as Appendix A (Volume 3). The need for additional overflow abatement to protect sensitive areas in the Upper Nepean River REZ has also been reviewed.

In Section 4.4, the costing spreadsheet model is used to select the minimum cost package of wet weather overflow actions to achieve 18 wet weather overflow events per ten years and to provide additional protection of sensitive areas where required. In Section 4.5, modifications to this package are proposed to address environmental and community concerns and to target overflow problems identified for chokes, exfiltration, SPS failures and odours. In Section 4.6, investigation and remediation actions in addition to those determined by the SEEKER model have been assessed on an inflow catchment basis and prioritised for addition to the I/E reduction program. The result is an integrated overflow strategy which will address both wet weather and dry weather overflows in the West Camden system.

The following sections summarise the overflow performance targets for each overflow category as required by the base case, the outcomes of the Upper Nepean River REZ assessment in Volume 2, overflow ranking results, the protection of sensitive areas, the I/E program and the SPS risk reduction program.

4.1.1 Wet weather overflows

Modelling indicates that although the West Camden system has a capacity of greater than four times the peak dry weather flow (PDWF), the system is currently operating at 18 overflow events per ten years which means that the most frequent overflow point is activated every 7 months on average. This is due to high levels of inflow and infiltration during wet weather. The system will be upgraded as the population connected to the system increases in order to at least maintain 18 wet weather overflow events per ten years as part of the base case. This will result in improvement in most parts of the system in terms of the number of overflows. However, there may be a slight deterioration in other parts of the system. Considering the system as a whole, the total numbers of overflow events and volumes will be maintained.

Analysis of the benefits and costs of additional system-wide wet weather overflow abatement in Volume 2 of this EIS indicates that maintaining 18 wet weather overflow events per ten years through to 2021 is the most appropriate catchment wide option for the Upper Nepean River REZ.

Analysis of the impacts of wet weather overflows on sensitive areas in Volume 2, Chapter 4, has demonstrated that additional abatement may be necessary to protect sensitive areas with primary contact recreation values in the Upper Nepean River REZ. This is supported by the economic evaluation in Volume 2, Chapter 4 which indicates that higher abatement in the GA gives a better economic outcome. The sensitive areas are:

WC1 - the Nepean River corridor (from Cowpastures Bridge to Macarthur Bridge) and

WC2 - the Narellan Creek corridor (at Smeaton Grange) and

WC3 - Wetland No. 159

The Nepean River corridor is commonly used for swimming. Therefore a higher abatement has been selected for the sub-catchments draining to this sensitive area. It is proposed to implement a five events per ten years overflow abatement level for this area. Additional costs above the base case have been calculated from the SEEKER model and are shown in Table 4.10. This decision is supported by the economic evaluation of Chapter 4 in Volume 2 which shows that the highest net present value is given by the 1 event in 10 year abatement. Low cost actions to provide protection of this area will also be identified for consideration in the second stage EIA.

The Narellan Creek corridor is primarily a terrestrial sensitive area with low usage for recreational purposes. Therefore the catchment wide 18 overflow events per 10 years abatement is considered the most appropriate for this area. Additional protection from wet weather overflows is not required for Wetland No. 159 because nutrient contributions from stormwater are far greater and flushing times will be faster in the larger storms when the overflows are activated.

4.1.2 Partially treated STP discharges

Partially treated wet weather STP discharges are one of the major overflow problems for the West Camden system. The proposed option in Volume 2, Chapter 4 requires wet weather treatment at West Camden STP to be upgraded as part of the base case. The MOST model indicates that there are currently 70 partially treated STP discharges per 10 years. This needs to be reduced to a level comparable to the overflow abatement in the rest of the West Camden sewerage system. The number of overflow events with reduced disinfection efficiency will be reduced to the overflow abatement standard for the rest of the sewerage system at less than 18 overflow events per 10 years.

4.1.3 Chokes

To meet the base case, Sydney Water aims to clear all chokes, repair the choke cause if found necessary, and give particular attention to areas with repeat chokes, so that the objective of more than 96% of customers not affected by surcharges continues to be met. In 1996/97, the choke density in the West Camden system was similar to that across the entire Sydney sewerage system. No suburbs in the West Camden system had a high choke density, therefore they do not need to be targeted for choke reduction for the base case is to be met. Choke occurrences were highest in the suburbs of Camden and Elderslie, both of which had a medium choke density. The remaining suburbs (Camden South, Narellan and Narellan Vale) had a low choke density. Both of the suburbs with a medium choke density, Camden and Elderslie, have areas which drain to the Nepean River sensitive area. As such, the benefits of reducing chokes in these suburbs should be evaluated as part of the integrated overflow reduction strategy. Choke density should be regularly reviewed as part of the continuous improvement process.

As discussed in Section 2.4, Sydney Water has already implemented management systems to repair repeat chokes, investigate their cause and ensure that additional chokes do not occur. These systems should be adequate to minimise any continuing impacts from chokes. However, response to chokes resulting in discharges to sensitive areas must be prioritised to minimise short-term impacts.

4.1.4 Exfiltration

Exfiltration of sewage can be a significant source of sewage overflows during dry weather. Catchments suspected of having exfiltration problems need to be investigated to determine the extent and impacts of the exfiltration problem and identify appropriate remedial actions. Three out of the six gauging sub-catchments in the West Camden system have been identified as moderate exfiltration candidates requiring further investigation, 806000, 828001 and 828005 (see Figure 2.5, Chapter 2). The 806000 sub-catchment drains to the section of the Nepean River which has been identified as a sensitive area, while the 828001 sub-catchment drains to the Narellan Creek sensitive area. Investigation works should be prioritised for these sub-catchments.

4.1.5 SPS failures

SPS failures can lead to sewage overflows during wet or dry weather. The base case does not require any specific actions to counter SPS failures, other than to continue with the existing SPS maintenance program. However, Sydney Water's long-term objective is that overflows caused by SPS failures occur less than 15 times per year across Sydney from all overflow structures during dry weather, except under circumstances beyond Sydney Water's control (such as blocked road access to SPSs). During 1996/97, 30 failures occurred at the 6 SPSs in the West Camden system as a result of unplanned power loss,

mechanical and electrical failures and telemetry failures. The SPS ranking results indicate that at least 6 of these SPS failures resulted in overflows during 1996/97.

Each SPS in the Sydney Water sewerage system has been ranked on the basis of asset condition, overflow potential and potential environmental impact, as described in Chapter 3. Where an SPS has been identified through the ranking process as lacking either telemetry, an alternative power supply or a standby pump, there may be a need to upgrade the SPS. All of the SPSs in the West Camden system have telemetry and automatic standby pumps. However, two SPSs do not have an alternative power supply.

Similarly, the response time (expected time to respond to and rectify an average failure at an SPS) and detention time (time between SPS failure and the start of overflow from the SPS) have been determined for each SPS. Where the response time is greater than the detention time at the SPS, there may be a need to either increase the SPS storage capacity or improve the response time so as to reduce the potential for sewage overflows. Three of the SPSs in the West Camden system have a detention time smaller than the response time.

Overflows from SPS 120 may impact on the State environment planning policy (SEPP) 14 listed Wetland No. 159, while overflows from SPS 453 may impact on the Nepean River corridor at Camden, both of which are considered to be sensitive areas. These two SPS are in the three top ranked SPSs in the West Camden system. SPS 120 in particular has a very high environmental sensitivity ranking score. SPS 453 has a moderate sensitivity which when combined with a poor asset ranking gives it a high overall ranking. Remedial works may be required at these SPSs to ensure protection of the sensitive areas for dry weather flows.

4.1.6 Odours

Odours from the Narellan Carrier and SPS 614 are being addressed in the short-term by dosing with an odour control chemical which will prevent the formation of hydrogen sulphide. Trials of chemicals have been conducted and the dosing is currently being implemented. Odours will naturally decrease in the long-term by increased sewage flow which will reduce sewage detention times and hence reduce sewage septicity. There are no specific additional objectives for reducing system-wide odours from the West Camden system since the current performance is well within typical levels. Management practices and response to complaints will ensure that any inconvenience caused by odour emissions is minimised.

4.2 Existing overflow abatement program

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

1. high recorded faecal coliform 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 and
5. focus on the Sydney Harbour catchments.

No interim I/E program project areas have been identified for the West Camden catchment for the initial investigations since the Upper Nepean has lesser environmental sensitivity and public usage than other potential exfiltration sub-catchments around Sydney.

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 SWC's SPSs have been ranked as part of the program (see Chapter 3) and works are to be identified to reduce the risk of SPS failures.

Investigations are proceeding to investigate a number of innovative "treat/discharge" technologies with 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 the West Camden sewerage system. The program is designed to maintain and upgrade the system assets and is updated annually. Part of the program is to increase the capacity of the West Camden system to cope with additional loads from population growth in the area. 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 five year program over the next 25 years according to their priority.

4.3 Overflow abatement strategies

The abatement of sewer overflow impacts can be accomplished in many ways. For this project, the general ways to abate overflows have been termed strategies and the specific steps to upgrade or improve systems have been termed actions. An example of this would be;

- strategy - upgrade wet weather treatment at STPs
- action - install 1 ML storage basin plus additional disinfection capacity at West Camden STP to provide the equivalent of an 18 overflow events per 10 years abatement standard.

One of the main objectives of the system licences is to set overflow performance requirements. Actions will need to be taken by SWC to meet the requirements of the licences.

Strategies fall into two general categories - non-structural (management) and structural. In addition, separate strategies have been developed for wet weather overflows and for dry weather (or system failure) overflows. The generic strategies outlined in this section have been developed in the following sections into system specific actions to meet the overflow abatement objectives for Penrith sewerage system. System specific structural and non-structural actions for each wet weather overflow category are described in Section 4.4. System specific structural and non-structural actions relating to dry weather (or system failure) overflow categories are described in Section 4.5.

Wet weather strategies range from keeping additional water out of the system or storing it until the peak flow in the sewer passes, to providing bigger pipes for transportation and extra treatment in the system or at the treatment plant. Dry weather strategies include measures to reduce the potential for and/or mitigate the impact of chokes, exfiltration, SPS failures and odours. Appendix I (Volume 2) presents the actions, their advantages and disadvantages, and what can be achieved by implementing the action.

Some strategies will improve the performance of all the overflow categories. Specific actions proposed in Sections 4.4 and 4.5 have therefore been evaluated on their overall benefits. Demand management, source control and sewage mining (or effluent reuse) are examples of strategies which Sydney Water is already implementing that reduce the potential for overflow impacts.

Demand management can reduce the dry weather sewage volume 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 storage capacity which increases the time

until overflows occur in both dry and wet weather. 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.

Source control is an important component in reducing the impacts of all overflows. Control of commercial wastewater 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 wastewater source control policy as discussed in Chapter 2. However, commercial wastewater is not a significant problem in the West Camden sewerage system.

Recommended management practices for system operation and maintenance to minimise overflows are identified for each overflow category in the following sections and are discussed further in Section 4.7.

4.3.1 Wet weather overflows

There are many strategies which meet, or partly meet, the wet weather overflow abatement objective of maintaining the existing number of overflow events (18 overflow events per 10 years abatement standard). Table 4.2 lists and screens strategies to determine a reduced number of significant strategies which can be used in the SEEKER cost optimisation model. The remainder of the strategies (including the low cost effective strategies like moving overflow location and raising overflow weir heights) will not be discarded, but considered where appropriate in providing additional protection to sensitive areas and in the detailed assessment of strategies for the second stage EIA. The strategies screening process uses the following screening criteria:

1. strategies which make up the bulk of the total cost of the overflow abatement are carried forward
2. strategies which have system wide or strategic influence, are carried forward and
3. strategies which accord with current Sydney Water policy are carried forward.

Applying the above screening criteria reduces the list to four main strategies for wet weather overflows and one main strategy for partially treated STP discharges, which were carried forward into the SEEKER cost optimisation modelling. The screened list includes:

1. I/I reduction in SWC sewer pipes and private sewers up to the boundary trap (property line)
2. storage at SPSs, STPs and at major designed overflows
3. modifications to reticulation pipes, sewer duplication
4. trunk main amplifications and
5. treatment of STP wet weather flows by settlement and disinfection.

While Sydney Water is responsible for reticulation sewers and trunk sewers, private sewers are the responsibility of the property owner. Sydney Water has reviewed alternative I/I reduction levels incorporating both Sydney Water sewers and privately owned sewers and determined that rehabilitation of Sydney Water sewers and private sewers from the main up to the boundary trap or property line will meet the objectives of the I/I and exfiltration correction programs. Rehabilitation of only the lower section of private sewers avoids inconvenience to property owners and can significantly reduce infiltration. As such, this strategy has been selected for the SEEKER modelling.

Table 4.2 Preliminary screening of structural wet weather strategies

Preliminary strategies list		Major cost groups of strategies	Strategies with system-wide significance	Strategies in accord with SWC strategic planning	Screened strategies list
Strategies for Wet Weather Overflows					
I/I reduction	- cracks in SWC sewers	yes	yes	yes	yes
	- cracks in private sewers to boundary trap	yes	yes	yes	yes
	- cracks in private sewers above boundary trap	yes	yes	no	-
	- reduce illegal connections	yes	no	-	-
Storage	- additional above and below ground storage	yes	yes	yes	yes
	- control systems to maximise use of existing pipe network capacity	yes	no	-	-
Reticulation modifications	- sewer duplication	yes	yes	yes	yes
	- cross connection to other sewer	yes	no	-	-
	- raise access chamber weirs	no	-	-	-
	- relocate O/Fs by sealing access chamber	no	-	-	-
	- relocate designed O/F points	yes	no	-	-
Trunk main amplifications - duplicate trunks		yes	yes	yes	yes
Local treatment of O/Fs	- sedimentation	yes	yes	no*	-
	- disinfection	yes	yes	no*	-
Source reduction (including sewer mining)		no	no	-	
Other non-structural strategies					
	- routine maintenance program	no	-	-	-
	- clean-up of site after overflow	no	-	-	-
	- public reporting of major overflows	no	-	-	-
Strategies for partially treated wet weather STP Discharges					
Additional STP treatment	- full treatment through STP	yes	yes	yes	yes
	- part treatment (settlement and disinfection)	yes	yes	yes	yes

* - Sydney Water is currently investigating localised treatment and discharge technologies offered by private sector companies to determine capital and operating costs, reliability and effectiveness.

4.3.2 Partially treated STP discharges

As shown in Table 4.2, the screened strategies for partially treated STP discharges comprise full treatment of all wet weather flows at the STP or increased partial treatment of STP wet weather flows by storage, settlement and disinfection. STP treatment costs were developed separately from the SEEKER model using the MOST model. Strategies were developed to upgrade the existing wet weather treatment at the STP such that the abatement standard for partially treated STP discharges matches the abatement standard for the rest of the sewerage system. Measurable gains could be achieved in water quality by following this strategy. Elimination of overflows above this level would make little improvement in water quality. The main wet weather overflow objectives for the Upper Nepean River REZ are related to minimising human health risks from pathogens. Sydney Water's ERA study has found that contributions of toxicants from wet weather overflows are relatively small compared to the contributions of stormwater. Similarly contributions of nutrients from wet weather overflows have been found to be relatively small compared to stormwater contributions.

As such, strategies to reduce partially treated STP discharges have concentrated on reducing the pathogen risks in the Upper Nepean River REZ.

Pathogen risks can be reduced either by storing wet weather flows for later treatment at the STP, or disinfecting wet weather discharges to reduce pathogen concentrations to acceptable levels. The MOST model considered combinations of these two strategies to achieve a range of partially treated STP discharge frequencies based on variations of:

1. fine screening then disinfection of wet weather flows
2. fine screening then storage and treatment at the STP and
3. fine screening then partial storage at the STP with disinfection of all wet weather flows that bypass the storage.

Sydney Water has decided that partially treated sewerage treatment plant discharges should receive at least full 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 future containment performance goal requires that only those events which will exceed 150 faecal coliforms per 100 millilitres will be considered as overflows from STPs. The future containment performance may be achieved by either storage or disinfection.

4.3.3 Choke related overflows

It is difficult to predict where chokes caused by blockages will occur in a system although there are ways to reduce choke occurrences and minimise their impact when they do occur. The strategies are summarised in Table 4.3.

All of these strategies are suitable as part of an integrated choke reduction strategy.

Table 4.3 Strategies to detect, prevent and minimise the impact of chokes

Category	Strategies[1]
Detection of chokes before they cause an Overflow	Closed Circuit Television (CCTV) inspection of sewers on a prioritised basis - particularly areas where trees are close to the sewer. (Tree roots are a major cause of chokes).
	Routine inspection (larger sewers only)
Prevention of chokes	Program for I/E reduction - sewer lining and rehabilitation programs will seal cracks in the pipes and reduce tree root entry to pipes. Tree roots already in the pipes will be removed.
	Root cutting - remotely operated cutting tools can be inserted at access chamber and used to clear sewer and reticulation pipes once the pipe section is identified as having root intrusion problems.
	Chemical cleaning - also used to reduce root infestation
	Bolt down access chamber covers - used to protect sensitive areas by moving the discharge point to a less sensitive location
	Clearing of pipe blockages detected during inspections
	Routine sewer flushing on a time or condition basis - avoids blockages due to siltation during low dry weather flows
Minimisation of choke impacts	Clean up site after overflow - use of sandbags and booms to contain overflow; portable pumps to return sewage to the sewer; removal of visible solids; flushing with fresh water to dilute and disperse pollutants.
	Public reporting of major choke overflows - notification of location, size and potential impact of overflows in local and regional media depending on the scale.

Notes:

1. Many of these are existing practises which will continue and be enhanced to ensure that the overflow abatement objectives are met.

4.3.4 Exfiltration

Sydney Water has established an interim I/E program as described in Chapter 4.2. The program is designed to investigate the impacts of exfiltration and implement actions to reduce exfiltration when it is detected. Strategies include rehabilitation, relining and replacement of leaking sections of pipe. Table 4.4 shows the process for identifying and developing specific actions for exfiltration. The leakage indicator referred to in Table 4.4 was determined by comparing expected sewer flow (derived from water consumption in each gauged catchment) to the gauged dry weather sewer flow.

Table 4.4 Action matrix for exfiltration

Leakage indicator Environmental indicator	Leakage acceptable	Leakage analysis indicates exfiltration
Indicator acceptable	(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 (i.e. median > 1000 cfu/ 100 ml - secondary recreation, median > 150 cfu/100 ml - primary recreation)	(3) Investigation as to source of contamination - Gauged catchment to I/E Program if no other major sources are identified.	(4) Gauged catchment to I/E Program for initial investigation at mini-catchment gauging level

4.3.5 Overflows caused by SPS failures

The strategies to reduce overflows from West Camden SPSs are summarised in Table 4.5. Locations of the individual SPSs are given in Table 2.4.

Table 4.5 Strategies to detect, prevent and minimise the impact of SPS failures

Category	Strategies[1]
Prevention of SPS overflows	Increase storage at SPSs - increases detention time before an overflow occurs, which increases the time available to respond to alarms
	Reduced call out time (response time) - reduce the time taken to respond to power failures, pump failures
	Backup or dual power supply - automatically switches in when main power supply fails
	Portable power supply - trailer mounted 415V generator which can be connected to bypass the main supply when the power fails. All SPS, except for 2, in West Camden are equipped with generator connections.
	Backup pumps - portable or submersible pumps can be used as a temporary measure during pump failure
	Relocate, modify or remove O/F discharge point - used to protect sensitive areas by moving the discharge point to a less sensitive location
	Partial treatment of overflow - screening or bag filters to reduce solids discharged with the overflow
Minimisation of SPS overflow impacts	Clean up site after overflow - use of sandbags and booms to contain overflow; portable pumps to return sewage to the sewer; removal of visible solids; flushing with fresh water to dilute and disperse pollutants.
	Public reporting of major choke overflows - notification of location, size and potential impact of overflows in local and regional media depending on the scale.

Note: Strategies in this table include existing practices to be continued and enhanced.

4.4 Proposed actions to achieve wet weather overflow abatement objectives

This section outlines the actions for the West Camden system that will meet the overflow abatement objectives for the Warragamba – Nepean REZ. The actions have been developed from the strategies described in the previous section.

It is important to note that the actions described in this EIS are only indicative of the measures required and that final action selection will be decided during the second stage Environmental Impact Assessment (EIA) which looks in detail at the localised impacts of implementing the actions. This second stage EIA is required by the approval process defined in the *EP&A Act*, 1979, for any works recommended in these EISs. The second stage EIA will be carried out prior to the works commencing.

4.4.1 Source reduction

The reduction of sewage at the source as a means of increasing the capacity of the existing mains, has limited application in the West Camden sewerage system. Demand management results in a small reduction in flow. However as the West Camden sewerage system is a rapidly developing residential area there is scope for the promotion of water saving devices in new housing construction. There are no large industrial users of water in the system to target for major demand management. The lack of possible significant industrial users of reclaimed water from sewer mining make this technology unsuitable for the West Camden system. There is no significant industrial waste discharger in the West Camden system and therefore little scope for control of pollutants at the discharge point.

4.4.2 Wet weather overflows

The SEEKER computer model (UPS, 1997) was used as a starting point to determine the lowest cost package of actions from the screened strategies identified in Table 4.2, to achieve the proposed 18 overflow events per ten years abatement level over most of the West Camden sewerage system. The model calculations were based on an abatement level of 19 events per 10 years. This will need to be adjusted in a future model run to match the existing system performance of 18 events per 10 years, which may result in a minor increase in the modelled cost estimates. The model calculated a minimum cost of $11.8 million, which comprises approximately $0.3m of I/I rehabilitation and $11.5m of transport amplification. There were no reticulation amplification or site storage components selected by the model as part of the lowest cost package of actions. STP wet weather treatment costs were determined separately using the MOST model.

Table 4.6 shows a comparison of the frequency, volume and duration of wet weather overflows for existing conditions and for the proposed wet weather strategy.

SEEKER predicts that the pump rates of SPS 440, SPS 484 and SPS 614 will need to be upgraded to meet the higher wet weather flows that will be transferred to those pumping stations when the proposed options are implemented.

Table 4.6 Wet weather overflow performance for existing conditions and the proposed abatement level for the West Camden sewerage system

Performance criteria	Existing conditions (1994)	Proposed 18 events per 10 years abatement (2021)
Frequency of wet weather overflow events over 10 years	18	18
Total wet weather overflow volume (ML) over 10 years	564	279
Total wet weather overflow duration (hours) over 10 years	443	209

4.4.3 Additional protection of sensitive areas

The Nepean River corridor is a popular swimming area. Therefore a higher abatement has been proposed for the sub-catchment draining to this sensitive area. This area should be given a five events per ten years overflow abatement. Additional costs above the base case have been calculated from the SEEKER model and are shown in Table 4.10. This decision is supported by the economic evaluation of Chapter 4 of Volume 2 which shows that the highest net present value is given by the 1 overflow event in 10 year abatement.

None of the other sensitive areas have been selected for additional wet weather abatement above the catchment wide abatement level proposed for the Upper Nepean River REZ after consideration of the impacts and potential benefits (refer to Volume 2, Chapter 4). However, low cost actions have been considered to reduce overflows from individual overflow structures to these areas. The Nepean River sensitive area in particular was identified by local community groups as having a high recreation value.

The following actions have been considered for these areas:

1. raising the weir levels in the overflow structures
2. bolting down the covers of access chambers which could surcharge into the areas
3. diversion of overflows to a point downstream of the sensitive area and
4. preliminary treatment at the discharge points.

The first two actions move the overflow discharge location upstream in the system and any impacts from doing this must be considered to determine if there is any net benefit. As the overflow points impacting on the Nepean River sensitive area are towards the downstream section of the sensitive area there does not appear to be any benefit in moving the overflows upstream. The drainage pathways around the other sensitive areas also mean that these actions are unlikely to be appropriate. However, diversion of overflows to a point downstream could move the overflow point outside the sensitive area. The discharge frequency to the WC1 and WC3 sensitive areas will be monitored in the short-term to determine the need for preliminary treatment such as screens or bag filters. However, these actions will only reduce floatables and solid matter in the overflows and will not reduce the risk from pathogens. Screening may therefore only be appropriate for the overflow at SPS 120 and others discharging to the Wetland No. 159 sensitive area to reduce visible pollution.

The impacts of implementing these actions need to be considered in more detail during the second stage EIA.

4.4.4 Partially treated STP discharges

The main wet weather overflow objectives for the Upper Nepean River REZ are related to minimising human health risks from pathogens. As such, actions to reduce partially treated STP discharges have concentrated on reducing the pathogen risks in the Upper Nepean River REZ.

The MOST analysis indicates that the lowest cost action for meeting the abatement standard for the West Camden STP is to provide disinfection of all wet weather flows, at a cost of $1.9 million. This would result in a total of 29 partially treated STP discharges per year but only 18 partially treated discharges per 10 years would have reduced disinfection efficiency.

Alternatively, use of a storage basin would enable the base case to be met through storage of all future wet weather flows up to the abatement level and return of these flows to the STP for full treatment when wet weather flow subsides. Storage has the advantage of providing some settling of wet weather flows which can reduce suspended solids concentrations. A storage basin of 5 ML would be sufficient to store all flows up to the proposed abatement standard. This action is estimated to cost $5.1 million, and would result in 18 partially treated STP discharges per 10 years, which would have reduced disinfection efficiency.

The size of the storage basin is determined by the full treatment STP rate, determined as part of the dry weather Hawkesbury-Nepean preferred strategy and the desired partially treated STP discharge frequency. The proposed solution is a combination of optimal storage and disinfection, comprising of a 1 ML storage basin at West Camden STP with 40 ML/d capacity for disinfection of storage discharges (increased from 15.5 ML/d), at a cost of $3.6 million. With this increased disinfection capacity flows up to 30ML/d will get full tertiary treatment without the need for temporary storage. Some flows between 30 ML/d and 40 ML/d will be temporarily stored prior to being returned to the main STP process train for treatment when the wet weather flow has subsided. The 1 ML basin will not be sufficient to store all flows up to the abatement standard (equivalent to 40 ML/d), but will provide some reduction in the amount of particulate matter through settling. Flows will exceed the 40 ML/d disinfection capacity 18 times per 10 years and these flows will receive only partial treatment and disinfection with reduced efficiency.

Despite a higher cost, the combined storage and disinfection option is preferred for the following reasons:

- the storage provides significant reduction of smaller wet weather overflows which are less diluted by stormwater
- increases the reliability of the STP to process sewage flows
- provides a cost effective compromise between disinfection only and full storage
- storage provides additional settlement of gross solids prior to disinfection and discharge and
- in large storm events the first flush, containing higher concentrations of contaminants, receives a higher level of treatment.

This solution provides the best value for money solution for partially treated STP discharge abatement.

4.5 Proposed actions to achieve dry weather overflow abatement objectives

Dry weather actions include measures to reduce the potential for and/or mitigate the impact of chokes, exfiltration, SPS failures and odours. The cost spreadsheet output is based only on minimising costs for the selected wet weather abatement option and does not consider environmental or any other community concerns. In Section 4.4 there was some consideration of such concerns through the assessment of the benefits of providing additional wet weather abatement for sensitive areas. However, to allow full consideration of all environmental and community concerns, the package of actions identified in Section 4.4 must be modified with consideration of actions which address the overflow problems identified for chokes, exfiltration, SPS failures and odour emissions. The final combination of actions could therefore differ from the lowest cost combination identified by the cost spreadsheet model.

The following sections identify additional areas with high chokes, exfiltration, SPS failures and odours and consider specific actions to reduce the potential for them to cause impacts. Options identified below are in addition to those already identified for abatement of wet weather overflows and have been developed with the assistance of the overflow ranking results presented in Chapter 3.

4.5.1 Choke related overflows

The West Camden sewerage system has sufficient hydraulic capacity to transport existing dry weather flows to the STP so there will be no overflows due to hydraulic bottlenecks in the system. As the population served by the system grows, Sydney Water will maintain and upgrade the system so that hydraulic capacity remains sufficient to transport all dry weather flows to the STP. Chokes will

therefore not be due to hydraulic capacity but only due to partial or complete pipe blockages caused by tree roots, collapsed pipes, siltation, grease build up or similar restrictions.

There are no suburbs with a high choke density in the West Camden sewerage system catchment. However, Camden and Elderslie have a medium choke density and overflows from some parts of these suburbs drain to the Nepean River sensitive area. As such, it is proposed to consider additional actions to reduce chokes in Camden and Elderslie as part of the integrated overflow strategy, particularly since these areas have also been identified as potentially having moderate exfiltration. Abatement works in these areas will be targeted at reducing all overflow problems simultaneously.

Inspection of sewers will be increased and response time to chokes improved for sewers draining to the Nepean River sensitive area. The suburbs draining to the Narellan Creek sensitive area have a low choke density therefore no further preventative measures are required.

As part of the development of a comprehensive management plan for creating a reliable information collection and processing system, the frequency, causes and solutions to chokes will need to be managed to produce meaningful, actionable, reliable and accurate performance statistics on chokes.

4.5.2 Exfiltration

The limited monitoring data for the three gauged sub-catchments identified by the leakage analysis as exfiltration candidates shows some minor dry weather deterioration of water quality in the Nepean River at Camden. Routine dry weather faecal coliform sampling will be initiated for all three gauged sub-catchments.

Rehabilitation works to reduce exfiltration can also reduce infiltration and will therefore contribute to reducing wet weather overflows. The three gauged sub-catchments identified as moderate exfiltration candidates have already been identified for I/I reduction works as part of the long-term wet weather overflow abatement actions. However, it is proposed to prioritise the investigation into these sub-catchments because they overflow towards the Nepean River and Wetland No. 159 sensitive areas. All of the areas should be added to the interim I/E program and rehabilitation should be conducted based on the outcomes of the investigations.

4.5.3 Overflows caused by SPS failures

The SPS ranking process (see Chapter 3) indicates that SPS 453 and SPS 614 do not have an alternative power supply. Sydney Water will investigate the potential impact of power supply failures on these SPSs, including a comparison of the typical duration of power supply interruption in the area with the detention time at the SPSs. If power supply interruptions are likely to result in overflows at these SPSs, Sydney Water will upgrade the SPSs to provide an alternative power supply.

Existing failure planning at SPS 614 will be reviewed to ensure an appropriate response to SPS failures or overflows.

SPS 120, 453 and 484 all have response times which exceed their detention times. Sydney Water will assess the best means to address this problem, either by upgrading the SPSs to increase the detention time, and so increase the time available for response, or by improving the response time to respond to the failure earlier.

Prioritisation of emergency response call-outs and of the upgrading works discussed above will reflect the relative ranking of the pump stations, as discussed in Chapter 3. SPS 120 has the highest ranking as its overflow discharges to a sensitive wetland. SPS 120 is followed in priority by SPS 484 and SPS 453. The ranking accounts for the sensitivity of the receiving environment and the potential magnitude of the overflow.

As part of the development of a comprehensive management plan for creating a reliable information collection and processing system, the frequency, causes and solutions to SPS failures will need to be managed to produce meaningful, actionable, reliable and accurate performance statistics on SPSs.

4.5.4 Odours

The only significant odour problem identified for the West Camden sewerage system is at SPS 614, as discussed in Chapter 2. The other major odour source is at the STP. Odours at SPS 614 are being addressed in the short-term through chemical dosing to reduce hydrogen sulphide formation. In the long-term, odour emissions are expected to decrease as population grows and the flow through SPS 614 increases. No additional capital works are required to reduce odours from the West Camden system as the existing approach is expected to adequately address the odour problems. Odour complaints will continue be investigated using the existing procedures. Siltation is predicted in many upstream sections of the carriers in the West Camden system. Low flow sections of these carriers will be regularly flushed to avoid siltation and generation of odours.

None of the identified sensitive areas require additional abatement to reduce the impacts of odours.

4.6 The proposed integrated overflow strategy

In this section, the overflow abatement actions proposed to address wet and dry weather overflows in the West Camden system are combined to give an integrated overflow strategy. Some of the actions identified by SEEKER will address dry weather overflow problems as well as wet weather overflow problems. Table 4.7 shows a comparison of the five main actions used by SEEKER against various selection criteria to assess their ability to address dry weather overflow problems.

Table 4.7 shows that I/I source reduction has the highest overall compatibility as part of an integrated overflow abatement strategy, as it is effective in reducing wet weather overflows, provides additional system capacity and can also reduce chokes and exfiltration. This means that maximising the I/I reduction component in the wet weather package determined by the SEEKER model may be a cost effective means of addressing both wet and dry weather overflows. An additional SEEKER run was therefore trialed which maximised I/I reduction to determine the impacts on costs.

The cost of $15.9m for the maximum I/I run is lower than the minimum cost of $11.8m for the 20 overflow events per 10 years abatement with an additional $6.8m for dry weather abatement works (see Table 4.10). However, the maximum I/I run only covers a small area for I/I rehabilitation and does not fully coincide with, and hence fix up, all of the dry weather problem areas. Therefore I/I reduction is only recommended to target the areas already selected by SEEKER in the minimum cost run, with additional I/E reduction for areas identified as having high or moderate exfiltration and medium choke density suburbs draining to sensitive areas. These additional areas are discussed further in Section 4.7.2.

Table 4.7 Comparison of overflow abatement options

Option selection criteria	Options				
	Source reduction (I/I)	Transport (interceptor and reticulation)	Treatment facility upgrade	Overflow storage	Partial treatment at overflow structure
Reduction of wet weather overflows from designed structures	high	moderate - does not address all I/I sources	required for upgraded transport	moderate - depends on location within the reticulation system	none
Reduction of wet weather reticulation surcharges	high - reduces flow to surcharge location	moderate - does not address all I/I sources.	required for upgraded transport	moderate - depends on location within the reticulation system	none
Reduction of exfiltration and infiltration	high - main contributor to flow issues	none	none	none	none
Reduction of chokes	moderate to high- some chokes removed during rehab. work, reduced tree root entry	low to moderate - increased capacity reduces the potential for chokes causing overflows	none - chokes in reticulation system issues not addressed	low - chokes in reticulation system issues not addressed	low - does not address upstream or downstream of structure
Reduction of odour emissions	moderate - reduced base flows will result in less overflows	low -some reduction of overflows	low - No impact to reticulation system related odours	potential odour source increased; control management should limit impact	none
Satisfaction of legal requirements of the *Clean Waters Act*	high - will reduce occurrence and volume of overflows	high - will reduce occurrence and volume of overflows	high - will reduce pollutant concentrations to receiving water	high - reduces volume of overflows at peak times	moderate - some reduction in pollutant concentration but little impact on volume of overflow
Compatibility with longer term solutions	high - compatible	low - high expenditure may impact other environmental programs	moderate - high expenditure may impact other environmental projects. Compatible with TCM	low - high expenditure may impact other environmental projects	low - high expenditure may impact other environmental projects
Environmental impact incurred by implementing the action	low to moderate - some construction disturbance	moderate - construction disturbance	low to moderate - construction disturbance but within SWC property mostly	moderate - construction disturbance	moderate - construction disturbance
Capital and operating costs	moderate	moderate	high	high	moderate to high - depends on treatment implemented
Overall suitability of action with respect to mngmt strategy	high - part of SWC system mngmt and in line with ESD	appropriate part of SWC system management	appropriate component of total catchment management	low -high cost	moderate - increases SWC infrastructure and operator complexity

To identify additional areas with high chokes and exfiltration to add to those which have already been targeted by the model, each inflow catchment in the West Camden system was assessed on the basis of infiltration/exfiltration, rainfall ingress, choke density and local environmental impact to arrive at a priority for remediation, as described in Chapter 3. This assessment incorporates the recommendations made in Section 4.5 for each of the dry weather overflow categories. The catchments have been prioritised for addition to the I/E program discussed in Section 2.2.

Table 3.5 in Chapter 3 lists those inflow catchments which have been assigned a priority of one for addition to the I/E program. The complete list of priorities for all of the inflow catchments in the West Camden system is provided in Appendix C (Volume 3). Inflow catchments with a priority of one will be added to the I/E program as soon as possible and remediated if investigations confirm the priority. On this basis, all of the inflow catchments listed in Table 3.5 will be added to the I/E program as soon as possible. Some of these inflow catchments have been identified for remediation by SEEKER as part of the cost-optimised package. Of these inflow catchments, WE4-01, EC1-02, EC11-06, EC11-07 and EC11-08 are considered particularly important as exfiltration from these catchments may potentially impact on sensitive areas. The remaining catchments should be placed on the I/E program for investigation according to the indicated priority and subsequently remediated if investigations upgrade their priority to one.

Figure 4.1 shows the components of the proposed upgrade, highlighting the sub-catchments identified for I/I reduction. The costs of the preferred upgrade are discussed in Section 4.7.2.

Other local actions will be identified and evaluated to reduce overflows from individual overflow structures to Nepean River sensitive area at Camden by relocating or removing the overflows. These options will be considered in detail during the second stage Environmental Impact Assessment (EIA). This EIA is required by the approval process, as defined by the *EP&A Act*, 1979, for any works or projects recommended in these EISs. The most suitable and cost-effective actions can then be selected for this sensitive areas.

The specific structural and management actions that are recommended for the West Camden sewerage system will be implemented through a proposed management plan which integrates the timetable for improvements, funding requirements, researching, system maintenance, training and standardised operating and emergency response procedures (see Section 4.7).

4.7 The proposed management plan

The management of West Camden is designed to deliver the system performance which meets the overflow abatement objectives for the Upper Nepean River REZ. It is important to note that the structural actions outlined in this volume of the EIS are only indicative of the measures required to meet the objectives and that final selection of actions will be decided during the second stage Environmental Impact Assessment (EIA).

Components of the management plan have been selected to achieve a balance between non-structural and structural actions that can be implemented progressively over the next 25 years. 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 4.8 provides a summary of the actions by overflow type.

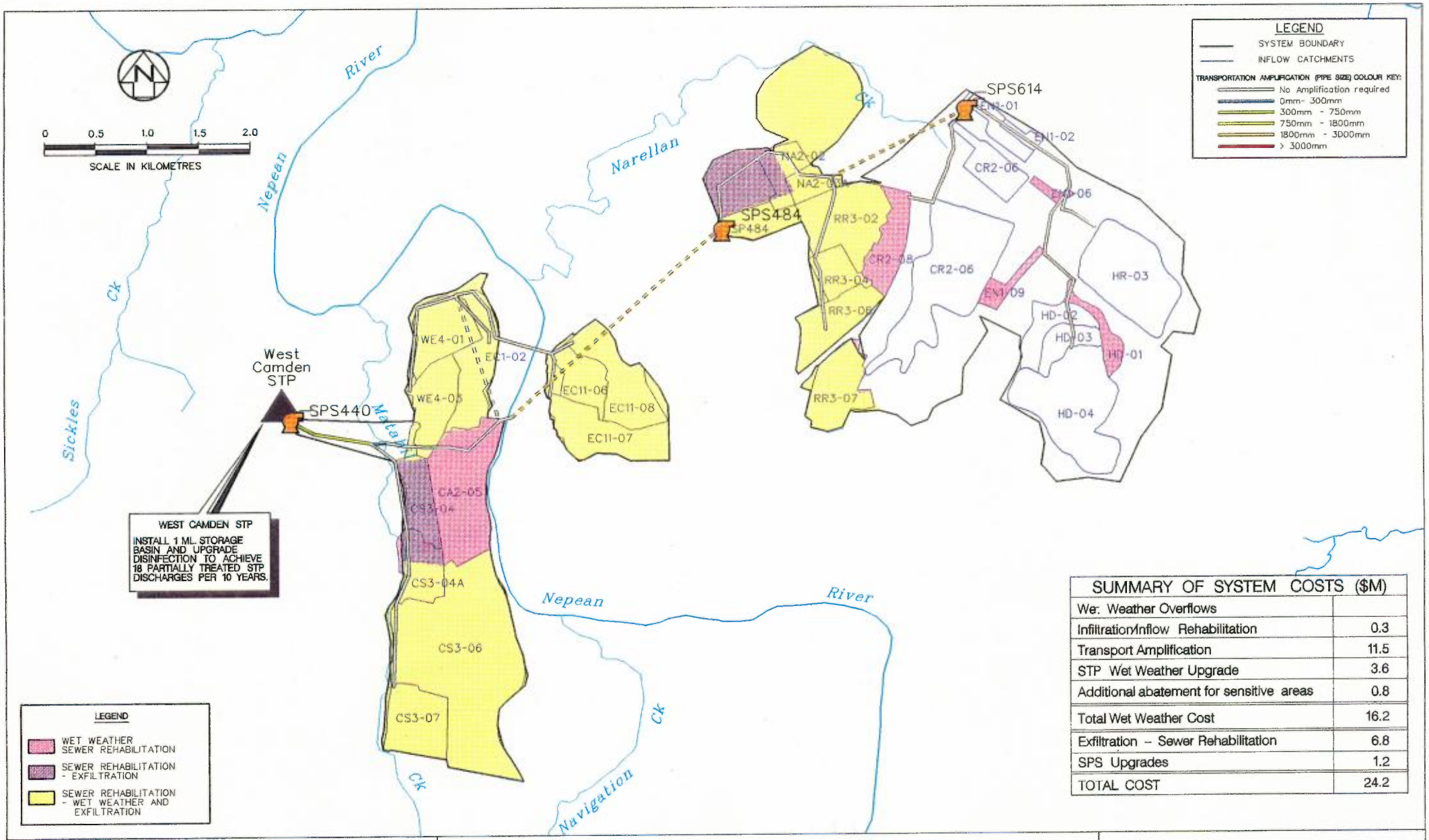
Table 4.8 Proposed actions for West Camden by overflow type

Overflow type	Actions
Wet weather overflows	Implement the 18 overflow events per 10 years abatement option across most of the West Camden system to maintain the existing number of overflow by implementing I/I reduction works and amplifying pipes to transfer more flow to STP. I/I rehabilitation of reticulation sewers only up to the boundary trap to minimise disturbance to private properties
	Implement the 5 events in 10 years overflow abatement option for the sub-catchments overflowing to the Nepean River corridor sensitive area.
	Ensure that all SPSs are sized to accommodate additional flows from future population growth.
	Investigate low-cost actions for additional protection of sensitive areas during detailed EIA process
Partially treated STP discharges	Install new 1 ML storage basin and increase disinfection capacity at STP to 40 ML/d to provide the equivalent of an 18 events per ten years abatement standard.
Chokes	Address medium choke density in Camden and Elderslie by adding inflow catchments WE4-01, WE4-03, EC1-02, CS3-04, CS3-04A, CS3-06, EC11-06, EC11-07 and EC11-08 to the I/E investigation program.
	Prioritise response times to sensitive areas at Nepean River, Narellan Creek and Wetland 159.
Exfiltration	Initiate routine dry weather faecal coliform sampling for the three gauged sub-catchments identified as moderate exfiltration candidates and add catchments to interim I/E investigation program on the basis of priorities identified in Table 3.5.
SPS failures	Prioritise response time to failures of SPS 120 and 453 to minimise impacts on sensitive areas. Consider installing preliminary treatment such as screens or bag filters.
	Assess likely impacts of power supply interruptions at SPS 453 and SPS 614 and provide alternative power supply if necessary to reduce risk of overflows.
	Upgrade SPS detention time or improve response time at SPS 120, 453 and 484 so that the detention time exceeds the response time.
Odours	Implement regular inspection and, where necessary, flushing of upstream sections of carriers prone to siltation.
	Continue chemical dosing at SPS 614 and monitor success of odour reduction measures. Consider additional odour reduction actions if odour complaints continue.

These actions will assist in meeting Sydney Water's long-term overflow abatement objectives, as identified in Table 4.1 of Volume 2 of this EIS by;

- reducing wet weather overflow events by over 70% to the Nepean River corridor sensitive area
- partially treated discharges from West Camden STP not causing water quality in the Nepean River to exceed swimming criteria in wet weather
- reducing the number of surcharges due to chokes which will continue to meet the objective that greater than 96% of customers are not affected by surcharges and work towards less than 10 internal surcharges per year due to SWC across Sydney in dry weather
- rehabilitating pipeline such that exfiltration does not cause dry weather failure of swimming or boating criteria and
- reducing the number of SPS failures and the resulting dry weather overflows to work towards less than 15 discharges per year from designed overflow structures in dry weather across Sydney.

The West Camden system already meets the long-term objective for odours, namely that less than three odour events per year occur for any individual asset.



SUMMARY OF SYSTEM COSTS ($M)	
Wet Weather Overflows	
Infiltration/Inflow Rehabilitation	0.3
Transport Amplification	11.5
STP Wet Weather Upgrade	3.6
Additional abatement for sensitive areas	0.8
Total Wet Weather Cost	16.2
Exfiltration – Sewer Rehabilitation	6.8
SPS Upgrades	1.2
TOTAL COST	24.2

Sydney WATER

SYDNEY WATER CORPORATION LIMITED
ACN 063 279 649

SEWERAGE OVERFLOWS LICENSING PROJECT
WEST CAMDEN SEWERAGE SYSTEM

FIGURE 4-1
COMPONENTS OF THE PREFERRED UPGRADE

Management actions for overflows are being implemented by SWC across all systems through the System Management Planning Process (SWC, 1997a) and will continue to be used as part of Sydney Water's continuous improvement process. These are an integral part of the proposed management plan and are in line with the USEPA's methods for controlling overflows (USEPA, 1996).

Table 4.9 shows the proposed management practices to reduce the potential for sewerage overflows and to minimise the impacts of overflows when they do occur.

Table 4.9 Recommended management practices for West Camden sewerage system

Management option	Description
Overflow Prevention	
Program for detection of unknown overflows	Locate and record unknown overflow locations as part of CCTV inspection program for reduction of I/I and exfiltration problems.
Overflow Impact Minimisation	
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. Use of signs at major overflows. Make public aware of need to contact Sydney Water Corporation promptly when aware of overflows. Use Streamwatch, messages on water bills.
Dry weather chokes	Continue to inform public on planting trees near sewers. Clean siltation from sewers prone to blockage. Continue repeat choke program
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	
Prevention of stormwater backflow into sewer at overflow structures	Regularly maintain outlet of overflows. This can be effective in stopping large volumes of stormwater entering the sewer.
Program for maintenance	Continue routine maintenance program for all sewers, overflows, pumps, including regular checks on pump start sequences. Ongoing program 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 manage system and implement continual improvement. Update and maintain Standard Operating Procedures for all aspects of the system operation and emergency responses. Update and maintain the system management planning process
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.

Note:

1. Most of the above management practises are already being carried out by Sydney Water Corporation and will be continued and improved in the future.

4.7.1 System inspection, operation and maintenance

The existing SWC system inspection, operation and maintenance programs are designed to monitor the performance and reliability of the SPSs and maintain the capacity and condition of the infrastructure. These programs will continue to be used and updated as part of the continuous improvement process, incorporating the recommended management practices discussed in Table 4.9

Particular attention will be given to response procedures used in emergency situations to prevent sewerage overflows reaching the receiving environment. The emergency response procedures will be standardised and set out as part of the System Management in accordance with SWC'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 SWC to enable the public to report overflows. This will feature as part of SWC community education efforts.

The proposed management strategy will also require additional monitoring of known overflow points to determine the frequency of overflows and any resulting environmental impacts, as discussed in Section 4.4.

In addition, to the monitoring known overflow points, there may be unknown overflows, that is, overflows from the system that could be occurring, but have not yet been detected and evaluated. Unknown overflows may have an impact on the receiving environment. Sydney Water will develop programs to identify unknown overflows and their causes, so that abatement actions can be identified.

4.7.2 Costing and funding

Table 4.10 identifies the estimated cost for components of the proposed strategy. The total estimated cost for the West Camden System over the next 25 years is $24.2 million. This figure includes I/E remediation in inflow-catchment 806000 but does not include any additional remediation that may be identified through the I/E program. The cost does not include costs for routine capital works (maintenance driven) and routine operating costs.

The costs presented in Table 4.10 have been analysed to reduce their conservativeness and duplication of some costs. The upgrades for wet weather overflow abatement developed in the SEEKER costing model will improve the physical condition of the sewers and therefore reduce the extent of exfiltration, chokes and SPS upgrades as a by product. This will reduce the extent of work, and hence cost, required to specifically target exfiltration, chokes and SPS upgrades.

The inclusion of costs for exfiltration, chokes and SPS upgrades in Table 4.10 is dependent on whether they have been included in previous categories, as well as their ranking in the SPS ranking spreadsheet or in the Chokes and Leakage Prioritisation spreadsheet.

Therefore, exfiltration areas will be added to Table 4.10 if they have a high priority ranking and are not already included in the SEEKER costing model. Similarly, choke suburbs will be included if they have a priority ranking (1 or 2) and are not included in the SEEKER costing model or in the exfiltration area costing. SPSs will be included if they have a high priority ranking and have not already been included in the SEEKER costing model. Further details for each exfiltration area, choke suburb or SPS are given in the notes attached to Table 4.10

The detailed costing of the remedial work will be developed as part of the investigation of the specific work necessary to be done in the sewerage system to achieve the overflow objectives. The final result of this detailed analysis will be either a reduction in the cost of the remedial works or an opportunity to achieve a higher level of overflow abatement at the same cost.

An economic evaluation study of the benefits and costs has been prepared for the West Camden sewerage system as part of the Upper Nepean geographic area and it is included in Chapter 4 of Volume 2 for the Upper Nepean Geographic Area. The study estimated the NSW community's willingness to pay for abatement works. Although the costs of the proposed actions 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.

Table 4.10 Summary of cost estimates

Proposed strategy	Basis of costing [1]	Number of components	Total estimated cost in year 2021 $m[1,2]
Wet Weather Overflow Abatement levels	Provided by the SEEKER model in *Strategic Options For Overflow Abatement - Using Ten years Time Series Modelling* (not including STP Upgrade costs)	-	11.8
Additional wet weather overflow abatement for sensitive areas	Based on components of the SEEKER model for sub catchments draining to sensitive areas.	1	0.8
Exfiltration per Sub-Catchment	'High' to 'Low' = $3.25m per catchment to be upgraded	0	0
	'Medium' to 'Low' = 2.25m per catchment to be upgraded	3[3]	6.8
SPS Failures	$600,000 per SPS average cost	2[2]	1.2
Chokes per suburb	'High' to 'Low' = $2.2m per suburb	0[4]	0
	'Medium' to 'Low' = 1.5m per suburb	0	0
STP Upgrade	Provided by the MOST model in *Wet Weather Treatment at STPs*	1	3.6
Odours	No additional cost as above costs will correct odour problems.	0	0
	Total $m		24.2

Notes:

1. Costs in dollars at 1997. The proposed strategy will be incorporated into the consolidated findings of the sewerage overflow licensing EIS outcomes of all SWC's sewerage systems and be consistent with the Environmental Indicators Monitoring Program required by the Operating Licence.

   Improved operational and management practices within normal operating expenditure will include; improved operations and management practices; improved reporting systems; additional water quality modelling and; additional wastewater modelling

   Costs for ongoing existing practices are not included in the above table as the above are intended to reflect new and additional costs.

   Details of the basis for costing is given in Appendix I (Volume 1)

2. Add SPS 120 and 453 to the SPS category. SPS 440, 484 and 614 are already included in SEEKER costs..
3. Medium exfiltration areas (806000, 828001, 828005) are not included in the SEEKER model costs.
4. Medium choke suburbs (Camden and Elderslie) are already included in the SEEKER costs.

4.7.3 Implementation

The components of the proposed management plan will be implemented as part of the rolling 5 year capital works program over the 25 year period. The immediate focus of the plan is on recommended management practices to reduce overflows, particularly overflows caused by system failures during dry weather conditions. Overflows during dry weather have greater potential for adversely affecting receiving environments than wet weather overflows because the sewage pollutants are more concentrated and there is less dilution in receiving waters.

Many of the recommended management practices have already been adopted by SWC to minimise the frequency and impacts of overflows during dry weather. Continuous improvement of these management practices will further reduce dry weather overflows at minimal expense.

There is potential to achieve substantial local benefits by abating overflows with significant impacts at a cost that is small relative to the total cost of overflow abatement for the system. In the short-term, the following low cost actions will be considered in more detail to determine the impacts on the rest of the system:

1. sealing overflow locations
2. raising weir levels at overflow structures
3. optimising/upgrading performance of sewage pumping stations
4. transfer of discharge point and
5. small treat/discharge facility (as part of the "pilot-scale study").

The frequency of discharge from major overflows or points in the reticulation system (particularly CA2-07 (reticulation overflow), EC11-05 and EN1-01 which drain to sensitive areas) will be verified by local monitoring over the next two years prior to the implementation of any structural works.

The two potential exfiltration sub-catchments in the West Camden sewerage system which have not already been identified for remediation will be added to the interim I/E program and monitored over the next two to five years to determine the extent and impacts of exfiltration. Where exfiltration is verified, the sub-catchments will be added to the I/E program for detailed inspection and remediation works.

Some structural actions will also be implemented in the short to medium-term to bring the SPS pump rates up to recommended levels. Major structural actions to abate wet weather overflows will be implemented in the medium to long term as the population connected to the system increases. Table 4.11 shows the delivery timetable for the components of the proposed management plan. The baseline for delivery of the components is from licensing of the system. Details of the background and consequences of the timetable's implementation are given in Volume 1 of the EIS.

Table 4.11 Delivery timetable for proposed management plan components

Proposed management plan Components	Delivery timetable				
	Up to 5 Years	5 to 10 Years	10 to 15 Years	15 to 20 Years	20 to 25 Years
Recommended management practices (as given in Table 4.9)	❐	❐	❐	❐	❐
Implement 18 overflow events per 10 years condition abatement of overflows across whole catchment		❐	❐		
Install 1 ML storage basin and disinfection at STP to improve wet weather treatment		❐	❐		
Monitor O/Fs and review/implement low cost actions for overflows & reticulation to reduce overflows to sensitive areas		❐	❐		
Repeat modelling of wet weather overflows, calibration from field data	❐	❐	❐	❐	❐
Flush low flow sections of carriers (as required)	❐	❐	❐	❐	❐
Review need for alternative power supply at SPS 453 and 614.	❐				
Increase detention time or reduce response time at SPS 120, 453 and 484 to reduce the likelihood of overflows.	❐				
Review capacity and amplify pumps to meet increased flows due to future population			❐	❐	❐
Conduct I/E investigations and remediation where appropriate of the high and medium exfiltration sub-catchments	❐	❐			
Conduct I/E investigations and remediation where appropriate of the medium to low exfiltration sub-catchments			❐	❐	❐
Implement dry weather monitoring program to confirm exfiltration sub-catchments and conduct prioritised I/E remediation	❐	❐	❐	❐	❐
Develop community education programs on sewerage overflows	❐				
Develop an on-going review process - SWC/EPA/community representatives	❐	❐	❐	❐	❐

Chapter 5

Assessment of Environmental Benefits of the Proposed Strategy

Synopsis for Chapter 5

This chapter describes the benefits gained from implementation of the proposed strategies as described in Chapter 4. These benefits are in line with the objectives identified by the Upper Nepean Catchment Management Committee (UNCMC).

The impacts of overflows to the aquatic environment in the Upper Nepean River REZ have been shown to be minor when compared to other point and non-point sources contributing pollutants to receiving waters. The proposed strategies will result in some improvement in water quality, mostly due to the improved treatment of wet weather discharges from West Camden STP. The aquatic environment will benefit from reduced nutrient and faecal coliform loads and reductions in dry weather impacts associated with chokes and exfiltration.

The impacts of overflows on the terrestrial environment are minor, and are primarily limited to impacts from chokes and exfiltration, since most wet weather overflows discharge directly to aquatic environments. The terrestrial environment will benefit from sewer rehabilitation to reduce dry weather overflows.

The impacts of overflows on the socio-economic environment are mostly related to recreational use of the waterways. A slight increase in the number of days conforming to criteria for swimming and boating will be achieved in the Upper Nepean River by implementing the strategy for the West Camden system. Visual amenity and air quality will also improve.

If the proposed overflow abatement strategy is not implemented, the environmental impacts of sewerage overflows, which are currently minor, may increase to significant levels as a result of population growth in the catchment and deterioration of sewers.

The proposed strategy meets the requirements of ecologically sustainable development, the goals of Sydney Water's Environment Plan and other environmental initiatives as well as the expectations of the community.

5. Assessment of environmental benefits of the proposed strategy

The proposed overflow abatement strategies for the West Camden sewerage system consider the environmental values set by the Upper Nepean CMC (UNCMC) as described in Chapter 3. The UNCMC has divided the catchment area for which it is responsible into five main zones and has set long-term environmental objectives for the waterways in these zones. Overflows from the West Camden sewerage system may potentially impact three of these zones, namely the Bargo/Central Nepean zone, West Camden zone and Narellan Urban zone. All of these zones have the objectives of protection of aquatic ecosystems and maintenance of visual amenity. The Bargo/Central Nepean and West Camden zones share the additional objectives of water quality adhering to guidelines for fisheries and shellfish aquaculture, and water quality suitable for agricultural water use (including stock watering, irrigation and farmstead water). The West Camden and Narellan Urban zones have the supplementary objective of water quality suitable for boating while the Bargo/Central Nepean zone has the objective of water quality suitable for swimming.

The proposed strategy will maintain the existing performance of 18 events per 10 years for future conditions, in spite of future population growth in the catchment. This includes improving wet weather treatment at West Camden STP to match the performance of the rest of the sewerage system (refer Chapter 4). Additional overflow abatement will be provided for the sensitive Nepean River corridor (5 events per 10 years). The strategy will substantially reduce wet weather overflow volumes from the West Camden sewerage system and provide water quality benefits in the Upper Nepean River REZ. The main benefits of the proposed abatement strategy are increased protection of sensitive aquatic environments and improved recreational suitability of the Nepean River.

5.1 Benefits to the aquatic environment

Implementation of the proposed strategy will result in localised benefits to the section of the Nepean River and its tributaries which receives overflow discharges from the West Camden sewerage system. Waterways potentially affected by overflows from the West Camden sewerage system include Matahil Creek, Narellan Creek and Navigation Creek, which are all tributaries of the Nepean River. Treated effluent from West Camden STP is discharged to Matahil Creek, approximately one kilometre upstream of the confluence with the Nepean River. The benefits to the Upper Nepean River REZ are discussed in detail in Volume 2 of this EIS.

The overall volume of wet weather overflows from the sewerage system will be halved after implementation of the proposed overflow abatement strategy, due largely to the transfer of additional wet weather flows to the STP. The volume of partially treated STP discharges will not change substantially, as increased wet weather storage capacity at the STP will be balanced by increased wet weather flows to the STP. The proposed 1 ML storage basin and 40 ML/d disinfection facility at the STP will allow the number of partially treated STP discharges to increase slightly from 70 to 75 per 10 years, but will reduce the number of partially treated discharges not receiving full disinfection to 18 per 10 years to match the performance of the sewerage system. The main benefit of the decrease in wet weather overflow volumes and the improvement in wet weather treatment at the STP will be improvements in the recreational suitability of the Nepean River downstream.

The benefits to the aquatic environment of the proposed strategy will primarily be of a localised nature and will add value to the aesthetic and community amenity of waterways. Wet weather pollutant loads throughout the West Camden sewerage catchment will decrease, particularly downstream of West Camden STP. There will be an increase in the number of days meeting ecosystem protection guidelines of one day (to 365 days per year) for phosphorus and 58 days (to 365 days per year) for chlorophyll-*a* in the Nepean River downstream of Matahil Creek. The reduction of nutrients entering the aquatic environment will improve the aquatic ecosystem so that the likelihood of environmental problems such as eutrophication, algal blooms, toxicity to aquatic lifeforms and human health impacts will be reduced.

However, due to the dominance of pollution from other sources, such as stormwater and agricultural runoff, the improvement in days complying with guidelines for swimming and boating will be minor. There will also be a decrease in the proportion of time meeting ecosystem protection guidelines for nitrogen in the order of 103 days per year, due to assumed increased loads of nitrogen from other sources.

Three sensitive areas have been identified in the West Camden sewerage system, all of which are considered to have a medium potential for impact from sewerage overflows. The Narellan Creek corridor and Nepean River corridor contain important aquatic ecosystems, as well as waters that are classified Class P or C under the Clean Waters Act (SPCC, 1980). Wetland No. 159 is a sensitive aquatic ecosystem, listed under SEPP 14. The benefits to these sensitive areas resulting from the implementation of the proposed strategies will be related to the reduction in nutrient loads discussed above, and the subsequent additional protection of the aquatic environment. Actual benefits to sensitive aquatic areas will be moderate, as nutrient loads from dry weather STP discharges and catchment runoff during wet weather will continue to dominate water quality.

In the event of an SPS failure, overflows from SPS 120 and SPS 453 may potentially impact on the sensitive areas of Wetland No. 159 and the Nepean River corridor respectively. These SPSs are to be upgraded to prevent overflows, which will provide additional benefits to sensitive aquatic ecosystems in the potentially impacted areas..

Other benefits to the aquatic environment will be gained by the rehabilitation of sewer catchments with identified exfiltration or choke problems. Dry weather sewage impacts that are likely to be associated with exfiltration have been observed in the Nepean River downstream of Narellan Creek. Sewer rehabilitation in the West Camden system will reduce dry weather sewage impacts in these creeks by reducing leakage from the system. Reduction in chokes and exfiltration will also provide localised improvements in water quality in impacted waterways.

5.2 Benefits to the terrestrial environment

The majority of wet weather overflows in the West Camden sewerage system drain directly to aquatic environments and do not impact on terrestrial ecosystems. Three designed overflow structures in the West Camden catchment discharge to the terrestrial environment along Matahil Creek. As all three of these discharges occur onto cleared rural land, terrestrial impacts are likely to be minor and as such the potential benefits to the terrestrial environment are minor. Wet weather overflows with a high activation frequency or volume have the potential to impact on riparian areas along receiving waters, as the nutrient load in the overflows may assist weed invasion of these areas. However, impacts on riparian areas from the West Camden system appear to be minor and will be further reduced by the overflow abatement strategy. No specific wet weather overflow abatement measures are required to protect the terrestrial environment.

The main source of terrestrial impacts would be from chokes as these may discharge to the terrestrial environment from random locations throughout the sewerage system. Choke frequency in the West Camden system is medium and the reticulation rehabilitation program will reduce the probability of chokes in the sewerage system. The potential for terrestrial impacts will therefore be further reduced.

Exfiltration may also impact the terrestrial environment. There are currently no reliable methods of measuring the volume of sewage exfiltration or the fate of the sewage once it leaves the sewer. The impacts from exfiltration will depend on a number of factors, such as soil type, permeability, wetness and vegetation cover, as described in Chapter 3. Three gauged sub-catchments in the West Camden system were identified as having a moderate likelihood of exfiltration.

Sydney Water has established a program of managing I/E (as described in Section 4.2). The I/E remediation works proposed for the West Camden system will reduce exfiltration and some surcharges from chokes in the sewers, and in doing so will reduce any impacts associated with exfiltration, such as nutrient enrichment of soils which would induce weed infestation. The program will also provide

localised protection for sensitive terrestrial areas, vegetation and fauna. Sensitive terrestrial areas in the West Camden sewerage system include riverflat forest, riparian vegetation and the Chellaston Street and Belgenny recreation reserves. These areas are not significantly affected by wet weather overflows, as all wet weather overflows drain either directly to aquatic environments or onto cleared rural lands. Therefore, benefits to these areas will primarily result from the I/E program and related remedial works. Additional overflow abatement for the Nepean River corridor will reduce the potential for any impacts on the terrestrial recreation areas along the Nepean River.

5.3 Benefits to the socio-economic environment

The main socio-economic benefits which will be achieved through implementing the proposed strategy include increasing the visual and recreational value of the environment. This is consistent with the objectives of the UNCMC. There will be a slight increase in the number of days conforming to ANZECC guidelines for swimming and boating in the Upper Nepean River REZ. The attractiveness and suitability of the waterways for recreation purposes will increase slightly, but not substantially, as the contribution of pollution loads from wet weather overflows is considered minor when compared to STP effluent and diffuse runoff.

Water quality modelling carried out in the Nepean River downstream of Matahil Creek to detect the impacts of the entire West Camden system predicts an additional eight days suitable for swimming (from 313 to 321) and seven days suitable for boating (from 349 to 356) per year following the implementation of the proposed abatement strategy. The Nepean River section between Macarthur and Cowpastures Bridge is a popular swimming and boating area. Additional overflow abatement is proposed for this area to reduce any local impacts on the recreational suitability of the Nepean River. Local residents also use the waterways for recreational fishing and exploration. As a result of implementing the proposed strategy the potential for human health impacts associated with these activities will decrease slightly. The long-term goal of water quality suitable for swimming will require control of all pollutant sources entering the Nepean River.

Decreased nutrients loads will result in decreased weed growth along waterways and terrestrial overflow locations and a reduction in algal blooms in the waterways. A decrease in the total volume of overflows will also result in a decrease in visual evidence sewage and particulate matter in the waterways. Improved visual amenity will increase the attractiveness of the waterways for passive recreation, as well as for water based recreation activities.

The proposed strategy will reduce chokes and exfiltration by rehabilitating damaged sewers and by regularly flushing blocked sewers due to siltation build-up. Sewer rehabilitation will improve the recreational suitability of the waterways during dry weather by reducing exfiltration impacts, and reduce the likelihood of choke induced overflows to private property. The incidence of odour emissions from the sewerage system and the potential for humans to come into direct contact with discharges will be reduced. These factors will contribute to in an improved community value for the West Camden environment.

Future generations will benefit from the proposed overflow abatement strategy as it will reduce existing overflow impacts and help to prevent increases in human health risks caused by bacteriological waterway contamination.

5.4 Consequences of not implementing the proposed management plan

If the measures outlined in the strategy for West Camden are not implemented, all types of overflows would increase in number of events and in total volume discharged due to increases in population and aging of sewers. Given the expected growth in the catchment, from a population of around 21,400 to around 101,200 in the next 25 years, modelling shows an increase of about 380% in ADWF is expected by 2021 and that wet weather overflow volumes will increase by a similar amount if no action is taken in the system (UPS, 1997).

The likely outcome of letting the system deteriorate would be a greater impact to aquatic, terrestrial and socio-economic environments, particularly identified high-value sensitive areas. If pollutant loads from all pollution sources (including urban and agricultural runoff) increase, the receiving environment is likely to become eutrophic. The waterways would not be capable of providing a suitable habitat for aquatic biota. Human health risks from contact with the water would increase. Algal blooms would occur more frequently and reduce the value and visual amenity of the waterways. This would lead to less likelihood of passive recreation by local residents who presently use the waterways in West Camden for this purpose. Another risk to human health may be posed from recreational fishing in these waters, as is currently practiced by the local community.

Terrestrial environments may also be affected by the increase in number of dry weather overflows due to chokes and exfiltration. This may result in greater nutrient enrichment of the soil, encouraging weed growth and limiting growth of native species which are adapted to low soil nutrient levels. Increases in discharges of sewage on land would promote odours and further decrease community values for the West Camden 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 proposed strategy is not implemented. The water quality modelling results show that removing all overflows will not prevent high nutrient loads being discharged to the waterways from other point and non point sources. The main consequences of not implementing the strategy would be reduced opportunity for recreational activities and degradation of the environment.

5.5 Justification of West Camden overflows abatement strategy

The West Camden overflow abatement strategy has been developed to work towards Sydney Water's long term objectives in line with the UNCMC's environmental uses and values identified for the Upper Nepean REZ. The strategy has been selected with due consideration of mitigating existing environmental impacts, benefits of alternative options, costs and economic evaluation of the NSW community's willingness to pay for overflow abatement. Justification of the Upper Nepean River REZ overflows strategy is discussed in Volume 2, Chapter 6.

The management plan includes a combination of structural and non-structural actions designed to;

- meet legal requirements and SWC's Operating Licence and Environment Plan
- best meet the four principles of ecologically sustainable development
- reduce overflows in a cost-effective manner as shown by the positive net present value calculated in the economic evaluation
- protect sensitive areas and
- minimise the impacts of overflows when they do occur.

Structural actions will be further refined and improved during the second stage EIA process prior to construction. Non-structural actions are focussed on recommended management practice in accordance with USEPA guidelines and are part of the continuous improvement process.

Chapter 6

Conclusions

Synopsis for Chapter 6

This chapter outlines the findings of the West Camden sewerage system overflows EIS, including the impacts of overflows, the proposed strategy, the benefits of this strategy and what actions Sydney Water will now be taking to monitor and assess the improvements.

The main overflows of concern are partially treated wet weather STP discharges and exfiltration draining to the Nepean River at Camden, a sensitive area used for swimming. Overflows from SPS 120 in the event of SPS failure are also of concern, as these overflows may impact on the sensitive Wetland No. 159. The volume and frequency of wet weather overflows from the West Camden system is small compared to the rest of Sydney Water's area of operations. The relative contributions of stormwater and dry weather STP discharges are much greater than wet weather overflows.

The base case of 18 wet weather overflow events per 10 years is therefore proposed for the West Camden System. Wet weather treatment at the STP will be upgraded and actions taken to reduce exfiltration and potential for SPS failures. The proposed strategy for the West Camden system is estimated to cost $24.2 million. The benefits of the strategy include a reduction in the level of pollutants being discharged into the waterways and a reduction in exfiltration volumes. A minor increase in the number of days available for primary and secondary contact recreation will be achieved in the main river, including the sensitive Nepean River corridor at Camden.

The management plan for the system balances structural and non-structural actions that can be implemented progressively over the next 25 years and will form part of Sydney Water's total quality assurance system. The plan focuses on best management practices and continuous improvement to reduce overflows, particularly those due to system failures in dry weather.

Assessment of the environmental impacts of overflows on the Upper Nepean River REZ has shown that the main overflows of concern from the West Camden system are partially treated wet weather STP discharges and possible exfiltration draining to the Nepean River corridor at Camden, which is a sensitive area used for swimming.

The volume and frequency of wet weather overflows is relatively small compared to the rest of Sydney Water's area of operations. The relative contributions of stormwater pollution and dry weather STP discharges are much greater than wet weather overflows.

6. Conclusions

The proposed management plan for the West Camden system is structured around the actions discussed in Chapter 4 and forms the overflow abatement strategy for the Upper Nepean River REZ. Table 4.7 outlines the proposed strategy for the West Camden sewerage system. The strategy has been selected to provide the optimum balance between the costs and social, economic, biophysical and ESD considerations.

The base case of 18 wet weather overflow events per 10 years is therefore proposed for the West Camden System. Wet weather treatment at the STP will be upgraded and actions taken to reduce exfiltration and potential for SPS failures. The cost of implementing the proposed strategy is approximately $24.2 million. This is comprised of $11.8m to prevent wet weather overflow impacts from increasing, $3.6m for upgrading wet weather STP treatment to improve the number of days suitable for swimming and boating, $0.8m to prevent wet weather overflows into the popular swimming area of the Nepean River. There is also $1.2m to fix up SPSs and $6.8m to reduce exfiltration, particularly to the Nepean River sensitive area. The NSW Government recently announced a $3.01 billion Waterways Package which includes $1.6 billion for the abatement of sewerage overflows. The funding will have to be reviewed after the public display of the EISs when the strategies have been approved.

The benefits of implementing the proposed strategy in the West Camden system would be reducing the level of pollutants being discharged into the waterways and reducing exfiltration volumes. A slight increase in the number of days available for swimming and boating will be achieved in the sensitive Nepean River corridor at Camden. Reducing the level of pollutants being discharged into the waterways will also improve the aquatic ecosystem.

Components of the management plan have been selected to achieve a balance between non-structural and structural actions that can be implemented progressively over the next 25 years. The immediate focus of the plan is on best management practices to reduce overflows, particularly due to system failures in dry weather.

Many of the proposed management practices have already been adopted by SWC 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 4.10.

Sewerage Overflows Licensing Project
Environmental Impact Statement

Volume 3: West Camden Sewerage System

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