



Summary of the environmental assessment

The recycled water would be substituted, as replacement flows, for water that is currently released from Warragamba Dam for extraction and river health purposes.

Introduction

The Replacement Flows Project (the Project) is part of the Western Sydney Recycled Water Initiative that is a component of the *2006 Metropolitan Water Plan*. The *2006 Metropolitan Water Plan* sets out how the NSW Government will achieve its objectives for securing Sydney's water needs over the next 25 years.

The Project involves the construction and operation of an Advanced Water Treatment Plant (AWTP) and associated works. It will include treating existing tertiary effluent from St Marys, Penrith and Quakers Hill sewage treatment plants (STPs) in north western Sydney at an AWTP located at St Marys, producing up to 50 million litres per day (ML/day) of highly treated recycled water. The recycled water would be substituted, as replacement flows, for water that is currently released from Warragamba Dam for extraction and river health purposes. The volume of tertiary treated effluent discharged directly from Penrith STP would be minimised, and sufficient volume of tertiary treated effluent discharged from St Marys and Quakers Hill STPs would be maintained for the downstream water users in South Creek.

The general study area for the Project is shown in **Figure 1**.

Need for the project

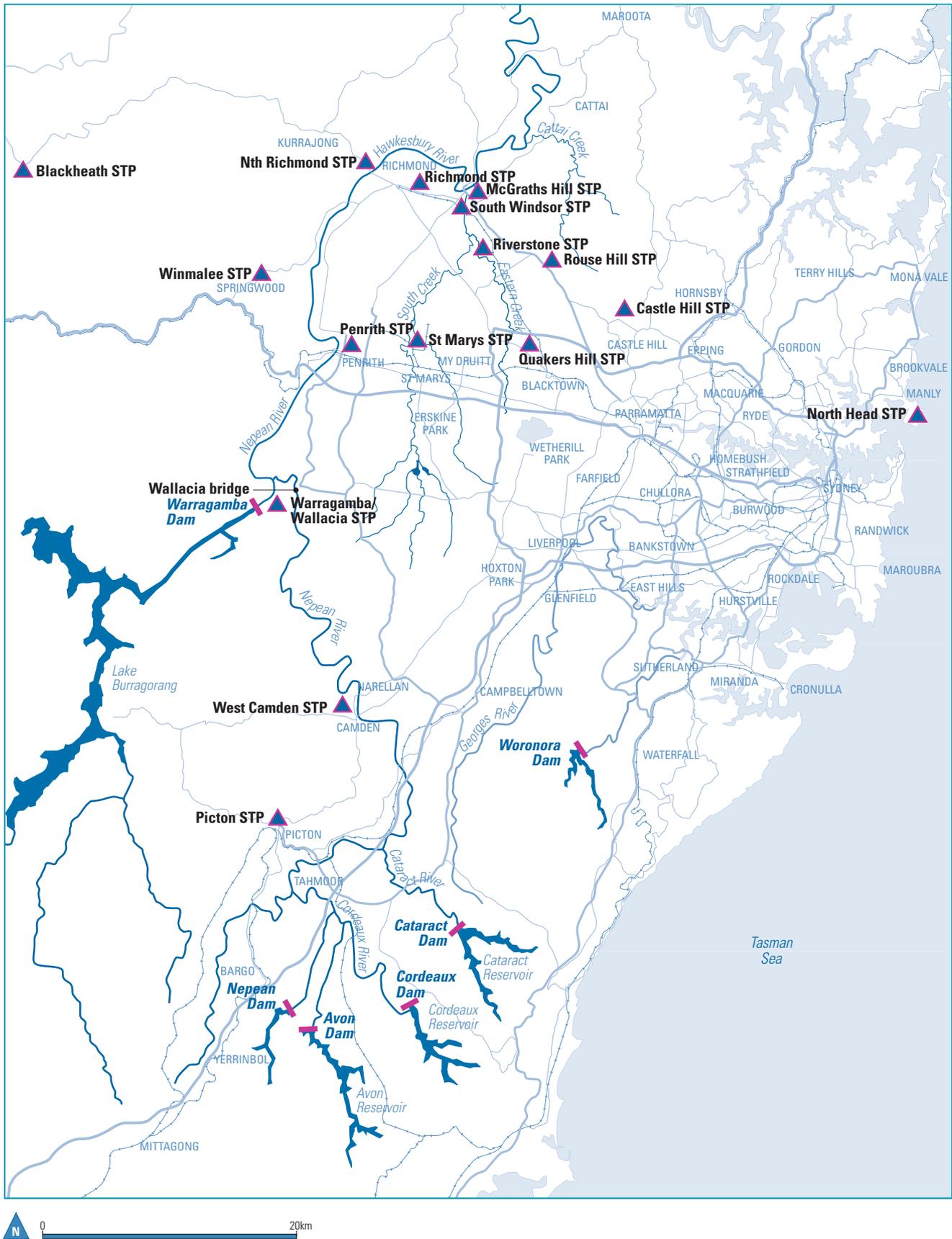
The *2006 Metropolitan Water Plan* objectives are to:

- provide a secure supply of water that can meet the long term needs of Sydney
- ensure that water supplies are adequate during drought
- minimise costs to the community and the environment.

The Replacement Flows Project objectives are to:

- save up to 18 billion litres per year of current Warragamba Dam discharges by providing high quality recycled water to the Nepean River as a replacement for existing Warragamba Dam releases
- reduce the discharge of nutrients from Penrith, Quakers Hill and St Marys STPs into the Hawkesbury-Nepean River and South Creek

Figure 1 General study area



- maintain appropriate flows for irrigation
- ensure environmental values are maintained – including aquatic ecosystems, primary industries, recreation and aesthetics and drinking water.

The Project, in combination with other planned river management changes, would ensure that the substitution of Warragamba Dam releases would deliver an equivalent or higher level of environmental benefit to the river and maintain water for irrigation/agriculture, recreational needs and for aquatic life.

This Environmental Assessment has been prepared under Part 3A of the *Environmental Planning and Assessment Act 1979* to obtain project approval for the Replacement Flows Project.

Purpose of the Environmental Assessment

This Environmental Assessment has been prepared under Part 3A of the *Environmental Planning and Assessment Act 1979* to obtain project approval for the Replacement Flows Project. It assesses the key environmental issues associated with the Project and proposes mitigation measures to address any potential impacts. It also includes a draft 'Statement of Commitments' that outlines Sydney Water's commitments for the management of environmental effects that could occur from the construction, commissioning, operation and maintenance of the project.

Strategic framework

2006 Metropolitan Water Plan

The *2006 Metropolitan Water Plan* outlines strategies to balance demand for water with a sustainable supply in the long-term. The plan is based on an adaptive management approach, with a diverse suite of options to meet Sydney's long term water needs during drought and non-drought times, while minimising the costs to the community and the environment. The key elements of the plan that are or will be put in place to achieve water savings, recycling and additional supply targets are summarised in **Figure 2**.

The *2006 Metropolitan Water Plan* reiterates the commitment of the *2004 Metropolitan Water Plan* to increase the environmental flow releases from the Upper Nepean Storages (Avon, Cordeaux, Cataract, Nepean) and to reconfigure weirs to allow those flows to contribute to the maintenance of the river water quality upstream and downstream of Penrith Weir. These releases will be a portion of all flows entering these storages. Current estimates are that the first 68 ML/day of flow into the catchments of these dams will be released from the dams and through the upstream weirs in the Nepean River (refer to **Table 1**). The Sydney Catchment Authority is proceeding with the works to enable these discharges to occur by 2009.

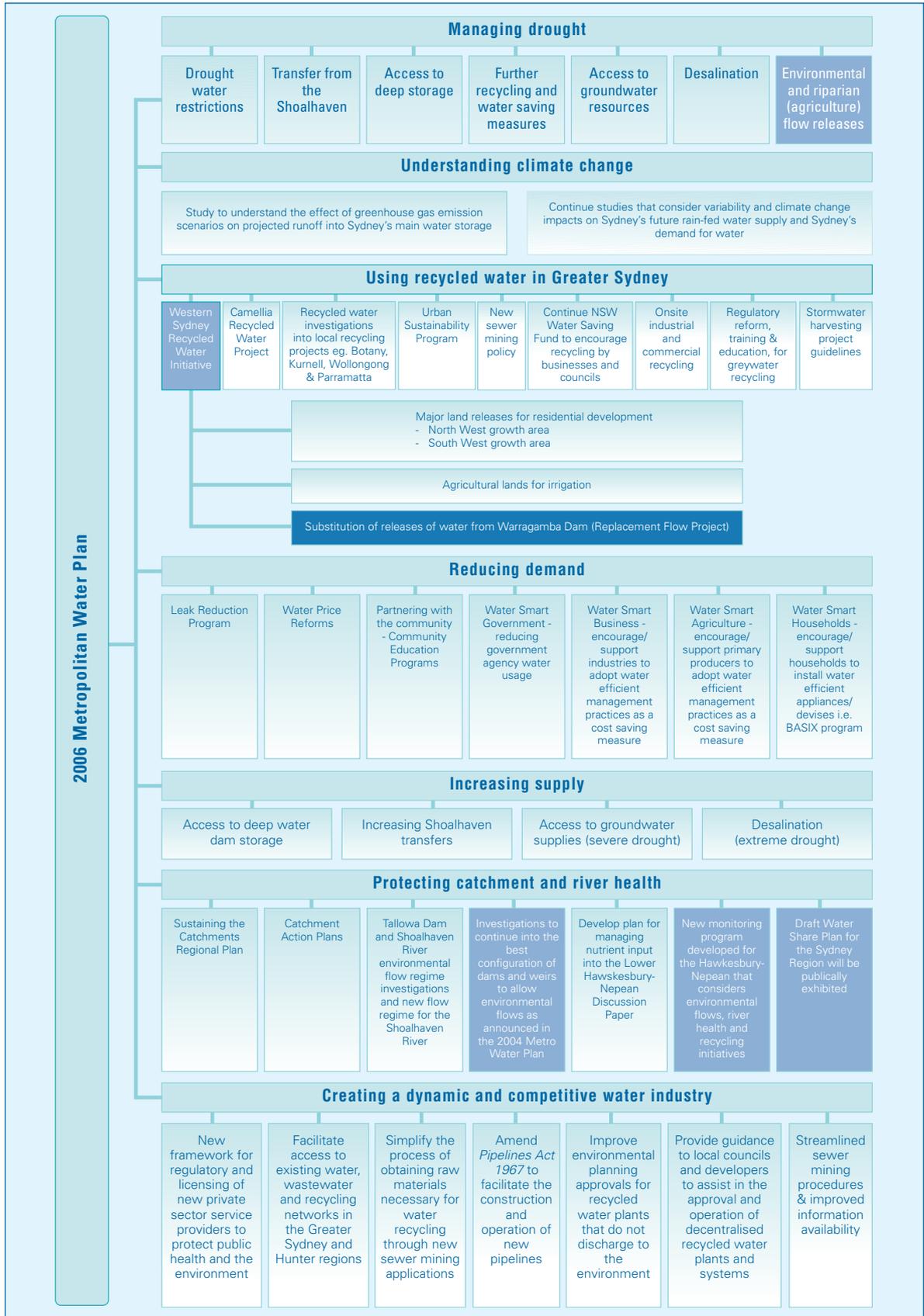
Table 1 Environmental Flows in the Hawkesbury-Nepean River system

Site	Current Flows (ML/day)	2010 Flows (ML/day)
Warragamba Dam	43.3 ¹	(43.3) ¹
Cataract Dam	1.3	Up to 16.5 ²
Cordeaux Dam	1.9	Up to 12.6 ²
Avon Dam	0	Up to 10.4 ²
Nepean Dam	4.4	Up to 28.5 ²

¹ This is the flow released during non-drought conditions. The current drought conditions discharge from Warragamba Dam is about 22 ML/day. The discharge from Warragamba Dam would cease if the Replacement Flows Project were implemented

² Flows from the Upper Nepean Dams would provide a base level of 68 ML/day. Flows up to this volume will be allowed to pass. For flows above this volume the total flow released will be 20% of the flow as long as the 20% is above the base value shown.

Figure 2 2006 Metropolitan Water Plan



The current releases from Warragamba Dam would effectively cease by 2009, in line with the replacement flows discharge at Penrith Weir and the increased flows from the Upper Nepean Dams.

The current releases from Warragamba Dam would effectively cease by 2009, in line with the replacement flows discharge at Penrith Weir and the increased flows from the Upper Nepean Dams. A final regime for environmental flow releases from Warragamba Dam will be formally set by 2015. Increases to interim environmental flows would, however, be considered from 2009, provided sufficient water is available. The Project would offset an equivalent portion of any future determination regarding environmental and riparian discharges from Warragamba Dam.

Outcomes of the Replacement Flows Project in the context of the Metropolitan Water Plan

The Replacement Flows Project, Upper Nepean dam releases and reuse projects are all initiatives under the *2006 Metropolitan Water Plan*. The outcomes for the Project and the Upper Nepean dam releases are forecast to be:

- in normal (non-drought) conditions, the same or greater flows in all stretches of the Hawkesbury-Nepean River upstream of its junction with South Creek
- in normal (non-drought) conditions, an increase in the proportion of catchment derived flows throughout the Hawkesbury-Nepean River system
- significant reduction in nutrient loads discharged to the Nepean River at Penrith due to the AWTP
- significant reductions in the nutrient loads discharged into South Creek, due primarily to the reduced loads discharged from St Marys and Quakers Hill STPs.

Description of the Project

The project consists of:

- an Advanced Water Treatment Plant (AWTP) at the St Marys STP site for the treatment of tertiary treated effluent from Quakers Hill, Penrith and St Marys STPs. The AWTP would produce about 50 ML/day of highly treated recycled water for discharge to the Hawkesbury-Nepean River downstream of Penrith Weir, and approximately 8 ML/day of concentrate to be discharged to the Northern Suburbs Ocean Outfall Sewer (NSOOS)
- a pipeline for the transfer of tertiary treated effluent from Penrith STP to the AWTP site at St Marys STP
- a pipeline for the transfer of tertiary treated effluent from Quakers Hill STP to the AWTP at St Marys STP
- a pipeline for the transfer of recycled water produced by the AWTP at St Marys STP to Penrith STP
- a pipeline for the transfer of the concentrate from the AWTP to Quakers Hill STP
- a storage pond at Quakers Hill STP for the temporary storage of the concentrate, when the NSOOS may not be available for discharge (during periods of extended wet weather)
- transfer of the concentrate to the NSOOS via an existing pipeline from Quakers Hill STP to Seven Hills and a new pipeline between Seven Hills and Vineyard Creek at Dundas
- balance storages and pumping stations at Penrith, Quakers Hill and St Marys STPs.

A new pumping station may also be required at Seven Hills where the existing pipeline joins the new pipeline to Vineyard Creek. Some upgrade works may also be required to the existing pipeline.

The project is shown schematically in **Figure 3**.

The estimated nutrient concentrations in the highly treated recycled water to be used as replacement flows is presented in **Table 2**. For comparison and to show the performance expected of the AWTP, typical tertiary treated effluent concentrations are also shown.

Table 2 Likely water quality of highly treated recycled water

Stage	Water quality (Concentration in mg/L)				
	Ammonia (NH ₄)	Oxides of nitrogen (NO _x)	Total nitrogen (TN)	Total phosphorus (TP)	Total dissolved solids (TDS)
Tertiary treated effluent	0.10	2.96	4.5	0.05	400-600
Replacement Flow (Highly Treated Recycled Water)	0.00	0.44	0.79	0.01	25-35

Total nitrogen (TN) and oxidised nitrogen (NO_x) (comprising the two nitrogen species of nitrite (NO₂) and nitrate (NO₃)) can stimulate algal production. Excess nitrogen concentration can lead to algal blooms. Similarly, ammonia is readily taken up by aquatic plants and can stimulate their growth. In addition, phosphorus in high concentrations is associated with excessive plant and algal growth.

The average volume of concentrate generated by the AWTP process is expected to be about 8 ML/day. The concentrate would contain between 3000 and 4000 milligrams per litre (mg/L) of total dissolved solids (TDS), approximately 7 times greater than the concentrations in the tertiary treated effluent from the STPs and approximately one tenth as salty as seawater (35,000 mg/L). The concentrate would also contain sulphate (500 to 1000 mg/L), chloride (1000 to 1500 mg/L), calcium (130 to 200 mg/L) and alkalinity (480 to 850 mg/L as CaCO₃). It would have a pH of 7.5 to 8.0 and contain the majority of nutrients originally in the effluent from the sewage treatment plants.

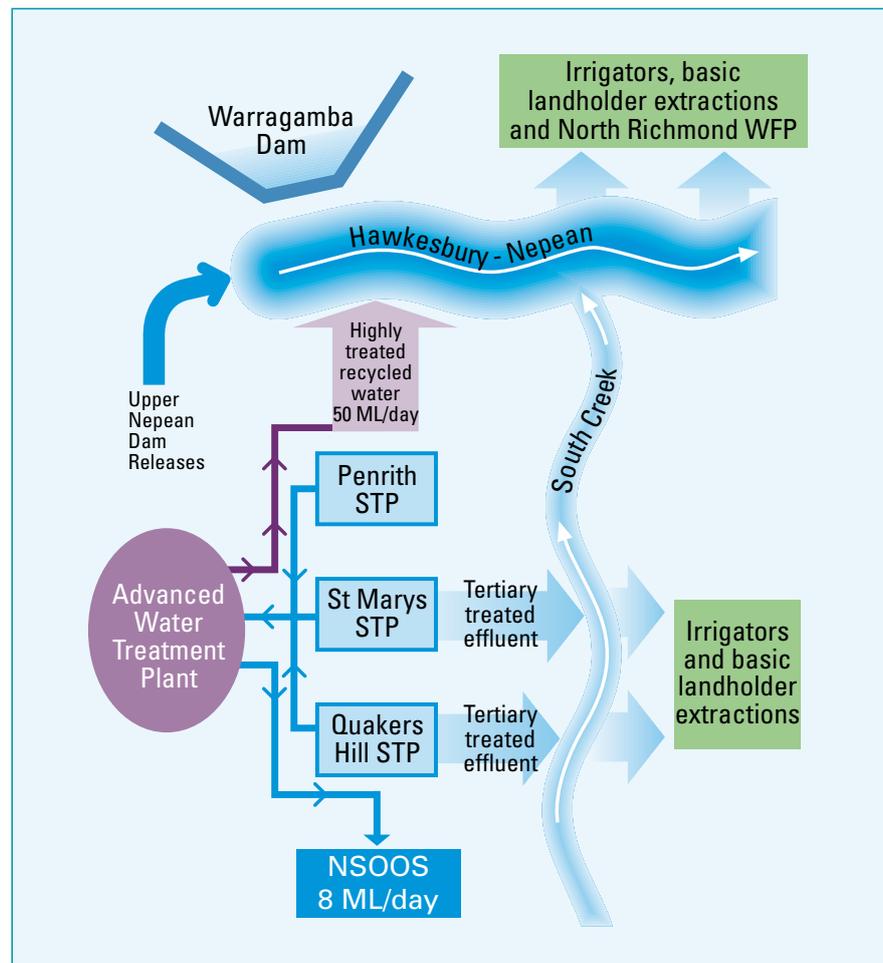
Alternatives

Options were considered for the major components of the scheme including:

- the AWTP location and configuration
- treatment options for the AWTP
- pipeline routes
- replacement flow discharge locations
- concentrate removal and disposal.

St Marys was selected as the preferred AWTP location due to its central location, land availability and the technical and operational advantages of the site.

St Marys was selected as the preferred AWTP location due to its central location, land availability and the technical and operational advantages of the site. Reverse osmosis was selected as the preferred main treatment technology due to its ability to achieve the goals of removing nutrients from the tertiary treated effluent, in particular the bioavailable forms of phosphorus and nitrogen.

Figure 3 Replacement flows project during normal operations

The pipeline routes were selected to minimise impacts on the local community, road users and the natural environment. This includes using areas that are void of significant vegetation (such as asset protection zones or fire-breaks), distant from sensitive receivers (residential areas) and away from significant infrastructure (main roads and rail).

Discharge of replacement flow downstream of Penrith Weir was selected as the preferred option as it provided better water quality outcomes during low flow conditions and did not have the additional costs, environmental and social issues associated with construction at the alternative location (Wallacia Bridge).

Disposal of the concentrate to the NSOOS was determined to be the preferred option after considering environmental and operational implications.

Environmental Impact and Mitigation

Key issues of river health and water users

The project would be constructed and operated within the Hawkesbury-Nepean River system. The area affected by the project includes residential, industrial, rural and natural areas. The operation of the project would have the potential to impact on the waterways in the project area and this is reflected in the assessment of key issues.

The environmental assessment of key issues is divided into reaches of the Hawkesbury-Nepean River and tributaries, addressing them in order from upstream to downstream. The water quantity and quality changes as a result of the project are summarised in **Figures 4, 5** and **6**. The assessment of the impacts of the Replacement Flows project is based on the assumption that the 2009 river management changes will occur. The impacts of these changes on other aspects of the waterways such as aquatic flora and fauna, recreation and agriculture are discussed below. Impacts on threatened aquatic species, fisheries and human health are considered for the Hawkesbury-Nepean River system as a whole.

Figure 4 Comparison of existing non drought flows with predicted 2009 flows (with Replacement Flows Project)

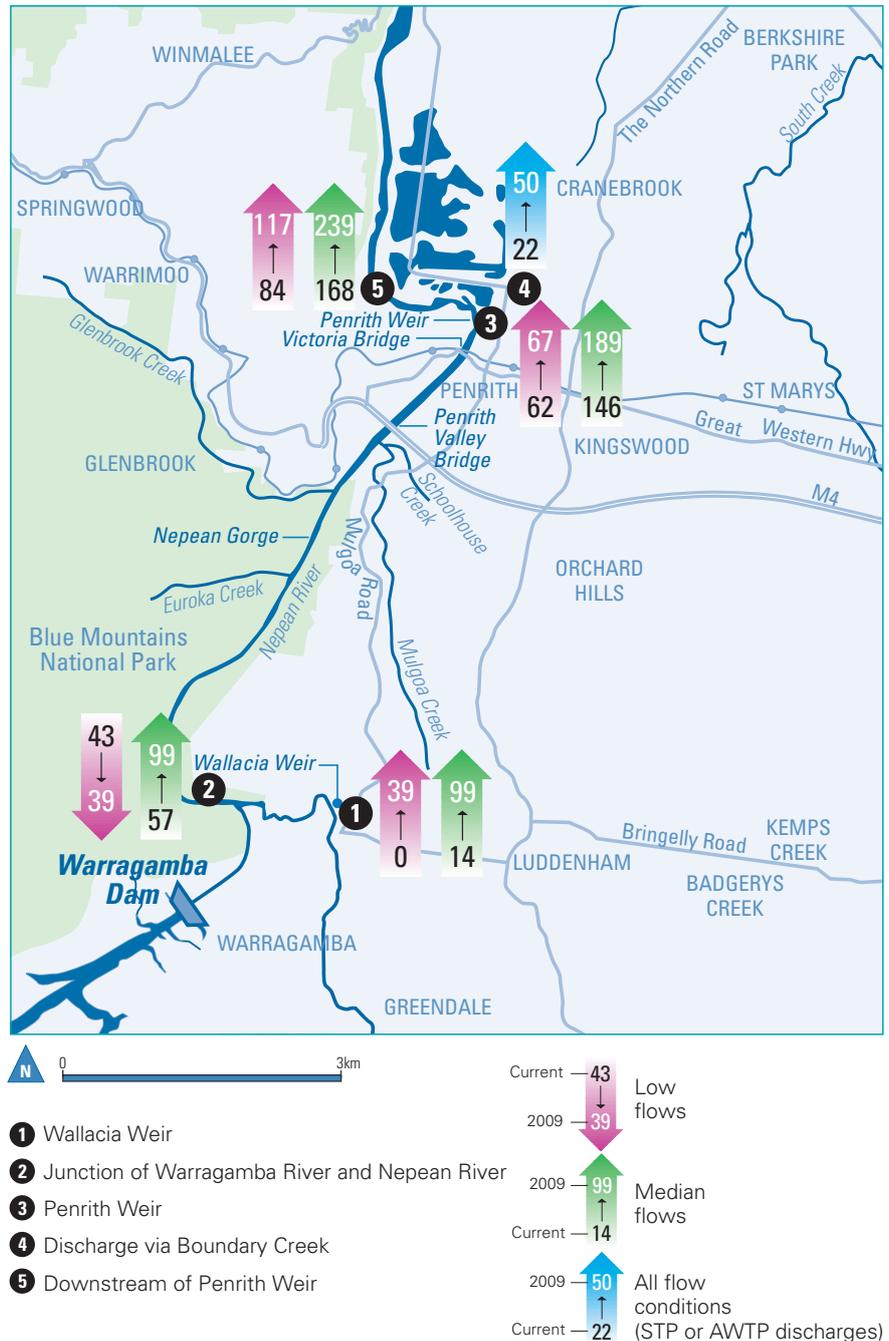
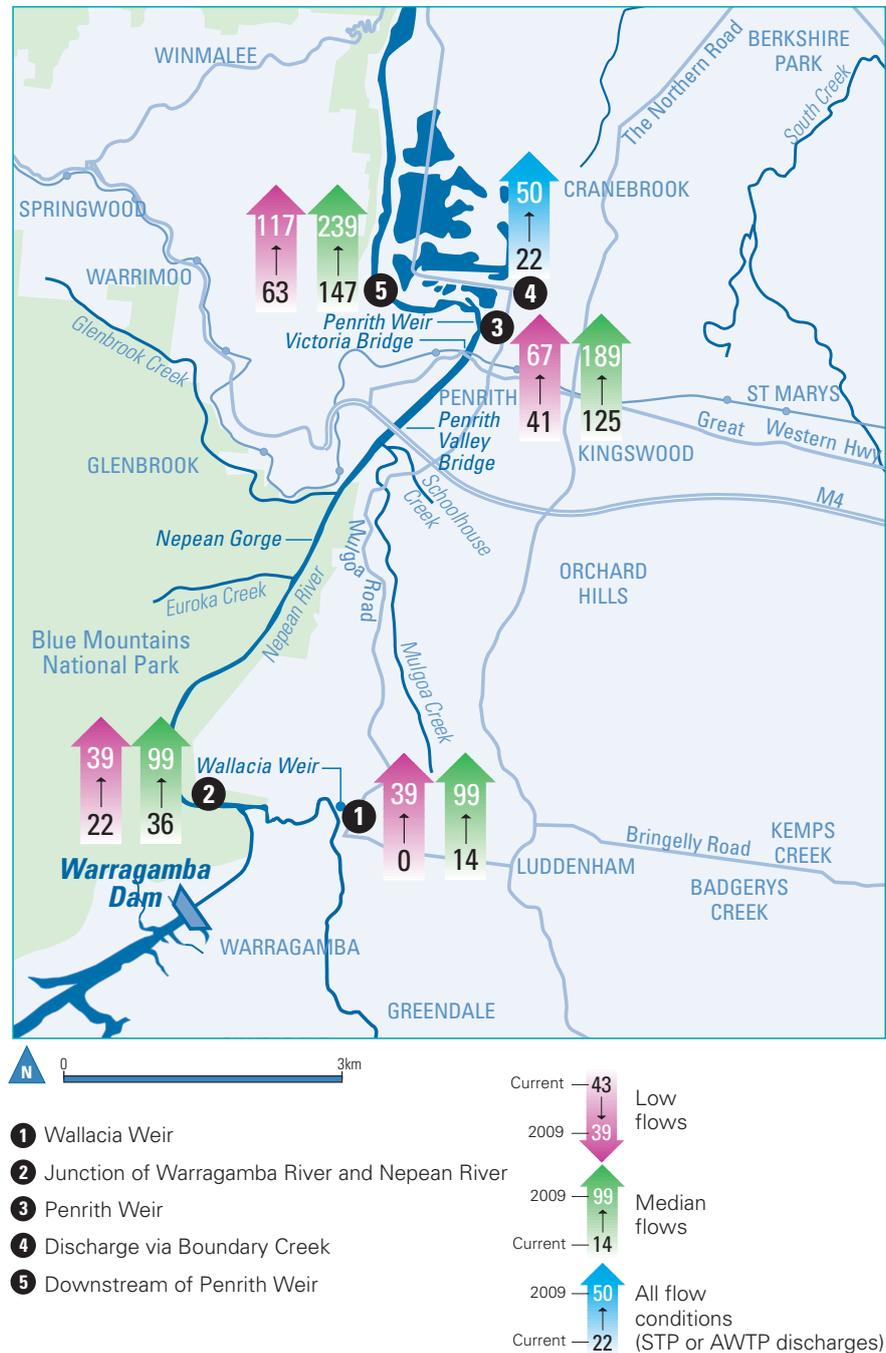


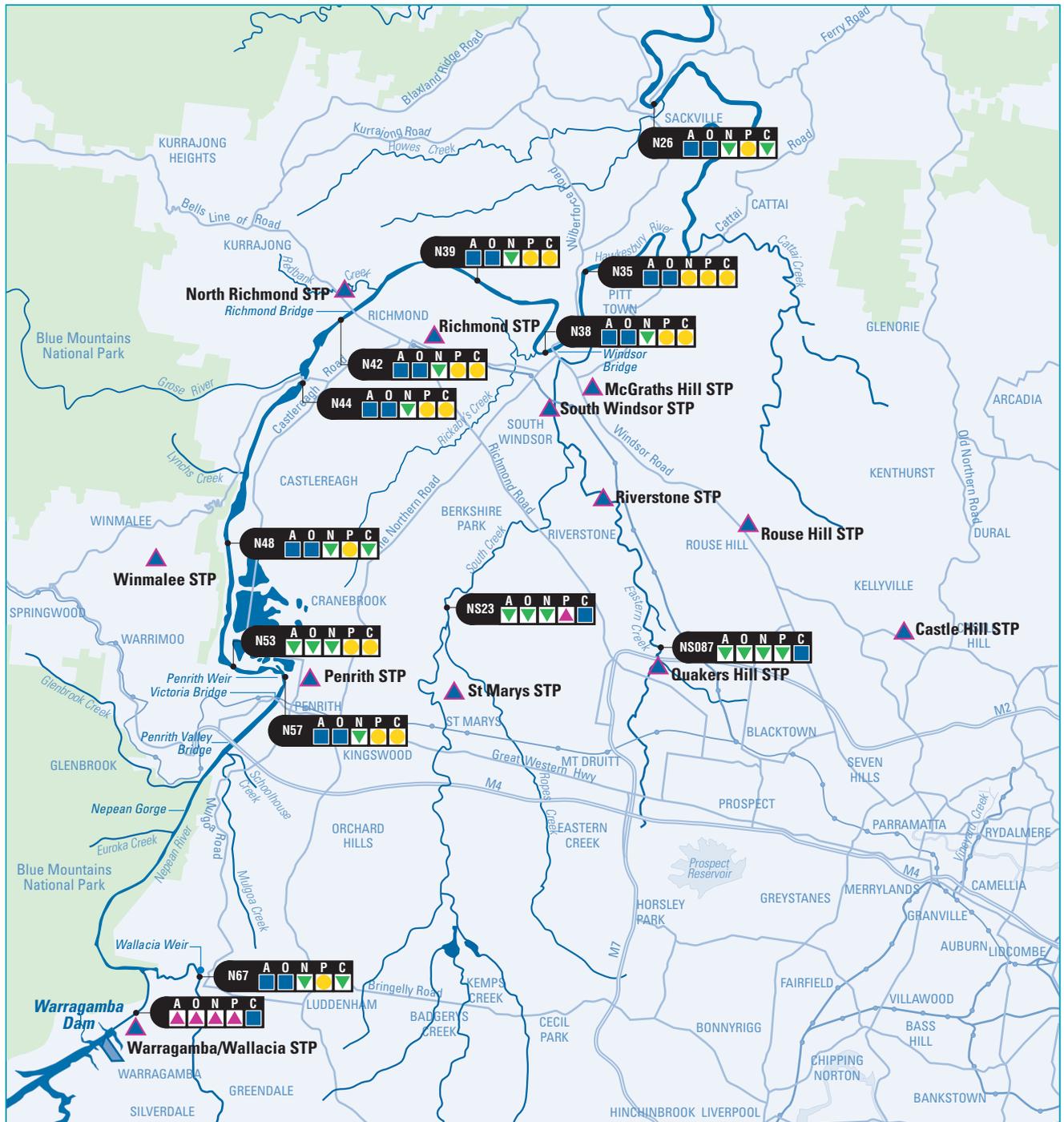
Figure 5 Comparison of existing drought flows with predicted 2009 flows (with Replacement Flows Project)



Warragamba River

Operation of the project would result in a reduction of flow volumes in the Warragamba River that would allow effluent from the new Wallacia STP to dominate water quality conditions in the river and potentially create favourable conditions for growth of exotic macrophytes. These conditions could also affect the health of native aquatic species. To mitigate this impact Sydney Water would develop an effluent management strategy to reduce the impact of the discharge from Wallacia STP to an acceptable level. The project would not have any additional impact on fish or other aquatic values with the implementation of this strategy.

Figure 6 Predicted changes in concentrations of key water quality indicators



▼ Concentration decrease
▲ Concentration increase
● No change
■ Not assessed

(N) Total Nitrogen
 (O) Oxidised Nitrogen
 (A) Ammonia
 (P) Total Phosphorus
 (C) Chlorophyll-a

Warragamba River
 Wallacia to Penrith Weir
 N67 - Nepean River at Wallacia
 N57 - Nepean River at Penrith Weir
Penrith to Yarramundi
 N53 - Nepean River downstream of Penrith STP

N48 - Nepean River at Smith Road
 N44 - Nepean River at Yarramundi Bridge
Yarramundi to South Creek
 N42 - Hawkesbury River at North Richmond
 N39 - Hawkesbury River at Freemans Reach
 N38 - Hawkesbury River at Windsor Bridge

South Creek to Sackville
 N35 - Hawkesbury River at Wilberforce
 N26 - Hawkesbury River at Sackville Ferry
South Creek
 NS087 - Downstream of Quakers Hill STP
 NS23 - Downstream of St Marys STP

The Warragamba River is not a popular or accessible area for recreation. The recreational amenity of the area may decrease due to decreased flows but overall this would have a minor impact on recreational values of the Hawkesbury-Nepean River system.

Nepean River – Wallacia Weir to Penrith Weir

Although there would be increased flows and improved water quality into this reach, the Penrith weir pool would still largely control the water levels and quality. The operation of the project would therefore have a neutral effect on the aquatic ecology of this reach, although there may be some positive effects on native fish diversity, abundance and growth. Native aquatic flora may also benefit and there may be positive effects on fish migration.

This reach of the river supports a number of recreational activities and the recreational amenity of this reach of the river would remain relatively unchanged as a result of the project.

The project would not have an adverse impact on agricultural users, with flow in this section increasing marginally.

Nepean River – Penrith Weir to Yarramundi

The Project (in conjunction with the 2009 river management changes) may have a beneficial effect on the aquatic ecology within this reach of the Nepean River, with the increase in flow continuing to support flowing water macroinvertebrate communities. The combination of increased flow and improved water quality may be beneficial to native fish species, while the improvement in water quality and flows within the main river channel would most likely favour native macrophytes over exotic macrophytes. The potential for excessive growth of other aquatic weeds should also decline with a reduction in nutrient loads.

The discharge of replacement flows via Boundary Creek has the potential to attract migrating fish away from the fishway at Penrith Weir. Although fish may be able to reproduce and survive in Boundary Creek, the attraction of the replacement flows could result in a reduction in fish migrating further up the Nepean River.

The major potential impact of the Project would be on fish species that migrate upstream during low flows. Those species that are stimulated to migrate by high flows would not be affected, as the discharge via Boundary Creek would only contribute a small percentage of the total river flow.

Under present conditions, the low flow (95th percentile) passing over Penrith Weir (including the fishway) is 62 ML/day, compared with over 22 ML/day from Boundary Creek. Despite its lower flow volume, Boundary Creek may attract some fish in these conditions, but the attraction would depend on water quality, particularly water temperature. The replacement flows discharge via Boundary Creek would be of a greater volume (up to 50 ML/day), the quality of the discharge would be improved and therefore there is potential to impact on fish migration. A study would be undertaken, in consultation with Department of Primary Industries (Fisheries), to determine whether the discharge of the Project would result in changes to the natural fish migration over Penrith Weir. Based on outcomes of this study appropriate design and other mitigation measures would be developed.

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Hawkesbury River – Yarramundi to South Creek

The operation of the project would have a neutral effect on aquatic ecology and recreational amenity within this reach, as it is effectively a freshwater tidal pool and flow and water levels would be relatively unchanged. Improved water quality could, however, lead to a reduction in growth of exotic macrophytes.

Agricultural water users in this reach would not be adversely affected by the Project, as flows into the freshwater tidal pool downstream of Yarramundi would increase.

Hawkesbury River - South Creek to Sackville

This reach is within the freshwater tidal pool and changes in flows or water levels are not expected. The operation of the project would therefore have a neutral effect on aquatic ecology within this reach of the river. Improved water quality could, however, lead to a reduction in the growth of exotic macrophytes and the occurrence of algal blooms.

The reduction in algae and aquatic weeds would be expected to increase the appeal and suitability of the river for recreational purposes and increased clarity would enhance the scenic qualities of the water resource. Due to the possible increased numbers of fish, recreational fishers may also benefit from the improvements to river health.

Similar to the Yarramundi to South Creek reach, agricultural water users in this reach would not be adversely affected by the project as flows into the freshwater tidal pool downstream of Yarramundi would increase.

South Creek

There will be a major reduction in flow and nutrient load in South Creek downstream of the STPs. Although concentrations of phosphorus would increase slightly and nitrogen concentrations would decrease, overall water quality would be relatively unchanged. The South Creek system would remain a relatively degraded environment and the Project would have a neutral effect on riparian, native fish, macroinvertebrate and macrophyte species within South and Eastern Creeks.

The waters of South Creek are not used extensively for recreational purposes and as such the changes to water quality and waterway health would have little effect on the recreational value of the creek.

The water requirements of downstream extractors were accounted for when determining the volumes of tertiary treated effluent that would continue to be discharged to South and Eastern Creeks. Consequently, there would be no adverse impacts on agricultural water users downstream of the STPs on South and Eastern Creeks.

Threatened aquatic species

Three threatened aquatic species were identified as having potential habitats within the project area. Macquarie Perch, Australian Grayling and Sydney Hawk Dragonfly are listed under the NSW *Fisheries Management Act 1994*, while the Macquarie Perch and Australian Grayling are also listed under the Commonwealth *Environmental Protection and Biodiversity Act 1999*. An assessment of significance was prepared for each of the species likely to occur in the study area. The assessments concluded that the project would not have a significant impact on the threatened species known to occur within the Hawkesbury-Nepean River in the area of the Project.

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Fisheries

The major commercial fisheries in the Hawkesbury-Nepean River System are located in the saline estuarine and marine areas downstream of Wisemans Ferry. The effects of the project on the freshwater reaches have been assessed to be neutral or beneficial and therefore there would be no adverse indirect impacts on downstream commercial fisheries.

Human health

A number of exposure pathways were assessed to examine the potential impact on human health of releasing highly treated recycled water (replacement flows) into Hawkesbury-Nepean River. These included undertaking water-based recreational activities and the unlikely scenario that someone would drink untreated river water downstream of the replacement flows discharge.

During effective operation of the AWTP (specifically the microfiltration and reverse osmosis processes), no additional risk from pathogens or chemicals was identified for the exposure pathways examined.

During effective operation of the AWTP (specifically the microfiltration and reverse osmosis processes), no additional risk from pathogens or chemicals was identified for the exposure pathways examined. Notably, the consumption of shellfish and irrigated vegetables, and in particular the consumption of treated drinking water produced by the North Richmond Water Filtration Plant, presented risks well below World Health Organisation benchmark values.

No unsafe concentrations of non-cancer risk chemicals were identified. Under conditions where the operation of the AWTP is significantly compromised, three carcinogenic chemicals were identified to be equal to or slightly above benchmark values where the predominant exposure pathway was by contact (through the skin) with river sediment closest to Penrith Weir. This risk, however, is likely to be over-estimated as the concentrations of these chemicals are below the detection limit of current analytical methods.

Other important issues

Terrestrial flora and fauna

Potential terrestrial flora and fauna impacts could occur during construction. At the AWTP site, impacts would be limited to the loss of isolated trees or small stands or regrowth within predominantly cleared areas. The proposed infrastructure and pipeline routes have been located to minimise impacts on remnant vegetation, in particular the endangered ecological communities of Cumberland Plain Woodland and River-flat Eucalypt Forest and threatened species such as the Cumberland Land Snail, Green and Golden Bell Frog and Juniper-leaved Grevillea, all listed under the NSW *Threatened Species Conservation Act 1995*.

The Cumberland Plain Woodland community is also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Standard construction environmental management practices would be implemented and techniques such as underground boring would be used to avoid areas of significant vegetation.

Waste Management

Spoil and other waste materials are likely to be generated during construction. Appropriate waste management strategies would be implemented, in accordance with the requirements of the NSW *Waste Avoidance and Resource Recovery Act 2001*. This would include investigation of opportunities for reuse of potential wastes such as spoil or disused construction materials.

Operational waste will include about 8 ML/day of concentrate from the AWTP that would be discharged to the NSOOS. No significant impacts would result from the addition of the concentrate stream to the NSOOS.

Noise and vibration

The main components of the project that would generate noise during operation would be the AWTP and the various pumping stations. An assessment of operational noise impacts was made according to the requirements of the Department of Environment and Conservation's *Industrial Noise Policy*. Due to the location of the works and the distances to sensitive receivers, the operational noise generated from the AWTP site and the pumping stations could be able to be managed to meet the requirements of the policy.

Noise management measures would be implemented to minimise construction noise impacts.

Construction activities, particularly related to the pipelines, would impact on the acoustic environment of the area and would present a short-term nuisance to adjoining residents and users of public reserves. Noise management measures would be implemented to minimise construction noise impacts. Construction activities would be undertaken in accordance with Australian Standard AS 2436-1981 *Guide to Noise Control on Construction* and noise goals would be adopted for construction as detailed in the Department of Environment and Conservation (DEC) noise control guidelines *Construction Site Noise*.

There is the potential for vibration impacts on properties under which boring would take place. General construction activities would be managed in accordance with appropriate standards for managing vibration.

Stakeholder Engagement and Consultation

During the planning process for the Environmental Assessment, the following activities were carried out to inform the community and stakeholders of the project and to receive and address issues and concerns raised.

Planning Focus Meeting

A Planning Focus Meeting was held in July 2006 and was attended by representatives from key Government agencies and Councils.

Meetings with local Councils

Meetings were held with all the local Councils affected by the project. These meetings established awareness of the project in the context of the *2006 Metropolitan Water Plan*. In some cases, specific details of infrastructure in the affected Council area were discussed.

Presentations

Sydney Water offered a detailed presentation on the project to a number of stakeholders. The majority of stakeholders accepted the offer and the presentations included general information on the project and specific issues of interest for each of the agencies.

Issue specific consultation

A pre-referral briefing was held with Commonwealth Department of Environment and Heritage (DEH) regarding potential impacts on matters of National Environmental Significance.

Local Aboriginal stakeholders were consulted in accordance with Department of Environment and Conservation guidelines.

Community information

The community has been informed about the project through the *2006 Metropolitan Water Plan* communication activities. In addition Sydney Water has established an information page for the project on the Sydney Water website. The website includes a range of fact sheets that are available for information and can be downloaded.

A free-call number (1800 685 833) is also available for general inquiries.

Justification for the Project

The Environmental Assessment has confirmed that the Replacement Flows Project, in combination with other planned river management changes, would ensure that the substitution of Warragamba Dam releases with highly treated recycled water released from below Penrith Weir would deliver an equivalent or higher level of environmental benefit to the Hawkesbury-Nepean River system.

The Replacement Flows Project has a long reaching beneficial affect on water quality, particularly with respect to nitrogen, with improvements in water quality persisting downstream of South Creek and continuing to Sackville.

The project would have greatest effect on reaches of the Hawkesbury-Nepean River downstream of the Warragamba River junction. It would reduce the concentrations and loads of nitrogen species in the Hawkesbury-Nepean River and reduce the nutrient loads entering South and Eastern Creeks. The Replacement Flows Project has a long reaching beneficial effect on water quality, particularly with respect to nitrogen, with improvements in water quality persisting downstream of South Creek and continuing to Sackville. Phosphorus concentrations would be largely unaffected by the Project in the majority of river reaches.

The Project, in conjunction with the Upper Nepean Dam releases, would also generally increase the variability of flows in the river system. The improvements in water quality and quantity may also to provide an improved habitat for fish, macroinvertebrates and native aquatic flora.

Improved water quality could lead to a reduction in water weed growth and algal blooms in the Hawkesbury-Nepean River from Penrith to Yarramundi and from the South Creek confluence to Sackville. This would, in turn, improve opportunities for people to use the river for recreation.

The implementation of the Project, in conjunction with the other strategies outlined in the *2006 Metropolitan Water Plan*, would further alleviate current demand pressures placed on Sydney's domestic water supply.