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Title: **Water Sustainability in Sydney's Rouse Hill Development Area: Past Practices and Future Plans**

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ABSTRACT

This paper outlines some of the processes (political, legal, planning, design, operational) involved in the progressive delivery of trunk water infrastructure (potable and recycled water, sewage collection and treatment, stormwater quality and quantity controls and revegetation of flood land) to the Rouse Hill Development area (RHDA) in the north-west of Sydney from 1989 to 2006 – in particular the environmental aspects of the these processes.

It discusses some of the policy and management processes of such a long program and identifies some of the good and bad aspects. It discusses this information in light of the continually evolving plans for the delivery of water infrastructure to new urban areas (greenfield sites) in Sydney that are contained in the two recent NSW Government plans: the 2005 Metropolitan Strategy and the 2006 Metropolitan Water Plan. These two plans have been introduced while ongoing debates continue on drought and low water storage dam levels, sustainable water usage, large scale recycled water schemes, desalination and the implementation of water sensitive urban design.

INTRODUCTION

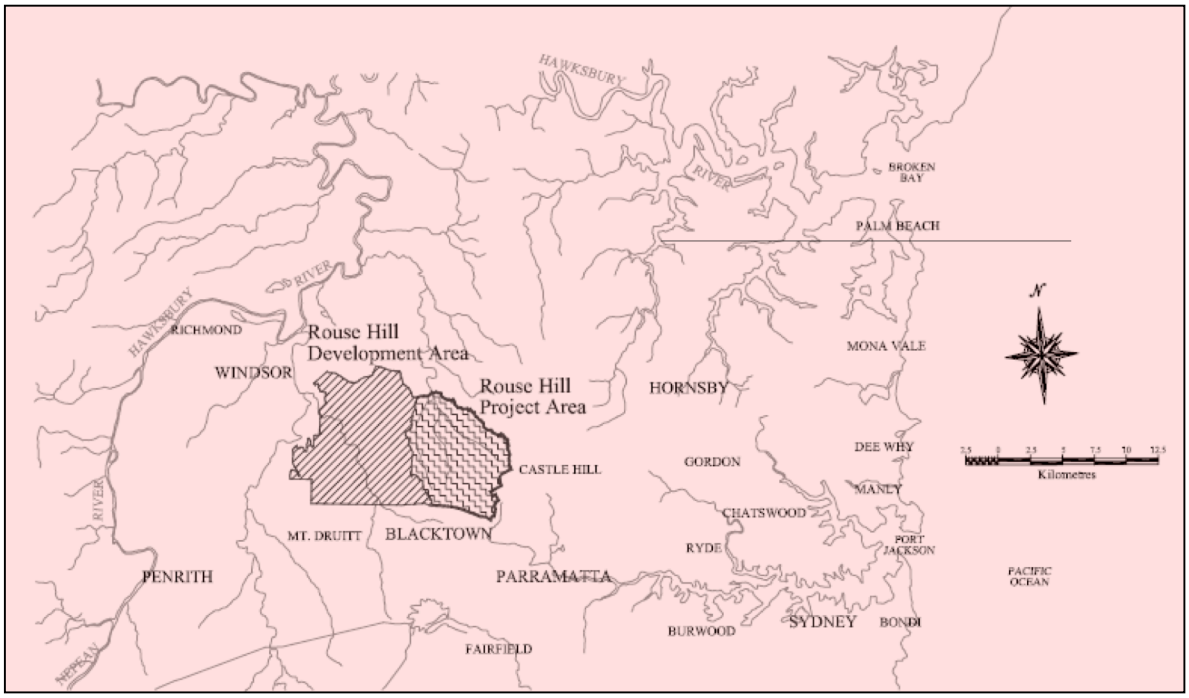
The Rouse Hill Development Area (RHDA) in the northwest of Sydney was identified in the 1980s as an area suitable for urban development (Refer Figure 1). It is an area of 13,000ha that can support a population of 320,000 people with progressive development occurring over a period of 25 years and more. It is the first large urban area in Sydney to be supplied with recycled water.

REGIONAL PLANNING

A regional environmental study released for public comment in 1984 provided the background for the preparation of a Sydney regional environmental plan (SREP 19) (DOP, 1989) for the area. The plan was released by the NSW Department of Planning in 1989. In 1989 the RHDA comprised cleared rural lands used for small scale agriculture and primary production and several small villages. A large proportion of the land comprised small land holdings of 2 hectares. Many of the public submissions received on the environmental study raised concerns about the effect that urban development would have on the water quality of the Hawkesbury – Nepean River and on the remnant native vegetation.

A drainage study by Government authorities identified the works necessary to manage stormwater and creek water quality and quantity issues. The use of in-stream stormwater basins for flood and pollution mitigation was proposed. Parts of the basins could also be also used for active recreation. Strong pollution controls were proposed by the State Pollution Control Commission (now Department of Environment and Conservation) on sewage effluent discharge by the Water Board (now Sydney Water). A large part of the effluent was to be treated to provide reticulated recycled water and the remainder discharged through in-stream artificial wetlands for further nutrient removal (Manidis Roberts, 1991).

Figure 1: Rouse Hill Development & Project Areas



Broad statements were made on the need to protect remnant native vegetation particularly along creeks. The Structure Plan (drawing) accompanying SREP 19 identified broad areas for protection at a scale of approximately 100,000.1, but did not provide any vegetation mapping. Cultural heritage was required to be taken into account in development but no mention appears to have been made of indigenous heritage. No commitment was made to protect agricultural activities and it was acknowledged that urban development would displace them.

INITIAL AREAS and DELIVERY MECHANISM

The first area to be developed within the RHDA was the Rouse Hill Project Area (Project Area) (See Figure 1) and this is being developed progressively in stages or precincts. Preparatory to the development of the precincts, local Councils have undertaken local environmental studies, prepared local environmental plans (LEP) and rezoned the precincts from rural to residential. In this paper, I will mainly discuss the environmental aspects of development associated with trunk water infrastructure, with which I have been associated over a period of 13 years.

The SREP19 anticipated that the delivery of infrastructure would involve cooperation between State, local Government and the private sector. A private company Rouse Hill Infrastructure Consortium (RHIC) was formed in 1989 to facilitate, finance and procure the delivery of trunk water infrastructure to the area (RHIC, 2006). It is an organisation established by both private and Government land developers and has operated under an agreement with the Sydney Water Corporation. Repayment of project financing occurs after the delivery of the infrastructure and is paid from developer contributions collected

by Sydney Water under its Act. At completion of commissioning the water infrastructure is handed over to Sydney Water as owner and operator. Trunk water infrastructure has been provided to three stages as shown in Table 1.

Table 1: Development Stages: Zoned & Serviced with Trunk Water Infrastructure

Stage	Gross Area (ha)	Residential Lots	Dates
1	1600	15,000	1992 – 1994
2	1060	10,000	1998 – 2002
3	1100	10,000	2003 – 2006
Total to Date	**3760**	**35,000**	

STATUTORY AUTHORITIES

There has been a plethora of statutory authorities who have provided statutory approvals and environmental requirements including the Department of Planning (land use), Sydney Water (water and sewage), two local Councils (rezoning), the Environmental Protection Authority (pollution), the Department of Land and Water Conservation (rivers and streams), the National Parks and Wildlife Service (flora, fauna, indigenous heritage). Each had its own legislation to administer and policies to apply. It has been a difficult journey through this maze of legislation, authorities and personnel. Over the three phases from 1992 to 2006 there have been significant changes in legislation, Government statutory authority arrangements (titles, policies, personnel) and in community environmental and social expectations. Examples of these will be discussed later.

PROJECT ENVIRONMENTAL IMPACT ASSESSMENTS

The Sydney regional environmental plan (SREP19) and the local environmental plans (LEPs) provided a broad background and focus for the project environmental assessments. The driving environmental water objective was to ensure the urban development in the Project Area did not cause increased water impacts downstream of the Project Area catchment to the Hawkesbury – Nepean River. This was to be achieved by limiting flood peaks, suspended solids and annual average level of nutrient discharges (phosphorus and nitrogen) to pre-development levels. These environmental objectives were considered admirable at the time, but later it became apparent that some of the environmental values within the Project Area catchment were being compromised in order to achieve the objectives for the streams below the Project Area catchment.

The Environmental Impact Statement for the new sewage treatment plant for the Project Area (Manidis Roberts, 1991) contained a study of the river health in the Project Area and downstream to the Hawkesbury River. It made a commitment to biological treatment to tertiary level, production and reticulation of recycled water and construction of in-stream wetlands to protect the downstream water quality. Impact assessments for the stormwater drainage works made commitments to build in-stream wet basins in the lower part of the catchment to limit urban nutrient run off and dry basins in the upper part of the catchment to mitigate flooding (GHD, 1992-1993).

Table 2 shows the main environmental measures approved for the Stage 1 trunk water infrastructure. In the following sections, I discuss the three environmental aspects of Table 2, the processes of achieving the objectives and how the objectives have changed or been changed as a result of changing legislation, Government policies and community expectations.

Table 2: Environmental Measures for Stage 1 (Staib, 2003)

Environmental Aspect	Environmental Issues	Initial Targets	Measure & Mitigative Function	Unmitigated Impacts
A. Water quality	1. Urban storm water run off pollution.	No increase in suspended solids and nutrients (phosphorus and nitrogen) downstream of catchment.[1]	In-stream wet basins trap nutrients and reduce pollution.	Basins impact creek continuity.
	2. Sewage effluent pollution.	Treat effluent to non-potable recycled water use standard, discharge remainder through in-stream artificial wetlands for further nutrient removal.	Tertiary treatment protects creeks, use of recycled water reduces amount of effluent.	In-stream wetlands impact creek continuity.
B. Water quantity	3. Flooding from urbanisation	No increase in peak floods downstream of the Project area catchment.[2]	In-stream dry basins mitigate flooding.	Basins impact creek continuity.
	4. Increased potable water use.	Maximise the amount of treated recycled water for non-potable urban use.	Recycled water reduces potable water demand.	Potable water makeup is needed to balance recycled water demand.
C. Land use	5. Clearance of remnant native flora.	Minimise disturbance of flora.	Landscaping repairs disturbed areas.	Significant areas still removed.
	6. Damage to indigenous heritage sites.	Minimise disturbance of sites.	Archaeological sites are salvaged scientifically and culturally.	Significant sites removed.

Notes: 1. Target for phosphorus was a 60% reduction. 2. Basins were designed to limit peak flood flows from the 1:100 year Annual Recurrence Interval flood through to the 1:2 year Annual Recurrence Interval flood.

WATER QUALITY: STORMWATER (Table 2, A1)

The original strategy for the Project Area was formulated in response to concerns about the high level of nutrients entering the Hawkesbury – Nepean River both from sewage treatment plants and from urban and rural run off. The strategy required building wet basins (essentially damming the local creeks in the lower part of the Project Area catchment) to permanently pond creek water. The basins operate to slow the water velocity which causes the suspended solids to settle out. Most of the nutrients phosphorus and nitrogen are contained within the suspended solids. The basins are achieving their purpose (GHD, 2001). The changing land use from small scale rural to urban has also assisted the process of reduction of phosphorus by eliminating the continuing nutrient input into the catchment from stock and fertilizers.

By 1998 concerns for the health of all streams and remnant vegetation within urban areas started to be raised both from government authorities and the community (Personal Com., 1998; NCC, 1999). New Government policies based on re-interpretation of existing legislation were applied to developments within 40 metres of the banks of creeks. The

objective was to maintain the integrity of the stream system by avoiding the construction of in-stream basins and culverts on creeks, i.e. any structure that could impede the restoration of native vegetation in riparian corridors or the passage of riparian and aquatic fauna.

In Stage 2 this required structures to be redesigned, e.g. culverts changed to bridges, culverts redesigned to facilitate fish and riparian fauna passage and eliminating some in-stream basins but accepting a lesser downstream water quality. By Stage 3 all in-stream basins that impacted riparian vegetation and the passage of riparian and aquatic fauna had been eliminated. Culverts on the main streams had been eliminated. Culverts on minor streams have been designed to facilitate aquatic and riparian fauna passage.

Water quality measures are now starting to move away from streams upslope into the urban catchment guided by the emerging principles of water sensitive urban design, e.g. constructing grassed swales and bio-retention filters, harvesting and reuse of stormwater and use of rainwater tanks (GHD 2001). Greater emphasis is being placed on preserving existing native vegetation in situ by decisions taken during initial land use planning and in infrastructure design. More money is being spent on restoration and rehabilitating of existing fragments of native vegetation in the urban and riparian areas (Staib, 2003).

Much of what was considered good environmental practice at the start of the development of the Project Area in the early 1990s is now less acceptable and is being replaced by new approaches. As the history of the Project Area from 1984 to 2006 has shown, this change has not happened overnight. The societal change necessary to bring it about has involved changes to peoples' attitudes, legislation, Government authorities, the design and construction industry, research, engineering standards, land zoning, land ownership and financial frameworks.

WATER QUANTITY: STORMWATER (Table 2, B3)

The original strategy for the Project Area was formulated to prevent increased downstream flooding caused by the significant increase in impervious surfaces that occur during urbanisation. The flood mitigation strategy involved building in-stream dry basins in the upper part of the Project Area catchment. This involved constructing a dam wall across the creek with a culvert at its base. These dry basins delayed the release of flood waters from the upper catchment allowing time for the flood waters from the lower catchment to escape downstream. These designs ensured that the flood peaks after urbanisation would be no greater than those pre-urbanisation. The basins were designed to limit peak flood flows from the 1:100 year Annual Recurrence Interval flood through to the 1:2 year Annual Recurrence Interval flood. The total amount of stormwater leaving the catchment though is greater after urbanisation.

The basins are achieving their objectives (GHD, 2001) but (as with the use of in-stream wet basins) concerns for the health of all streams within the catchment started to be raised both from Government authorities (Personal comm., 1998) and the community. This meant that for Stages 2 and 3 flood mitigation measures could no longer be constructed in-stream. Many were moved off stream into the flood plain or into gullies or small side streams. This increased the cost firstly because of the increased number of basins needed

and secondly because some of the basins moved from flood prone land to land capable of being developed for housing.

As most of the land in the Project Area was privately owned, the drainage authority (under existing legislation and town planning regimes) was obliged to pay market values for this potential urban land – in some cases up to 4 times the cost of flood prone land. Water sensitive urban design (wsud) approaches were explored during the Stage 3 design phase in an attempt to meet the new environmental objectives but were sometimes difficult to implement because of the constraints imposed by legislation, current land ownership and institutional inertia. The approaches included increasing the amount of pervious surfaces in new urban areas, the use of rain water tanks and the use of stormwater detention tanks on individual housing lots (GHD, 2001).

WASTE WATER TREATMENT and RECYCLED WATER (Table 2: A2, B4)

Treatment

The environmental impact statement for the sewage treatment plant (Manidis Roberts, 1991) and Sydney's endorsement of it made a commitment to tertiary treatment of sewage effluent and to the installation of a dual reticulation system to supply both potable and recycled water to households. The recycled water is used for toilet flushing, car washing and gardening. A percentage of the treated sewage effluent is also discharged to the creek via constructed artificial wetlands to remove further nutrients prior to it entering the Hawkesbury River. Construction of recycled water distribution mains has continued throughout the three project phases and the whole of the Project Area will be eventually serviced.

The recycled water plant was pre-commissioned in late 1994 and initially met the performance criteria in terms of virus removal. Unfortunately more testing showed the treatment process of deep-bed sand filtration and chlorination did not produce consistent results. A new design incorporating ozonation and micro-filtration was finally accepted and the treatment plant modified to enable full commissioning in 2001 to supply a population of 25,000. The plant is currently being upgraded to cater for 100,000 people. The capacity of the new plant is to be four times the original and will also allow for a considerable reduction in the amount of potable water make-up needed to balance supply and demand especially during summer (Sydney Water, 2005). The current water restrictions do not apply to recycled water and as there is a considerable amount of potable water make-up added to the recycled water, the new plant should significantly reduce this potable water usage.

During the design of the current upgrade, the first 5 years performance of the plant, the initial environmental objectives and the currently available technologies have been assessed and the most appropriate technology selected. The assessment found that the sewage treatment and recycled water plants have performed as predicted in all areas of operation except for the concentration of total nitrogen in the effluent. This may have affected the streams downstream of the treatment plant although with many factors

affecting stream water quality there was insufficient monitoring data to be definite (Sydney Water, 2005).

Usage

The development and implementation of new urban water use strategies are often fraught with difficulties and vested interests. In the Project Area there has been much debate about the use of rain water tanks in areas where the extension of the recycled water system is already planned and where the majority of the basic recycled water infrastructure (treatment plant, distribution mains and reservoirs) was already in place. If recycled water demand is supplied through tank water, the use of and flow of water through the reticulated water system would be lowered. This would mean that the existing recycled water infrastructure would work under capacity and inefficiently, producing problems with the water quality in pipes due to low flow or stagnant conditions. It would also lower the revenue necessary to recover the cost of the already installed recycled water treatment and distribution system - now probably larger than needed (Personal Comm., 2001). Several compromises have been suggested: recycled water connected to toilets and outside taps, tank water connected to washing machines.

In new areas a balance needs to be struck between distributed recycled water (non-potable), use of rain water tanks and use of captured stormwater, use of recycled water (potable water) etc. The infrastructure needed for each is expensive and could complete inefficiently with each other. One could call for better integration at the planning stage to minimise conflicts like this. Unfortunately with changing community expectations, changing technology and changing legislation this ideal planning approach is not always possible.

Recycled water remains a small part of overall water usage in Sydney. Current usage is approximately 15 billion litres per year compared to potable usage at approximately 600 bl/y – approximately 2.5%. Of the current recycled water usage, 65% is used for on-site processes at sewage treatment plants and 9% reticulated in the Rouse Hill Project Area. The 2006 Metropolitan Water Plan (NSW Govt., 2006) forecasts recycled water supply increasing to 70 bl/y by 2015 to just over 10% of potable usage. This usage is still only a very small percentage of all the sewage effluent discharged into the sea or rivers.

Pricing

Early costing by Sydney Water indicated that the price charged for recycled water was less that the direct cost of producing it. This led to some people in Sydney Water being less than enthusiastic about providing recycled water to future urban development areas. However, these estimates did not include the environmental benefits of using recycled water. The current price charged for recycled water is considerably less than the price of potable water. The current charges for recycled water as a percentage of the charges for potable water are: connection 40%; usage 20%. The NSW Independent Pricing and Regulatory Tribunal which regulates certain state monopoly industries is to revise these progressively up to 2008 to: connection 20% and usage 80% in an attempt to ensure recycled water as well as potable water is used prudently (IPART 2006).

PROGRESSIVE ENVIRONMENTAL IMPROVEMENTS and FUTURE PLANS

While the Project has delivered environmental solutions to the water cycle, it has sometimes neglected impacts created by these environmental solutions. These initial shortcomings are being addressed progressively over the ongoing stages. Table 3 shows how some of these environmental aspects have been addressed.

Table 3: Improved Environmental Measures for Stage 3

Environ. Aspect	Environmental Issue	Mitigative Measure	Stage 1 Unmitigated Impact	Stage 3 Mitigative Measure
Water Quality	Urban run-off pollution	Wet Basins trap nutrients and prevent pollution	But impact creek continuity	• Wet basins moved off line to protect creek continuity. • Water sensitive urban design features added.
	Sewage effluent pollution.	Tertiary treatment protects creeks, use of recycled water reduces amount of effluent.	• In-stream wetlands impact creek continuity. • Recycled water includes an amount of potable water make-up	• In-stream wetlands eliminated in future works. • Recycled water plant upgraded to reduce amount of potable make-up water.
Water Quantity	Flooding from Urbanisation	Dry basins mitigate flooding	But impact creek continuity	• Dry Basins moved off line to protect creek continuity. • Water sensitive urban design features adopted.
	Increased potable water use.	Recycled water reduces potable water demand.	Recycled water includes an amount of potable water	• Recycled water plant upgraded to reduce amount of potable make-up water.
Land Use	Clearance of flora	Landscaping repairs some disturbed areas	But significant areas of flora are still removed	• Broad scale mapping identifies important areas for protection • Infrastructure design changed to avoid flora • Compensatory planting restores riparian ecosystem.
	Damage to indigenous heritage sites	Archaeological sites are salvaged scientifically and culturally.	But significant sites are removed.	• Baseline mapping identifies significant areas for protection • Infrastructure design changed to avoid significant sites. • Large areas coincident with protected vegetation are preserved.

Early planning for the remainder of the RHDA outside the Project Area was less than enthusiastic about recycled water, but a number of external forces have combined to require the NSW Government to put recycled water back onto the agenda, including continual pressure from environmental groups, the expanding population of Sydney (approximately 1% per year), the need to avoid construction of new dams and the severe droughts in the catchment areas of Sydney's dams. Future green field developments, it appears, will be supplied with recycled water (non-potable) but the use of recycled water in existing areas and for potable use are still being debated (Taylor, 2006) .

In 2004 the preparation of a renewed strategy for greenfield urban development commenced in Sydney with the progressive development and release of the 2005 Metropolitan Strategy (NSW Govt., 2005) and 2006 Metropolitan Water Plan (NSW Govt., 2006). The Metropolitan Strategy makes a commitment to recycled water (non-potable for the new greenfield areas of Sydney. This includes the remainder of the RHDA now called the North-West Growth Centre.

The Water Plan contains an assessment of the supply of, and the demand for, water in the Metropolitan area of Sydney and explores many possibilities for (a) the increased supply of water including recycled water, extraction of presently inaccessible deep water from existing dams, groundwater aquifers, inter-catchment transfers, rainwater tanks, large scale desalination and (b) the reduction in demand for water including house-scale water efficiency improvements (NSW Govt., 2006a), water restrictions and demand management. The semi-independent review of the Metropolitan Water Plan (White et al, 2006) supported the objectives of the Plan but recommended that there needs to be ongoing high level coordination, adequate allocation of funds and adaptive management to bring it to fruition.

DISCUSSION

Those people who have worked on the environmental aspects of the planning and delivery of water infrastructure to the Rouse Hill Project Area would acknowledge that converting good environmental ideas and science into practical solutions has been difficult with many management, engineering, societal and political issues to overcome. Many changes and many adaptations to changed circumstances have been necessary along the way. Not the least were the societal changes that occurred from conception to delivery e.g. changes in community, environmental and social expectations, legislation and Government statutory authority arrangements. The future will not be different. We still have a Sydney population that is growing at about 1% per year and we have the added issue of global warming with its ramifications for water usage and supply.

The Rouse Hill trunk water delivery project with its many participants from Government, private industry and the community has shown that it is possible to make significant environmental gains in the design and delivery of water infrastructure, but that the participants need to be prepared to change their normal way of doing business in face of changing external circumstances. The water infrastructure being delivered in the Rouse Hill project area has moved us in the direction of sustainable water management but sustainability has not been specifically measured. The Metropolitan Water Plan (NSW Govt, 2006) describes major initiatives to improve sustainability of water use but does not provide any measures of sustainability. It would have been laudable if the plan had attempted to identify indicators for sustainable water use, the targets for such indicators and how the actions proposed in the plan would advance these indicators. In many Sydney Water publications over the years the use of indicators has been discussed e.g. achievement of supply without constructing any more dams and release of sufficient water from dams to maintain downstream river and ecosystem health.

CONCLUSION

As the Rouse Hill project has shown, changes in the way we deliver water infrastructure take considerable time to implement (20 years to date for the Rouse Hill area). However, the environmental gains in the Rouse Hill area though are small in terms of what will be necessary in the future. The Metropolitan Water Plan raises some challenging issues and ideas. It seeks to provide a framework for water supply and usage in Sydney for the immediate future. It will not be delivered painlessly but will require overcoming a lot of issues in face of a changing climate and a growing community. It is not a blueprint fixed on paper but a pencil sketch. In the end it has to be delivered – certainly the planet needs it.

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