International Conference "Water, Environment, Energy and Society" (WEES–2009)
New Delhi, 12–16 January 2009

Reconciliation of Future Water Demand and Supply in Western Sydney, Australia

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ABSTRACT: The growing population and climate change is putting pressure on the limited fresh water resources in Western Sydney (Australia), and is forcing to revisit water management strategies. This paper intends to inform and help water managers in formulating water management strategies to live in harmony with less water in this urban and peri-urban landscape. As a case study, this paper presents quantification of different water demands, availability and supply options in South Creek catchment, Western Sydney. The macro analysis presented here shows that if contemporary water use practices continued there would be a two-fold increase in potable water demand around year 2025 in South Creek catchment. However, there is potential to meet the region's domestic, industrial, agricultural and environmental water demands provided all water resources are integrated, used and reused in a harmonised fashion. Our analysis clearly indicates that there is need to reduce water consumption, improve water use efficiency, recycle more effluent and harvest stormwater to reconcile future water demands with available water supplies in South Creek catchment. The challenge is to match the right water quantity with right water user, and putting in place the necessary infrastructure and mechanisms for sustainable water management in the region.

Keywords: Hydrology, Rainfall-Runoff, South Creek Catchment, Peri-urban Landscape.

INTRODUCTION

Water is an essential input in the growth and development of human society, and also for maintaining fresh water ecosystems. Its use in the most of urban and peri-urban catchments across Australia has reached or even exceeded their water yield capacity. Similar trends could be observed in other major cities around the world, for example, Chennai and Delhi in India, cities in Northern China, Cairo in Egypt, Mexico City in Mexico, and Las Vegas in Western United States. Securing more water supplies through dams, described as 'the engineering solution' does not seem to be an option anymore in Sydney as current water extractions are on its maximum. For instance, the long-term sustainable catchment yield for Sydney's Water System has been rated at 600 gigalitres per year (GL Yr^{-1}) while the current water use is estimated about 625 GL Yr^{-1} (IPART, 2003). The water demands, however, are ever increasing to feed the growing population, increasing urbanization and economic growth of the region.

The population in Sydney is projected to grow from current level of 4.34 million to 5.16 million by 2026 and 5.93 million by 2051 (Mackintosh and Parr, 2004). Multiplying with the per capita water demand of 400 litres per day (without water use restrictions) suggests that Sydney would require an extra annual water supply of 120 GL Yr^{-1} by the year 2026, and of 232 GL Yr^{-1} by the year 2051. Further, there is necessity for increasing the legitimate share for environmental flows to protect river health, and to sustain freshwater ecosystems and their benefits for human and nature well-being. The projected changes in rainfall and higher evaporation rates due to climate change are likely to reduce flow in streams (CSIRO, 2007), and thereby decrease the sustainable yield of Hawkesbury-Nepean catchment which contributes nearly 80% to Sydney's Water System. The growing population and reduced rainfall in the catchment is putting considerable pressure on the region's limited fresh water resources, and is forcing the water authorities to revisit their water use and management strategies.

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Given the fact that Western Sydney is witnessing water stress conditions, there is need to assess how we manage current water resources, and to explore options to meet future water demands. Traditional approach of using water once and quickly pipping away to drains and creeks seems to be an inefficient use of water in particular when facing water use restrictions. Also it is not necessary to use potable quality water for irrigation of parks, golf courses, market gardens, and residential outdoor and indoor (laundry and toilet flushing). The contemporary use of potable water for the above mentioned purposes could be replaced with nonpotable water which could be sourced from stream flows, stormwater harvesting and treated effluent from sewage treatment plants. There is hope that the region's domestic, industrial, agricultural and environmental water requirements could be supplied by developing a mix water supply system integrating all available water resources and allowing use and reuse of water in a harmonised fashion. This approach of total water cycle management requires the understanding and quantification of different water sources and their quantity and quality, different water users and their demands, and matching up right water supply with right water users. Unfortunately there is so far not available a complete picture of total water cycle in Western Sydney. Water managers are looking for answers to questions like 'Is there enough water?', and 'Where should investment go to secure future water supplies?'

The CRC for Irrigation Futures has developed a System Harmonisation™ research program to identify opportunities for improved management of water resources to deliver optimal production and environmental outcomes in a region. As part of the ongoing System Harmonisation™ research program, this study was designed to inform and help water managers in formulating water management strategies to live in harmony with less water in Western Sydney. It estimates different water demands, availability and supply in South Creek catchment treated as a hydrological laboratory for Western Sydney. The South Creek catchment currently supports a population of around 300,000 in the region. The future population in the catchment is expected to approach one million in next 25–30 years with the proposed development of North West and South West growth centres for residential allotments (GCC, 2006). This study in particular focuses on the impact of proposed North West and South West growth centres on potable water demand, and explores the options to reconcile future water demands with available water supplies in South Creek catchment.

SOUTH CREEK CATCHMENT

The South Creek catchment covers an area of around 625 km^2 in gently undulating plains and low hills of Western Sydney. The major waterway in the catchment, South Creek rises in low hills near Narellan and runs over 64 km in north towards Windsor (Figure 1). The climatic conditions are moderate with warm to hot summer, cool to cold winter and reliable rainfall through out the year. The average temperature varies from high around 28–30°C in January to low around 2–5°C in July. On individual days, day temperature may rise up to 40–43°C in summer months (January–February), and fall lower than or close to 0°C in winter months (July–August). The average annual rainfall is less than 800 mm with fairly uniform distribution over the catchment. The rainfall characterized by thunder storms during summer months is higher than that occurs over long durations in winter months. Future climatic conditions are likely to be warmer and drier with an increase in temperature and changes in rainfall in the region (CSIRO, 2007).

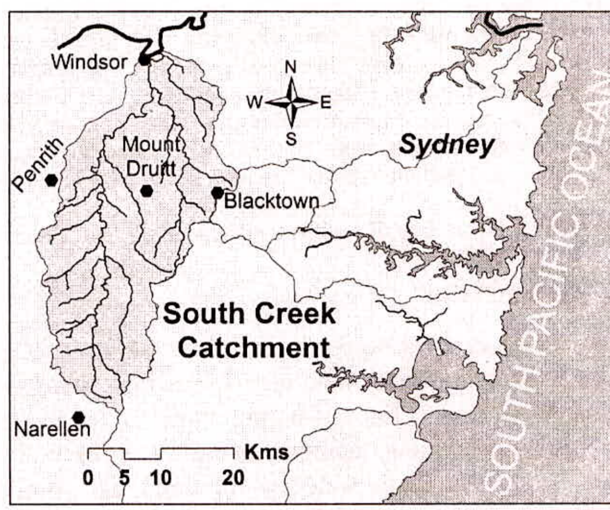

Fig. 1: Location of South Creek catchment in Western Sydney

Demographics and Landuse

Since the arrival of European settlers in 1788 the South Creek catchment has been subjected to continually landuse change from clearing native vegetation to pastures for grazing and intensive cultivation followed by modern urbanisation. In the year 2000 there was left only 22% of total land under natural conditions (EPA, 2001). The agriculture dominated area has been transformed to a peri-urban agriculture area where urban area exceeds the area under agriculture. In the year 2000 nearly 20% of total land was occupied by urban development, which was higher than 17% of total land occupied by agriculture activities (EPA, 2001). Not only agricultural area has been reduced the traditional agricultural activities of grazing and farming have been replacing by the peri-urban agriculture activities such as market gardens, cut flowers, nurseries, greenhouse, hydroponics, etc. The agriculture landuse in the region is further under pressure to shrink where it is competing for land and water resources demanded by the growing population and its associated increasing urbanisation.

The South Creek catchment currently supports a population more than 300,000 with the majority being resident in urban areas established in the central belt between Penrith and Blacktown (Figure 2). The future population, however, is expected to reach one million over next two decades with the proposed development of North West and South West growth centres (Figure 2). In addition there will be significant development for employment land (~8000 ha) in the catchment. The urban area in South Creek catchment, therefore, is likely to be increased around 60% of the total area in next 25–30 years to accommodate the projected population growth in the region.

Contemporary and Future Scenarios

The water availability, demand and supply are estimated for three different scenarios in South Creek catchment (Table 1). The 'Contemporary' scenario represents the current conditions with a population of 323,000 living in about 112,000 private dwellings in the catchment. These numbers are estimated from the suburb records of 2006 census of population and housing (http://www.abs.gov.au/websitedbs/d3310114.nsf/Home/census). The total urban area, recreation space (parks and golf courses) and irrigated agriculture are based on the landuse map of South Creek catchment in the year 2000 (EPA, 2001).

Table 1: Description of different scenarios used for estimation of water availability, demand and supply in South Creek catchment

Scenario Description	*Contemporary*	*Future_ YIA*	*Future_ NIA*
Year	~ 2001–6	~ 2025	~ 2025
Population (× 1000)	323	764	764
Housholds (× 1000)	112	264	264
Urban Area (ha)	12536	35944	35944
Recreation Space (ha)	738	1746	1746
Irrigated Agriculture (ha)	2204	2204	0
Climate Change (change in annual rainfall)		–7%	–7%

The 'Future' scenario represents the expected conditions around the year 2025 with the proposed North West and South West growth centres. The Nort West growth centre has been planned to build around

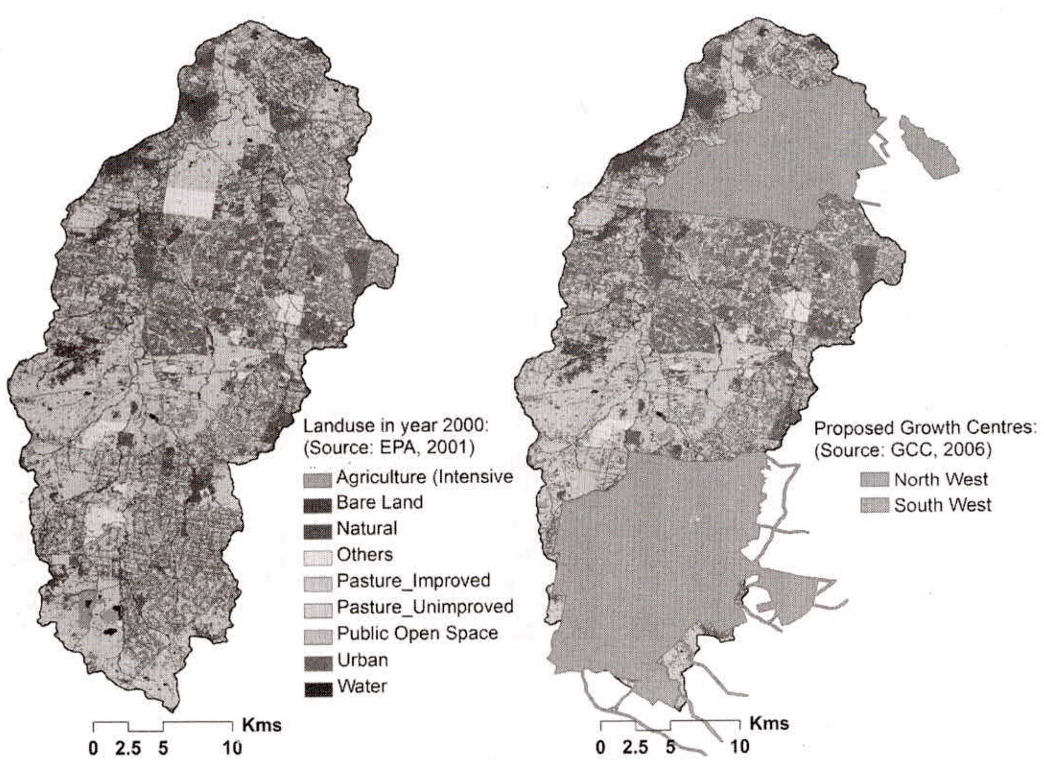

Fig. 2: Contemporary and projected future landuse in South Creek catchment

66,000 new homes spread over an approximate area of 10,000 ha area, and the South West for 115,000 new homes spread over an approximate area of 17,000 ha. The North West and South West growth centres fall nearly 90% and 80%, respectively in South Creek catchment (Figure 2). The future developments in South Creek catchment, therefore, are estimated about 153,000 new households over an area of 23408 ha. The population and recreation space under future scenario is kept in the same ratio to the households as in the contemporary scenario. This gives an increase of 441,000 in the population and about 1000 ha in the recreation space (parks and golf courses) under future scenario. The future scenario is further divided into two different options: one keeping all contemporary irrigated agriculture (Future_YIA) and the other eliminat-ing all contemporary irrigated agriculture (Future_NIA) (Table 1). These scenarios are designed to explore what impact irrigated agriculture may have on overall water demand and supply in South Creek catchment.

The annual rainfall received in South Creek catchment varied from 485 to 959 mm over the last 15 years from 1992 to 2006 (Figure 3). There were about 40% chances of receiving the annual rainfall equal to average annual rainfall of 683 mm. The annual rainfall since year 2002, however, had been lower than the average annual rainfall (Figure 3) indicating the recent drought in the region.

In a recent climate change report, CSIRO (2007) has projected about ±7% changes in annual rainfall in Hawkesbury-Nepean catchment including South Creek catchment. The report also projected 0.2 to 1.6°C increase in average temperature which is expected to increase evaporation rate and thereby potential reduction in stream flows. In this study, being on conservative side and keeping it simple we considered only –7% changes in annual rainfall to represent climate change conditions under future scenario (Table 1).

ESTIMATION OF WATER AVAILABILITY, DEMAND AND SUPPLY

The main sources of water in South Creek catchment could be identified as rainfall-runoff, potable water, and treated sewage effluent. Similarly the main water demands were identified as residential water use, non-residential urban water use, agricultural irrigation, and irrigation of recreation space (parks and golf courses). The Sydney Water supplies potable water from the dams outside of the catchment to residential and non-residential properties, and also for irrigation of some parks and golf courses and intensive agriculture activities such as market gardens, hydroponics, green-houses and nurseries. The following simple approach was used to estimate the total water availability, demand and supply in South Creek catchment:

Rainfall-Runoff

The runoff generated from the rainfall received in the area could be obtained following equation as,

$$Q = CIA \quad \ldots (1)$$

Where,

Q = Rainfall-Runoff Volume,

C = Runoff Coefficient (% of rainfall that appears as runoff),

I = Rainfall, and

A = Catchment Area (~625 km^2).

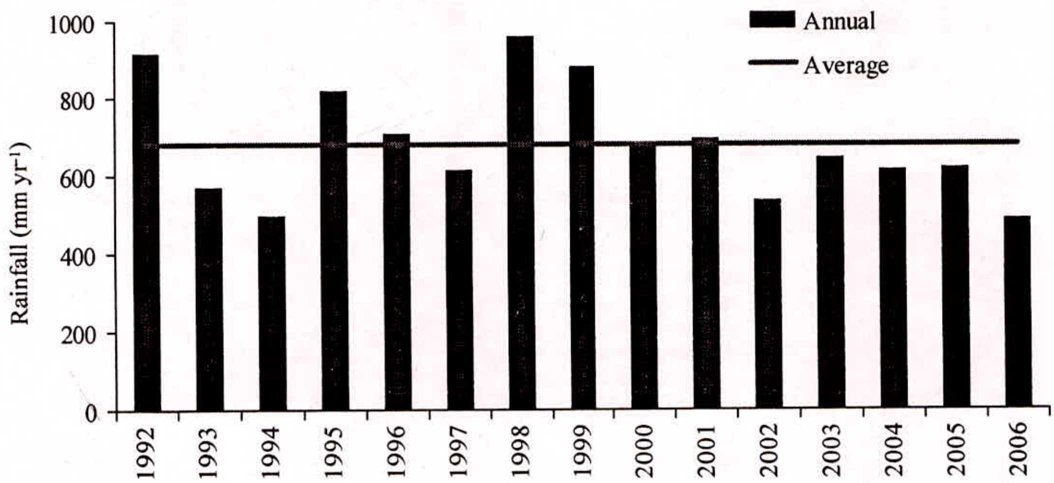

Fig. 3: Rainfall received in South Creek Catchment from 1992 to 2006

The runoff and stream flow generated from rainfall received in a catchment depends on the rainfall amount, duration and its intensity itself. It also depends on several catchment characteristics such as topography, soils and its infiltration capacity, moistures in the soil profile, and landuse in the area. In this study, the landuse in South Creek catchment was divided into three main runoff categories: natural, rural and urban. The runoff coefficients were estimated at 0.11 for natural, 0.23 for rural and 0.47 for urban landuse. It implies that 11% of the rainfall received over the natural areas flows to streams as rainfall-runoff, 23% over the rural areas and 47% over the urban areas. These values are based on literature, especially on "Managing Urban Storm Water: Council Handbook (NSW EPA, 1997)" which reported the average annual volumetric runoff coefficients recorded from a number of catchments around Sydney.

Treated Sewage Effluent

The urban areas of South Creek catchment are served by five sewage treatment plants, which discharge on an average of 27119 megalitres per year (ML Yr^{-1}) of treated effluent in South Creek and its tributaries (Rae, 2007). This gives an average rate of 243 kilolitres per household per year (KL hd^{-1} Yr^{-1}) of the treated effluent production from an estimated 112,000 households in the catchment (Table 1). This rate was used to estimate the total treated effluent production from the number of estimated contemporary and future households in South Creek catchment.

Residential Water Use

The average residential water use rate has been estimated at 252 KL hd^{-1} Yr^{-1} in Sydney region (IPART, 2004). Nearly 27% of the residential water is used for outdoor activities such as garden and lawn irrigation (IPART, 2003). These rates were multiplied with the number of estimated contemporary and future households (Table 1) to estimate total residential indoor and outdoor water use in South Creek catchment.

Non-residential Urban Water Use

The water use in non-residential properties could be highly variable in terms of volume and type. Therefore, it was not possible to estimate the non-residential water use by multiplying the average water use rate with number of non-residential properties. However, the non-residential urban water use could be estimated through a simple sewage flow analysis. The sewage flow is mainly from indoor water use in residential and non-residential properties and some possible inflow of stormwater during wet periods. The treated effluent production rate of 243 KL hd^{-1} Yr^{-1} in South Creek catchment was estimated to be 33% higher than the estimated residential indoor water rate of 183 KL hd^{-1} Yr^{-1} (~73% of total residential water use). It is likely that this extra sewage effluent is mainly discharged from non-residential properties such as schools, hospitals, community services, and commercial centres in the catchment. Therefore, the non-residential urban water use was indirectly estimated by subtracting the residential indoor water use from the treated sewage production.

Agricultural and Recreation Space Irrigation

The potable and nonpotable water is used for irrigation of agriculture activities such as market gardens, dairy pasture, greenhouse crops, and hydroponics, and for irrigation of recreation space such as parks and golf courses in South Creek catchment. The irrigation water use was estimated by multiplying the irrigation rate with irrigation area under different irrigation activities. In this study, the agricultural and recreation space landuse in South Creek catchment was divided into different main irrigation activities (Table 2). In case of the unspecified irrigation activity as "Agriculture-other" the irrigation rate was set to 6 megalitres per hectare per year (ML ha^{-1} Yr^{-1}) assuming it covers the irrigation activities such as cut flowers, fruit/ citrus tress, vineyards and tree plantations. In the absence of

Table 2: Estimated irrigation rate and potable water use for main irrigation activities in South Creek catchment (adapted from Yiasoumi, B., 2006)

Irrigation Activity	*Area (ha)**	*Irrigation Rate (ML ha^{-1} Yr^{-1})***	*Irrigation Volume (ML Yr^{-1})*	*Potable Water Use (%)***
Market gardens	1098	7.0	7687	42
Dairy and pastures	283	6.0	1697	0
Greenhouse crops	193	3.0	578	90
Nursery	2	10.0	417	70
Hydroponics	39	1.5	59	95
Turf farm	4	9.0	32	0
Mushroom farm	1	2.0	2	90
Agriculture—other	545	6.0	3270	10
Parks***	659	6.0	3956	40
Golf course***	79	9.0	707	40
Total	2942		18403	

* Landuse map of South Creek catchment in year 2000 (EPA, 2001).
** Yiasoumi, B. (2006) NSW DPI, unpublished report.
*** Rough estimates.

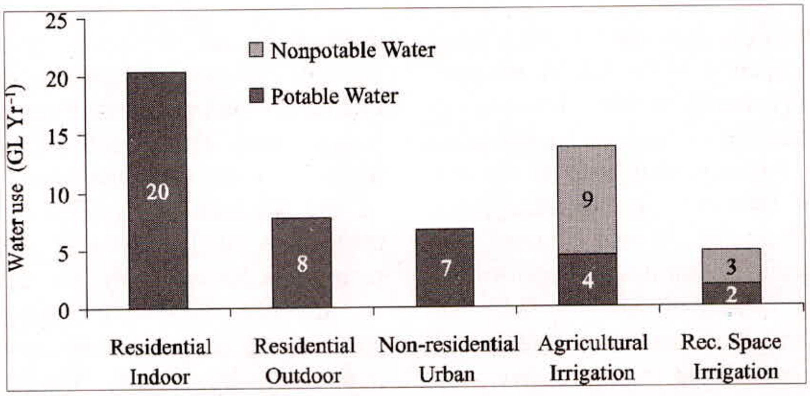

Fig. 4: Estimated contemporary water use in South Creek catchment

data available the irrigation rate for parks was also set to 6 ML ha^{-1} Yr^{-1} equal to the pasture irrigation rate, and that for golf course was set to 9 ML ha^{-1} Yr^{-1} equal to the turf irrigation rate. It was also assumed that about 40% of the irrigation water for parks and golf courses comes from potable water source.

Figure 4 shows the estimated water use for 'Contemporary Scenario' in South Creek catchment. The contemporary water use is estimated to be 41 GL Yr^{-1} from potable source, and 12 GL Yr^{-1} from nonpotable sources. The majority of potable water use is estimated for residential properties (28 GL Yr^{-1}) followed by non-residential properties (7 GL Yr^{-1}). This is in agreement with the potable supply recorded in South Creek catchment from 23 to 30 GL Yr^{-1} with an average of 26 GL Yr^{-1} for residential properties, and from 5 to 8 GL Yr^{-1} with an average of 7 GL Yr^{-1} for non-residential properties during the years from 1992 to 2006.

The contemporary irrigation water use is estimated to be 13 GL Yr^{-1} for agricultural irrigation, and 5 GL Yr^{-1} for recreation space irrigation. Using the reported share of potable water use for irrigation activities in Table 2 it is estimated that approximately 4 GL Yr^{-1} of water for agricultural irrigation comes from potable source. The potable water supply for primary production in the catchment, however, has been recoded from 1.9 to 3.5 GL Yr^{-1} with an average of 2.7 GL Yr^{-1} during the years from 1992 to 2006. The majority of contemporary irrigation water use comes from nonpotable water sources (Figure 4). The irrigators in South Creek catchment are entitled to extract about 8.4 GL Yr^{-1} from surface water sources. There are also listed some groundwater entitlements for the purpose of irrigation, but no information was available on the entitlements volume.

RECONCILING WATER DEMAND AND SUPPLY

If the contemporary practices are to be continued the potable water demand is estimated to be more than double under 'Future Scenario' (Figure 5) representing the expected conditions around the year 2025 in South Creek catchment (Table 2). Since agriculture has been assumed not to expand in future scenario the increase in estimated potable water demand is due to increase in residential and non-residential urban water use, and irrigation water use for recreation space. The residential water use is estimated to increase from 28 GL Yr^{-1} under contemporary scenario to 67 GL Yr^{-1} under future scenario. Similarly the non-residential

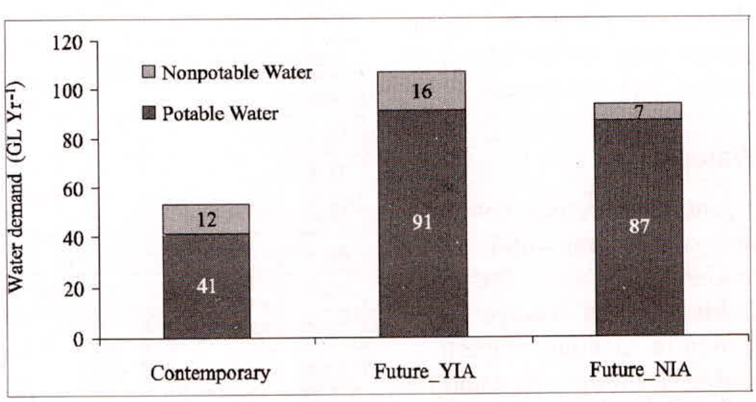

Fig. 5: Estimated water demands under different scenarios in South Creek catchment

urban water use is estimated to increase from 7 GL Yr^{-1} under contemporary scenario to 16 GL Yr^{-1} under future scenario. The analysis reported here is based on a conservative assumption that non-residential urban water use in properties such as schools, hospitals, community services, and commercial centres would increase in proportion to the increase in population and households in South Creek catchment.

The estimated potable water demand under future scenario without agriculture (Future_NIA) is only 5% lower as compared to future scenario with agriculture (Future_YIA). It indicates that keeping or not keeping agriculture in place would not have a significant impact on future potable water demand in South Creek catchment. However, it could provide the opportunity to use the recycled water from sewage treatment plants.

In this study, a range of strategies are explored to reconcile future water demand with available water supplies in South Creek catchment (Table 3). These strategies are focused on the potential replacement of potable water use with nonpotable water use to reduce potable water demand. The nonpotable water refers to the water that has not been treated for human consumption, but still could be used for other purposes such as irrigation, and residential outdoor and indoor water use in laundry and toilet flushing. It could be extracted from different sources such as stream flows, stormwater harvesting in rain tanks and detention basins, and pumped from groundwater aquifer. Another major source of nonpotable water is the recycled water from sewage treatment plants which could be reused safely for different beneficial purposes. The nonpotable water may or may not require water treatment depending on the source and user i.e. matching right quality with right user.

Table 3: Strategies to Reconcile Water Demand and Supply in South Creek catchment

Reconciling Strategy	*Replace Potable Water use with…*	*….. Nonpotable Water use for*
RS1		Agricultural Irrigation
RS2	RS1 +	Recreation Space Irrigation
RS3	RS2 +	Residential Outdoor in New dwellings
RS4	RS3 +	Residential Indoor (Laundry and Toilet) in New dwellings
RS5	RS4 +	Residential Outdoor in Existing dwellings
RS6	RS5 +	Residential Indoor (Laundry and Toilet) in Existing dwellings

The first and second strategies outlined in Table 3 assume to replace potable water use with nonpotable water use for all irrigation activities of agriculture and recreational space in South Creek catchment. The third and fourth strategies assume that all new dwellings in the North West and South West growth centres will have a dual-reticulation system to use nonpotable water for residential outdoor water use, and for residential indoor laundry and toilet flushing. The residential laundry and toilet water use are separated as 17% and 15%, respectively of the total residential water usage (IPART, 2003). In the fifth and sixth strategy, it is assumed that the old suburbs in South Creek catchment would be retrofitted with a dual-reticulation system to use nonpotable water for residential outdoor water use, and for residential indoor laundry and toilet flushing.

Table 4 summarizes the estimated impacts of each reconciling strategy on potable and nonpotable water demands in South Creek catchment. The "*reference*" represents the situation where contemporary water use pattern is to be continued in the catchment (Figure 5). With the contemporary water use pattern to be continued the potable water demand is estimated to be around 91 GL Yr^{-1} under future scenario with agriculture in South Creek catchment. This demand could be lowered by 10% through the reconciling strategies RS1 and RS2, i.e. replacing potable water use with nonpotable water use for irrigation of agriculture, parks and golf courses (Table 3). A major reduction of 21% in the future potable water demand could be expected through strategies RS3 and RS4 to use nonpotable for residential outdoor and indoor (laundry and toilet flushing) in all new dwellings in the North West and South West growth centres. The use of nonpotable water for residential outdoor and indoor (laundry and toilet flushing) in existing dwellings could further reduce the future potable water demand by 16%.

The maximum potential use of nonpotable water implemented in the reconciling strategy R6, i.e. use of nonpotable water for agricultural irrigation, recreation space (parks and golf courses) irrigation, and residential outdoor and indoor (laundry and toilet flushing) in households (Table 3), could reduce the estimated potable water demand from 91 to 49 GL Yr^{-1} under future scenario in South Creek catchment (Table 4). It implies that nearly 47% of the estimated potable water demand could be replaced by nonpotable water under future scenario. Table 4 also suggests that nearly 50% of the potable water use could be replaced by nonpotable water use under contemporary scenario. However, even after implementing the reconciling strategy R6 the potable water demand under future scenario is estimated to be 18% higher than the estimated contemporary potable water use of 41 GL Yr^{-1} in the catchment. This reduction of estimated potable water demands from 49 to 41 GL Yr^{-1} would require the reduction of water consumption through the promotion of water saving devices and practices for residential and non-residential indoor water use in the catchment.

Table 4: Estimated Water Demands for Different Reconciling Strategies in South Creek Catchment

Reconciling Strategy	*Water Demand (GL Yr^{-1})*			
	Contemporary Scenario		*Future Scenario (Future_YIA)*	
	Potable	*Nonpotable*	*Potable*	*Nonpotable*
Reference	41	12	91	16
RS1	37	17	87	20
RS2	35	18	82	25
RS3			72	35
RS4			63	44
RS5	27	26	55	52
RS6	21	33	49	58

While moving from the *'reference situation'* to implementing the reconciling strategy RS6 the estimated nonpotable water demand is increased from 12 to 33 GL Yr^{-1} under contemporary scenario, and from 16 to 58 GL Yr^{-1} under future scenario (Table 4). This nonpotable water could be sourced from stream flows, stormwater harvesting and treated effluent from sewage treatment plants. Figure 6 shows the estimated water availability from rainfall-runoff and sewage effluent in South Creek catchment.

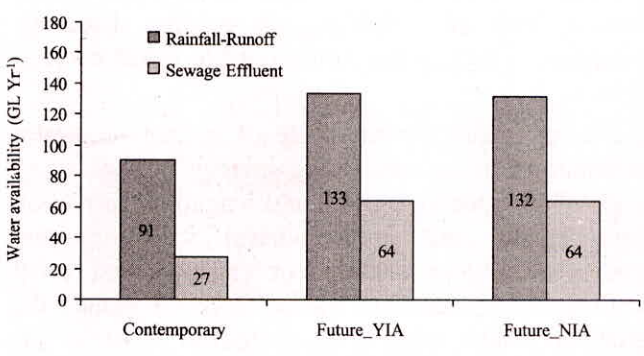

Fig. 6: Estimated water availability in South Creek catchment

The rainfall-runoff is estimated to increase from 91 GL Yr^{-1} under contemporary scenario to 133 GL Yr^{-1} under future scenario with agriculture (Future_YIA). This increase is estimated mainly due to increase in urban area from nearly 12, 536 ha under contemporary scenario to 35,944 ha under future scenario (Table 1). The rainfall-runoff from the urban areas could be harvested as stormwater, treated and then used as nonpotable water. The infrastructure such as rain tanks and detention ponds to harvest stormwater from 30% of urban area with a runoff coefficient of 0.47 could potentially provide about 32 GL Yr^{-1} of stormwater from a rainfall of 635 mm yr^{-1} under future scenario in South Creek catchment. Further there would be available about 64 GL Yr^{-1} of treated effluent produced from sewage treatment plants. This indicates that the potential availability of nonpotable water from stormwater harvesting and treated effluent production would be higher than the potential demand of nonpotable water under future scenario in South Creek catchment.

CONCLUDING REMARKS

The sustainable yield for Sydney's Water System has been rated at 600 GL Yr^{-1} while the current water use is estimated about 625 GL Yr^{-1}. The growing population and reduced rainfall in the catchment is putting considerable pressure on the region's limited fresh water resources, and is forcing the water authorities to revisit their water use and management strategies.

The South Creek catchment, treated as a hydrological laboratory for Western Sydney, currently supports a population of around 300,000 in the region. The future population of South Creek catchment is expected to approach one million in next 25–30 years with the proposed development of North West and South West growth centres to accommodate 181,000 new households. If contemporary water use pattern is to be continued in the catchment, the proposed urbanisation through the North West and South West growth centres would double the potable water demand around year 2025 in South Creek catchment. In particular, the residential water use is expected to increase from 28 GL Yr^{-1} under contemporary scenario to 67 GL Yr^{-1} under future scenario. Wether agriculture in future is retained or not, there is not much impact on future potable water demand in the catchment. It is interesting to note that nearly 47% of estimated potable water demand could be replaced with nonpotable water to meet future water demands in the year 2025. It is also noteworthy that even after implementing the maximum potential use of nonpotable water for irrigation of agriculture, horticulture, parks and golf courses, and for residential outdoor and indoor water use (laundry and toilet flushing), the potable water demand under future scenario is estimated nearly 18% higher than the estimated potable water use under contemporary scenario. Therefore, a sensible way forward to reconcile water demand and available water supply in South Creek catchment is to reduce water consumption, improve water use efficiency, and develop a mixed water supply system allowing use and reuse of water resources.

The macro analysis presented in this study indicates that the potential availability of nonpotable water from stream flows, stormwater harvesting and treated effluent production could be and would be higher than the potential demand of nonpotable water in South Creek catchment. This gives an opportunity to meet the region's domestic, industrial, agricultural and environmental water requirements provided all water resources are integrated, used and reused in a harmonised fashion. The challenge is to match the right water quantity with right water user, and putting in place the necessary infrastructure and mechanisms for sustainable water management in the region. This warrants the need of additional studies analysing the feasibility, and economic and environmental benefits of a mixed (integrated) water supply system in Western Sydney which may provide a sustainable solution for reconciling future water demand and supply in the region.

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