REPORT H05.3032

HYDE PARK AND COOK & PHILLIP PARK WATER RE-USE FEASIBILITY STUDY

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SECTION 1 INTRODUCTION

This report has been commissioned by the Environmental Development Unit of City of Sydney Council to ascertain the feasibility of replacement of potable water use with alternate acceptable water supplies at Sydney's Hyde Park and Cook & Phillip Park.

The report is based on data received from City of Sydney Council including historical technical data, anecdotal data and a series of previous consultants' reports. No further system testing or metering was performed to ascertain or verify these results, nor was any equipment dismantled.

Hyde Park is one of Sydney's premier parklands, occupying approximately 16.6 Hectares on the Eastern fringe of the CBD. The park is bordered by St James Road to the North, College Street to the East, Elizabeth Street to the West and Liverpool Street to the South. Park Street divides the park into North and South precincts. There are five (5) water features throughout the park, two (2) cafes and four (4) public toilets.

Cook & Phillip Park is located to the East of Hyde Park bordered by College and William Streets. The park is approximately 2 hectares consisting of approximately 1.5 hectares of irrigated landscaped lawn.

The park contains seven (7) water features. Cook & Phillip Aquatic Center contains three (3) swimming pools, one at 1.2ML capacity, one at 600kL capacity and a hydrotherapy pool at 100kL capacity.

The aquatic center also incorporates 34 showers, 20 WC and 5 urinals.

1.1 STUDY APPROACH

- Site inspection of Hyde and Cook & Phillip Parks.
- Review of historical data submitted by City of Sydney Council.
- Review of anecdotal data compiled by City of Sydney Council.
- Discussions with City of Sydney representatives and attendance of weekly project meetings.
- Review of relevant previous consultant reports commissioned by City of Sydney.
- Incorporation of outcomes from internal stakeholder workshop regarding potential water reuse options, including water sources, storage capacity and positioning

1.2 PURPOSE OF REPORT

The purpose of this report is to examine available options to limit or replace existing town's water usage at Sydney's Hyde Park and Cook & Phillip Park.

This report details the parameters of a range of water treatment and recycling systems proposed to achieve the City's objective to minimise potable water consumption in the City's parks.

By water cycle modeling, this report will confirm that a significant reduction in the consumption of potable water can be made through the introduction of various water treatment, water harvesting and alternate water systems, as described herein.

1.2 PURPOSE OF REPORT Cont.

Initiatives for optimisation of potable water consumption discussed in this report include the following:

- Rainwater Harvesting
- Stormwater Harvesting
- Greywater Recycling
- Blackwater Recycling
- Alternate water supplies. (Busby's Bore, CCT ground water, Cook & Phillip Park Groundwater and Cook & Phillip Park pool Backwash reclamation).

SECTION 2 EXECUTIVE SUMMARY

This study was commissioned to assess the feasibility and possible extent of replacement of potable water use in Hyde Park and Cook & Phillip Park by acceptable irrigation quality water from alternate sources. The study investigated the various water sources, storage options and required treatment for the different sources in accordance with the City's commitment to water conservation and replacing potable water used in the City's parks.

The study has established that the demand by park facilities for irrigation quality water is approximately 60 ML per year and that the available and acceptable non-potable sources of irrigation quality water can provide approximately 110 ML per year. The major water use considered for the purposes of this report is parks irrigation, with minor uses being the water features, the Living Colour programme, street tree watering and street cleaning. The acceptable supply significantly exceeds the expected annual demand.

The sources of non-potable water investigated were Cross City Tunnel seepage, Busby's Bore, park storm water harvesting, road storm water harvesting, Cook & Phillip park subsoil ground seepage, Cook & Phillip Park backwash water reclamation, onsite black water recycling and external black water reclamation. Of these sources, Cross City Tunnel, Busby's Bore, storm water harvesting, road storm water harvesting, and Cook & Phillip Park subsoil ground seepage were deemed acceptable and available sources. (Cross City Tunnel subject to further negotiations with CCM).

This report considered four alternate water supply options referred to as the Platinum, Gold, Silver and Bronze packages, the Platinum package including all available alternate water sources, grading down to the Bronze package which includes only Busby's Bore supply. This report recommends the adoption of the Gold package which incorporates the Cross City Tunnel ground water seepage supply, Busby's Bore supply and parks stormwater harvesting. The estimated cost of the works associated with the Gold package is $2.4 million. This option provides 267 kL per day with the related demand of 160 kL per day.

For the Gold package, limited water treatment is required generally; with passage through a strainer for all sources and disinfection possibly with a UV system to remove bacteria and fungi Capacity for future expansion such as the location of additional water sources, additional associated treatment requirements and capacity for construction of additional storage have been factored into the design concepts.

Options reviewed as possible primary tank storage locations were the use of Busby's Bore as an existing tank or the construction of a new primary storage tank in either the south east corner of Hyde Park North or on the lower terrace level below Cook & Phillip Leisure Center in Cook & Phillip Park. Other storage sites reviewed and deemed unacceptable were unused railway tunnels and other sites in Hyde Park North or South. This report recommends the main storage tank to be located in Cook and Phillip Park due to minimal heritage, access, construction and future expansion constraints compared with the alternate location in Hyde Park.

Main water storage is recommended to be a 500 m3 effective capacity reinforced concrete twin-cell tank, with an associated subterranean plant room, located as shown on the lower terrace of Cook and Phillip Park, with an access stairway, full forced ventilation and classification as a non-confined space. Day tanks of 100m3 are recommended to be located in Hyde Park North and Hyde Park South, and a 25m3 day tank located as shown in Cook & Phillip Park.

The cost of production for irrigation quality water for the four supply packages has been estimated and for the three viable options was assessed at approximately $1.20 per kL. The fourth (Bronze package) was assessed to cost approximately $2.90 per kL. The current cost of potable water purchased from Sydney Water is $1.20 per kL and is projected to increase to $2.00 per kL within the next ten years.

SECTION 3 DESCRIPTION OF PROJECT

3.1 CLIENT DISCUSSIONS

- Numerous meetings with Ms Kate Black and Mr Chris Derksema of City of Sydney throughout the project.
- Further meetings with relevant City of Sydney internal stakeholders and external contractors to enable their input and asses available knowledge.
- Two internal stakeholder workshops.

3.2 DOCUMENT SURVEYS

- Water Consumption Analysis and Supply Options Final Report prepared by Hughes Trueman June 2004.
- Hyde Park Watering Requirements & Water Restrictions Options prepared by URS Australia Pty Ltd February 2006.
- Cook and Phillip Park Watering Requirements & Water Restrictions Options prepared by URS Australia Pty Ltd February 2006.
- Busby's Bore Water Reclamation Project, Feasibility report 2004. (Prepared for Clean Up Australia)
- Cook and Phillip Park Water Efficiency Audit, prepared by NSW Department of Commerce February 2006.
- Cross City Tunnel: Water Reuse Options Report, March 2005 prepared by BHBB Operation and Maintenance.
- Storm Water Drawings Hyde Park South issued by City of Sydney.
- Survey Drawings for Hyde Park North and South, issued by City of Sydney.
- Sydney Water Storm Water Network Plans – William and College Streets.
- Hydraulic drawings for Cook and Phillip Park, issued by City of Sydney.
- Aerial Photos of Hyde and Cook + Phillip Parks, issued by City of Sydney.
- National Guidelines for Water Recycling Managing Health & Environmental Risk.

3.3 INSPECTION OF SITES

Site inspections of both Hyde Parks North and South and Cook and Phillip Parks were undertaken. During the site inspections the following items where reviewed. No system testing or metering was performed to ascertain these results, nor was any equipment dismantled.

- Water features and associated plant.
- Pool filtration plant and equipment.
- Roof and storm water drainage systems.
- Suitable options for water storage tank locations including plant and equipment.
- William Street storm water infrastructure.

SECTION 4 OVERVIEW OF WATER USE

4.1 COST OF POTABLE WATER

The average current cost of water for facilities such as Hyde Park and Cook & Phillip Park are as follows:

$1.20 per kilolitre – incoming water

$1.15 per kilolitre – waste discharge (non-applicable for properties listed as parks)

Therefore, overall pricing is based on $1.20 per kilolitre consumed, as both Hyde Park and Cook & Phillip parks including the Leisure Center are listed as park usage.

These costs are used in analyses of economic viability of system options examined in the report.

Given the current water shortages Sydney is suffering and the debate on the issue, it is likely that these charges will increase in the future. Data compiled by the Independent Pricing and Regulatory tribunal of N.S.W (IPART) in their document "Prices of Water Supply Wastewater and Storm Water Services" predict the cost of Tier 2 water to increase to $1.85/kL by 2008 subject to CPI. It would therefore not be unrealistic to suggest the cost of water in ten years would be $2.00/kL. The following is an extract from this document.

Water Usage Charge for Filtered Water to Metered Properties

Charge	Commencement Date to 30 June 2006 ($0kL)	1 July 2006 to 30 June 2007 ($0kL)	1 July 2007 to 30 June 2008 ($0kL)	1 July 2008 to 30 June 2009 ($0kL)
Tier 1 water usage charge	1.20	1.23 x $(1+\Delta CPI_1)$	1.26 x $(1+\Delta CPI_2)$	1.31 x $(1+\Delta CPI_3)$
Tier 2 water usage charge	1.48	1.59 x $(1+\Delta CPI_1)$	1.72 x $(1+\Delta CPI_2)$	1.85 x $(1+\Delta CPI_3)$

Table 1 – Cost Increase Predictions for Water Usage

4.2 WATER RESTRICTIONS

Australia is one of the driest continents in the world and is vulnerable to drought. Over the last century Sydney has experienced four (4) major droughts, with the longest lasting from 1934-1942. Prior to the drought currently being experienced in Sydney, the last drought in Sydney was from 1992-1998.

In November 2002, water restrictions were introduced to Sydney to manage the region's water supply during drought conditions.

Level 3 water restrictions are currently mandatory across Sydney, Illawarra and the Blue Mountains. The restrictions apply to all Sydney Water customers including residents, businesses, local Councils and Government agencies. At the time of writing this report an application to Sydney Water had been approved for temporary exemption to allow irrigation of Hyde Park.

Level 3 water restrictions are summarised as follows:

- Hand-held hosing of lawns and gardens and drip irrigation is now allowed only on Wednesdays and Sundays before 10.00am and after 4.00pm.
- No other watering systems or sprinklers are to be used at any time.

4.2 WATER RESTRICTIONS Cont.

- A permit from Sydney Water is required to fill new or renovated pools bigger than 10,000 litres.
- No hosing of hard surfaces, including vehicles, at any time.
- No hoses or taps to be left running, unattended, except when filling pools or containers.
- Fire hoses must only be used for fire fighting purposes – not for cleaning.

Recycled water, bore water and water used for testing fire systems, fire fighting and related activities are excluded from restrictions.

4.3 OVERVIEW OF WATER USES

Considered for the purposes of this report, potable water is consumed for park irrigation, water feature make up, irrigation of City of Sydney "Living Colour Program" and street cleaning.
With the availability of an alternate water supply, the above uses could be supplied using this non-potable water source via required filtration plant.

Potable water supply serving toilets, cafes and drinking fountains should remain connected to the potable supply in the short term as it is outside the scope of this report. That is, future connections (for example public toilets) should be considered during the course of an amenities upgrade in Hyde Park.

4.4 OVERVIEW OF ALTERNATIVE WATER SUPPLIES

Potable water is water that is suitable for human consumption as defined in AS3500.0 National Plumbing Code of Australia Glossary of Terms.

Potable water is traditionally supplied from the Authorities mains. Methods of water reclamation, or water re-use, can be introduced to minimise the consumption of potable water.
Such methods include:

- ***Rainwater and Stormwater Harvesting***

  Collection of rainwater from roofs or clean hard standing surfaces in lieu of potable water use. Sources are rain dependent and therefore non-guaranteed or inconsistent source of supply.

- ***Greywater Systems***

  Water that is not supplied by local Authorities and has been reclaimed from an alternative source, such as re-use of waste water from basins and showers, etc.

- ***Blackwater Systems***

  Water that is not supplied by local Authorities and has been reclaimed from an alternate source such as re-use of waste water from toilets, urinals, sinks, etc.

- ***Reclamation of Pool Backwash***

  Highly contaminated water requiring sophisticated filtration techniques including reverse osmosis

4.4 OVERVIEW OF ALTERNATIVE WATER SUPPLIES Cont.

- ***Alternate Water Supplies***

  - Water harvested from Busby's Bore.

  - Harvesting subterranean water flows from Cross City Tunnel; and

  - Cook & Phillip Park.(Details of these water sources are detailed later in this report.)

  The following sections provide a more detailed description of the available options for each of the above.

SECTION 5 CURRENT WATER USES (SUITABLE FOR SUBSTITUTION BY ALTERNATE SUPPLIES)

5.1 IRRIGATION

Irrigation of the parks' vegetation will be the primary user of all water in the two parks and the volumes have been determined using the data provided in the Hughes Trueman and URS Australia Pty Ltd reports. A maximum annual usage of 51.0ML (Hyde Park 44ML and CPP 7ML) has been assessed as a reasonable demand given normal rainfall during the year. (Refer Appendix 3.) It is noted that the URS Report estimates a total use of 44 ML for irrigation of the whole of Hyde Park. In practice, as the URS Report notes, the full irrigation of both parks does not currently take place. This study has assumed the maximum potential use to provide an upper limit to the irrigation demand.

5.2 WATER FEATURES

The twelve different water features could be supplied by an alternate non potable water supply. Five water features are located in Hyde Park and seven water features are located in Cook and Phillip Park.
Records provided by the City indicate an annual water use of 5 ML, 4 ML to Hyde park and 1 ML to Cook and Phillip Park, We note that the records include comments on faulty water meters, vandalism etc. Due to these comments, GNFP carried out an independent estimate of the Hyde Park water features' annual water use and estimated a minimum water use of 3.2ML. These figures compare reasonably and we have adopted a design use value of 4 ML per year. The conservative value reflects in part the current non-operation of the fountain in the south-west corner of the north park (Busby's Bore fountain) and its likely future repair and reuse.

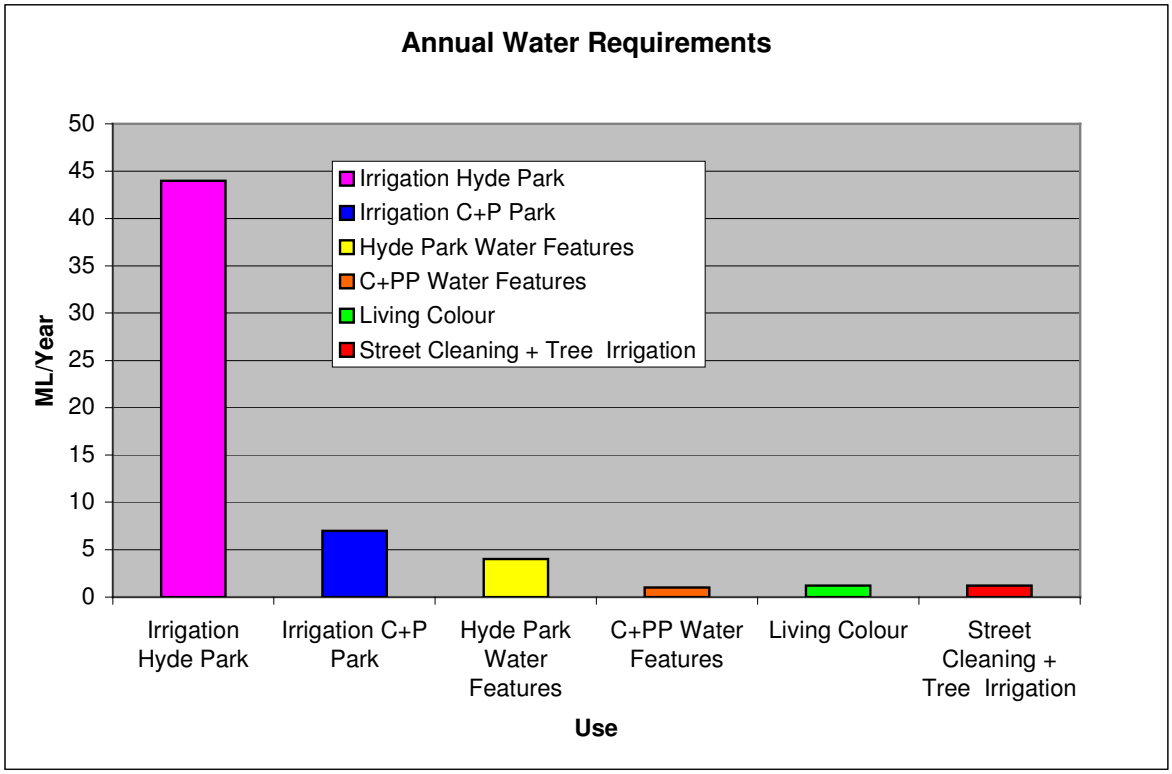
5.3 STREET CLEANING & TREE WATERING

The Hughes Trueman report identifies approximately 1.2ML of water being supplied by the Bay Street Depot or associated standpipes in the city for use in street cleaning and tree watering operations. Although not all of this water will be used around the parks, the 1.2ML has been adopted as a conservative estimate of the demand for reclaimed water for street cleaning uses.

5.4 LIVING COLOUR PROGRAMME

The Living Colour program run by the City of Sydney in Sept/Oct/Nov each year notes a particular water demand of approximately 1ML plus, and a figure of 1.2ML has been adopted as a typical additional demand for that event.

5.5 SUMMARY GRAPH



Graph 1 – Annual Water Requirements

Annual Water Requirements	ML/Annum
Irrigation Hyde Park	44
Irrigation C+P Park	7
Hyde Park Water Features	4
C+PP Water Features	1.0
Living Colour	1.2
Street Cleaning + Tree Irrigation	1.2

Table 1 – Annual Water Requirements

SECTION 6 ALTERNATE SOURCES OF WATER

6.1 BUSBY'S BORE

Busby's Bore was constructed in the early 1800's and upgraded in 1872, to provide a source of water for Central Sydney. Whilst the bore was originally capable of providing a flow of 1.5 to 1.8ML per day, we have been advised by COS that currently a minimum consistent flow of 50kL per day can be achieved. Another recent study by a consulting engineering group suggested that 110kL per day would be able to be achieved consistently. We also note that a section of Busby's Bore under Oxford Street was backfilled with sand in 1934 to prevent settlement under tramlines.

6.2 STORMWATER HARVESTING

The volume of rainfall runoff on the paths and other hard surfaces of both Hyde Park and Cook & Phillip Park have been calculated and the runoff available for irrigation use has been quantified. The runoff has been determined and included for the east catchment area of Hyde Park North, the Park Street/College Street corner catchment area of Hyde Park South, and the catchment area of Cook & Phillip Park. The roof runoff from Cook & Phillip Park Leisure Center is small and is included in the general Cook & Phillip Park catchment runoff. No runoff has been included from the grassed areas in the parks given the high absorption characteristics of these areas.

6.3 SUBSOIL WATER COLLECTION

Subsoil ground and drainage water is collected by a drainage pit in Cook & Phillip Park. The volume of water collected is approximately 3kL per day. This water can be diverted into the non-mains irrigation tanks.

6.4 ROAD STORMWATER HARVESTING

The street stormwater runoff has been calculated at the corner of College and Park Streets and is collected from the Sydney Water main passing East down William Street. The minimum daily average supply is 29.6kL. based on approximately 15 000m2 of catchment.

6.5 CROSS CITY TUNNEL (CCT)

The Cross City Tunnel currently experiences seepage water inflow of more than 300kL per day. Testing has indicated that the water sourced from two collection sites in the CCT is similar in quality to Busby's Bore water and should be suitable for park irrigation purposes. Monitoring by Cross City Motorway suggests that a minimum consistent supply of 170kL per day could be expected from the CCT. However, due to the relative infancy of the tunnel, the potential short and long term groundwater flow cycles are not well known and hence flow rates should be considered indicative at this stage.

6.6 COOK & PHILLIP PARK (C&PP) BACKWASH WATER RECLAMATION

Cook & Phillip Park disposes of approximately 6,200kL of backwash water per annum that could be treated and used as irrigation water. The treatment system costs in the order of $150,000 and operates at an efficiency of approximately 80 to 85 per cent. This results in a supply of treated (actually potable) water of approximately 5,000kL per annum (that is, 13.7kL per day).

6.7 ON-SITE -BLACKWATER RECYCLING

- Cook and Phillip Park, with an annual water use of approximately 135ML, 70% of which is estimated to discharge to sewer, could provide in the order of 65ML/annum of irrigation quality water via a sewage treatment plant.

- Sewer discharge from Hyde Park amenities were noted as insufficient to warrant blackwater recycling.

6.8 OFF-SITE – BLACKWATER RECYCLING

Sewage Water Recycling from one of a number of off site CBD buildings which surround the park, may be viable if/when negotiations with future developers involved with future building developments surrounding the park, which may enable harvesting of significant and reliable volumes.

6.9 MAINS WATER SUPPLY

This is the city's potable water supply from Sydney Water and is charged to City of Sydney. Restrictions in place due to the continuing drought limit the water supply available for park use. It is the intent of this study to demonstrate other water supplies can supplant the use of mains water generally throughout Hyde and Cook & Phillip Parks for irrigation and other uses.

SECTION 7 QUALITY OF WATER SUPPLIES

7.1 BUSBY'S BORE (BB)

Historically, Busby's Bore water slowly and progressively became more polluted due to the growth of the city throughout the 1800's and in the 1890's the Bore's use was discontinued as a potable water source.
Current quality tests and analyses available of the water from Busby's Bore indicate that it is acceptable for irrigation use given sand or similar filtration for removal of particulate matter.
This water may also require treatment for Fusarium fungus.

For detailed water analysis refer Appendix 2 (A).

7.2 STORM WATER HARVESTING

This water is acceptable for irrigation use subject to passage through a strainer to remove particulate matter.

This water may also require treatment for Phytopthera, Fusarium and other bacteria or fungi.

For detailed water analysis refer Appendix 2 (D).

7.3 SUBSOIL WATER COLLECTION

This water is acceptable for irrigation use subject to passage through a strainer to remove particulate matter. The onsite test results referred to in the "Cook & Phillip Park Water Efficiency Audit" prepared by NSW Department of Commerce, indicate a Total Dissolved Solids (TDS) of 500ppm and recommend water for non potable reuse via simple strainer. Given the very low contributing volume, water from this source can be mixed with the other sources without salinity problems.

7.4 ROAD STORMWATER HARVESTING

This water is the most highly polluted of all the available non-mains sources, having contaminants such as oil, petrol, rubber, brake pad dust, general rubbish and faecal material and will need significant filtration including disinfection. Graeme Monagle (City of Sydney – Roads & Streetscapes Senior Contract Coordinator advised there is a very low probability of pollution by illegal sewage connections to this storm water main. No water analysis was available.

7.5 CROSS CITY TUNNEL (CCT)

This ground water seepage water supply, as advised by CCM, is of similar content to that of Busby's Bore, and is advised to be of consistent quality. As such it requires minimal particulate straining only and possible UV or disinfection. However, ground water in the Sydney region is generally known to be high in iron and manganese. Further investigations should be conducted at the detailed design phase.

For detailed water analysis refer Appendix 2 (C).

7.6 COOK & PHILLIP PARK POOL BACKWASH WATER

This water is heavily contaminated with high salinity, oils, fats, bacteriological and other pollutants. The cost of water reclamation is very expensive, given the relatively small volume to be gained and this water has not been included in the available sources.

For detailed water analysis refer Appendix 2 (B).

7.7 ONSITE - BLACKWATER

Given reasonable volumes, the reclamation of blackwater can be cost effective and environmentally beneficial. With the use of a package sewage treatment plant, significant volumes of blackwater (sewage) can be reclaimed into irrigation quality water.

7.8 OFFSITE - BLACKWATER

Effluent to be pre-treated offsite by others and accepted by the City as an acceptable quality for irrigation purposes.

7.9 MAINS WATER SUPPLY

This supply is potable water supplied by the Sydney Water water mains and no treatment is needed.

Water is charged at $1.20 per kL consumed and is measured via Authority water meters located adjacent to each connection point. As previously mentioned, this cost is likely to increase significantly in the near future.

For detailed water analysis refer Appendix 2 (E).

SECTION 8 WATER TREATMENT

The following table outlines the pollutant content of the various water supplies and the likely treatment needed for each supply.

WATER TREATMENT REQUIREMENTS		
Source	**Pollutants and Treatment Type Required**	**Comment**
Busby's Bore	Particles, bacteria and/or fungal spores - particulate strainer and disinfection	Disinfection, probably UV treatment rather than chemical, subject to regular monitoring.
Cross City Tunnel	As advised to date, similar requirements to those of Busby's Bore (particulate strainer and disinfection).	Possibly may not need UV disinfection, dependent on possible contaminant presence, subject to regular monitoring.
Park stormwater	Particles, bacteria and/or fungal spores - particulate strainer and disinfection	Disinfection, probably UV treatment rather than chemical, subject to regular monitoring.
Road stormwater	Oils, food, faeces, bacteria, fungi as well as usual pollutants – requires gross pollutants trap, particulate strainer, sand filter and bacterial/UV disinfection	Will require chlorination and UV for disinfection and bacteria removal, plus treatment to remove chlorine products before use. (Expensive treatment)
C&PP Subsoil	Particles, bacteria and/or fungal spores - particulate strainer and disinfection	Disinfection, probably UV treatment rather than chemical, subject to regular monitoring.
C&PP Backwash Water	Highly contaminated, very saline, fats, bacteria, chlorine products etc.	Multi-purpose series of filters plus reverse osmosis system and UV.
Off-site Blackwater Recycle	As required prior to supply to CoS	No further treatment by CoS should be required.
On-site Blackwater Recycle	Sewage treatment plant, extensive filtration, possible reverse osmosis, significant chemical and possibly UV disinfection	Very expensive treatment, but may be cost-effective for the volume available (not considered further due to its inclusion in the Stage 2 Sewer Mining Project by Clean Up Australia)

Table 3 – Water Treatment Requirements

Note:

- The above processes are all subject to confirmation at detailed design stage.
- The processes are also subject to the results of regular monitoring. Regular monitoring in the sense used in this table means monitoring by CoS at a predetermined frequency to ensure appropriate treatment procedures are used for the particular water quality being received and to hence ensure that the minimum water quality standards required are consistently achieved. The frequency of monitoring would in all likelihood decrease over time as confidence in the quality was increased.
- The cost estimates provided in this report are indicative and are subject to confirmation at detailed design stage. These cost estimates will in large part be dependent on the results of the regular monitoring noted above.
- The "bacterial" items requiring disinfection generally in the above sources (other than road stormwater and blackwater) include fusarium and phytopthera, fungi susceptible to sterilisation on subjection to UV radiation, and other bacteria and mycotoxins.

SECTION 9 ANALYSIS OF ALTERNATE WATER SUPPLIES

9.1 HYDE PARK STORMWATER HARVESTING

The estimated total area of Hyde Park is 16.6 Ha. Stormwater run off from the hardstand areas was calculated for both Hyde Park North and Hyde Park South.

With the absence of detailed stormwater drainage documents for Hyde Park North, survey information was used to establish the two (2) authority street connection points, one located in Elizabeth Street located adjacent to Market Street [N2] and the other located on the corner of Park and Elizabeth Street [N1]. The hardstand catchment areas for each connection point were calculated at approximately 30,000m2 and 18,000m2 respectively.

Hyde Park South stormwater catchment areas were calculated based on detailed stormwater drainage diagrams. Four (4) separate Authority's street connections were identified. 1 Corner of Liverpool [S1] and Elizabeth Street [S2], 2 Corner of Elizabeth and Park Street [S3], 3 Corner of Park and College Street and 4, Elizabeth Street adjacent to Bathurst Street. The calculated hardstand catchments for each of these areas are 3000m2, 430m2, 2500m2 and 7800m2 respectively. [Refer Figure 1 below].

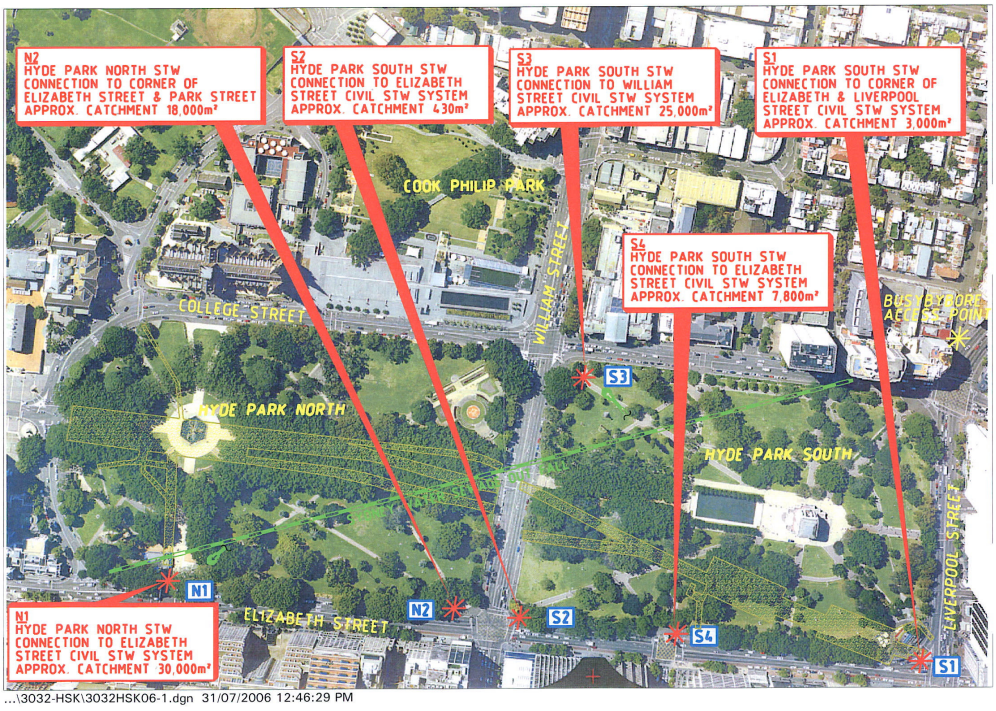


Figure 1 – Storm Water Street Connection Points

The landscaped and lawn areas were not included in our storm water catchment calculations as a soakage factor of up to 95% was assumed for the majority of these areas.

Based on the above mentioned catchment areas, using average monthly rainfall data sourced from the Bureau of meteorology for the local area, the following maximum and minimum monthly catchment volumes were calculated.

9.1 HYDE PARK STORMWATER HARVESTING Cont.

Area Description	Hardstand Catchment m²	Min Volume m³/Month	Max Volume m³/month
North 1	30,000 m²	1,650m³	3,150 m³
North 2	18,000 m²	990m³	1,890 m³
South 1	3,000 m²	165m³	315 m³
South 2	430 m²	25 m³	45 m³
South 3	2,500 m²	135 m³	265 m³
South 4	7,800 m²	430 m³	820 m³

Table 4 – Maximum and Minimum Catchment Volumes for Hyde Park

Retention tanks constructed upstream of each street stormwater connection would intercept the stormwater runoff and with minimum pre-treatment and or disinfection, be fit for reuse for irrigation purposes.

This water could be utilised locally via a pressure pump system connected directly to the existing irrigation system or pumped back to a centrally located larger storage tank located in Hyde Park North adjacent to College Street or Cook and Phillip Park [N1]. Local use of this water would provide the most efficient use of pump energy and would therefore be the preferred option.

A retention/day tank installed in Hyde Park South on the corner of College and Park Streets i.e. S3 will provide additional benefit to the City, by ameliorating a current stormwater surcharge problem occurring during storm events (refer Figure 2). To assess the degree of alleviation of the stormwater surge by the proposed park stormwater harvesting system, further specific flood study and hydraulic grade line analysis of existing stormwater infrastructure is recommended.

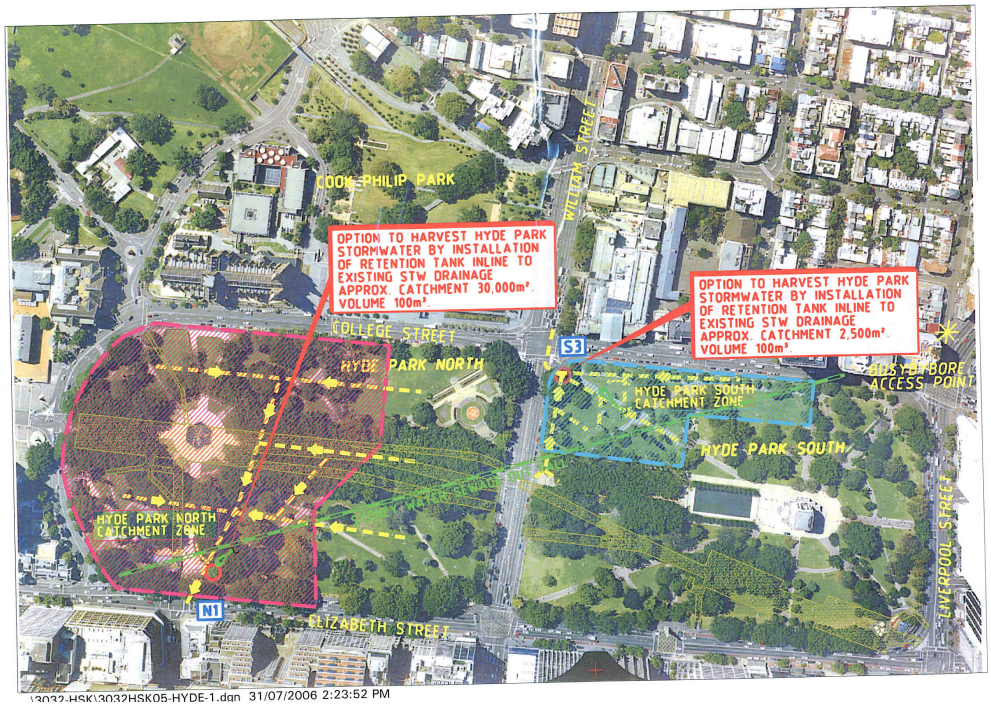


Figure 2 – Hyde Park Stormwater Catchment

9.2 COOK + PHILLIP PARK

Cook and Phillip Park is approximately 2 hectares, 1.5 hectares of this being of landscape and lawn area. An onsite inspection and review of the existing stormwater drainage documents was undertaken to determine the rainwater catchment area. From the review it was noted separation of roof water catchment and stormwater was impractical and not feasible due to the configuration of the existing stormwater drainage. There is benefit in separating the roof catchment from the stormwater as roof water is deemed a cleaner source of water requiring minimal pre-treatment before reuse compared with stormwater drainage.

By harvesting the sites combined roof and stormwater we are able to achieve greater catchment areas and therefore larger storage volumes for reuse water however this water will need a more sophisticated level of filtration before it is suitable for reuse.

Based on the above mentioned catchment area, using average monthly rainfall data sourced from the Bureau of meteorology for the local area, the following maximum and minimum monthly catchment volumes were calculated. A 20% inefficiency has been factored in to the below calculations. To allow for evaporation and soakage.

Area Description	Catchment m²	Min Volume m³/Month	Max Volume m³/month
Cook + Phillip Park	2750m²	200m³	395m³

Table 4 – Maximum and Minimum Catchment Volumes for C&PP

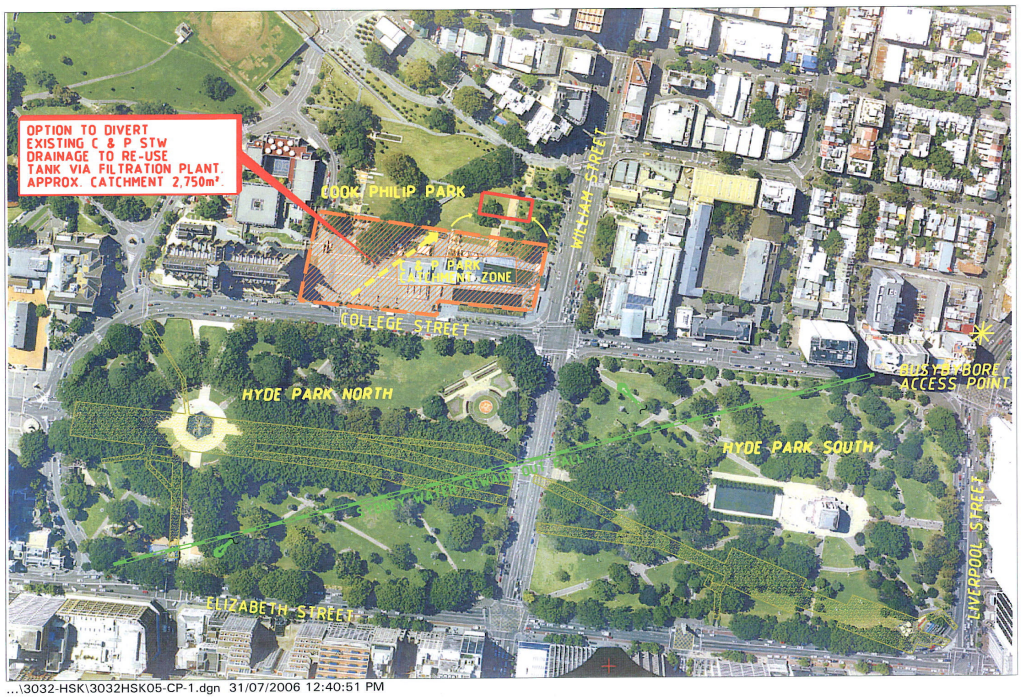


Figure 3 – Cook & Phillip Park Stormwater Harvest Catchment

9.3 WILLIAM STREET ROAD WATER CATCHMENT

Harvesting storm water from the existing Sydney Water stormwater main located under William Street has been reviewed. Road water catchment is deemed to be of very poor quality and would require a sophisticated level of treatment before it could be considered for reuse.

The scheme to harvest the road stormwater would involve diverting the existing stormwater main located under William Street to inside the landscape area at the base of Cook + Phillip Park. The pipe work would pass though a gross pollutant trap and through a staged holding tank. From the holding tank the water would be would be pumped through a series of filtration units and directed to the large holding tank at a quality suitable for reuse. [Ref: Schematic Diagrams HSK-01/02 Section 9.9].

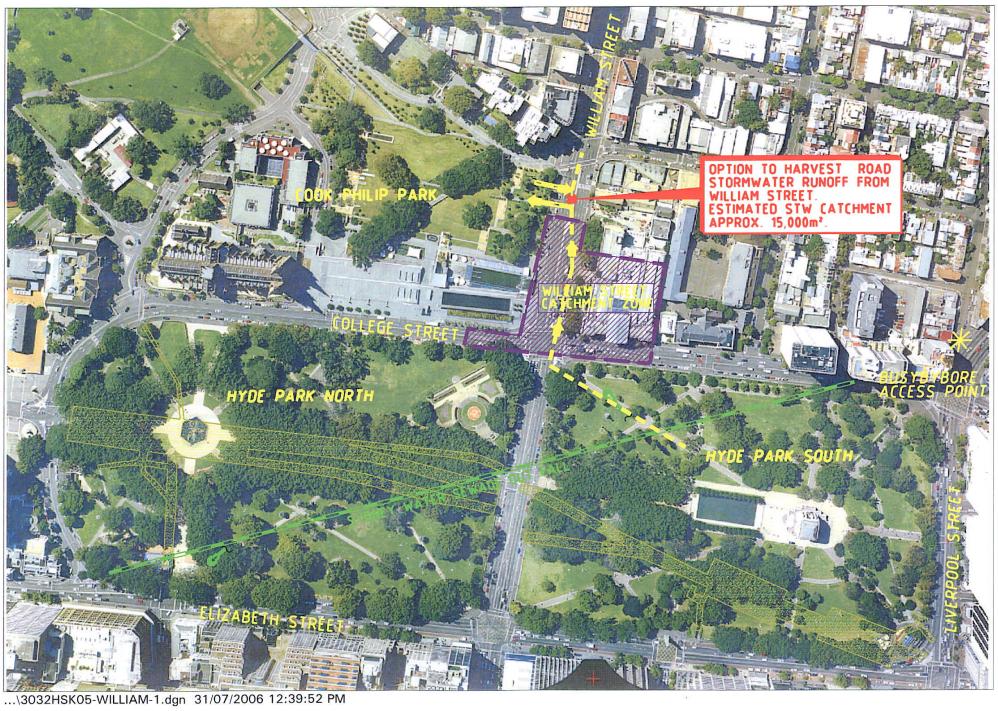


Figure 4 – William Street Road Stormwater Harvest Catchment

9.4 BLACK & GREY WATER RECYCLING

There may be an opportunity to recycle sewage from one of a number of CBD buildings, which surround the Park. Should the opportunity of a new development or major refurbishment present it self in the near future, City of Sydney may to be able to negotiate with the developer to recycle the grey or black water for the Park's reuse.

Estimated flows for a hypothetical residential development of 140 apartments could approximate 50kL/day or 18.3 ML/per annum.

9.5 BUSBY'S BORE

Busby's Bore has a reliable daily minimum supply of 50kL and will be provided to City of Sydney by Sydney Water without cost. The water is of acceptable quality for irrigation with only simple strainer treatment required. The basic infrastructure is in place and accessible near the corners of Oxford and College Streets. Sydney Water has agreed to fund and carry out the works required to deliver the Busby's Bore water to the proposed location of the Alternate Water Supply storage tank. The water will pass through a strainer and a form of disinfection. Note that any chemicals used for disinfection eg., chlorine, will be removed prior to water storage.

9.6 CROSS CITY TUNNEL

The Cross City tunnel supply is of irrigation quality and is of similar quality to Busby's Bore. Preliminary analysis undertaken by Cross City Motorway (CCM) suggests that the water is viable for reuse. Further, negotiations between CCM and the City will be required before this water can be considered a guaranteed source of water in the parks.

9.7 COOK PHILLIP SUB SOIL SEEPAGE COLLECTION

This source is readily available at little additional cost and with relatively minor capital works required. The water is of irrigation quality with a need only for particulate straining. No other treatment is likely to be required, although bacterial presence would need to be checked and minor chemical or UV disinfection carried out, if necessary.

9.8 ON-SITE BLACKWATER RECYCLE

Hyde Park blackwater recycling based on the limited number of existing fixtures connected to the sewer i.e. two (2) cafes and four (4) public toilets, would prove insufficient to sustain a proprietary sewage recycling plant.

Cook and Phillip Park, based on data provided in the Cook and Phillip Park water efficiency audit prepared by NSW Department of Commerce, could provide recycled blackwater in the order of 65ML/Annum. A package sewage recycling plant suitable for this application would be in the order of approximately $500,000 installed.

Due to the City's involvement with the Clean-Up Australia Stage 2 Project involving Woolloomooloo sewer mining, this water source was not considered further at this stage because the removal of 65ML or thereabouts from the Stage 2 Project could impact on the viability of that project.

9.9 OFF-SITE – BLACKWATER RECYCLING

Sewage Water Recycling from one of a number of off site CBD buildings which surround the park, may be viable if/when negotiations with future developers involved with future building developments surrounding the park, which may enable harvesting of significant and reliable volumes.

9.10 ALTERNATE WATER SUPPLY SCHEMATICS

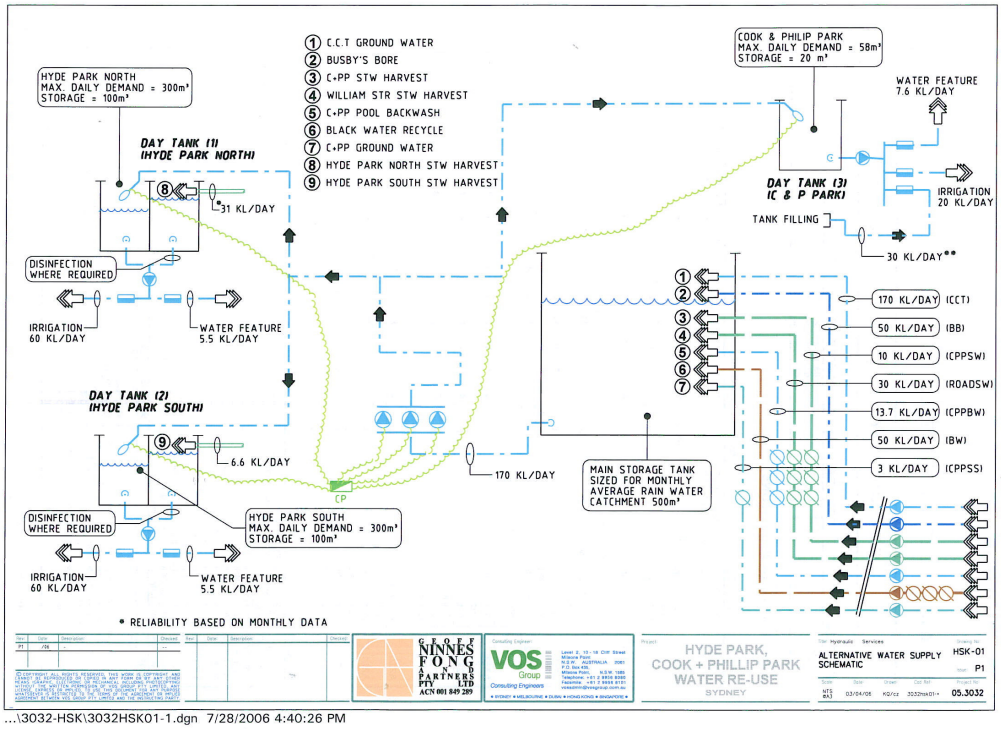


Figure 5 – Alternative Water Supply Schematic HSK-01

9.9 ALTERNATE WATER SUPPLY SCHEMATICS Cont.

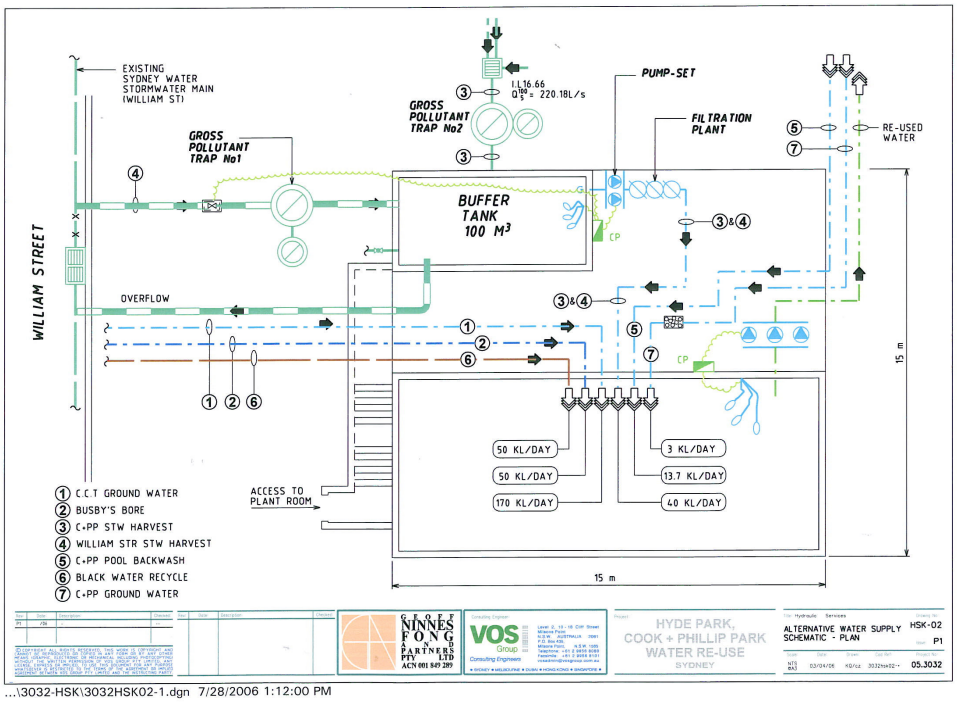


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Figure 6 – Alternative Water Supply Schematic HSK-02

SECTION 10 RELIABILITY OF ALTERNATE WATER SUPPLIES

10.1 RELIABILITY DEFINITIONS

(1) Guaranteed Supply:

A water source that consistently supplies a known quantity of water on a daily basis.

(2) Non-Guaranteed Supply:

A water source that supplies water on a random basis, without any reliable or predictable daily inflow. Total quantity is assessed on an annual basis and averaged for the particular period under study, i.e. daily, monthly, etc.

Note: A water source may possess guaranteed and non-guaranteed supply characteristics, such as delivery of a reliable daily supply (guaranteed) and a non-reliable and variable additional supply (non-guaranteed).

10.2 ALTERNATE WATER SUPPLY CHARACTERISTICS

WATER SOURCES AND CHARACTERISTICS	QUANTITY (kL/day)	QUALITY	TREATMENT	RELIABILITY
Busby's Bore (BB)	50.0	Non-potable, particulates, bacteria/fungal spores	Particulate filter, UV or chemical disinfection	Guaranteed
CPP Subsoil (CPPSS)	3.0	Non-potable, particulates, possible bacteria/fungal spores	Particulate filter, UV or chemical disinfection	Guaranteed
Park Stormwater (PSW)	47.4	Non-potable, particulates, bacteria/fungal spores	Particulate filter, UV or chemical disinfection	Not guaranteed
Road Stormwater (RSW)	29.6	Non-potable, particulates, bacteria/fungal spores, oils, rubber, brake pad dust, faecal matter, rubbish, food scraps	Gross pollutants trap, trash/particulate strainer, sand filter, flocculation, bacteria & UV disinfection	Not guaranteed
Cross City Tunnel (CCT)	170.0	Non-potable, particulates, possible bacteria/fungal spores	Particulate filter, possible UV or chemical disinfection if needed	Guaranteed (pending negotiations between CoS & CCM)
C&PP Backwash (CPPBW)	17.3	Non-potable, highly polluted, high salt content, fats, oils, bacteria, possible spores, etc.	Expensive treatment, best to recycle within CPP pools centre if reclaimed	Guaranteed Not currently feasible
Off-Site Blackwater Recycle	50.0	Non-potable, treated to irrigation quality by suppliers	No further treatment needed	Guaranteed "futuristic' subject to negotiations with future developers.
On-Site Blacktwater Recycle	178.0	Non-potable, sewage, highly contaminated	Sewage treatment plant, filtration, extensive treatment, needs significant plant space	Guaranteed (volume currently included for Stage 2 Woolloomooloo sewer mining project).
Mains Supply (MWS)	-	Potable	No further treatment needed	Guaranteed

Table 5 – Water Characteristics Matrix

Note: All treatment processes are subject to future detailed design confirmation.

10.3 RELIABILITY OF ALTERNATE SUPPLY

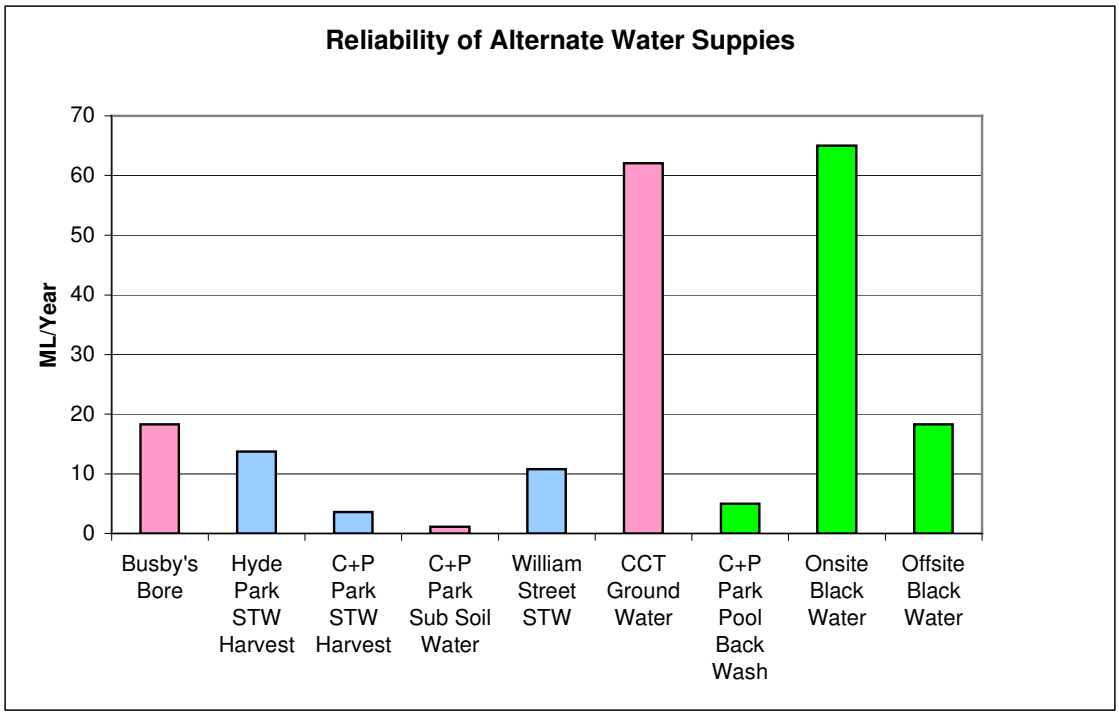
The following table/graph indicate all possible alternate water supplies investigated by this report. The colours identify the source's reliability (pink being guaranteed, blue being non-guaranteed and green indicating a guaranteed supply classifying as futuristic due to either availability or feasibility.

Each source has been tabled with a total contribution in ML/Year and its portion in percentages to the total annual demand

Source	ML/Annum	Reliability	% of Non Potable Demand
Busby's Bore	18.3	Guaranteed	31.3
Hyde Park STW Harvest	13.7	Non-Guaranteed	23.5
C+P Park STW Harvest	3.6	Non-Guaranteed	6.2
C+P Park Sub Soil Water	1.1	Guaranteed	1.9
William Street STW	10.8	Non-Guaranteed	18.5
CCT Ground Water	62.1	Guaranteed	106.3
C+P Park Pool Back Wash	5	Guaranteed	8.6
On-Site Blackwater	65	Guaranteed	104.5
Off-Site Blackwater	18.3	Guaranteed	31.3

Table 6 – Alternate Water Sources

Note: Non-potable demand is 58.4ML per year.

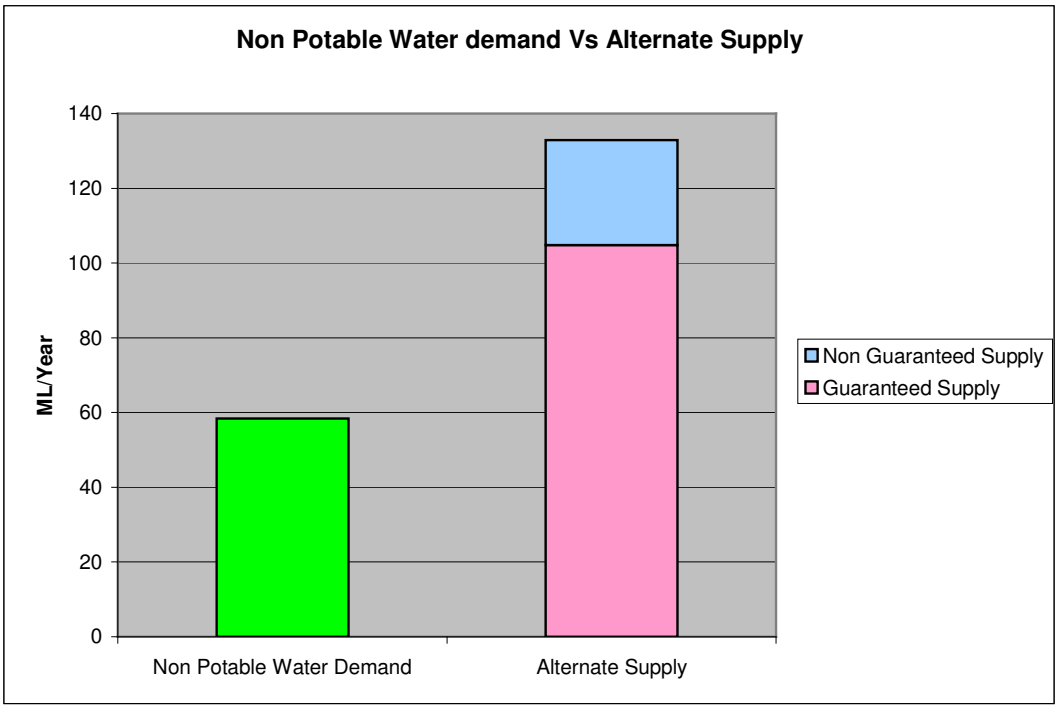


Graph 2 – Alternate Water Supplies

10.4 TOTAL DEMAND VERSUS GUARANTEED AND NON-GUARANTEED SUPPLIES

The following graph illustrates the relationship between the current non-potable demand (58.4ML/Annum) and the guaranteed and non-guaranteed alternate supplies.

79% of the possible alternate water sources are of guaranteed supply. Therefore, the total current non-potable demand of 58.4ML/Annum can be supplied by 55% of the guaranteed source.



Graph 3 – Water Use Vs Alternate Supplies

Supply	ML/Annum
Total Non Potable Water Demand	58.4.
Guaranteed Alternate Water Supply	104.8
Non - Guaranteed Alternate Water Supply	28.1

Table 7 – Guaranteed Water Supply Vs Usage

SECTION 11 ALTERNATE WATER SUPPLY PACKAGES

The provision of water can be grouped in packages which give defined benefits and this report has used, in the following, a "Platinum, Gold, Silver, Bronze" means of delineation of the various groupings.

Platinum:
- delivers highest quantity of water and provides treatment systems for all the widely varying degrees of contamination/pollution of the water sources.
- does not differentiate between guaranteed and non-guaranteed supplies.
- allows maximum capability for future expansion.
- includes CCT Groundwater, Busby's Bore, CPP Stormwater, William Street (Road) Stormwater, , CPP Pool Backwash Water, Black Water, Hyde Park North Stormwater, Hyde Park South Stormwater (can later add treated park sewage and future supplies).

Gold:
- delivers maximum quantity of cost-effective water (i.e. the water sources that require minimum treatment cost and/or provide a secondary cost or social benefit such as mitigation of storm surge)
- includes supplies CCT Groundwater, Busby's Bore, CPP Stormwater, Hyde Park North Stormwater, Hyde Park South Stormwater .

Silver:
- delivers water from the minimum treatment cost sources only.
- includes CCT Groundwater, Busby's Bore.

Bronze:
- delivers water from the minimum treatment cost sources that are currently readily available.
- includes Busby's Bore.

Water Supply Package	Water Sources	Supply per Source (kL/day)	Total Annual Supply per Source (ML)	Total Daily Supply (KL)	Percentage of City's Total Demand of 160 kL/day (%)	Recommended Effective Storage Volume (m^3)
Platinum	Busby's Bore	50.0	18.3	364	228%	700 (based on peak daily demand of 711m^3)
	Cross City Tunnel	170.0	62.1			
	Park Stormwater	47.4	17.3			
	Road Stormwater	29.6	10.8			
	C&PP Subsoil*	3.0	1.1			
	Residential Blackwater**	50.0	18.3			
	Treated Park Sewage***	NA	NA			
	C & PP Pool BW****	13.7	NA			
	Future Water Sources*****	NA	NA			
Gold	Busby's Bore	50.0	18.3	267	167%	700
	Cross City Tunnel	170.0	62.1			
	Park Stormwater	47.4	17.3			
Silver	Busby's Bore	50.0	18.3	220	138%	700
	Cross City Tunnel	170.0	62.1			
Bronze	Busby's Bore	50.0	18.3	50	31%	100

Table 8 Alternate Water Supply Packages

* Not considered in other options – volume insignificant.
** Future potential only, subject to ongoing negotiations with developers
*** Minor source, figures not available
**** C&PP pools backwash water, if treated, would be more beneficially used in C&PP Park
***** Future requirements may realise or necessitate future water source development.

SECTION 12 REVIEW OF WATER STORAGE REQUIREMENTS

12.1 ANNUAL USE AND SUPPLY ESTIMATES

Total annual estimated water use is 58.4ML (58,400m3) and total annual supply from all alternate sources is 106.9ML (106,900m3). Hyde Park use is 50.4ML and CPP use is 9.8ML.

12.2 GUARANTEED AND NON-GUARANTEED DAILY SUPPLIES

From the above, an average daily use of 160m3 is estimated. The guaranteed water supply varies dependent on the supply package selected.

Supply Package	Guaranteed Supply (kL/day)	Non-Guaranteed Supply (kL/day)	Total Supply (kL/day)	Total Demand (kL/day)	Percentage of Demand Provided by Guaranteed Supply
Platinum	287	77	364	160	179%
Gold	220	47	267	160	138%
Silver	220	0	220	160	138%
Bronze	50	0	50	160	31%

Table 9 Guaranteed and Non-Guaranteed Daily Supplies

12.3 MAXIMUM DAILY WATER DEMAND

The maximum total weekly demand is 4.98ML (4,980m^3), giving a daily peak demand of 0.711ML (711m^3). (Hyde Park's weekly use is 4.57ML, Cook & Phillip Park's weekly use 0.41ML).

12.4 ESTIMATE OF STORAGE REQUIRED

1) To cater for the average water demand, the minimum stored supply must be greater than 160m^3.

2) To meet the maximum daily demand volume, the stored volume must be greater than or equal to the daily supply volume plus the stored volume. The stored volume varies according to the selected package as per the table below.

Supply Package	Maximum Daily Demand Volume (m^3)	Daily Supply Volume (m^3)	Minimum Stored Volume (m^3)
Platinum	711	364	347
Gold	711	267	444
Silver	711	220	491
Bronze	711	50	661

Table 10 Estimate of Storage Required

Subject to final design, our recommendation is that a main storage tank of 500m3 be provided, to enable satisfaction of demand on most days throughout the year. For reasons explained in the next section, we also recommend that storage day tanks of 100m3 each be located in Hyde Park North and Hyde Park South, and a smaller storage day tank of 25m3 be located in Cook & Phillip Park.

The total storage capacity of all recommended storage tanks is approximately 725m3. We note that the greater the storage capacity, the greater the capacity to use other supplies should these become available.

12.4 ESTIMATE OF STORAGE REQUIRED Cont.

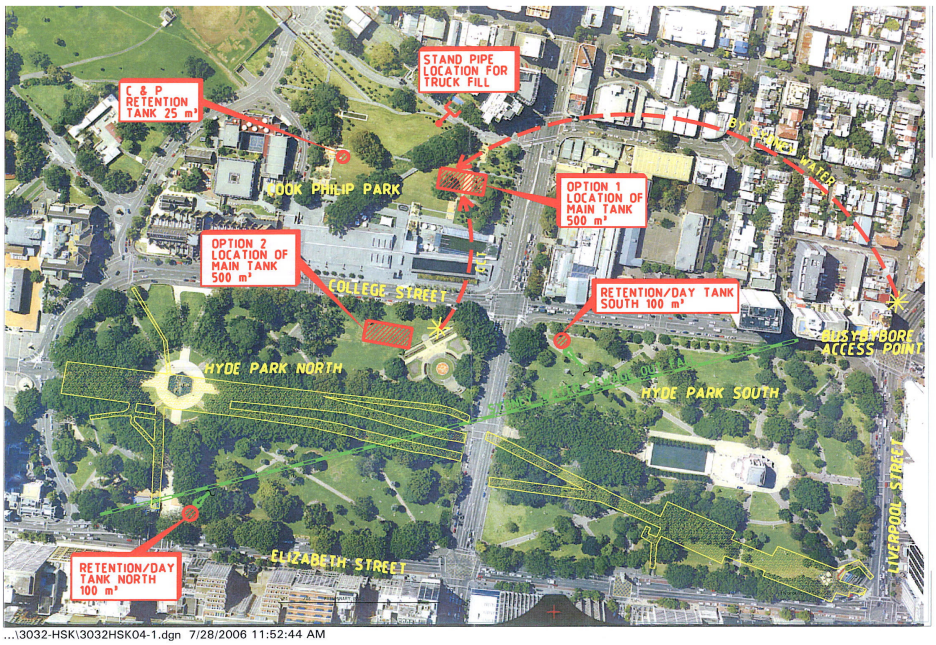


Figure 7 – *Aerial Plan - Location of Proposed Storage Tanks and Day Tanks*

SECTION 13 REVIEW OF POSSIBLE SITES FOR STORAGE TANKS AND TREATMENT PLANT

13.1 SITE OPTIONS

13.1.1 Hyde Park North and Hyde Park South

Very few acceptable sites are available for the location of a main large storage tank and associated plant of plan dimensions of approximately 340m2. The main tank could feasibly only be located under the lawn area adjacent to the Sandringham Gardens in Hyde Park North. For OH&S reasons, (to obviate definition as a confined space with all the associated operational difficulties) and for plant access reasons, it is very important that the plant room be accessible by stairs and not simply a ground level hatch. Provision of such access in Hyde Park North or South was not acceptable to many of the stakeholders and was also not acceptable for heritage reasons. Other locations for the main tank and plant room were considered in both Hyde Park North and Hyde Park South, but the space and access requirements and heritage considerations negated these options.

13.1.2 Cook & Phillip Park

The lower terraced and grassed area of Cook & Phillip Park presented minimum problems in terms of OH&S and heritage considerations, was the least expensive to construct to the capacity recommended, and has potential for future expansion should this be deemed appropriate or necessary in the future. The location is also optimum for collection of the road stormwater from William Street. No particular other potential uses or associated negotiations were apparent for this site, and the facility could be accommodated simply and unobtrusively. This option is the most attractive in terms of minimisation of political, public and heritage problems, accessibility, functionality, and cost.

13.1.3 Busby's Bore

The use of Busby's Bore as a tank would reduce its more beneficial use as the major guaranteed non-potable water supply, given that inflow of water occurs all the way along the bore. Use of the bore as a tank for a portion of its length would also by definition need to be waterproofed and made structurally adequate, also thus affecting its primary role as a source of non-potable water. For the above reasons considered in conjunction with the associated costs of transformation to a viable tank system, this option was deemed unacceptable.

13.1.4 Currently unused rail tunnel/s

The currently unused rail tunnels may be activated for rail use in the future and this possibility negated their consideration as a viable option for conversion to storage tank use. Serious concerns were also raised about the current levels of asbestos contamination from brake pads within the tunnel network. If the unused tunnels are not structurally sound, the possibility exists their use may cause damage and flooding to other operating tunnels in the rail network. If it is intended that the disused tunnels are to be used, then the structural issues regarding these tunnels need to be addressed and their structural adequacy or otherwise confirmed.

13.1.5 Cook & Phillip Park Car Park

The construction of a large tank and plant facilities on the lowest floor level of the Cook & Phillip Car Park was also considered as an option. Conversion of the lowest level of the Cook & Phillip Car Park presented considerable strategic and logistical problems and would also have been expensive to construct. Further consideration of this site would also have been subject to successful negotiations with the car park operator.

In consideration of all the above, it is hence the recommendation of this report that the main storage tanks and plant room be located on the lower grassed terrace of Cook & Phillip Park. The recommended location of the main tanks and plant and the day tanks are as shown on the attached plan.

13.1 SITE OPTIONS

MAIN STORAGE TANKS, PLANTROOMS AND STORAGE AREAS LOCATED IN HYDE PARK	
Advantages	**Disadvantages**
• Nearest to most of the areas that use the water supply. • Shortest distance from Busby's Bore and CCT to the storage tanks. • Central for servicing and control operations. • Adjacent to CCT rising main. • Possible centralisation of other future park plant.	• Subject to significant constraints imposed by heritage and public use requirements. • Access is limited to means that are almost "invisible" to the public. • Plant rooms/storage areas will need to be operated as confined space workplaces for OHS reasons due to limited access options. • Difficult to locate the storage tank/plant room such that future expansion could be enabled. • Must not create any discernible noise or other indications of operation that affect the public. • Cost premium due to difficult construction access , setup space etc. • Restitution and restoration costs very high after construction completed.

Table 11 Storage Tank Hyde Park

MAIN STORAGE TANKS, PLANTROOMS AND STORAGE AREAS LOCATED IN COOK & PHILLIP PARK	
Advantages	**Disadvantages**
• Fewer constraints (compared with constructing some infrastructure in Hyde Park North, British Lawn area) due to extend of change in the 1990's work. Some heritage features, such as the avenue of Moreton Bay figs and the memorial obelisk remain and need to be avoided. Any new works need to be consistent with the existing landscape design of the park. • Able to easily accommodate tanks/rooms of capacity and size recommended. • Ability to easily accommodate future expansion if required. • Can be designed such that normal OHS conditions apply rather than confined space regulations, with normal stairs and entry doors, also good for plant access and removal. • Able to capture CPP stormwater and Williams Street road runoff, not viable if storage tanks in Hyde Park.	• Stored water needs to be pumped back to Hyde Park after being harvested from that Park or adjacent sources. • Longer piping distance from the Busby's Bore and CCT water sources.

Table 12 Storage Tank Cook & Phillip Park

13.1 SITE OPTIONS Cont.

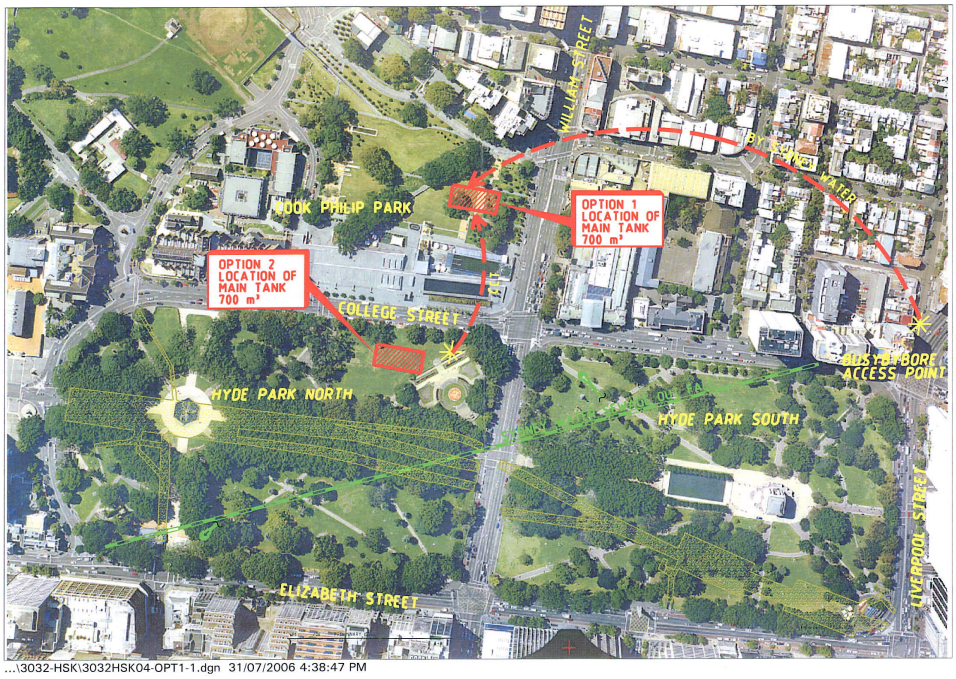


Figure 8 – Proposed Tank Locations

SECTION 14 COST ESTIMATES FOR PROPOSED ALTERNATE WATER SUPPLY SYSTEMS

14.1 COST ESTIMATE OF SUPPLY PACKAGES

Items Common to all Packages	
(1) Reticulation (includes rising mains, stormwater drainage, site restoration)	$480,000
(2) Structures (includes excavation, concrete works for footings, slabs, walls, and stairs, works, water-proofing, topsoil)	
Main tanks/plantrooms/stairs	$520,000
Day tanks, including plant	$390,000
Sub-total of common elements	**$1,390,000**

Table 13 Cost Common to all Packages

Cost Estimate of Treatment Systems	
(1) Treatment system for Busby's Bore, CCT, CPP SSW	$220,000
(2) Treatment system for Park and Road Stormwater, Busby's Bore, CCT, CPP SW	$550,000
(3) Treatment system for sewage	$500,000
(4) Treatment system for CPP backwash water	$150,000
Package Estimates	

Table 14 Estimated Treatment Costs

Platinum Package	
Common elements	$1,390,000
Treatment system (2)	$550,000
Treatment system (3)	$500,000
Treatment system (4)	$150,000
Diversion of William Street Stormwater	$200,000
Sub-total	$2,790,000
Preliminaries, Builder's margin, fees	$480,000
TOTAL	**$3,270,000**

Table 15 Costs Associated in Platinum Package

Gold Package	
Common elements	$1,390,000
Treatment system (2)	$550,000
Sub-total	$1,940,000
Preliminaries, Builder's margin, fees	$390,000
TOTAL	**$2,330,000**

Table 16 Costs Associated in Gold Package

14.1 COST ESTIMATES OF SUPPLY PACKAGES Cont.

Silver Package	
Common elements	$1,390,000
Treatment system (1)	$220,000
Sub-total	$1,610,000
Preliminaries, Builder's margin, fees	$300,000
TOTAL	**$1,910,000**

Table 17 Costs Associated in Silver Package

Bronze Package	
Reticulation plus 200m^3 tank	$540,000
Treatment system (1)	$220,000
Sub-total	$760,000
Preliminaries, Builder's margin, fees	$152,000
TOTAL	**$912,000**

Table 18 Costs Associated in Bronze Package

14.2 SUPPLY PACKAGE COST ESTIMATE SUMMARY

Supply Package	**Water Sources**	**Cost Estimate**
Platinum	Busby's Bore, CCT, Park Stormwater, R... Stormwater, CPP Subsoil, Residential Blackwater, Treated Park Sewage, CPP Backwash, Future Sources	$3,270,000
Gold	Busby's Bore, CCT, Park Stormwater, Road Stormwater	$2,330,000
Silver	Busby's Bore, CCT	$1,910,000
Bronze	Busby's Bore	$912,000

Table 19 – Package Cost Summary

14.3 ESTIMATED COST OF ALTERNATE WATER SUPPLY PER KILOLITRE

Supply Package	Estimated Capital Cost	Period (Years)	Annual Supply Volume (ML)	Annual Estimated Operational Costs	$/kL
Platinum	$3,270,000	50	134	$98,000	$1.22
Gold	$2,330,000	50	98	$70,000	$1.20
Silver	$1,910,000	50	80	$58,000	$1.19
Bronze	$912,000	50	18	$35,000	$2.90

Table 20 – Water Cost per Kilolitre

Note: The above figures are exclusive of GST.

SECTION 15 RECOMMENDATIONS

The water supply package recommended for adoption and implementation is the Gold supply package, for which the works estimate is approximately $2.4 million. This package uses water from the Cross City Tunnel, Busby's Bore and park stormwater harvesting. Essentially the cost of production of irrigation quality water ($/kL) is estimated to be similar for the three higher packages. The Platinum package has a significantly higher capital cost than the Gold package however when considering the capital cost, the cost of production and the quantity produced, the Gold option provides the optimal outcome.

Main water storage is recommended to be in the order of $700m^3$, being the volume required to satisfy peak daily demand. To this end, it is recommended that a $500m^3$ effective capacity reinforced concrete twin-cell tank with an associated subterranean plant room is constructed on the intermediate terrace in Cook & Phillip Park. Three separate day tanks are recommended to be constructed, two in Hyde Park of volume $100m^3$ each, and one in Cook and Phillip Park of volume $25m^3$. The main storage tank and plantroom is to be constructed with an access stairway, full forced ventilation and classification as a non-confined space. The total available storage volume is $725m^3$. Although the Cook and Phillip Park tank location incurs a penalty in relation to the required pump reticulation to the proposed day tanks in Hyde Parks North and South, the pump energy has been estimated as minor (10 mW/Hrs per annum, or 9.4 tonnes of CO^2 emission) when considered in conjunction with the addition stormwater harvesting capacity.

The main tank location of Cook and Phillip Park (option 1) is recommended due to minimal heritage constraints and access and buildability considerations. The location also enables harvesting of stormwater runoff from Cook and Phillip Park and William Street where the alternative location would require duplication of equipment. The recommended site will also be more amenable to expansion of storage capacity to meet future needs than would the Hyde Park location.

Treatment is to be as recommended within this report, namely passage through a strainer for most sources, sand filtration and disinfection. Treatment such as UV for fungus/bacteria disinfection may also be required. The inclusion of park sewage water will necessitate a full separate sewage treatment plant if adopted.

The recommended water supply supersedes the average daily water demand generally, and hence it is also recommended that the development of new markets/clients for the excess water is a necessity and may prove to be economically beneficial.

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APPENDIX 1
WATER SUPPLY & DEMAND SPREADSHEET

APPENDIX 2
WATER QUALITY TEST RESULT DATA

(A) BUSBY'S BORE
(Ref : Table 5.1 Feasibility Report – Busby's Bore – Prepared for 'Cleanup Australia')

(B) C+PP POOL BACKWASH
(Ref: Appendix D – Water Consumption Analysis and Supply Options Report – Prepared by Hughes Trueman – June 2004).

(C) CROSS CITY TUNNEL WATER QUALITY PARAMETERS
(As supplied to COS by CCT)

(D) HYDE PARK STORMWATER ANALYSIS
(As supplied to COS by Trace Inorganiz Laboratory)

(E) SYDNEY WATER – FILTERED WATER ANALYSIS
(www.sydneywater.com.au)

APPENDIX 2 (A)
BUSBY'S BORE

APPENDIX 2 (B)
HYDE PARK STORMWATER ANALYSIS

APPENDIX 2 (C)
CROSS CITY TUNNEL WATER QUALITY PARAMETERS

APPENDIX 2 (D)
C+PP POOL BACKWASH

APPENDIX 2 (E)
SYDNEY WATER – FILTERED WATER ANALYSIS

APPENDIX 3
HYDE PARK AVERAGE WEEKLY WATERING REQUIREMENTS CHART

(Ref: URS Report Feb 2006)

APPENDIX 4
COOK & PHILLIP PARK AVERAGE WEEKLY WATER REQUIREMENTS

(Ref: URS Report Feb 2006))

APPENDIX 5
PROJECT SITE MAP – ARIAL PHOTO

APPENDIX 6
ALTERNATIVE WATER SUPPLY SCHEMATICS

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H05.3032 HSK-02

APPENDIX 7
AUSTRALIAN HISTORICAL CLIMATE DATA

(Australian Bureau of Meteorology)

APPENDIX 8
INTERNAL AND EXTERNAL STAKEHOLDERS

City of Sydney Business Unit	Council Officer	Job Title
Business Services	Paul Patterson	Reprographics Officer
Civil Engineering Services	Doug Tillinghast	Trades Group Manager
Civil Engineering Services	Glenn Tasker	Street Furniture Maintenance Supervisor
Civil Engineering Services	Ken Willimott	Former Manager Civil Engineering Services
Cleansing & Waste Services	Steve Wacher	Manager Cleansing & Waste Services
Design	Ray Masters	Specialist Development Engineer
Design	Adam Fowler	Senior Landscape Architect
Environmental Development	Chris Derksema	Manager, Environmental Design
Environmental Development	Kate Black	Senior Environmental Development Officer
Finance/ Procurement	Ian Rudgley	Procurement Manager
Information Management	Peter Francis Ryan	Land Information Officer
Legal Services	Emma Broomfield	Solicitor
Maintenance (Parks, Civil & Trades)	Chris Binns	Manager Maintenance (Parks, Civil & Trades)
Office of the Chief Executive Officer	Monica Barone	Acting Chief Executive Officer
Parks & Recreation	Collette Holland	Contract Coordinator, Aquatic Facilities
Parks & Recreation	Craig Milton	Contract Co-ordinator Parks & Open Spaces
Parks & Recreation	Joel Johnson	Manager Parks & Recreation
Parks & Recreation	Mark Driver	Co-ordinator Parks & Open Spaces
Parks & Recreation	Patrick Houlcroft	Contract Coordinator Parks & Open Spaces
Parks & Recreation	Karen Sweeney	Arboricultural Services Manager
Parks & Recreation	Susan Lymberry	Tree Management Plan Co-ordinator
Project Development	Laurence Johnson	Referrals & Strategy Manager
Project Management	Geoff Brew	Manager Project Management
Project Management	Jeffrey Kerr	Project Manager
Project Management	Kevin Chahoud	Minor Works Project Manager
Risk Management	Ross Pullinger	Manager Risk Management
Risk Management	Tony Rolls	A/Risk Manager
Roads & Streetscapes	Rick Henson	A/Senior Contract Coordinator
Roads & Streetscapes	Graeme Monagle	Senior Contract Co-ordinator
Strategic Planning & Project Development	Catherine Hart	Director Strategic Planning & Project Development
Urban Design & Heritage	Anthony Smith	Team Leader - Urban Design & Heritage

Company	Name	Job Title
Clouston Associates	Carl Nugent	Project Landscape Architect
Clouston Associates	Crosbie Lorimer	Director
Total Landscape Care	Matthew Boorer	Area Manager (Hyde, Cook & Phillip Parks)
URS Australia Pty Ltd	Mick Battam	Senior Soil and Irrigation Scientist
NSW Department of Commerce	Inge Diamond	Water Reduction Engineer
NSW Department of Commerce	Reid Butler	Water Reduction Engineer
NSW Department of Commerce	Bruce Smith	Principal Engineer/ Hydraulics & Water Savings/ Engineering Services
Sydney Water Corporation	Fernando Ortega	Water Conservation & Recycling Coordinator
Cross City Motorway	Shane Wells	Corporate Affairs Manager