Cardno

Engineering the Future

CRIGHTON PROPERTIES

KINGS AVENUE TERRIGAL

Water Cycle Plan

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WATER CYCLE PLAN

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	DRAFT FINAL	☐
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	SUPERSEDED	☐

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EXECUTIVE SUMMARY

Crighton Properties Pty Ltd is preparing a re-zoning submission for the proposed residential development of their Parkside property, Kings Avenue, Terrigal. Crighton Properties Pty Ltd proposes a 146 lot "Parkside" residential community title subdivision that uses Water Cycle Management technologies that integrates water supply, wastewater and stormwater management. The subdivision proposal provides a conventional internal road system to service the 146 lots public reserve and community land.

At Parkside the use of water sensitive urban design principles in conjunction with the reuse of wastewater and storm water will achieve a 50% reduction in the demand for potable water relative to a comparable standard development. As well, the active management of stormwater run-off from the site during subdivision construction, building and afterwards will ensure that there are no unacceptable discharges from the site to the region's coastal lagoons. These measures mean that the development will outperform the Government's BASIX targets and will set a new benchmark for water efficiency in a development of this size.

Household and community facility wastewater is to be initially piped to the proposed community title, owned and operated wastewater effluent recycled treatment system. At "Parkside" a community owned and managed wastewater treatment facility will treat and reticulate recycled water to each house for toilet/laundry use. The recycled water would be treated to a similar standard to that produced at Olympic Park Homebush. Advanced wastewater treatment technologies (MBR) would be employed to ensure the recycled water met the Department of Health guidelines.

The reclaimed treated water will be reticulated back to the households and community facilities for internal uses only, for WC flushing and laundry uses as required. Waste from the treatment plant will be discharged to the sewer. The use of onsite treated wastewater or the optional use of rainwater tanks and the use of AAA fixtures will on average account for approximately 30% of water usage.

The online BASIX's project compliance report for the proposed Water Cycle Management (WCM) systems for Parkside indicates a score of 44% to 51%, based on a similar coastal suburb of Sydney, should be achieved.

Reticulated water is available to the site adjacent in Kings Avenue, with the Council's water system having sufficient capacity and pressure to service the Parkside development.

Sewer services are also available within the Kings Ave area within Sewer Catchment C18, however the pump station will require upgrading to meet the future development demands within this catchment with the sewage pumping station C18 nearing capacity at present. An outline of the expected augmentation works required is stated within the report in Section 6.2. In respect to the main gravity sewers servicing flows from Parkside, there should be enough capacity within the existing sewage gravity system to accommodate the estimated future loads from the Kings Avenue sub catchments and the Parkside development with recycling of wastewater in place.

The control of water quality for the Parkside development is a critical factor, not only for approving authorities, but also for Crighton Properties. Best practice principles indicate that there are alternative methods of improving water quality on small to medium sized sites. Upon completion of the construction activity semi-permanent water quality measures installed during subdivision and building construction are to be replaced by permanent mechanisms that will collect and treat the rainfall runoff from pavement and landscape areas, prior to it discharging into the creek and existing dams. Semi-permanent water quality practices will be based upon the guidelines prescribed by Managing Urban Stormwater Soils and Construction. Permanent measures will include; grass lined inter-allotment bio-swales, grass lined overland flow paths and buffer strips. At the subdivision level minor gross pollutant

traps and wetlands/ponds, making use of the existing dams will be used to ensure there no unacceptable discharges from the development site.

Stormwater quantity control or onsite detention will be provided within the wetland/pond system. Post development flows will match pre development flows from the catchment areas. The site is located near the top of the Terrigal Valley catchment and the urbanised footprint lies beyond the catchment formed creek channels and the extent of any potential flooding from the main creek.

Changes to the existing downstream stormwater infrastructure will not be necessary because the Parkside on site detention system will be sized to ensure that the hydraulic capacity of the existing Kings Avenue culverts are not exceeded. Only minor interfacing between the existing sub-surface and surface drainage systems, and the new subdivision sub-surface and surface drainage systems will be required.

It is considered the Parkside development will be one of the first truly integrated developments on the Central Coast that incorporates new technologies, sustainable development and water conservation initiatives for the community it serves.

1.0 INTRODUCTION

Crighton Properties Pty Ltd is preparing a re-zoning submission for the proposed residential development of their Parkside property, Kings Avenue, Terrigal. Crighton Properties Pty Ltd proposes a 146 lot residential community title subdivision that uses Water Cycle Management technologies that integrates water supply, wastewater and stormwater management.

This report establishes the integrated water cycle management plan (WMP) objectives, addresses the technical, infrastructure and water management planning issues that may be raised by Gosford City Council and DIPNR. These planning issues are addressed in terms of their scale and significance of effects on the environment.

The Integrated Water Cycle Management Plan should satisfy the following inherent and BASIX planning issues: -

- the protection of natural systems and the integration of stormwater treatment measures with the natural and man made environment. The site is located relatively close to the creek alignments, which are likely to be defined as protected waters under the Rivers and Foreshores Improvement Act 1948. Development consent from the Department of Infrastructure, Planning and Natural Resources (DIPNR) is required for any development within 40m of the watercourse traversing the site. As such water quality treatment of stormwater runoff, point stormwater discharge controls as well as setbacks are required.

- the reduction of runoff volumes and peaks, the protection of water quality downstream of the development and the identification of infrastructure augmentation requirements for stormwater drainage, water supply and sewer reticulation. Gosford City Council planning and development regulations are concerned with water conservation, pollution control, flow management and the provision for water, sewerage and stormwater drainage infrastructure. More specifically:

  DCP 112 - Residential Subdivision
  DCP 115 – Building in flood liable areas
  DCP 165 – Water Cycle Management
  Coastal Lagoons Management Plan

- Demonstrate water use sustainability. From 1 July 2004 the Government is introducing the Building Sustainability Index to make sure new household use less water and electricity. This planning requirement with respect to water quantity management requires that a 40% water reuse saving through the reuse of non-potable water and/or rainwater.

2.0 DESCRIPTION OF SITE

The site is located on the southern side of Kings Avenue, Terrigal. The vast majority of the site is rural in nature and is vegetated with varying densities of remnant bushland and cleared grass areas. A variety of young and mature trees occupy the slopes up to 25%. The survey shows the local area topography is steep and falls towards the north. Incised gullies and small to medium sized turkey nest dams the existing natural creek system and riparian zones.

The development site is currently zoned 7c(2) conservation under Gosford City Council Local Environmental Plan. Crighton wants to rezone the 7c(2) parcel of land to a new residential zone, which will support the proposed uses.

3.0 OVERVIEW OF PROPOSAL AND IMPACTS

The subdivision proposal provides a conventional internal road system to service the 146 lots public reserve and community land. The geometrical layout of the residential community title subdivision is shown in **Figure 2.0**

The potential key impacts are:

- The proposed dwellings and internal access roads, in association with increased hardstand areas around the periphery of the dwellings will serve to increase the impervious area of the site and as such increase stormwater runoff volumes and peak discharge levels to the local creek and downstream creek system. Onsite detention will be provided to manage increased runoff.

- Without active management increased run off would lead to continued physical and nutrient changes in the natural watercourses as evident by scouring, erosion and the transportation of sediment. Urban activities may also generate a higher level of contaminants that are transported in the stormwater system to the natural creek system, leading to the pollution of the natural watercourse environment downstream of the development, particularly Terrigal Lagoon. Best Management practices are to be implemented before and during construction as well as after the subdivision is built for the purpose of reducing to acceptable or negligible levels, the potential export of pollutants.

- The new development will increase the demand for potable water in an environment where potable water is becoming a scare resource.

- The new development will increase wastewater load to the existing sewerage system.

Due to the range of impacts, best management practice will be incorporated into the site to enhance the water sustainability and environmental amenity of the development proposal. Therefore Water Sensitive Urban Design (WSUD) principles will play a key role in the development proposal.

"In practice WSUD can be achieved by integration of urban planning and design for the provision of water, waster water and stormwater services at a range of cascading scales from region to allotment." (Coombes and Kuczera, 2002).

At Parkside, Terrigal WSUD is to be implemented at the subdivision level through the community title technological approach to Urban Water Cycle Management. The technology approach to urban water cycle management will minimise the use of potable water supplied from an external source, through the use of treated wastewater generated by households, the use of roof water and the use of stormwater capture from the catchment contributing above Kings Avenue.

In recent years there has been increasing recognition of the need to re-use wastewater and storm water, in addition to quantity and quality control. The re-use of treated wastewater and use of storm water both contributing to the conservation of potable water.

'It is increasingly being recognized that new development will not be sustainable with respect to water unless integrated strategies to manage the water cycle are implemented. This paper supports the adoption and implementation of such integrated strategies and promotes the conservation of our drinking water and the more efficient and effective re-use of our stormwater and wastewater resources to reduce the use of high quality drinkable water for purposes which only require a lower quality of water".
(Water Cycle Management National Committee of Water Engineering)

Gosford City Council DCP 165 requires water conservation through the use of rainwater tanks. The BASIX initiative requires a 40% reduction in water reuse against the "base scenario water use", through the reuse of treated non-potable water and/or rainwater. Base scenario water use is taken to be the average potable water consumptions (indoor and outdoor) for typical households derived from Sydney metropolitan data. *"A typical house hold in Sydney uses 388 KL/year of potable water"*. (Sydney Water). On average major in-house uses represent 55% of total domestic water use. Toilet flushing 17.7%, showers, bath, hand basin 21.0%, laundry 12.5%, kitchen, dishwashing, drinking and cooking 3.8%. The remaining 45% drinkable water is applied to lawns and gardens. It should be noted that these percentages are based on consumption records when extended water restrictions where not implace.

There are three recognised methods for reducing potable water usage in the urban environment:

1. Wastewater recycling, this will be the primary contributor to potable water reduction on average accounting for 30% of water usage;

2. Stormwater reuse, this will be the secondary contributor to potable water reduction on average accounting for 45% of water usage;

3. Water Efficient Appliances and Fixtures, which use potable water throughout the household, on average accounting for 25% of water usage.

The opportunity exists to conserve potable water and better use the water available on site. The supply and use of water involves the complex interaction of environmental and human behaviour processes and whilst at face value a 75% potable water savings seems possible, the reality will be in the range 40 to 50 percent. Primarily this can be achieved through integrating and managing the use of internal and external potable water, wastewater and stormwater runoff reuse.

4.0 WATER MANAGEMENT CYCLE OBJECTIVES

The principle objectives for the conservation of potable water and better use of water available on the Parkside site are:

- Use of technologies that make water use more efficient. For example in the household the use of AAA+ efficient appliances and fixtures.
- Use of demand management. Individual households through the community title approach will be provided financial insensitive for water reduction and collection reuse around the household. Each household will be connected to a metered water reuse demand management system.
- Reuse of harvested rainwater and stormwater for the purpose of conserving potable water, for outdoor purposes.
- Re-use of treated wastewater to minimise wastewater load discharging to the existing sewer system and to reduce overall demand on potable water supply in 'fit for purpose' applications.
- Protection of the existing watercourse through pollutant, sediment and erosion control measures to improve and maintain the water quality of the watercourse and downstream lagoon.

5.0 INTEGRATED WATER CYCLE MANAGEMENT

The key parts of the integrated water cycle management system are therefore:

- Section 5.1 Wastewater Treatment and Reduction
- Section 5.2 Conservation of Potable water
- Section 5.3 Urban Stormwater Pollution Control
- Section 5.4 Flow Management in the Local Environment
- Section 6.0, Water, Sewer & Stormwater Infrastructure integration with existing infrastructure

5.1 Wastewater Treatment and Reduction

Treated Wastewater

The nature of the site and locality to sewer services will probably preclude the use of an extensive Onsite Effluent Disposal (OSED) for the whole of the development. More recently there have been technological advances in wastewater treatment, with dedicated small foot print package treatment and recycling systems available that can service a small community and meet Councils' and Public Health Authority requirements. It will be demonstrated that the reuse of wastewater / recycling will be the primary contributor to potable water reduction. The domestic wastewater (black and grey) will be indirectly connected to Gosford Council's sewer reticulation system. Household and community facility wastewater is to be initially piped to the proposed community title, owned and operated wastewater effluent recycled treatment system. At "Parkside" a community owned and managed wastewater treatment facility will treat and reticulate recycled water to each house for toilet/laundry use.

The reclaimed treated water will be reticulated back to the households and community facilities for internal uses only, for WC flushing and laundry uses as required. Waste from the treatment plant will be discharged to the sewer. The use of onsite treated wastewater or the optional use of rainwater tanks outlined below will on average account for approximately 30% of water usage.

Underpinning the AAA fixtures or optional roof water harvesting, this development will adopt a recycled waste water system as the backbone of water saving initiatives.

Wastewater Treatment Facilities

It is proposed that a large portion of the sewage discharge will be mined or reclaimed for internal reuse within the development. The recycled water would be treated to a similar standard to that produced at Olympic Park Homebush. Advanced wastewater treatment technologies (MBR) would be employed to ensure the recycled water met the Department of Health guidelines. Refer to Appendix NSW Health Circular 2004/71, 21 Oct 2004 – Interim Guidance for Greywater and Sewage Recycling in Multi-Unit Dwellings and Commercial Premises. This guide has been selected to be the most appropriate considering the nature of a community title and the proposed integrated recycling scheme.

All sewage flow from within the development will be directed to community title owned and operated pumping stations positioned at the bottom of each catchment located within the development. Refer to Sketch 1 in Appendix B

Sewerage will be transferred via an internal rising main to a dedicated wastewater / water treatment facility. During periods of low demand any excess sewerage flow will simply bypass the pump stations at a pre determine level within each pump well, then gravitating to Council's sewer system in Kings Avenue.

The proposed treatment system will comprise of the following main components:

- Inlet ,
- Flow balancing tanks
- Water treatment building (housing pumps, SCA, MBR and RO equipment)
- Bio reactor
- MBR filtration
- Reverse Osmosis
- UV & Chlorine Disinfection
- Recycled Water day tank
- Recycling pressure pumping system
- Waste pump station

It is expected the treatment facility will have an ADWF capacity of 65 KL /day with a maximum capacity of 80 KL/day. A preliminary concept footprint of the wastewater water treatment facility is attached in Sketch No. 2 Appendix B.

Preliminary advice has been sort from DEC - EPA, Newcastle in respect to the development. Under the POEO Act wastewater cannot be discharge into any waters, drains or gutters, streams etc. In essence the system would need to be totally enclosed to ensure no discharge occurs to the environment that will cause pollution, either physical or chemical outside the development.

Normally a treatment plant of this capacity is not required to be licenced under the requirements of the POEO Act. It however requires approval under the Local Government Act and its Regulations. It is proposed that the treatment facility will be under the care and control of the body corporate of the community title and will not be the responsibility of Council to operate or maintain.

Advice from DEC indicated it may be prudent for the eventual body corporate to make application to the EPA for a limited licence to discharge treated effluent / wastewater to waters in the event of a malfunction of the recycling system. The licence would require ongoing rigorous operational monitoring and reporting to the EPA along with LBL fees if applicable on an annual basis, to a similar standard which all Council's have to comply with. This would be in addition to the testing and monitoring / reporting required by the Department of Health to ensure the recycled water meets their guideline standards.

Wastewater Reduction

Flow measurements will be monitored daily to quantify the amount of sewage treated and amount discharged to Council's system. Table 1. below indicates a 30% reduction will occur in the average discharge to sewer, allowing for the additional discharge from back washing within in the filtration treatment processes, associated with the MBR plant.

5.2 Conservation of Potable Water

5.2.1 Reclaimed Wastewater and Conservation of Potable Water

The reclaimed wastewater would be reticulated around the development in a recycled water system that runs parallel to the normal potable reticulation system. It is proposed each residence for toilet flushing and laundry purposes will use the recycled water.

Normally a residential development of this size, based on figures published by Sydney Water for an occupancy rate of 3.5 equivalent persons (EP) would discharge on average 586 litres of wastewater per day per dwelling, which equates to approximately 31ML per annum (Based on 350 days occupancy) of sewage discharge.

The following Table 1. shows the predicted break up of the typical house hold waste streams and proportion of normal potable usage. It is expected the percentage of external water usage will be dramatically reduced to meet sustainable levels with the Coast's water supply. An estimated 20% maximum for external use has been assumed based on the expected long term water situation.

Table 1. WASTEWATER STREAMS

Wastewater Source	Average Waste Water Discharge per dwelling		Potable Water Use	
	% Wastewater	Litres per day	% without water restrictions	% with water restrictions
Toilet	32	188	17.7	23.5
Bath / Shower/ Hand Basin	38	223	21.0	27.8
Kitchen,drinking, cooking,dishwasher	7	41	3.8	5.1
Laundry	23	134	12.5	16.6
Total	**100%**	**586**	**55%**	**73%**

(Source – Sydney Water)

From the above table it is evident toilet flushing and laundry account for approximately 32% and 23%, respectively of the total wastewater discharged normally to the sewer. With the proposed recycling it is expected there will be a saving of potable water of approximately 16.45 ML pa (322 L/d x146 ET x 350 days) for the development. This equates to a saving of at least 30% of the potable water consumption per dwelling based on average consumption records before the introduction of water restrictions. It is expected this percentage will be greater where the amount of external potable watering from Council's supply system is dramatically reduced as water conservation measures become a permanent reality on

the Central Coast. The Parkside development will ensure significant water savings and contribute to sustainability.

A summary of the potable water savings is outlined as follows:

Table 2. WASTEWATER REDUCTIONS

Wastewater Source	Total Wastewater			Recycled Reclaimed Water	
	% Total	Litres per day	KL for Development	Min consumption for development KL/day	Max consumption for development KL/day
Toilet	32	188	26.97	21	30-
Hand basin	5	29	4.06	-	-
Bath / Shower	33	194	27.98	-	-
Kitchen	7	41	6.38	-	-
Laundry	23	134	19.75	16 KL	23
Total	**100**	**586 L**	**85 KL**	**37 KL**	**53 KL**

Note: Minimum consumption /day is based on a 20% decrease on the predicted average, while maximum is based on 20% increase from predicted average.

Thus from the above table it can be seen there should be a substantial reduction in sewage discharged to Council's system, taking into account recycling. It is expected there will be an approximate minimum 30% reduction in wastewater discharge to Council's sewer.

The recycled water will provide a consistent reduction in potable water consumption, and will not be weather dependant, which is the case for roof water harvesting / reuse systems. The use of reclaimed water for the laundry purposes will require the addition treatment of Reverse Osmosis (RO) process, which has been similarly added to the Olympic Park process when recycled water was further, extended for laundry use.

The proposed WCM strategy operating in the development may require residents to alter their paradigm in respect to the use of recycled water in the home. It is unclear at this time if all future residents within the development will be accepting of recycled water for laundry purposes. In instances where residents do not want to use recycled water for laundry use they will be given the option to install roof water tanks (min 5000 L) in accordance with Council's DCP 165 requirements. These roof water tanks will be dedicated to laundry purposes and any outdoor watering, with an approved potable water top up.

5.2.2 Stormwater and Conservation of Potable Water

Rainwater

Optional below ground rainwater tanks are suggested for use by households for the purpose of toilet flushing and laundering only where recycled water is not totally accepted by the user for internal use or when the water demands for a particular site warrant supplementary initiatives.

The other source of water is the water available from the rainfall runoff process captured in rainwater tanks or from the subdivisions ground surfaces and upstream catchments. The coastal fringe has a reliable seasonal rainfall average and the new urban area will generate a greater quantity of stormwater runoff. A review of historical rainfall data indicates that there is sufficient rainfall to maintain good reliability of water supply. This source of water will be the secondary contributor to potable water reduction.

This water will be available for external use like car washing and gardening. It is anticipated that this source of water on average will account for 45% of the normal average water usage and will assist conservation of the potable water supply, even if water restrictions are still in place.

The additional volume of rainfall runoff from the subdivision, ground surface and upstream external catchments is to be captured en mass in the proposed water quality control ponds/wetlands and made available for reuse in community applications such as external use on open space areas. This source of water will be the supplementary contributor to potable water reduction.

The implications are that the Parkside Development will reduce its reliance on the external potable water supply by up to 45% because of the use of rainwater tanks as well as the capture and use of ground surface and upstream catchment runoff on community open space landscape areas. This is a significant water savings and contributes to sustainability.

5.2.3 Water Wise and Conservation of Potable Water

Potable Water

Gosford City Council advised that reticulated potable water is available in Kings Avenue. It is intended, that the subdivision be connected to the existing reticulated water supply.

In addition to recycled effluent and storm water reuse systems, potable water demand reduction initiatives will involve a community title based education, incentives and regulation programs to encourage the conservation of potable water.

Initiatives for outside use will include:

- Garden tips like using native trees and plants; using mulch deeply around garden beds; watering slowly and deeply around the base of plants; avoid watering when its windy; watering during the coolest parts of the day; use a drip irrigation system.
- Carry out regular maintenance of taps, hoses and fittings
- Washing cars, boats etc on grass – a specific dedicated areas for each lot.
- Cover swimming pools to reduce evaporation

Initiatives for inside use will include:

- The use of AAA plumbing fittings
- The use of AAA and AAAA appliances
- 6/3 dual flush cisterns
- Pressure regulation
- Behavioral changes in the way water is used essentially reducing the period of time water is left running – consumer education and economic incentives in reduced costs.

A recent Sydney Water Corporation paper that the adoption of AAA rated showerheads and dual flush toilets (40% 9/4.5 and 60% 6/3) reduced indoor portable water consumption by 15-20%. A recent study by Coomes (2002) for the Urban and Regional Land Corporation (Victoria) found the combined use of AAA fittings and appliances can be expected to reduce indoor potable water consumption by 23%.

The implications are that the Parkside Development will accrue a 15-20% water savings of the indoor household potable water consumption by applying water wise initiatives. This is a significant water savings and contributes to sustainability.

5.2.4 BASIX Compliance

An online Basix's project compliance report was applied to the proposed development. The details of BASIX's project report is contained in Appendix A on a typical residential residence of 250m^2 roof area, utilising AAA water efficient fittings and appliances as well as recycled water or optional roof water harvesting. A score of 44% to 51% is indicated by the BASIX report. Refer to Appendix A.

5.3 Urban Stormwater Pollution Control

The management of the storm water runoff system should be undertaken in two phases Certification and Post Development.

Subdivision construction processes have the potential to destroy the effectiveness of the receiving water transport system and adversely effect water quality. Once the catchment has been urbanised the increase in runoff events and quantity can de-grade the waterway eco systems health and amenity.

5.3.1 Phase 1 - Construction Management

The development of the site has the potential to affect the current quality of stormwater runoff, initially by civil construction activity and then while the pavements and buildings are being constructed. The proposed construction of the access roads, building pads, dwelling construction and landscaping will serve to increase the amount of exposed surface on the site and thus increase the potential for erosion and sediment transport.

Construction and building activities require a soil water management plan to address the water quality issues associated with the removal of vegetation, removal of unwanted stockpile of dumped fill, drainage construction, excavation, importing of fill, construction of building pads, building works, services installation as well as road and pavement works. It is envisaged that construction works will be carried out in the following stages:-

- Stage 1 Site Preparation
- Stage 2 Installation of storm water drainage systems, services and construction of pavements.
- Stage 3 Installation of permanent water quality devices including, sediment traps and exfiltration basins.
- Stage 4 Building construction

Stage 1 to 4 has been prepared in accordance with the guidelines contained in Managing Urban Stormwater Soils and Construction (Department of Housing 1998) and Council's Design Development Specification D7.

The control of water quality for the Parkside development is a critical factor, not only for approving authorities, but also for Crighton Properties. The marketing image of the project focuses strongly on the natural features of the site and its close proximity to the good water quality in the local lagoons and beaches. *Similar circumstances were found at the Casuarina Beach Project on Tweed Heads. Authority approved strategies and controls included:*

- *Protection of bare ground with mulch sourced from cleared land vegetation on the site itself, and rapid re-growing and vegetation following earthwork disturbance*
- *No top soil was imported*
- *Installation of temporary retarding basins during constructions, to trap and settle sediments that are transport on site.*

Like controls are to be implemented during the Parkside Construction phase, together with the following due to the site topography:

- Stabilized site access.
- Barrier fencing and sediment fencing.
- Energy dissipater on pipe outlets.
- Geo fabric filter on drainage inlets
- Embankment
- Diversion of flow around disturbed areas using catch drains or banks
- Use of soil binder e.g. Terra-Control
- Grassing and landscaping

These controls are outlined in best management practice guidelines like Managing Urban Stormwater Soils and Construction.

In addition the site will be monitored and on-going maintenance carried out. The temporary treatment systems would be removed after the site-disturbed surfaces are fully stabilized.

The construction activity has potentially significant environmental impacts but with the proposed mitigation measures will render the potential impacts insignificant.

5.3.2 Phase 2 - Post Development Management

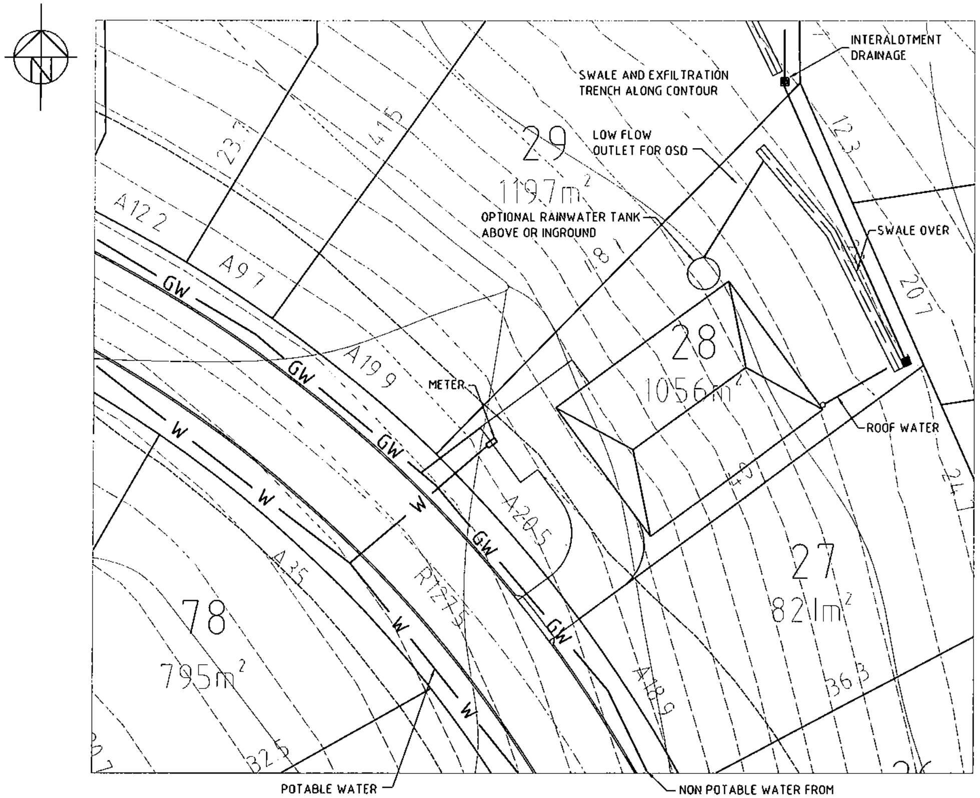
It is expected that pollutants like the silt, clay sized particles, nitrates, phosphates from decaying plant matter, garden fertilizers and animal faeces, oils and greases could contribute to the pollution of the creek system as well as the water to be re-used, if no controlled. Many of these pollutants transported in stormwater runoff can reach polluting levels when accumulated over time. This can have a harmful effect on human health, the existing creek and wetland ecosystem.

Best practice principles indicate that there are alternative methods of improving water quality on small to medium sized sites. Upon completion of the construction activity semi-permanent water quality measures installed during construction are to be replaced by permanent mechanisms that will collect and treat the rainfall runoff from pavement and landscape areas, prior to it discharging into the creek and dams. The proposed treatments will include:-

I. The use of grass lined inter allotment bio swales and exfiltration systems on lots as shown in **Figure 1.0** Bio Swales and Roof Water Tanks.

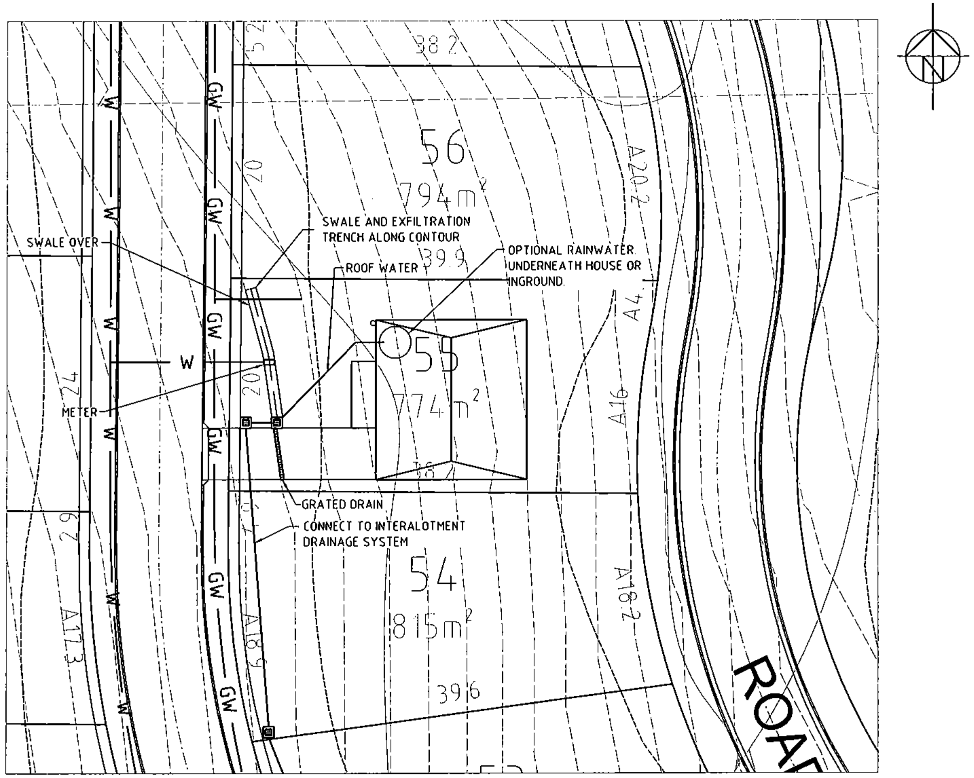
The water quality of the stormwater runoff from the individual lots is to be managed in two ways. Overflow from the roof water is regarded as relatively clean and will be piped to the interlotment drainage system at the rear of the lots. Runoff from the rest of the lot will be captured in grass lined swale and exfiltration trenches running along the ground contour at the rear and front of the lots. The treated water will be directed into the interlotment drainage system. The interlotment drainage system is a separate drainage system and will not be connected to the road drainage system. This captured water will be connected directly to the creek system for the purpose of maintaining in creek-wet weather and low flows.

This approach has been successful on other projects. *At Heritage Mews, Castle Hill a typical lot scale solution included the use of gravel absorption/ detention trenches with low flow outlets directed to the creek. At Macquarie Cove, North Ryde prior to discharging into the Lane Cove National Park a lot system dependent on contour swales and infiltration trenches to delay and filter the stormwater.* The use of infiltration trenches is consistent with Gosford City Council Best Management Practice guidelines for nutrient control. Mudgway et al (1997) and Schueler (1987) summarises the expected pollution removal rates.



PLAN VIEW - FALL TO REAR

SCALE 1: 250



PLAN VIEW - FALL TO STREET

SCALE 1: 250

LOT BIOSWALES AND ROOF WATER TANKS

FIGURE 1.0

5 2.5 0 5 10 15 20 25

SCALE OF METRES (1:250 AT A1 SHEET BEFORE REDUCTION)

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Table 3.0 – Pollutant Retention Rates for Infiltration Trenches

Pollutant	Retention (%)	Pollutant	Retention (%)
Suspended solids	71-79	Total Phosporus	50-75
Total nitrogen	60-70	Bacteria	75-98
Lead	25-99	Biochemical Oxygen Demand	70-90
Zinc	51-99		

Source: Mudgway et al (1997), Schueler (1987)

II. Grass lined overland flow paths and buffer filter strips.

The technique is to be applied where sheet flow may occur for the purpose of maximising filtration and minimising erosion. The performance criteria for this technique are highly dependent on residence time and slope. The technique is to be applied in a practical sense.

It is likely that the development of these lands will increase the pollutant loading to the watercourse downstream of the residential lots and roadways unless strategies are put in place to capture and retain pollutants. The development could conceivability cause an increase of the pollutant average annual loads. Four constituents are normally used as stormwater quality indicators sediments, nutrients, phosphorous and nitrogen. In this regard minor grass pollutant traps and wetlands are to be used to reduce the transference of pollutant loads for water reuse and protection of the existing creek environment.

After construction has been completed a variety of pollutants including gross pollutants (greater than 3mm in size), sediments, nutrients, oils and greases from the new pavement and landscaped surface will be treated through permanent water quality control structures. Permanent water quality structures must be maintained periodically to ensure their effectiveness.

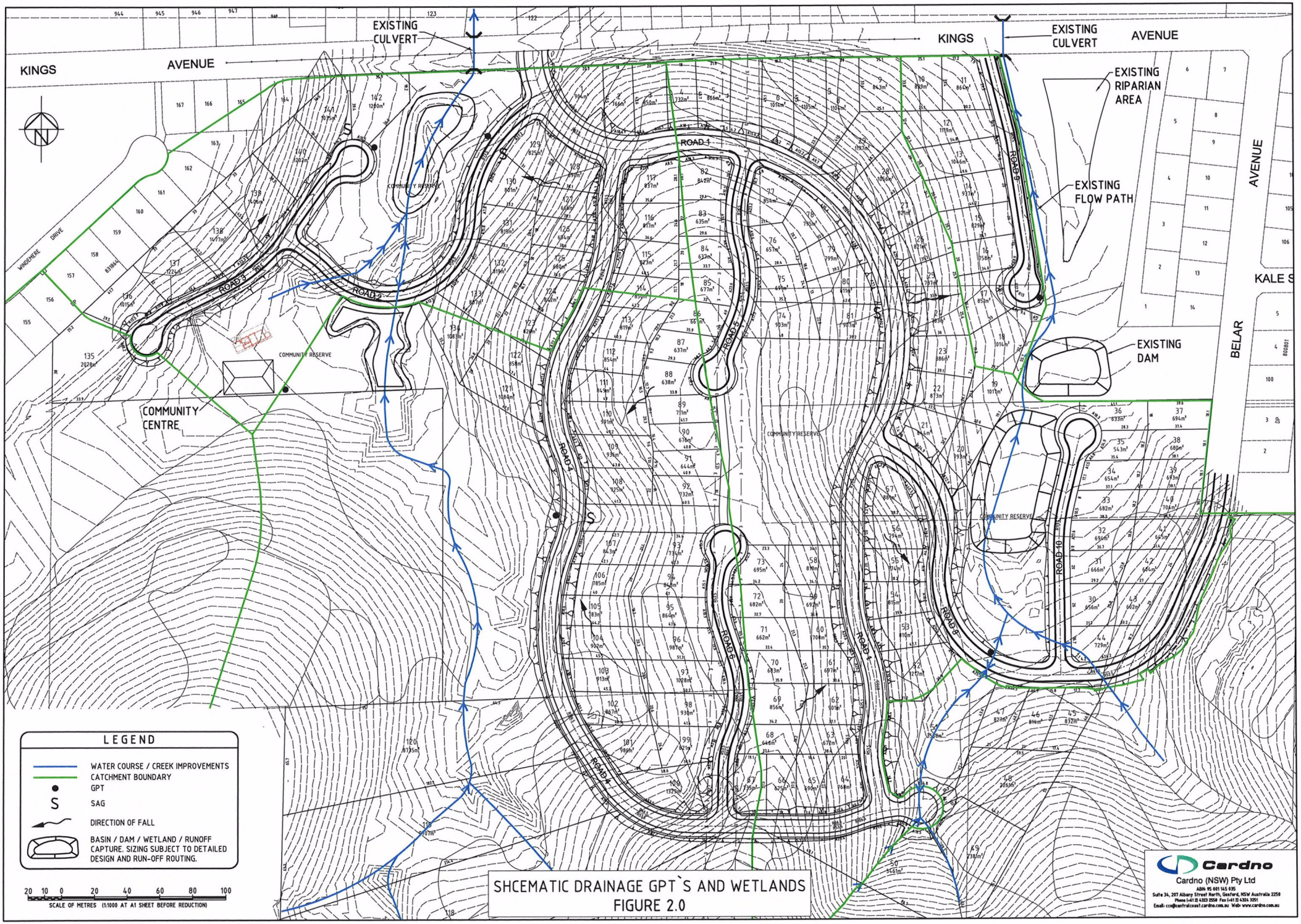
Best practice principles indicate there are alternative methods of improving water quality on small to medium sized urban sites. **Figure 2.0** shows the Schematic Drainage Plan including GPTs and Wetlands/OSD Ponds. It should be noted that 3 of the 4 ponds shown on this plan are existing and pond configuration will be decided at the detailed design phase.

The preference is the use of proprietary GPT'S and the combined biological and reticulation processes found in wetland type basins.

A study conducted by the Cooperative Research Centre for Catchment Hydrology, Department of Civil Engineering, Monash University, Victoria showed that "a *stormwater treatment sequence involving an efficient gross pollutant trap, such as the CDS unit, followed by a constructed wetland or a bioretention zone can be expected to treat a wide spectrum of pollutants found in stormwater. The constructed wetland or bioretention zone in the treatment sequence would be designed to promote biological uptake of soluble pollutants under dry weather flow conditions and removal of fine suspended particulates under storm flow conditions and would compliment the performance of a CDS unit".*

Design criteria for such a system would include:

1. Intercept of at least 75% of sediment with a grain size of 0.04 or greater under average annual runoff conditions.
2. Peak flow velocities less then 0.3 metres per second in the 1year ARI storm even taking into account backwater effect.
3. Ensure GPT'S are capable of gravity drainage.
4. Are accessible and can be maintained.


KINGS AVENUE
EXISTING CULVERT
EXISTING RIPARIAN AREA
EXISTING FLOW PATH
EXISTING DAM
BELAR AVENUE
KALE S
WINDERMERE DRIVE
COMMUNITY CENTRE
COMMUNITY RESERVE
ROAD 1
ROAD 2
ROAD 3
ROAD 4
ROAD 5
ROAD 6
ROAD 7
ROAD 8
ROAD 9
ROAD 10
LEGEND
WATER COURSE / CREEK IMPROVEMENTS
CATCHMENT BOUNDARY
GPT
SAG
DIRECTION OF FALL
BASIN / DAM / WETLAND / RUNOFF CAPTURE. SIZING SUBJECT TO DETAILED DESIGN AND RUN-OFF ROUTING.
20 10 0 20 40 60 80 100
SCALE OF METRES (1:1000 AT A1 SHEET BEFORE REDUCTION)
SHCEMATIC DRAINAGE GPT`S AND WETLANDS
FIGURE 2.0
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Proposed Treatments

Upon completion of the construction activity semi-permanent water quality measures installed during construction are to be replaced by permanent mechanisms that will collect and treat the rainfall runoff from pavement and landscape area, prior to it discharging into Terrigal Valley Creek system.

The treatments will consist of the following:-

a) Minor gross pollutant trap (GPT). There are several proprietary GPT's available that remove gross pollutants (generally greater then 3mm in size) sediments oil greases. They include CDS, Ecosol, Humescepter, Humesguard and others. Some proprietary GPT's like the CDS unit have a better performance regime for removing the finer sediment. GPT's should be sized at the detailed design phase. Six to eight GPTs are to be strategically placed within the subdivision, with one in each branch watercourse.

The technology and operational characteristics of CDS unit is widely known to local and state government authorities. *CDS units have been in service for many years with over 200 CDS devices installed in NSW.*

The performance of CDS unit are extremely encouraging as they assist in implementing the policy of zero effluent discharge because wastes like solids, sediments or biological wastes in the stormwater runoff are treated on site prior to discharging clean water from the site.

The Cooperative Research Centre for Catchment Hydrology, Department of Civil Engineering Monash University has monitored the GPT's behaviour and performance with respect to Total suspended solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) concentration during wet and dry weather flows.

Wet Weather

These results indicate that during storm events the CDS trap:

- *"Removes a considerable amount of TSS above a background concentration during storm events with a mean removal efficiency of approximately 70%;*
- *Consistently retains TP, thought to be because P is in particulate form, with a mean removal efficiency of approximately 30%; and*
- *Has a variable influence on TN concentrations, thought to be because of the variable forms of nitrogen in stormwater.*

These results suggest the CDS unit does retain suspended particles and associated pollutants during storm events, however, these pollutants are retained in a permanent pool of water and have the potential of being flushed downstream ".

Dry Weather

"*Monitoring in dry weather conditions, during flows typically less than one litre per second, investigated the stratification of pollutant concentrations within the separation chamber and their possible export downstream. The results showed:*

- *concentrations of TSS, TP and TN to be stratified within the separation chamber of the CDS unit due to limited vertical mixing;*
- *the highest pollutant concentrations (most particularly TSS) were found at the bottom of the containment sump;*

- *low TSS concentrations in the inflow and no significant trends for TSS removal, with a slight increase in TSS concentrations sometimes observed at the outflow during dry weather flow conditions*
- *variable trends for TP removal but overall higher concentrations were observed at the outlet, this was attributed to the phosphorous released from the sediment in the submerged containment sump; and*
- *A consistent removal of TN during dry weather".*

Conclusion

"The CDS unit can remove nearly all gross pollutants and a significant proportion of the finer pollutants, particularly during storms. An annual removal efficiency of 65% and 21% for TSS and TP respectively were estimated by assuming typical pollutant concentrations during different flow conditions and using removal efficiencies estimated using data collected in this study."

The manufactures experience, based upon extensive field studies and records indicates the following benefits and performance.

Pollutant Type	**Retention**	**Pollutant Type**	**Retention**
Gross Pollutants >25mm	99%	TSS	70%
Course Sediments >0.125mm	95%	Free Oil	95%
Floatable Pollutants	99%	Total Phosphorus	Greater than 20%

The CDS unit or similar device has the added benefit of being included in the maintenance regime of the community title subdivision. Regular maintenance will compliment their performance and provide the platform for approaching a policy of zero effluent discharge. The GPTs will significantly reduce the transference of pollutant loads to the local creek system and Terrigal Lagoon.

b) Wetland Systems

Crighton Properties recognises the environmental value of Terrigal Lagoon and the need for its ongoing protection. Planning strategies for the Parkside development have identified the need for a comprehensive post development pollution control infrastructure to ensure the quality of stormwater before it is discharged off site.

The wetland system will treat stormwater runoff only. A combined effluent and stormwater wetland system is being discouraged by local authorities because of the potential higher nitrogen and phosphorous in the effluent. In addition chloride is required as a disinfectant. The proposed treated effluent system will be kept separate from the stormwater system and the wastewater will discharge to the sewer.

In the past the Cardno Group has been involved in the implementation over sixteen (17) Wetlands or Water Pollution Control Ponds. They include:

Northern Water Feature-
Homebush Bay, NSW

Lake Annan –
Mount Annan, NSW

Federal Park Wetland-*Leichhardt (saline wetland), NSW*

EPIC Pond –
North Watson, ACT

Eastern & Southern Water Quality Control Ponds-*(concept design) Homebush Bay, NSW*

Yerrabi Water Quality Control Pond – *Gungahlin, ACT*

McGovern Basin and Wetland –
Dubbo, NSW

Woronora Bridge Wetland –
Woronora, NSW

Smithfield Wetland –
Smithfield, NSW

Helensburgh Water Quality
Control – *Pond – Helensburgh, NSW*

Glenmore, NSW

Pelican Water Golf Course
Water Quality Treatments
Rescue and Relocation of hundreds
Of native plants

Australian Newsprint Mills, Albury
Effluent Re-use Pond – *Thurgoona, NSW*

Isabella Weir Water Quality
Control Pond – *Tuggeranong, ACT*

Stranger Water Quality
Control Pond – *Isabella Plains, ACT*

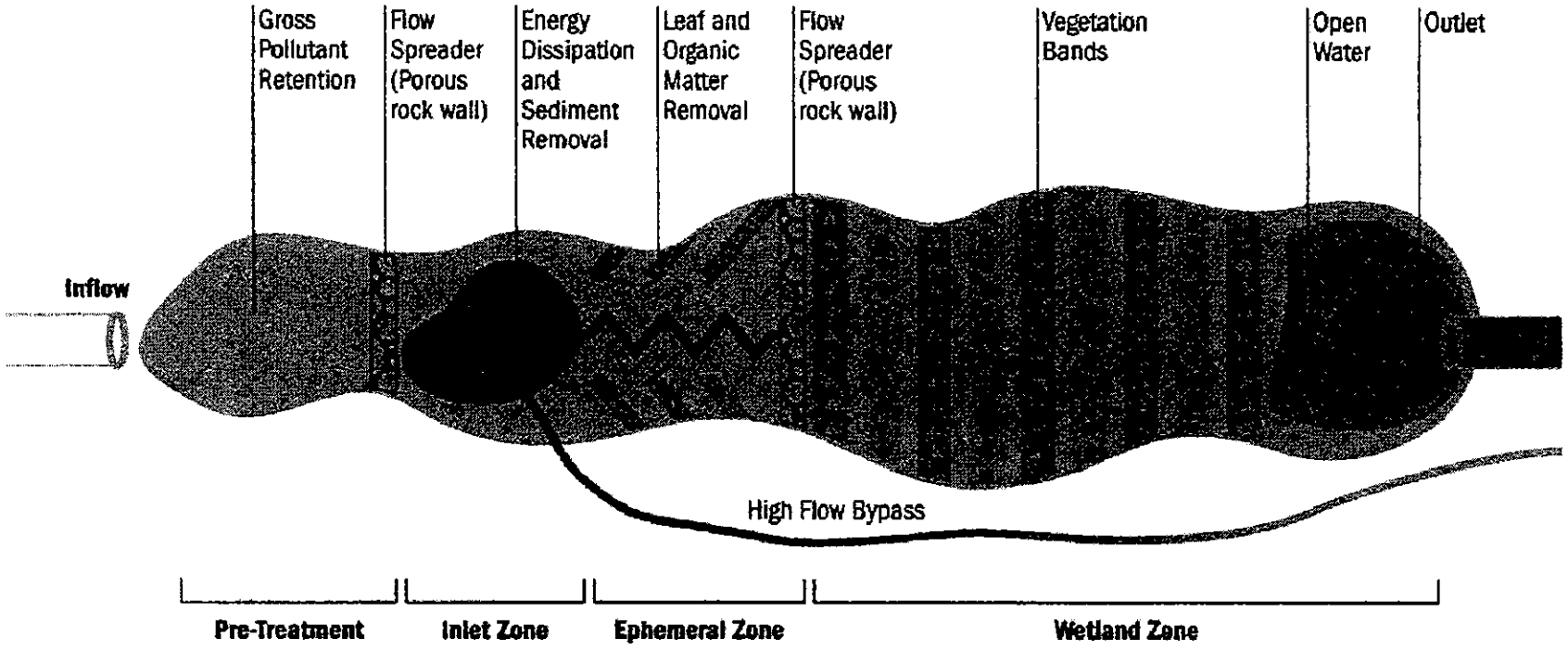
Lower Stranger Water Quality
Control Pond – *Bonython, ACT*

Gordon Estate Water Quality
Control Pond – *Gordon, ACT*

Our experience shows that the implementation of a wetland system involves the following key aspects:

- Selection of appropriate design criteria. The National Water Quality Management Strategy now identifies a suite of guidelines including Guidelines for Urban Stormwater Management, The Australian Water Quality Guide lines for Fresh and Marine Waters and the ANZECC (2000) Water Quality Guidelines for Aquatic Ecosystems Protection.

- Hydrological and Hydraulic Design, essentially the wetland system will consist of a sediment trap, an upstream pond with a deep open water body with literal emergent macrophyte plantings, a functional boundary and the wetland made up of shallower substrate zones vegetated with emergent plants. A typical constructed wetland is shown in **Figure 3.0** The design of the wetland system including their physical size, morphology and planting will be based on the best practice guidelines



SCHEMATIC REPRESENTATION OF A CONSTRUCTED WETLAND SYSTEM

FIGURE 3.0

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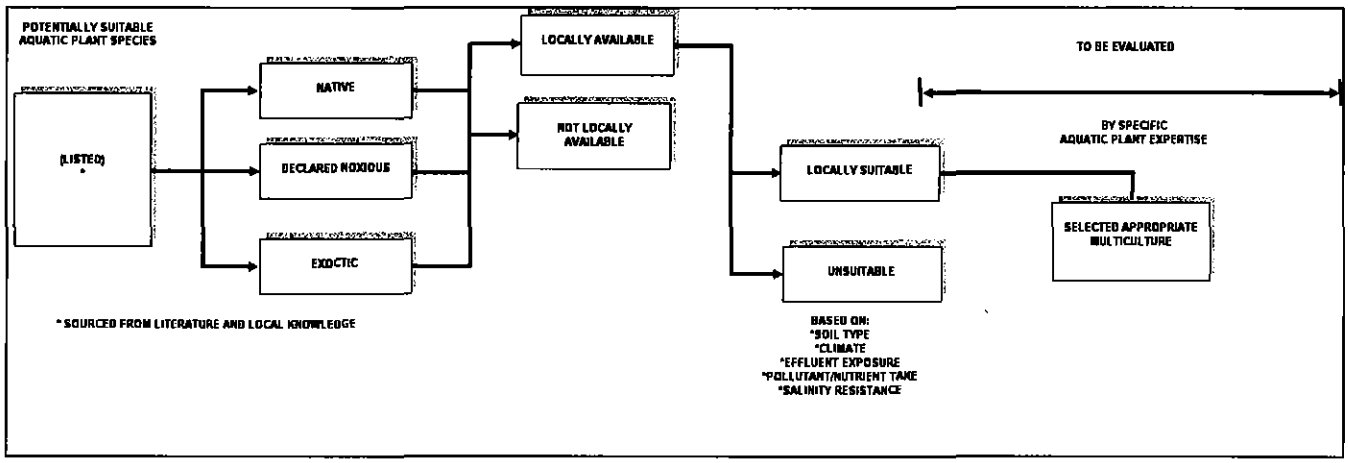
- Selection of appropriate aquatic vegetation as outlined in **Figure 4.0**

Figure 4.0 Wetlands - Appropriate Aquatic Vegetation Selection



Because the proposed development will be managed under the community title arrangement both monitoring and maintenance can be readily integrated with the development. The typical; monitoring and management program may be structured as follows.

Figure 5.0: Wetlands - Monitoring Program

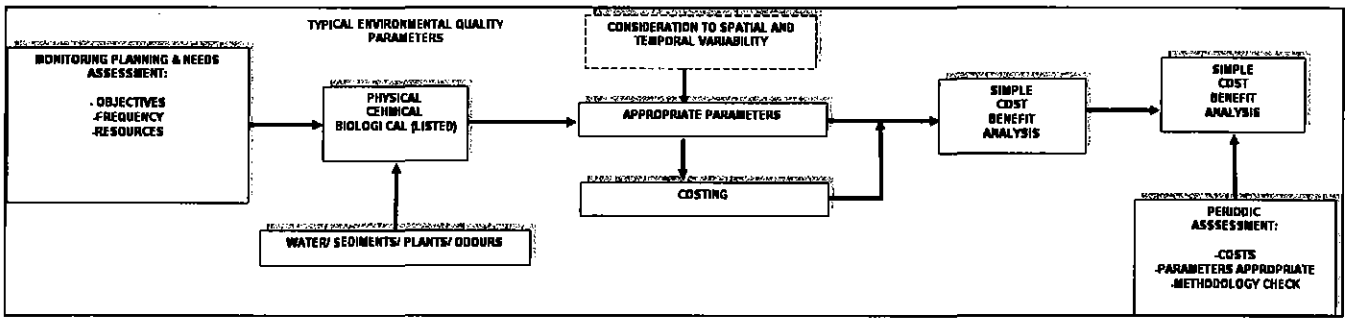
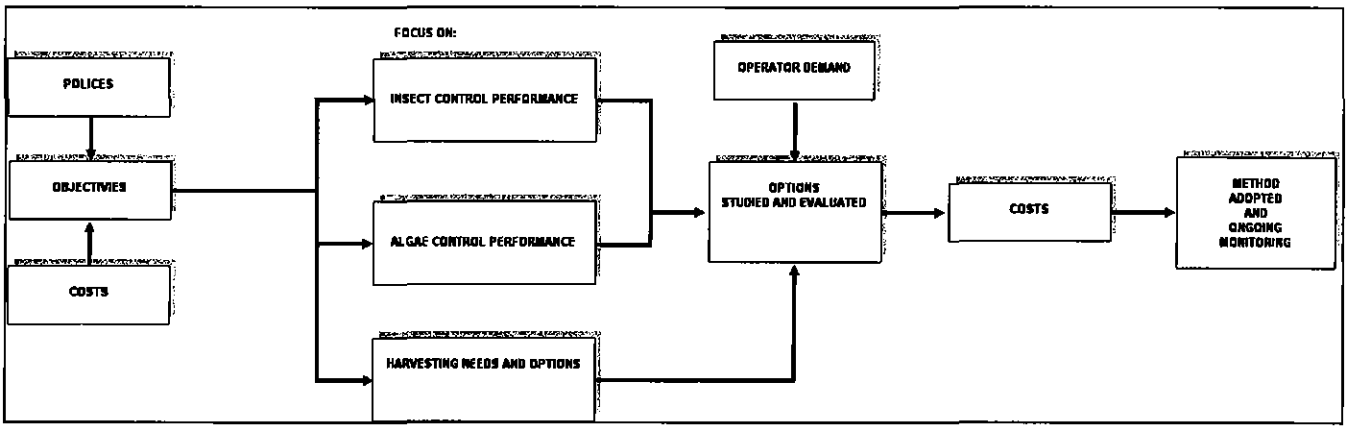


Figure 6.0 Wetlands – Management



Confidence in the wetland performance comes from understanding:

- how the pollutant load is estimated,
- how the pollutant load is transported in the drainage system,
- the wetland retention system,
- site conditions and rainfall patterns.

Pollutant Load

Research indicates that there are four methods for estimating pollutant loadings, which can be determined by computer simulation. The design is able to select a suitable method for an application. Using the Event Mean Concentration (EMC) method the following information is available from reliable sources like the EPA, NSW

Table 4.0 Land Use/ Vegetation Categories Examples (EMC) Values in mg/L

	Land Use/ Vegetation Categories				
Pollutant	**Native Vegetation/ Forest**	**Rural Grazing**	**Industry**	**Urban**	**Construction**
Sediments	85	500	50 to 200	50 to 200	4,000
Suspended Solids	6	30	60	85	
Total Nitrogen	0.2	0.8	1.0	1.2	
Total Phosphorous	0.03	0.09	0.12	0.13	

Research shows that pollutant concentration variations among landuse types are significant but the differences between same landuse types is not statistically significant, and the data may be combined to characterise a typical urban site like "Parkside".

Transport System

The proposed development will be made up of impervious and pervious surfaces. Imperious surfaces in urban areas are subject to the build up of pollutant concentrations between rainfall events. With sufficient rainfall these pollutants get washed off. Impervious surfaces experience a "first flush" effect where by pollutant concentrations are higher at the being of a storm, as rainfall continues, the surface accumulation is depleted and pollutants are diluted by the larger flows in the stormwater system. Pervious surfaces respond differently were pollutant washoff is the result of erosion. Pollutants are attached to solids and particulate matter or are dissolved (eg nitrites, nitrates or phorsphorus) in the flow.

In the design process both mechanisms are taken into account because landuse configuration pervious and impervious fractions do affect mass pollutant load.

Typically pollutant loading can be determined by applying a method to determine the amount of runoff and a pollutant load allowance for a particular landuse. The concept is shown in the table below. The table shows that the mass of pollutants curving at the stormwater system outfall, wetland pond is equal to the mass generated from runoff and rainfall. In reality pollutant loads get deposited, suspended and spread out as they are transported downstream over time. An example of pollutant load estimation is as follows.

Condition	Runoff Coefficient Cv	EMC (glm^3)	Annual Runoff Depth (mm)	Annual Runoff Volume (m^3)	Load (tones)
Pre-Development	0.175	500	315	157,500	78.8
Construction	0.40	4,000	3604,000	3604,000	1,440
Post-Development	0.42	120	378,000	378,000	45.4

Wetland Retention System

The Wetland Retention System consists of sizing the pond and wetland. This involves setting design standards that are usually based upon a trade off between the advantages of providing a particular level of protection of the environment and receiving waters as outlined in water quality standards like ANZEC (2000) Water Quality Guidelines for Aquatic Ecosystem Protection.

Typical the design standards for the pond could be:

- Identification of the appropriate design storm duration and corresponding flow rates
- Identification of particle sizes to be captured for the purpose of establishing efficiency
- Identification of the water quality standard
    - suspended solids < 50mg/L
    - pit 6.5-8.5
    - oil and greases < 5mg/L

as outlined in the ANZECC (2000) Water Quality Guidelines for Aquatic Ecosystems Protection

Pollutants will enter the pond under varied flow conditions as defined by a hydrograph. The process of hydrological routing pollutant mixed pond as well as maximizing pollutant removal efficiencies in a pond is quite complex and is usually performed in a computer package like MUSIC, XP SWMM or XP AQALM.

Beyond the pond is the wetland that contains a variety of native aquatic plants, a diversity of shallow recesses and micro-environments which all play important roles in pollutant processing. Pollutants are removed through the biological, chemical and physical processes found in the wetland.

Wetland Performance

Typically the performance of a wetland is represented by a set of pollutant removal curves. Lawerance developed a set of generic phosphorous, nitrogen and suspended solids versus hydraulic resident time removal curves from the study of existing wetlands in Canberra. Similarly Duncan (1997) from the Co-operative Research Centre (CRC) for Catchment Hydrology (CRCCH), Victoria describes the review of the 88 Australian and overseas studies of wetland performance. The review identified 26 sites that demonstrated good design and good water quality monitoring practices. The chosen sites were subject to a regression analysis between the retention percentage of each pollutant (suspended solids, total phosphorous and total nitrogen) and a suite of explanatory variables shown in Table 5.0.

Table 5.0: Correlations between Pond/Wetland Performance and Explanatory Variables.

Pollutant (parameter)	R^2 for Variables			
	Area Ratio	Storage Depth	Resident Time	Hydraulic Loading Rate
Suspended Solids	0.78	0.79	0.79	0.78
Total Phosphorous	0.52	0.43	0.38	0.56
Total Nitrogen	0.35	0.10	0.24	0.69

*Hydraulic Loading Rates – the ratio of the estimated average annual runoff volume and the surface area of the pond/wetland

The regressions are strong for suspend solids and weaker for the nutrients (HP and TN) with better predictability for the removal of pollutants when the hydraulic load rate is applied. Duncan developed a set of pollutant retention curves, showing pollutant output (TP and TN). The hydraulic loading rate was estimated for the Western and Eastern Wetlands and plotted on the curves. The pollutant output was estimated to be between 10 and 30 percent.

Various authorities have developed guidelines or best practice targets for pollutant reduction in constructed urban wetlands. These targets reflect the expected performance of a well constructed wetland.

Table 6.0. Expected Performance Targets/Reduction in Pollutant Loads.

Pollutant	Victoria Stormwater Committee 1999	Landcom WSUD Target 2004
Suspended Solids	80% reduction from typical urban load	80% retention of the average annual load
Total Phosphorus	45% reduction from typical urban load	45% retention of the average annual load
Total Nitrogen	45% reduction from typical urban load	45% retention of the average annual load

Typically these performance targets should provide the basis of attaining the ambient water quality. The simplified water quality retention analysis indicates that expected water quality targets could be met and that there is potentially, a recognized reduction in pollutant loads from the "Parkside" development.

The technology is available to manage the design and long-term performance of a wetland system, providing suitable water quality for protection of the downstream receiving waters and Terrigal Lagoon.

5.4 Flow Management In The Local Environment

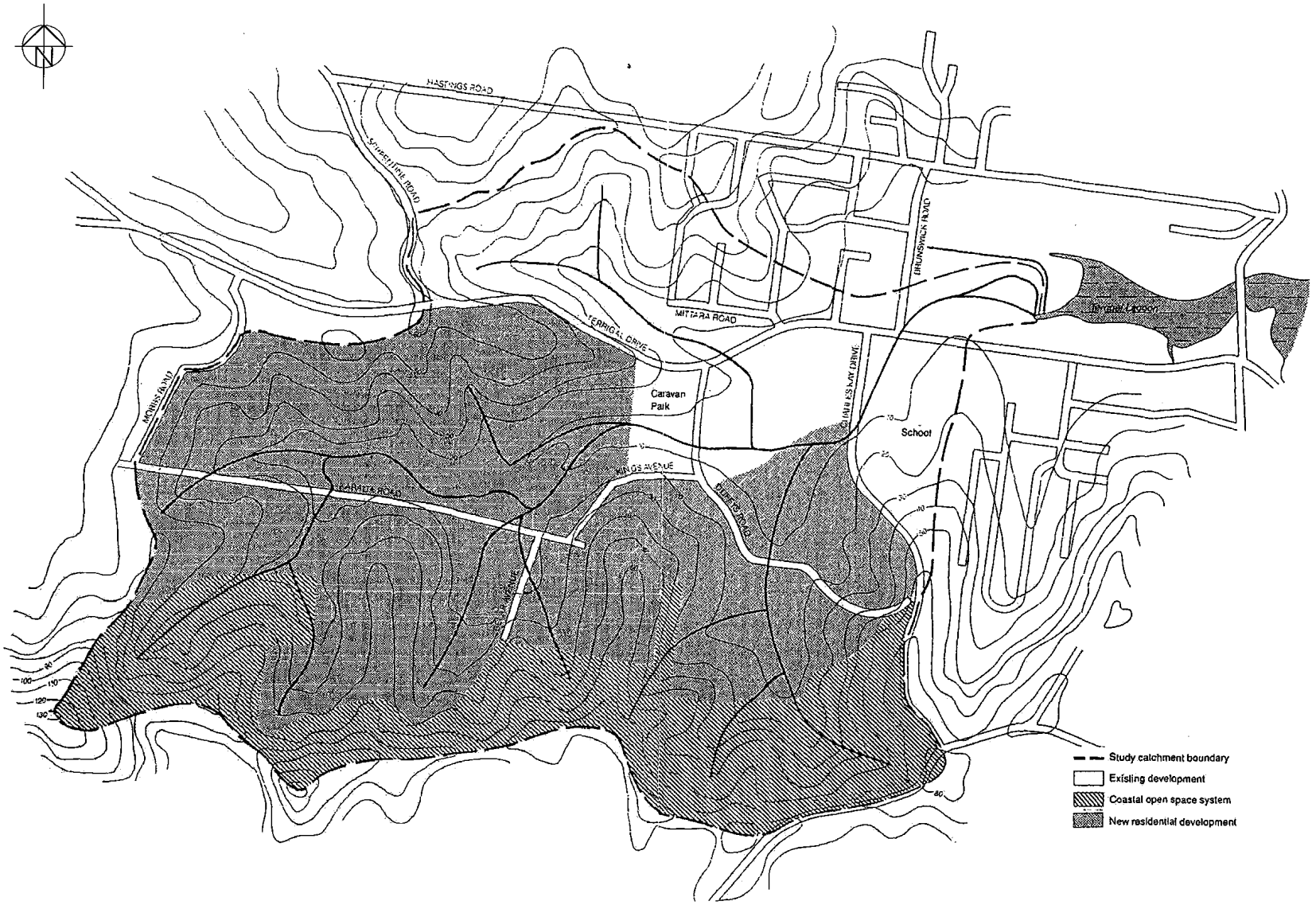
5.4.1 Background

The Parkside Residential Development is located at the top of The Terrigal Valley catchment and is part of the Erina/Greenpoint/Terrigal Release Area. The area drains to Terrigal Lagoon. The extent of new residential development is shown in the Terrigal Valley Development Control Plan.

In 1991 Trunk Drainage Strategies were developed by Kinhill Engineers Pty Ltd, on behalf of Gosford City Council for the expected increase in stormwater runoff that would result from urbanisation of the Terrigal Valley catchment. Over the past 12 years most of the trunk drainage strategies have been implemented. The drainage strategy conveys the 1% Annual Exceedance Probability (AEP) flood event from the urbanised catchment.

In November 1994 Sinclair Knight Merz reviewed the size of the Karalta Road Subdivision floodway channel in relation to Crighton Properties subdivision adjacent to Kings Avenue, Terrigal. They found that the KH report reflected "very intensive residential development as would be found in an in an inner urban environment" that contained an impervious fraction of 0.8. An inspection of the existing catchment indicates a developed impervious fraction of 0.45.

As well the adopted land usage for the Post Development Drainage Model refer to **Figure 7.0**, found in the Kinhill report shows that residential development extended south of Kings Avenue into the proposed Parkside Development.



ADOPTED LAND USAGE FOR POST DEVELOPMENT MODEL

FIGURE 7.0

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The implication is that the trunk drainage system has been designed conservatively and the drainage system potentially has spare capacity. However, Gosford City Council policy requires that post development flows are not to exceed pre-development flows for the design 1 year to 100 year ARI events.

5.4.2 Preliminary Stormwater Runoff Assessment

For the rezoning submission preliminary site specific Rafts modeling was undertaken to determine the potential difference in flows leaving the site for pre and post development conditions. The site is divided into two sub-catchments by a ridgeline that runs north-south, between Lindford Place and Bridgewater Street. The catchment to the west and east of the ridge measures 33 Ha and 20 Ha, respectively.

The subdivision Stormwater Runoff Scheme is shown in **Figure 8.0**

Peak flow rates and runoff volumes for pre and post development conditions was estimated at critical locations in the catchment. Estimated discharges at the site boundaries for the western and eastern catchment are given in Table 7.0

Table 7.0. Preliminary Estimated 1% AEP Dischages

Development State	Catchment	
	Western (33 Ha)	Eastern (20.2 Ha)
Pre Development	12.68 m^3/s	7.20 m^3/s
Post-Development	15.08 m^3/s	8.63 m^3/s

The preliminary modeling estimates indicate that there is a significant increase in peak flows from the urbanised sub-areas. The preliminary onsite detention basins sizing is given in Table 8.0.

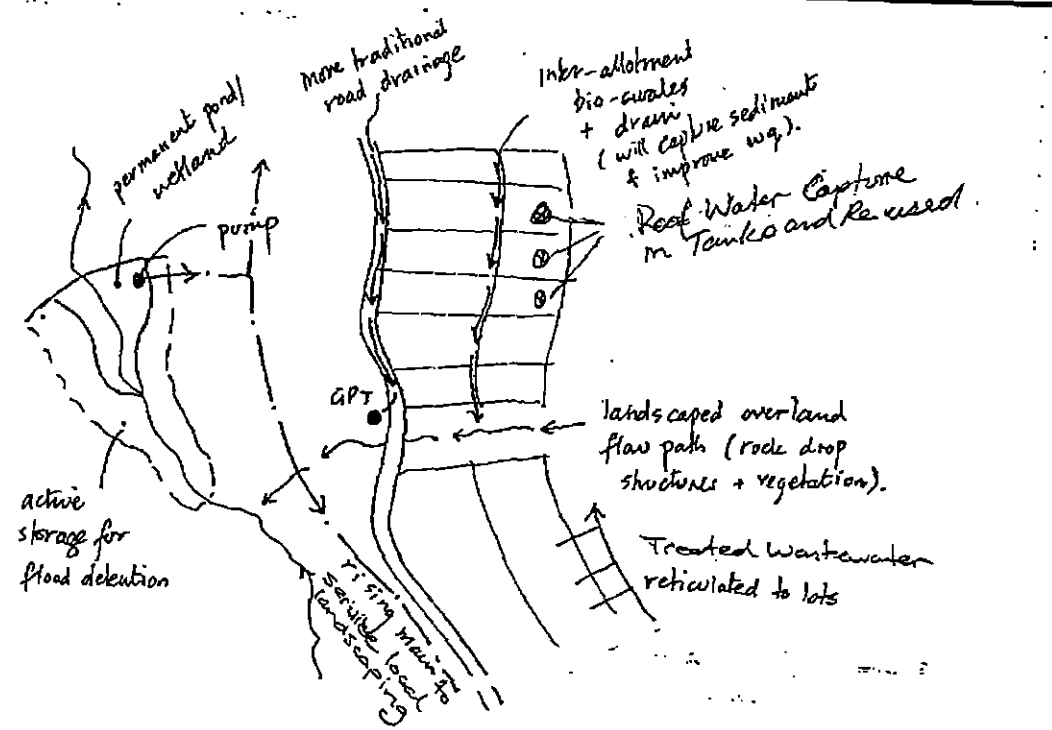
Table 8.0 Preliminary OSD Basin Sizing

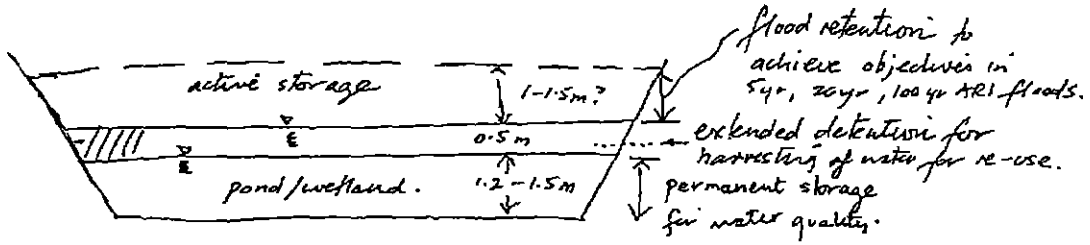
Catchment		Upstream Basin	Downstream Basin
Western	Area x Depth Volume	1550m^2 x 0.43m 655m^3	1775m^2 x 0.63m 655m^3
Eastern	Area x Depth Volume	1670m^2 x 1.60m 2674m^3	Existing 225m^3

The OSD Storage will be accommodated within the site wetlands basins, which should have depth to width ratio of 3:1 that includes a buffer zone.

5.4.3 Flood Assessment

The development is located near the top of the Terrigal Valley catchment consisting of undulating to rolling hills and generally moderately inclined slopes. The development drains into the upper reaches of a branch creek that feeds into Terrigal Lagoon. The site is therefore not within a low-lying area that would be inundated in the event of a major flood. The site and the urbanisation footprint lies beyond the catchment formed creek channels and the extent of any potential flooding from the main creek.





STORMWATER RUNOFF CONCEPT SCHEME

FIGURE 8.0

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The creek reaches within the property are steep which indicates that flooding affects occur in the downstream direction. On site the incised nature of the gullies will contain the extent of flooding except where the creek crosses over the proposed access roads. At these cross drainage locations, culverts or bridges will be provided to pass the design 1 in 100 year ARI event without flood flows over topping the road access.

Hydrological modeling indicates that peak discharges at the creek outlets from the site approach the magnitude of which trunk drainage system commence. Accordingly peak discharge and any potential flooding will be controlled by the onsite combined wetland/OSD system.

Council's Policy

Council's Flood Management Policy is outlined in Development Central Plan No. 115 Building in Flood liable areas.

The policy essentially restricts development in flood liable locations. These are designated as floodways, flood fringe and flood storage areas. The policy requires a minimum floor height for buildings.

A review of the policy indicates the proposed residential development proposal complies with the intention of DCP No. 115 because lots will be located beyond and above the Flood Planning Level.

Free Board and Flood Hazard.

The proposed roads and lots because of the sloping nature of the topography are generally located above the creek gullies.

In accordance with the policy, the flood hazard at the site is rated as low hazard. Flood flows are principally contained to the naturally defined creek channels. It is unlikely that people and their possessions will need to be evacuated from the site.

Riparian Zones

Riparian zones are to be maintained onsite by adhering to a 10m setback from the centerline of the creeks. Disturbance to the riparian zones will be minimized by reducing the number of discharge points, providing scour and erosion protection at the outlets as well as dissipating and dispersing the pipe or overland concentrated flow. Discharge site will be decided in consultation within DIPNR representative. Preliminary discussions have been held on-site with a DIPNR representative.

6.0 WATER, SEWER and STORMWATER INFRASTRUCTURE

6.1 Water

The area is serviced by a 300 mm dia trunk water main, which runs along Kings Avenue, which is inter connected to the main supply 500mm dia main running along Terrigal Drive to the north and to the 375 mm dia main in Karalta Rd to the west. These distribution mains are normally fed from the Erina PRV, (114mH), which is serviced from the Springfield Service Reservoir. This part of the water supply system can also be back fed from the Forresters Beach area. Refer to part sketch of the water supply system attached in Appendix A.

The proposed 145 Lot community title development will require a 150 mm dia water connection off the 300mm dia main in Kings Ave to supply the proposed subdivision. This main will supply potable water and fire service supply to the development. In addition to Council's metered connection, it is proposed each residence and facility will be individually metered with digital output capability. Technology will be provided to allow each residence to monitor their potable water consumption easily via a data link to a main monitoring facility.

Potable water consumption generally ranges from 900 L/day to 2000 L/day in the height of summer when in the past increased outdoor watering occurs. With the present ongoing drought, and real possibility Level 3 water restrictions continuing into the future there will be a growing need to minimise water consumption per capita, throughout all the year

General enquiries made at Council indicate the existing water supply reticulation adjacent to the proposed Crighton Properties development should be able to accommodate the proposed development, without the need for any major upgrade of the local water supply system – especially when considering water saving initiatives on the site.

6.2 Sewer

Crighton Properties Pty Ltd engaged Sinclair Knight Consulting Engineers to investigate the upgrading of the sewerage system for the rezoning proposal back in 1992. SKN recommended a number of upgrading options for the down stream infrastructure. Their modelling indicated when the existing allocated lots are fully developed there will be a shortfall in the capacity of the downstream system which will require upgrading of pumping station C18, and the gravity main between C18 & pumping station C3.

Some of the infrastructure recommendations of the SKM report have in part, been implemented by Council since the 1992 SKM report.

Pump station (SPS) C18 now pumps to SMH XY/11, rather than to SPS C3. The upgraded rising main now connects to a dedicated sewer trunk line which runs along Terrigal Drive to the main pump station Terrigal Major. This gravity sewer consists of an initial section of 300mm dia DICL from XY/11 to SMH XY/7, and 500mm dia DICL from SHM XY/7 to FA/1B, receiving manhole for Terrigal Major pump station, Refer to Sketch 3A, in Appendix B.

Existing System Capacity
In 1999 Gosford City Council upgraded the pumping capacity of SPS C18, to 85 L/s @ 17mH which services the Duffys Rd Kings Ave catchment and part of the Stratford Park Estate. The rising main has been replaced with a 250 mm dia rising main to Terrigal Drive and redirected from discharging to pump station C3, in Brunswick Rd. Although it is noted the last section of the C18 rising main reduces to a 200mm dia main.
Enquiries made with Council indicate the existing pump capacity can be further upgraded to 140 L/s @29mH as required with the installation of larger impellors, with the existing 60kW motors. There is however concern with the present storage capacity of the existing pump well.

Existing Well capacity
Preliminary calculations indicate the stations well capacity is inadequate in respect to minimum starts and outage storage. Based on PWD design criteria, the following expression is generally adopted to limit starts to 10 per hour:

$W_V = 900 \times Q_p / S$ where WV = control volume (L)
Qp = pump capacity (L/s)
S = allowable starts /hr

Exitsing $W_V = 900x85/ 10 = 7.65M^3$

Future $W_V = 900x\ 140/10 = 12.6\ M^3$

The present operating depth within the 2.7m dia pump station is approx 1.2m allowing for a freeboard of 0.3m below the incoming invert for TWL and 0.4m above the base for BWL. Thus the available volume is equal to 6.87 M^3.
The present well volume is just sufficient for the present pump duty but will be inadequate for a higher flow rate (140 L/s).

The EPA now have a general requirement for sewerage systems, and particularly sewage pump stations to contain surcharges, where a mechanical break down or an electrical outage occurs. This requirement usually requires pump stations to have at least 2 hrs ADWF storage provision, either within the pump well or available within an adjacent tank.

The present Outage Storage required based on minimum 2 hrs at ADWF (2x3600x 11.22) equates to an additional storage requirement of ~70m3. This is allowing for the existing well's capacity, but not accounting for storage within the upstream reticulation system draining into the pump station.

Similarly if the pumps are upgraded to 140 L/s the outage storage required based on 2 hrs ADWF is ~151M^3. Thus it is evident the present Outage Storage volume is inadequate for the present pump duty.

There are a number of options available to increase the operating capacity by either building a new larger diameter pump well or keeping the existing pump station and build a large adjacent chamber, which will provide the required outage storage, and meet the minimum storage requirements for the future flow.

Determination of existing Hydraulic Load based on tenements

Average Dry Weather Flow (ADWF)
The analytical method generally used is based on PWD, Manual of Practice Sewer Design. The following design assumptions have been adopted:

(i) a design flow allowance of 240 litres per person per day for (DPWS design criteria)
(ii) nominal 4.0 person occupancy per tenement. (DPWS allowance)

(iii) assumed instantaneous flow rate of 0.011 litres/ sec/ tenement.

ADWF = No. of Tenements X 0.011 Litres /sec

Peak Dry Weather Flow (PDWF)

PDWF is estimated peak dry weather flow in sewers during dry weather conditions and is used to calculate self-cleansing requirements of pipes. It depends on catchment size and is calculated according to the following equation

PDWF = rx ADWF

where: = r = $(1.74 + 56/T_{0.4})^{1/2}$
T = ultimate number of tenements to be connected (based on DPWS)

Peak Wet Weather Flow (PWWF)

PWWF is the expected peak rate of flow in sewers during wet weather and is used to calculate hydraulic capacities of specific sewerage system components, pumping stations and inlet works etc. It is estimated as:

PWWF= PDWF + SA
where: SA is a storm allowance flow factor (0.058 / ET)

The additional flow during wet weather comprises rainfall dependant infiltration plus stormwater inflow. Policing of illegal stormwater connections to sewer and tight construction specification are two ways that infiltration and inflow can be reduced. The following factors generally affect infiltration and inflow:

(i) Rainfall - inflows are proportional to rainfall intensity and volume.

(ii) Soil movement - infiltration is increased by reactive soils, mine subsidence and settlement, none of which are likely to be a major influence at this site.

(iii) Water table - pipelines below temporary or permanent water tables are more susceptible to infiltration. This is not a key concern at this site as the sewer system should not be at an excessively depth, due to the general slope of the site and sewer reticulation should be above any seasonal water-logging of lower areas on the site.

(iv) Flooding - sewers on flood prone land are highly susceptible to stormwater inflow. Flooding is not evident at this site where the development is proposed.

Estimate of Equivalent Tenements (ET)

In theory the existing capacity of SPS C18 based on ET's using the above PWD design criteria at the present pump rate of 85 L/s is equivalent to ~1000 ET contributing to the pump station. If the pumps were upgraded to the future capacity o 140 L/s this would equate to ~1700 ET contributing to the pump station.

The number of existing residential lots presently developed within the C18 catchment is approximately 605 tenements, based on the number of existing lots, refer to sketch drawing in Appendix A, showing the extent of the C18 sewerage catchment.

The C18 catchment has two existing mobile village parks, Bangalow Village in Mobbs Rd with 140 permanent sites and a manager's residence. This park generally accommodates 200 residents. Taking a conservative approach, it is assumed this village is equivalent to 2/3 ET per site, thus the estimated hydraulic load is equivalent to 95 ET

The other is Tingari Village, located off Duffys Rd with 169 permanent sites, with a manager's residence; the site generally accommodates 220 persons. Council plans indicate that a proportion of the original village drains to the C3 sewer catchment. Again adopting a conservative approach the estimated hydraulic load is 114 ET. Presently a part of the village drains to the C3 catchment via IAB line which was the original sewer line before the Kings Ave was developed prior to 1990. It is expected in time this anomaly will be changed, so for this desk top study the whole of the village will be assumed to be within the C18 catchment.

It is noted that these parks cannot be redeveloped further into medium residential lots as they fall under the provisions of LEP 443, Feb 2004, which Gosford City Council brought into maintain affordable housing within the shire. In any case it would be highly unlikely a re development of these sites would yield a greater density than exists at present.

Thus the present estimated hydraulic load within the C18 catchment based on all the residential lots being developed is:

Existing residential lots	605
Existing 7 (2c) Lots connected	10
Sports Stadium	10
Bangalow Village	95
Tingari Village	114
Total	834 ET

This figure confirms Council's belief that the present load on SPSC18 is nearing the present capacity of the sewage pump station.

Future Development

There is still an amount of 7(C2) zoned land north of Kings Ave residential area which is unlikely to be rezoned to residential lots, but there are small pockets where a one or two small residential lots will be created. It is estimated there may be approximately 25 additional residential lots developed apart from Crighton's proposed development. Normally Council would require a contingency of 1.1 factor to allow for any future dual occupancy, and or any infill development of the existing residential lots. The estimated additional loading for infill development of existing lots is 84 ET (834 x 0.1).

The remaining area available for future development is that area to the south of Kings Ave contained in the proposed Crighton properties rezoning application. Refer to Sketch 3B, in Appendix B.

This area is proposed to produce 146 residential lots, Club house and community pool are estimated to be equivalent to 150 ET.

Thus the future total development is estimated to be made up as follows:

Existing Development	834 ET
Crighton Development	150 ET
Estimated Future Residential Subdivision	25 ET
Future allowance for dual occupancy	84 ET
Total	**1093 ET**

Rising Main C18 capacity

Drawings obtained from Council indicate the majority of the C18 rising main is made up of a combination of 250mm dia, 225mm dia and 200mm dia rising main discharging to sewer manhole XY/11 in Terrigal Drive.

The limiting factor for any increase in flow rate within the existing rising main will be the increased velocity in the 200mm dia rising main. Severe scouring of this section of the main will occur at a discharge rate of 140 L/s, and with a corresponding increase in head. It would be expected this section of the C18 rising main will need to be upgraded at least to accommodate the future flow rate of 140 L/s.

Gravity sewer reticulation

As described previously RM C18 pumps to a dedicated sewer carrier which delivers flow to the Terrigal Major pumping station. This line runs in parallel to the FR sewer line which picks up the development from the southern side of Terrigal Dr. The FR line is in within the TM catchment and caters for **approx 546** lots on the southern side of Terrigal Drive, plus the inflow from rising main C3. There is an inter connection between these two lines (XY & FR) to provide additional flow capacity in case of this main reaching full capacity. It is expected in wet weather conditions the FR line would frequently overflow to the XY line whenever RM C3 is operating discharging at 80 L/s, and the line is running full.

The main gravity sewer which services the Kings Ave area accepts flows from part of Stratford Park, Bangalow Village and flows to SPS C18. The BA line would also service the subject Crighton Property adjacent to sewer line BA/ 14 to GA/12. This sewer main consists of 300mm dia and 225mm dia sewer pipelines. Based on a preliminary desk top calculations these lines have the following carrying capacity based on Colebrook White k=0.6mm. Refer to Sketch 3C, in Appendix B.

Table 9.0 Capacity of Gravity Sewer

Sewer manhole section	Pipe Dia mm	Pipe Type	Average Pipe grade %	Flow Capacity Q_f Litres/sec	Flow Capacity ET	Estimated Exist ET load	Estimated Future ET load
XY7 – FA1b	500	DICL	0.15	160	**1960**	Equiv to 1000	1093
XY7 – XY11	300	DICL	1.4	130	**1590**	Equiv to 1000	1093
FR/8 – FR/3	400	VCP	0.13	82	**980**	1546 (equiv) Incl RM C3	1623 Incl RM C3
BA/1 – BA/9	300	VCP	0.48	77	**910**	676	900 **(840)**
BA/9 – BA/14	225	UPVC	0.73	44	**510**	369	556 **(511)**
BA/14 – GA/3	225	UPVC	0.33	29	**339**	281	384 **(339)**
GA/3 – GA/12	225	UPVC	0.35	30	**348**	281	309

Note: 1. With both XY & FR sewer lines inter connected it is expected any over capacity would be transferred to the larger dia XY line, which appears to be the present operational situation with these main sewer carriers.
2. The future flows have included a 1.1 factor on the existing ET's to allow for future dual occupancy/ infill
3. The lines shown in red indicated there is a capacity issue without recycling, if the Crighton proposed development of 150 ET is included. The future ET figures in brackets (511) indicated the estimated ET when accounting for the recycling of reclaimed wastewater within the proposed Crighton development, allowing a reduction of discharge equivalent to 105 ET (150ET x 0.7), 30% allowing for RO & WAS discharge).
4. The C18 catchment from the BA line upstream will require further dynamic modelling and investigation, to confirm the operational capacity of the whole system to SPS C18.

From the simplistic desk top analysis, and as exhibited in the above table, it appears the proposed recycling facilities within the proposed Crighton development should enable the proposed development to be accommodated within the existing sewage gravity reticulation, including the estimated future loads from the Kings Ave sub catchments. Without recycling, the BA/9 to GA/3 lines, will be under capacity, and augmentation of these lines would be required as a result of proposed Crighton development.

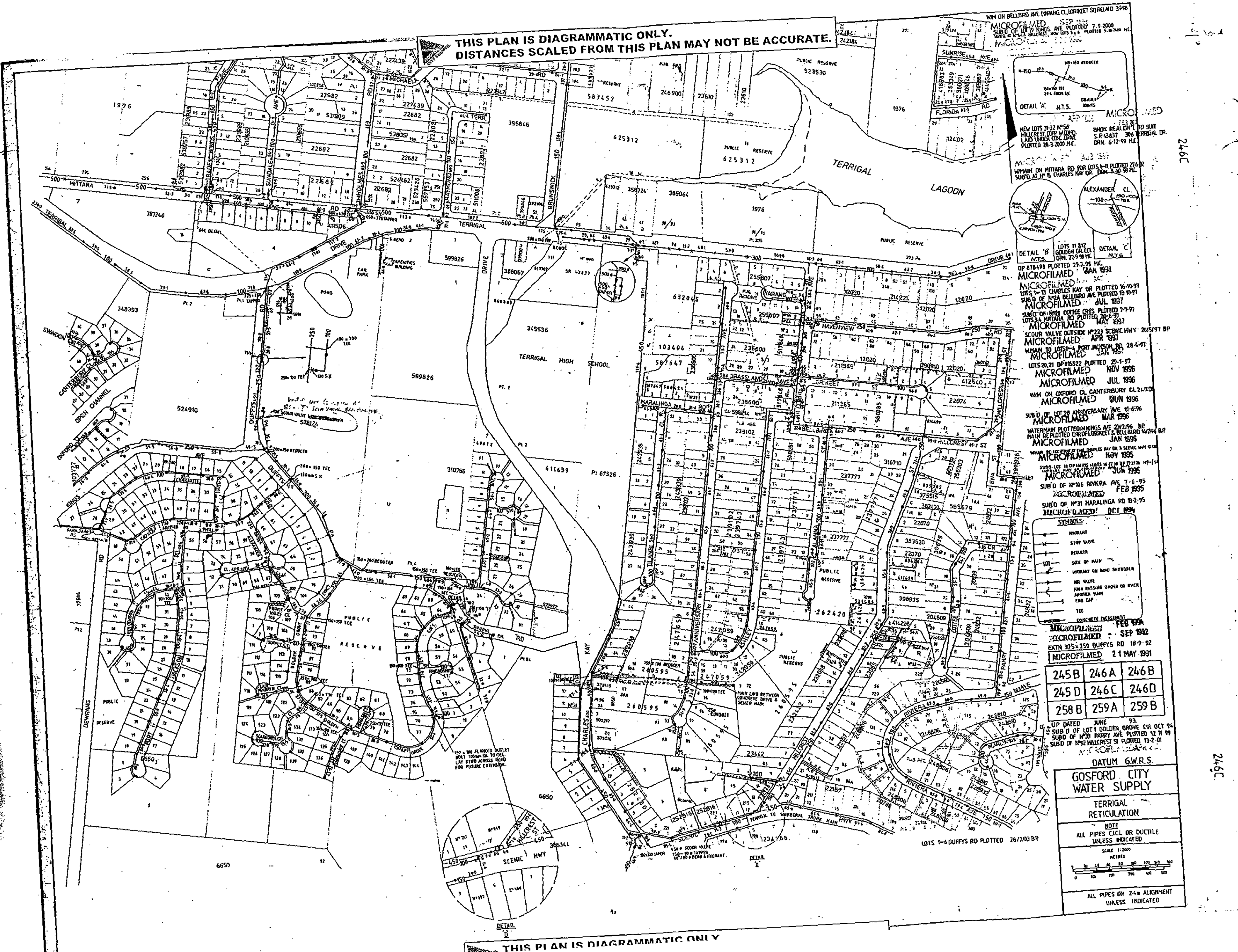
Further detailed investigation will be required with dynamic modelling to determine the actual operating capacity of this section of the gravity sewer and confirm available capacity within the C18 catchment.

6.3 Stormwater

Changes to the existing downstream stormwater infrastructure will not be necessary because the Parkside on site detention system will be sized to ensure that the hydraulic capacity of the existing Kings Avenue culverts are not exceeded. Only minor interfacing between the existing sub-surface and surface drainage systems, and the new subdivision sub-surface and surface drainage systems will be required.

APPENDIX A

Water Supply


THIS PLAN IS DIAGRAMMATIC ONLY.
DISTANCES SCALED FROM THIS PLAN MAY NOT BE ACCURATE.
TERRIGAL LAGOON
TERRIGAL HIGH SCHOOL
PUBLIC RESERVE
MITTARA
TERRIGAL DRIVE
DUFFYS RD
CHARLES KAY DRIVE
SCENIC HWY
HILLCREST ST
DEWRANG RD
OPEN CHANNEL
DETAIL 'A' N.T.S.
DETAIL 'B' N.T.S.
DETAIL 'C' N.T.S.
DETAIL 'D'
SYMBOLS
HYDRANT
STOP VALVE
REDUCER
SIZE OF MAIN
HYDRANT ON ROAD SHOULDER
AIR VALVE
MAIN PASSING UNDER OR OVER ANOTHER MAIN
END CAP
TEE
CONCRETE DEADMENT
EXTN 375×250 DUFFYS RD 18-9-92
MICROFILMED 21 MAY 1991
245B 246A 246B
245D 246C 246D
258B 259A 259B
UP DATED JUNE 93.
DATUM G.W.R.S.
GOSFORD CITY WATER SUPPLY
TERRIGAL RETICULATION
NOTE
ALL PIPES C.I.C.L OR DUCTILE UNLESS INDICATED
SCALE 1:2000
METRES
ALL PIPES ON 2.4m ALIGNMENT UNLESS INDICATED
LOTS 1-6 DUFFYS RD PLOTTED 28/7/03 BP
THIS PLAN IS DIAGRAMMATIC ONLY
246C


KARALTA RD.
KINGS AVE
HELENA PDE.
MITTARA RD
TERRIGAL DR
SALISBURY DR
MOBBS RD
LINK TERRIGAL DR
DIAGRAM 'A'
DIAGRAM 'B'
DIAGRAM 'C'
DIAGRAM 'D'
SYMBOLS
GOSFORD CITY WATER SUPPLY
ERINA RETICULATION
NOTE
ALL PIPES C.I.C.L. OR DUCTILE UNLESS INDICATED
ALL PIPES ON 24m ALIGNMENT UNLESS INDICATED
DATUM G.W.R.S.
245A 245B 246A
245C 245D 246C
258A 258B 259A
259809
PUBLIC RESERVE

OPTION 1.
Recycled Water - WC + Laundry.

BASIX

Home Account Logout Help Definitions Sample Pro

Project Portfolio

Project Address & Type
Project Details

Landscape
Stormwater
Water
Thermal Comfort
Energy

Project Summary
Report
BASIX Certificate
Alternative Assessment

Save Project

Project Summary

This page displays the proposed development's score for water, thermal comfort and energy. T learn more about the **BASIX targets** go to the **About BASIX** section of the **BASIX website**.

Once you have achieved the **BASIX targets** for Water, Thermal Comfort and Energy you will be able to print a unique BASIX Certificate for your project.

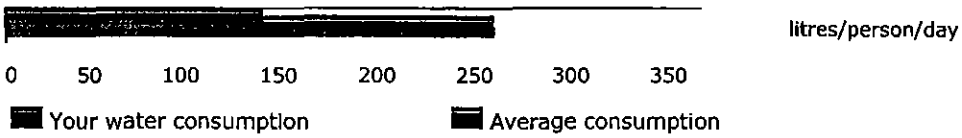
The footprint graphs on this page show the proposed development's water consumption and greenhouse gas emissions compared to the average dwelling of the same type.

Summary

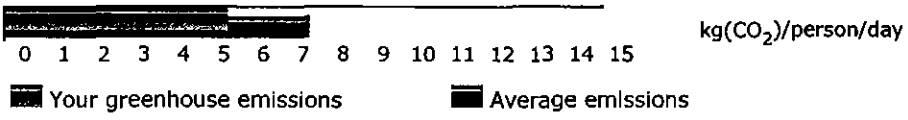
Water	✓	(44)	44%
Thermal Comfort	✓	(pass)	
Energy	*	(0)	0%

Water and Energy Consumption

Potable Water Consumption Footprint



Greenhouse Footprint



Energy Back to top Project Report

Project Report

Close Print Report

Description of project

Project address and type

Project name	Sample Project OPTION 1.
Street number	42
Street name and type	basix Place
Suburb	BROOKVALE / = TERRIGAL
Post code	2100
Local government area	Warringah Council / GOSFORD.
Deposited Plan number	333
Strata Plan number	
Lot number	3
Section	
Project type	Detached dwelling
Nature of project	Erecting a new residential building

Project details

Site area	800	m²
Gross floor area	240	m²
Roof area	250	m²
Number of bedrooms	4	
Total area of vegetation (garden and lawn)	200	m²
Concession claimed (if applicable)	not applicable	

Commitments

Commitments	DA plans	CDC/CC plans & specifications	Certifier check
LANDSCAPE			
Landscaping			
The applicant must plant at least 40 square metres of indigenous vegetation on the site. Vegetation is indigenous if it is listed in the BASIX Specification as indigenous to the local government area in which the development is to be constructed.	✓	✓	
WATER			
Recycled water use (not rainwater or stormwater)			
The applicant must connect the development to a reticulated recycled water supply system which is capable of supplying at least 350 litres per day of reticulated recycled water to the development (from off the site).		✓	✓

The applicant must connect the reticulated recycled water supply system to all toilets in the development, so that reticulated recycled water can be used for toilet flushing.		✓	✓
The applicant must connect the reticulated recycled water supply system to the cold water tap that supplies each clothes washing machine in the development, so that reticulated recycled water can be used for clothes washing.		✓	✓
Showerheads			
The applicant must install showerheads with a minimum rating of 3A in all showers in the development.		✓	✓
Toilets			
The applicant must install a toilet flushing system with a minimum rating of 3A in each toilet in the development.		✓	✓
Tap fittings			
The applicant must install taps with a minimum flow rate of 3A in the kitchen in the development.		✓	
The applicant must install bathroom taps (other than showerheads) with a minimum flow rate of 3A in each bathroom in the development.		✓	
THERMAL COMFORT - Deemed to Comply			
General			
The applicant must construct the dwelling so that it is not significantly overshadowed.		✓	✓
The applicant must construct the dwelling so that the total skylight area of the dwelling is less than 2% of its gross floor area.	✓	✓	✓
Construction			
The applicant must construct the dwelling in accordance with the following specifications:			
· Ground floor(s): 143 square metres of concrete slab on ground floors	✓	✓	✓
· External walls: 170 square metres of brick veneer and 100 square metres of timber, weatherboard or cement sheet	✓	✓	✓
· Walls shared with garage: 25 square metres of plasterboard	✓	✓	✓
· Ceilings: 180 square metres of ceiling area with roofspace over it.	✓	✓	✓
· Roof space: a large roofspace		✓	✓
The areas referred to above are the maximum permitted and must be calculated in accordance with the BASIX Specification.			
Cross ventilation			
The applicant must construct the dwelling in accordance with the requirements for ventilation in the BASIX Specification.	✓	✓	✓
Glazing and shading			
The applicant must install the glazing and shading set out below:			
· North sector: 31 square metres of clear, single glass, shaded by 600-1100 mm eave/projection	✓	✓	✓
· East sector: 16 square metres of clear, single glass, shaded by min 600 mm eave/projection	✓	✓	✓

· South sector: 22 square metres of clear, single glass	✓	✓	✓
· West sector: 12 square metres of toned, double glass, shaded by min 1800 mm eave/projection	✓	✓	✓
The areas specified above for glazing are the maximums permitted.			
Note: 5% of total glazing in the development is exempt from the shading requirements referred to above.			
The glazing and shading referred to in this commitment must meet the requirements set out in the BASIX Specification.	✓	✓	✓
The applicant must construct the dwelling so that a minimum of 50% of the glazing has aluminium frames.	✓	✓	✓
Required insulation and roof colours			
The applicant must construct the dwelling in accordance with the following insulation requirements:			
· External walls: insulation with an R-value of R1.5 must be added to the brick veneer walls or, alternatively, these walls must have an R-value of R1.7. Insulation is not required in walls adjacent to a garage or the external walls of a garage.		✓	✓
· External walls: insulation with an R-value of R1.5 must be added to the timber, weatherboard or cement sheet walls or, alternatively, these walls must have an R-value of R1.7. Insulation is not required in walls adjacent to a garage or the external walls of a garage.		✓	✓
· Ceilings: insulation with an R-value of R2.5 must be added to each ceiling which has a roofspace over it, except ceilings directly above a garage. (If a roof is insulated with a foil-backed blanket, then the R-value of the insulation to be added to the ceiling under that roof may be reduced by R0.5).		✓	✓
The applicant must construct the dwelling so that all roofs are light coloured, as defined in the BASIX Specification.		✓	✓
The applicant must install the following roof ventilation system in the dwelling: wind-driven ventilator. This system must comply with the BASIX Specification.		✓	✓
Energy			
Active cooling			
The applicant must install a three phase a/c system - (EER between 2.5 - 3.0), or one with a higher EER, for living areas of the dwelling.		✓	✓
The bedrooms (as constructed) must not incorporate any active cooling system or any ducting which is designed to accommodate any active cooling system.		✓	✓
Active heating			
The applicant must install a three phase a/c system - (EER between 2.5 - 3.0), or one with a higher EER, for living areas of the dwelling.		✓	✓
The bedrooms (as constructed) must not incorporate any active heating system or any ducting which is designed to accommodate any active heating system.		✓	✓
Hot water			
The applicant must install the following hot water system in the development: solar (electric boosted).	✓	✓	✓
Lighting			
The applicant must install standard or compact fluorescent lighting			

as the primary type of artificial light in each of the following rooms:			
· the kitchen		✓	✓
· the garage		✓	✓
· the laundry		✓	✓
The applicant must install a window in the kitchen of the dwelling for natural lighting.	✓	✓	✓
The applicant must install a window in each bathroom and toilet in the development for natural lighting.	✓	✓	✓
Cooking			
The applicant must install a gas cooktop & electric oven in the kitchen of the dwelling.		✓	
Design enhancements			
The applicant must construct each refrigerator space in the development so that it is well ventilated, as defined in the BASIX Specification.		✓	
The applicant must install a fixed outdoor clothes drying line as part of the development.		✓	

END BASIX COMMITMENTS

1. In these commitments, "applicant" means the person carrying out the development.
2. Commitments identified with a ✓ in the "DA plans" column must be shown on the plans accompanying the development application for the proposed development.
3. Commitments identified with a ✓ in the "CC/CDC plans and specs" column must be shown in the plans and specifications accompanying the application for a construction certificate / complying development certificate for the proposed development.
4. Commitments identified with a ✓ in the "OC" column must be certified by a certifying authority as having been fulfilled, before a final occupation certificate for the development may be issued.

BASIX Report

The following scores have been achieved for this development:

Water 44 %

Thermal PASS

Energy 29 %

	Score	Appliance score	Total
Water	44	2.6	47
Energy	29	0.0	29

These scores are based on the following commitments relating to appliances:

Appliance Selections

Clothes washer

The applicant must install a clothes washer with a minumum water efficiency rating of 2A in the dwelling.

Dishwasher

The applicant must install a dishwasher with a minumum water efficiency rating of 4A in the dwelling.

END APPLIANCE SELECTIONS

OPTION 2.
Recycled Water - WC's. + Roofwater tanks
LDRY, Earth,

BASIX

Project Portfolio

Project Address & Type
Project Details

Landscape
Stormwater
Water
Thermal Comfort
Energy

Project Summary
Report
BASIX Certificate
Alternative Assessment
Save Project

Project Summary

This page displays the proposed development's score for water, thermal comfort and energy. To learn more about the **BASIX targets** go to the **About BASIX** section of the **BASIX website**.

Once you have achieved the **BASIX targets** for Water, Thermal Comfort and Energy you will be able to print a unique BASIX Certificate for your project.

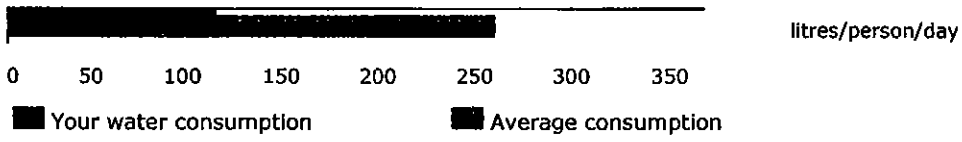
The footprint graphs on this page show the proposed development's water consumption and greenhouse gas emissions compared to the average dwelling of the same type.

Summary

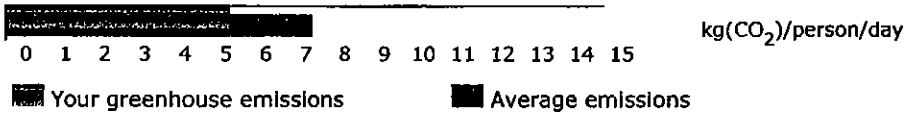
Water	✓	(51)	51%
Thermal Comfort	✓	(pass)	
Energy	✱	(0)	0%

Water and Energy Consumption

Potable Water Consumption Footprint



Greenhouse Footprint



Energy Back to top Project Report

Project Report

Close Print Report

Description of project

Project address and type

Project name	Sample Project OPTION 2
Street number	[redacted]
Street name and type	basix Place
Suburb	BROOKVALE / Terrigal
Post code	2100
Local government area	Warringah Council / Gosford
Deposited Plan number	[redacted]
Strata Plan number	[redacted]
Lot number	[redacted]
Section	
Project type	Detached dwelling
Nature of project	Erecting a new residential building

Project details

Site area	800	m²
Gross floor area	240	m²
Roof area	250	m²
Number of bedrooms	4	
Total area of vegetation (garden and lawn)	200	m²
Concession claimed (if applicable)	not applicable	

Commitments

Commitments	DA plans	CDC/CC plans & specifications	Certifier check
LANDSCAPE			
Landscaping			
The applicant must plant at least 40 square metres of indigenous vegetation on the site. Vegetation is indigenous if it is listed in the BASIX Specification as indigenous to the local government area in which the development is to be constructed.	✓	✓	
STORMWATER			
Collection of rainwater and stormwater			
The applicant must install a rainwater tank on the site. This rainwater tank must meet, and be installed in accordance with, the requirements of all applicable regulatory authorities.	✓	✓	✓
Rainwater tank			

Rainwater tank			
The applicant must configure the rainwater tank to collect rain runoff from at least 124 square metres of the roof area of the dwelling.		✓	✓
The applicant must connect the rainwater tank to the cold water tap that supplies each clothes washing machine in the development, so that rainwater can be used for clothes washing.		✓	✓
The applicant must connect the rainwater tank to at least one outdoor tap in the development so that rainwater can be used to irrigate vegetated areas of the site.		✓	✓
The rainwater tank must have a capacity of at least 5000 litres.	✓	✓	✓
WATER			
Recycled water use (not rainwater or stormwater)			
The applicant must connect the development to a reticulated recycled water supply system which is capable of supplying at least 350 litres per day of reticulated recycled water to the development (from off the site).		✓	✓
The applicant must connect the reticulated recycled water supply system to all toilets in the development, so that reticulated recycled water can be used for toilet flushing.		✓	✓
Showerheads			
The applicant must install showerheads with a minimum rating of 3A in all showers in the development.		✓	✓
Toilets			
The applicant must install a toilet flushing system with a minimum rating of 3A in each toilet in the development.		✓	✓
Tap fittings			
The applicant must install taps with a minimum flow rate of 3A in the kitchen in the development.		✓	
The applicant must install bathroom taps (other than showerheads) with a minimum flow rate of 3A in each bathroom in the development.		✓	
THERMAL COMFORT - Deemed to Comply			
General			
The applicant must construct the dwelling so that it is not significantly overshadowed.		✓	✓
The applicant must construct the dwelling so that the total skylight area of the dwelling is less than 2% of its gross floor area.	✓	✓	✓
Construction			
The applicant must construct the dwelling in accordance with the following specifications:			
· Ground floor(s): 143 square metres of concrete slab on ground floors	✓	✓	✓
· External walls: 170 square metres of brick veneer and 100 square metres of timber, weatherboard or cement sheet	✓	✓	✓
· Walls shared with garage: 25 square metres of plasterboard	✓	✓	✓
· Ceilings: 180 square metres of ceiling area with roofspace over it.	✓	✓	✓

· Roof space: a large roofspace		✓	✓
The areas referred to above are the maximum permitted and must be calculated in accordance with the BASIX Specification.			
Cross ventilation			
The applicant must construct the dwelling in accordance with the requirements for ventilation in the BASIX Specification.	✓	✓	✓
Glazing and shading			
The applicant must install the glazing and shading set out below:			
· North sector: 31 square metres of clear, single glass, shaded by 600-1100 mm eave/projection	✓	✓	✓
· East sector: 16 square metres of clear, single glass, shaded by min 600 mm eave/projection	✓	✓	✓
· South sector: 22 square metres of clear, single glass	✓	✓	✓
· West sector: 12 square metres of toned, double glass, shaded by min 1800 mm eave/projection	✓	✓	✓
The areas specified above for glazing are the maximums permitted.			
Note: 5% of total glazing in the development is exempt from the shading requirements referred to above.			
The glazing and shading referred to in this commitment must meet the requirements set out in the BASIX Specification.	✓	✓	✓
The applicant must construct the dwelling so that a minimum of 50% of the glazing has aluminium frames.	✓	✓	✓
Required insulation and roof colours			
The applicant must construct the dwelling in accordance with the following insulation requirements:			
· External walls: insulation with an R-value of R1.5 must be added to the brick veneer walls or, alternatively, these walls must have an R-value of R1.7. Insulation is not required in walls adjacent to a garage or the external walls of a garage.		✓	✓
· External walls: insulation with an R-value of R1.5 must be added to the timber, weatherboard or cement sheet walls or, alternatively, these walls must have an R-value of R1.7. Insulation is not required in walls adjacent to a garage or the external walls of a garage.		✓	✓
· Ceilings: insulation with an R-value of R2.5 must be added to each ceiling which has a roofspace over it, except ceilings directly above a garage. (If a roof is insulated with a foil-backed blanket, then the R-value of the insulation to be added to the ceiling under that roof may be reduced by R0.5).		✓	✓
The applicant must construct the dwelling so that all roofs are light coloured, as defined in the BASIX Specification.		✓	✓
The applicant must install the following roof ventilation system in the dwelling: wind-driven ventilator. This system must comply with the BASIX Specification.		✓	✓
Energy			
Active cooling			
The applicant must install a three phase a/c system - (EER between 2.5 - 3.0), or one with a higher EER, for living areas of the dwelling.		✓	✓
The bedrooms (as constructed) must not incorporate any active cooling system or any ducting which is designed to accommodate		✓	✓

any active cooling system.			
Active heating			
The applicant must install a three phase a/c system - (EER between 2.5 - 3.0), or one with a higher EER, for living areas of the dwelling.		✓	✓
The bedrooms (as constructed) must not incorporate any active heating system or any ducting which is designed to accommodate any active heating system.		✓	✓
Hot water			
The applicant must install the following hot water system in the development: solar (electric boosted).	✓	✓	✓
Lighting			
The applicant must install standard or compact fluorescent lighting as the primary type of artificial light in each of the following rooms:			
· the kitchen		✓	✓
· the garage		✓	✓
· the laundry		✓	✓
The applicant must install a window in the kitchen of the dwelling for natural lighting.	✓	✓	✓
The applicant must install a window in each bathroom and toilet in the development for natural lighting.	✓	✓	✓
Cooking			
The applicant must install a gas cooktop & electric oven in the kitchen of the dwelling.		✓	
Design enhancements			
The applicant must construct each refrigerator space in the development so that it is well ventilated, as defined in the BASIX Specification.		✓	
The applicant must install a fixed outdoor clothes drying line as part of the development.		✓	

END BASIX COMMITMENTS

1. In these commitments, "applicant" means the person carrying out the development.
2. Commitments identified with a ✓ in the "DA plans" column must be shown on the plans accompanying the development application for the proposed development.
3. Commitments identified with a ✓ in the "CC/CDC plans and specs" column must be shown in the plans and specifications accompanying the application for a construction certificate / complying development certificate for the proposed development.
4. Commitments identified with a ✓ in the "OC" column must be certified by a certifying authority as having been fulfilled, before a final occupation certificate for the development may be issued.

BASIX Report

The following scores have been achieved for this development:

Water 51 % [redacted]

Thermal PASS

Energy 29 % [redacted]

	Score	Appliance score	Total
Water	51	5.9	57
Energy	29	0.0	29

These scores are based on the following commitments relating to appliances:

Appliance Selections

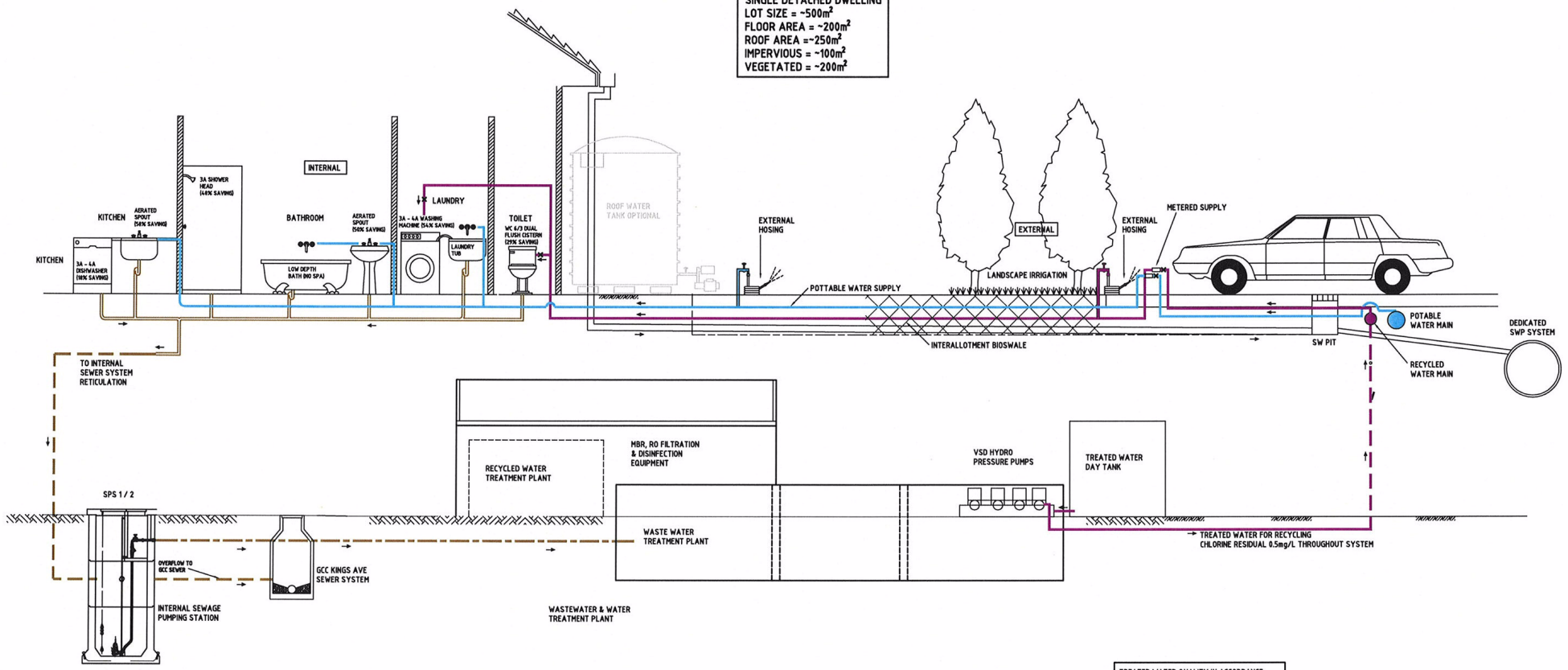
Clothes washer

The applicant must install a clothes washer with a minumum water efficiency rating of 3A in the dwelling.

Dishwasher

The applicant must install a dishwasher with a minumum water efficiency rating of 4A in the dwelling.

END APPLIANCE SELECTIONS



TREATED WATER QUALITY IN ACCORDANCE WITH NSW HEALTH CURRENT GUIDELINES FOR SEWAGE RECYCLING (CIRCULAR 2004/71)

E.coli	<1/100 ml
Total Coliform	<10/100 ml
Virus	<2/250 L
Cryptosporidium	<1/50 L
Giardia	<1/50 L
Turbidity	<2 NTU
pH	6.5-8.0
BOD_5	<10 mg/L
SS	<10 mg/L
Disinfection	0.5 mg/L FAC

OPTION 1

RECYCLED WATER - LAUNDRY & WC FLUSHING & OUTDOOR
(NO ROOF TANK REQUIRED - OPTIONAL)

DATE PLOTTED: 23 June, 2005 - 8:53am

REV	DATE	REVISIONS	D.B.	L.A.B.
1		PRELIMINARY	DRN	CHK

CLIENT:

DESIGNED: L.A.B.
DRAWN: D.B.
CHECKED: L.A.B.
RECOMMENDED: PROJECT MANAGER DATE
DATUM: AHD
A1
COORDINATE SYSTEM:
APPROVED: PROJECT DIRECTOR DATE

Cardno
Cardno (NSW) Pty Ltd
ABN: 95 001 145 035
Suite 34, 207 Albany Street North, Gosford, NSW Australia 2250
Phone (+61 2) 4323 2558 Fax (+61 2) 4324 3251
Email: ccc@centralcoast.cardno.com.au Web: www.cardno.com.au

POTABLE WATER & WASTEWATER SCHEMATIC

PROPOSED "PARKSIDE" DEVELOPMENT

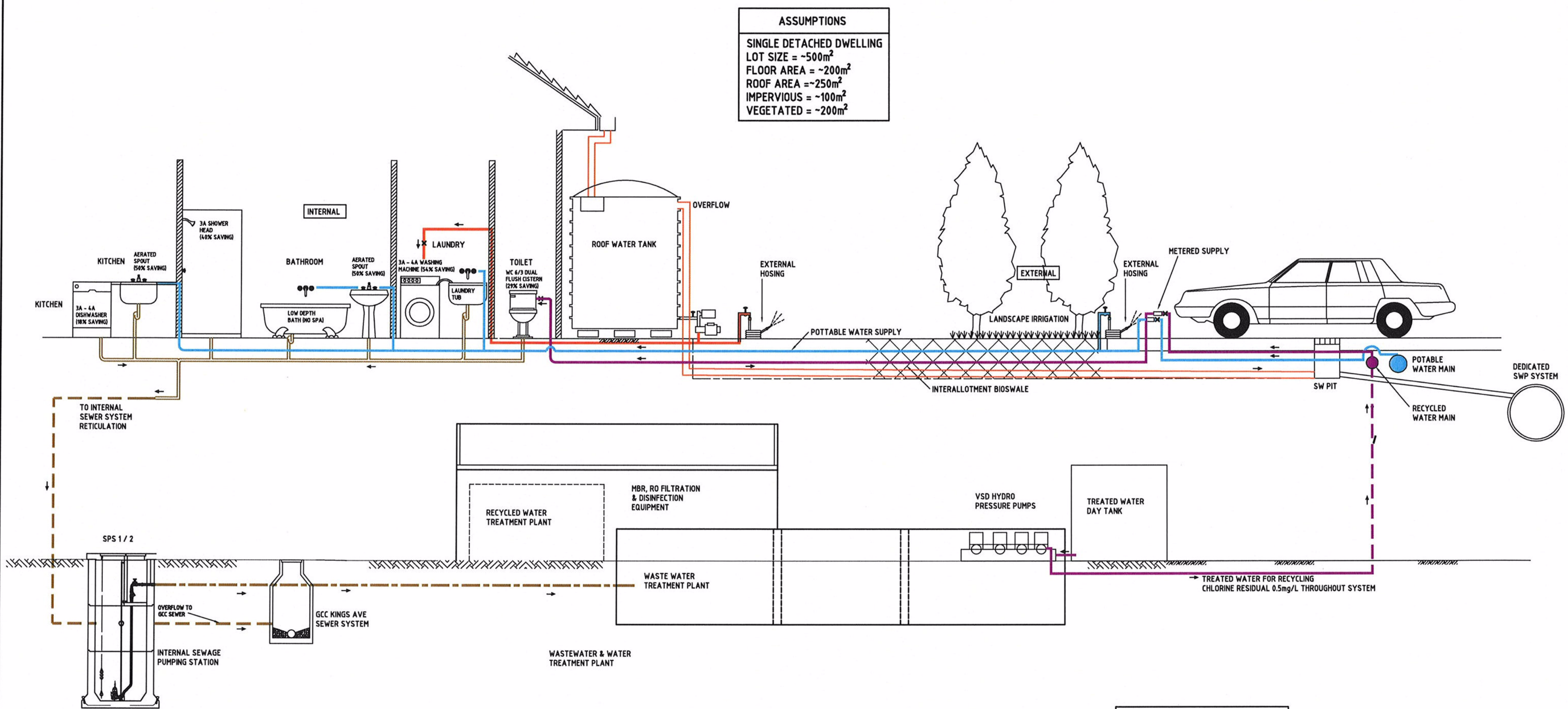
at: KINGS AVE TERRIGAL
for: CRIGHTON PROPERTIES

DRAWING STATUS: PRELIMINARY

DRAWING NUMBER: 89020904-001

REV: 1

0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150mm A1 ON ORIGINAL



ASSUMPTIONS
SINGLE DETACHED DWELLING
LOT SIZE = ~500m^2
FLOOR AREA = ~200m^2
ROOF AREA = ~250m^2
IMPERVIOUS = ~100m^2
VEGETATED = ~200m^2

OPTION 2

RECYCLED WATER - WC FLUSHING ONLY
ROOF WATER TANK - LAUNDRY & OUTDOOR

TREATED WATER QUALITY IN ACCORDANCE WITH NSW HEALTH CURRENT GUIDELINES FOR SEWAGE RECYCLING (CIRCULAR 2004/71)

E.coli	<1/100 ml
Total Coliform	<10/100 ml
Virus	<2/250 L
Cryptosporidium	<1/50 L
Giardia	<1/50 L
Turbidity	<2 NTU
pH	6.5-8.0
BOD_5	<10 mg/L
SS	<10 mg/L
Disinfection	0.5 mg/L FAC

REV	DATE	REVISIONS	DRN	CHK
1		PRELIMINARY	D.B.	L.A.B.

CLIENT:

DESIGNED: L.A.B.
DRAWN: D.B.
CHECKED: L.A.B.
RECOMMENDED:
PROJECT MANAGER DATE

DATUM: AHD | A1
COORDINATE SYSTEM:
APPROVED:
PROJECT DIRECTOR DATE

Cardno
Cardno (NSW) Pty Ltd
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Email: cco@centralcoast.cardno.com.au Web: www.cardno.com.au

POTABLE WATER & WASTEWATER SCHEMATIC

PROPOSED "PARKSIDE" DEVELOPMENT

at: KINGS AVE TERRIGAL
for: CRIGHTON PROPERTIES

DRAWING STATUS: PRELIMINARY
DRAWING NUMBER: 89020904-002
REV: 1

A1 ON ORIGINAL

DATE PLOTTED: 23 June, 2005 - 8:53am
XREF's:
CAD FILE: P:\8902_09 - Crighton Properties\89020904_Kings_Ave\Acad\Civil\basix-2.dwg

APPENDIX B

Sewerage

REV	DATE	REVISIONS	DRN	CHK
2	23/06/05	MOVED POSITION OF STP	D.B.	L.A.B.
1	19/05/05	PRELIMINARY - FOR INFORMATION ONLY	D.B.	L.A.B.

CLIENT:

DESIGNED L.A.B.
DRAWN D.B.
CHECKED L.A.B.
RECOMMENDED
PROJECT MANAGER DATE
DATUM AHD
A1
COORDINATE SYSTEM
APPROVED
PROJECT DIRECTOR DATE

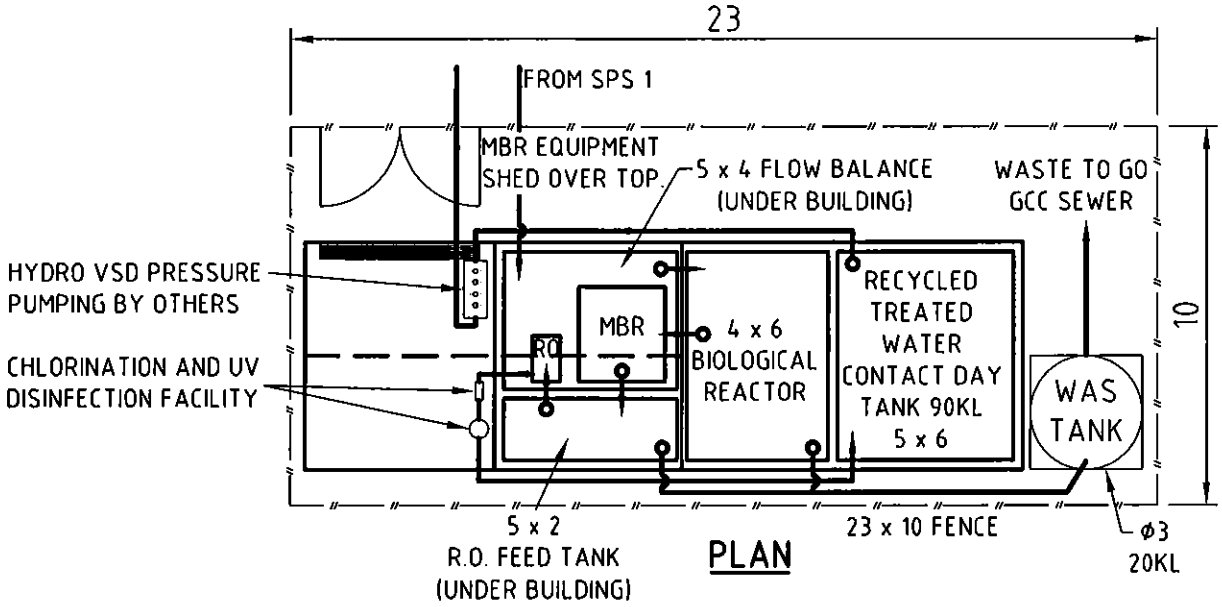
Cardno MBK
Cardno MBK (NSW) Pty Ltd
ABN 95 001 145 035
Suite 31, 207 Albany Street North, Gosford, NSW Australia 2250
Phone 61 2 4323 2558 Fax 61 2 4324 3251
Email cca@centralcoast.cardno.com.au Web www.cardno.com.au

CONCEPT SEWER RETICULATION

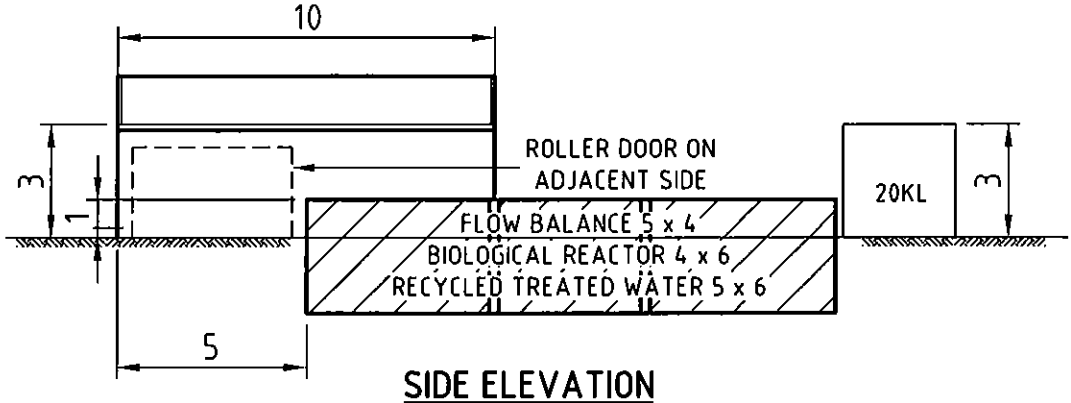
PROPOSED RESIDENTIAL DEVELOPMENT
AT: KINGS AVENUE
TERRIGAL N.S.W.
FOR: CRIGHTON PROPERTIES

DRAWING STATUS: PRELIMINARY
DRAWING NUMBER: SKETCH 1
REV 2

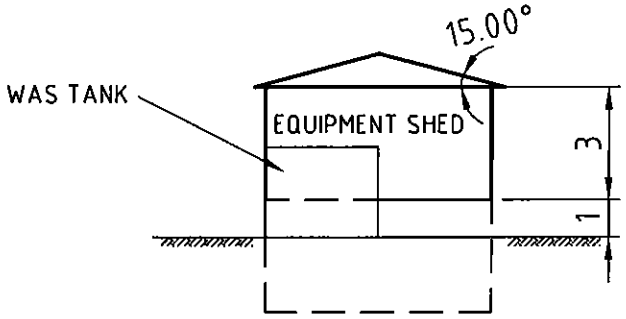
A1 ON ORIGINAL



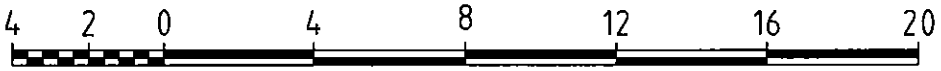
PLAN



SIDE ELEVATION



END ELEVATION



SCALE OF METRES (1:200 AT A1 SHEET BEFORE REDUCTION)

PRELIMINARY
FOR INFORMATION ONLY

Rev	DATE	REVISIONS	Drn	Chk
1	19/05/05	REVISIONS	D.B.	L.A.B

WASTE WATER/WATER TREATMENT PLANT

PROPOSED RESIDENTIAL DEVELOPMENT
at: KINGS AVENUE
TERRIGAL N.S.W
for: CRIGHTON PROPERTIES

DATE: 19/05/05
DGN: L.A.B.
DRN: D.B
CHK: L.A.B.
REC:
APP:

Cardno
Cardno (NSW) Pty Ltd
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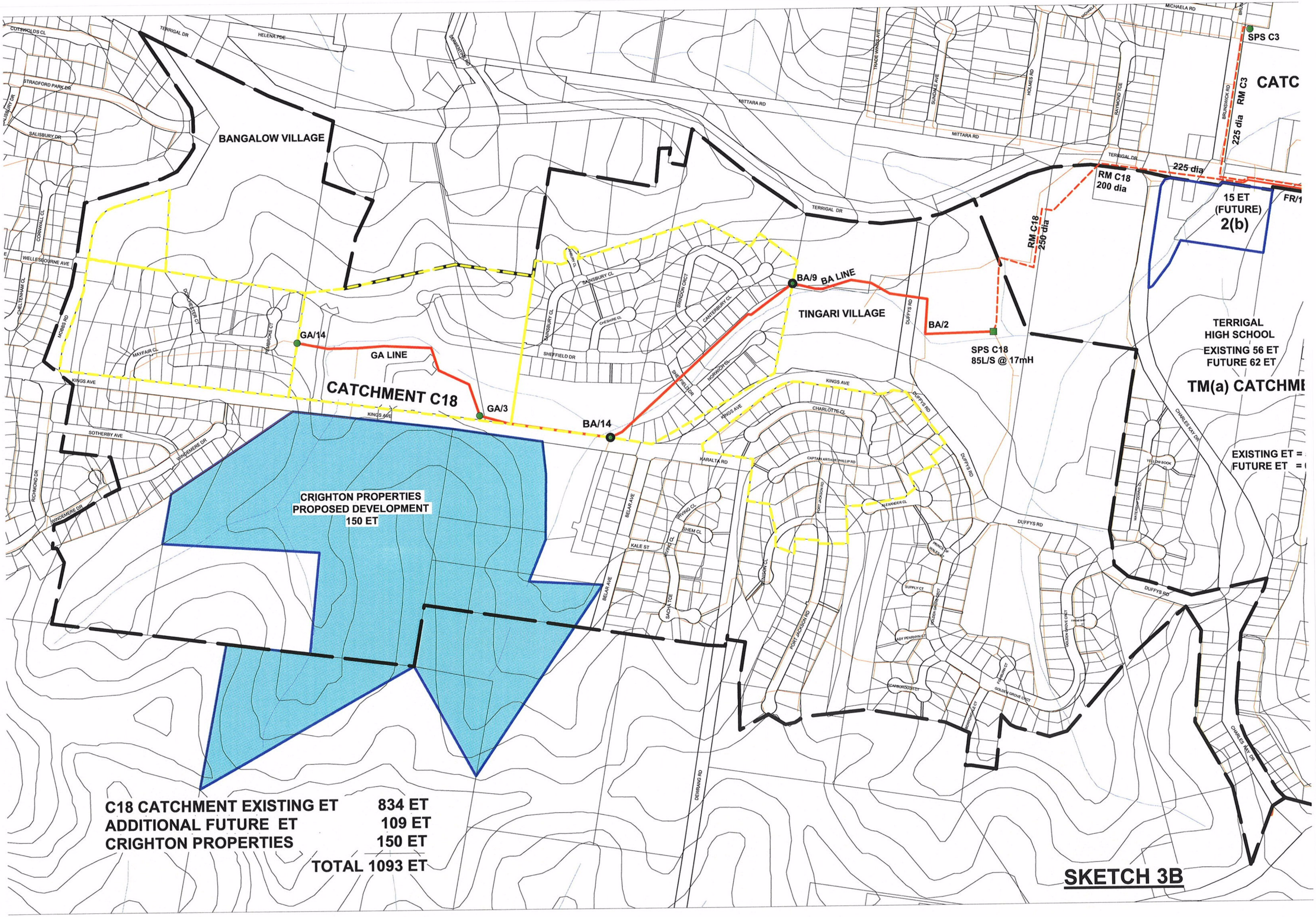
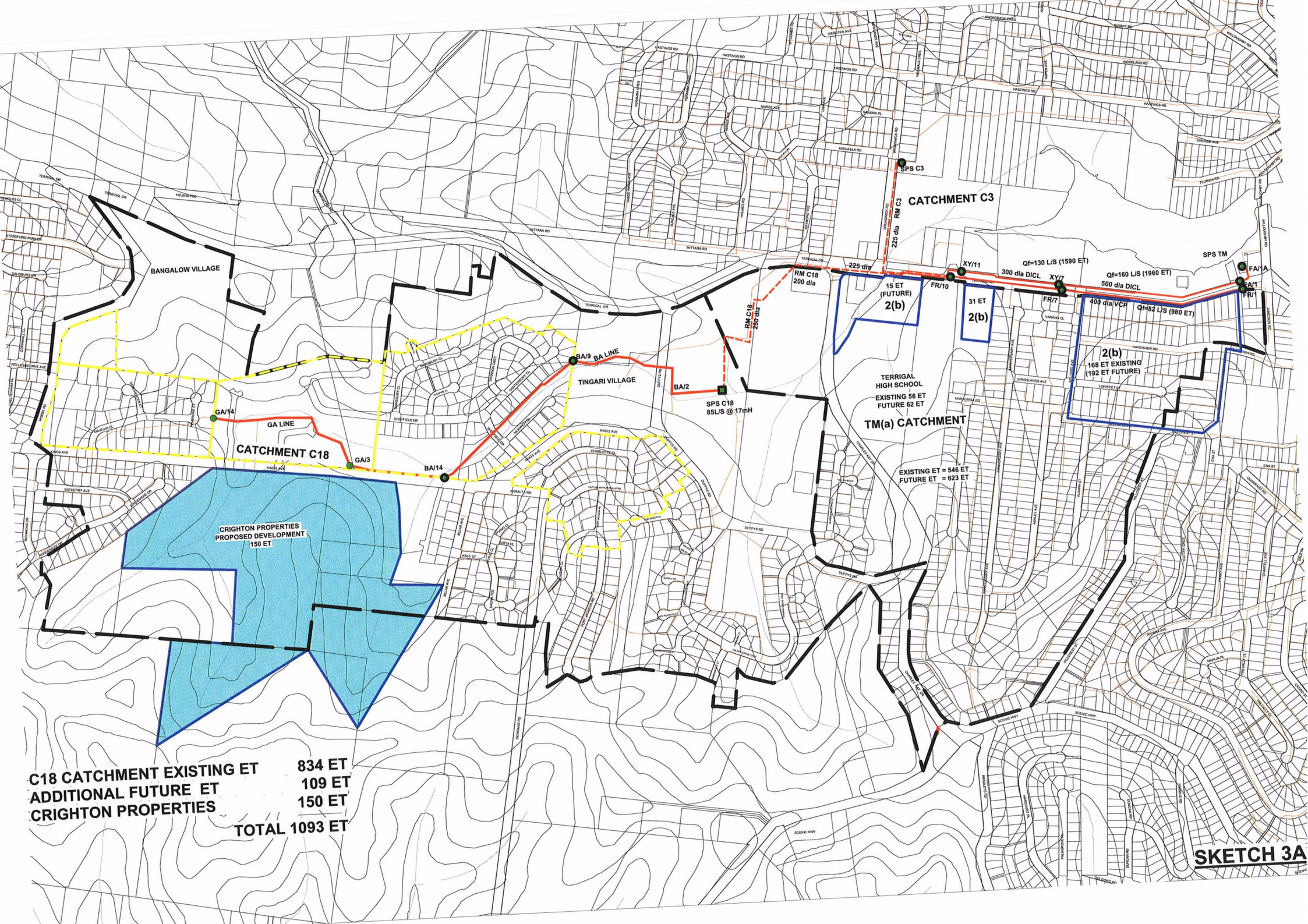
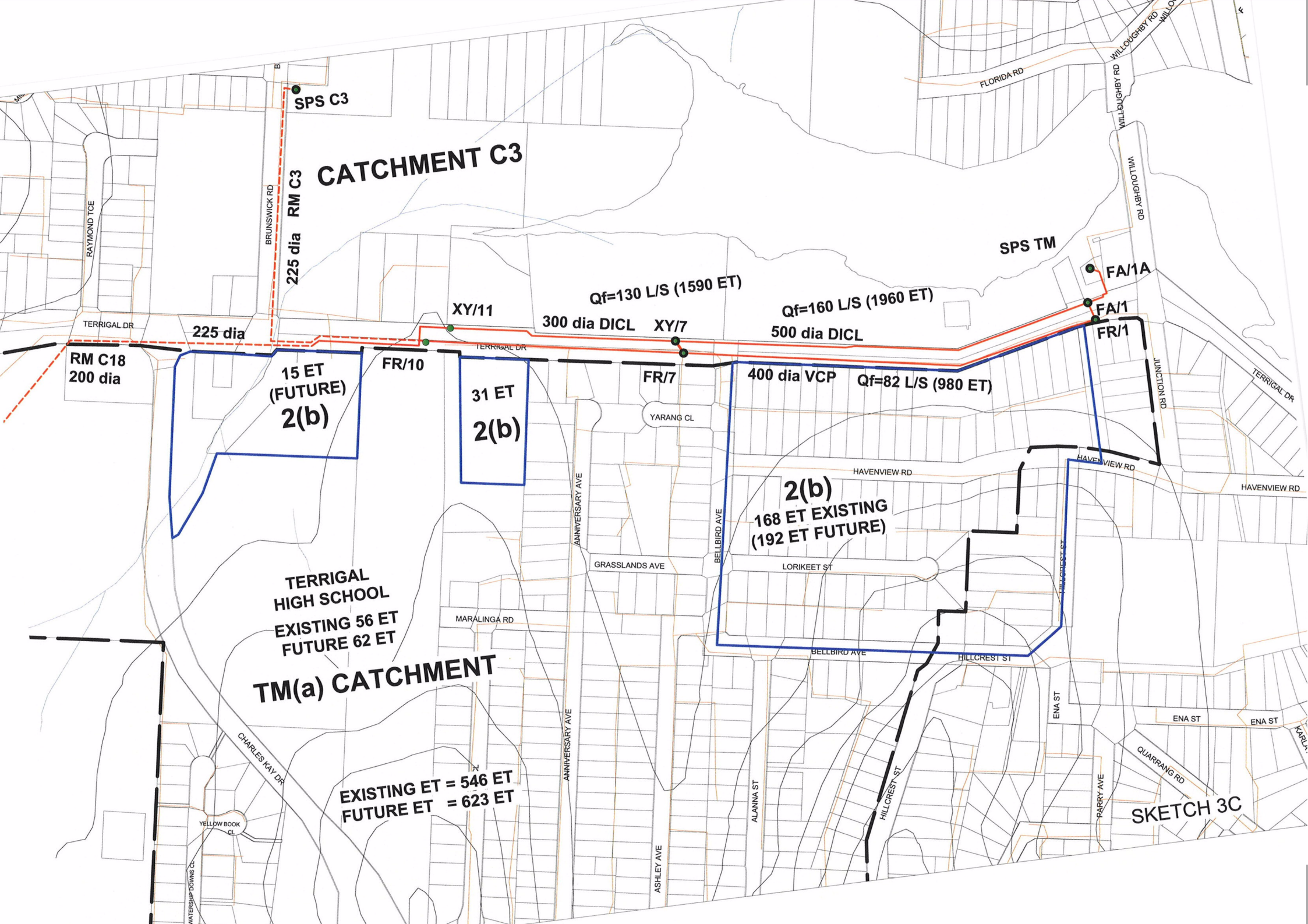
Gosford, NSW Australia 2250
Phone (+61 2) 4323 2558 Fax (+61 2) 4324 3251

DRAWING No: SKETCH 2
Rev 1


BANGALOW VILLAGE
CATCHMENT C18
GA/14
GA LINE
GA/3
BA/14
BA/9
BA LINE
TINGARI VILLAGE
BA/2
SPS C18
85L/S @ 17mH
RM C18
250 dia
RM C18
200 dia
225 dia
RM C3
225 dia
SPS C3
CATC
15 ET
(FUTURE)
2(b)
FR/1
TERRIGAL
HIGH SCHOOL
EXISTING 56 ET
FUTURE 62 ET
TM(a) CATCHME
EXISTING ET =
FUTURE ET =
CRIGHTON PROPERTIES
PROPOSED DEVELOPMENT
150 ET
C18 CATCHMENT EXISTING ET 834 ET
ADDITIONAL FUTURE ET 109 ET
CRIGHTON PROPERTIES 150 ET
TOTAL 1093 ET
SKETCH 3B


BANGALOW VILLAGE
TERRIGAL DR
MITTARA RD
HASTINGS RD
SPS C3
CATCHMENT C3
RM C3
225 dia
RM C18
200 dia
RM C18
250 dia
225 dia
XY/11
Qf=130 L/S (1590 ET)
300 dia DICL
XY/7
Qf=160 L/S (1960 ET)
500 dia DICL
SPS TM
FA/1A
FA/1
FR/1
FR/7
FR/10
15 ET
(FUTURE)
2(b)
31 ET
2(b)
400 dia VCP
Qf=82 L/S (980 ET)
2(b)
168 ET EXISTING
(192 ET FUTURE)
TERRIGAL
HIGH SCHOOL
EXISTING 56 ET
FUTURE 62 ET
TM(a) CATCHMENT
EXISTING ET = 546 ET
FUTURE ET = 623 ET
BA/9
BA LINE
TINGARI VILLAGE
BA/2
SPS C18
85L/S @ 17mH
GA/14
GA LINE
CATCHMENT C18
GA/3
BA/14
CRIGHTON PROPERTIES
PROPOSED DEVELOPMENT
150 ET
C18 CATCHMENT EXISTING ET 834 ET
ADDITIONAL FUTURE ET 109 ET
CRIGHTON PROPERTIES 150 ET
TOTAL 1093 ET
SKETCH 3A


SPS C3
CATCHMENT C3
225 dia RM C3
RAYMOND TCE
BRUNSWICK RD
TERRIGAL DR
225 dia
RM C18
200 dia
15 ET
(FUTURE)
2(b)
FR/10
XY/11
Qf=130 L/S (1590 ET)
300 dia DICL
XY/7
TERRIGAL DR
FR/7
31 ET
2(b)
SPS TM
FA/1A
FA/1
FR/1
Qf=160 L/S (1960 ET)
500 dia DICL
400 dia VCP
Qf=82 L/S (980 ET)
FLORIDA RD
WILLOUGHBY RD
JUNCTION RD
TERRIGAL DR
YARANG CL
HAVENVIEW RD
HAVENVIEW RD
HAVENVIEW RD
2(b)
168 ET EXISTING
(192 ET FUTURE)
ANNIVERSARY AVE
BELLBIRD AVE
GRASSLANDS AVE
LORIKEET ST
HILLCREST ST
TERRIGAL
HIGH SCHOOL
EXISTING 56 ET
FUTURE 62 ET
MARALINGA RD
TM(a) CATCHMENT
BELLBIRD AVE
HILLCREST ST
ENA ST
ENA ST
ENA ST
CHARLES KAY DR
EXISTING ET = 546 ET
FUTURE ET = 623 ET
ANNIVERSARY AVE
ASHLEY AVE
ALANNA ST
HILLCREST ST
PARRY AVE
QUARRANG RD
YELLOW BOOK CL
WATERSHIP DOWNS CL
SKETCH 3C