SUTHERLAND SHIRE WATERCOURSE ASSESSMENT & REHABILITATION PRIORITISATION

VOLUME 2

CHAPTER 4

PORT HACKING CATCHMENT PROFILE

2012

appliedecology
appliedecology.com.au

DOCUMENT VERIFICATION

Project Title	**Sutherland Shire Watercourse Assessment & Rehabilitation Prioritisation**
Document Title	**Port Hacking Catchment Profile**
Description	**Final report**
Client	**Sutherland Shire Council**
Client contact	**Ms Shelley Reed**

Revision	Prepared by	Reviewed by	Date
A	AC MB	SR	May 2011
B	MB AC	JS	Dec 2012
C			
0			

ACKNOWLEDGMENTS

APPLIED ECOLOGY Pty Limited wishes to thank all representing organisations who contributed to the production or commented on the content of this report, including:

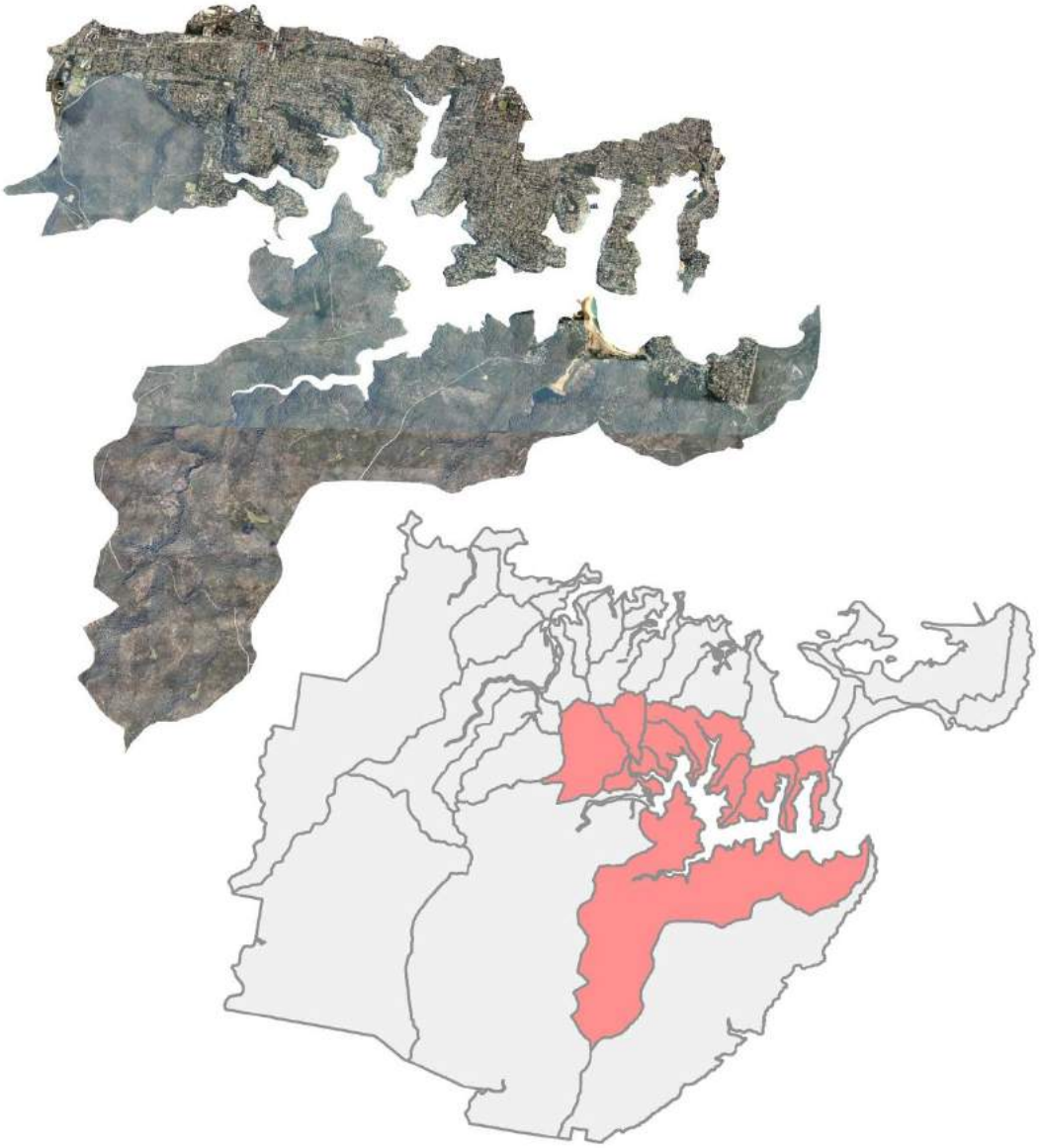
Shelley Reed, Rosemary Kearney, Christine Guthrie Sutherland Shire Council

CONTENTS: CHAPTER 4

Chapter 4 PORT HACKING CATCHMENT

CATCHMENT OVERVIEW

CATCHMENT AREA: 56.8 KM^2



WATERWAYS

SUMMARY OF DRAINAGE SYSTEM

Port Hacking catchment includes nine sub-catchments:

SOUTH WEST ARM
NORTH WEST ARM
GUNNAMATTA BAY
BURRANEER BAY
TURRIELL BAY
GYMEA BAY
YOWIE BAY
DENTS CREEK
SAVILLE CREEK

MAJOR NAMED WATERWAYS

ALCHERINGA GULLY
BLACK GULLY
BUNDEENA CREEK
BUNDEENA GUL
COONONG CREEK
DENTS CREEK
KAREENA CREEK
SAVILLES CREEK
YOWIE GULLY

TOTAL LENGTH OF MAPPED WATERWAYS: 38.3 KMs

PRIMARY CREEKS: 5 KMs

SECOND ORDER CREEKS: 22.7KMs

FIRST ORDER & MINOR DRAINAGE LINES: 8.3 KMs

OPEN DRAINS: 2.3 KMs

NUMBER OF SQIDS: 76

Most of the streams in the subcatchments are first and second order streams that drain directly to Port Hacking. The exception is North West Arm subcatchment, which includes a third order stream formed by the confluence of Dents and Saville Creeks. Hacking River discharges into this catchment but forms a separate catchment management unit within Sutherland Shire.

GEOLOGY, GEOMORPHOLOGY AND SOILS

The area is made up of the sandstones that outcrop frequently in the Sydney region. Port Hacking, because of its sheltered nature, is protected from the high energy waves that strike the shore along the exposed coastline outside. The resulting platforms and cliffs are not as strongly developed as elsewhere along the Sydney coast.

The sandstone mass of the coastal area was gently pushed up to form a plateau of several hundred metres elevation some millions of years ago. Erosion by a small river carved a gorge into the plateau at this site, cutting down to the lower sea level of the glacial era. As sea level rose after the glacial, the valley became a bay. Today, numerous streams drain the remaining expanses of the eroded plateau.

In general, the soils developed on sandstone are of low fertility. Despite this, they are able to support a considerable variety of native vegetation that has developed upon them. Soils on plateau land are often up to 2m deep. On sandstone ridges soils are generally sandy podsols interspersed with pockets of derived clay. Clay Ridges and Plateaus also have deep soils derived from Wianamatta clay and supports rich land producing good quality forest. Much of this has been cleared historically for farming, and more recently for urban expansion.

Fire has been identified as one of the processes involved in landform change in sandstone areas of the Sydney Basin. Fire kills grass, exposing soil to removal by rain. Fire passing over an area also heats rock, causing fragments to flake off the surface. Less frequently, but also importantly, tree trunks smoulder on the ground for several days, causing a deeper weakening of the rock below.

Summary Characteristics for Soil Classifications

Gymea (gy): Undulating to rolling rises and low hills on Hawkesbury Sandstone with local relief 20-80m, slopes 10-25%, and rock outcrops <25%. Broad convex crests, moderately inclined side slopes with wide benches, localised rock outcrop on low broken scarps. Vegetation includes extensively cleared open forest (dry sclerophyll) and eucalypt woodland. Soils are shallow to moderately deep (30-100cm) Yellow Earths and Earthy Sands on crests and insides of benches, shallow (<20cm)Siliceous Sands on leading edges of benches, localised Gleyed Podzolic Soils and Yellow Podzolic Soils on shale lenses, and shallow to moderately deep (<1m) Siliceous Sands and Leached Sands along drainage lines. Limitations for use of these soils include localised steep slopes, high soil erosion hazard, rocky outcrops, shallow highly permeable soil and very low soil fertility (Hazelton & Tille, 1990).

Disturbed Terrain (xx): Occurs within other landscapes and is mapped as xx. The topography varies from level plains to undulating terrain, and has been disturbed by human activity to a depth of at least 1m. The original soil has been removed, greatly disturbed or buried. Most of these areas have been levelled to slopes of <5%. Landfill includes oils, rock, building and

waste material, and the original vegetation has been completely cleared. Limitations for this soil 'type' are dependent on the nature of fill material, and may result in a mass movement hazard (subsidence), soil impermeability leading to poor drainage, low fertility and toxic material (Hazelton & Tille, 1990).

Hawkesbury (ha): Rugged, rolling to very steep hills on Hawkesbury Sandstone with local relief 100-200m, slopes >25%, and surface rock >50%. Narrow crests and ridges, narrow incised valleys, steep sideslopes with narrow rocky benches, broken scarps and boulders. Vegetation is mostly uncleared eucalypt woodland, open forest (dry sclerophyll) and tall open forest (wet sclerophyll). Soils are shallow (<50cm) discontinuous Lithosols/Siliceous Sands associated with rocky outcrops, Earthy Sands, Yellow Earths and locally deep sands on inside of benches and along joints and fractures, localised Yellow and Red Podzolic Soils associated with shale lenses, and Siliceous Sands on narrow valley flats. Limitations for use include extreme soil erosion hazard, mass movement (rock fall) hazard, steep slopes, rocky outcrops, shallow, stony, highly permeable soil, and very low soil fertility (Hazelton & Tille, 1990).

Blacktown (bt): Gently undulating rises on Wianamatta Group shale with local relief to 30m, and slopes are usually <5%. Broads rounded crests and ridges with gently inclined slopes. Vegetation has been almost completely cleared, but originally was eucalypt woodland, open forest and tall open forest (wet sclerophyll). Soils are shallow to moderately deep (<150cm) Red Podzolic Soils and Brown Podzolic Soils on crests, upper slopes and well drained areas, deep (1.5-3m) Yellow Podzolic Soils and Soloths on lower slopes and in drainage depressions and localised areas of poor drainage. Limitations include moderately reactive, highly plastic subsoils, and low soil fertility (Hazelton & Tille, 1990).

Mangrove Creek (mc): Level to gently undulating tidal flats/mudflats, mangrove and saltmarsh on Quarternary Marine sediments. Local relief and elevation is <3m, slope gradients <3%. Regularly inundated by tidal waters. Vegetation includes mangrove open scrub, saltmarsh herbfield, sedgeland and low open forest. Soils are deep (>2m) waterlogged Calcareous Sands and Siliceous Sands on mangrove flats, with deep (>2m) Calcareous Sands, occasional Siliceous Sands and Humic Gley Soils on saltmarsh and forest flats. Use of these soils is limited by regular tidal flooding and water logging, acid sulphate potential, saline soils, and very low soil fertility (Hazelton & Tille, 1990).

Lucas Heights (lh): Gently undulating crests, ridges and plateau surfaces of the Mittagong Formation with alternating bands of shale and fine-grained sandstones. Local relief is 10-50m, and slopes <10%. Rock outcropping is absent. Vegetation comprises extensively to completely cleared dry sclerophyll low open forest and low woodland. Soils are moderately deep (50-150cm) hardsetting Yellow Podzolic Soils and Yellow Soloths on ridges and plateau surfaces, Lateritic Podzolic Soils on crests, Yellow Earths on shoulders of plateaus and ridges, and Earthy Sands in valley flats. Limitations for use include stoniness, hardsetting surfaces, and low soil fertility (Hazelton & Tille, 1990).

Bundeena (bu): Very low rolling rises on exposed Hawkesbury Sandstone coastal headlands, with local relief up to 80m and slope gradients <20%. Ridges and crests are broad, up to 200m wide, and gently inclined slopes with occasional benches are up to 50m wide. Small swamps and seepage areas are common on benches and along drainage lines. Rocky outcrops occur over 30-50% of the land surface. Soils are Siliceous Sands and Earthy Sands occurring on benches, with Yellow Earths on midslope and Gleyed Podzolic Soils on lower slopes. Acid peats occur in areas of poor drainage. Limitations to use include high erosion hazard, highly permeable soils, very low soil fertility and seasonally high watertables (Hazelton & Tille, 1990).

Kurnell (kn): Gently undulating to rolling coastal dunefields and relict dunes. Local relief to 15m, slope gradients 1-10%. Dunes are generally north-south oriented with convex narrow crests, broad (1000-2000m) gently inclines concave swales and isolated swamps. Vegetation includes extensive heathland. Soils are deep (>2m) Podzols on dunes and in swales, with Organic Acid Peats in swamps. Limitations to use include extreme wind erosion hazard, highly permeable soils, very low fertility and localised permanently high water tables (Hazelton & Tille, 1990).

Yarrawarrah (ya): Undulating to rolling, low, broad-benched hills on Hawkesbury Sandstone associated with the staged planation of the Woronora Plateau. Ridges, hillcrests, valleys and drainage depressions are broad. Benches contain sedgeland, swamps and prominent sandstone outcrops. Vegetation includes low open woodland, shrubland, wet heath and sedgeland. Soils are Lateritic Yellow Earths and Lateritic Podzolic Soils on crests. Shallow (<20cm) Siliceous Sands/Lithosols are associated with rocky outcrops. Moderately deep Earthy Sands occur on benches. Localised Yellow Podzolic Soils and Gleyed Podzolic Soils in seasonally waterlogged areas, and Acid Peats in drainage depressions. Limitations for use include high erosion hazard, generally shallow soils with low wet bearing strength, highly permeable soils and seasonally high watertables, and very low fertility (Hazelton & Tille, 1990).

SUMMARY OF CONTAMINATION ISSUES

The entire extent of Port Hacking has been mapped as Acid Sulphate soils Class 1, with areas of Class 2, 3 and 4 in a number of nearby terrestrial regions. The absence of extensive industrial activities in the catchment has meant that contaminants are largely restricted to mobilised sediments, litter and organic matter, and waste material from unmaintained or poorly maintained septic systems. Concerns have been expressed regarding the mobilisation of leachates from Helensburgh coal mine and tip, which may be discharged to Port Hacking via Hacking River.

LAND USE

HISTORIC LAND USE

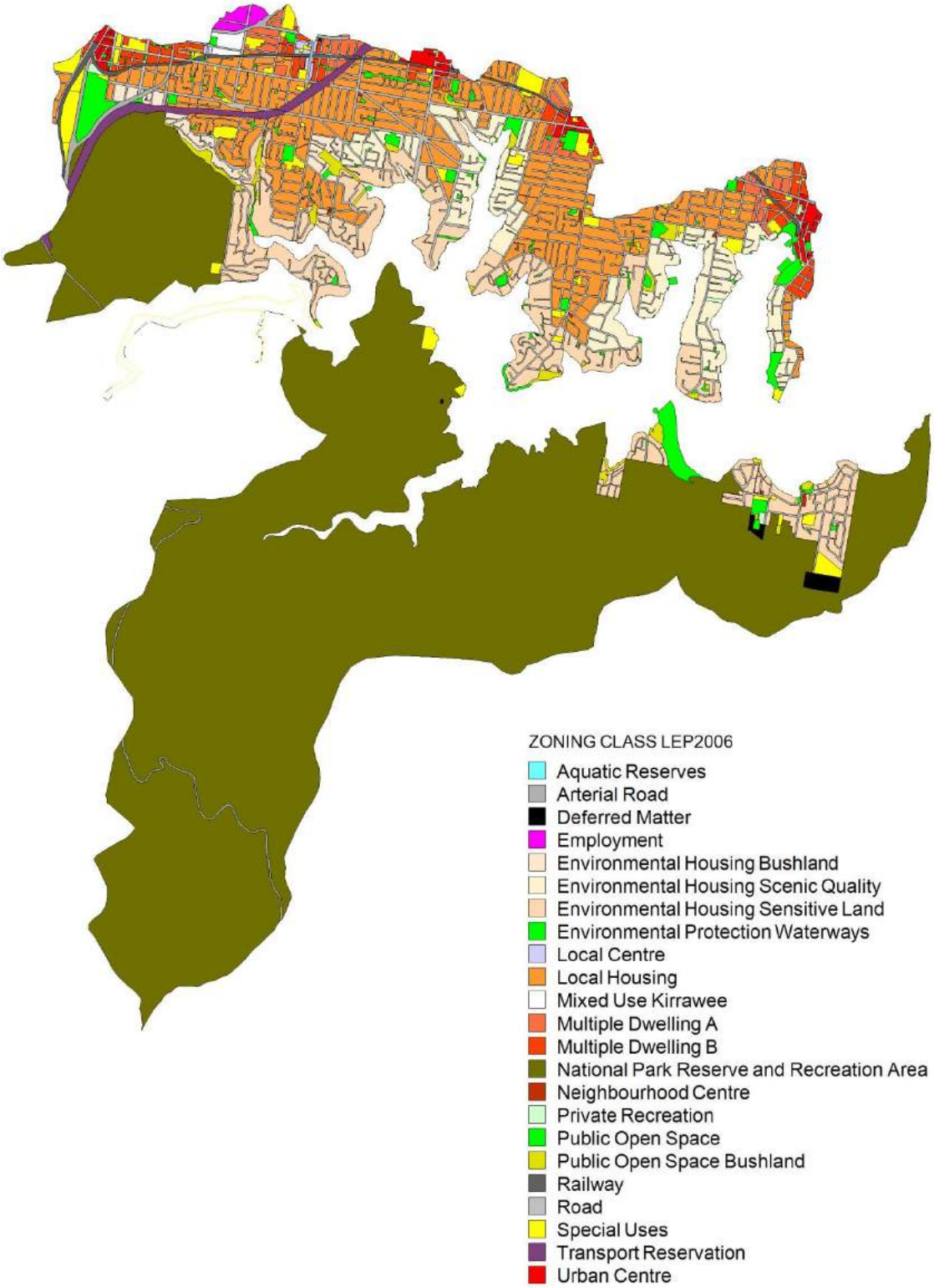
Prior to the arrival of European settlers, the Port Hacking region was relatively fertile, rich in food and water, and was more densely populated than more inland areas. Populations were estimated at five to ten people per square mile (Morris, 1979). The local aborigines were from the Dharawal tribe, and they called Port Hacking Deeban. The Port Hacking clans lived in smaller territorial groups of families that were related through kinship and marriage. They relied on hunting and gathering for food, which included land mammals, birds, fish and whales, along with a range of plant derived foods.

The port was described by Bass and Flinders in 1796 as very shallow, and with few places suitable for shipping (Kavanagh, 2004). In 1827 Robert Dixon, Assistant Surveyor to the colony, was directed to map all the branches of the port, and in particular to note the extent of the sand shoals and the direction of the main channel.

In 1856, however, the first permanent European settlers in the Port Hacking area reported that there was no permanent aboriginal settlement remaining (Morris, 1979). Rock paintings and carvings still exist today in many locations throughout Royal National Park, on the southern side of Port Hacking. Axe grinding and tool sharpening grooves provide evidence of daily life, along with extensive middens, often found near rock shelters.

By 1920 the main channel of Port Hacking had silted up. As a result, the original ferry service between Simpson's Hotel and Little Turriell Point was abandoned. It was replaced by two services from Cronulla, one to Simpson's Hotel (abandoned due to silting in the 1940s) and the other to Hordern's Beach at Bundeena.

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATHCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	11.63	0%	0%	0.00
Environmental Housing Sensitive Land	405.78	7%	43%	174.48
Environmental Housing Scenic Quality	232.44	4%	57%	132.50
Environmental Housing Bushland	35.30	1%	57%	20.12
Local Housing	539.88	10%	51%	266.81
Multiple Dwelling A	45.13	1%	64%	28.88
Multiple Dwelling B	58.77	1%	64%	37.40
Mixed Use Kirrawee	8.83	0%	64%	5.65
Urban Centre	33.40	1%	94%	31.31
Local Centre	5.03	0%	88%	4.36
Neighbourhood Centre	3.13	0%	86%	2.69
Employment	11.81	0%	95%	11.22
Special Uses	97.62	2%	38%	30.15
Public Open Space	89.47	2%	5%	4.47
Public Open Space Bushland	45.77	1%	0%	0.00
Private Recreation	4.29	0%	5%	0.21
Environmental Protection Waterways	27.40	0%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	3520.79	62%	0%	0.00
Railway	29.15	1%	33%	19.75
Arterial Road/Road	430.62	8%	66%	261.32
Transport Reservation	43.39	1%	5%	2.17
TOTAL	5679.60	100%	18%	1033.49

VEGETATION COMMUNITIES

Overview of vegetation

Port Hacking is surrounded by a wide variety of terrain, ranging from coastal cliffs broken by beaches and small inlets to an ancient high plateau broken by extensive and deep river valleys. The geology of the area consists mostly of the Triassic Hawkesbury Sandstone with some sections of the surrounding environment having the more recent and richer Wianamatta shale capping. Deep below the Hawkesbury sandstone belt lies Narrabeen Sandstones and Shales which includes a mixture of shale and sandstone that contain untapped coal seams which run right through Sydney and are mined extensively where they come closer to the surface south of Sutherland Shire. Sections of recent alluvium fringes of estuarine watercourse where the endangered ecological communities; Swamp Oak Floodplain Forest and Swamp Sclerophyll Woodlands grow still.

Coastal Heathland

On the more exposed sections of coast is Coastal Heathland, characterized by hardy, low-growing, salt-tolerant shrubs that spread across rocky, hard terrain with very little topsoil. The sea coast itself is composed mostly of high cliffs reaching heights up to one hundred metres towards the south. The heathlands are a hotspot for many small birds such as the beautiful New Holland Honeyeater.

Common vegetation of exposed Coastal Heathland on sandstone includes Coastal Rosemary (*Westringia fruticosa*), Darwinia (*Darwinia fascicularis* ssp. *fascicularis*), Bracelet Honey-myrtle (*Melaleuca armillaris*), Scrub-oak (*Allocasuarina distyla*), White Kunzea (*Kunzea ambigua*), Sundew (*Drosera spathulata*), Grass Trees (*Xanthorrhoea* spp.), Ridged Heath-myrtle (*Baeckea imbricata*),Snakehood Orchids (*Pterostylis* sp.), prostrate forms of Coast Banksia (*Banksia integrifolia*) and Long-Leaf Matrush (*Lomandra longifolia*).

Common vegetation on top of the ancient sand dunes includes Silver Banksia (*Banksia marginata*), Scrub-oak (*Allocasuarina distyla*), Silky Hakea (*Hakea sericea*) and Pine Heath

(*Astroloma pinifolium*). Sections of rare and threatened clifftop grasslands occur along exposed and windy sites which are generally dominated by Long-leaf Mat-Rush (*Lomandra longifolia*) and Kangaroo Grass (*Themeda australis*). Many heath specialist birds are present, including Lewin Honeyeater (*Meliphaga lewinii*), New Holland Honeyeater (*Phylidonyris novaehollandiae*), Beautiful Firetail (*Stagonopleura bella*), Chestnut-rumped Heathwren (*Hylacola pyrrhopygia*) and the Southern Emu-wren (*Stipiturus malachurus*).

Littoral Rainforest

Littoral rainforest is often destroyed during coastal development, but has survived in Royal National Park near Bundeena where it can be seen growing behind Jibbon Beach. This remnant patch comprises a typical Tuckeroo (*Cupaniopsis anarcoides*) forest under grown by Coastal Tea Tree (*Leptospermum laevigatum*) and Long-Leaf Matrush (*Lomandra longifolia*).

Exposed Uplands

Away from Port Hacking and its tributary streams the terrain rises to a series of very rocky ridges and plateaus characterized by hardy, low-growing shrubs and very poor, rocky soil. These ridges are the remnants of an ancient, much larger plateau that has been deeply eroded into an extensive series of river valleys. This specific ridge land habitat is particularly significant for Sydney as it has been historically unprotected and destroyed to make way for cheap development. As a result, many species that are only found on ridges are now threatened with extinction.

Valley Sides

On the sides of the steep river valleys that punctuate the uplands the terrain changes to exposed rock with collected pockets of soil. Although still fairly rocky, a large number of eucalyptus and other tree species are prevalent. Small streams are to be found reasonably frequently and understory plants cohabitate with the larger trees, although the terrain is still fairly open and easy to move through. Tree heights in this area reach an average maximum of about ten metres. While the plant mix and geography conditions in this area are typical of NSW coastal areas, many widespread genera have highly localized species that are conserved in the Royal National Park. This sort of habitat is one of the most floristically diverse in Sydney Basin.

Factors that shape this habitat are bushfires, low phosphorus/nitrogen levels, intense summer heat and low water levels. The result is a diverse floristic assembly of flora and fauna with different evolutionary responses to fire in similar habitats. Scribbly gums (*Eucalyptus racemosa, E. sclerophylla, E. haemastoma*) have smooth barked trees in a manner which reduces their chance of catching on fire while stringy barks (*Eucalyptus* sp.) have bark which easily catches alight clearing the way for its fire-stimulated seedlings.

Common species in this environments include Smooth-barked Apple (*Angophora costata*), Sydney Peppermints (*Eucalyptus piperita*), Port Jackson Pine (*Callitris rhomboidea*), Red Bloodwoods (*Corymbia gummifera*), *Pomaderris* sp., Old Man Banksia (*Banksia serrata*), Hairpin Banksia (*Banksia spinulosa*), Rock Banksia (*Banksia oblongifolia*), Sydney Boronia (*Boronia ledifolia*), Native Sarsaparilla (*Smilax glyciphylla*), False Sarsaparilla (*Hardenbergia violacea*), Dusky Coral Pea (*Kennedia rubicunda*), Hop Bush (*Dodonaea triquetra*), and Native Pea (*Dillwynia sieberi*). Less frequent species include Dwarf Apple (*Angophora hispida*), parasitic Devils Twine (*Cassytha* sp.), Native Panic (*Entolasia stricta*), Saw Sedges (*Lepidosperma* spp.), Forest Grass Trees (*Xanthorrhoea arborea*), Sydney Waratah (*Telopea speciosissima*), Flannel Flowers (*Actinotus minor* and *A. helianthi*), Bluberry Ash (*Elaeocarpus reticulatus*), Silky Hakea (*Hakea sericea*), Variable Bossiaea (*Bossiaea heterophylla*), Bonnet Orchids (*Cryptostylis erecta*), Hyacinth Orchids (*Dipodium variegatum, D. punctatum, D. roseum*), *Pomax umbellata*, Native Parsley (*Lomatia silaifolia*), edible Native Currants (*Leptomeria acida*), Broad Leaved Geebungs (*Persoonia levis*), Sydney Golden Wattles (*Acacia longifolia*), Gymea Lilies (*Doryanthes excelsa*), She-oaks (*Allocasuarina littoralis, A. distyla, A. verticillata*), Flax Leafed Wattle (*Acacia linifolia*), Bracken (*Pteridium esculentum*), Grey Spider Flower (*Grevillea buxifolia, G. sphacelata*), Red Spider Flower (*Grevillea oleoides*), Pink Spider Flower (*Grevillea sericea*) and Native iris (*Patersonia sericea, P. glabrata, P. longifolia*) to literally name a few of the hundreds of beautiful flora encountered in this diverse and widespread habitat. Certain hybrid species may be encountered such as the common *Banksia ericifolia x spinulosa* or the rare *Angophora costata x hispida*. Birds that frequent this habitat include Golden Whistlers (*Pachycephala pectoralis*),Yellow-tailed Black Cockatoos (*Calyptorhynchus funereus*), Laughing Kookaburra (*Dacelo novaeguineae*), Eastern Whip Birds (*Psophodes olivaceus*), New Holland Honey Eaters (*Phylidonyris novaehollandiae*), Eastern Spinebill (*Acanthorhynchus tenuirostris*), Rufous Whistler (*Pachycephala rufiventris*), Willie Wagtails (*Rhipidura leucophrys*), Superb Fairy Wrens (*Malurus cyaneus*), Crimson Rosella/Mountain Lowry (*Platycercus elegans*), Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*) and White-browed Scrubwrens (*Sericornis frontalis*).

Figure 1 *Angophra costata* open forest with *Doryanthes excelsa* dominating the ground stratum.

Valley Floors

With rich soils and good supply of water the valley floors are cooler and more humid than any other part of the park. Larger tree species such as Australian Cedar (*Toona cilliata,* previously *T. australis*) and the large eucalypt species dominate. Trees reach 50 metres or more and a rich understory of fern, wattles, and other medium-size plants proliferate. Some small areas are classified as temperate rainforest. These areas are characterized by dense groves of very large trees including the iconic Port Jackson Fig (*Ficus rubiginosa*) and Moreton Bay Fig (*Ficus macrophylla*) trees. The absence of light leads to a limited diversity in the undergrowth other than a profusion of ferns.

Impressive groves of Turpentine (*Syncarpia glomulifera*) and Blackbutt (*Eucalyptus pilularis*) trees may be seen growing straight up into the sky forming an open canopy with widely spaced trunks. These areas are generally considered open forest, and may have a grassy understory, a sclerophyll shrubbery or a rainforest subcanopy with a rainforest understory that is more dense nearer to the valley floor or permanent watercourses. In these turpentine forests numerous Cabbage Palms (*Livistona australis*) grow in dense tall thickets which are rarely touched by fire or they may exist as young plants in open grassy spaces which are burnt regularly enough not to form visible trunks. Rainforest pockets are dominated by Jackwood (*Cryptocarpa glaucescens*) and Sassafras (*Doryphora sassafras*). The Lilli Pilli (*Acmena smithii*) produces a fruit edible raw. Another common species is the Coachwood (*Ceratopetalum apetalum*) which were used extensively from Australian rainforests to manufacture horse-drawn coaches.

Birds distinctive to these rich rainforest habitats include Topknot Pigeons (*Lopholaimus antarcticus*), Green Catbirds (*Ailuroedus crassirostris*), Rufous Fantails (*Rhipidura rufifrons*) and Black-faced Monarchs (*Monarcha melanopsis*). Two other birds often encountered in dense scrub or rainforest include the flightless Brush Turkey (*Alectura lathami*) and the Superb Lyre Bird (*Menura novaehollandiae*), well known for its capacity to mimic nearly everything it hears.

Riparian Forest/Scrub

In a zone generally up to 10-25m away from running water grows a distinct vegetation community that includes a number of rare or threatened species only found along a limited number streams in the area. Common vegetation growing in Riparian Forests include Blackbutts (*Eucalyptus pilularis*), Smooth-barked Apples (*Angophora costata*), Water Gums (*Tristanopsis laurina*), Bottlebrush (*Callistemon* sp.), Tea Trees (*Leptospermum* sp.), Woolsia (*Woolsia pungens*), Coastal Heath (*Epacris* sp.), Heath Banksia (*Banksia ericifolia*), Sweet Pittosporum (*Pittosporum undulatum*), Pine Leafed Geebungs (*Persoonia pinifolius*), Willow Leaved Hakea (*Hakea salicifolia*), *Lomandra Fluviatilis*, Bulrushes (*Typha orientalis, T. dominigensis*), Rushes (*Juncus* spp.), Reeds (*Phragmites australis*) and Tree Ferns (*Cyathea* sp, *Dicksonia* sp).

Mangroves and Saltmarsh

Mudflats are widespread along much of the shoreline of Port Hacking, sustaining mangroves and saltmarsh throughout the estuary, with the occasional clump of stunted tree on the seaward coastline in sheltered coves. Mangroves are almost exclusively the Grey Mangrove (Avicennia marina var. australasica) growing up to 4m, with the River Mangrove (Aegiceras corniculatum) found on the shoreward edge of mangrove forests or in the brackish upstream end of Port Hacking estuary.

These mangroves are important nursery grounds for nearly all major angling fish including Yellowfin Bream (*Acanthopagrus australis*), Flat-tail Sea-Mullet (*Liza argentea*), Luderick (*Girella tricuspidata*) and Sand Whiting (*Sillago ciliata*). Mangroves provide rich organic matter to the estuary by fixing carbon into the river system through the breakdown of leaves in the thick rich black mud. Many crustacean and mollusc species rely on mangroves as a source of food whether by providing foraging through leaf litter, mud or direct predation of the mangrove trees and seeds.

Dozens of different bird species may be seen foraging in the rich mudflats in and around mangrove flats many of these birds being threatened with extinction and protected by international agreements. Commonly seen bird species include Eastern Curlews (*Numenius madagascariensis*), Striated Herons (*Butorides striatus*), Brown Honeyeaters (*Lichmera indistincta*), Little Egrets (*Egretta garzetta*), Royal Spoonbills (*Platalea regia*), White-faced Grey Herons (*Egretta novaehollandiae*), Australasian Little Bitterns (*Ixobrychus dubius*), Pied Oyster Catchers (*Haematopus longirostris*), Australasian Pelican (*Pelecanus conspicillatus*), Sacred Ibis (*Threskiornis molucca*), Chestnut Teal (*Anas castanea*) and Azure Kingfishers (*Alcedo azurea*).

Summary list of vegetation communities

Much of the vegetation on the northern side of Port Hacking has been cleared and replaced with urban development. Remaining vegetation is largely restricted to remnant patches of:

- Sydney Sandstone Gully Forest (most common remnants, found along drainage gullies and coastal shores behind mudflats)
- Sydney Sandstone Ridgetop Woodland (minor patches on higher ground)
- Littoral Rainforest (at the southern ends of peninsulars)
- River Flat Eucalypt Forest (upstream end of Gunnamatta Bay)

In the northwestern part of the Port Hacking catchment more of the original vegetation remains, including:

- Sydney Sandstone Gully Forest (common along drainage gullies and coastal shores behind mudflats)
- Sydney Sandstone Ridgetop Woodland (common on higher ground)
- Littoral Rainforest (at the southern ends of Grays Point and Gymea Bay peninsulars)
- Mangroves (in shallow areas of North West Arm)

Most of the southern side of Port Hacking has its original vegetation conserved in Royal National Park, with the exception of two suburban inholdings at Bundeena and Maianbar. The diversity of vegetation communities in this part of the catchment is greater, reflecting a similar composition to what would have been expected on the northern shore. Vegetation communities immediately south of Port Hacking include (EEC denotes Endangered Ecological Communities; NSW Threatened Species listings, 2011):

- Sydney Sandstone Gully Forest (common along drainage gullies and coastal shores behind mudflats)
- Sydney Sandstone Ridgetop Woodland (common on higher ground)
- Littoral Rainforest EEC (common in patches along much of the shoreline)
- Coastal Dune Heath (patches at the eastern end of the estuary)
- Kurnell Dune Forest EEC (patches behind mangroves at the eastern end of the estuary)
- Sydney Freshwater Wetlands EEC (small patches perched on sandstone shelves)
- Swamp Oak Floodplain Forest EEC (associated with creeks and freshwater wetlands)
- Swamp Sclerophyll Forest EEC (associated with creeks and freshwater wetlands)
- Coastal Saltmarsh EEC (patches on shallow marine areas, usually in protected bays)
- Mangroves (in shallow areas, especially around the delta areas of creeks)

SIGNIFICANT VEGETATION

MAPPED VEGETATION COMMUNITIES OF PORT HACKING CATCHMENT

- Littoral Rainforest
- Sydney Freshwater Wetland
- Swamp Sclerophyll Forest
- Kurnell Dune Forest
- Mangrove
- Sydney Turpentine Ironbark Forest
- River-Flat Eucalypt Forest
- Coastal Saltmarsh
- Sydney Sandstone Ridgetop Woodland
- Coastal Dune Heath
- Sydney Sandstone Gully Forest
- Swamp Oak Floodplain Forest

LEP 2006 SIGNIFICANT VEGETATION

LEP TAG	NAME	CLASS
T23	*Ficus Rubiginosa*_Port Jackson Fig Tree	Significant Group of Trees or Vegetation
T35	Eucalyptus	Significant Group of Trees or Vegetation
T34	*Eucalyptus microcorys*_Tallowood	Significant Group of Trees or Vegetation
T33	Eucalyptus	Significant Group of Trees or Vegetation
T36	*Eucalyptus racemosa*_ghost gum	Significant Group of Trees or Vegetation
T37	*Eucalyptus pilularis*_Blackbut	Significant Group of Trees or Vegetation
T38	*Eucalyptus pilularis*_Blackbut	Significant Group of Trees or Vegetation
T39	*Eucalyptus pilularis*_Blackbut	Significant Group of Trees or Vegetation
T41	*Angophora Costata*_3	Significant Group of Trees or Vegetation
T52	Street tree	Significant Group of Trees or Vegetation
T55	*Angophora costata*_smooth bark Angophora	Significant Group of Trees or Vegetation
T56	*Eucalyptus racemosa*_Ghost gum	Significant Group of Trees or Vegetation
T56	*Eucalyptus racemosa*_Ghost gum	Significant Group of Trees or Vegetation
T57	*Ulmus pervifolia*_Chinese elm	Significant Group of Trees or Vegetation
T58	*Eucalyptus racemosa*_Ghost gum	Significant Group of Trees or Vegetation
T59	*Angophora costata*_smooth bark Angophora	Significant Group of Trees or Vegetation
T61	*Quercus robur*_English Oak	Significant Group of Trees or Vegetation

THREATENED SPECIES: FLORA RECORDS

Records of threatened flora species in Port Hacking catchment during the last 30 years include (from NSW Wildlife Atlas, 2011; accessed March, 2011):

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
Prostanthera densa	Villous Mint-bush	V
Eucalyptus camfieldii	Heart-leaved Stringybark	V
Eucalyptus scoparia	Wallangarra White Gum	E1
Syzygium paniculatum	Magenta Lilly Pilly	V
Melaleuca deanei	Deane's Paperbark	V

THREATENED SPECIES: FAUNA RECORDS

Records of threatened bird species in Port Hacking catchment during the last 30 years include (from NSW Wildlife Atlas, 2011; accessed March, 2011):

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
Pyrrholaemus saggitatus	Speckled Warbler	V
Circus assimilis	Spotted Harrier	V
Pandion haliaetus	Osprey	V
Botaurus poiciloptilus	Australasian Bittern	V
Burhinus grallarius	Bush Stone-curlew	E1
Cacatua leadbeateri	Major Mitchell's Cockatoo	V
Ptilinopus superbus	Superb Fruit-Dove	V
Haematopus fuliginosus	Sooty Oystercatcher	V
Haematopus longirostris	Pied Oystercatcher	E1
Xanthomyza phrygia	Regent Honeyeater	E1
Daphoenositta chrysoptera	Varied Sittella	V
Puffinus assimilis	Little Shearwater	V
Glossopsitta porphyrocephala	Purple-crowned Lorikeet	V
Lathamus discolor	Swift Parrot	E1
Polytelis swainsonii	Superb Parrot	V
Ninox strenua	Powerful Owl	V
Tyto novaehollandiae	Masked Owl	V
Tyto tenebricosa	Sooty Owl	V

Records of threatened mammal species in Port Hacking catchment during the last 30 years include (from NSW Wildlife Atlas, 2011; accessed March, 2011):

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
Cercartetus nanus	Eastern Pygmy-possum	V
Dugong dugon	Dugong	E1
Arctocephalus forsteri	New Zealand Fur-seal	V
Phascolarctos cinereus	Koala	V
Pteropus poliocephalus	Grey-headed Flying-fox	V
Chalinolobus dwyeri	Large-eared Pied Bat	V

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V
Myotis macropus	Southern Myotis	V
Scoteanax rueppellii	Greater Broad-nosed Bat	V

Records of threatened frog, reptile and invertebrate species in Port Hacking catchment during the last 30 years include (from NSW Wildlife Atlas, 2011; accessed March, 2011):

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
Heleioporus australiacus	Giant Burrowing Frog	V
Pseudophryne australis	Red-crowned Toadlet	V
Chelonia mydas	Green Turtle	V
Hoplocephalus bungaroides	Broad-headed Snake	E1
Varanus rosenbergi	Rosenberg's Goanna	V
Menippus fugitivus	Grays Point Beetle	E2

THREATENING PROCESSES

Summary of impacts

Key issues for Port Hacking catchment are the mobilisation of sediments that increase the sediment loading. While this is traditionally a shoaled estuary with limited deepwater access, the rate of delivery of sediment has increased with ongoing urban development. Poor management of waste material, including litter, organic matter and human wastes, and its subsequent movement into the estuary contribute to the cumulative effects of this type of impact.

Hacking River discharges to Port Hacking at the western end of the estuary. This river conveys leachates from Helensburgh tip/landfill site and from Helensburgh Coal Mine. Serious concerns have been expressed about the adequacy of management of these leachates at the source. Potential impacts may exist for Port Hacking as the receiving environment.

Use of motorised water craft is associated with the discharge of untreated sewage directly into the river, along with petrol and oil residue, anti-fouling treatments containing heavy metals, litter and galley wastes. Anchors and propellers damage seagrasses, disturb sediments, and help to spread invasive species.

GUNNAMATTA BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 2.2 KM^2

SUBURBS: CRONULLA

WATERWAYS

MAJOR NAMED WATERWAYS: NIL

TOTAL LENGTH OF MAPPED WATERWAYS: 0.1 KMs

PRIMARY ORDER CREEKS: 0. KMs

SECOND ORDER CREEKS: 0 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.1 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

One site was sampled in the Gunnamatta Bay subcatchment:

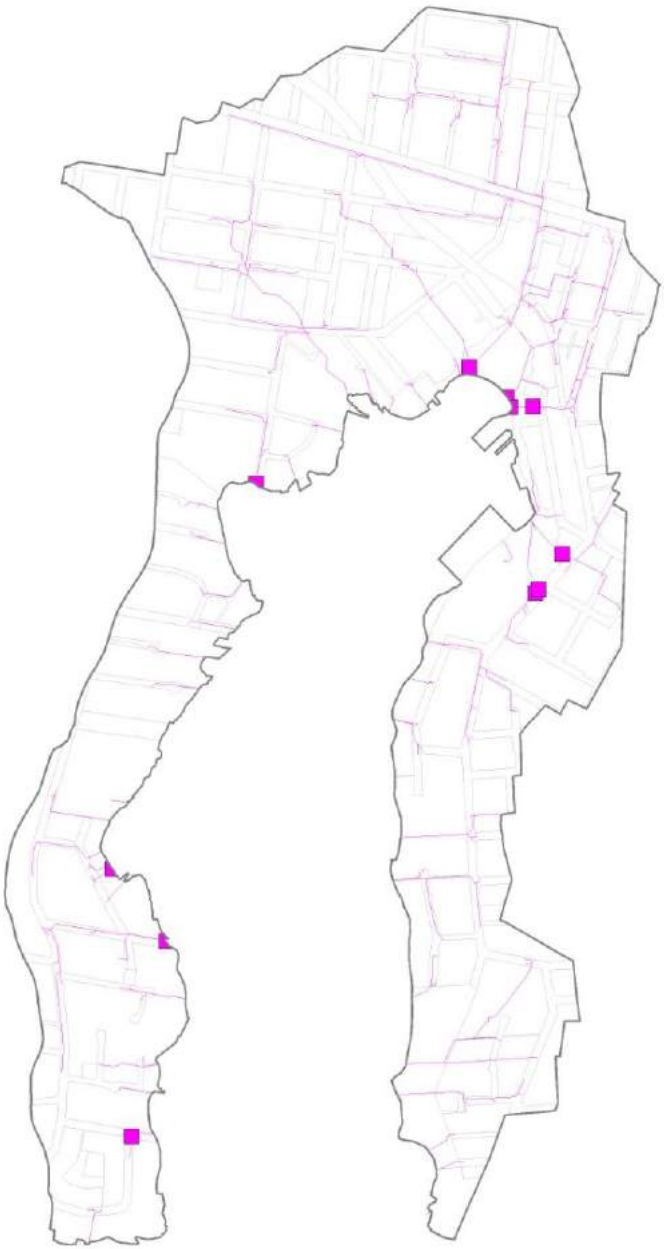
1. Tonkin Park GPT, Gunnamatta Bay

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	=
SUMMER 00 +/- ANZECC 2000 values	+	-	+	-	-
TREND ↓↑	↓	↓	↓	↓	↓

PARAMETER	Enterococci	Grease	TN	TP	TSS
SUMMER 95 +/- ANZECC 2000 values	+	=	+	-	+
SUMMER 00 +/- ANZECC 2000 values	+	-	+	-	-
TREND ↓↑	↑	↓	↓	↑	↓

A number of parameters showed an increase in values during the survey period, notably enterococci and total phosphorus which were consistently outside ANZECC 2000 guideline values. Decreases in values for other parameters were reported, many of which were within guideline values at the end of the survey period.

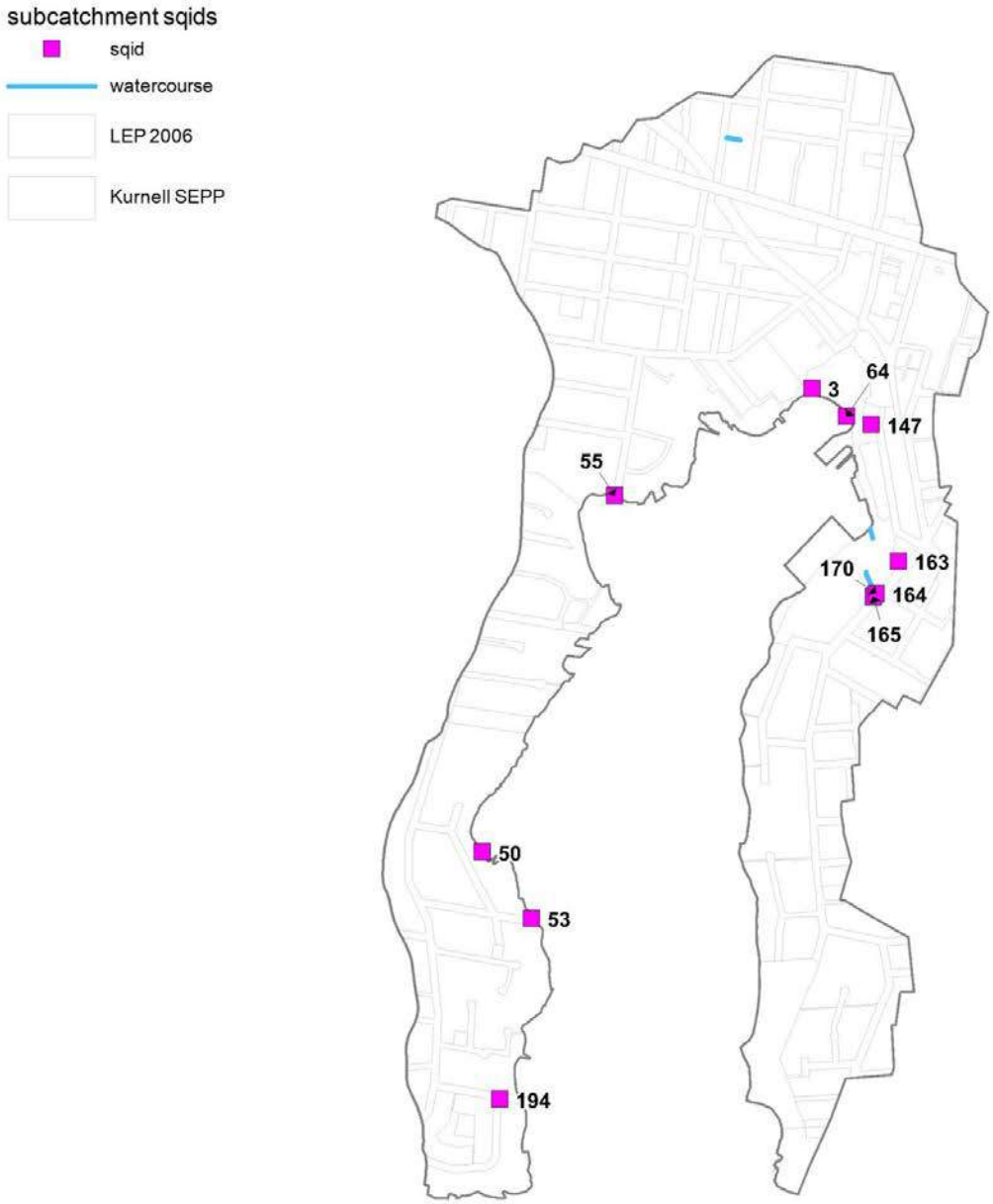
RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	DEVICE CATEGORY	DEVICE TYPE	LOCATION	SITE DESCRIPTION	SUBURB	APPROX. CATCHMENT
3	GPT	GPT	Deeban Walk	Tonkin Park	Cronulla	58.6 Ha
53	GPT - Other	Trash Rack	Lugano Avenue	Lugano Avenue Ramp	Burraneer	6 Ha
55	GPT - Other	Trash Rack	Gunnamatta Road	End of road, in park	Woolooware	3.6 Ha
64	End of pipe trap	Nettech Device	Tonkin Street	Seawall (middle)	Cronulla	2.7 Ha
50	GPT - Other	Trash Rack	Bulls Road	At the back of property	Burraneer	1 Ha
147	GPT - Other	Ecosol GPT	Tonkin Street	Reserve	Cronulla	4.4 Ha
163	GPT	Ecosol GPT	Nicholson Parade	Gunnamatta Park	Cronulla	4.1 Ha
165	GPT	Ecosol GPT	Nicholson Parade	Gunnamatta Park	Cronulla	3.9 Ha
170	GPT - Other	Litter Basket	Nicholson Parade	Gunnamatta Park	Cronulla	0.05 Ha
194	GPT	Ecosol GPT	Eurabalong Rd	Cnr of Rutherford Ave and Eurabalong Rd in reserve	Burraneer	2.5 Ha
213	End of pipe trap	Nettech Device	Tonkin Street	Next to boat ramp	Cronulla	

LOCATION OF SQIDS



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Gunnamatta Bay subcatchment is situated entirely on Gymea Soil Landscape (gy), with a small area of Disturbed Terrain (xx) around Cronulla (from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations in Geology and Soils section for Port Hacking catchment).

TOPOGRAPHY

The typical height of the subcatchment is less than 30m ASL dropping steeply to 2m ASL at Port Hacking.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 1	7.90
CLASS 2	1.97
CLASS 3	2.38
CLASS 5	182.31

Most of the Gunnamatta Bay subcatchment is classified as Class 5, with minor areas of Class 3 ASS/PASS at Darook Park, Gunnamatta Park, and below Bay Lane. Class 2 ASS/PASS occurs at Tonkin Oval and Class 1 soils are associated with foreshore areas.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

Gunnamatta is a Dharawal word meaning “place of beach and sandhills”, and was originally used for the whole Cronulla area. The bay was first noted in 1827 by Robert Dixon, but remained quite isolated for many years, other than the occasional visit from a steamer gathering shells for lime production (Lawrence, 1997). In the early 1900s waterfront land became available under the Holt-Sutherland Estate free selection terms. Land was offered for sale at public auction and the area was proclaimed a village in 1899.

Around 1900 John Want opened a fish hatchery at Cabbage Tree Bay, near Bundeena. A few years later he opened another fish hatchery at Hungry Point, on the eastern side of Gunnamatta Bay. Most of this peninsular had been set aside for defence purposes in 1874, but this was subdivided and sold in 1895, except for 7 acres which were to become the State Fish Hatcheries, and later home to NSW State Fisheries Research Centre. In 1907 the

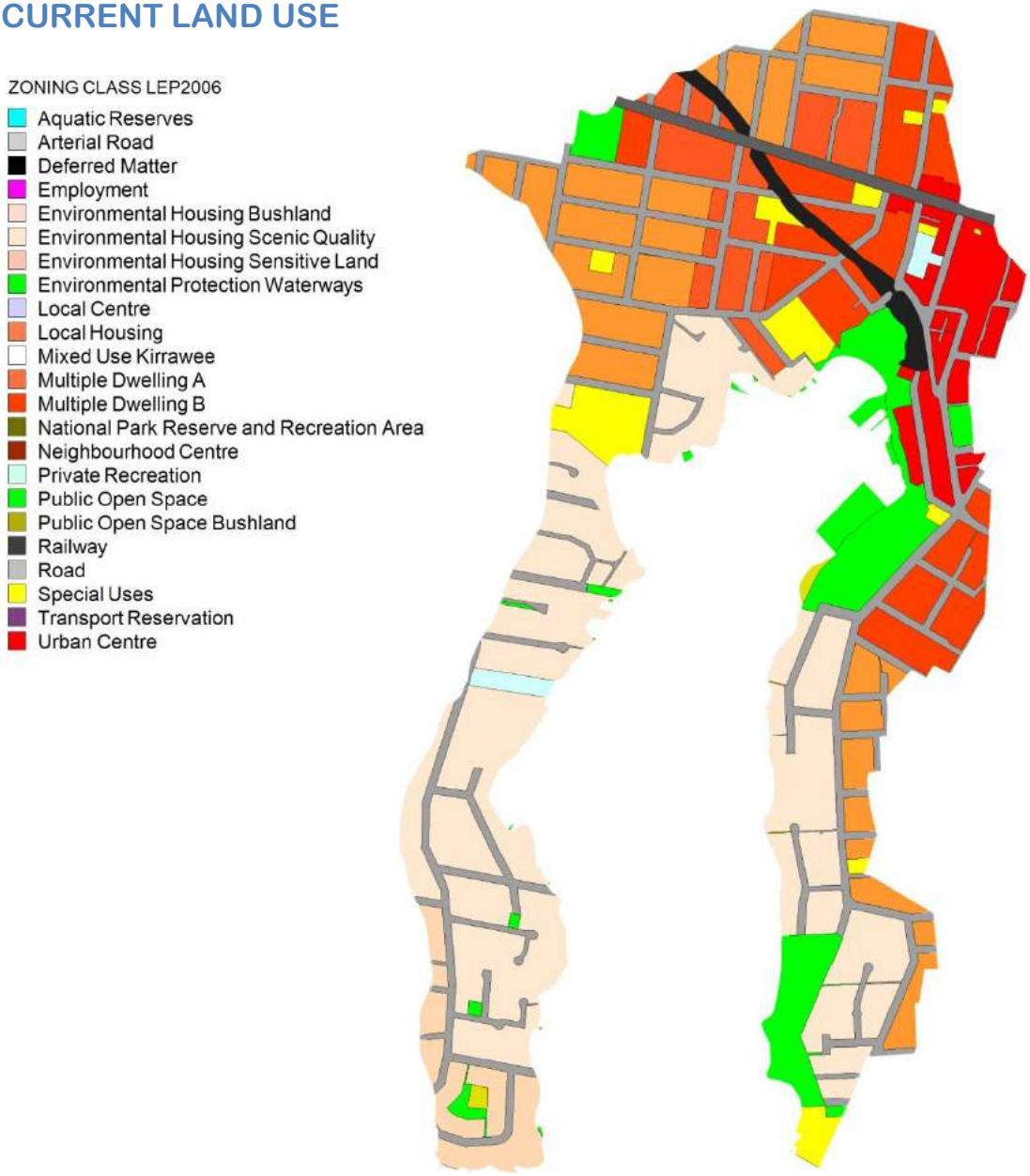
fisheries was operated under the supervision of a Norwegian fisheries expert, Harald Dannevig. His job was to study the biology and ecology of marine life in the area with a view to establishing a prosperous fishing industry off the coast nearby (Lawrence, 1997). He was lost at sea in 1914; his role in understanding Australian marine biology has been recognised with the new research library at the State Fisheries Centre named in his honour.

Sale of town lots in the Village of Gunnamatta began in 1900. It was described by Surveyeor Twynam as "more or less covered with forest growth and the surface thus protected, it presents some charming sites for residential occupation" (Curby, 1998; p.20). Key areas of Twynam's assessment were to locate areas with good farming land and marketable timber; he found neither at Gunnamatta Bay. He described it as very poor and covered with low scrub and generally less than 18 inches of sandy loam soil and gravel overlying bedrock. Despite this he indicated that the more attractive parts should be reserved for public use, "especially in future years when this locality is more frequently visited" (Curby, 1998; p.20).

Around 1910 Gunnamatta Bay was described as having "wide stretches of clear, shallow water offer[ing] absolute immunity from both sharks and undertow; while the overhanging caves and foliaged knolls along its margin are more than ordinarily picturesque" (Lawrence, 1997; p. 97). In 1909 the ferry commenced operating between Cronulla, from Gunnamatta Bay, and Audley, and by 1937 it was described as a honeymoon paradise. However, in 1926 during a period of drought, Sutherland Shire Council utilised the creek at the northern end of Gunnamatta Bay Park as an emergency water supply for local residents. The creek was fed by a natural spring, but was later piped.

The Depression brought more people to the area, looking for somewhere to camp and eke out a living. Churches and Benevolent Societies opened up orphanages and places for homeless women in the area. Shell gritting experienced a resurgence on the tidal flats of Gunnamatta Bay. Following World War II urban development in the area began in earnest. Located adjoining Cronulla, this part of the Shire continued to see itself as separate from the rest, and clung to its identity as a seaside town for many years. This attitude is still evident today.

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	7.86	4%	43%	3.38
Environmental Housing Scenic Quality	62.41	28%	57%	35.57
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	29.58	13%	51%	15.08
Multiple Dwelling A	11.80	5%	64%	7.55
Multiple Dwelling B	21.56	10%	64%	13.80
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	10.95	5%	94%	10.29
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.00	0%	86%	0.00
Employment	0.00	0%	95%	0.00
Special Uses	8.98	4%	46%	4.13
Public Open Space	16.96	8%	5%	0.85
Public Open Space Bushland	0.68	0%	0%	0.00
Private Recreation	1.64	1%	5%	0.08
Environmental Protection Waterways	2.72	1%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	0.00	0%	0%	0.00
Railway	3.68	2%	33%	1.21
Arterial Road/Road	44.69	20%	66%	29.49
Transport Reservation	0.00	0%	5%	0.00
TOTAL	223.48	100%	54%	121.44

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

0.9 HECTARES SYDNEY SANDSTONE GULLY FOREST

8.3 HECTARES LITTORAL RAINFOREST

2.1 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

3.7 HECTARES RIVER_FLAT EUCALYPT FOREST

LEP 2006 SIGNIFICANT VEGETATION

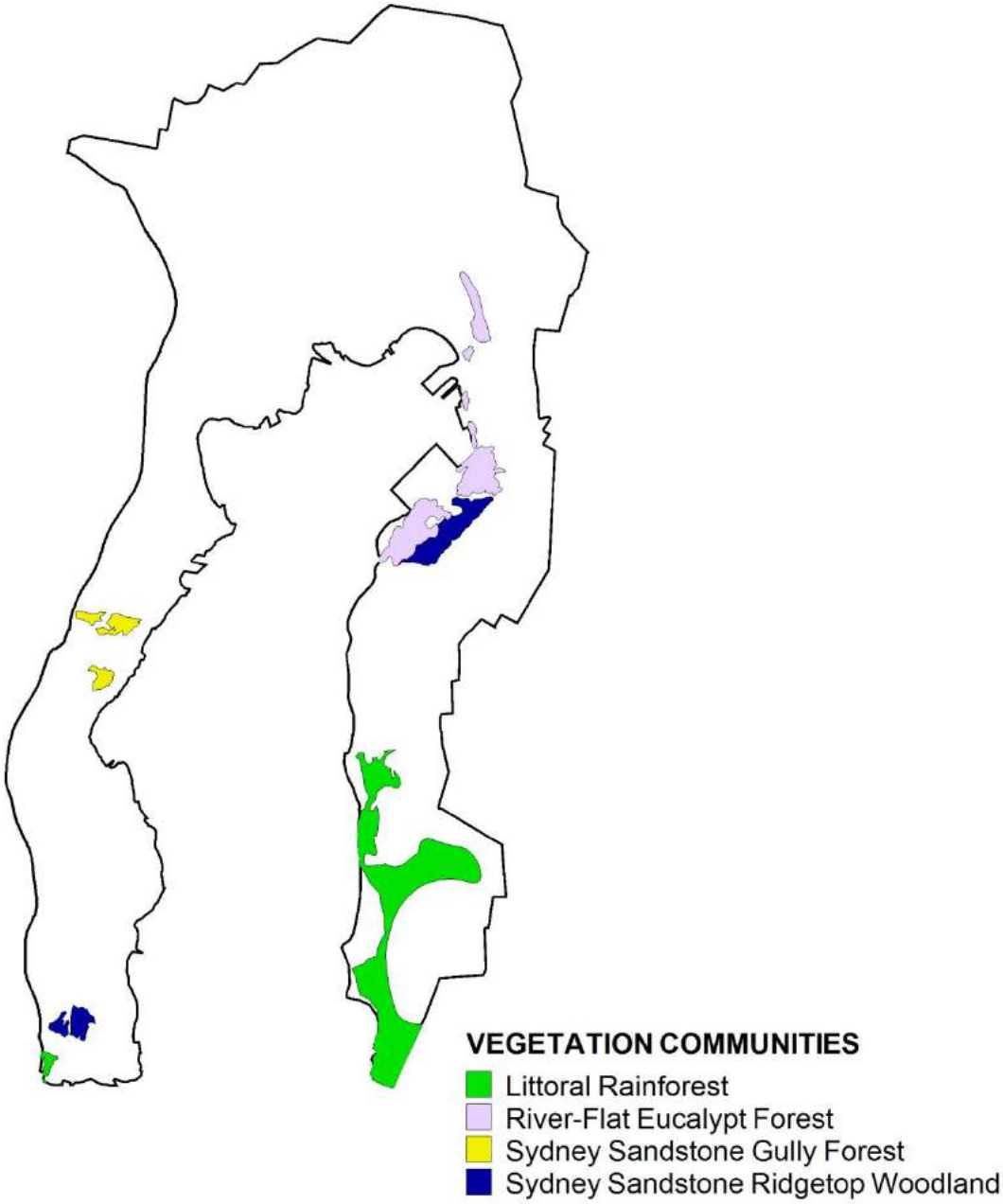
T59 *Angophora costata*_smooth bark Angophora Significant Group of Trees or Vegetation

T61 *Quercus robur*_English Oak Significant Group of Trees or Vegetation

T62 *Eucalyptus racemosa* and Angophora costata Significant Group of Trees or Vegetation

T69 Linear cultural exotic planting Significant Group of Trees or Vegetation

T70 Eucalypt canopy Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas
   - Gunnamatta Park
   - Darook Park

2) Greenweb Support areas
   - None noted

3) Greenweb Restoration areas
   - Woolaware Rd/Cross Rd/Gunnamatta Rd/Dodson Ave/Tonkin St/Tonkin Oval/Waratah St
   - Nicholson Pde/Darook Park Rd/Stacey St/Redgum Ave/Wangi Ave

Bushcare Groups

- Dunkeld Close Reserve
- Shell Road Reserve
- Tonkin Park
- Gunnamatta Park
- Gunnamatta Foreshore

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution

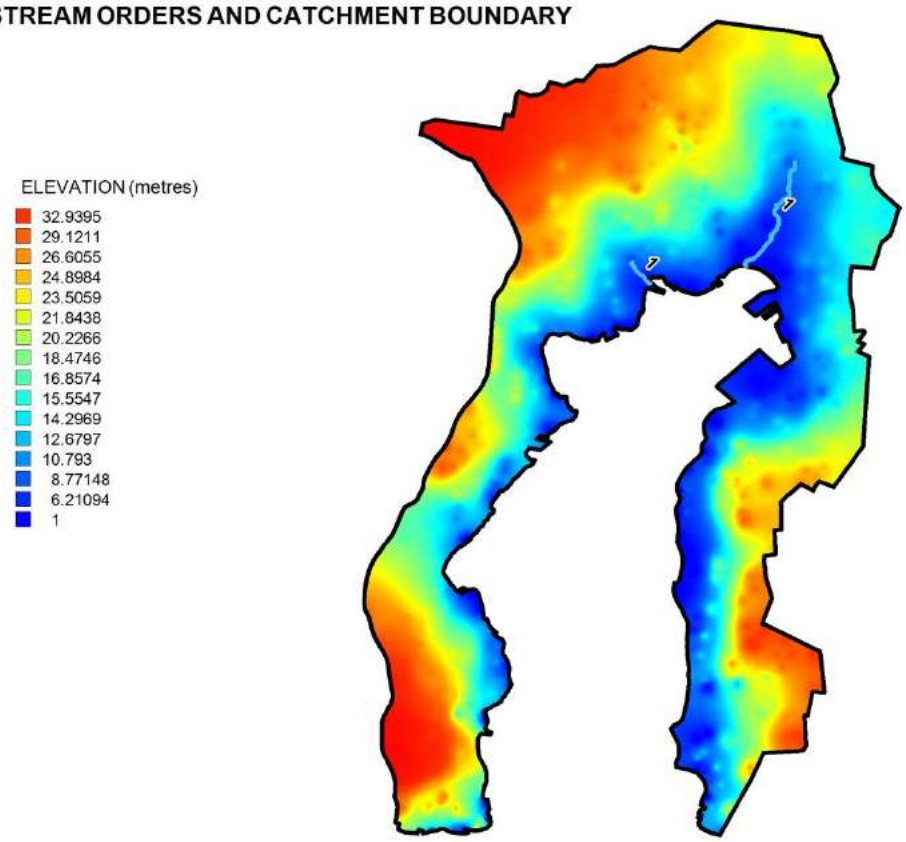
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

RIPARIAN IMPACTS

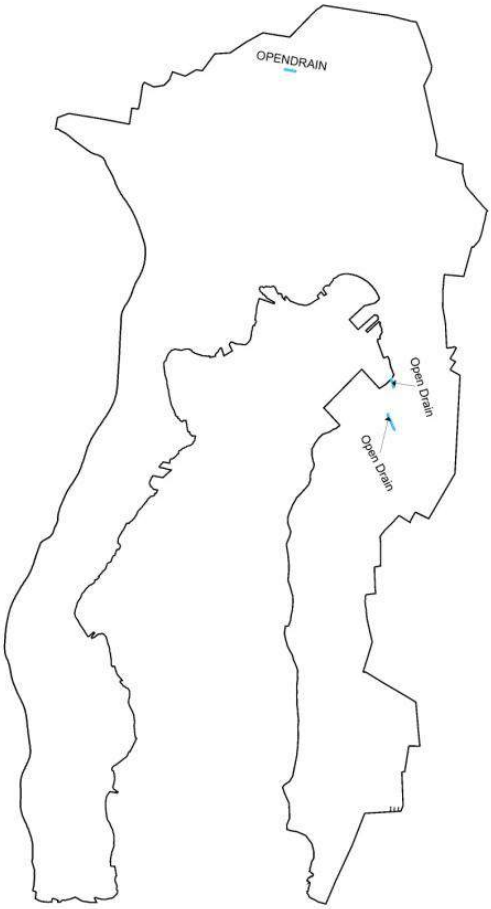
- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species

- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

CATCHMENT ELEVATION MODEL:
STREAM ORDERS AND CATCHMENT BOUNDARY



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY

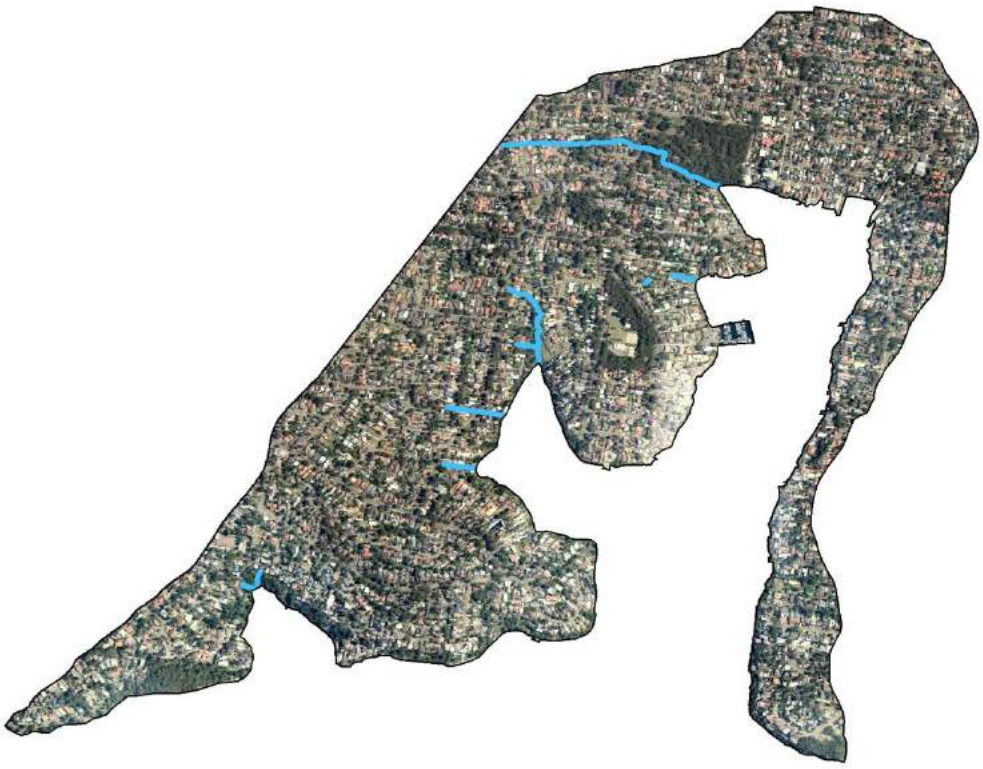


BURRANEER BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 2.7 KM^2

SUBURBS: LILLI PILLI
CARINGBAH SOUTH
DOLANS BAY



WATERWAYS

MAJOR NAMED WATERWAYS: NIL

TOTAL LENGTH OF MAPPED WATERWAYS: 1.5 KMs

PRIMARY ORDER CREEKS: 0.3 KMs

SECOND ORDER CREEKS: 0.8 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.4 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

Two sites were sampled at Burraneer Bay:

1. Burraneer Park

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	=
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-

TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**
SUMMER 95 +/- ANZECC 2000 values	+	=	-	-	-
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓

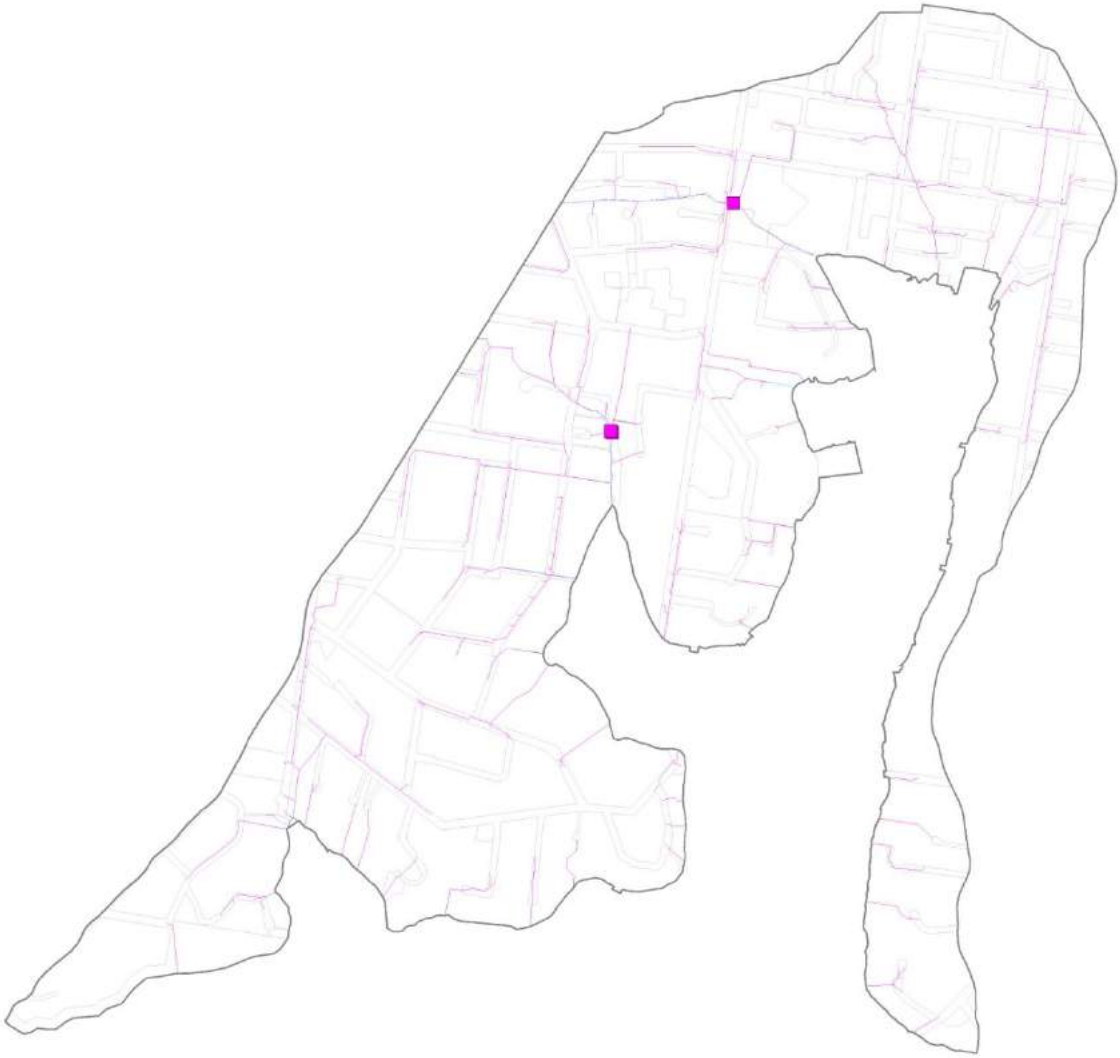
A reduction in values was recorded for all parameters sampled at Burraneer Park, so that all parameters were reported to be within ANZECC 2000 guideline limits at the end of the survey period.

2. Dolans Bay

PARAMETER	**NH3**	**BOD**	**Cu**	**Pb**	**Zn**
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	=
WINTER 02 +/- ANZECC 2000 values	+	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**
SUMMER 95 +/- ANZECC 2000 values	-	=	-	-	-
WINTER 02 +/- ANZECC 2000 values	-	-	+	-	-
TREND ↓↑	↓	↓	↑	↓	↓

A reduction in values was recorded for all but one parameter sampled, so that all parameters except total nitrogen were reported to be within ANZECC 2000 guideline limits at the end of the survey period.

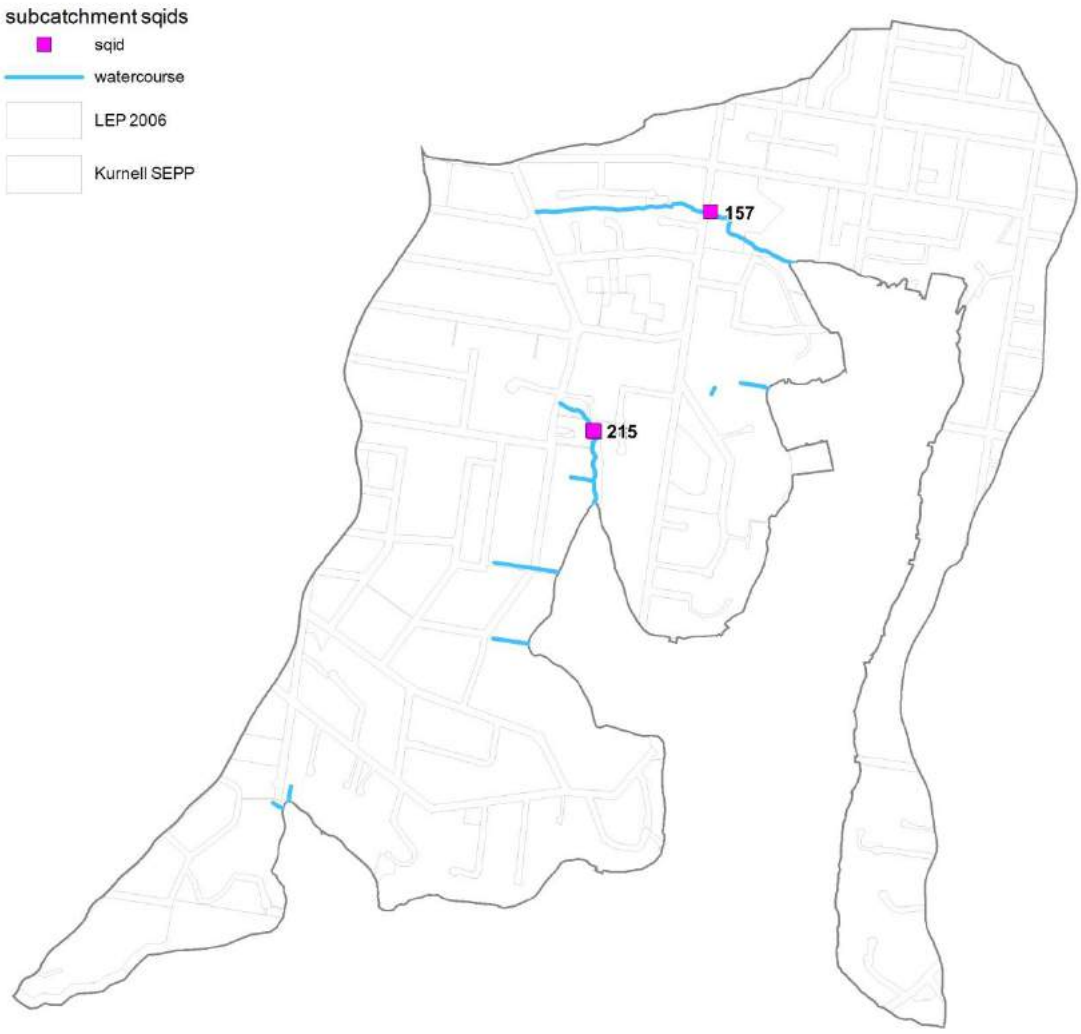
RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
157	GPT - Other	Trash Rack	Gannons Road	Burraneer Park	Caringbah	27.6 Ha
215	GPT - Other	Child Proof Grate	Parthenia St Reserve	Behind No.4 Ellery Pl	Dolans Bay	

LOCATION OF SQIDS



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Burraneer Bay subcatchment landscape is primarily Gymea Soil Landscape (gy), with minor areas of Disturbed Terrain (xx) north of the bay itself. Foreshores around Dolans Bay and Port Hacking suburbs are Hawkesbury Soil Landscape (ha) (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

The catchment rises to a maximum of 66m ASL at its most western catchment boundary. The typical height of the plateau is between 30-50 m ASL dropping steeply to 4m ASL at Port Hacking with the two headlands at 43 and 51m ASL .

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 5	239

Class 5 ASS/PASS soils include a 300m strip around the foreshores of Burraneer Bay. Land outside this area is not classified as AAS/PASS.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

Burraneer is an Aboriginal word meaning point of the bay. It was named by Surveyor Robert Dixon in 1827, who chose many Aboriginal names for many of the bays in the area. Early land grants in the area included 4600 acres to John Connell Laycock, who built Fernleigh at Burraneer Bay in 1860, described as a lovely sandstone dwelling that is still standing (Kavanagh, 2004). Poor management led to this property becoming mortgaged, and it was eventually bought by Thomas Holt in 1861.

The eastern peninsular of Burraneer Bay was known as Crossing Point, and was the first link between the northern and southern shores of Port Hacking. With no road until the early 20th century, the only transport to early landholdings around Bundeena was by water. Built in the 1860s, Simpson's Hotel relied on the small ferry to bring guests and supplies to the premises. In its early days the ferry left from Crossing Point and followed an established route that went to Bundeena and then to Simpson's Hotel. Following increased silting of the channel, the ferry later abandoned the stop at Simpson's Hotel, and was moved to a wharf in Gunnamatta Bay.

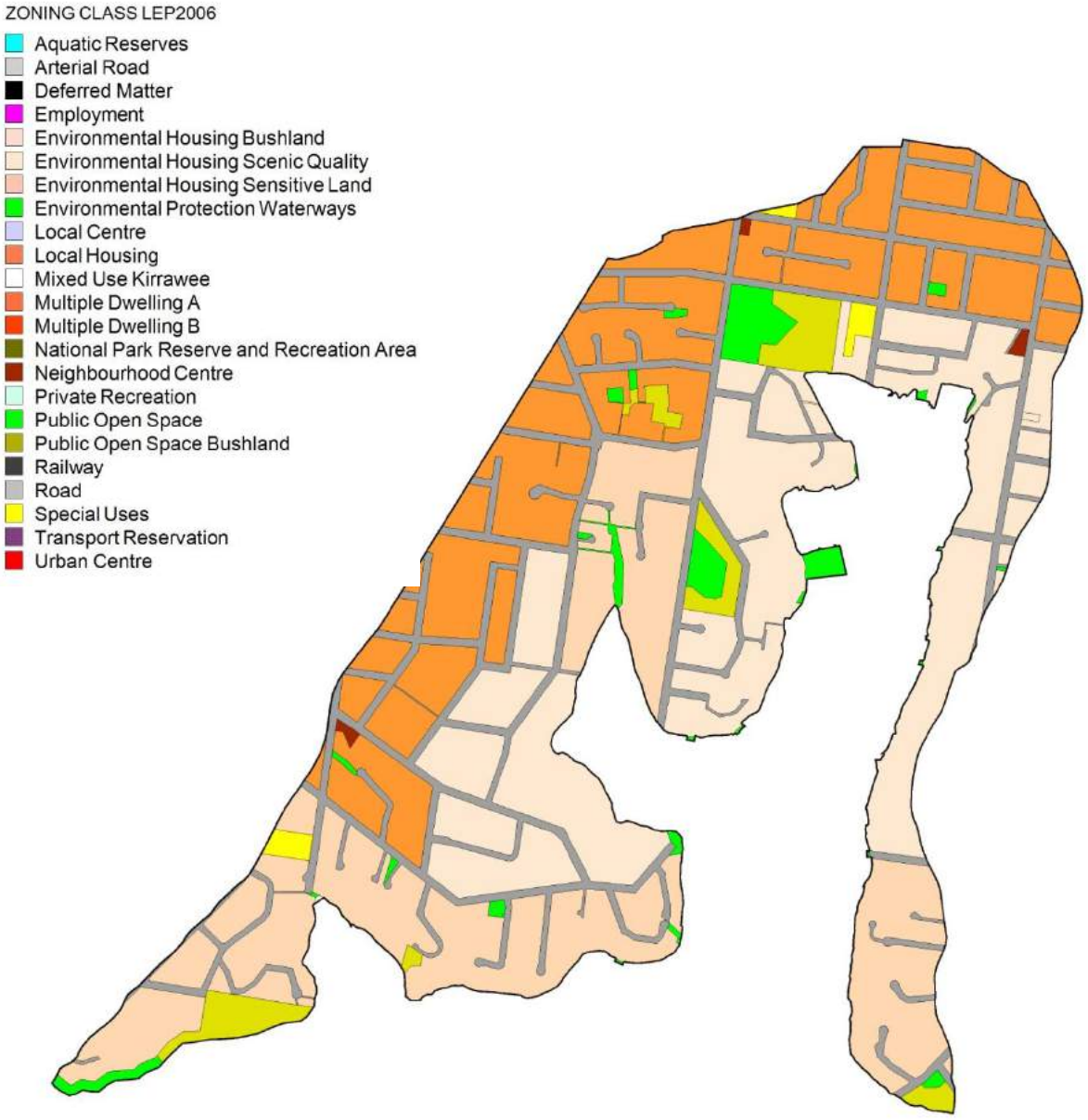
Burraneer Point was home to the Marine Shell Products factory and was one of the few local industries in the area in the 1880s to 1900s. They bought shell grit from the beaches and used it as a source of calcium carbonate for lime and other products. The first subdivision took place in 1889. Many tenants lived in tents and temporary shelters until they could build permanent homes. Thomas Holt offered incentives to some tenants to build better quality homes, part of his plan to attract "men of means" to the area (Jackson, 2006).

In 1893 Burraneer School opened at today's Burraneer Park. Then, in 1909 a royal commission recommended to clear inner city slums and relocate working class families to the healthier outer suburbs of Sydney (Ashton et al, 2006). Following World War I, this gave the impetus to a growing subdivision boom around the edges of Sydney, and fostered the urban sprawl that has become characteristic of the Shire. Before this time, Burraneer Bay and its surrounding catchment were characterised by natural bushland and waterways, and this fuelled the land sales strategies of the time. The area was advertised as rustic, and country town-like, with swimming, boating and fishing at the doorstep.

The western peninsula of Burraneer Bay includes the suburbs of Dolans Bay and Port Hacking. Dolans Bay was named after Patrick Dolan who held land there from 1856 (Jackson, 2006). His son Dominick lived at the head of Burraneer Bay from the early 1860s, and was one of the earliest settlers in the area. Dolan chose the land because of its magnificent outlook and excellent soil. He grew flowers, vegetables and fruit in the area for many years.

In the early 1900s Port Hacking was still in pristine condition and fish were plentiful. Sharks continued to be present and residents of Burraneer were so desperate for a shark-proof fence in the bay that they offered to build it themselves. The native bushland was not valued, and local reserves became dumping grounds. Bushland in a number of reserves was cleared to prevent dumping of rubbish (Jackson, 2006). To protect coral and marine life, a marine reserve was proclaimed at the bay in 1979 and named Shiprock Aquatic Reserve. This is a popular SCUBA dive site in the area, particularly on days when there is poor weather out to sea.

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	62.75	23%	43%	26.98
Environmental Housing Scenic Quality	74.11	28%	57%	42.24
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	66.88	25%	51%	34.11
Multiple Dwelling A	0.00	0%	64%	0.00
Multiple Dwelling B	0.00	0%	64%	0.00
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	0.00	0%	94%	0.00
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.54	0%	86%	0.47
Employment	0.00	0%	95%	0.00
Special Uses	1.78	1%	46%	0.82
Public Open Space	6.95	3%	5%	0.35
Public Open Space Bushland	9.79	4%	0%	0.00
Private Recreation	0.00	0%	5%	0.00
Environmental Protection Waterways	1.21	0%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	0.00	0%	0%	0.00
Railway	0.00	0%	33%	0.00
Arterial Road/Road	43.72	16%	66%	28.86
Transport Reservation		0%	5%	0.00
TOTAL	267.74	100%	50%	133.83

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

6.0 HECTARES SYDNEY SANDSTONE GULLY FOREST

9.1 HECTARES LITTORAL RAINFOREST

4.6 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

0.0 HECTARES MANGROVE

LEP 2006 SIGNIFICANT VEGETATION

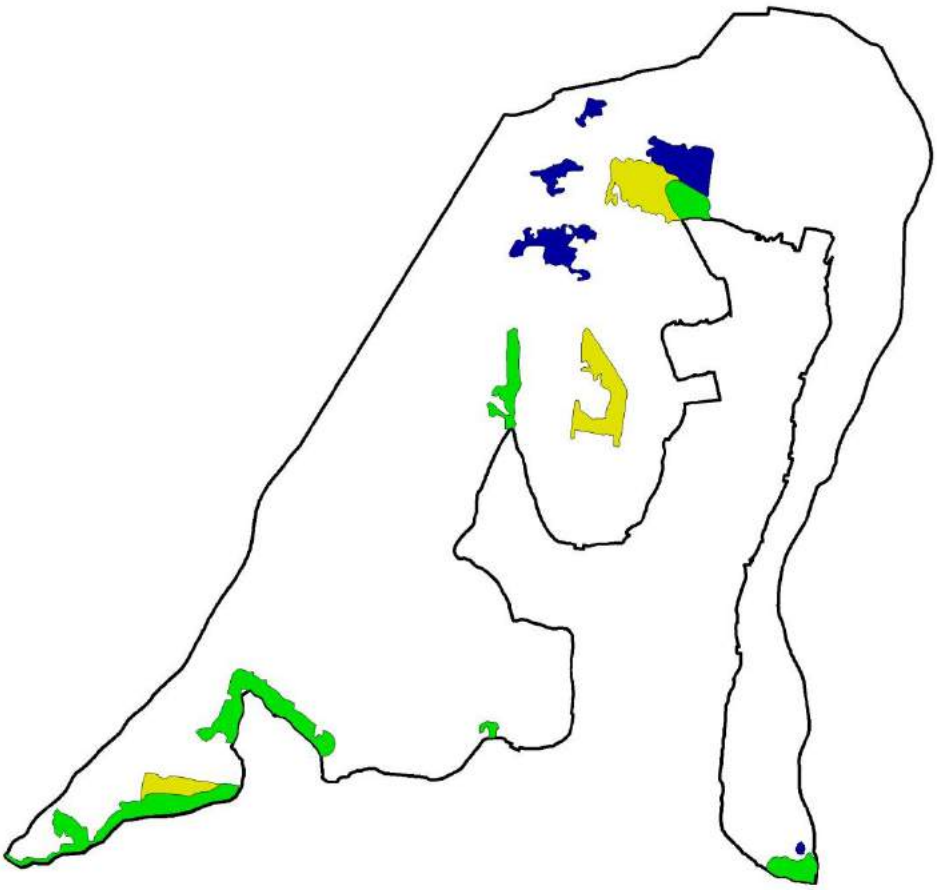
T53 Eucalyptus racemosa_Ghost gum Significant Group of Trees or Vegetation

T54 *Eucalyptus fibrosa* Significant Group of Trees or Vegetation

T56 *Eucalyptus racemosa*_Ghost gum Significant Group of Trees or Vegetation

T57 *Ulmus pervifolia*_Chinese elm Significant Group of Trees or Vegetation

T58 *Eucalyptus racemosa*_Ghost gum Significant Group of Trees or Vegetation



VEGETATION COMMUNITY

- Littoral Rainforest
- Mangrove
- Sydney Sandstone Gully Forest
- Sydney Sandstone Ridgetop Woodland

BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Lilli Pilli Point Reserve
- Little Turriell Bay foreshores
- Burraneer Park
- Rutherford Reserve

2) Greenweb Support areas

- Lilli Pilli Point Rd/Kamira Rd/North East Crescent/Little Turriell Bay Rd/Turriell Point Rd/Moombara Cres/

3) Greenweb Restoration areas

- Turriell Point Rd/Walker Rd/Bass St/Wistaria St/Parthenia St/Gannons Rd/Yeramba Ave/Rawson Pde/Northcote Ave/Nemesia Ave
- Dominic St/Dolans Rd/Willaburra Rd/Bayview Rd/Woolaware Rd

Bushcare Groups

- Lilli Pilli Point Reserve
- Kamira Rd, Lilli Pilli
- Little Turriell Bay Road Reserve
- Shiprock Reserve
- Gannons Road Reserve
- Fernleigh Road Reserve
- Burraneer Park
- Rutherford Reserve

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns

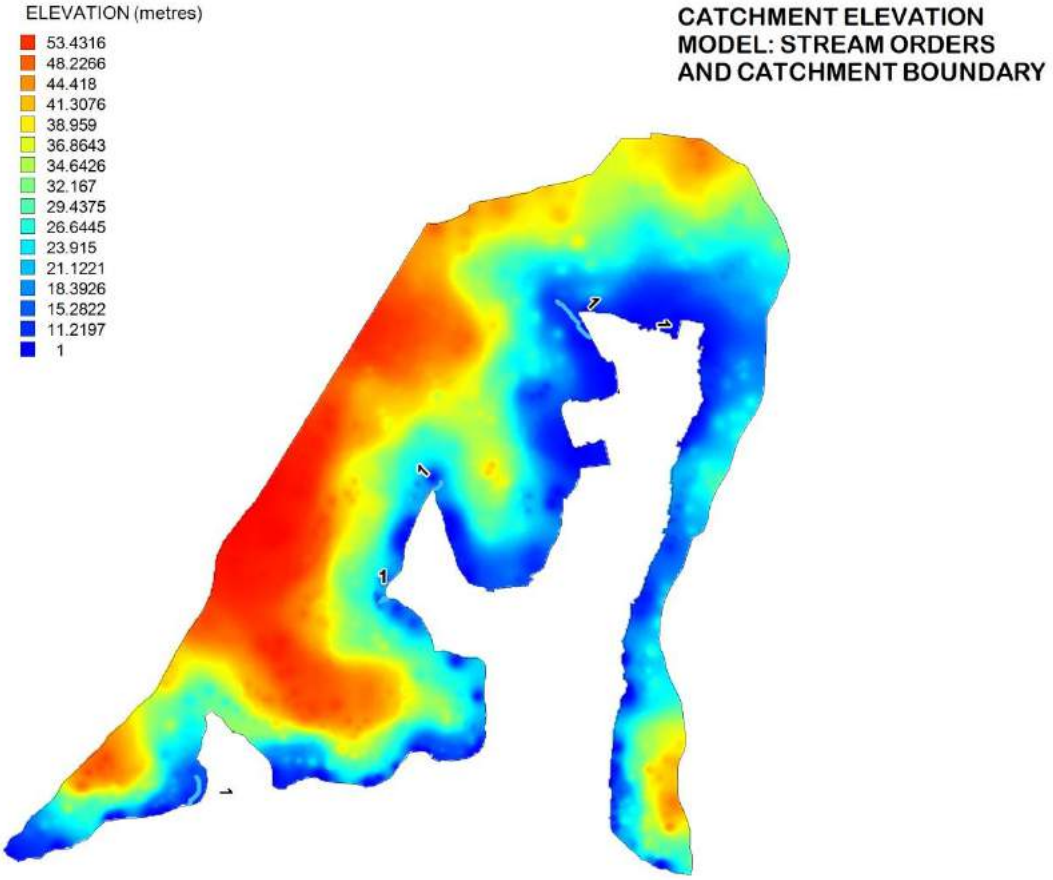
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

RIPARIAN IMPACTS

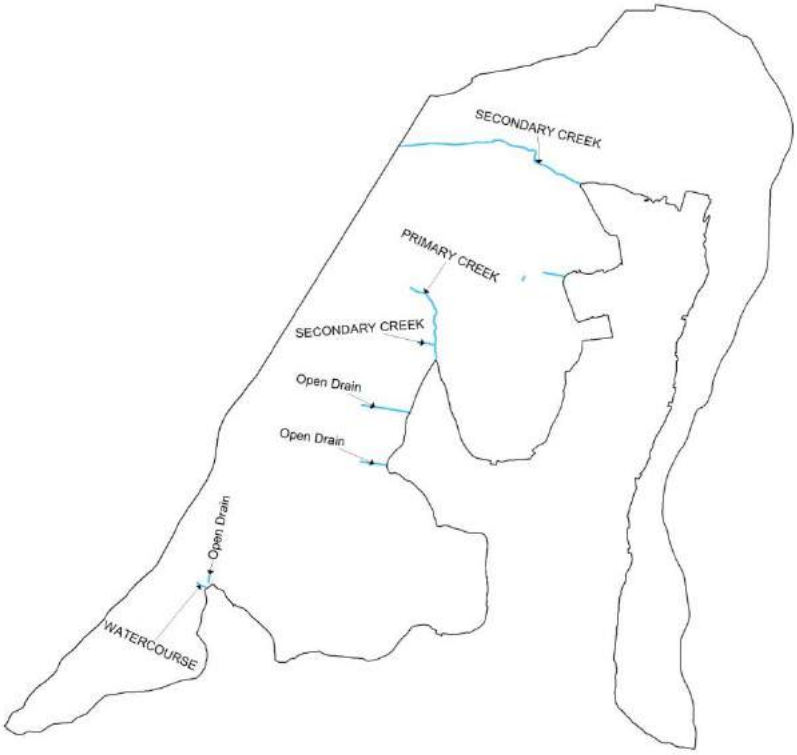
- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality

- Disturbance from pedestrian access
- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY

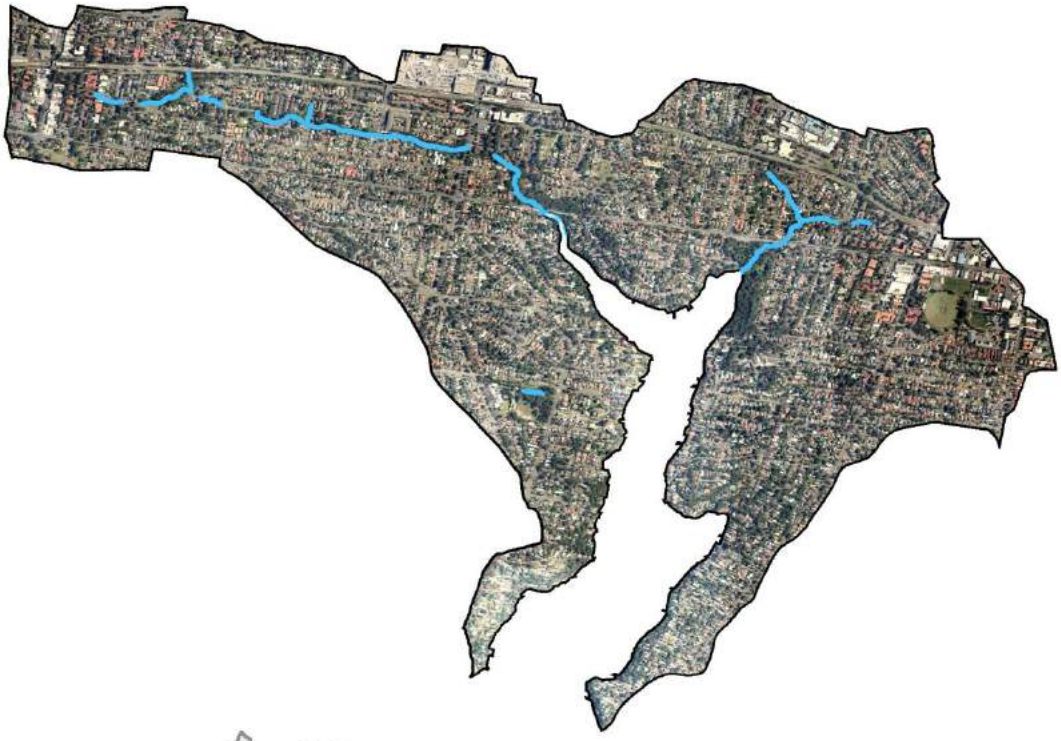


YOWIE BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 4.7 KM^2

SUBURBS: MIRANDA
GYMEA
CARINGBAH
YOWIE BAY



WATERWAYS

MAJOR NAMED WATERWAYS: YOWIE GULLY

KAREENA CREEK

TOTAL LENGTH OF MAPPED WATERWAYS: 2.6 KMs

PRIMARY ORDER CREEKS: 0 KMs

SECOND ORDER CREEKS: 2.4 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.2 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

Two sites were sampled in Yowie Bay subcatchment:

1. Yowie Bay East CDS

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	=
SUMMER 00 +/- ANZECC 2000 values	-	=	+	+	-
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**

SUMMER 95 +/- ANZECC 2000 values	+	=	+	-	-
SUMMER 00 +/- ANZECC 2000 values	++	-	-	-	+
TREND ↓↑	↑	↓	↓	↓	↑

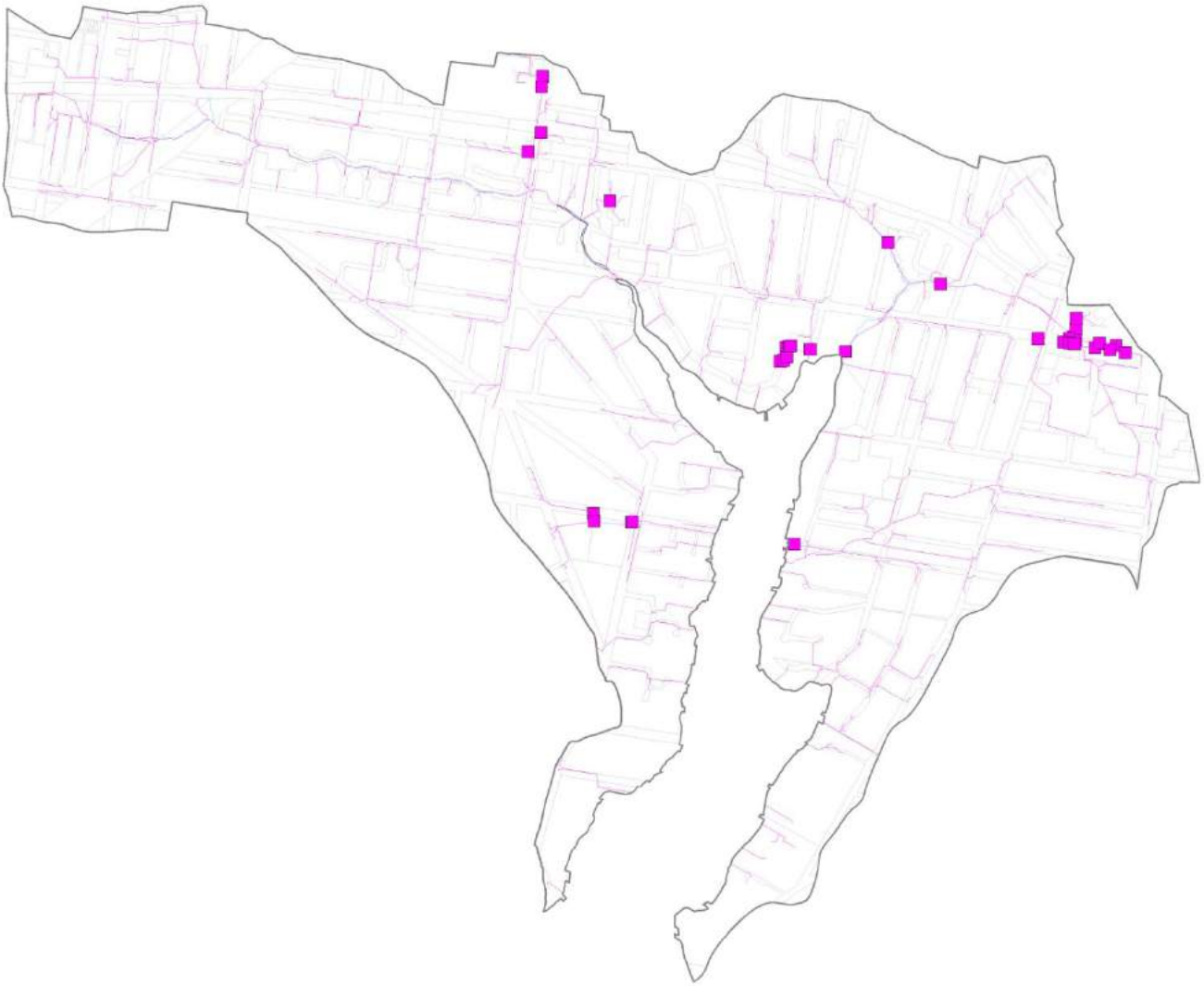
A number of parameters showed an increase in values during the survey period, notably enterococci and total suspended solids which were consistently outside ANZECC 2000 guideline values. Decreases in values for other parameters were reported, a number of which were within guideline values at the end of the survey period.

2. Ewey Creek, Yowie Bay West

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	=
SUMMER 00 +/- ANZECC 2000 values	=	=	+	-	+
TREND ↓↑	↓	↓	↓	↓	↑
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**
SUMMER 95 +/- ANZECC 2000 values	+	=	+	-	-
SUMMER 00 +/- ANZECC 2000 values	+	-	+	+	-
TREND ↓↑	↑	↓	↑	↑	↓

There was a reduction in values for some parameters, but an increase in values for others; at the end of the survey period about half of the parameters sampled had values reported that were outside the ANZECC 2000 guidelines ranges.

RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

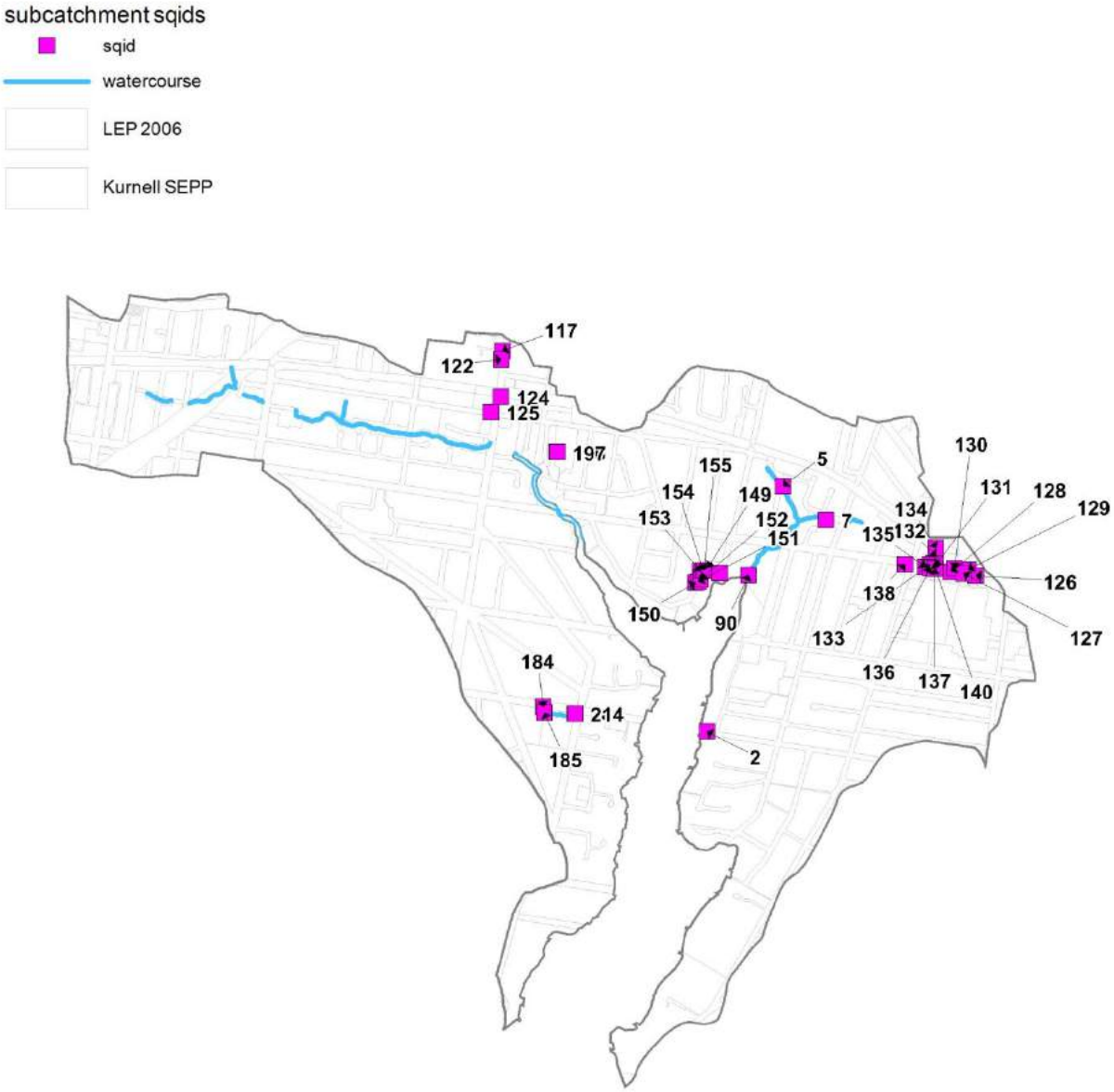
ID	DEVICE CATEGORY	DEVICE TYPE	LOCATION	SITE DESCRIPTION	SUBURB	APPROX. CATCHMENT
2	GPT	GPT	Burraneer Bay Road	Adjacent to 75 Baliga Avenue	Yowie Bay	37.9 Ha
7	GPT	GPT	Binalong Avenue	Opposite Nioka Place	Caringbah	53 Ha
129	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue (corner Park Lane)	Caringbah Shopping Centre	Caringbah	0.37 Ha
140	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.02 Ha
141	GPT - Other	Trash Rack	Wonga Road (corner of Attunga Road)	Reserve	Yowie Bay	14 Ha
117	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	Kiora Road	Miranda Shopping Centre	Miranda	0.18 Ha
122	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	Kiora Road	Miranda Shopping Centre	Miranda	0.11 Ha
124	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	Kiora Road (corner Gibbs Street)	Miranda Shopping Centre	Miranda	0.16 Ha
126	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue (corner Burns Lane)	Caringbah Shopping Centre	Caringbah	0.19 Ha
128	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.23 Ha
130	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.29 Ha
131	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.15 Ha
132	Gully Pit Pollutant Filter	Enviropod Pollutant	President Avenue	Caringbah Shopping Centre	Caringbah	0.14 Ha

ID	DEVICE CATEGORY	DEVICE TYPE	LOCATION	SITE DESCRIPTION	SUBURB	APPROX. CATCHMENT
		Filters		(infront of McDonalds)		
133	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue (corner Park Lane entry)	Caringbah Shopping Centre	Caringbah	0.23 Ha
134	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	President Avenue	Caringbah Shopping Centre (Coles Carpark)	Caringbah	0.16 Ha
135	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.28 Ha
136	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.1 Ha
137	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.16 Ha
138	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	President Avenue (corner Willarong Road)	Caringbah Shopping Centre	Caringbah	0.59 Ha
125	Gully Pit Pollutant Filter	Enviropod Pollutant Filters	Karimbla Road (cnr Kiora Road)	Miranda Shopping Centre	Miranda	0.19 Ha
149	GPT	CDS	Kareena Road	Kareena Park	Miranda	15 Ha
150	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Matson Crescent	Residential	Miranda	1.8 Ha*
151	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Matson Crescent	Residential	Miranda	1.8 Ha*
152	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Matson Crescent	Residential	Miranda	1.8 Ha*
153	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Matson Crescent	Residential	Miranda	1.8 Ha*

ID	DEVICE CATEGORY	DEVICE TYPE	LOCATION	SITE DESCRIPTION	SUBURB	APPROX. CATCHMENT
154	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Matson Crescent	Residential	Miranda	1.8 Ha*
90	GPT	GPT	Kareena Road	Camellia Garden near carpark	Miranda	22.6 Ha
5	GPT	CDS	Winifred Avenue	End of Winifred Avenue	Caringbah	20.7 Ha
184	End of pipe trap	Nettech Device	Wonga Road	adjacent to footpath	Yowie Bay	5.9 Ha
185	End of pipe trap	Nettech Device	Wonga Road	in reserve	Yowie Bay	6.2 Ha
196	GPT - Other	Filtration Unit	Karimbla Road Reserve	In Karimbla Road Reserve - western side	Miranda	
197	GPT - Other	Filtration Unit	Karimbla Road Reserve	In Karimbla Road Reserve - western side	Miranda	
214	GPT - Other	Child Proof Grate	Wonga Road (cnr of Attunga Rd)	Reserve	Yowie Bay	
155	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Matson Crescent	Residential	Miranda	1.8 Ha*
127	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	President Avenue	Caringbah Shopping Centre	Caringbah	0.16 Ha

*Common for six Matson Crescent Pollutant Filters

LOCATION OF SQIDS



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Yowie Bay subcatchment landscape is primarily Gymea Soil Landscape (gy), with minor areas of Blacktown Soil Landscape(bt) north of the bay towards Caringbah. Foreshores around Willarong Point are Hawkesbury Soil Landscape (ha) (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

The catchment rises to a maximum of 76m ASL at its most western boundary. The typical height of the plateau is between 40-55 m ASL dropping steeply to 4m ASL at Port Hacking.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 5	238

Class 5 ASS/PASS are located in a 300m zone around the foreshores of Yowie Bay.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

Yowie Bay (originally known as Ewey Bay) was the site of the first landing by Bass and Flinders in their exploration of Port Hacking (Kavanagh, 2004). The site was important because of its supply of freshwater from Ewey Creek. It is believed that the name came from natives calling to each other in the area “Ewe-ey”, and that it echoed. Popular legend adds that the name means place of echoes, but no records have been found to support this.

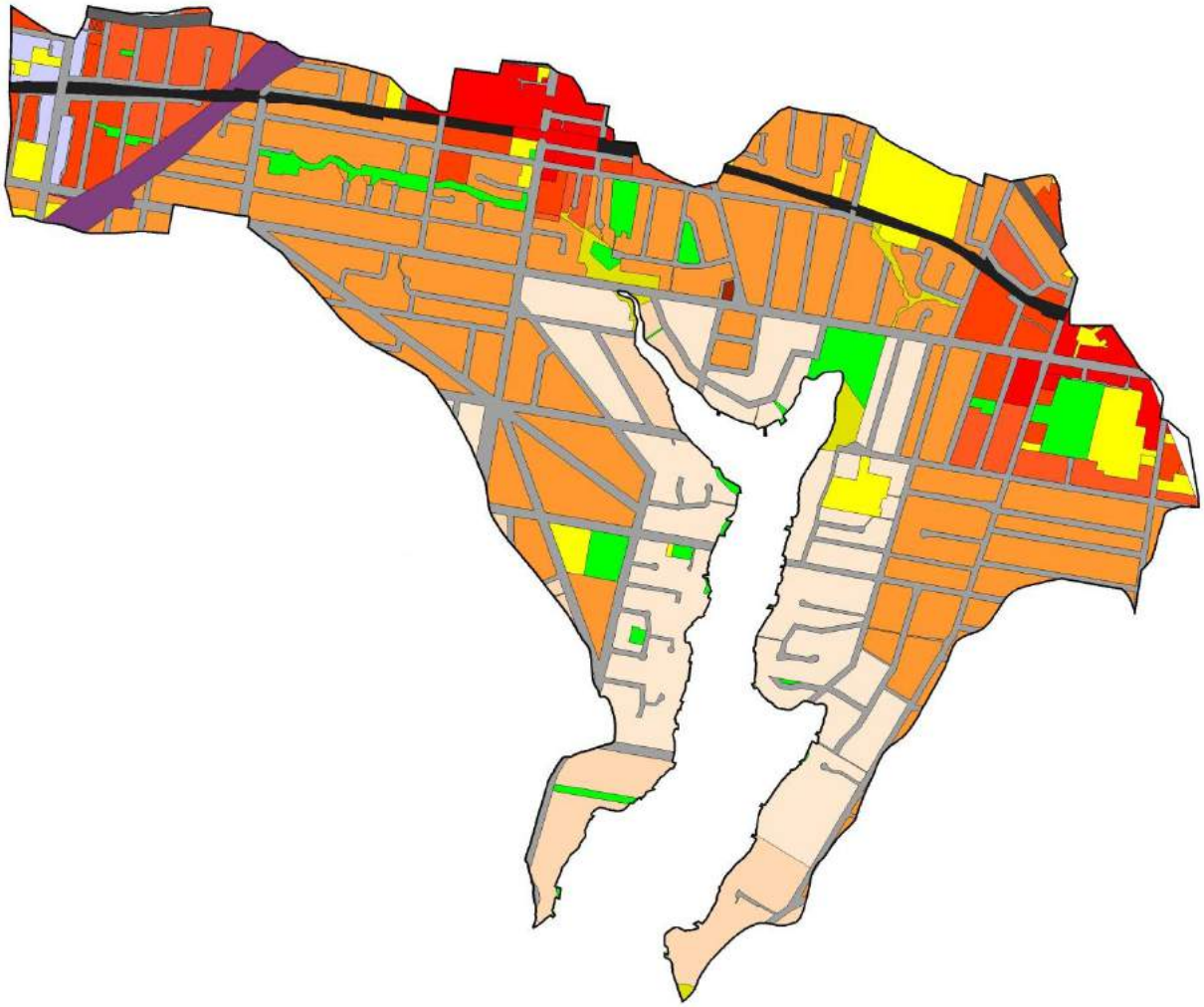
While mapping parts of Botany Bay and Port Hacking in 1827, Robert Dixon noted an overland track connecting the head of Ewey Creek with Gwawley Bay to the north, and a fence running northwest from this point. He also noted the availability of freshwater in the area. Much of the land to the north of Yowie Bay was part of a land grant of 1000 acres to Gregory Blaxland, following the crossing of the Blue Mountains. He sold this grant to John Connell Jnr in 1834. The property became known as Old Farm, and included land from the northern part of Ewey Creek to Gwawley Bay. This land eventually fell to Thomas Holt in 1868 as part of his land acquisition dealings (Kavanagh, 2004).

Much of the scrub was cleared in the area in 1862, and in 1868 Thomas Holt began sheep farming in the area. He cleared and burnt before seeding the area with imported grasses. Footrot and dingoes made sheep farming unsustainable, and he switched to cattle, but this was also unsuccessful. He then drilled for coal and experimented with oyster farming in Yowie Bay. Holt then felled stands of blackbutt and ironbarks and shipped them from Woolaware Bay. Turpentines were also harvested in the area and used for pilings for wharves around the colony.

In 1885 the railway from Sydney was extended to Sutherland, and then to Waterfall, improving access to the whole area. Following Holt's death, the western shore of Yowie Bay was subdivided in 1889 to form the Village of Weeroona, and became a popular destination for tourists arriving by train. Following the depression of the 1890s the Holt Sutherland Company was in serious debt, and the title was transferred to a new company. An act of parliament broke the transfer of leases to heirs, boosting the progress of development in the district (Kavanagh, 2004).

Confusion over the name for the area began around this time, with Yowie appearing as an alternative to Ewey, and both names persisted for many years. In 1934 Sutherland Council attempted to resolve this by declaring that Ewey Bay was the correct name, but popular opinion came out in favour of Yowie Bay, and this name became established (Kavanagh, 2004).

CURRENT LAND USE



ZONING CLASS LEP2006

- Aquatic Reserves
- Arterial Road
- Deferred Matter
- Employment
- Environmental Housing Bushland
- Environmental Housing Scenic Quality
- Environmental Housing Sensitive Land
- Environmental Protection Waterways
- Local Centre
- Local Housing
- Mixed Use Kirrawee
- Multiple Dwelling A
- Multiple Dwelling B
- National Park Reserve and Recreation Area
- Neighbourhood Centre
- Private Recreation
- Public Open Space
- Public Open Space Bushland
- Railway
- Road
- Special Uses
- Transport Reservation
- Urban Centre

CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATHCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	23.04	5%	43%	9.91
Environmental Housing Scenic Quality	74.26	16%	57%	42.33
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	150.09	32%	51%	76.54
Multiple Dwelling A	20.21	4%	64%	12.94
Multiple Dwelling B	17.46	4%	64%	11.17
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	15.59	3%	94%	14.65
Local Centre	3.76	1%	88%	3.31
Neighbourhood Centre	0.19	0%	86%	0.17
Employment	0.00	0%	95%	0.00
Special Uses	21.01	5%	30%	6.30
Public Open Space	16.77	4%	5%	0.84
Public Open Space Bushland	5.02	1%	0%	0.00
Private Recreation	0.15	0%	5%	0.01
Environmental Protection Waterways	0.15	0%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	0.00	0%	0%	0.00
Railway	9.42	2%	33%	3.11
Arterial Road/Road	100.09	22%	66%	66.06
Transport Reservation	7.72	2%	5%	0.39
TOTAL	464.91	100%	53%	247.71

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

22.8 HECTARES SYDNEY SANDSTONE GULLY FOREST

1.8 HECTARES LITTORAL RAINFOREST

0.2 HECTARES SYDNEY TURPENTINE IRONBARK FOREST

1.3 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

0.003 HECTARES MANGROVE

LEP 2006 SIGNIFICANT VEGETATION

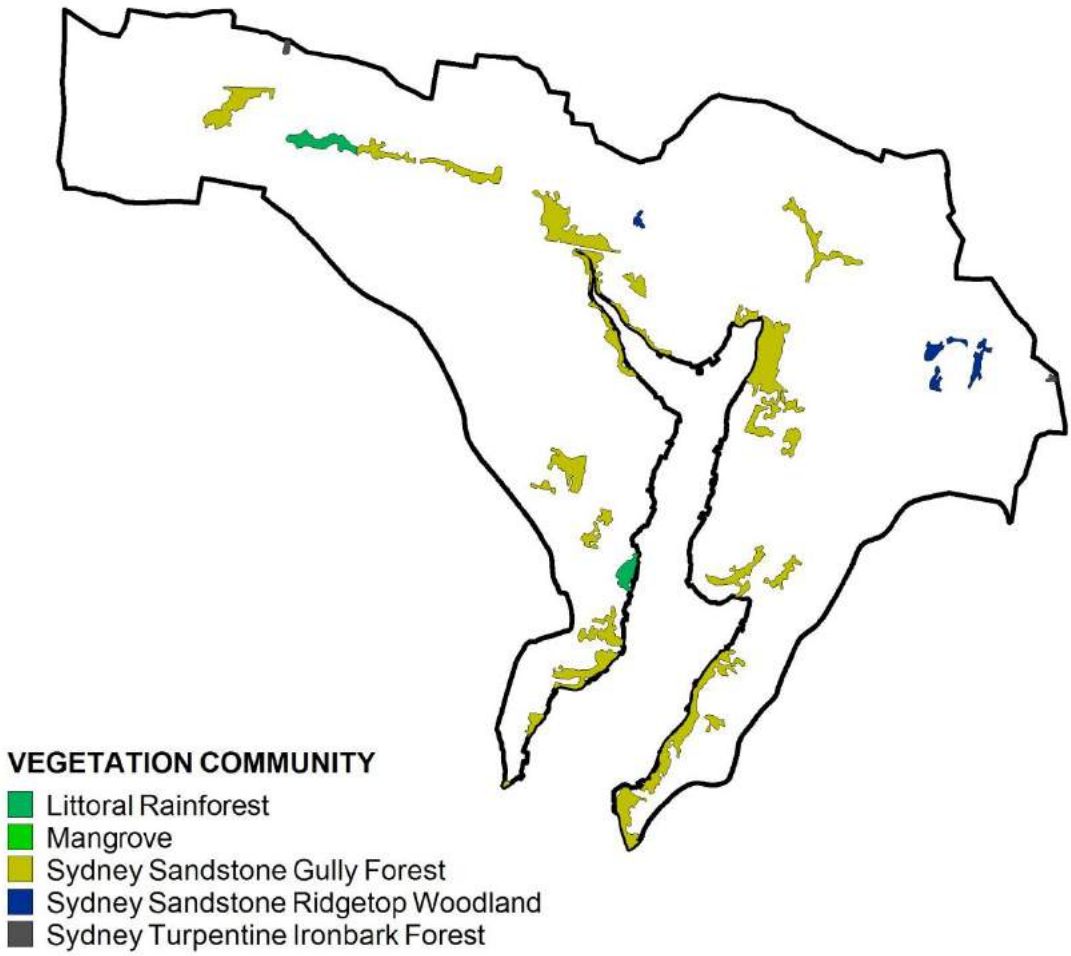
T41 *Angophora Costata*_3 Significant Group of Trees or Vegetation

T40 *Eucalyptus microcorys* and *Lophostemon confertus* Significant Group of Trees or Vegetation

T32 *Eucalyptus pilularis* and *Eucalyptus globoidea* Significant Group of Trees or Vegetation

T49 *Eucalyptus microcorys* Significant Group of Trees or Vegetation

T31 *Eucalyptus* Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Attunga Rd Reserve
- Yowie Point foreshores
- Yowie Gully/President Avenue Reserve
- Kareena Park, Caringbah South
- Willarong Point foreshores

2) Greenweb Support areas

- Attunga Rd/Coora Rd
- Laguna St/Kanoona St
- Willarong Rd

3) Greenweb Restoration areas

- Attunga Rd/Sherwood Ave/Balowrie St/Wonga Rd/Forest Rd/President Ave/Matson Cres/Karimbla Rd/
- Wonga Reserve
- President Ave/Winifred Ave/Binalong Ave
- Taren Rd/Burraneer Bay Rd/Baliga Ave/La Boheme Ave/Turtle Rd/Waterview Ave/Yowie Ave

Bushcare Groups

- Yowie Bay Old Baths Reserve
- Kareena Park
- Calliope Rd Southern Unmade Road Reserve
- Ewey Creek
- Wonga Reserve

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream

- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

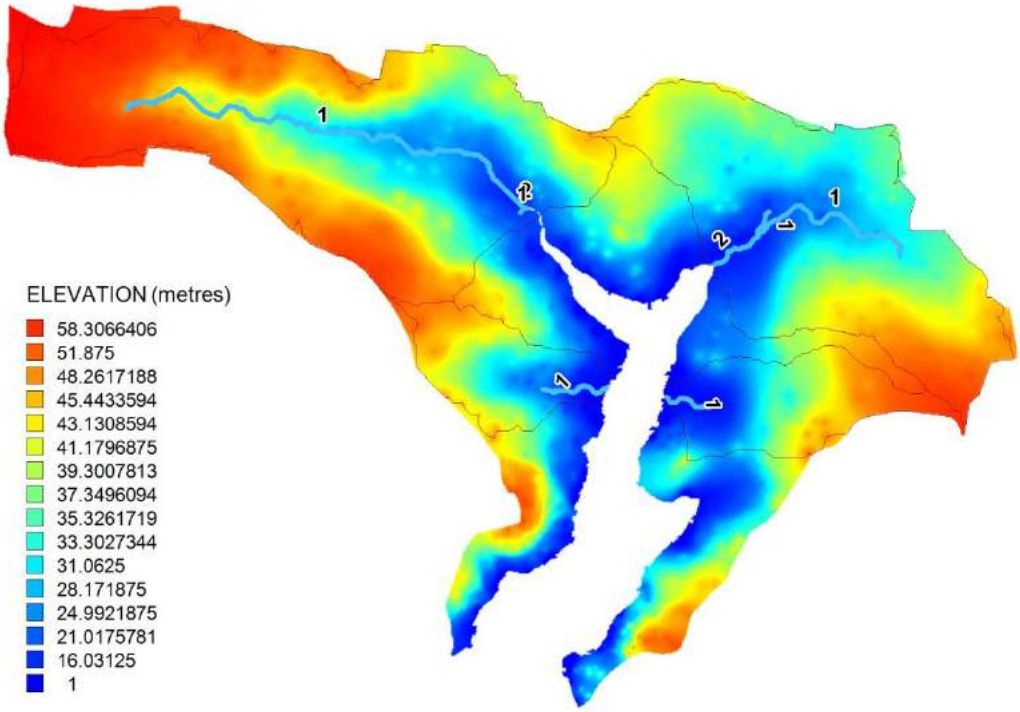
RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others

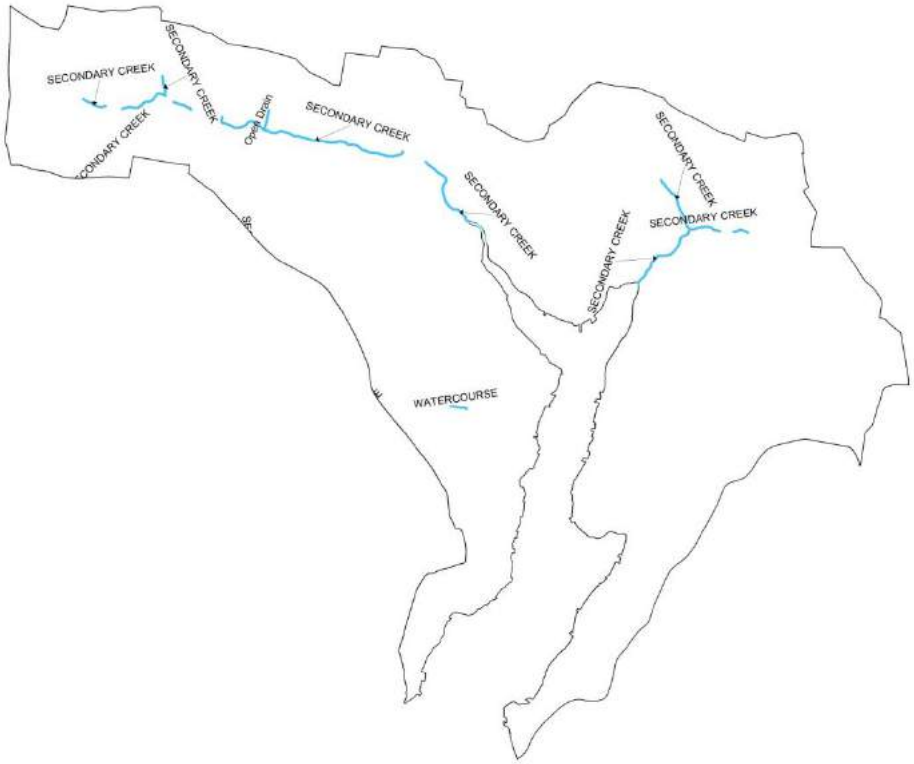
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP

CATCHMENT ELEVATION MODEL: STREAM ORDERS AND CATCHMENT BOUNDARIES



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARIES



GYMEA BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 2.1 KM^2

SUBURBS: GYMEA BAY
MIRANDA
YOWIE BAY

WATERWAYS

MAJOR NAMED WATERWAYS: COONONG CREEK

ALCHERINGA GULLY

TOTAL LENGTH OF MAPPED WATERWAYS: 1.9 KMs

PRIMARY ORDER CREEKS: 0 KMs

SECOND ORDER CREEKS: 1.5KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.4 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

One site was sampled in Gymea Bay subcatchment:

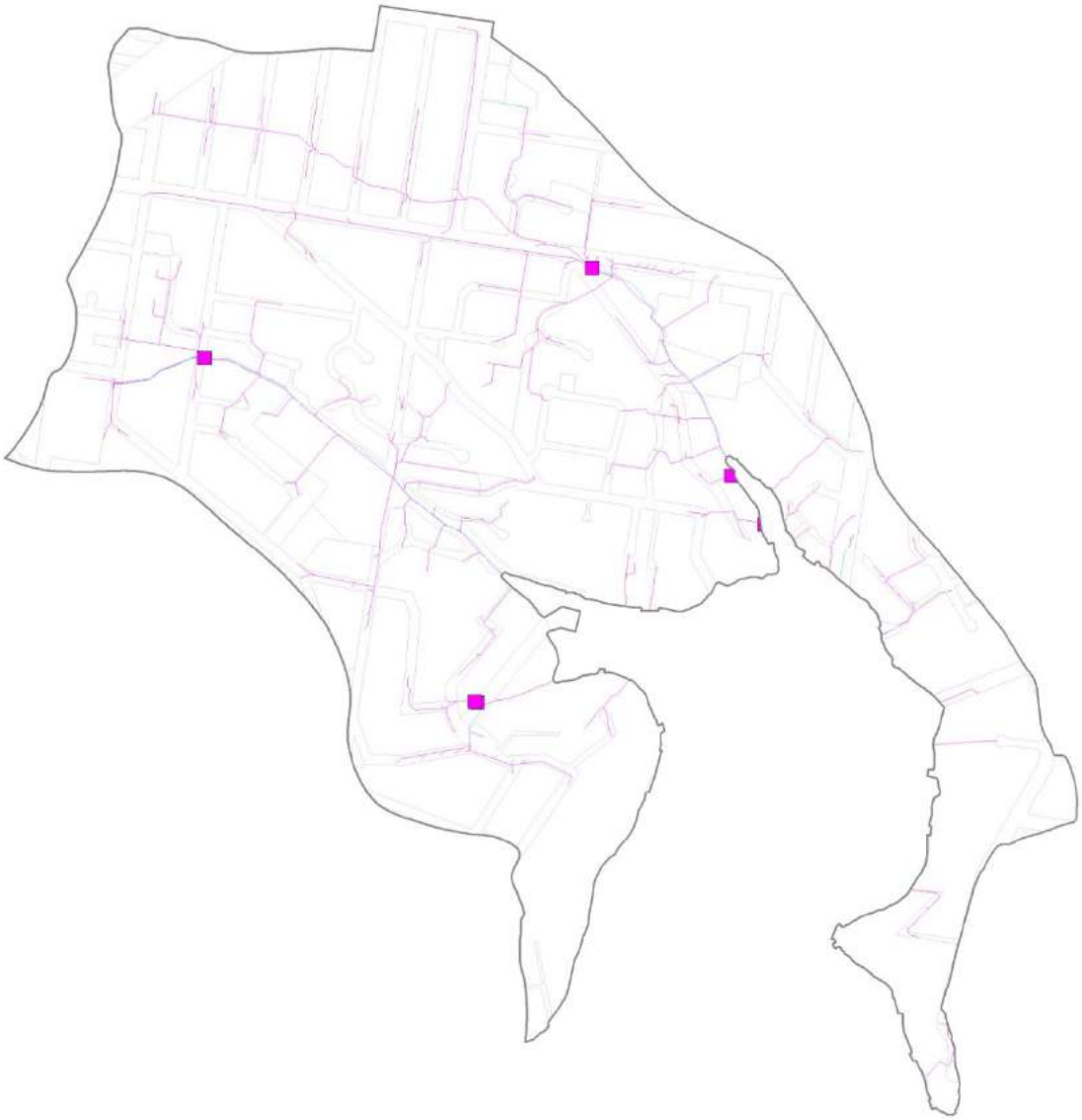
1. Coonong Creek

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	=	+	+	=
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**

SUMMER 95 +/- ANZECC 2000 values	-	=	+	-	+
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓

A reduction in values was recorded for all parameters sampled, so that all parameters were reported to be within ANZECC 2000 guideline limits at the end of the survey period.

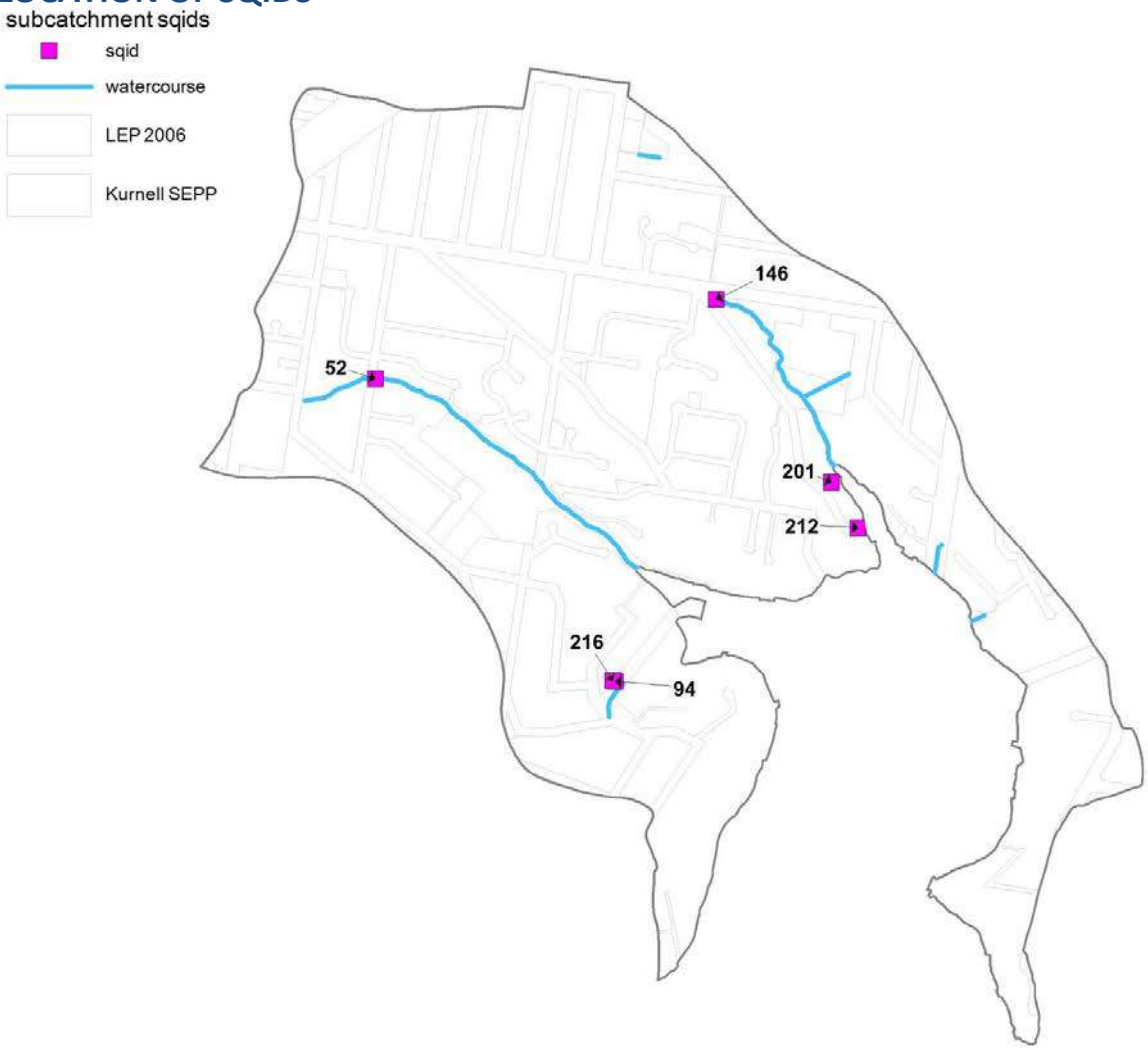
RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
52	GPT - Other	Trash Rack	Coonong Road	Coonong Creek	Gymea Bay	15 Ha
94	GPT	CDS	Ellesmere Road	In Bath Reserve	Gymea Bay	11.3 Ha
146	GPT - Other	Trash Rack	Alkaringa Road	Corner Alkaringa and Forest Road	Miranda	50 Ha
201	End of pipe trap	Nettech Device	42 Alkaringa Rd	Foreshore of property, end of pipe	Gymea Bay	1 Ha
212	GPT	Trash Rack	Gymea Bay	Foreshore of 58 Alkaringa Rd, Gymea Bay	Gymea Bay	
216	GPT - Other	Child Proof Grate	Ellesmere Road	In Bath Reserve	Gymea Bay	

LOCATION OF SQIDS



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Gymea Bay subcatchment landscape is predominantly Gymea Soil Landscape (gy), with minor areas of Mangrove Creek Soil Landscape (mc) below Alcheringa Gully outflow. Foreshores around Gymea Bay are Hawkesbury Soil Landscape (ha) (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

The catchment rises to a plateau at a maximum of 74m ASL from a minimum of 2m ASL at Port Hacking. The landform bounding Port Hacking is typically steep (slope is ~30+%).

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 5	125

Class 5 ASS/PASS areas fall within a 300m zone around the foreshores of Gymea Bay.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

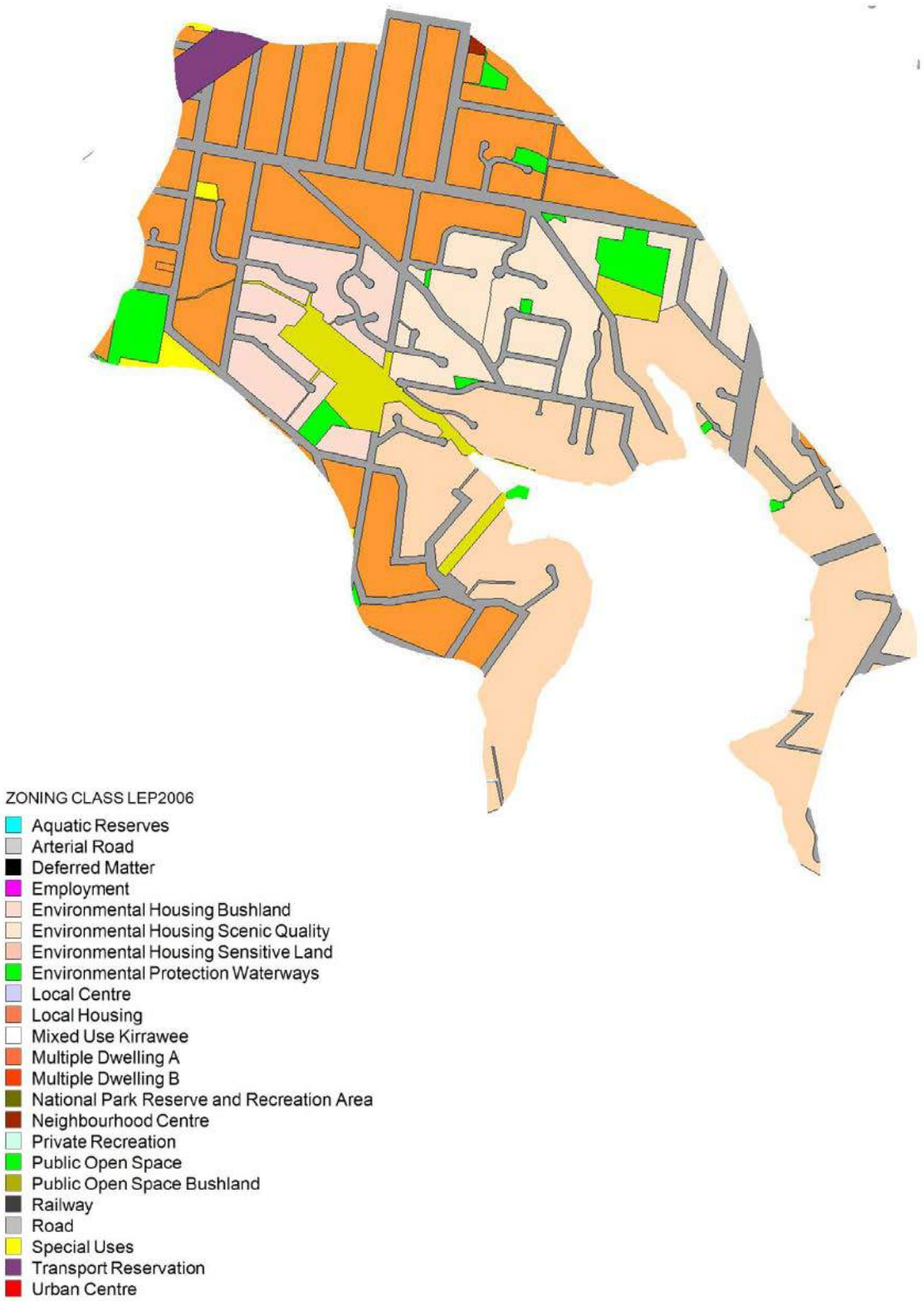
HISTORIC LAND USE

Gymea Bay was named in 1855 because of the presence of the plant (Lawrence, 1997). The giant Gymea lilies (*Doryanthes excelsa*) grow up to 3m in height, with a distinctive red to pink flower head with long, broad green leaves at the base. These leaves were used by aborigines to weave baskets, along with strips of cabbage tree palms (*Livistona australis*). In 1856 the first land sales commenced in the area, including SW Gray, remembered in the naming of nearby Grays Point. In 1897 George Smith acquired 5 acres where he operated the first dairy in the Shire. After milking the cows were released to wander down to drink at the creek before it entered the northwestern corner of Gymea Bay. This creek was originally called Stapleton's Creek after the local landholder who ran the abattoir and established a butchery at Sutherland. During the 1990s locals restored bushland around this creek and it was renamed Coonong, an aboriginal name meaning "running water".

Gymea Bay was a tranquil place with only a boatshed and, from the 1920s, a few holiday cottages. It could be accessed by water, or from the tram to Miranda and strolling down the dirt road. Koalas were common in the area between Gymea Bay and Sylvania Road. The first residential subdivision in this part of Port Hacking was at Gymea Bay in 1917, but these were isolated waterside dwellings with virtually no transport until a railway station opened in 1939. In general, it was a rural community with cows, chickens, orchards and vegetable gardens (Lawrence, 1997).

The post World War II period brought many changes, and in the 1950s new streets formed and skeleton house frames appeared in what had been bushland. Families moved in, businesses opened, along with shops, schools and a technical college.

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	57.67	28%	43%	24.80
Environmental Housing Scenic Quality	21.67	10%	57%	12.35
Environmental Housing Bushland	12.38	6%	57%	7.06
Local Housing	56.92	27%	51%	29.03
Multiple Dwelling A	0.00	0%	64%	0.00
Multiple Dwelling B	0.00	0%	64%	0.00
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	0.00	0%	94%	0.00
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.19	0%	86%	0.17
Employment	0.00	0%	95%	0.00
Special Uses	1.54	1%	46%	0.71
Public Open Space	6.91	3%	5%	0.35
Public Open Space Bushland	7.84	4%	0%	0.00
Private Recreation	0.00	0%	5%	0.00
Environmental Protection Waterways	0.53	0%	0%	0.00
Aquatic Reserves		0%	0%	0.00
National Park Reserve and Recreation Area	0.00	0%	0%	0.00
Railway		0%	33%	0.00
Arterial Road/Road	39.74	19%	66%	26.23
Transport Reservation	2.55	1%	5%	0.13
TOTAL	207.94	100%	48%	100.81

VEGETATION COMMUNITIES

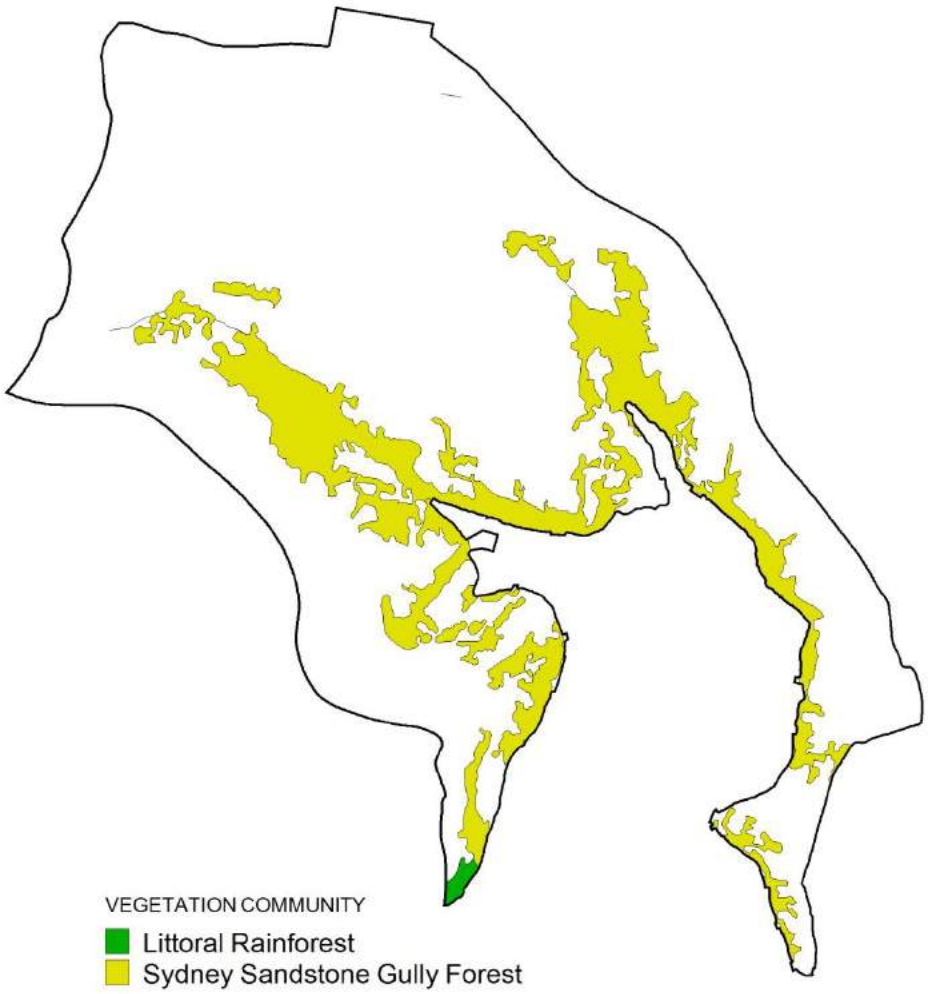
MAPPED VEGETATION COMMUNITIES

32.1 HECTARES SYDNEY SANDSTONE GULLY FOREST

0.5 HECTARES LITTORAL RAINFOREST

LEP 2006 SIGNIFICANT VEGETATION

T36 *Eucalyptus racemosa*_ghost gum	Significant Group of Trees or Vegetation
T33 *Eucalyptus*	Significant Group of Trees or Vegetation
T37 *Eucalyptus pilularis*_Blackbut	Significant Group of Trees or Vegetation
T38 *Eucalyptus pilularis*_Blackbut	Significant Group of Trees or Vegetation
T39 *Eucalyptus pilularis*_Blackbut	Significant Group of Trees or Vegetation
T40 *Eucalyptus microcorys* and *Lophostemon confertus*	Significant Group of Trees or Vegetation
T32 *Eucalyptus pilularis* and *Eucalyptus globoidea*	Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Ellesmere Rd/Bayhaven Place
- Coonong Creek Bushland
- Gymea Bay foreshores
- Wonga Rd/Alkaringa Rd/Forest Rd

2) Greenweb Support areas

- Coopernook Avenue/Ellesmere Rd, Gymea Bay
- Ellesmere Rd/Vernon Avenue/Matong Place
- Bunarba Rd/Valley Way/Alkaringa Rd/Sylvania Rd/Coonong Rd/Forest Rd
- Attunga Rd/Waratah Rd/Kiwong St/Maroopna Rd/Kiora Rd

3) Greenweb Restoration areas

- Coonong Rd/Gymea Bay Oval

Bushcare Groups

- Coopernook Avenue Reserve
- Gymea Bay Baths Reserve
- Coonong Creek Bushland
- Alcheringa Reserve
- Kiora Rd South Bushland, Yowie Bay

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization

- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

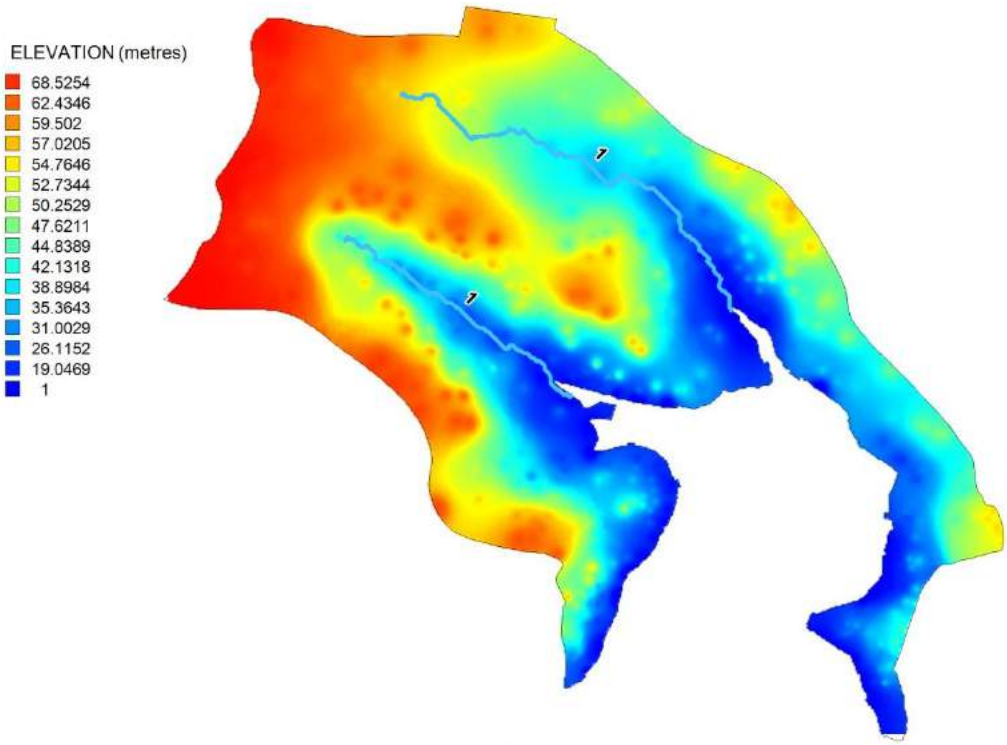
RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access

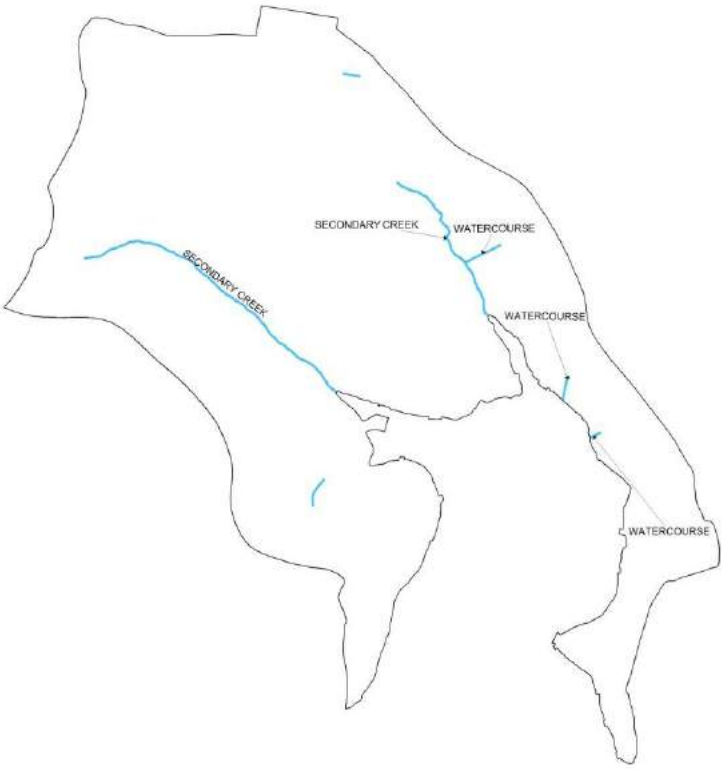
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP

CATCHMENT ELEVATION MODEL: STREAM ORDERS AND CATCHMENT BOUNDARY



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY

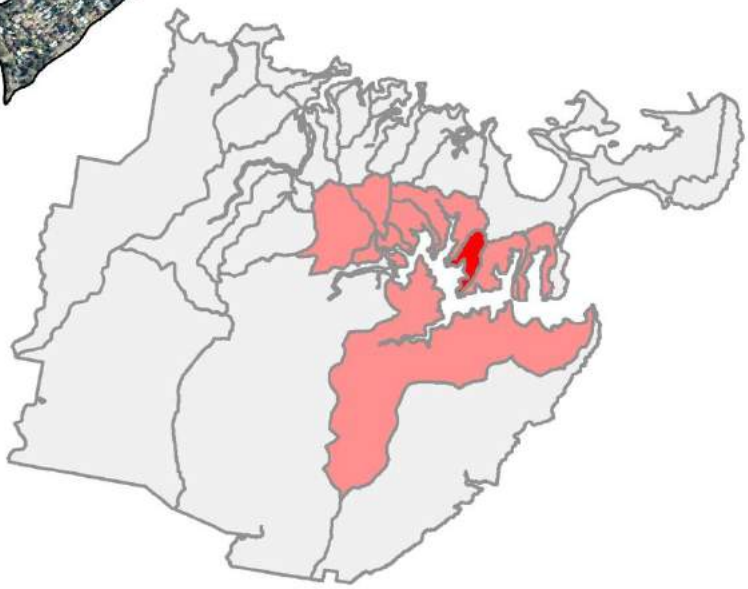


TURRIELL BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 1.6 KM^2

SUBURBS: CARINGBAH SOUTH



WATERWAYS

MAJOR NAMED WATERWAYS: NIL

TOTAL LENGTH OF MAPPED WATERWAYS: 0 .7 KMs

PRIMARY ORDER CREEKS: 0 KMs

SECOND ORDER CREEKS: 0.4 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.3 KMs

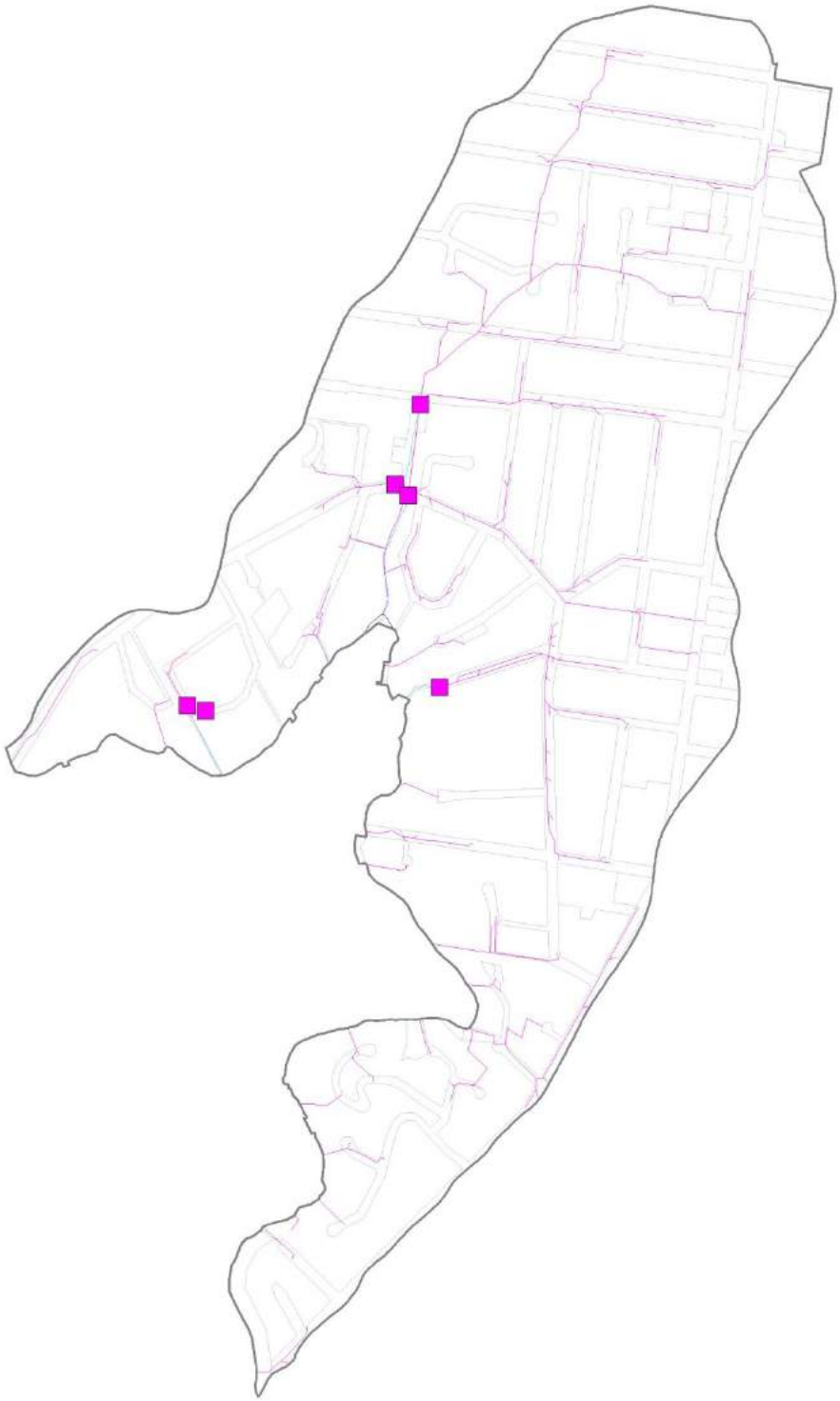
WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

No sites sampled in this subcatchment

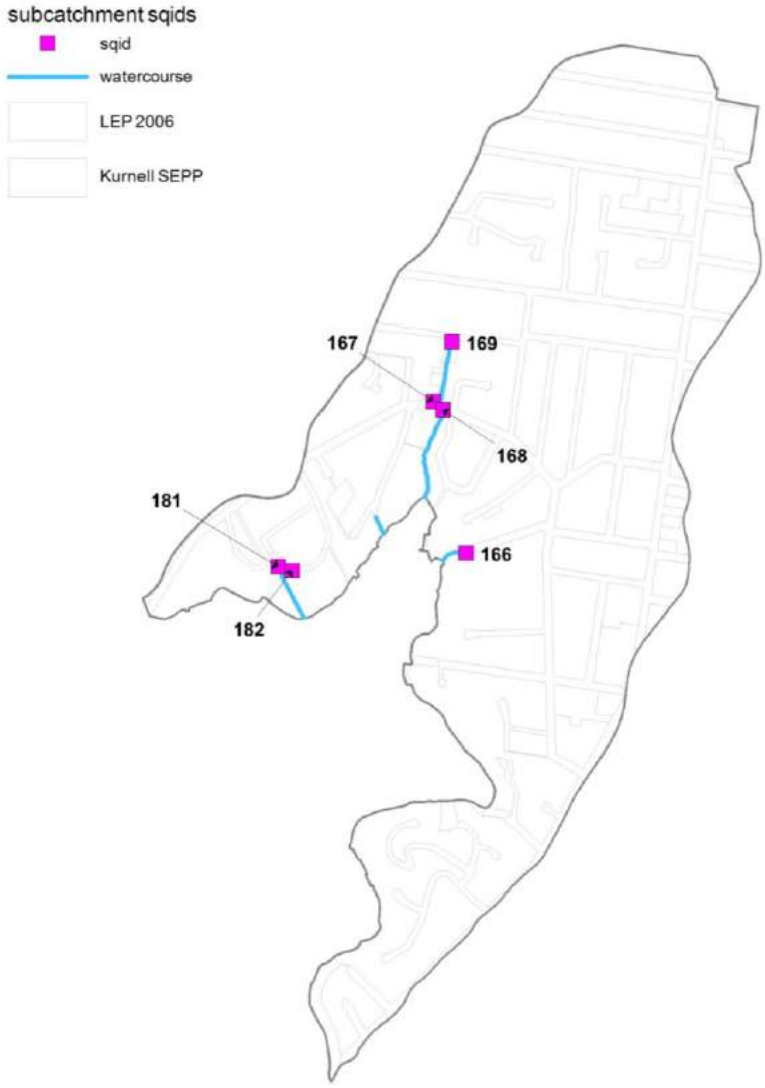
RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
166	End of pipe trap	Storm trap	Whites Avenue	End of road	Caringbah	11.6 Ha
167	GPT	CDS	Crescent Road	Road reserve	Caringbah	4.8 Ha
168	GPT	CDS	Crescent Road	Road reserve	Caringbah	15.6 Ha
169	GPT - Other	Trash Rack	Ash Avenue	Reserve	Caringbah	57.9 Ha
181	GPT - Other	Litter Basket	Beauford Avenue	Residential	Caringbah	0.39 Ha
182	GPT - Other	Litter Basket	Beauford Avenue	Residential	Caringbah	0.83 Ha

LOCATION OF SQIDS



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Turriell Bay subcatchment landscape is primarily Gymea Soil Landscape (gy), and foreshores in the area are Hawkesbury Soil Landscape (ha) (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

The catchment rises to a maximum of 66m ASL at its most northern boundary. The typical height of the plateau is between 40-55 m ASL dropping steeply to 4m ASL at Port Hacking with the two headlands at 55m ASL .

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 5	96

Class 5 ASS/PASS areas are located along the foreshore areas of Gannons Bay and Great Turriell Bay.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

Turriell Bay adjoins Turriell Point, originally called Tyrells Point. Like much of the land in the area, Turriell Bay and Turriell Point owned by John Connell who received the land as part of a grant in the 1830s. And, following the pattern for land in the surrounding catchments, this formed part of Thomas Holt's estate by the 1860s.

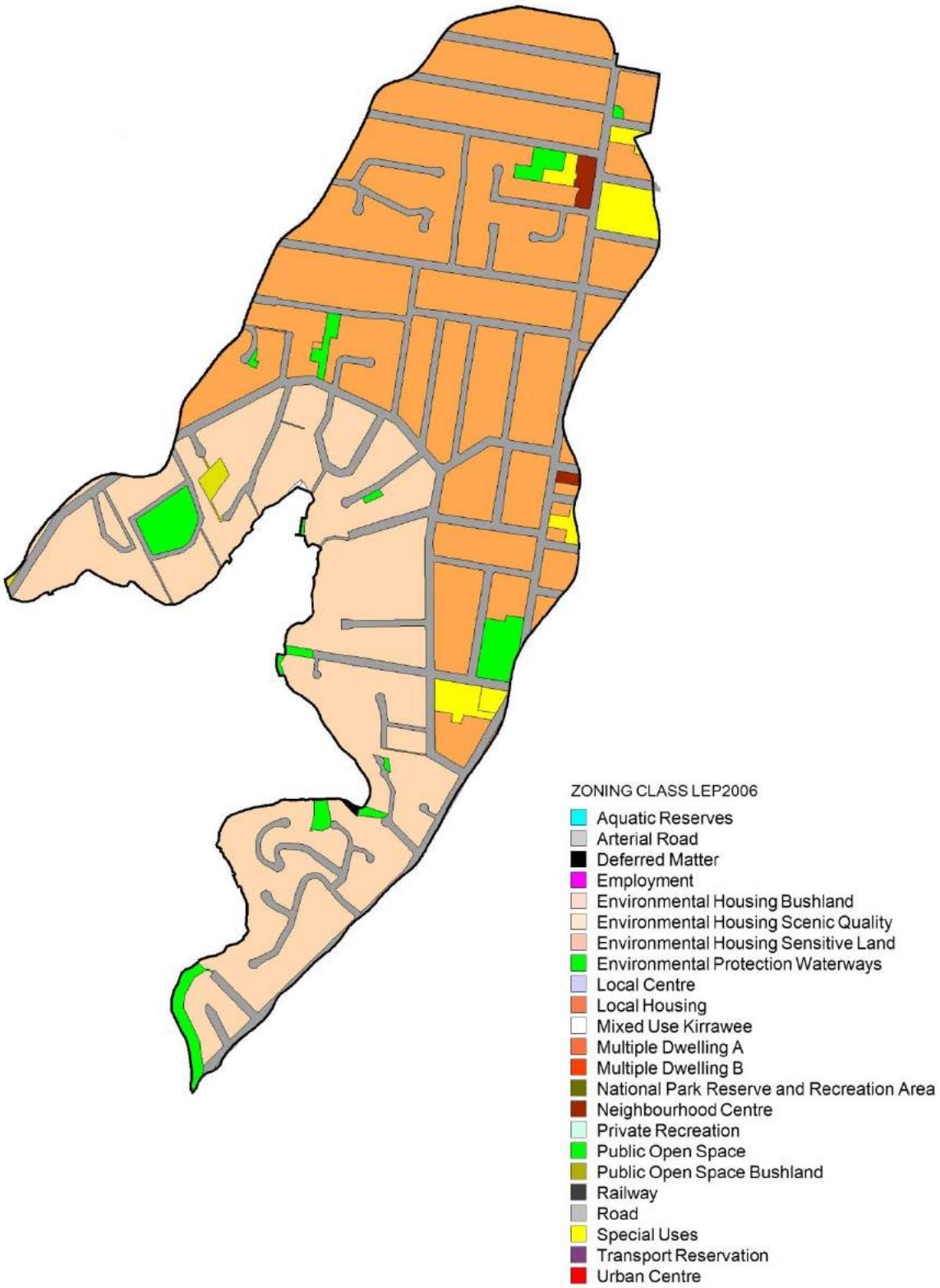
One of Holt's supervisors, Thomas Walker, described the Turriell Point area in 1868 as "Tiny Bay", with a fine view up and down the Port Hacking River (Kavanagh, 2004). The scrub was cleared back from the shoreline, and many trees had been ringbarked. Walker also remarked on the potential for fire in the piles of felled scrub and trees, and noted the fine paddocks of native and imported grass that were becoming established. In reality, Thomas Holt's practice of seeding imported grasses to "improve" the local pastures began a lengthy history of replacing native species with exotic species.

Walker named the small point adjoining Turriell Bay Lilli Pilli after the local myrtle trees, which were abundant in the area. Unlike most of the district, Lilli Pilli was not suitable for market gardening, but later became popular with weekend visitors and holiday makers. Lilli

Pilli Reserve is a narrow tract of land around the headland and was gazetted in the early 1900s. At this time there was little regard for bushland reserves, despite their tourist value, and they became dumping grounds for rubbish. In 1923 trees were hacked down and shrubs set on fire in Lilli Pilli Reserve. Fire became a frequent event, either deliberately lit or wildfires.

Many of the local families became related through marriage, with the Simpsons a good example. Edward Simpson was a nephew to John Want, a lawyer who operated the fish hatcheries in the area. Simpson was also a lawyer, and worked for Richardson and Wrench, who managed the sales of subdivisions in the area (Lawrence, 1997). He owned land around Little Turriell Bay in the 1880s, and this was later subdivided in the early 1900s as part of the growing land boom in the area. He built a sandstone house which later became known as Nuimburra, and this was restored along with its grounds in the 1980s and again in 2005.

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.07	0%	0%	0.00
Environmental Housing Sensitive Land	50.67	32%	43%	21.79
Environmental Housing Scenic Quality	0.00	0%	57%	0.00
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	66.60	42%	51%	33.97
Multiple Dwelling A		0%	64%	0.00
Multiple Dwelling B		0%	64%	0.00
Mixed Use Kirrawee		0%	64%	0.00
Urban Centre		0%	94%	0.00
Local Centre		0%	88%	0.00
Neighbourhood Centre	0.65	0%	86%	0.56
Employment		0%	95%	0.00
Special Uses	3.86	2%	46%	1.78
Public Open Space	5.53	3%	5%	0.28
Public Open Space Bushland	0.48	0%	0%	0.00
Private Recreation		0%	5%	0.00
Environmental Protection Waterways	0.21	0%	0%	0.00
Aquatic Reserves		0%	0%	0.00
National Park Reserve and Recreation Area		0%	0%	0.00
Railway	30.71	19%	33%	10.13
Arterial Road/Road		0%	66%	0.00
Transport Reservation		0%	5%	0.00
TOTAL	158.80	100%	43%	68.50

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

8.9 HECTARES SYDNEY SANDSTONE GULLY FOREST

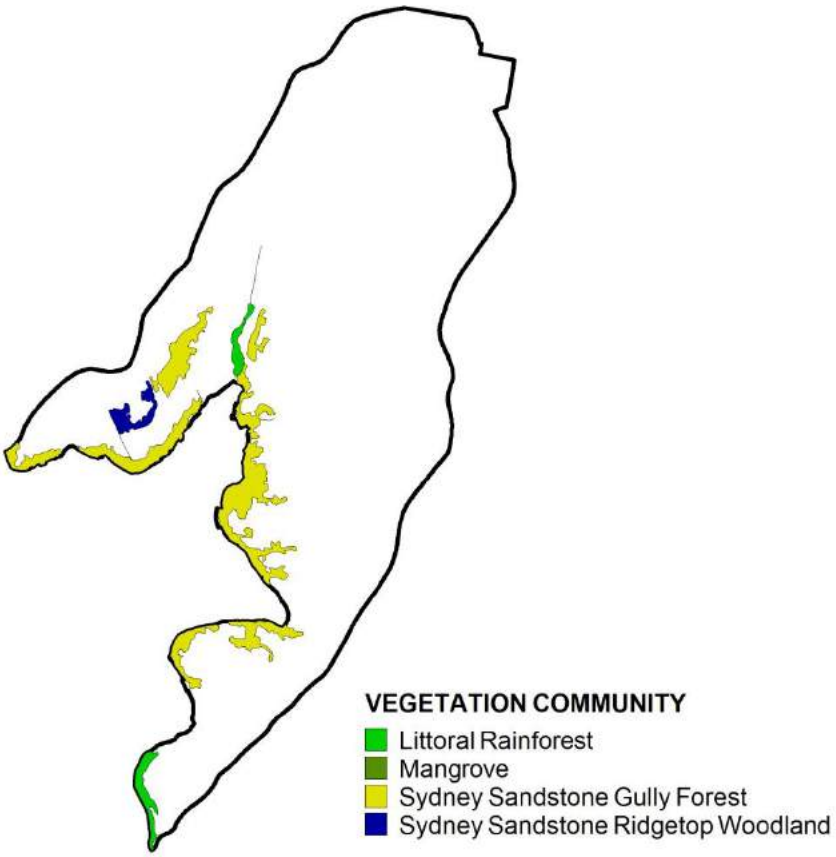
1.2 HECTARES LITTORAL RAINFOREST

0.8 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

0.01 HECTARES MANGROVE

LEP 2006 SIGNIFICANT VEGETATION

T52 Street Tree Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Willarong Point Foreshores
- Great Turriell Bay foreshores
- Gannons Bay foreshores
- Lilli Pilli Point Reserve

2) Greenweb Support areas

- Willarong Rd/Crescent Rd/Waring Ave/Beauford Ave/Bruce Ave/Dean St/Allambie Ave/Whites Ave/Mirral Rd/Turriell Bay Rd/Lilli Pilli Point Rd/Boomerang Ave/Randell Ave/Swan St/Koala Rd

3) Greenweb Restoration areas

- None noted

Bushcare Groups

- Turriell Bay Road Reserve
- Beauford Park
- Eden Place Reserve
- Buckinbah Place Reserve
- Boomerang Avenue Reserve No.1
- Lilli Pilli Point Baths Reserve

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization

- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

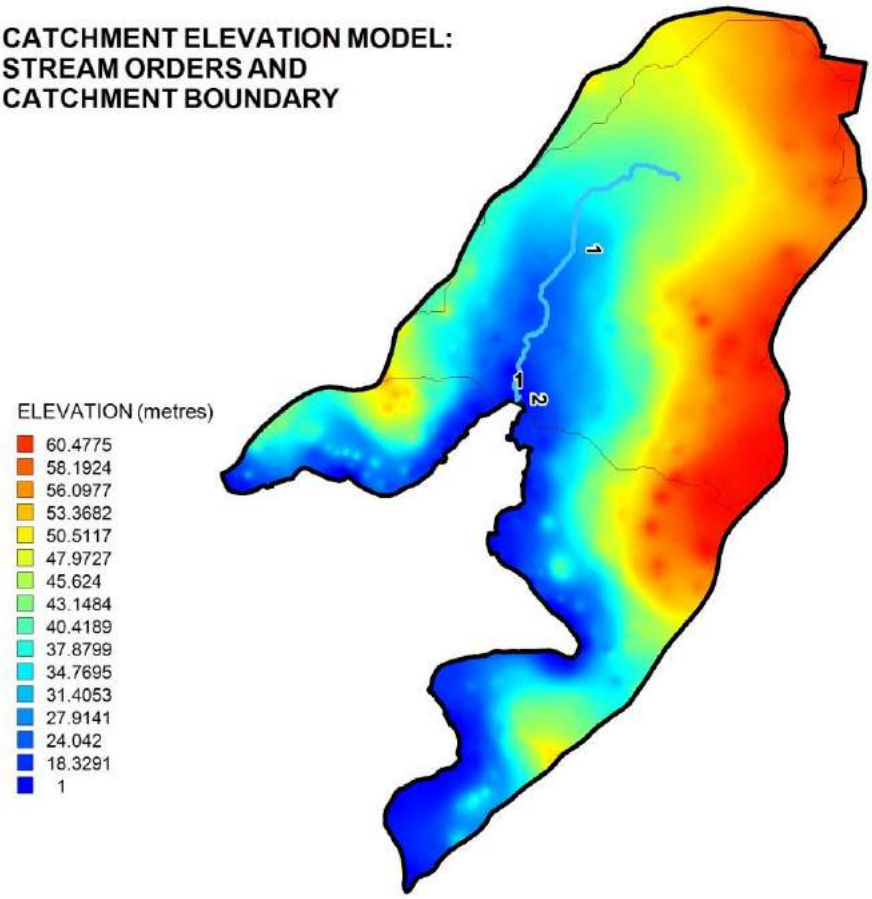
RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access

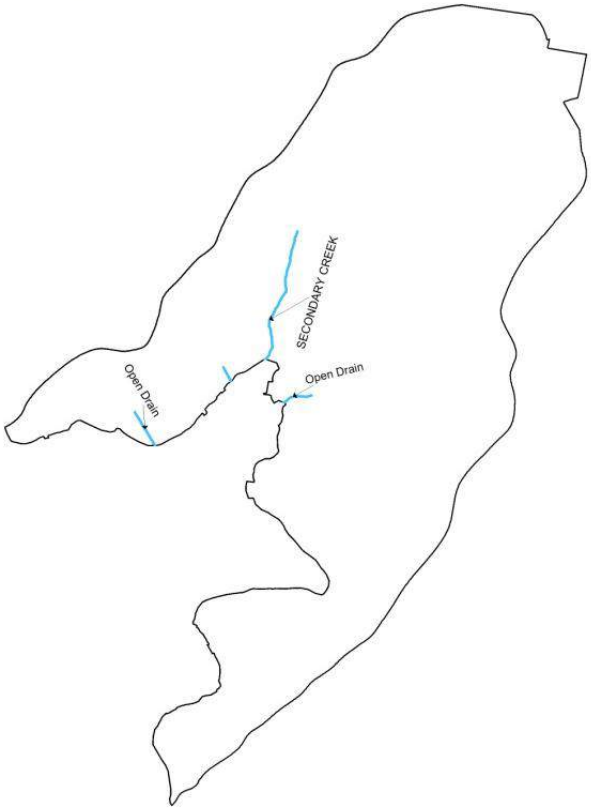
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP

CATCHMENT ELEVATION MODEL: STREAM ORDERS AND CATCHMENT BOUNDARY



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY



DENTS CREEK SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 2.3 KMs

SUBURBS: CARINGBAH SOUTH
GYMEA BAY
KIRRAWEE
GYMEA

WATERWAYS

MAJOR NAMED WATERWAYS: DENTS CREEK

TOTAL LENGTH OF MAPPED WATERWAYS: 2.6 KMs

PRIMARY ORDER CREEKS: 1.4 KMs

SECOND ORDER CREEKS: 0.8 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.4 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

One site was sampled in Dents Creek subcatchment:

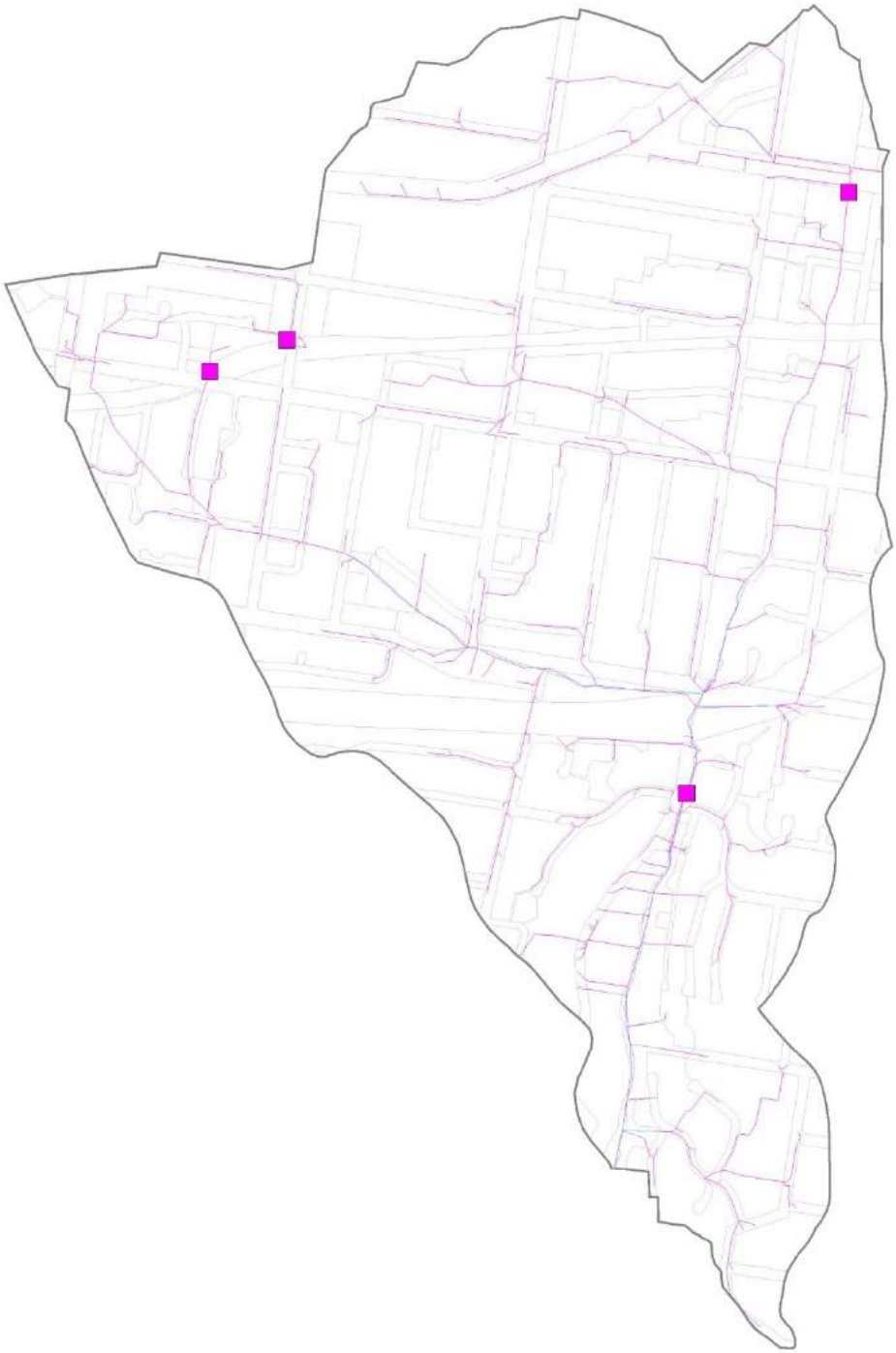
1. Dents Creek above North West Arm Rd

PARAMETER	NH3	BOD	Cu	Pb	Zn
WINTER 97 +/- ANZECC 2000 values	-	=	+	+	+
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	+
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**
WINTER 97	+	-	+	+	-

+/- ANZECC 2000 values					
WINTER 02 +/- ANZECC 2000 values	-	-	+	+	-
TREND ↓↑	↓	↓	↓	↓	=

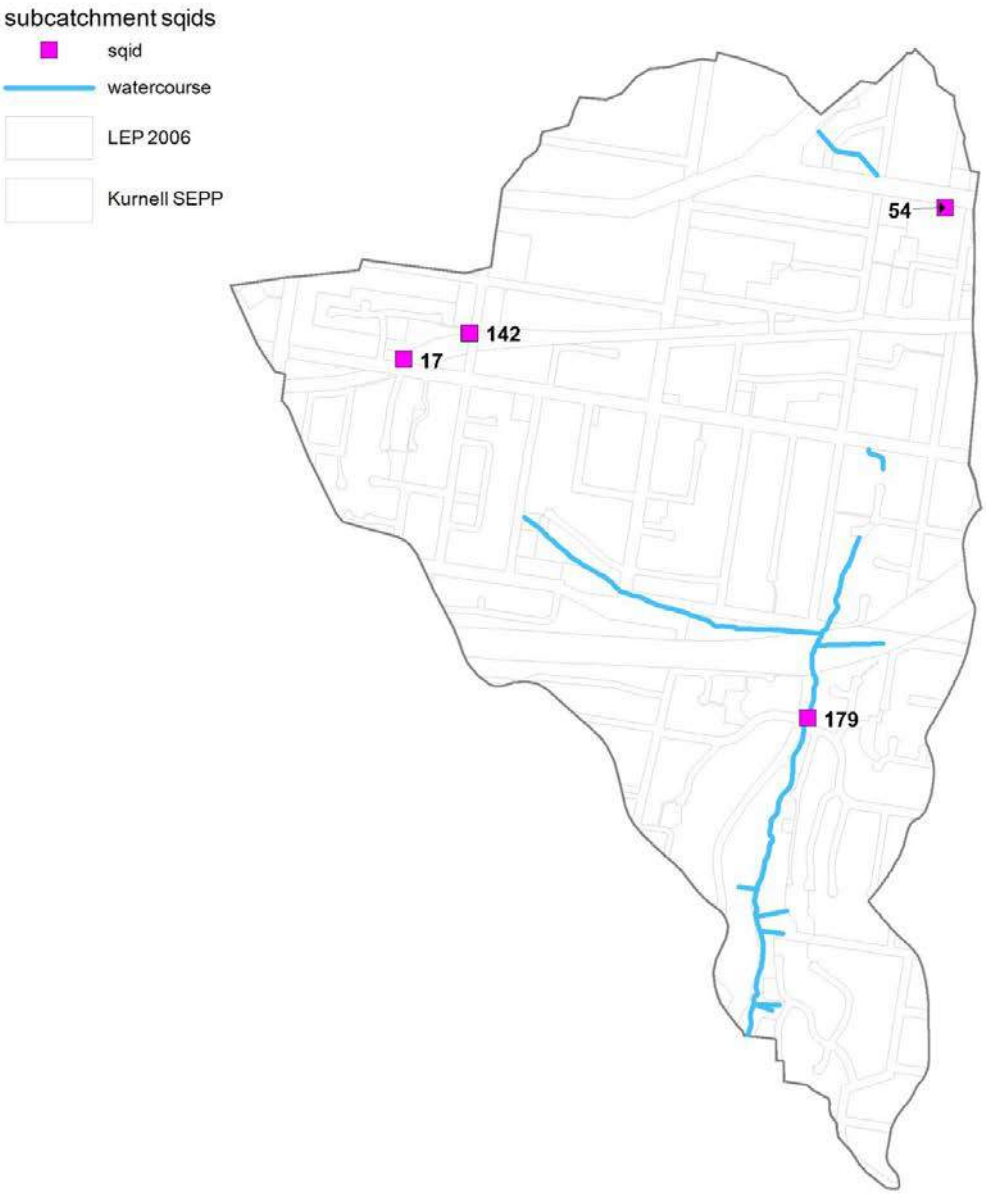
A reduction in values was recorded for MOST parameters sampled, so that all parameters except zinc, total phosphorus and total nitrogen were reported to be within ANZECC 2000 guideline limits at the end of the survey period.

RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
54	GPT - Other	Trash Rack	Kingsway	Hazelhurst Retreat	Gymea	30.2 Ha
17	GPT	Humeceptor	President Avenue	Access via Oak Road (Kirrawee Carpark at rear)	Kirrawee	0.84 Ha
142	GPT - Other	Litter Basket	Oak Road	Kirrawee Carpark (entrance to carpark)	Kirrawee	0.13 Ha
179	GPT - Other	Trash Rack	North West Arm Road	Dents Creek	Gymea	156 Ha



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Dents Creek subcatchment landscape is primarily Gymea Soil Landscape (gy) in the upper half of the subcatchment, with a minor area of Blacktown Soil Landscape (bt) towards Gymea. The downstream half of the subcatchment is Hawkesbury Soil Landscape (ha) (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

Dents Creek catchment rises to 110 m ASL in the north from a minimum of 4m ASL in the south. Watercourses generally run north-south in the southern part of the catchment bisecting the plateau which typically sits between 50-70 m ASL.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 5	8.9

Minor areas of Class 5 ASS/PASS are mapped around Coonong Creek Bushland, within a zone 300m from the foreshores of Gymea Bay. Areas immediately within the riparian corridor are mapped as Class 4 ASS/PASS.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

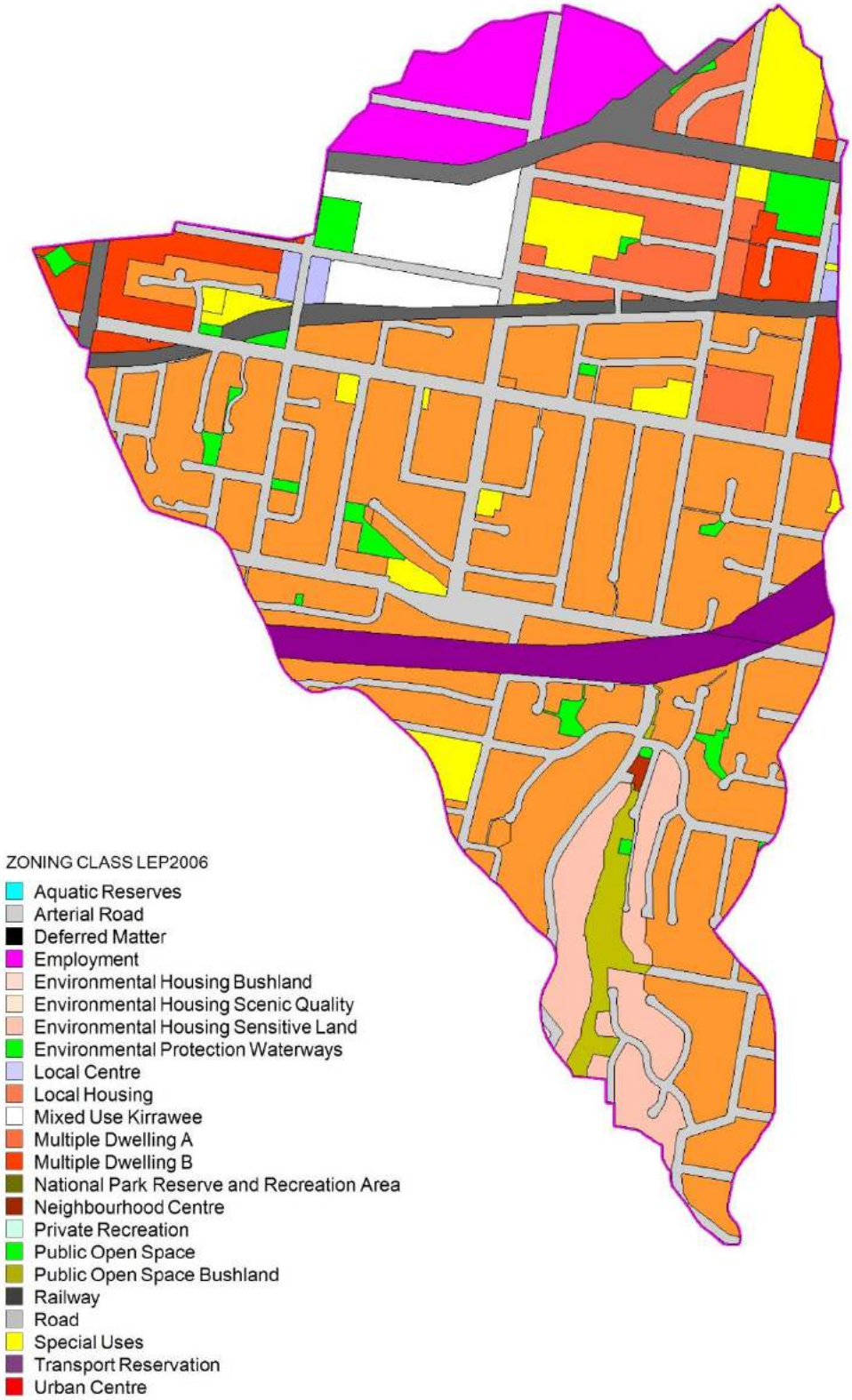
HISTORIC LAND USE

Dents Creek is named for a driller, Fred Dent, who was considered to be skilled in the use of a diamond tipped drill. He was employed by Thomas Holt in 1861 to drill exploration bores for coal along what is now Dents Creek, but was unsuccessful. Proclamation of the National Park ruled out further exploration in the area. Early settlers in the area included Henry Derrey and his wife Marie. They built a small house and started a market garden on their three acre block. This block remained in use as a market garden until the 1980s (Barton & Turner, 2011). On the eastern side of North West Arm dairy farmers in the 1920s allowed their cattle to graze across to Dents Creek (Lawrence, 1997).

In the 1920s a large stately home was constructed in the upper reaches of Dents Creek. The Hotham Farm homestead still stands at the corner of President Avenue and Hotham Road. The farm was 20 acres, and bred chickens using the latest technology including battery powered incubation facilities.

In 1911 Bob Dashwood hacked a path through the bush alongside Dents Creek to his property near North West Arm. He maintained the track for a decade, and it later became North West Arm Road. When the Savilles Creek Bridge was opened in 1922 the Holt-Sutherland Estate Company decided to widen the road to 20 feet, believing that this would entice more buyers to Holt subdivisions in the area (Barton & Turner, 2011).

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	10.02	4%	43%	4.31
Environmental Housing Scenic Quality	0.00	0%	57%	0.00
Environmental Housing Bushland	0.02	0%	57%	0.01
Local Housing	93.13	40%	51%	47.50
Multiple Dwelling A	12.80	6%	64%	8.19
Multiple Dwelling B	8.59	4%	64%	5.50
Mixed Use Kirrawee	8.83	4%	64%	5.65
Urban Centre	0.00	0%	94%	0.00
Local Centre	1.20	1%	88%	1.05
Neighbourhood Centre	0.18	0%	86%	0.16
Employment	11.81	5%	95%	11.22
Special Uses	11.00	5%	46%	5.06
Public Open Space	5.13	2%	5%	0.26
Public Open Space Bushland	3.29	1%	0%	0.00
Private Recreation	0.00	0%	5%	0.00
Environmental Protection Waterways	0.00	0%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	0.00	0%	0%	0.00
Railway	4.67	2%	33%	1.54
Arterial Road/Road	51.42	22%	66%	33.94
Transport Reservation	9.18	4%	5%	0.46
TOTAL	231.27	100%	54%	124.84

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

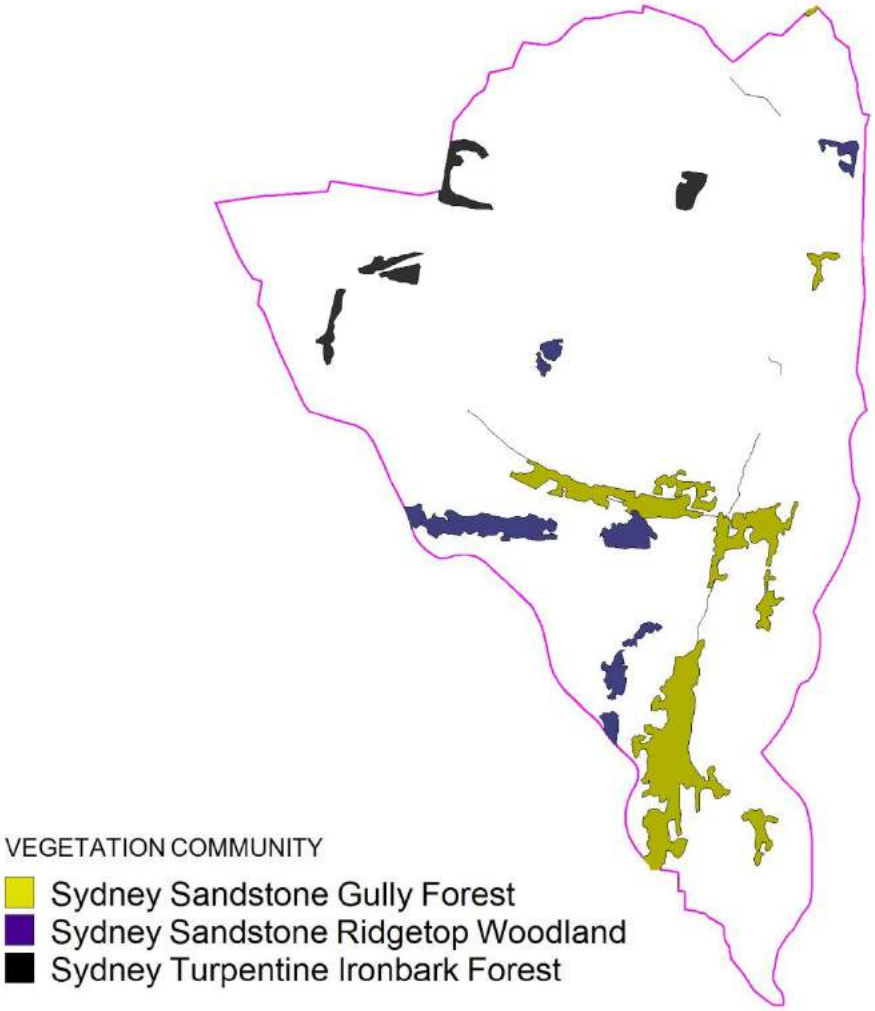
10.9 HECTARES SYDNEY SANDSTONE GULLY FOREST

4.5 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

2.4 HECTARES OF SYDNEY TURPENTINE IRONBARK FOREST

LEP 2006 SIGNIFICANT VEGETATION

T30 *Eucalyptus microcorys/E.pilularis* Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Dents Creek Reserve

2) Greenweb Support areas

- North West Arm Road/Narooma Place

3) Greenweb Restoration areas

- Gymea Bay Oval and surrounding streets
- Hunter Street Reserve and surrounding streets
- Johnstone Avenue Reserve

Bushcare Groups

- Dents Creek Reserve
- Forest Road Closure

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution

- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

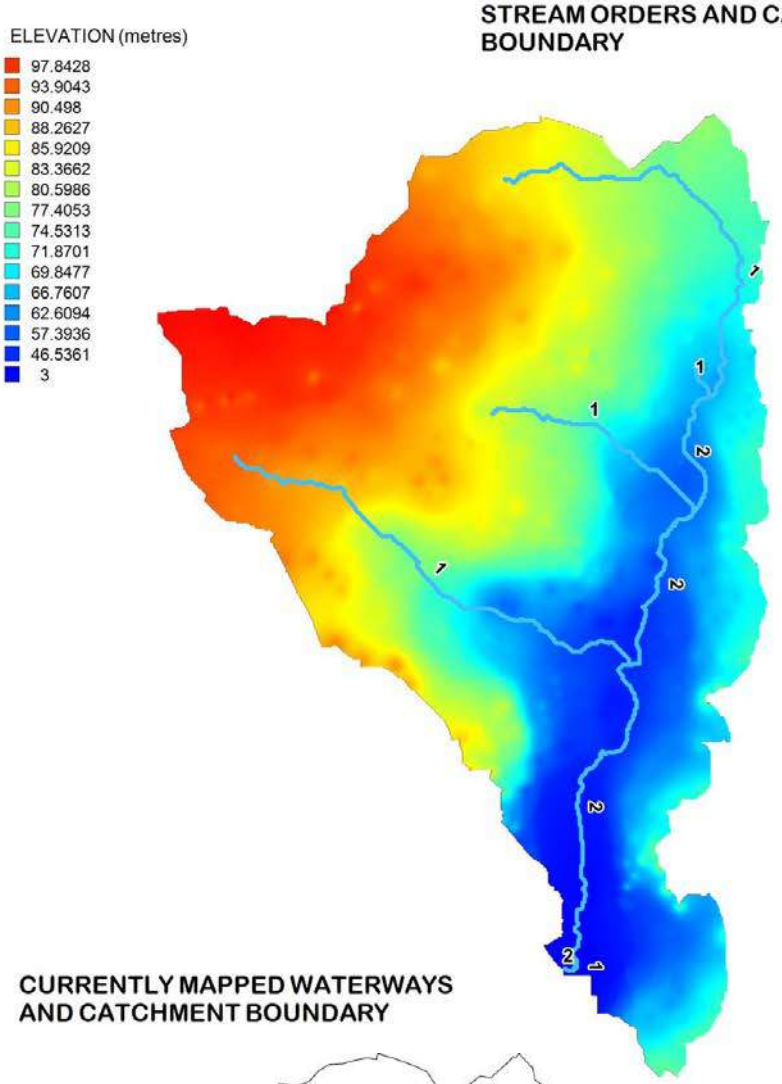
RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species

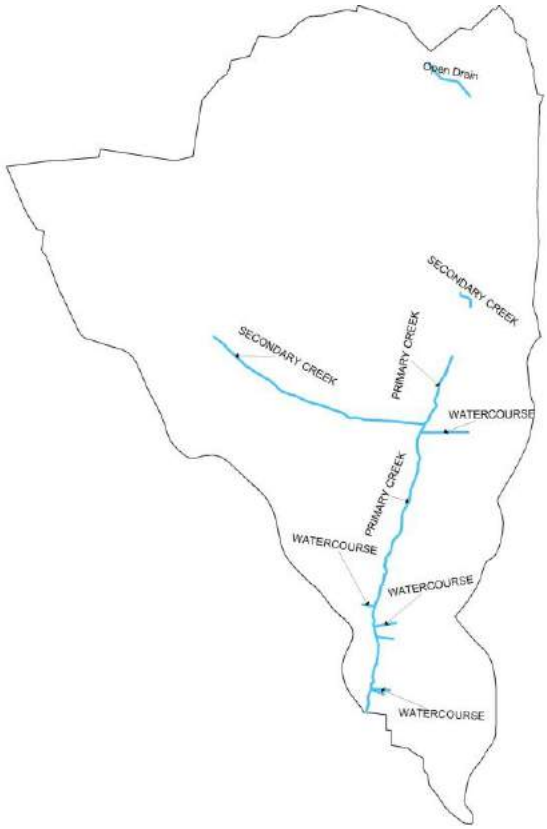
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP

CATCHMENT ELEVATION MODEL: STREAM ORDERS AND CATCHMENT BOUNDARY



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY



SAVILLE CREEK SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 6.2KMs

SUBURBS: SUTHERLAND

KIRRAWEE

GRAYS POINT

WATERWAYS

MAJOR NAMED WATERWAYS: SAVILLE CREEK

TOTAL LENGTH OF MAPPED WATERWAYS: 3.4 KMs

SECOND ORDER CREEKS: 2.1 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 1.3 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

One site was sampled in Savilles Creek subcatchment:

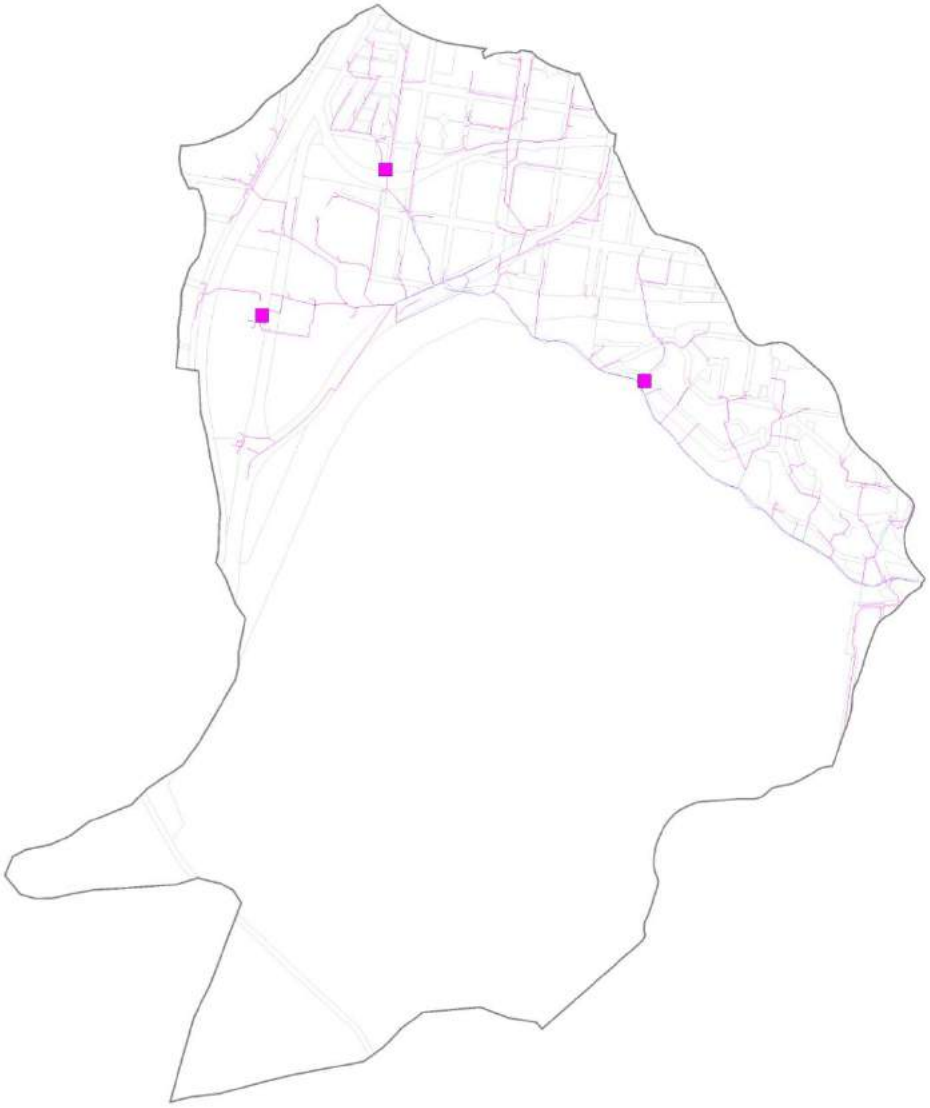
1. Savilles Creek

PARAMETER	NH3	BOD	Cu	Pb	Zn
WINTER 95 +/- ANZECC 2000 values	+	+	+	+	=
WINTER 02 +/- ANZECC 2000 values	+	-	+	-	+
TREND ↓↑	=				↑
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**
WINTER 95 +/- ANZECC 2000 values	+	=	+	-	-

WINTER 02 +/- ANZECC 2000 values	+	-	-	-	+
TREND ↓↑	↑			=	↑

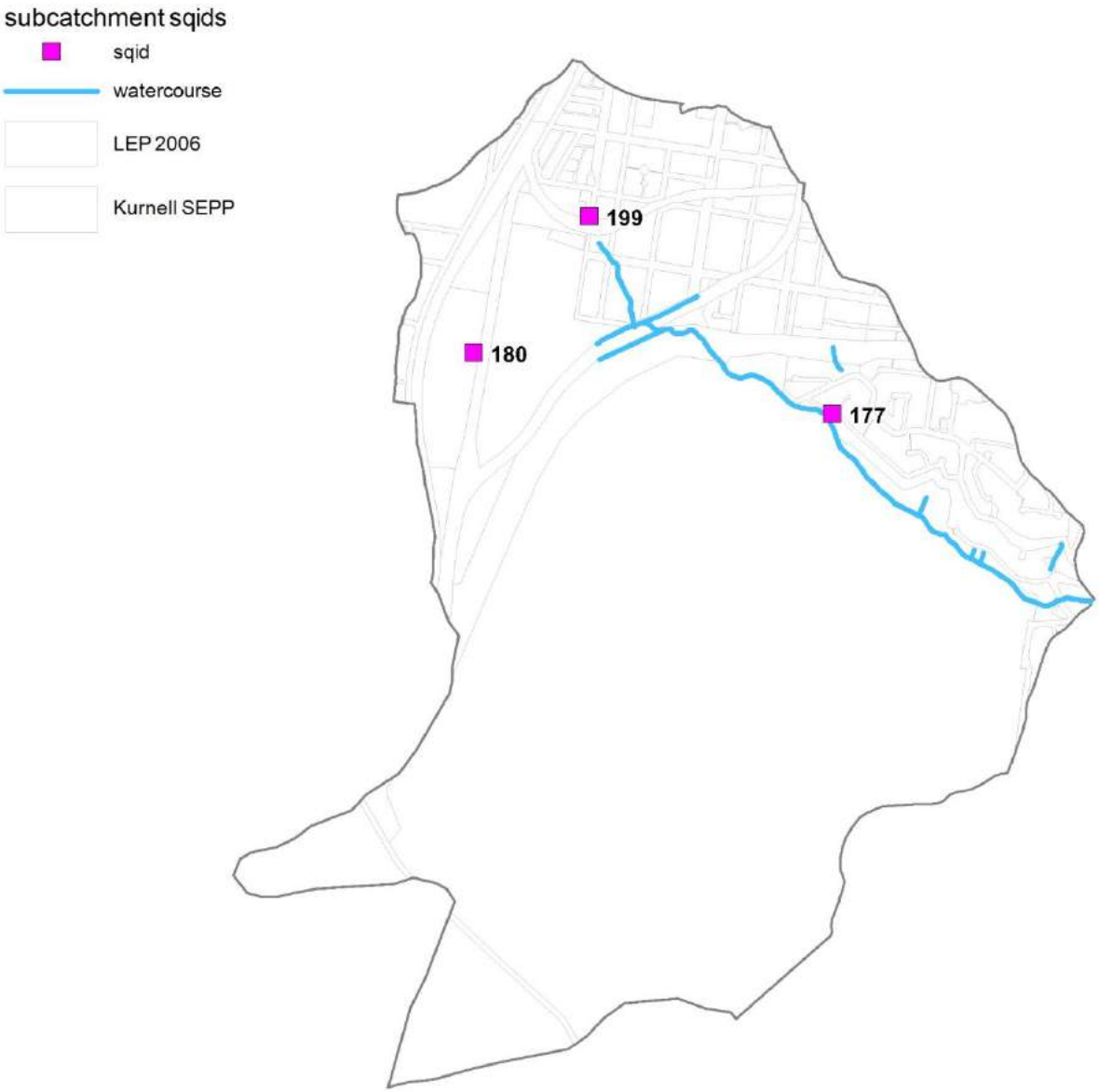
A number of parameters showed an increase in values during the survey period, including zinc, enterococci and total suspended solids. Decreases in values for other parameters were reported, a number of which were within ANZECC 2000 guideline values at the end of the survey period.

RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
177	GPT - Other	Trash Rack	Gore Avenue	Savilles Creek	Kirrawee	19.5 Ha
180	GPT - Other	Trash Rack	Rawson Avenue	SSHED Business Incubator	Loftus	6.8 Ha
199	GPT	Stormwater 360 Vortech	Eton St	End of Eton St near Scout Hall	Sutherland	8.8 Ha



GEOLOGY, GEOMORPHOLOGY AND SOILS

GEOLOGY, GEOMORPHOLOGY AND SOILS

Savilles Creek subcatchment landscape in the upper half is primarily Gymea Soil Landscape (gy), with minor areas of Disturbed Terrain (xx) around Sutherland suburb. Ridge tops south of Savilles Creek are Lucas Heights Soil Landscape (lh), while the downstream half of the subcatchment is Hawkesbury Soil Landscape (ha) (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

The headwaters of Saville creek are located in the north west of the catchment at an elevation of ~85m ASL dropping to 7m ASL as the creek nears its confluence with Dents Creek at Port Hacking. Much of the development in the catchment occurs to the north of Saville Creek on a plateau at ~90m ASL.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 5	37

Minor areas of Class 5 ASS/PASS have been mapped in the lower part of the Savilles Creek subcatchment within a 300m zone around the foreshores of Gymea Bay. Areas immediately within the riparian corridor are mapped as Class 4 ASS/PASS.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

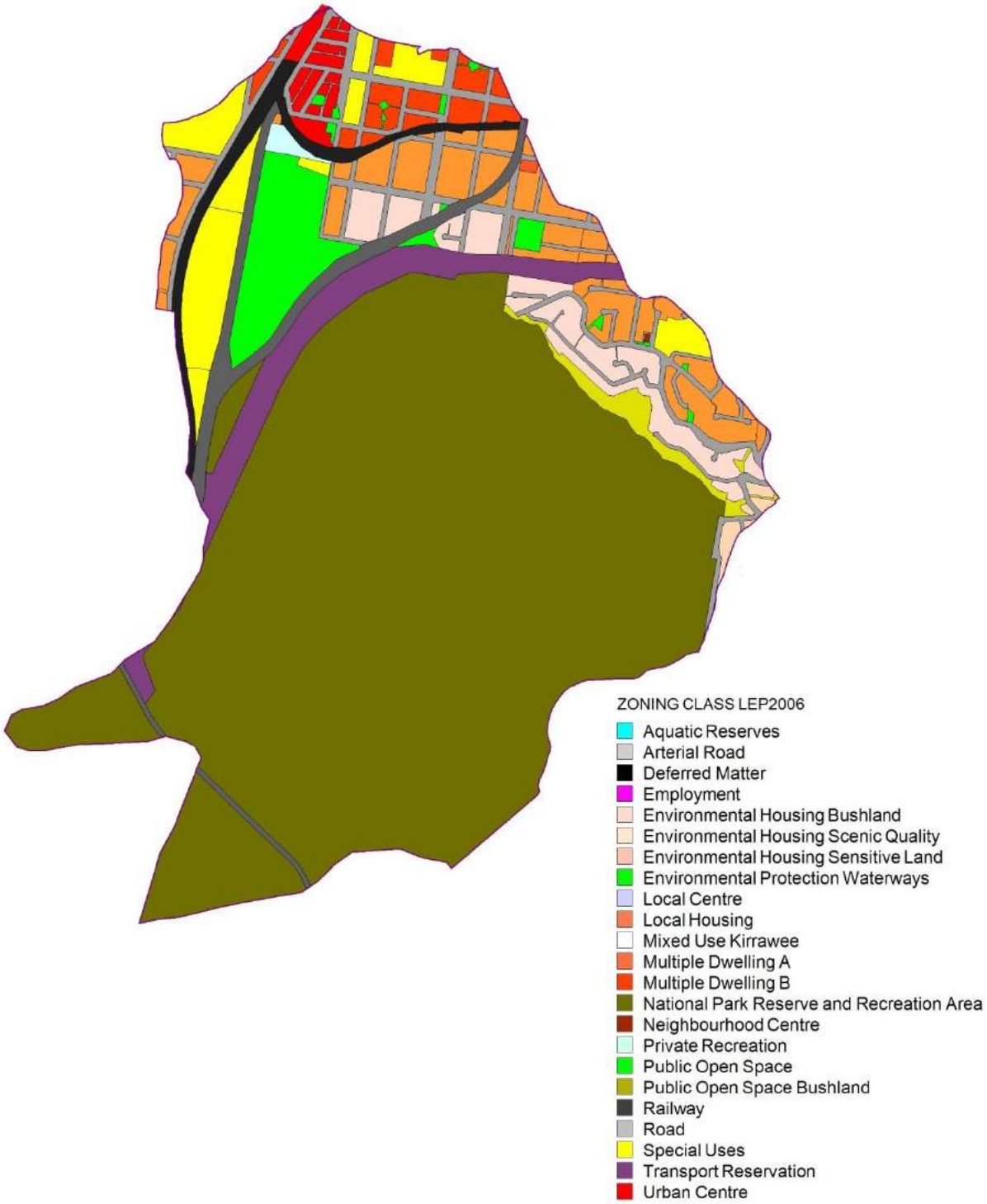
HISTORIC LAND USE

Much of Savilles Creek catchment is retained in the Royal National Park, although land to the north of the creek is part of the suburbs of Kirrawee and Sutherland. Saville Creek meets Dents Creek in what was once a pristine pool, described in the 1870s as a deep, crystal clear swimming hole surrounded by sandy beaches and groves of swamp oaks. The area was secluded and miles from any human habitation (Barton & Turner, 2011). In 1922 a Baptist holiday camp was built on the western side of the creek. Other swimming holes were common along the creeks in the area, and these became more popular with the opening of the Savilles Creek Bridge in 1922.

Another large pool was located on the upper reaches of Savilles Creek near Stapleton's slaughter yards, near the national park. These swimming holes were popular well into the 1950s when they were replaced with a chlorinated pool at Sutherland. Development around

Savilles Creek was limited to the northern side, and from the 1920s comprised small fibro houses spread through the bush. Many of these began as weekenders, but during the Depression they became permanent homes for families that eked out a living in the area. Many of these blocks functioned as small farms, supplying fruit and vegetables, milk, butter, jams, cakes and bread to families around Sutherland.

CURRENT LAND USE



CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATHCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	2.44	0%	43%	1.05
Environmental Housing Scenic Quality	0.00	0%	57%	0.00
Environmental Housing Bushland	22.90	4%	57%	13.05
Local Housing	36.62	6%	51%	18.67
Multiple Dwelling A	0.32	0%	64%	0.20
Multiple Dwelling B	10.83	2%	64%	6.93
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	6.77	1%	94%	6.36
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.07	0%	86%	0.06
Employment	0.00	0%	95%	0.00
Special Uses	28.07	5%	30%	8.42
Public Open Space	24.45	4%	5%	1.22
Public Open Space Bushland	6.43	1%	0%	0.00
Private Recreation	1.54	0%	5%	0.08
Environmental Protection Waterways	1.54	0%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	390.78	63%	0%	0.00
Railway	11.38	2%	33%	3.76
Arterial Road/Road	52.38	8%	66%	34.57
Transport Reservation	23.94	4%	5%	1.20
TOTAL	620.45	100%	15%	95.58

VEGETATION COMMUNITIES

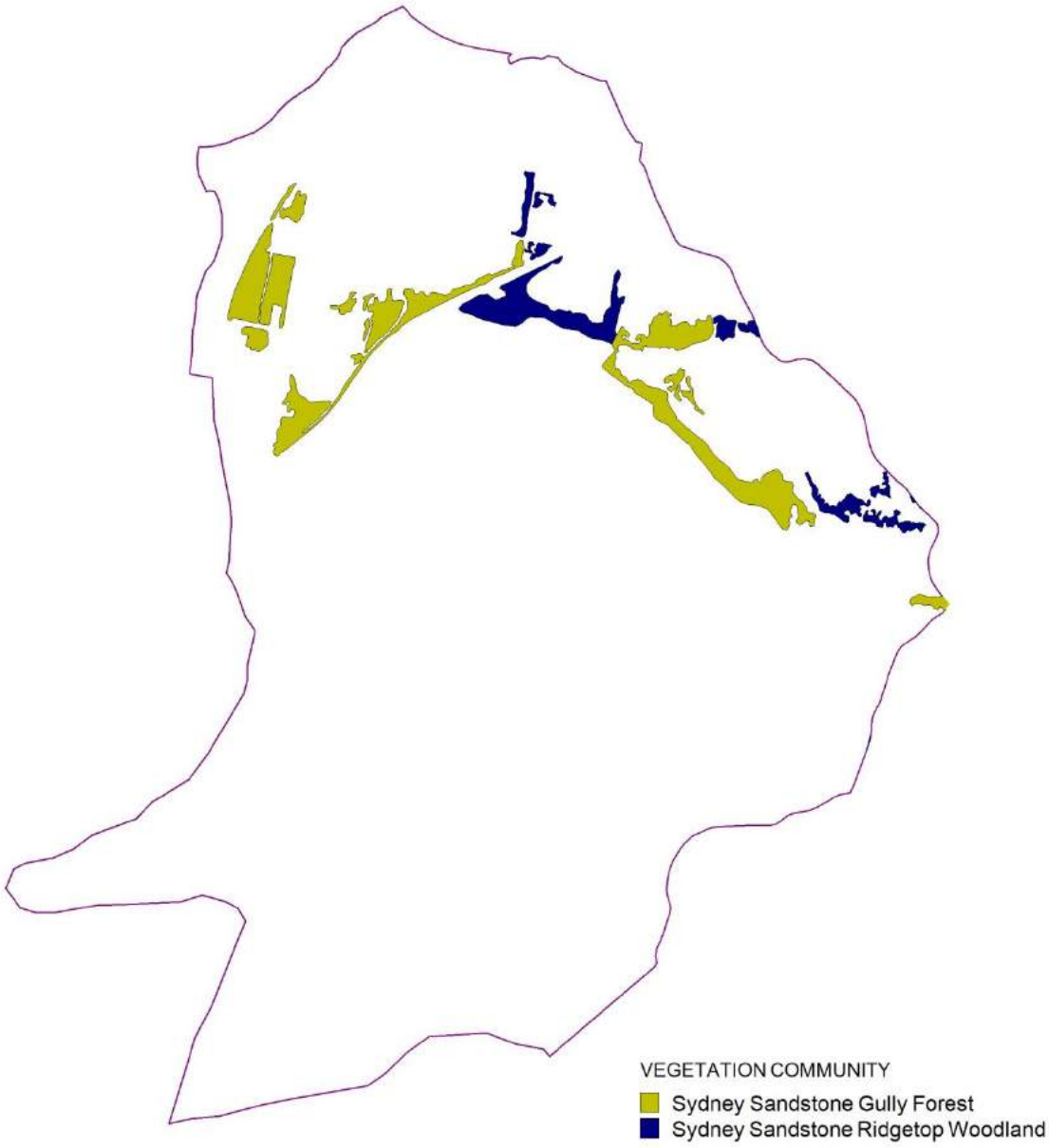
MAPPED VEGETATION COMMUNITIES

18.7 HECTARES SYDNEY SANDSTONE GULLY FOREST

7.9 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

LEP 2006 SIGNIFICANT VEGETATION

T23 *Ficus Rubiginosa*_Port Jackson Fig Tree Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Savilles Creek Reserve
- Waratah Park

2) Greenweb Support areas

- Gore Avenue, Kirrawee
- Grafton St, Kirrawee

3) Greenweb Restoration areas

- Mundakal Reserve and surrounding streets

Bushcare Groups

- Savilles Creek Reserve
- Pollard Place, Kirrawee
- Grafton Street, Sutherland
- Bee Keepers, Sutherland
- Rawson Avenue, Sutherland
- Kirrawee Avenue Reserve

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel

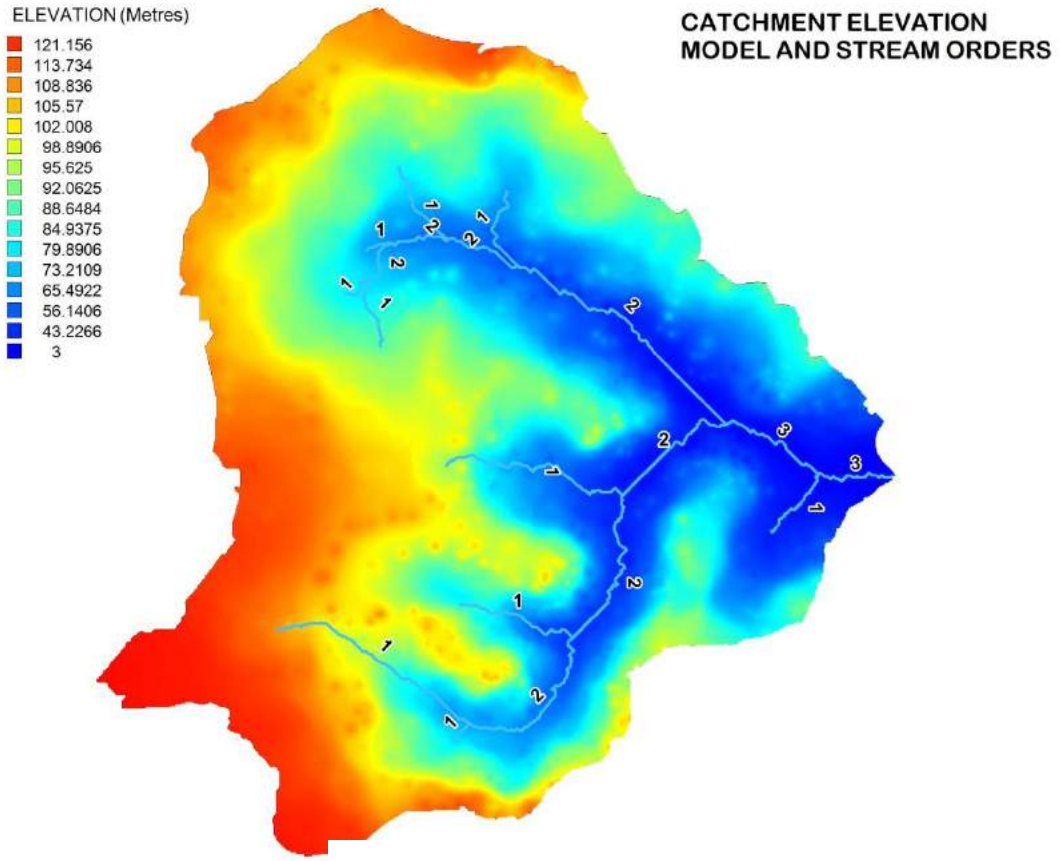
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

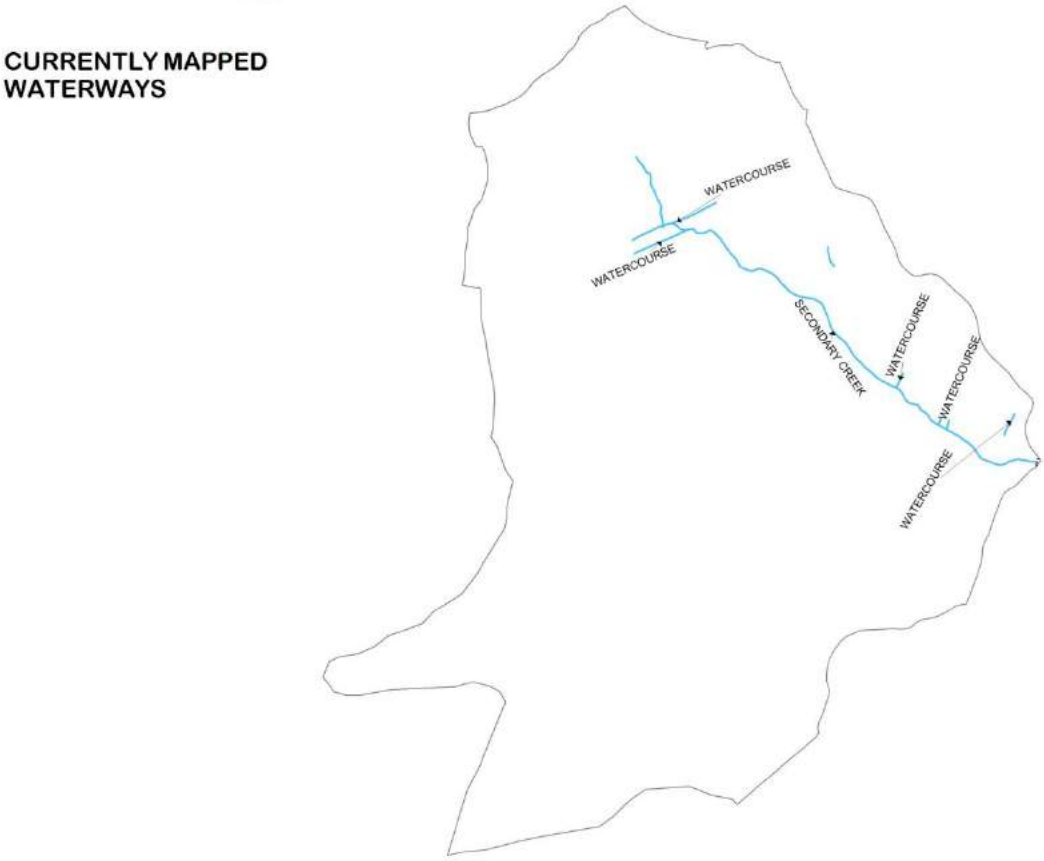
RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species

- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP





NORTH WEST ARM SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 1.9 KM^2 (184.8 HECTARES)

SUBURBS: GRAYS POINT

GYMEA BAY

WATERWAYS

MAJOR NAMED WATERWAYS: DENTS CREEK

TOTAL LENGTH OF MAPPED WATERWAYS: 1.3 KMs

PRIMARY CREEKS: 0.57 KMs

SECOND ORDER CREEKS: 0.25KMs

FIRST ORDER & MINOR DRAINAGE LINES: 0.33 KMs

OPEN DRAINS: 0.16 KMs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

One site was sampled in North West Arm subcatchment:

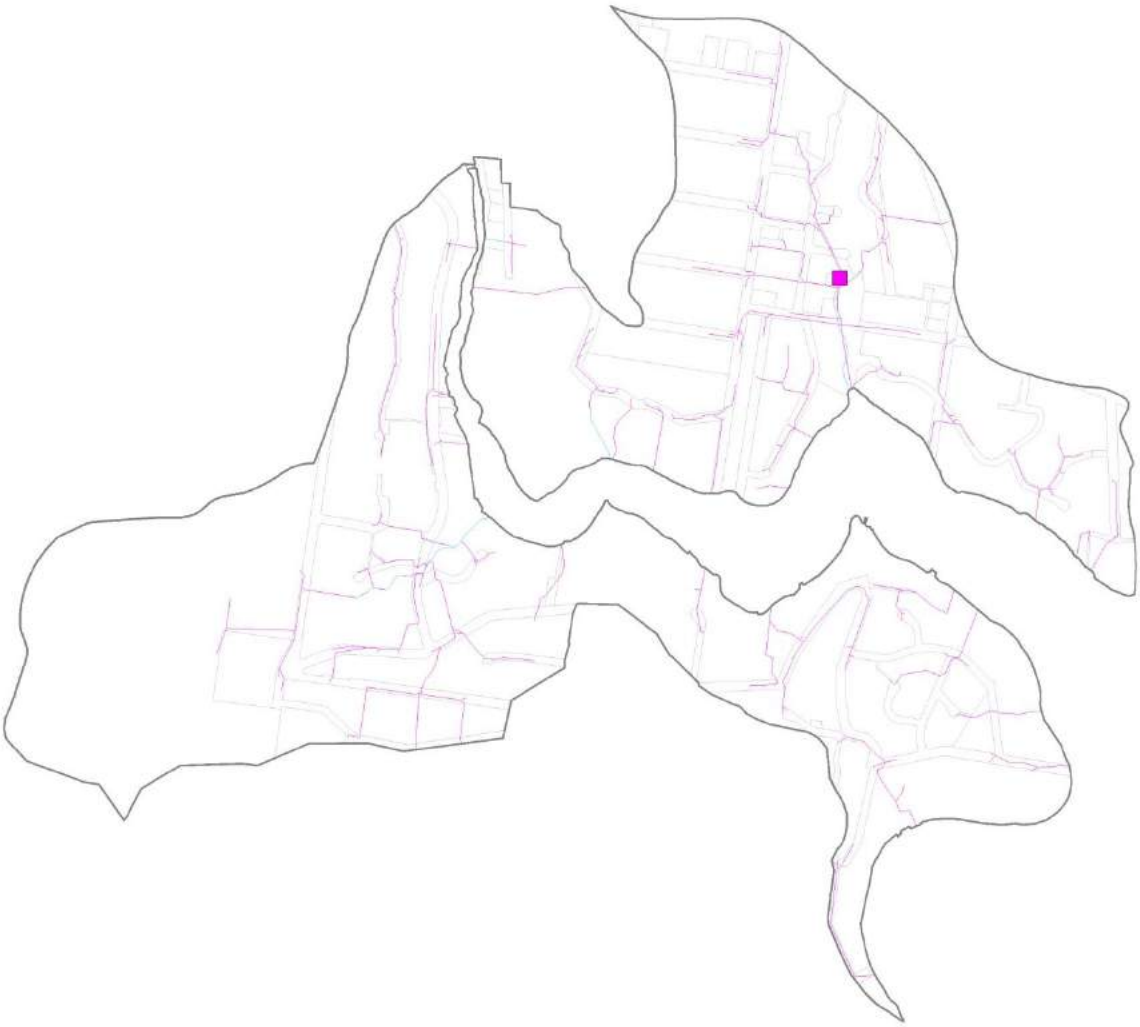
1. Below Dents Creek confluence

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	+
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**
SUMMER 95	-	=	-	-	+

+/- ANZECC 2000 values					
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓

A reduction in values was recorded for all parameters sampled, so that all parameters were reported to be within ANZECC 2000 guideline limits at the end of the survey period.

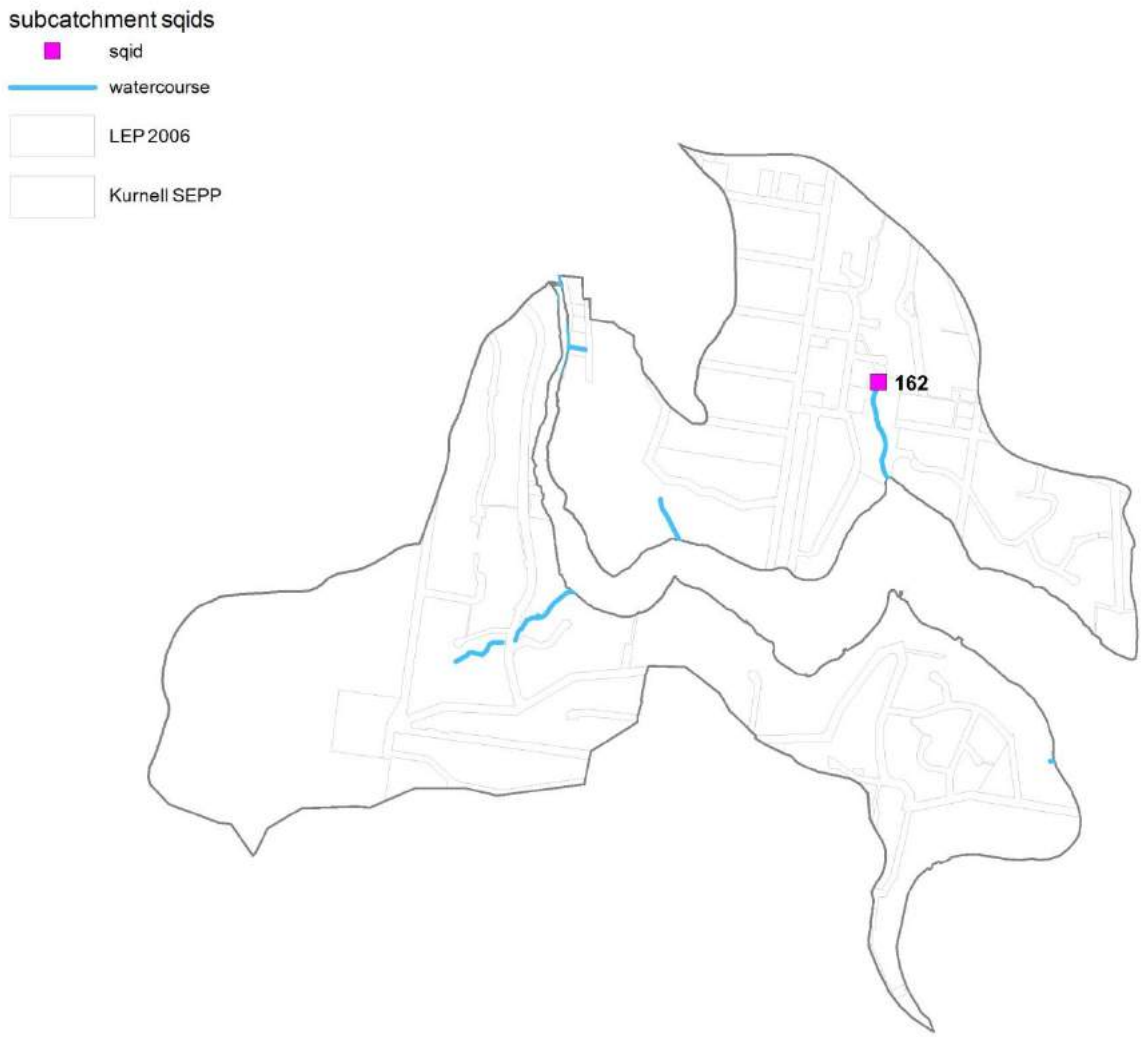
RETICULATED STORMWATER SYSTEM



STORMWATER QUALITY IMPROVEMENT DEVICES

LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
162	GPT	CDS	Uloola Place	Reserve	Gymea Bay	16.3 Ha



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

North West Arm subcatchment landscape is primarily Hawkesbury Soil Landscape (ha), with Mangrove Creek Soil Landscape (mc) around the upper extent of the estuary (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

The catchment rises from 1m ASL at Dents Creek and Port Hacking to just over 100m ASL in the most western, and undeveloped, area of the catchment. The plateau in the north east rises to 80m and is highly developed. The typically greater than 33% slopes to Port Hacking are also highly developed.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS1	<1
CLASS2	1
CLASS3	<1
CLASS5	157

Class 1 ASS/PASS was mapped immediately adjoining North West Arm bay on several waterfront properties on Arcadia Ave. Class 2 ASS/PASS was mapped on neighbouring properties. A small area of Class 3 soils is mapped at Swallow Rock. Class 5 ASS/PASS areas include all land within a 300m zone around North West Arm bay.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

North West Arm is the inlet between the suburbs of Gymea Bay to the north and Grays Point to the south. Dents Creek and Savilles Creek drain into North West Arm, but form separate subcatchment management units. Collectively, the system discharges into the western part of Port Hacking. The landholding map for 1835 shows Grays Point as a section of nameless barren ground. By 1880 it has been divided into blocks of various sizes owned by Thomas Holt, with the exception of 50 acres towards the south, owned by SW Gray. SW Gray never lived in the area, unlike John Gray who was a park ranger in the nearby National Park (Barton & Turner, 2011).

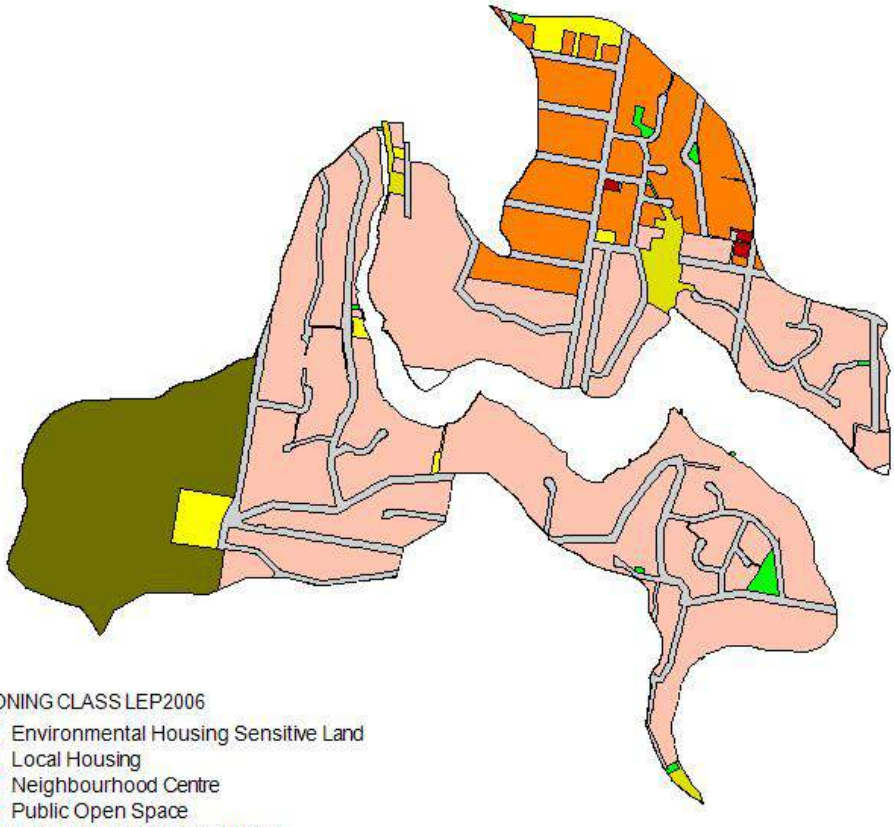
Settlement and development in the area followed the usual pattern for Sutherland Shire: random and sporadic habitation in isolated locations, followed by Thomas Holt's failed

pastoral experiments in 1860s to 1870s, a small farming phase that lasted until 1900, then a weekender stage that lasted until the Depression. At this point the battlers arrived and lived frugally off the land, while after the war settlers began to arrive on a more regular basis. It wasn't until the 1960s that real suburban development began. Despite this, subdivision began in 1902 with the release of 11 large blocks on Grays Point. Several years later, these were further subdivided into 20 lots.

In 1911 the northern section of Grays Point, along North West Arm, was divided into 89 lots, indicating the start of the trend towards residential rather than farming in the area (Barton & Turner, 2011). These blocks were advertised as ideal for permanent residences, weekend or camp sites as this was the last of the water frontage blocks left in Port Hacking. Bob Dashwood had cleared a track to his property in the area, following the line of Dents Creek. When the Savilles Creek Bridge was opened in 1922, the Holt-Sutherland Estate Company widened Dashwood's track to 20 feet and considerably improved its condition, believing that this would encourage buyers to the area. By 1939 access to the area was still via this road, although a bus service had commenced in 1937. Sutherland Shire Council took over management of the road in the 1950s.

Early descriptions of the area include that recorded by Robert Walker, a manager on Thomas Holt's estate in 1868. He described excellent pastures with fine kangaroo grass, rocky soils and steep sandstone banks on the eastern side of North West Arm. Walker also noted that there had been no clearing of scrub or ringbarking of trees in the area (Barton & Turner, 2011). Access to the area continues to be an issue, and may have contributed to the slower rate of development of the area; as a result there is considerable bushland remaining in the residential areas, and the national park is nearby.

CURRENT LAND USE



ZONING CLASS LEP2006

- Environmental Housing Sensitive Land
- Local Housing
- Neighbourhood Centre
- Public Open Space
- Public Open Space Bushland
- Road
- Special Uses

CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	0.00	0%	0%	0.00
Environmental Housing Sensitive Land	97.79	53%	43%	42.05
Environmental Housing Scenic Quality	0.00	0%	57%	0.00
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	23.34	13%	51%	11.90
Multiple Dwelling A	0.00	0%	64%	0.00
Multiple Dwelling B	0.00	0%	64%	0.00
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	0.00	0%	94%	0.00
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.36	0%	86%	0.31
Employment	0.00	0%	95%	0.00
Special Uses	4.10	2%	46%	1.89
Public Open Space	1.12	1%	5%	0.06
Public Open Space Bushland	2.96	2%	0%	0.00
Private Recreation	0.00	0%	5%	0.00
Environmental Protection Waterways	0.00	0%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	28.24	15%	0%	0.00
Railway	0.00	0%	33%	0.00
Arterial Road/Road	26.24	14%	66%	17.32
Transport Reservation	0.00	0%	5%	0.00
TOTAL	184.16	100%	40%	73.53

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

4.3 HECTARES LITTORAL RAINFOREST

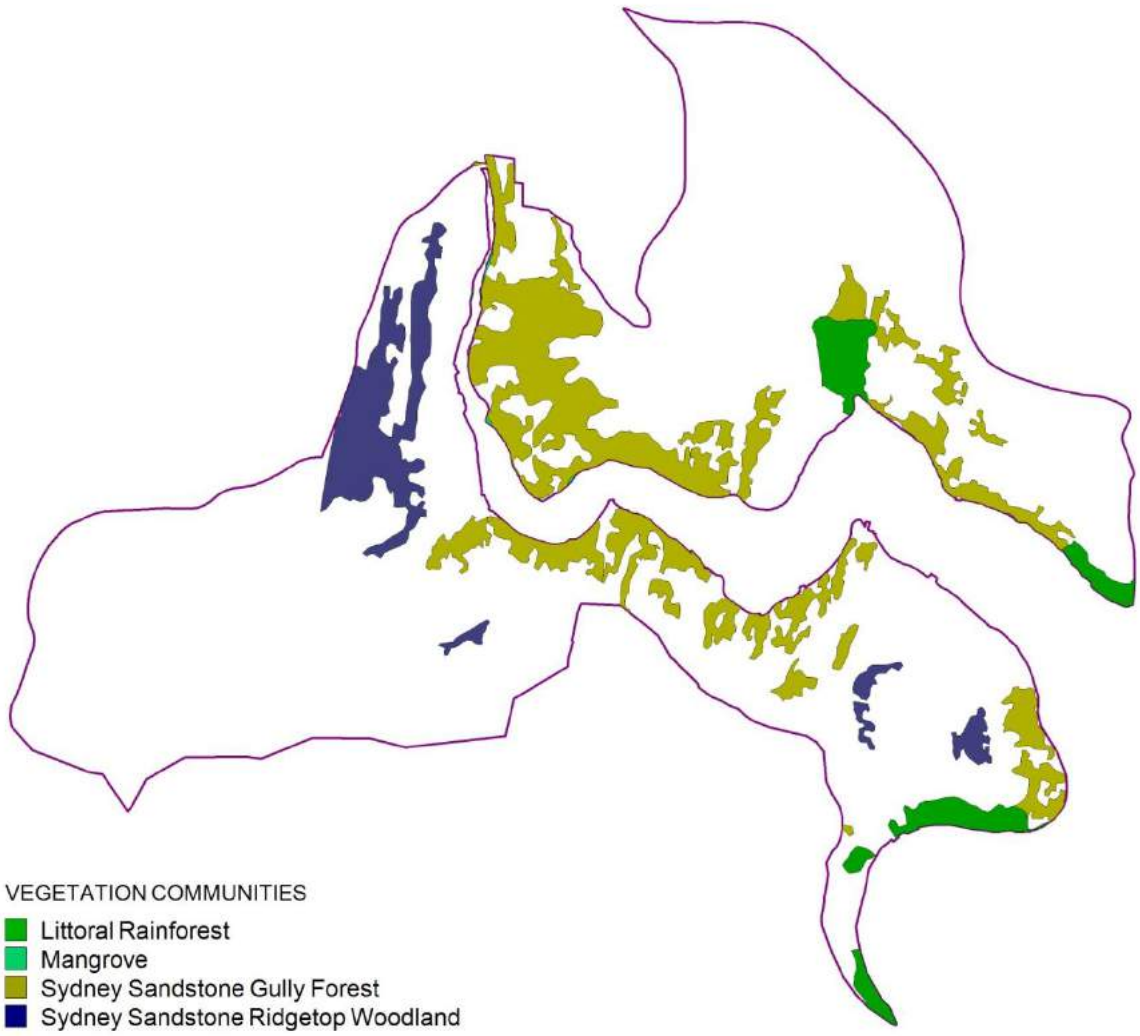
0.1 HECTARES MANGROVE

21.4 HECTARES SYDNEY SANDSTONE GULLY FOREST

7.1 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

LEP 2006 SIGNIFICANT VEGETATION

T35 *Eucalyptus*	Significant Group of Trees or Vegetation
T34 *Eucalyptus microcorys*_Tallowood	Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Grays Point Reserve
- Mansion Point Road, Grays Point
- Swallow Rock Road, Grays Point
- Naranganah Ave/Rosemont Place
- Arcadia Avenue

2) Greenweb Support areas

- Mansion Point Road/Peninsular Road/Inderi Place
- Budyan Road/Moyran Parade
- Angle Road/Noyana Ave
- Marina Cres
- Naranganah Ave/Ellesmere Rd/Coopernook Ave
- Arcadia Avenue

3) Greenweb Restoration areas

- Grays Point Road
- Kingfisher Crescent
- Peninsular Road
- North West Arm Road
- Huskisson St/Yarra Burra St/Gymea Bay Oval

Bushcare Groups

- Grays Point Reserve
- Kyogle Reserve, Grays Point
- Marina Crescent Reserve, Gymea Bay

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream

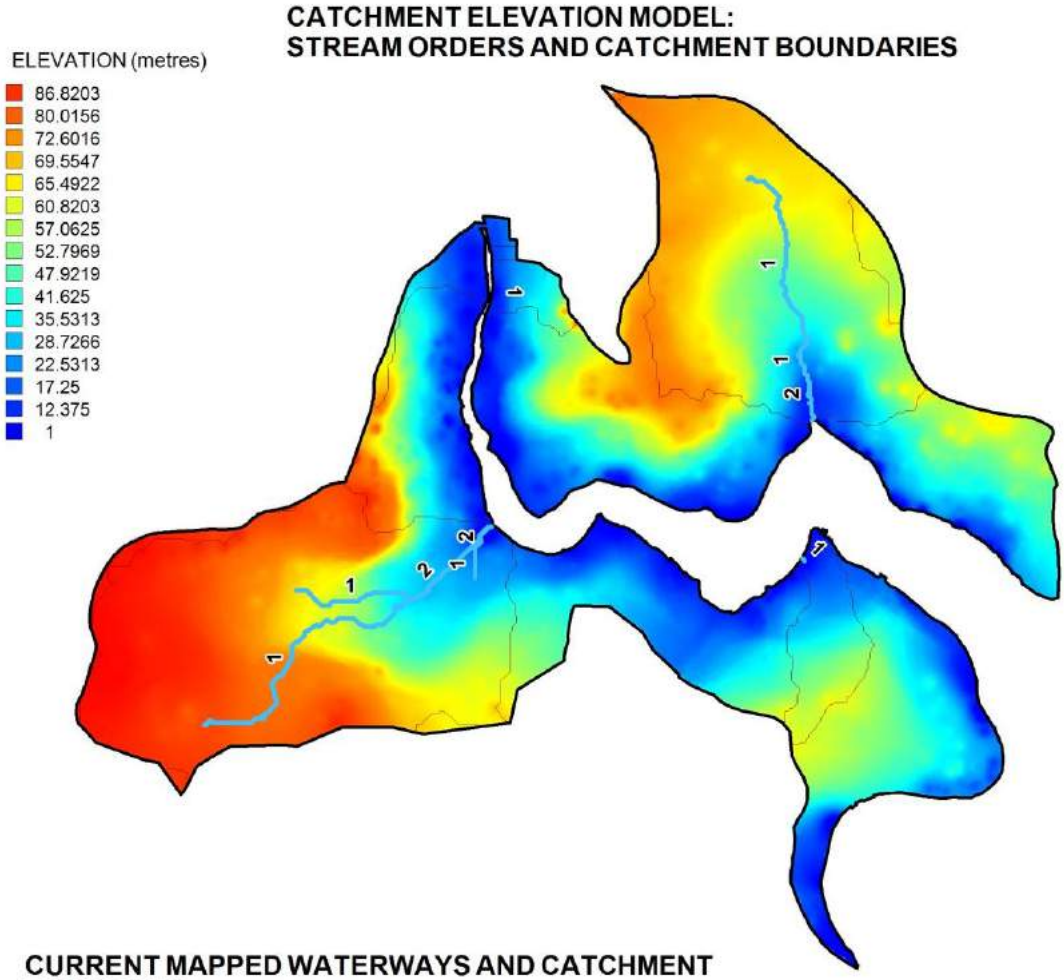
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

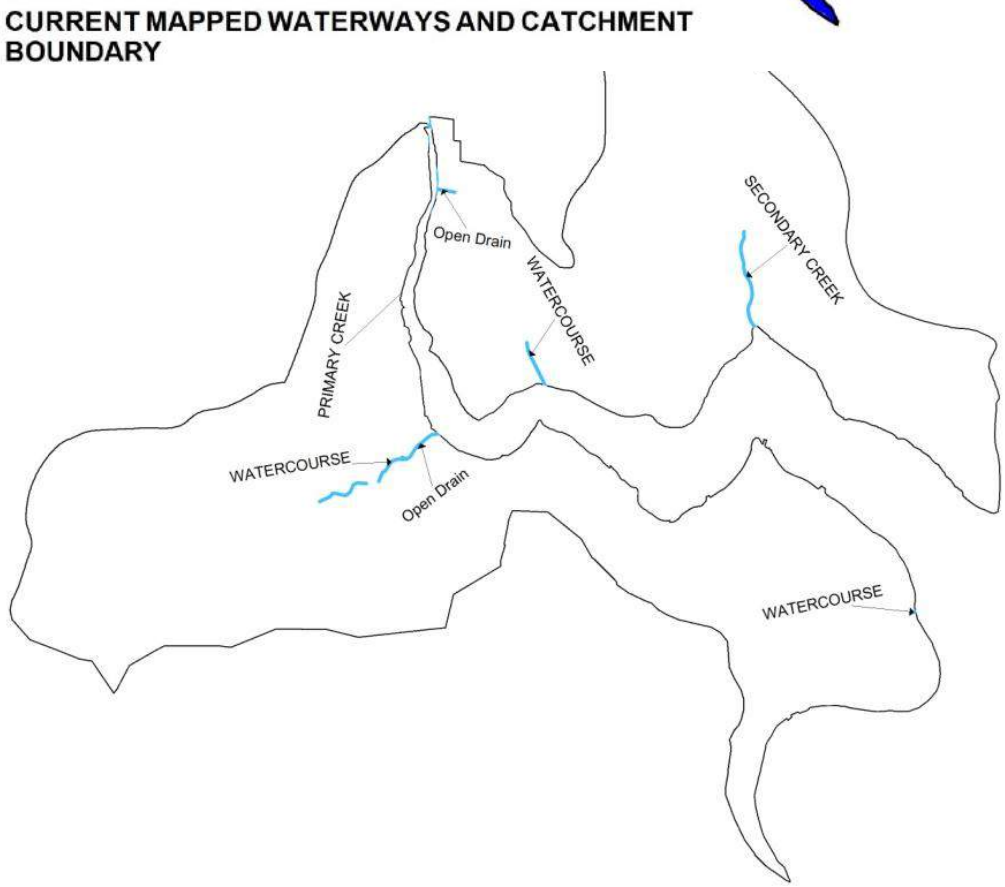
RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others

- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access
- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP





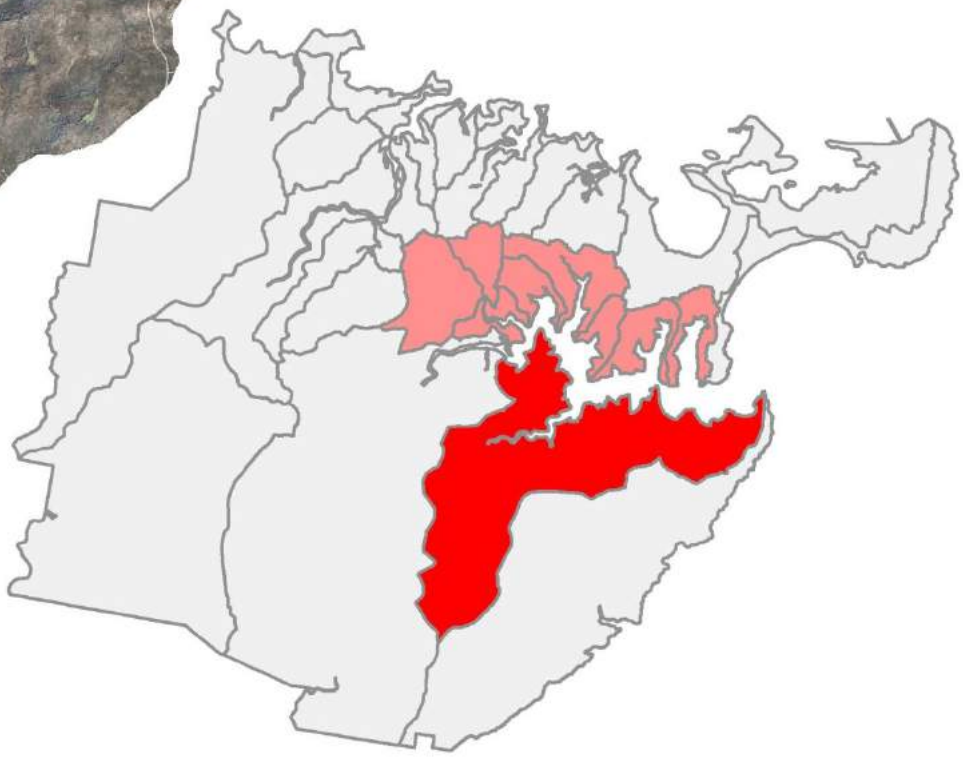
SOUTH WEST ARM SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 33 KM^2

SUBURBS: MAIANBAR

BUNDEENA



WATERWAYS

MAJOR NAMED WATERWAYS:	BLACK GULLY
	BUNDEENA CREEK
	BUNDEENA GUL
TOTAL LENGTH OF MAPPED WATERWAYS:	4.7KMs
PRIMARY CREEKS:	0.4KMs
SECOND ORDER CREEKS:	2.3KMs
FIRST ORDER & MINOR DRAINAGE LINES:	2KMSs

WATER QUALITY ASSESSMENT

As part of their Strategic Water Quality Monitoring Plan, Sutherland Shire Council commenced monitoring water quality in a number of streams across the shire. Trends in water quality data collected from each stream were assessed and ranked against the ANZECC 2000 guidelines for recreational water quality in urban streams (SSC, 2004).

Samples were analysed summer and winter for between three and seven years at each site. This data has been interpreted here to give a brief historic summary of water quality in the subcatchment. First and last reported values for each parameter were assessed as higher (+) than the ANZECC 2000 guideline value, lower (-) than the guideline value, or equivalent (=) to the guideline value. The overall trend during the survey period was identified as increasing (↑) or decreasing (↓). This provides an indication whether management actions are having a positive effect on water quality, and whether further actions are required, for example, a parameter that exceeds the guideline value at the start of the survey period may still exceed it at the end of the period, but have shown significant improvements during the reporting period.

One site was sampled in South West Arm subcatchment:

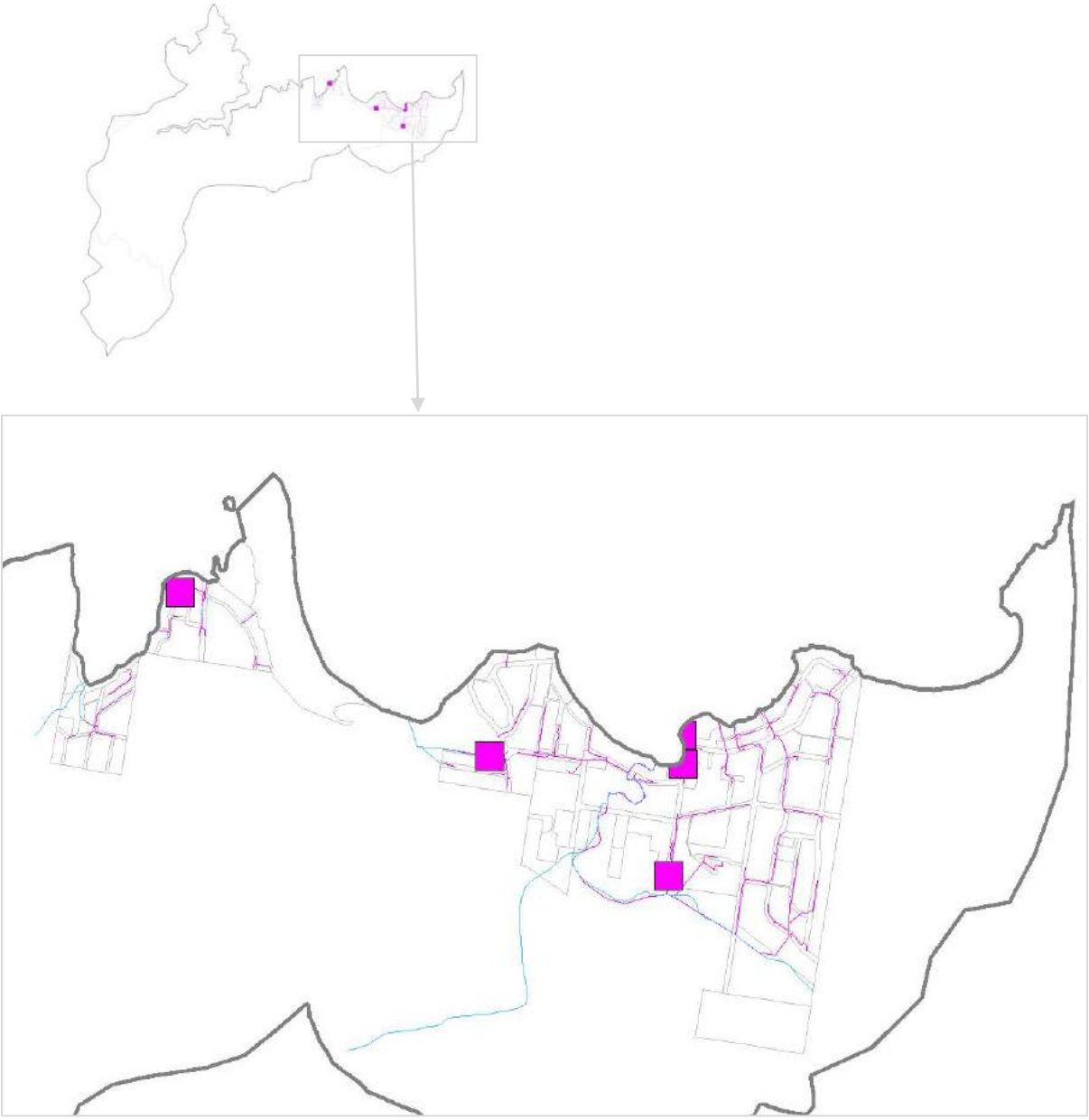
1. Bundeena Creek

PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	=
WINTER 02 +/- ANZECC 2000 values	+	-	-	-	-
TREND ↓↑	↑	↓	↓	↓	↓
PARAMETER	**Enterococci**	**Grease**	**TN**	**TP**	**TSS**

SUMMER 95 +/- ANZECC 2000 values	+	=	+	-	+
WINTER 02 +/- ANZECC 2000 values	-	-	+	-	-
TREND ↓↑	↓	↓	↓	↓	↓

A reduction in values was recorded for most parameters except ammonia, and most parameters, except ammonia and total nitrogen, were reported to be within ANZECC 2000 guideline limits at the end of the survey period.

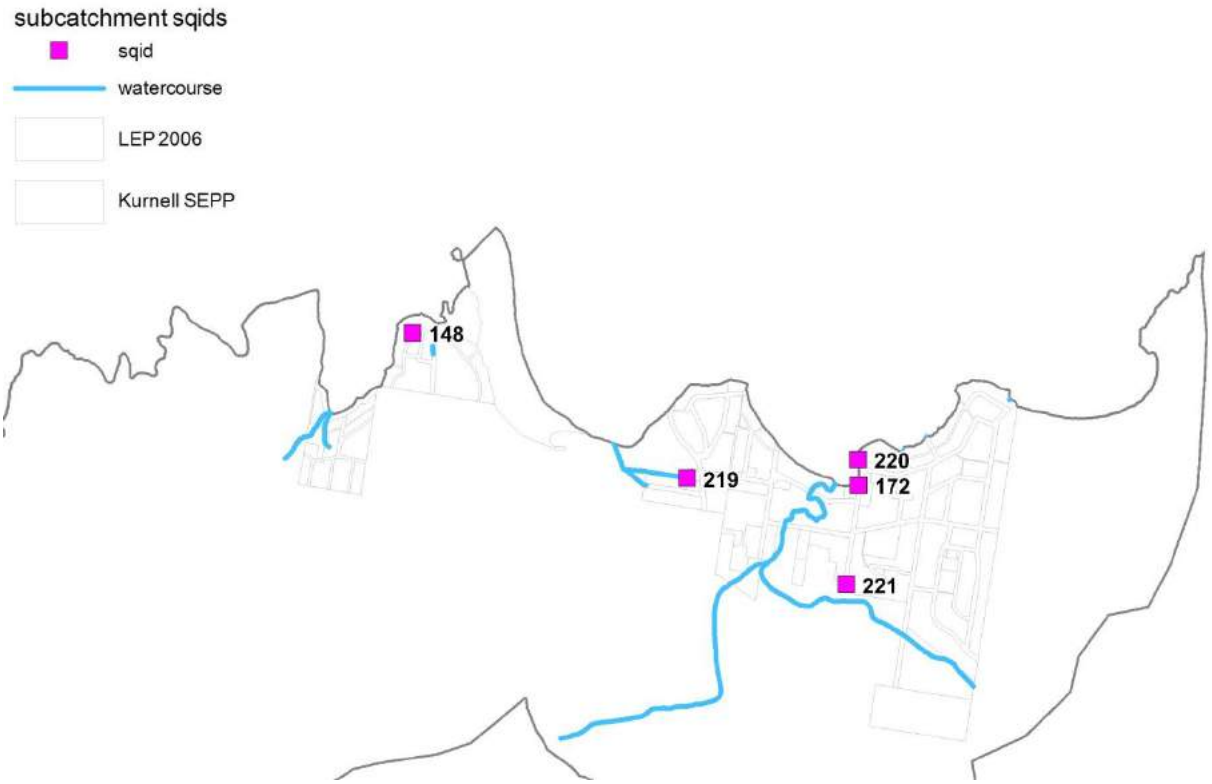
RETICULATED STORMWATER SYSTEM



STORMWATER QUALITY IMPROVEMENT DEVICES

LOCATION OF SQIDS

ID	DEVICE CATEGORY	DEVICE TYPE	LOCATION	SITE DESCRIPTION	SUBURB	APPROX. CATCHMENT
148	Gully Pit Pollutant Filter	Ecosol Pollutant Filters	Pacific Crescent	Residential	Mainbar	0.2 Ha
172	GPT - Other	Iplex GPT	Brighton Street	Coastal	Bundeena	4.7 Ha
219	GPT - Other	Floating Litter Trap	Sea Breeze Lane, Bundeena	end of Sea Breeze Ln	Bundeena	
220	GPT	CDS	Brighton St	Near Bundeena Wharf Carpark	Bundeena	0.7 Ha
221	GPT	Trash Rack	Brighton St	End of Brighton Street (South)	Bundeena	7 Ha



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

South West Arm subcatchment landscape is more complex than other parts of Port Hacking catchment. Bundeena has Kurnell Soil Landscape (kn) in areas adjoining Port Hacking, with Bundeena Soil Landscape (bu) on higher ground. Bonnie Vale has Kurnell Soil Landscape (kn) adjoin Port Hacking but has Hawkesbury Soil Landscape (ha) on higher areas. Maianbar has a small area of Kurnell Soil Landscape (kn) at Constables Point, and Hawkesbury Soil Landscape (ha) around the rest of the foreshores area, with Yarrawarrah Soil Landscape (ya) on ridges. South West Arm inlet itself has foreshore areas with Hawkesbury Soil Landscapes (ha) and Yarrawarrah Soil Landscape (ya) on the eastern ridge. West of the inlet, Wants Point and Lightning Point have Gymea Soil Landscapes (gy) along the foreshores west of Carruthers Bay, with Yarrawarrah Soil Landscape (ya) on the eastern side of the ridge and Bundeena Soil Landscape (bu) on the western side of the ridge (derived from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations provided in Geology and Soils section for Port Hacking Catchment).

TOPOGRAPHY

Topography is highly variable. The catchment rises from 1m ASL at the coast to 210m ASL at the southern most section of the catchment. There are numerous hills, ridges and spurs rising to between 125m and 170m ASL bisected by waterways forming very steep valley sides.

Much of the settlement in the catchment lies between 2m and 52m ASL.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS1	1896.45
CLASS2	313.38
CLASS3	402.36
CLASS5	6728.70

Class 2 ASS/PASS has been mapped in the upper reaches of South West Arm inlet, around Constables Point, Cabbage Tree Basin and Bonnie Vale, between Gunyah Beach and Yarmouth Swamp, and behind Jibbon Beach. Class 3 ASS/PASS is mapped around Jibbon Beach, Gunyah Beach and Simpsons Beach spit. Class 1 ASS/PASS areas include a number of wet areas around Bundeena Creek, Cabbage Tree Creek, South West Arm inlet and other minor areas. Class 5 ASS/PASS is mapped for a 300m buffer zone around Port Hacking and all other ASS/PASS areas.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

Popular folklore reports that outlaws lived along Cabbage Tree Creek, between Bundeena and Maianbar, from 1815 to 1862 (Philpott, 1979). These outlaws set up a distillery that supplied illicit spirits to Sydney's lower class hotels. Evidence of this shipping trade can still be seen near Cabbage Tree Creek at low tide. The rocks and stones there had served as ballast, which was discarded by the ships before returning fully loaded.

The first land grant was made in 1821 near Bundeena, followed by other land grants in the 1840s. None of the grantees settled on their land. In 1863 more land grants were made on the southern side of Port Hacking, at locations now known as Bonnie Vale, Bundeena and Gogerly's Point (Philpott, 1979). The Bonnie Vale land grant of 50 acres was made to George Simpson, and later his son built a house on the property. At Bundeena a grant of 400 acres was made to Owen Byrne, and known as Yarmouth Estate until it was subdivided in 1886. This provided the basis for the town, but it did not develop for another 30 years. In the 1860s Thomas Holt of Holt-Sutherland Estate Land Company bought up all the crown lands available in the parish of Sutherland (later Sutherland Shire), along with any holdings available for sale. He bought the Simpson and Byrne holdings, which later prevented them from being included in the National Park when it was proclaimed in 1879.

In 1886 a steam railway was built to Sutherland from Sydney, and a road link constructed to Audley. With the area becoming more accessible, tourists began to come to the area. Simpson converted his house at Bonnie Vale into a licensed resort hotel. Simpson's Hotel remained a popular resort during the early part of the 20th century, and was linked by a small ferry to the northern shore of Port Hacking at Little Turriell Point. In 1905 the only permanent residents of the area were at the hotel. Over the next 20 years a few more people arrived, but the main obstacle was the lack of access to the area and around the area.

In the 1920s the first road was built to Bundeena through the National Park, and the first car arrived there in 1923 after a two day journey (Philpott, 1979). With the onset of the depression in 1929 Bundeena went from being a resort town to a shanty town, and shacks were built spreading east from Simpson's to Jibbon Beach, and west to Cabbage Tree Creek. A number of these shacks still exist in the National Park today. Bundeena returned to being a holiday town and weekender area, and was visited by over one million people during World War II.

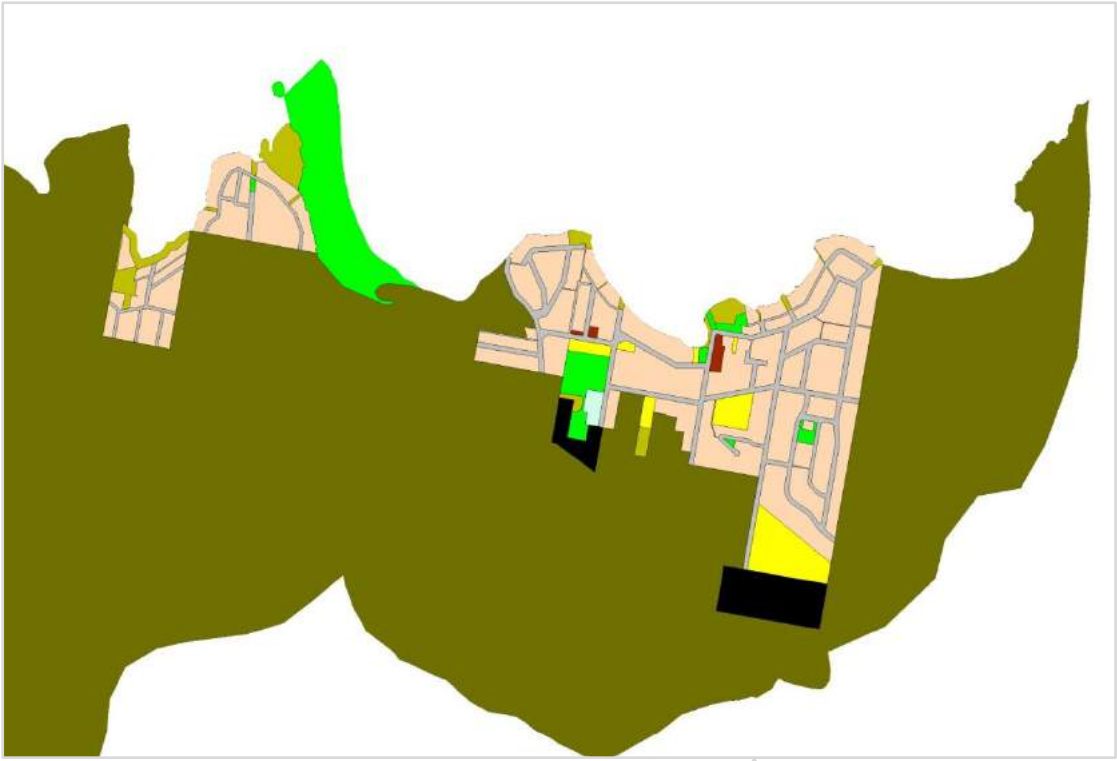
In 1946, following the provision of electricity to the area, preliminary investigations were made for the provision of a water supply. Eventually it was decided to pipe water from the Engadine-Sutherland main, via a pipeline that crossed Hacking River at Audley weir, to a reservoir erected on high ground above Maianbar. This project was commenced in 1955 and

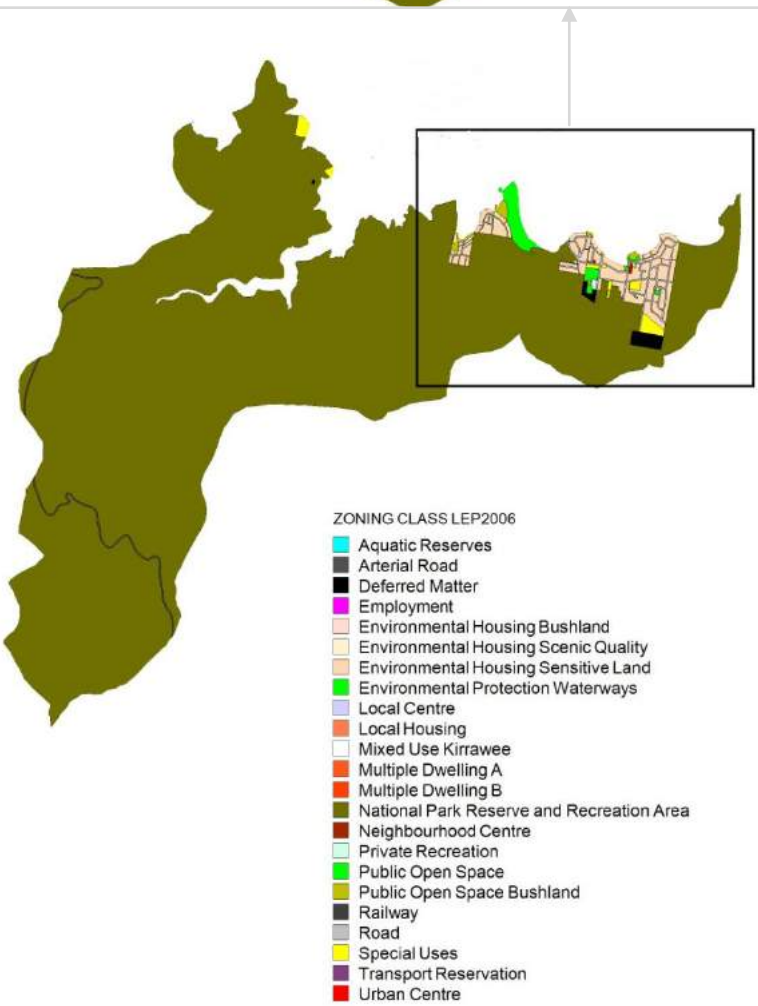
completed in 1958, and water supply to the area was assured for the population of 33,000 at the time.

During the 1960s a subdivision was developed to the southeast of the older part of Bundeena and since that time the population has increased and changed from being predominantly weekender residents and holiday makers to mainly permanent residents from the mid 1970s. Today, the town is comprised of permanent residents with a large contingent of tourists visiting regularly on weekends and holidays.

Much of the South West Arm catchment has been managed as national park since 1879, although 10 000 acres were leased to the army for firing ranges for artillery and the infantry in 1890 (Stanley & Hutton-Neve, 1976). This area extended from Port Hacking south to Flat Rock Creek. The firing range was used until 1916 when it was moved to Holsworthy. The army continued to use the area for military exercises until the 1960s, and their four wheel drive vehicles did considerable damage across much of the countryside.

CURRENT LAND USE





CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	11.38	0%	0%	0.00
Environmental Housing Sensitive Land	93.53	3%	43%	40.22
Environmental Housing Scenic Quality	0.00	0%	57%	0.00
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	0.00	0%	51%	0.00
Multiple Dwelling A	0.00	0%	64%	0.00
Multiple Dwelling B	0.00	0%	64%	0.00
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	0.00	0%	94%	0.00
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.93	0%	86%	0.80
Employment	0.00	0%	95%	0.00
Special Uses	10.40	0%	10%	4.78
Public Open Space	5.64	0%	5%	0.28
Public Open Space Bushland	9.28	0%	0%	0.00
Private Recreation	0.97	0%	5%	0.05
Environmental Protection Waterways	27.40	1%	0%	0.00
Aquatic Reserves	0.00	0%	0%	0.00
National Park Reserve and Recreation Area	3115.00	94%	0%	0.00
Railway	0.00	0%	33%	0.00
Arterial Road/Road	37.66	1%	66%	24.86
Transport Reservation	0.00	0%	5%	0.00
TOTAL	3312.20	100%	2%	70.99

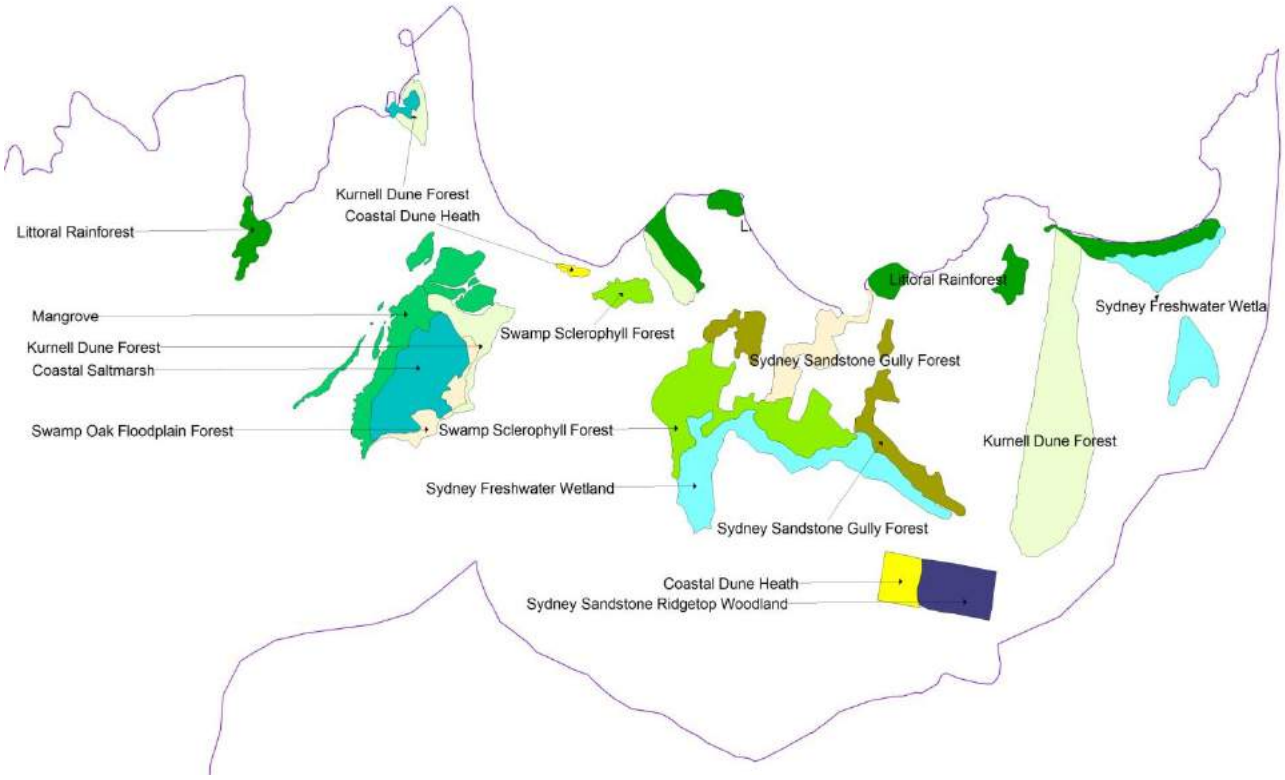
VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

3 HECTARES COASTAL DUNE HEATH
11 HECTARES COASTAL SALTMARSH
30 HECTARES KURNELL DUNE FOREST
13 HECTARES LITTORAL RAINFOREST
11 HECTARES MANGROVE
7 HECTARES SWAMP OAK FLOODPLAIN FOREST
16 HECTARES SWAMP SCLEROPHYLL FOREST
20 HECTARES SYDNEY FRESHWATER WETLAND
8 HECTARES SYDNEY SANDSTONE GULLY FOREST
6 HECTARES SYDNEY SANDSTONE RIDGETOP WOODLAND

LEP 2006 SIGNIFICANT VEGETATION

T45 Vegetated Island Significant Group of Trees or Vegetation
T47 Smooth Bark Apple_*Angophora*_Canopy Significant Group of Trees or Vegetation
T48 Remnant Canopy Significant Group of Trees or Vegetation



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Cabbage Tree Point Reserve
- Bundeena Reserve
- Maianbar Reserve

2) Greenweb Support areas

- Eric Street, Bundeena
- Pacific Cres, Maianbar
- Maianbar streets

3) Greenweb Restoration Areas

- Bundeena streets

Bushcare Groups

- Cabbage Tree Point Reserve
- Horderns Lane, Bundeena
- Bundeena Reserve
- Beach Street Road Closure
- Yarmouth Swamp
- Constables Point
- Kara Karook Street Reserve
- Newcombe Street, Maianbar

THREATENING PROCESSES

INSTREAM IMPACTS

- Loss of riparian habitat
- Degradation of riparian habitat
- Loss of emergent vegetation
- Removal of large woody debris
- Loss or reduction of allochthonous material as a stream input
- Loss or reduction of shading of stream
- Changes to the proportion of catchment impervious surface
- Changes to infiltration patterns
- Construction of dams and other impediments to flow
- Draining of wetland areas

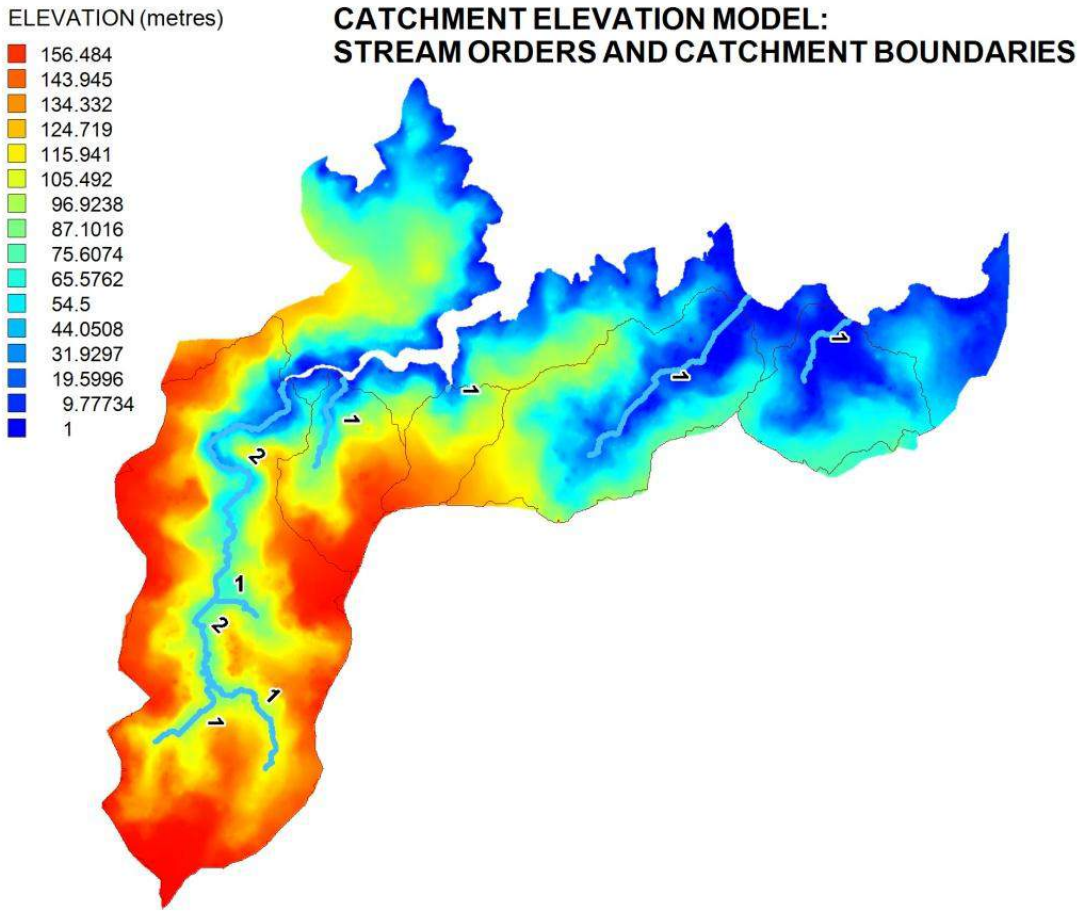
- Channelization
- Modification of channel bedform
- Modification of bank configuration
- Pipe replacement of channel
- Erosion
- Sedimentation
- Point source pollution
- Non-point (diffuse) source pollution
- Increased nutrient loads
- Introduction of toxic compounds
- Introduction of oils and organobenzenes
- Introduction of herbicides and pesticides in runoff
- Reduction of light penetration
- Algal bloom
- Emergent aquatic weeds
- Floating aquatic weeds
- Change in temperature regime
- Barriers to fish passage
- Change to hydrological flow regimes
- Change to pH through mobilisation of ASS/PASS
- Stormwater deposition of litter
- Dumping of rubbish
- Increased allocthonous inputs immediately following fire or clearing
- Increased peak discharges associated with storm flows
- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
    - Gambusia
    - Carp
    - Cane Toads
    - Koi Carp (goldfish)

RIPARIAN IMPACTS

- Invasion by weeds
- Loss of species through replacement by others
- Loss of diversity (reduction in species numbers)
- Loss of habitat quality
- Disturbance from pedestrian access

- Disturbance from vehicle access
- Disturbance from excessive use by stock or other animals
- Clearing of vegetation
- Deliberate introduction of exotic plant species
- Selective removal of vegetation including
    - Loss of canopy
    - Loss of shrub layer
    - Loss of groundcover species
- Removal of habitat elements including
    - Loss of leaf litter
    - Loss of fallen timber
    - Loss of standing dead trees
    - Loss of rocks
    - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
    - Damage to plants
    - Damage to abiotic habitat elements
    - Injured or killed animals
- Inappropriate fire regime
- Erosion
- Sedimentation
- Plant diseases including
    - Phytophthora (dieback)
    - Myrtle rust
    - Smut
    - Common rust
    - Mistletoes
- Feral animals including
    - Foxes
    - Rabbits
    - Deer
    - Cane Toads
    - Wild pigs
    - Feral cats
    - Introduced birds

RECREATED WATERWAYS MAP



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY