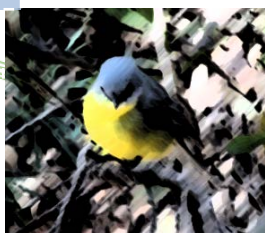


**SUTHERLAND SHIRE WATERCOURSE
ASSESSMENT & REHABILITATION
PRIORITISATION**

**VOLUME 2
CHAPTER 1**

**BOTANY BAY
CATCHMENT PROFILE**

2012



DOCUMENT VERIFICATION

Project Title	Sutherland Shire Watercourse Assessment & Rehabilitation Prioritisation
Document Title	Botany Bay 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			

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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

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Chapter 1 BOTANY BAY CATCHMENT

CATCHMENT OVERVIEW

CATCHMENT AREA: 20.9 KM²



WATERWAYS

SUMMARY OF DRAINAGE SYSTEM

The Botany Bay catchment includes two sub-catchments:

WOOLOOWARE BAY

WEENY BAY / QUIBRAY BAY

MAJOR NAMED WATERWAYS:

NO NAMED WATERWAYS

TOTAL LENGTH OF MAPPED WATERWAYS: 6.4 KMs

PRIMARY CREEKS: 0 KMs

SECOND ORDER CREEKS: 0.9 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 3.8 KMs

OPEN DRAINS: 1.7 KMs

NUMBER OF SQUIDS: 16

GEOLOGY, GEOMORPHOLOGY AND SOILS

GEOLOGY AND GEOMORPHOLOGY

The Botany Basin includes two large tidal bays; Botany Bay is located ~15 km south of central Sydney whereas Bate Bay (part of the Pacific Ocean catchment) is to the south of that and east of Cronulla. Kurnell Peninsula, the landing place of Captain Cook, separates these bays; it is a coastal sand barrier complex with large dunes reaching an elevation of 30-40 m that becomes an elevated sandstone plateau at the eastern end of the peninsula.

Botany Bay has a roughly circular shape of 6-7 km diameter and natural water depths that generally are less than 5 m but reach 10 m at the entrance and locally have been enhanced by dredging to 20 m.b.s.l.(metres below sea level). The entrance to Botany Bay is a narrow (1 km) gap between the rocky headlands of La Perouse and Inscription Point so Botany Bay is largely protected from sea storms.

Two major rivers enter Botany Bay; Georges River (103 km in length) in the southwest and Cooks River (21 km long) in the northwest which has an artificial entrance (about 1.5 km to the south of the original) that was created in 1947 for the development of Sydney Airport.

Areas of exposed rock are limited within Botany Basin and consist of Triassic Hawkesbury Sandstone but the overlying Wianamatta Group shale crops out on adjacent high ground to the west and southwest. These rocks have been shown to dip towards a meridional axis passing through the centre of the Bay. Unconsolidated sediment dominates in the Botany Basin, concealing the positions of the bedrock drainage channels. These channels extend for varying, but considerable, distances onto the shelf, and formed when the sea level was more than 110 m lower than at present (Albani, 1998).

The geological history of Botany Bay was strongly influenced by the climatic events of the Quaternary Period. During conditions of low sea level, the numerous coastal streams were rejuvenated and river valleys were entrenched and accentuated: a large volume of eroded material was deposited on the inner shelf. During high sea-level stands, some of the newly deposited sediment was remobilised by marine processes and transported back into the drowned river valleys causing partial siltation. The oscillating cycles of sea level of the Pleistocene are well recorded in the sediment cover of Botany Bay.

Bate Bay was once the main entrance to Botany Bay, and Kurnell was an island. The bedrock topography of Botany Basin is characterised by steep valleys incised into rock but the valleys have shallow gradients at levels above 30-40 m.b.s.l. The deepest erosion of the bedrock occurred when the sea was more than 100 m below its present level. Since that time the gradual rise of sea level has led to progressive infilling of the bedrock channels with a tombolo forming between Kurnell and Cronulla. The present form of Botany Bay could not have existed until the water level had risen to about 30 m below present day sea level to cover the lowest part of Runway Ridge and inhabitants of Kurnell Island could have walked to Kyeemagh along this ridge until about 9000 years B.P.

SOILS

The main soil landscapes present in Botany Bay catchment are Mangrove Creek (mc), Kurnell (kn), Wollongong (wg) and Disturbed Terrain (xx). These are described in more detail below.

As part of the assessment process, Urban Land Capability and Rural Land Capability classes were determined for these soil landscapes. Urban capability is the ability of an area of land to support a particular intensity of urban development without serious erosion and sedimentation occurring during construction, and possible instability and drainage problems in the long term. For soil landscapes in Botany Bay catchment these are as follows:

- Mangrove Creek: not capable of urban development
- Kurnell: not capable of urban development
- Wollongong: not capable of urban development
- Disturbed Terrains are areas of land that have been highly modified through removal, disturbance or burial of the original soils as a result of human activities, and to a depth of 1m

In many parts of Sutherland Shire, areas classified as “not capable of urban development” have been extensively urbanised. These areas have experienced cracking of roads and buildings, sedimentation of streams, blocked drains and flooding.

Rural capability is the ability of an area to sustain permanent agricultural or pastoral production without permanent damage. Land which is used beyond its rural capability will deteriorate rapidly, resulting in permanent loss of soil resources. For soil landscapes in Botany Bay catchment the following assessments were made:

- Mangrove Creek: not capable of regular cultivation or grazing
- Kurnell: not capable of regular cultivation or grazing
- Wollongong: not capable of regular cultivation or grazing

Most of the land in this part of Sutherland Shire was cleared for grazing, with some minor market gardening. The legacy of this early development is seriously depleted soil resources. The soil landscapes listed above are described in the following sections:

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).

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).

Wollongong (wg): Beaches and coastal foredunes and hind dunes on Quarternary marine and windblown sands. Beach plains with relief up to 10m, slopes <3%; foredunes with relief <15m and slope gradients up to 35%. Vegetation includes spinifex grasslands and herblands to closed scrub on foredunes. Soils are deep (>2m) Calcareous Sands on beaches, Siliceous Sands on foredunes, and isolated Humus Podzols in swales. Limitations include extreme wind erosion hazard, non cohesive, highly permeable soils, very low soil fertility, localised flooding and permanently high watertables.

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).

SUMMARY OF CONTAMINATION ISSUES

Early development in the area was agricultural and pastoral, leaving local soils depleted. In the 20th century the Kurnell peninsula became the site for a number of heavy industrial plants, including Union Carbide who made batteries, and an oil refinery. Spills and leachates from these and other factories and businesses were originally allowed to be discharged without regulation. Over more recent decades these industries have become highly regulated to prevent major impacts on the environment.

Calls for a cleanup of Botany Bay and the Kurnell peninsula began in the 1980s; there was opposition to the zoning of toxic chemical industries directly adjacent to the Towra Point Nature Reserve. A few years later toxic industry was banned from the area, sandmining was ceased and heavy industry encouraged to move away.

Despite increasing regulations, and constant lobbying by local residents to have these industrial developments moved from the area, spills and contamination of the environment continue today. In March 2011, a fire in a water purification plant ignited thousands of litres of hydrogen peroxide. The water filtration plant was located next to the oil refinery. During the fire, liquid substances from the plant leaked into nearby wetlands where attempts were made to contain the damage before it entered Quibray Bay. Further environmental impacts resulted from the toxic smoke that was generated during the fire. A 500m exclusion zone was established around the filtration plant during the fire, and local residents were evacuated.

LAND USE

HISTORIC LAND USE

Botany Bay was the site of first contact between the indigenous population and Europeans. Captain Cook landed near Kurnell and met aboriginal people from the Gweagal tribe. Aborigines had been living in Australia for over 40 000 years at this time, and had developed a lifestyle that reflected a lengthy period of adaptation to the local environment. They relied on a relatively unmodified environment for food and water, raw materials, and shelter from extremes of weather. They had developed places where they created a visual record of their religious beliefs and spiritual practices, ceremonial and ritual grounds, and places for the disposal of their dead.

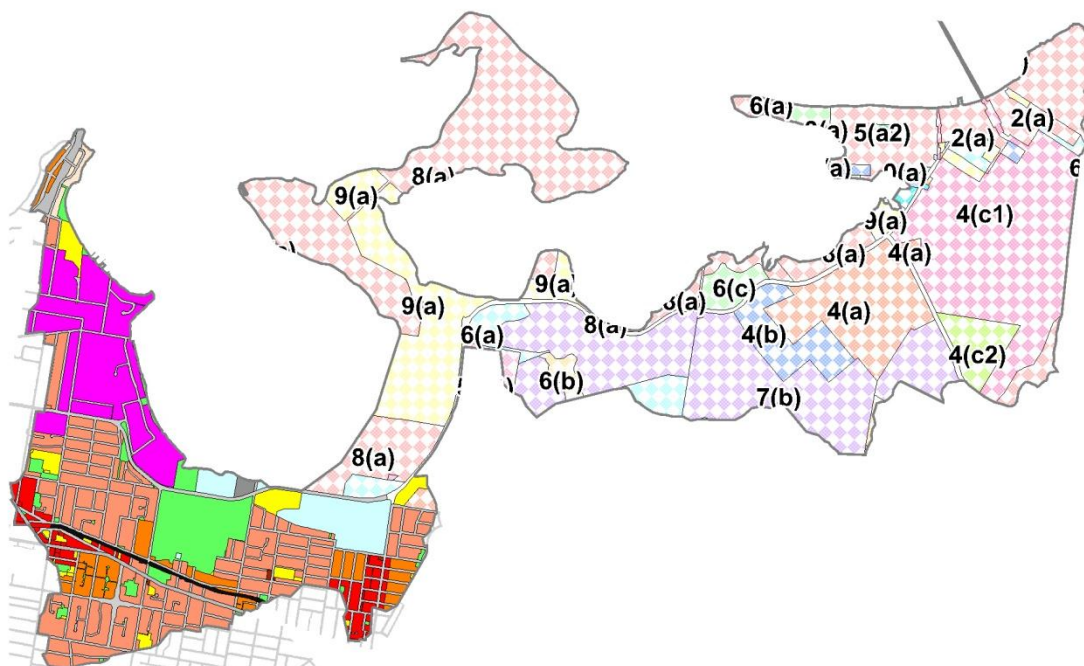
The aboriginal economy was based on hunting and gathering, and labour was partially divided on the basis of sex. Coastal regions were rich in food supplies, and tribal areas tended to be smaller. Most of the aborigines who lived near Sydney died out rapidly after colonisation due to the introduction of diseases such as small pox and measles. More than 30 aboriginal sites are conserved in Kamay Botany Bay National Park, which includes areas around Kurnell and Towra Point. These include rock engravings, burial sites, axe grinding grooves and other places with signs of aboriginal occupation.

Two of Australia's earliest European explorers landed here first - James Cook in 1770, and the Comte de Lapérouse in 1788. Cook's botanists, Joseph Banks and Daniel Solander, first explored Australia's natural world here. After the favourable reports of Cook and Banks, it was here that the British Government decided to set up a penal colony.

The First Fleet of British convicts and settlers arrived at Botany Bay in January 1788, but it was decided that Port Jackson (in Sydney Harbour) would be a more appropriate site for the colony. Before the ships set sail for their new destination, they were joined by a French expedition under Jean-Francois de Galaup, Comte de Lapérouse. Lapérouse stayed in Botany Bay for six weeks, building an observatory, stockade and garden on La Perouse Peninsula.

Over the years, parts of the area have been used for agriculture, defence, recreation and even a camp for homeless people during the Depression of the 1930s. Botany Bay National Park was created in 1984, however certain areas in the park had been set aside for public use many years before. The oldest of these, 100 hectares of land at Captain Cooks Landing Place, was first dedicated for public recreation in 1899. The dual name Kamay Botany Bay National Park was adopted in 2002.

CURRENT LAND USE



SEPP ZONING BY CLASS KURNELL PENINSULA

- 2(a) Residential
- 3(d) Business (Neighbourhood)
- 4(a) General Industrial
- 4(b) Industrial (Light)
- 4(c1) Industrial Special (Oil Refinery)
- 4(c2) Industrial Special
- 5(a) Special Uses - Electricity
- 5(a) Special Uses - Fire Station
- 5(a) Special Uses - School
- 5(a) Special Uses - Telephone Exchange
- 5(a) Special Uses - W.S. & D.
- 6(a) Recreation Existing
- 6(b) Recreation Proposed
- 6(c) Recreation Private
- 7(a) Environmental Protection (Waterways)
- 7(b) Environmental Protection (Special Development)
- 8(a) National Parks and Nature Reserves - Existing
- 9(a) Reservations Open Space (Regional)
- E4 - Environmental Living

ZONING BY CLASS LEP2006

- Aquatic Reserves
- Arterial Road
- Deferred Matter
- Employment
- Environmental Housing Bushland
- Environmental Housing Scenic Quality
- Environmental Housing Sensitive Land
- Environmental Protection Low Impact Rural
- Environmental Protection Water Catchment
- Environmental Protection Waterways
- Excluded
- 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)

ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
LEP ZONING CLASS				
Deferred Matter	2.49	0%	0%	0.00
Environmental Housing Sensitive Land	0.00	0%	43%	0.00
Environmental Housing Scenic Quality	6.04	0%	57%	3.08
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	195.39	9%	51%	97.69
Multiple Dwelling A	39.46	2%	64%	27.62
Multiple Dwelling B	25.69	1%	64%	17.98
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	4.98	0%	94%	3.98
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.62	0%	86%	0.56
Employment	116.66	6%	95%	114.33
Special Uses	27.25	1%	30%	10.90
Public Open Space	70.07	3%	5%	0.00
Public Open Space Bushland	0.36	0%	0%	0.00
Private Recreation	40.89	2%	5%	2.04
Environmental Protection Waterways	0.01	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	6.18	0%	33%	2.04
Arterial Road/Road	129.03	6%	66%	85.16
Transport Reservation	0.00	0%	5%	0.00
SEPP ZONING CLASS				
2(a) Residential	82.97	4%	50%	41.49
3(d) Business (Neighbourhood)	1.72	0%	79%	1.36
4(a) General Industrial	92.41	4%	42%	38.81
4(b) Industrial (Light)	138.01	7%	0%	0.00
4(c1) Industrial Special (Oil Refinery)	219.78	11%	63%	138.46
4(c2) Industrial Special	26.25	1%	1%	0.26
5(a) Special Uses	10.61	1%	0%	0.00

ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
5(a) Special Uses (Woolaware)	1.542967	0%	0.51	0.79
6(a) Recreation Existing	51.46	2%	0%	0.00
6(b) Recreation Proposed	10.99	1%	0%	0.00
6(c) Recreation Private	22.37	1%	1%	0.22
7(a) Environmental Protection (Waterways)	2.92	0%	0%	0.00
7(b) Environmental Protection (Special Development)	237.71	11%	0%	0.00
8(a) National Parks and Nature Reserves - Existing	389.86	19%	0%	0.00
9(a) Reservations Open Space (Regional)	136.11	7%	0%	0.00
E4 - Environmental Living	3.98	0%	0%	0.00
unzoned	6.64	0%	0%	0.00
TOTAL	2093.84	100%	28%	586.78

VEGETATION COMMUNITIES

The following vegetation communities have been mapped in the Botany Bay catchment by Sutherland Shire Council:

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

A brief description of these communities has been extracted from the Sydney Metropolitan CMA's draft Native Vegetation of the Sydney Metropolitan Catchment Management Authority Area, Volume 2: Vegetation Community Profiles (SMCMA, 2009). These are presented below.

Estuarine Mangrove Forest

Stands of Mangroves form a low closed to open forest on mudflats found along Sydney's harbour, river coves and estuaries. There are two mangrove species found in Sydney. Grey mangrove (*Avicennia marina*) is the taller and more common, often seen in pure stands. It comprises very few species other than the canopy, with the understorey mostly an open mudflat sometimes with scattered saltmarsh herbs. The second mangrove species is river mangrove (*Aegiceras corniculatum*). It is more often a small tree or shrub found scattered amongst swathes of grey mangrove or along upper reaches of coastal riverbanks. It occurs where freshwater influences from runoff or rivers cause lower salinity levels in water inundating the mudflats.

Sea level rise associated with climate change poses a significant threat to the current distribution to Estuarine Mangrove Forest in the Sydney basin. While the species appears to be an aggressive recoloniser, opportunities for re-establishment in Sydney are constrained by built environments and steep sandstone banks. Current threats include ongoing recreation pressures, pollution arising from oil spills and outfalls and reclamation.

Estuarine Saltmarsh

Saltmarshes consist of low succulent herbs and rushes on tidally inundated land. These marshes form plains that adjoin open water and mangroves. Throughout the marsh, salinities vary greatly according to tidal influence, evaporation and freshwater accumulation. Some of the areas are flooded regularly, while at slightly higher elevations

flooding is rare. After rain freshwater accumulates and adds extra water to the marsh, leaving pools of standing water when the tide recedes. Chenopod species dominate areas more frequently inundated by the tides, while sea rush (*Juncus kraussii*) occupies the more elevated terrestrial margin. Local scalds occur in small depressions where intensely saline deposits accumulate from the evaporation of tidal waters preventing the growth of any plants at all.

Sea-level rise from climate change represents the greatest threat to the long term persistence of the Saltmarsh community. Small rises will permanently inundate these intertidal zones. Reclamation has altered the landscape of estuarine environments. Heavy recreational pressure, rubbish dumping, invasion by weeds and sedimentation are ongoing threats to the community (Keith 2004). Infestation of saltmarsh plains by the exotic sharp rush (*Juncus acutus*) is prevalent in some areas of the Georges River (Pickthall et al. 2004).

Estuarine Swamp Oak Forest

In the succession from mangroves and saltmarsh to terrestrial sclerophyll and mesophyll forests and woodlands, Estuarine Swamp Oak Forest occurs as the initial community above tidal influence. It fringes the margins of saline waterbodies that include rivers, lagoons and tidal lakes. Swamp oak (*Casuarina glauca*) forms dense monospecific stands above a thick ground cover of salt tolerant herbs, rushes and sedges. The shrub layer is low growing and sparse comprising a mix of terrestrial species while others typical of wetlands. It is a community of relatively low species diversity.

Estuarine Swamp Oak Forest is widespread along the coast of the Sydney Basin where it is rarely found at elevations above two meters above sea level. Waterfront urban and industrial development has occurred on areas likely to have once been occupied by this community. Typically land infill has been used to reclaim estuarine environments to make use of flat accessible lands. Remaining areas often support a conspicuous cover of exotic species such as lantana (*Lantana camara*) and buffalo grass (*Stenotaphrum secundatum*).

Coastal Sand Swamp Paperbark Scrub/Coastal Sand Swamp Sedgeland (Sydney Freshwater Wetlands)

Freshwater wetlands in lagoons and depressions are a feature of the large low-lying sand deposits found along the coast. These sites carry a complex of reedlands, rushlands and herbfields which fringe open water or cover shallower soaks. There are a wide variety of water loving species that can occur at different sites. Generally there is little woody vegetation with only scattered individuals of emergent small trees and shrubs. A complex array of sedgelands may be found including twigrushes (*Baumea* spp.), saw-sedges (*Gahnia* spp.), and tall spike rush (*Eleocharis sphacelata*). Tall reeds such as common reed (*Phragmites australis*) may completely dominate as they do in the highly disturbed Botany Wetlands. These may obscure smaller herbs such as slender knotweed (*Persicaria decipiens*).

Threats facing this community are high. Coastal sand flats have been extensively cleared and modified on the Kurnell Peninsula, Botany, Sans Souci and around the lagoon systems of the northern beaches. As well, these sites are subject to habitat degradation resulting from altered hydrology/nutrient levels, weed invasion, off-road vehicles, illegal waste dumping and sand extraction.

Sydney Turpentine Ironbark Forest

Sydney Turpentine-Ironbark Forest is a tall open forest found on shale and shale enriched sandstone soils on the coast and hinterland of Sydney. It has been extensively cleared but was once widely distributed between Sutherland and the Hornsby Plateau with outlying examples found on shale rich deposits at Campbelltown, Menai, Kurrajong and Heathcote. The primary distribution of this forest occurs in areas receiving between 900 and 1250 millimetres of mean annual rainfall and at elevations between 10 and 180 metres above sea level.

The forest is characterised by an open layer of mesic and sclerophyllous shrubs and small trees with a grassy ground cover. The composition of the canopy is variable depending on location and substrate. Typically it is recognised by an upper stratum of turpentine (*Syncarpia glomulifera*), red mahogany (*Eucalyptus resinifera*) and various ironbarks species (of which *Eucalyptus paniculata* most often recorded). On the north shore these forests are found on shale enriched sheltered sandstone slopes where ironbark species are far less frequently recorded. Instead blackbutt (*Eucalyptus pilularis*) is more common.

Current distribution for Sydney Turpentine Ironbark Forest are remnants which are small and scattered. Identified threats include clearing, physical damage from recreational activities, rubbish dumping, grazing, mowing, weed invasion.

Coastal Sandstone Foreshores Forest (Sydney Sandstone Ridgetop Woodland)

Coastal Sandstone Foreshores Forest is found on sheltered sandstone slopes found along the foreshores of Sydney's major waterways and coastal escarpments. It is an open forest with a moist shrub layer and ground cover of ferns, rushes and grasses. The flora of this community has a maritime influence given its exposure to prevailing sea breezes. The canopy can be dominated by pure stands of smooth-barked apple (*Angophora costata*) though more regularly is found in combination with other tree species. Localised patches of bangalay (*Eucalyptus botryoides*) and coast banksia (*Banksia integrifolia* subsp. *integrifolia*) occur closest to the coast, whereas Sydney peppermint (*Eucalyptus piperita*) and blackbutt (*Eucalyptus pilularis*) prefer more protected locations and in the case of the latter, some minor shale enrichment in the soil.

A prominent layer of hardy mesic small trees and shrubs is present. These include sweet pittosporum (*Pittosporum undulatum*), cheese tree (*Glochidion ferdinandi*) and blueberry ash (*Elaeocarpus reticulatus*). In the suburban environment, the proliferation of these

species in the understorey at long unburnt sites has generated considerable debate, particularly as there appears to be strong correlation between time since fire and their density (Rose & Fairweather 1997). It is also appears that these species are more common in these littoral zones than other sheltered sandstone forests situated further away from the coast.

This forest is restricted to sandstone soils derived from either the Hawkesbury or Narrabeen geology. The distribution is coastal and requires a combination of low elevation between 2-45 metres above sea level and mean annual rainfall that exceeds 1100 mm per annum. It is noticeable that most sites are exposed to salt laden winds that are carried across the coastal plain before hitting the Collaroy and Narrabeen escarpments, or across the waters of the harbour and the Georges and Hacking Rivers.

Clearing for urban development has occurred across the range of the community. Weed infestation is widespread in stands close to urban margins. Fire is likely to have been excluded for long periods of time and many stands are isolated within dense urban land uses. The absence of fire may be preferentially encouraging some mesic woody species over pyrophytic species. Dieback arising from *Phytophthora* is severely affecting stands in the Sydney Harbour area.

Coastal Sand Bangalay Forest (Sydney Sandstone Ridgetop Woodland)

Coastal Sand Bangalay Forest is restricted to flat, low-lying marine sand deposits of the coastal zone and wind-formed dunes found above some sandstone headlands. A low to moderately tall open forest of bangalay (*Eucalyptus botryoides*) and smooth-barked apple (*Angophora costata*) is common with swamp mahogany (*Eucalyptus robusta*) present where the community grades into poorly drained soils. Tall *Banksia* trees may join the eucalypt canopy or form a sparse layer underneath. The semi-sheltered habitat of this forest encourages a mix of mesophyllous and sclerophyllous species found in the shrub layer. Sweet pittosporum (*Pittosporum undulatum*), cheese tree (*Glochidion ferdinandi*), coffee bush (*Breynia oblongifolia*) and tree broom-heath (*Monotoca elliptica*) are typical. A high cover of bracken fern (*Pteridium esculentum*) and spiny-headed mat-rush (*Lomandra longifolia*) often dominates the ground layer with grasses, sedges and other forbs in lower abundance.

Where this forest is found on the low lying marine sands elevations rarely exceed 10 metres asl. This flat undulating landscape has been attractive for urban and industrial development in Sans Souci, Narrabeen and Kurnell areas and as result much of the original forest cover is gone. This is typical for much of the distribution along the eastern seaboard although significant stands still remain patchily distributed along the southern and central coasts. The larger remaining areas of this forest found in the study area occur on the sheltered side of the larger headland dunes. These elevated positions (up to 40 m asl) can be found at, Kurnell and La Perouse. In the Sydney region the community forms part of the sand dune forests complex found between Shellharbour and Port Stephens.

The community has been extensively cleared, with the remaining examples are highly fragmented and patchily distributed. Weed invasion (particularly from bitou bush—*Chrysanthemoides monilifera* subsp. *rotundata*) is common within remaining stands. Heavy recreation use occurs within currently reserved areas. Frequent fire may pose localised threats near the urban perimeter.

Coastal Sandstone Gully Moist Heath (Sydney Sandstone Gully Forest)

Coastal Sandstone Gully Moist Heath is a low to moderately tall woodland and forest with a closed wet heath layer found on sandstone gullies and sandy drainage lines. The canopy is open to sparse featuring eucalypts such as red bloodwood (*Corymbia gummifera*), smooth-barked apple (*Angophora costata*) and Sydney peppermint (*Eucalyptus piperita*). More prominent is the dense diverse heath layer that may include several different species of banksias, hakeas, tea-trees and casuarinas. Also found within the heath layer are mesic plants such as black wattle (*Callicoma serratifolia*) and blueberry ash (*Elaeocarpus reticulatus*). Permanent water from rock seepage or creek lines encourages a range of fern species including coral fern (*Gleichenia dicarpa*) and sedges (*Empodisma minus*).

The distribution of the community is restricted to high rainfall zones along the coast where mean annual rainfall exceeds 1250mm per annum. The soils are generally very infertile rocky siliceous sandstones and sandstone colluvium associated with the Lambert soil landscape in northern Sydney and the Hawkesbury Sandstone Soil Landscape in the South of Sydney. Similar heaths might be expected to occur north of the study area in the hinterland of the Central Coast although no evidence is available from systematic site data available to this project. Broader regional classifications include this unit within coastal sandstone gully forest complexes.

Clearing is likely to have had limited affect on the distribution of the community because of the infertile soils and precipitous nature of the habitat. Current threats are likely to arise from local weed invasion from upstream developments, frequent fire and trail riding.

Coastal Sand Littoral Forest (Kurnell Dune Forest)

Coastal Sand Littoral Forest describes a forest and woodland community that incorporates a prominent component of littoral rainforest species amongst the sclerophyllous shrub and small tree layer. The forest floor is well shaded by tuckeroo (*Cupaniopsis anacardioides*) and other waxy-leaved species often occurring at or below a canopy of banksia, casuarina and/or eucalypt trees. A high diversity of vines can be found across multiple layers of the vegetation. The woody vine cockspur thorn (*Maclura cochinchinensis*), identifiable by its long spikes, is a useful diagnostic species for the community. Habitat and disturbance are both very influential in the structure and composition of the community at any given location. It is restricted to coastal sand deposits receiving greater than 1050 millimeters of mean annual rainfall.

The most extensive areas remain on the older low-lying (c. 1.5-10 metres asl) transgressive barrier dunes along the northern side of the Kurnell Peninsula. On the drier siliceous sands the forest forms a eucalypt dominated forest comprising bangalay (*Eucalyptus botryoides*) and/or swamp mahogany (*Eucalyptus robusta*) with a grassy and ferny ground cover. On the humic podsols associated with poorly drained areas eucalypts are less prominent and are dominated by tall coast banksia (*Banksia integrifolia* subsp. *integrifolia*) and swamp oak (*Casuarina glauca*) above a ground cover of sedges thriving amongst the water logged soils. Above 10 metres asl this community is increasingly restricted to sheltered situations where there is greater protection from prevailing winds and fire. Eucalypts may once have consistently dominated; however, today lower growing banksia scrubs with young regenerating eucalypts are more common.

Widespread and intensive disturbance arising from sand mining, industrial and urban development has resulted in extensive loss of this community. In many instances the original topography of the landscape has irreversibly changed with the loss and migration of sand dunes. Extant areas are often in dynamic stages of succession and heavily cloaked in invasive weeds such as lantana (*Lantana camara*) and bitou bush (*Chrysanthemoides monilifera* subsp. *rotundata*).

Coastal Dune Littoral Rainforest (Littoral Rainforest)

A closed canopy dominated by tuckeroo (*Cupaniopsis anacardioides*) and a sandy substrate helps differentiate this littoral rainforest from others found in the Sydney basin. This community forms a low closed canopy of rainforest trees with an occasional emergent eucalypt, casuarina, banksia or paperbark. It is situated on recent sand deposits, typically in swales or depressions on low lying sheltered hind dunes less than 10 metres in elevation. Many tree species are shared with other littoral rainforest communities. These include lilly pilly (*Acmena smithii*) and cheese tree (*Glochidion ferdinandi*). In the Sydney region the threatened species the magenta lilly pilly (*Syzygium paniculatum*) has also been recorded amongst the small tree layer.

Only small isolated stands of this rainforest occur in the SMCMA on the Kurnell Peninsula. At Towra Point the understorey is threatened by encroaching lantana, spreading from sites of previous disturbance. The lantana can smother the understorey, inhibiting the development of the ferns and vines that are otherwise present in less disturbed sites. While similar habitats are found south of Sydney, tuckeroo is not present and the sand littoral rainforests are considered to form part of the Temperate Littoral Rainforest community (Tozer et al. 2006).

Invasive weeds such as *Lantana camara* and *Chrysanthemoides monilifera* subsp. *monilifera* are prolific in disturbed landscapes that adjoin the remaining stands in the Sydney basin.

Coastal Sand Mantle Heath (Coastal Dune Heath)

Coastal Sand Mantle Heath is an open to closed heath found on shallow to moderately deep sand mantles that are perched above some of Sydney's major sandstone headlands. The landscape on which it occurs are a component of the relictual dune systems that are formed from windblown deposits of sand. As a result of their age they have been exposed to long periods of weathering and soil leaching that has produced highly podsolised soils. These shallower dunes support a wallum heath community that is unlike those found on Pleistocene dunes elsewhere in the greater Sydney Region. The heath tends to have a diverse range of larger shrubs with coast tea-tree (*Leptospermum laevigatum*), wallum banksia (*Banksia aemula*), scrub she-oak (*Allocasuarina distyla*) and heath-leaved banksia (*Banksia ericifolia*) commonly recorded, though no single species dominates at all sites. The composition of the heath, such as the prominence of the heath-leaved banksia, appears to reflect a transitional environment between the sandstone headland heaths nearby and the heaths found on deeper dunes.

Occasionally there are localised patches of emergent low growing eucalypts that include red bloodwood (*Corymbia gummifera*) and smooth-barked apple (*Angophora costata*). More consistent however is the diverse range of woody shrubs such as wattles, geebungs, peas, grevilleas and paperbark amongst others. A number of other smaller plants are indicative of a sand heath assemblage. These include wedding bush (*Ricinocarpos pinifolius*), grass tree (*Xanthorrhoea resinosa*) and tree broom-heath (*Monotoca elliptica*). The cover of vegetation found on the ground is variable depending on disturbance and drainage conditions. On drier sites that carry a more open heath structure a dense cover of ferns can be found whereas poorly drained sites will include a greater abundance and cover of sedge species. This heath community is situated on headlands at North Head, Malabar, La Perouse and the Kurnell Peninsula. It is restricted to elevations between 20-80 metres ASL.

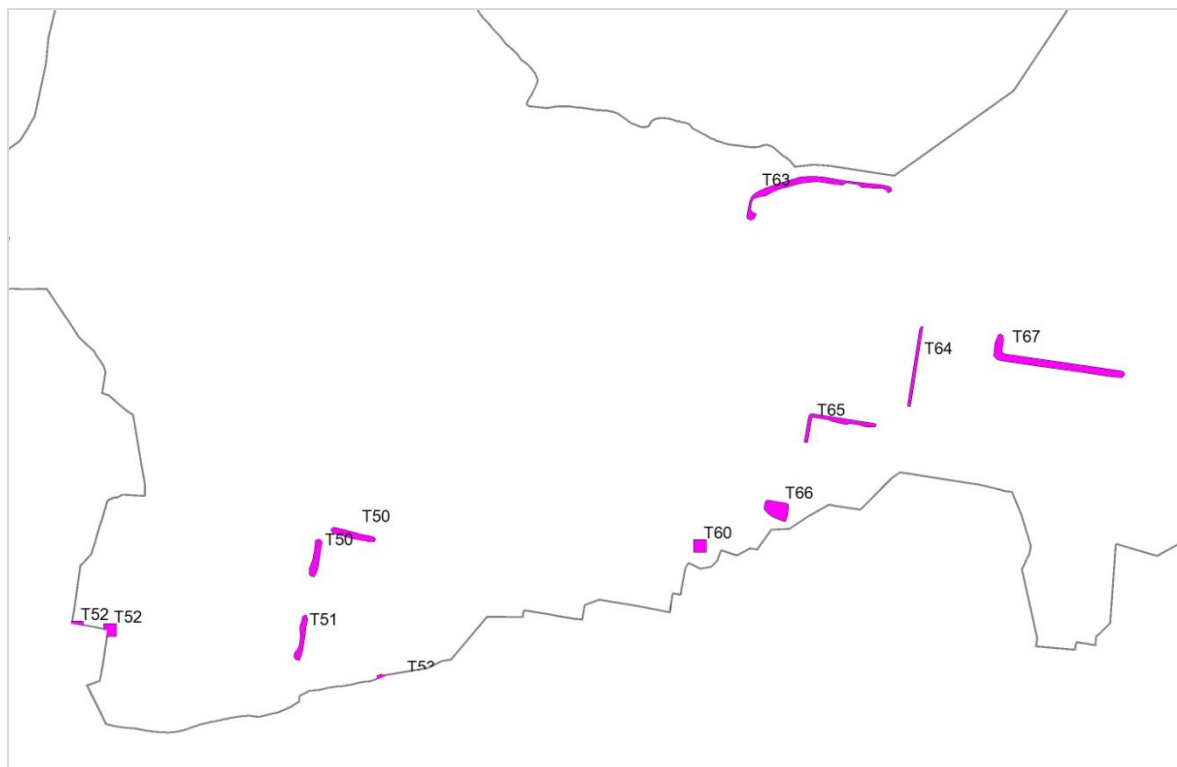
SIGNIFICANT VEGETATION

EXTANT MAPPED VEGETATION COMMUNITIES

COMMUNITY	HECTARES
COASTAL DUNE HEATH	138
COASTAL SALTMARSH	153
KURNELL DUNE FOREST	170
KURNELL DUNE FOREST - DEGRADED	19
LITTORAL RAINFOREST	34
MANGROVE	103
NON NATURAL WETLANDS	14
SWAMP OAK FLOODPLAIN FOREST	64
SWAMP SCLEROPHYLL FOREST	30
SYDNEY FRESHWATER WETLAND	62
SYDNEY SANDSTONE GULLY FOREST	25
SYDNEY SANDSTONE HEATH	1
SYDNEY SANDSTONE RIDGETOP WOODLAND	3
SYDNEY TURPENTINE IRONBARK FOREST	3
TAREN POINT SHOREBIRD COMMUNITY	0.17

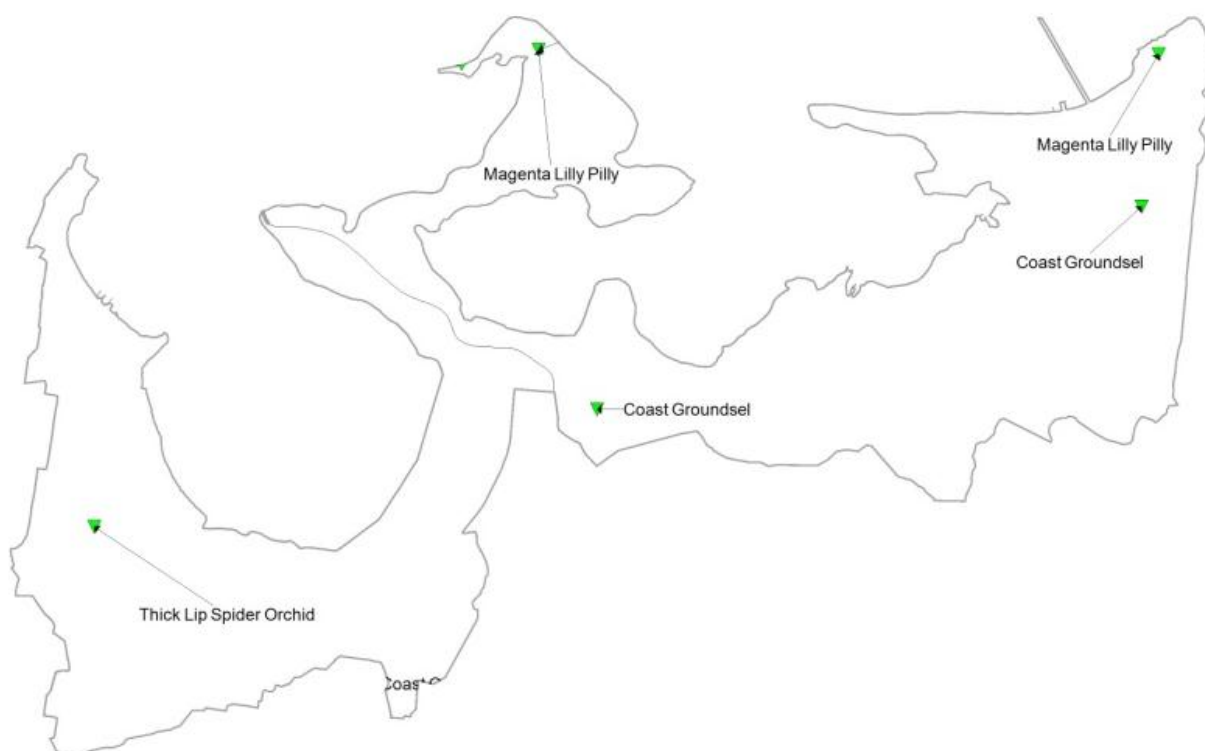
LEP 2006 SIGNIFICANT VEGETATION

LEP TAG	NAME	CLASS
T52	Street tree	Significant Group of Trees or Vegetation
T51	Eucalyptus racemosa_Ghost gum	Significant Group of Trees or Vegetation
T50	Eucalyptus racemosa	Significant Group of Trees or Vegetation
T60	Ficus rubiginosa_Port jackson fig	Significant Group of Trees or Vegetation
T66	Eucalyptus globoidea and Eucalyptus paniculata	Significant Group of Trees or Vegetation
T65	Eucalyptus paniculata and Eucalyptus pilularis	Significant Group of Trees or Vegetation
T64	Eucalyptus_snappy gum_street plantings	Significant Group of Trees or Vegetation
T63	Sarcocornia quingue_etc	Significant Group of Trees or Vegetation
T67	Ficus hillii	



THREATENED SPECIES: FLORA RECORDS

SCIENTIFIC NAME	COMMON NAME	LEGAL_ STATUS
<i>Caladenia tessellata</i>	Thick Lip Spider Orchid	E1
<i>Syzygium paniculatum</i>	Magenta Lilly Pilly	V
<i>Senecio spathulatus</i>	Coast Groundsel	E1



THREATENED SPECIES: FAUNA RECORDS

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

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
<i>Pandion haliaetus</i>	Osprey	V
<i>Oxyura australis</i>	Blue-billed Duck	V
<i>Botaurus poiciloptilus</i>	Australasian Bittern	E1
<i>Burhinus grallarius</i>	Bush Stone-curlew	E1
<i>Charadrius mongolus</i>	Lesser Sand-plover	V
<i>Diomedea exulans</i>	Wandering Albatross	E1
<i>Haematopus longirostris</i>	Pied Oystercatcher	E1
<i>Sterna albifrons</i>	Little Tern	E1
<i>Sterna fuscata</i>	Sooty Tern	V
<i>Epthianura albifrons</i>	White-fronted Chat	V

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
<i>Daphoenositta chrysoptera</i>	Varied Sittella	V
<i>Petroica boodang</i>	Scarlet Robin	V
<i>Lathamus discolor</i>	Swift Parrot	E1
<i>Calidris alba</i>	Sanderling	V
<i>Calidris tenuirostris</i>	Great Knot	V
<i>Limicola falcinellus</i>	Broad-billed Sandpiper	V
<i>Limosa limosa</i>	Black-tailed Godwit	V
The Shorebird Community occurring on the relict tidal delta sands at Taren Point (Threatened Ecological Community)		

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

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
<i>Dugong dugon</i>	Dugong	E1
<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheath-tail-bat	V
<i>Arctocephalus forsteri</i>	New Zealand Fur-seal	V
<i>Pteropus poliocephalus</i>	Grey-headed Flying-fox	V
<i>Miniopterus schreibersii oceanensis</i>	Eastern Bentwing-bat	V
<i>Myotis macropus</i>	Southern Myotis	V
<i>Chelonia mydas</i>	Green Turtle	V

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

SCIENTIFIC NAME	COMMON NAME	LEGAL STATUS
<i>Litoria aurea</i>	Green and Golden Bell Frog	E1
<i>Crinia tinnula</i>	Wallum Froglet	V

THREATENING PROCESSES

SUMMARY OF IMPACTS

The Botany Bay catchment as defined in Sutherland Shire is only a small part of the whole catchment area that impacts on Botany Bay itself. The catchment of Botany Bay is approx 1165 km² in area, beginning from Prospect Reservoir in the north-west. The two main rivers entering Botany Bay are the Georges River and the Cooks River. Botany Bay and its catchment waterways are subject to ongoing threats due to nutrient and sediment-laden run-off from various non-agricultural land uses. A substantial part of the catchment is highly developed with almost 40% of its area being used for urban, industrial or commercial purposes.

- Pollutants of concern are nitrogen, phosphorus and total suspended solids.
- Development pressure is contributing to degradation of bushland and recreational areas which is increasing sediment loads within the catchment.
- Urban development (including ports and airports) has encroached on more than half of the Bay's shoreline and much of the riparian lands upstream.
- Dredging and foreshore development have been likely primary causes of significant local beach erosion
- Seagrass beds have been lost or damaged in a number of locations.
- Water quality in the two major tributary rivers has declined.
- Oil spills associated with the oil refinery loading wharf and Mascot airport
- Inappropriate location of sewer discharges
- Management of foreshores for recreation and conservation
- Management of foreshores erosion control

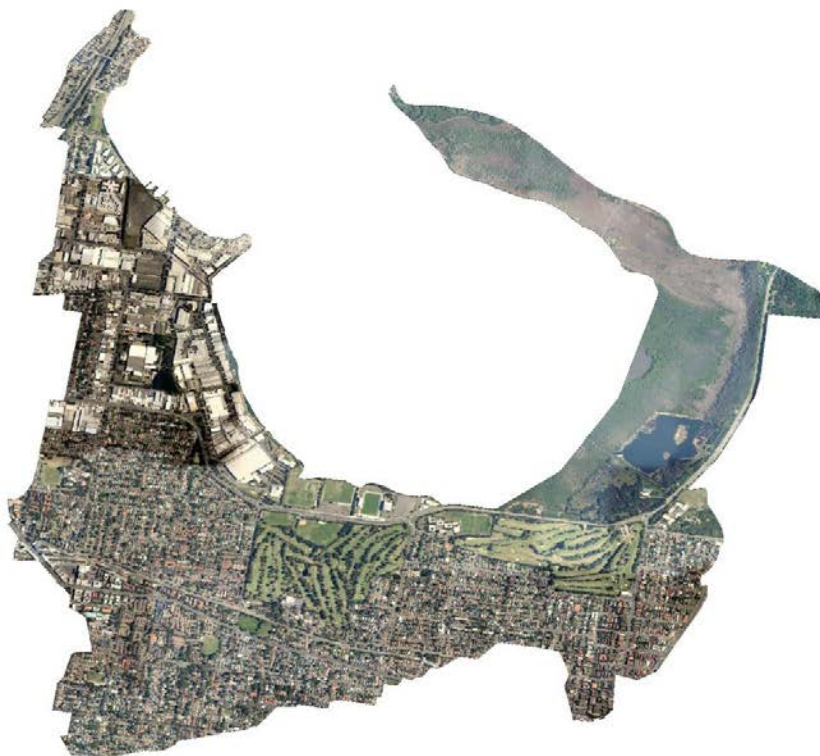


WOOLOOWARE BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 8.5 KM²

SUBURBS: WOOLLOOWARE
CARINGBAH
TAREN POINT
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.

Five sites were sampled in Woolaware Bay subcatchment, including:

1. Production Rd, Taren Point

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 ↓↑	↓	↓	↓	=	↓

Improvement in values for a number of parameters, while others worsened over the sample period; however, most parameters still do not meet ANZECC 2000 guideline values.

2. Endeavour Rd, Taren Point

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 great improvement in values recorded for most parameters, although many still do not meet ANZECC 2000 guideline values.

3. Resolution Dr, Taren Point

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 ↓↑	↑	↓	=	↑	↓
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Significant increases in ammonia and enterococci were recorded at this site during the sampling period, with the changes exceeding ANZECC 2000 guidelines. Improvements were recorded for most other parameters, and many of these were within guideline ranges.

4. Sharks Leagues Club Channel

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 ↓↑	↓	↓	↓	↓	↓

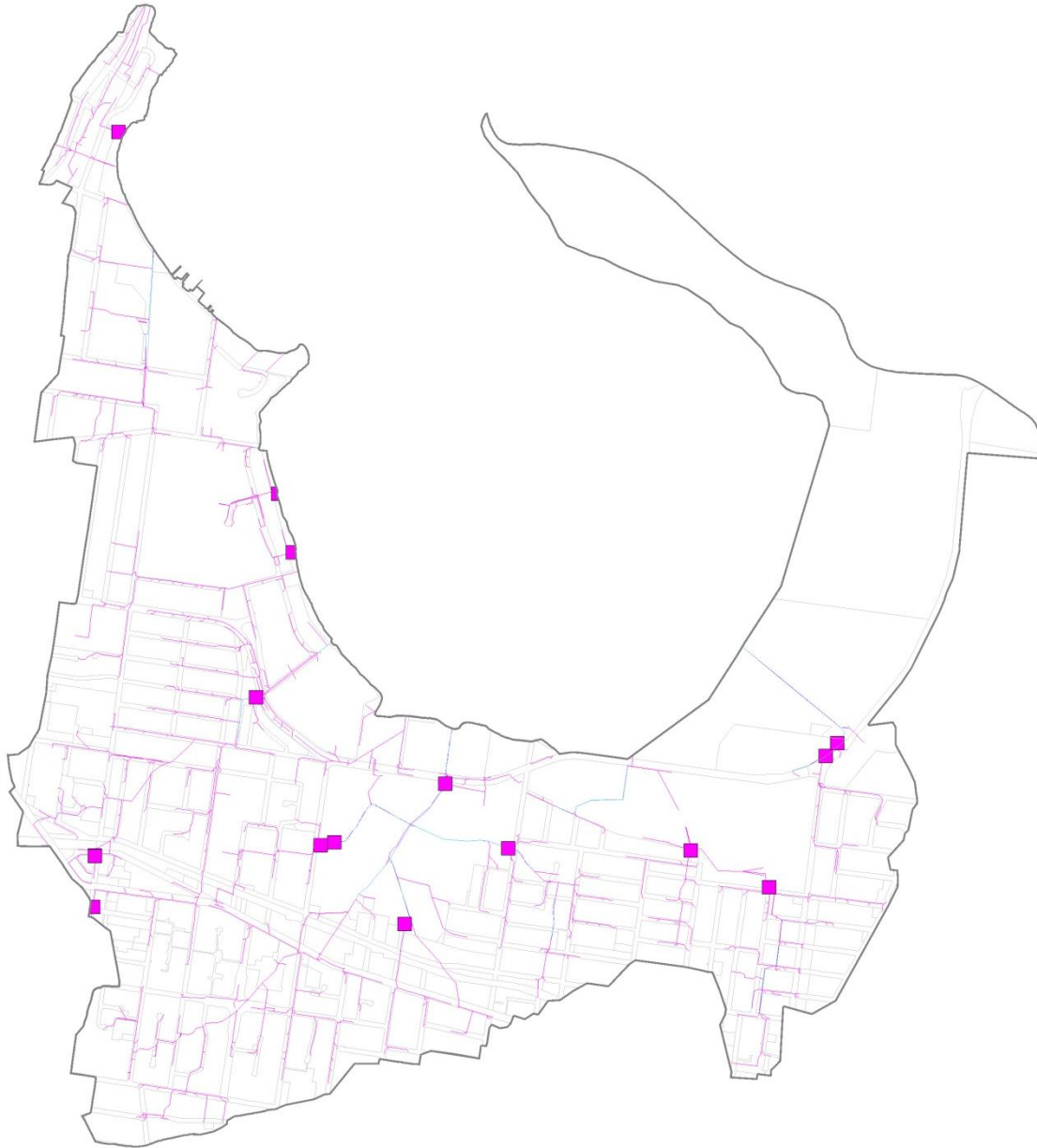
Significant improvements were recorded for most parameters over the survey period, with the result that most of them are now well within ANZECC 2000 guideline value ranges.

5. Elouera Rd Channel

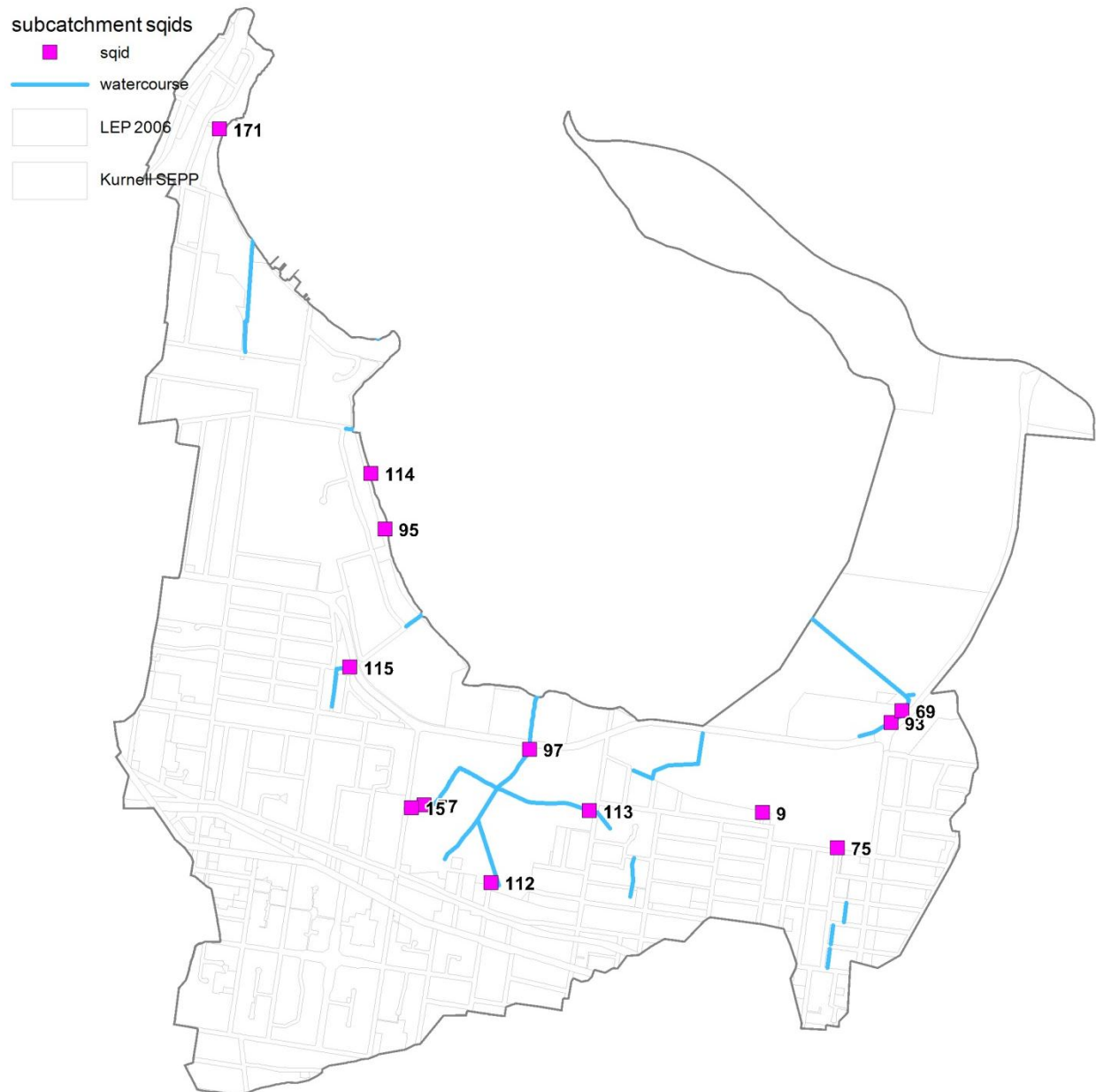
PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	+
WINTER 02 +/- ANZECC 2000 values	+	-	+	+	+
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	Enterococci	Grease	TN	TP	TSS
SUMMER 95 +/- ANZECC 2000 values	+	+	+	+	+
WINTER 02 +/- ANZECC 2000 values	+	+	+	+	+
TREND ↓↑	↑	↑	↑	↑	↑

While a reduction in ammonia and heavy metals were reported for this site, enterococci, grease and nutrient loads increased. Most values were outside the guideline ranges provided by ANZECC 2000.

RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS



LOCATION OF SQIDS

ID	DEVICE CATEGORY	DEVICE TYPE	LOCATION	SITE DESCRIPTION	SUBURB	APPROX. CATCHMENT
77	Wetland	Wetland	Gannons Road (downstream from GPT)	Woollooware Golf Course	Woollooware	26.2 Ha
97	Detention Basin	Detention Basin	Captain Cook Drive	Playing Fields	Woollooware	157 Ha
9	GPT	GPT	Sturt Road	Cronulla Golf Course	Cronulla	18.5 Ha
15	GPT	GPT	Gannons Road	Woollooware Golf Course	Woollooware	16.9 Ha
75	GPT	GPT	Hume Road (opposite Wyanbah Road)	Cronulla Golf Course	Cronulla	44.5 Ha
93	GPT	GPT	Captain Cook Drive	H1 Site opposite Cronulla High School	Cronulla	17.1 Ha
95	GPT	GPT	Northumberland Road	Behind Industrial units	Caringbah	12.5 Ha
114	GPT	GPT	Northumberland Road	Behind industrial units	Caringbah	16 Ha
115	GPT - Other	Floating Litter Trap	Murrami Avenue	Canal in park	Caringbah	91.6 Ha
139	Gully Pit Pollutant Filter	Enviropond Pollutant Filters	Port Hacking Road (corner Mansfield Avenue)	Caringbah Shopping Centre	Caringbah	0.07 Ha
112	End of pipe trap	Nettech Device	Dolans Road	Woollooware Golf Course	Woollooware	9.9 Ha
113	GPT	GPT	Woollooware Road	Woollooware Golf Course - 40m south of Sturt Road	Woollooware	35.5 Ha
76	GPT - Other	Litter Basket	Mackay Street	Caringbah Carpark	Caringbah	1.8 Ha
171	GPT - Other	Trash Rack	Woodlands Road	Woodlands Road Reserve	Taren Point	1.3 Ha
69	Wetland	Wetland	Captain Cook Drive	H1 Site - opposite Cronulla High School	Cronulla	22 Ha

GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Woolaware Bay subcatchment soil landscapes include Mangrove Creek Soil Landscape (mc) around Towra Point and much of the Woolaware Bay foreshores. Areas immediately behind the foreshores, and all of the catchment including foreshore areas around Shell Point and towards Taren Point, are Disturbed Terrain Soil Landscape (xx). A small area of Gynea Soil Landscape (gy) remains around the suburb of Woolaware (from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations in Geology and Soils section for Botany Bay catchment).

TOPOGRAPHY

More than half the subcatchment is below 5m AHD. The remainder of the subcatchment is less than 30m AHD, apart from a small area of maximum elevation (38m) in the southwestern corner.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 1	2.3
CLASS 2	182.1
CLASS 3	180.7
CLASS 4	37.7
CLASS 5	254.4

Lowlying areas around the foreshores are classified as Class 2 ASS. Additional land to an elevation of around 5m are classified as Class 3 ASS. Most of the Class 4 ASS land is in wetland areas near Cronulla Park.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

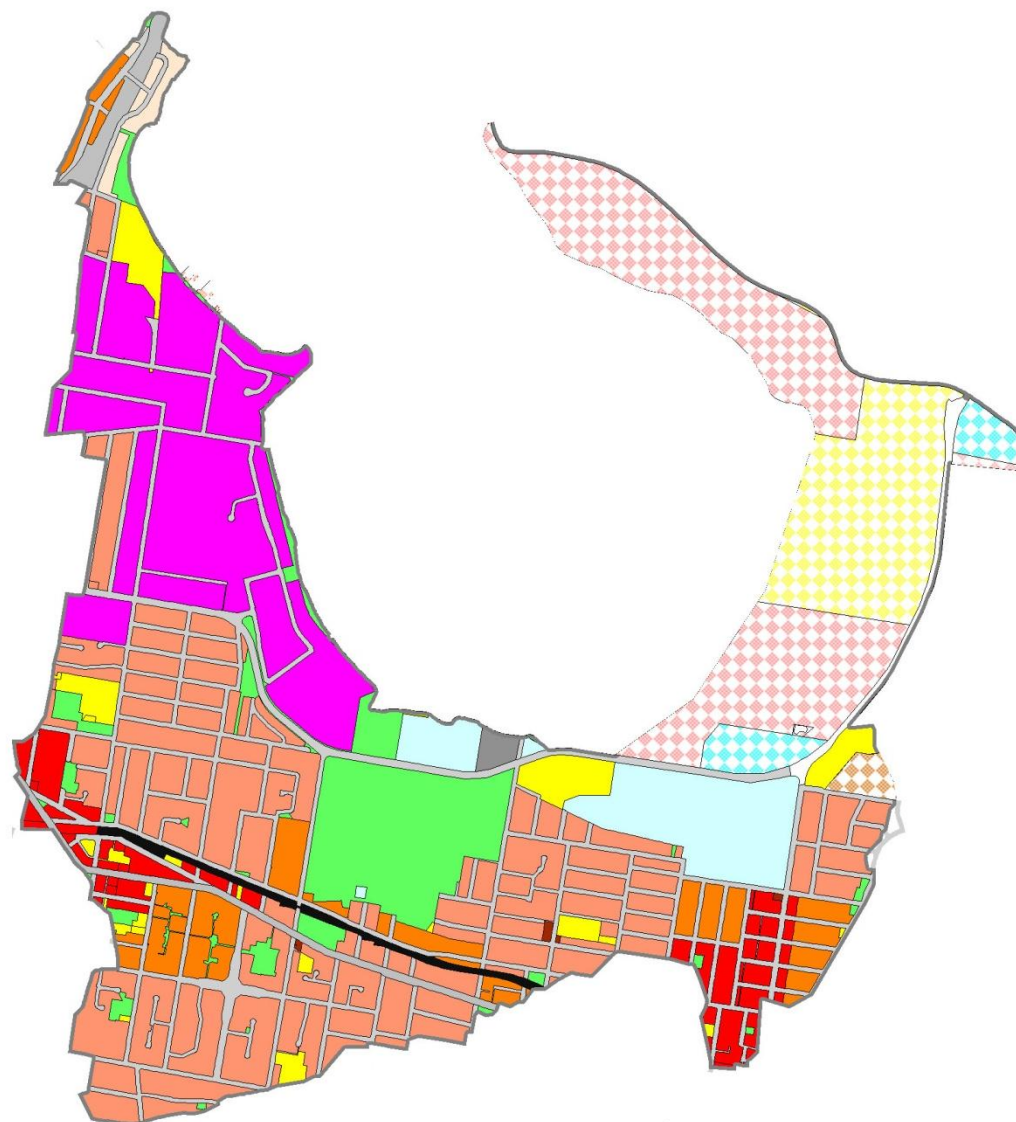
HISTORIC LAND USE

Woolaware Bay is bounded by the suburbs of Taren Point, Caringbah and Woolaware. It was originally a thickly forested area, with mangrove swamps around Woolooware Bay. In the 1830s John Connell purchased Woolooware Bay for his logging interests. On his death in 1849 his estate was divided between his two grandsons, and Elias Pearson Laycock received the property around Woolaware Bay. Gangs of grasscutters cut the grass in the area and it was shipped to Sydney for stock feed when other areas were suffering from drought (Lawrence, 1997). John Connell junior cut timber from this property and it was hauled along a canal dug by John senior. The property produced fruit and vegetables, along with cattle, and later operated as a dairy.

Woolaware and the adjoining bay were named from the aboriginal word woolawa, meaning muddy track, which described the original land route to the area (Jackson, 2006). Taren Point was originally known as Comyns Point, or Cummins Point, named after an early resident. Caringbah (aboriginal for Pademelon Wallaby) was originally known as Highfield, and along with Taren Point, became part of the Holt estate in the 1860s. In 1868 the area was assessed as having good areas of brickmaking clay (Jackson, 2006). Despite this, the main early industries in the area were market gardening and poultry farming, and in 1880 a syndicate was formed to mine coal nearby.

Dolans Estate, nearby, was subdivided in 1889, and included much of the land immediately south of Woolaware Bay. In 1910 the area to the west, known as St Mervyns Estate, was also subdivided. Just prior to this in 1908, 4 hectares at the northern end of Dolans Rd were leased by Sutherland Shire Council to be used as a nightsoil depot, marking the beginning of sanitary services in the Shire (Jackson, 2006). Large areas of mangrove swamps were later reclaimed to create parks and playing fields including Endeavour Field, Woolooware Golf Course and Cronulla Golf Course. The area was further subdivided after the railway line from Sutherland to Cronulla was opened in 1939.

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

SEPP ZONING BY CLASS

- 5(a) Special Uses - W.S.&D.
- 6(a) Recreation Existing
- 7(a) Environmental Protection (Waterways)
- 7(b) Environmental Protection (Special Development)
- 8(a) National Parks and Nature Reserves - Existing
- 9(a) Reservations Open Space (Regional)
- E4 - Environmental Living

CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

LEP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	POTENTIAL IMPERVIOUS	HECTARES IMPERVIOUS
Deferred Matter	2.49	0%	0%	0.00
Environmental Housing Sensitive Land	0.00	0%	43%	0.00
Environmental Housing Scenic Quality	6.04	1%	57%	3.44
Environmental Housing Bushland	0.00	0%	57%	0.00
Local Housing	195.39	29%	51%	99.65
Multiple Dwelling A	39.46	6%	64%	25.26
Multiple Dwelling B	25.69	4%	64%	16.44
		0%		
Mixed Use Kirrawee	0.00	0%	64%	0.00
Urban Centre	4.98	1%	94%	4.68
Local Centre	0.00	0%	88%	0.00
Neighbourhood Centre	0.62	0%	86%	0.53
Employment	116.66	18%	95%	110.83
Special Uses	27.25	4%	30%	8.18
Public Open Space	70.07	11%	5%	3.50
Public Open Space Bushland	0.36	0%	0%	0.00
Private Recreation	40.89	6%	5%	2.04
Environmental Protection Waterways	0.01	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	6.18	1%	33%	2.04
Arterial Road/Road	129.03	19%	66%	85.16
Transport Reservation	0.00	0%	5%	0.00
TOTAL	665.13	100%	54%	361.75

SEPP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	APPROXIMATE IMPERVIOUS	HECTARES IMPERVIOUS
5(a) Special Uses	1.54	1%	51%	0.79
6(a) Recreation Existing	13.20	7%	0%	0.00
7(a) Environmental Protection (Waterways)	0.51	0%	30%	0.15
7(b) Environmental Protection (Special Development)	0.01	0%	0%	0.00
8(a) National Parks and Nature Reserves - Existing	98.99	54%	0%	0.00
9(a) Reservations Open Space (Regional)	57.90	32%	0%	0.00
E4 - Environmental Living	3.98	2%	0%	0.00
unzoned	6.64	4%	66%	4.38
TOTAL	182.76	100%	1%	0.94

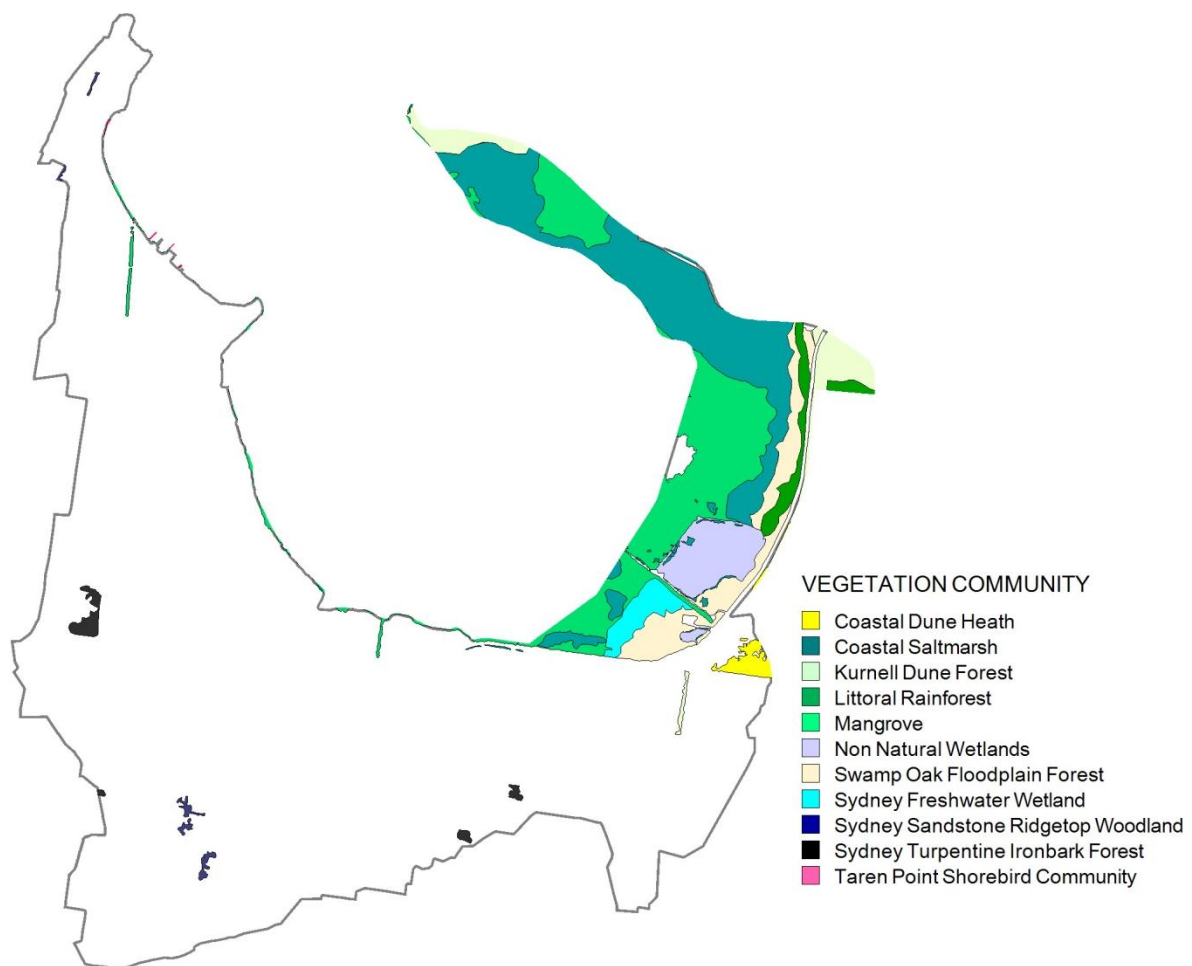
VEGETATION COMMUNITIES

LEP 2006 SIGNIFICANT VEGETATION

LEP TAG	NAME	CLASS
T52	Street tree	Significant Group of Trees or Vegetation
T51	Eucalyptus racemosa_Ghost gum	Significant Group of Trees or Vegetation
T50	Eucalyptus racemosa	Significant Group of Trees or Vegetation
T60	Ficus rubiginosa_Port jackson fig	Significant Group of Trees or Vegetation
T66	Eucalyptus globoidea and Eucalyptus paniculata	Significant Group of Trees or Vegetation
T65	Eucalyptus paniculata and Eucalyptus pilularis	Significant Group of Trees or Vegetation
T64	Eucalyptus_snappy gum_street plantings	Significant Group of Trees or Vegetation
T63	Sarcocornia quinque_etc	Significant Group of Trees or Vegetation
T67	Ficus hillii	

MAPPED VEGETATION COMMUNITIES

3.0 HECTARES	COASTAL DUNE FOREST
60 HECTARES	COASTAL SALTMARSH
11.8 HECTARES	KURNELL DUNE FOREST
6.0 HECTARES	LITTORAL RAINFOREST
56.6 HECTARES	MANGROVES
13.9 HECTARES	NON NATURAL WETLANDS
18.4 HECTARES	SWAMP OAK FLOODPLAIN FOREST
5.9 HECTARES	SYDNEY FRESHWATER WETLAND
1.3 HECTARES	SYDNEY SANDSTONE RIDGETOP WOODLAND
2.6 HECTARES	SYDNEY TURPENTINE IRONBARK FOREST
0.2 HECTARES	TAREN POINT SHOREBIRD COMMUNITY



BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Taren Point
- Woolaware Bay foreshores

2) Greenweb Support areas

- Cronulla Golf Course
- Cronulla Sutherland Leagues Club
- Solander Playing Field
- Captain Cook Oval
- Woolaware Golf Club

3) Greenweb Restoration areas

- Resolution Drive
- Northumberland Rd

Bushcare Groups

None noted

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)

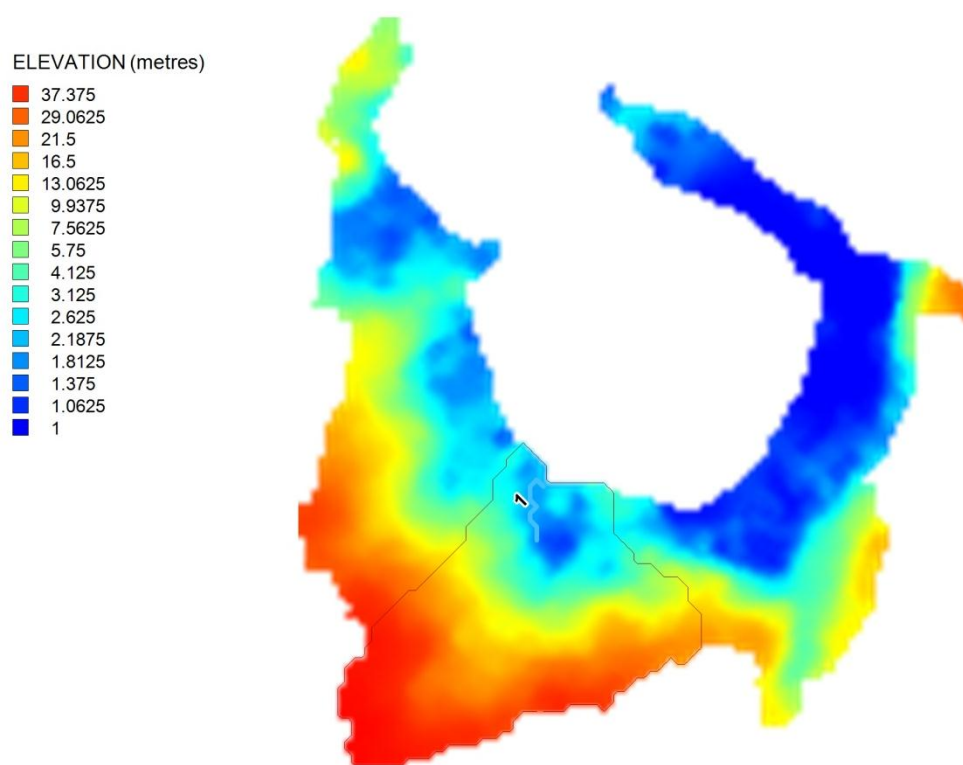
RIPARIAN IMPACTS

- 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

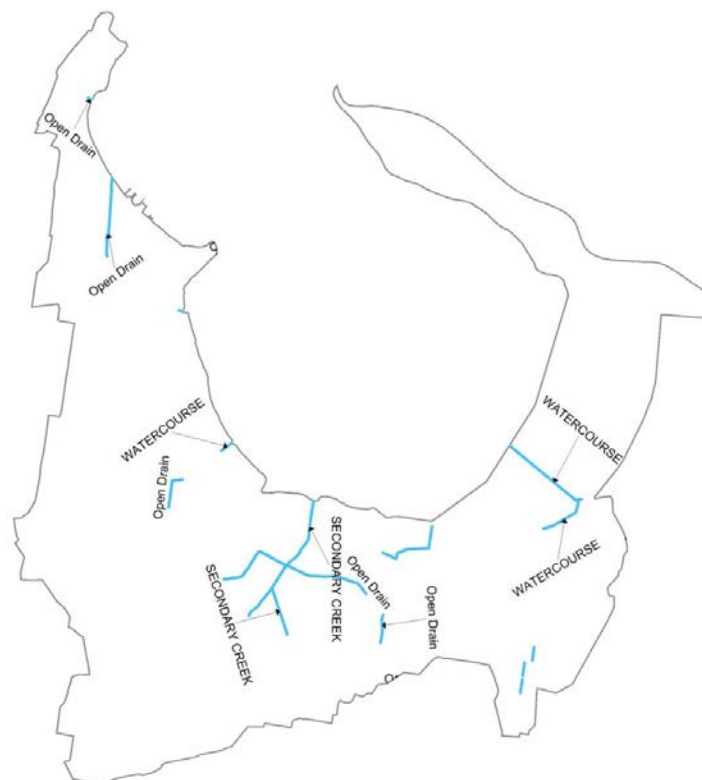
- Loss of shrub layer
 - Loss of groundcover species
- Removal of habitat elements including
 - Loss of leaf litter
 - Loss of fallen timber
 - Loss of standing dead trees
 - Loss of rocks
 - Loss of microhabitat architecture
- Dumping of rubbish
- Littering
- Vandalism including
 - Damage to plants
 - 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 BOUNDARY



WEENEY BAY/QUIBRAY BAY SUBCATCHMENT

SUBCATCHMENT OVERVIEW

CATCHMENT AREA: 11.9 KM²

SUBURBS: KURNELL



WATERWAYS

MAJOR NAMED WATERWAYS: NIL

TOTAL LENGTH OF MAPPED WATERWAYS: 1.52 KMs

PRIMARY ORDER CREEKS: 0 KMs

SECOND ORDER CREEKS: 0 KMs

FIRST ORDER & MINOR DRAINAGE LINES: 1.52 KMs

WATER QUALITY ASSESSMENT

Two sites were monitored in the Weeny Bay/Quibray Bay subcatchment:

1. Sir Joseph Banks Drive

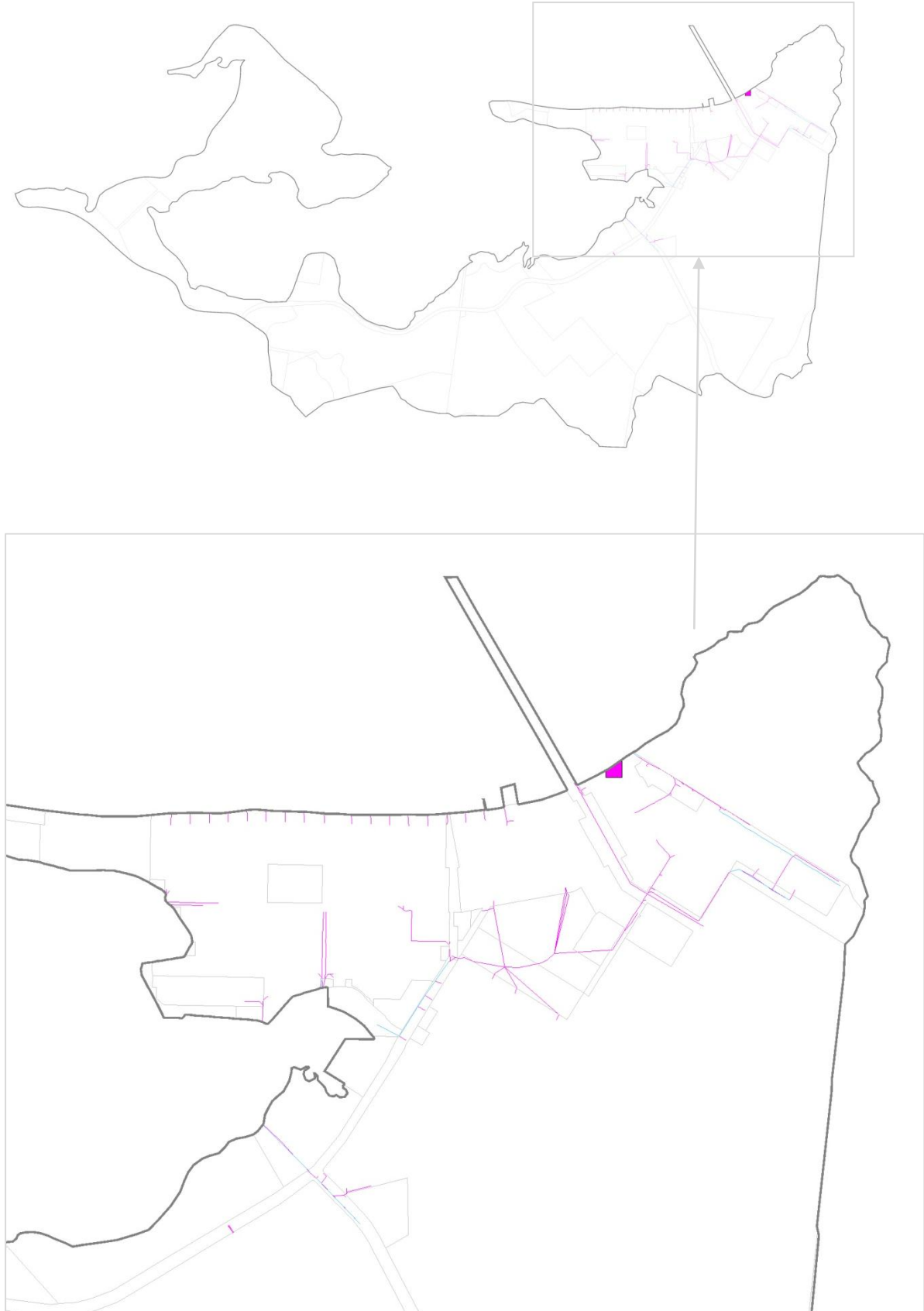
PARAMETER	NH3	BOD	Cu	Pb	Zn
SUMMER 95 +/- ANZECC 2000 values	+	=	+	+	+
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓	↓	↓	↓
PARAMETER	Enterococci	Grease	TN	TP	TSS
SUMMER 95 +/- ANZECC 2000 values	-	++	++	-	+
WINTER 02 +/- ANZECC 2000 values	-	-	-	-	-
TREND ↓↑	↓	↓↓	↓↓	↑	↓

A reduction in values for most parameters was reported from this site, so that values for most parameters were within ANZECC 2000 guideline ranges at the end of the survey period.

2. Silver Beach Kurnell

Insufficient data was recorded at this site, and results were not reported.

RETICULATED STORMWATER SYSTEM



LOCATION OF SQIDS

ID	Device category	Device type	Location	Site description	Suburb	Approx. catchment
37	GPT - Other	Sand Filter	Prince Charles Parade	Silver Beach	Kurnell	1.5 Ha

LOCATION OF SQIDS



GEOMORPHIC SETTING

GEOLOGY, GEOMORPHOLOGY AND SOILS

Weeny Bay/Quibray Bay subcatchment soil landscapes include Mangrove Creek Soil Landscape (mc) around Towra Point and Weeny Bay, and most of the foreshores of Quibray Bay. Kurnell Soil Landscape (kn) dominates around Bonna Point and inland areas behind Weeny Bay. Wollongong Soil Landscape (wg) is present across the peninsula between Quibray Bay and Bate Bay, and there is a large area of Disturbed Terrain (xx) around Kurnell itself (from Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet Map and Report; see summary explanations in Geology and Soils section for Botany Bay catchment).

TOPOGRAPHY

Most of Weeny Bay/Quibray Bay subcatchment is less than 5m AHD. The remainder of the subcatchment is less than 10m AHD except for around 5% which reaches a maximum elevation of 20m near where Towra Point joins the main peninsula and towards the easterly draining areas near the sea cliffs.

ASS/PASS, URBAN SALINITY

LEP (00 &06) CLASS	HECTARES
CLASS 1	8.72
CLASS 2	225.6
CLASS 3	418.3
CLASS 4	346.87
CLASS 5	179.41

Class 2 ASS land includes all the lowlying foreshore areas around Weeny and Quibray Bays and Towra Point. Class 3 ASS areas include higher parts of Towra Point, Bonna Point and along Captain Cook Drive. Large areas of the peninsula are considered Class 4 ASS including all wetland areas.

OTHER CONTAMINATION ISSUES

None noted

LAND USE

HISTORIC LAND USE

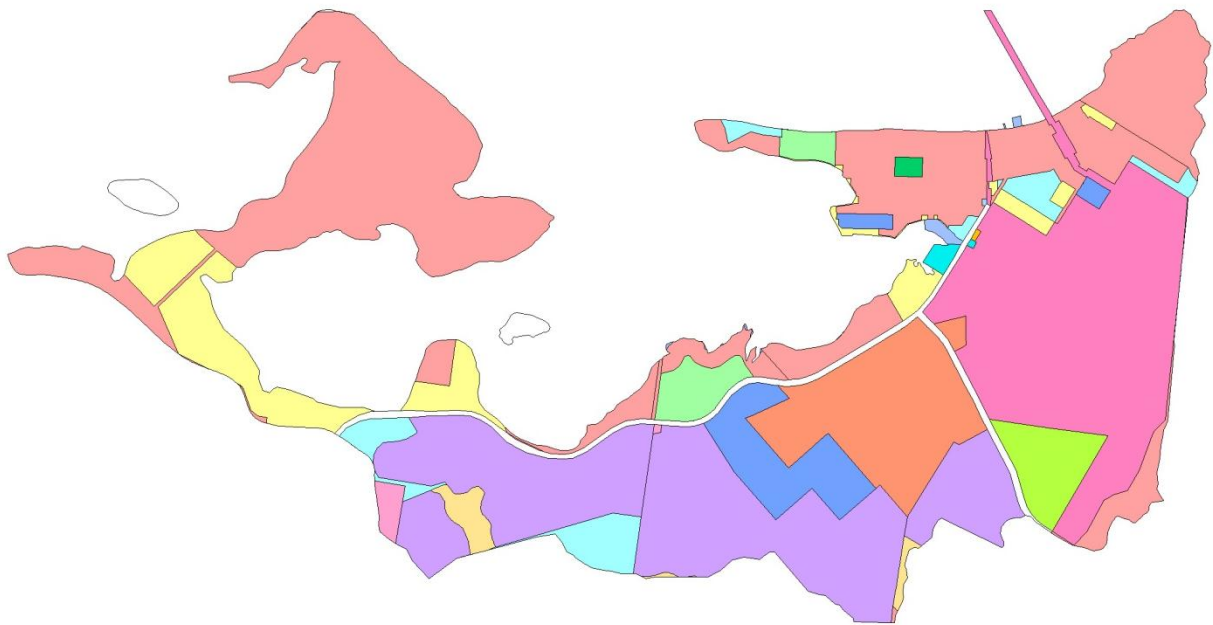
Early settlers attracted to the southern region of Sydney were the shell gatherers and timber getters. Aboriginal middens were raided for shells that were used to produce lime for mortar for buildings in the settlement. Weeny Bay and Quibray Bay provided the breeding grounds for fish that attracted fishermen to the area of Botany Bay around Kurnell, and by late 1800s Kurnell was a small fishing village. A sandy track ran along the edge of the swam at the base of the sandhills near Quibray Bay, giving rough access to Cronulla.

Up until the time of the Depression, fishermen's shacks dotted the area and a shanty town developed as a refuge for homeless and unemployed. A regular weekend ferry service commenced in 1903, sailing from Sans Souci to Kurnell, via Brighton-le-Sands and Botany (Lawrence, 1997), and ran until 1927. In May 1926 the Silver Beach Estate subdivision was opened for private sale, and more than 60 blocks sold in a single weekend. During the 1940s a bus service operated along the rough cart track to Kurnell from Cronulla, passing the huge sand dunes that were immortalised in the film about the World War I Australian Light Horse campaign in Palestine, the Forty Thousand Horsemen. Shortly after this film was completed mining of the sandhills began for use by the construction industry and others. Gradually over the next 50 years the sandhills dwindled away, until Sutherland Shire Council voted to end sand mining, and heritage authorities moved in to conserve the remaining sand dunes and the fragile environments they form part of.

During the 1950s the Australian Oil Refinery was established at Kurnell, along with a lubricating refinery and chemical laboratories, and a new wave of residential housing development. The Towra Point Nature Reserve was gazetted in 1974 after plans for an airport in the area were vetoed. In 1988 the Towra Point wetlands became part of Botany Bay National Park. They were listed as Ramsar wetlands of international significance following the recapture in Japan of a Grey-tailed Tattler (*Heteroscelus brevipes*) banded at Towra Point by Berrice Forest (C. Forest, pers. comm.), and this subsequently led to the development of JAMBA and other agreements.

The 1970s was the beginning of modern residential development at Kurnell. Commenting on the welcome to Kurnell sign, one Sydney paper noted "there is nothing welcoming about the oil refinery, the LP gas plant, the brick works, the sandmining scars, the smell of sewerage and the unofficial rubbish tips and rusted mechanical hulks that line either side of Captain Cook Drive.

CURRENT LAND USE



SEPP ZONING CLASS

- 2(a) Residential
- 3(d) Business (Neighbourhood)
- 4(a) General Industrial
- 4(b) Industrial (Light)
- 4(c1) Industrial Special (Oil Refinery)
- 4(c2) Industrial Special
- 5(a) Special Uses - Electricity
- 5(a) Special Uses - Fire Station
- 5(a) Special Uses - School
- 5(a) Special Uses - Telephone Exchange
- 5(a) Special Uses - W.S. & D.
- 6(a) Recreation Existing
- 6(b) Recreation Proposed
- 6(c) Recreation Private
- 7(a) Environmental Protection (Waterways)
- 7(b) Environmental Protection (Special Development)
- 8(a) National Parks and Nature Reserves - Existing
- 9(a) Reservations Open Space (Regional)

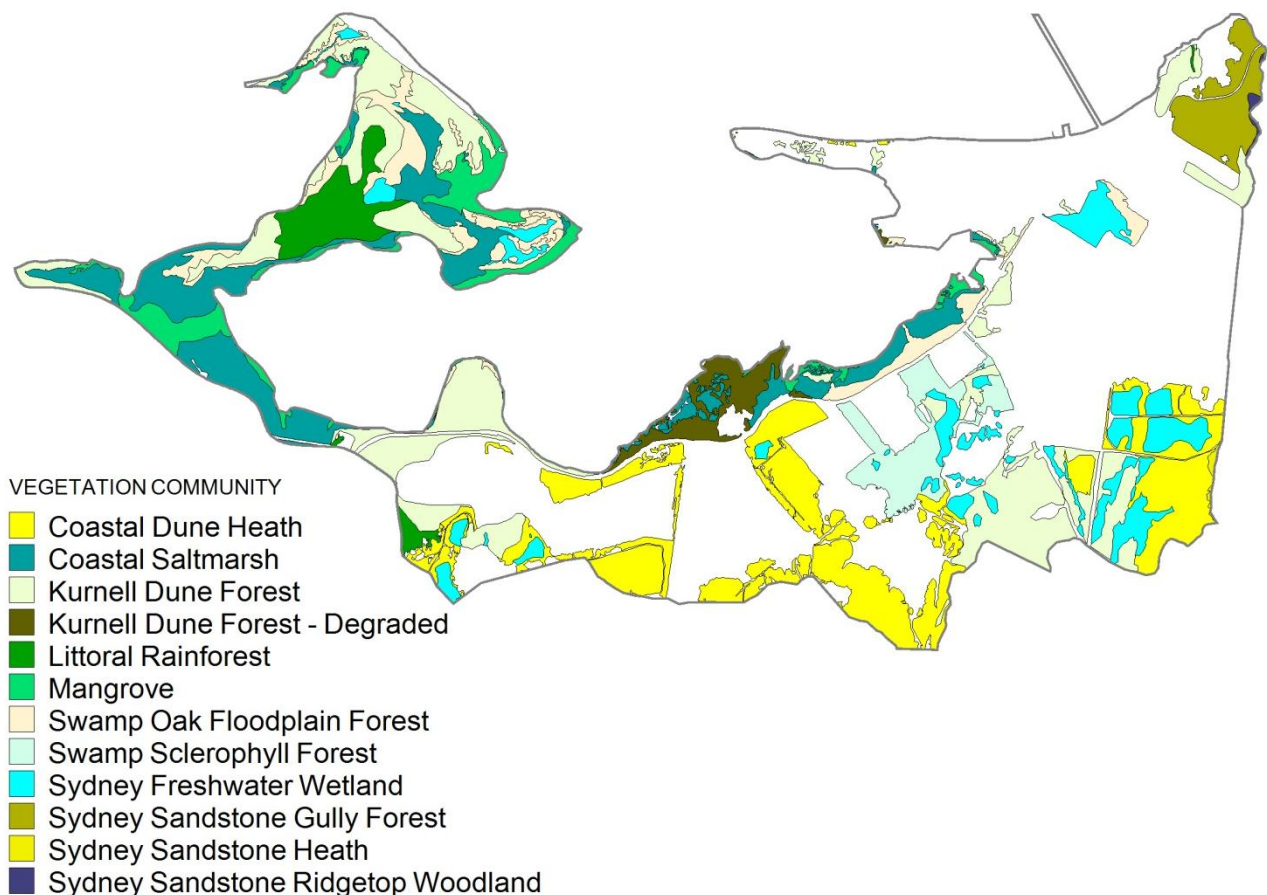
CATCHMENT IMPERVIOUS SURFACE (% AND DISTRIBUTION)

SEPP ZONING DESCRIPTOR	HECTARES	% CATCHMENT	APPROXIMATE IMPERVIOUS	HECTARES IMPERVIOUS
2(a) Residential	82.97	7%	50%	41.49
3(d) Business (Neighbourhood)	1.72	0%	79%	1.36
4(a) General Industrial	92.41	7%	42%	38.81
4(b) Industrial (Light)	138.01	11%	0%	0.00
4(c1) Industrial Special (Oil Refinery)	219.78	18%	63%	138.46
4(c2) Industrial Special	26.25	2%	1%	0.26
5(a) Special Uses	10.61	1%	0%	0.00
6(a) Recreation Existing	38.26	3%	0%	0.00
6(b) Recreation Proposed	10.99	1%	0%	0.00
6(c) Recreation Private	22.37	2%	1%	0.22
7(a) Environmental Protection (Waterways)	2.42	0%	0%	0.00
7(b) Environmental Protection (Special Development)	237.70	19%	0%	0.00
8(a) National Parks and Nature Reserves - Existing	290.86	23%	0%	0.00
9(a) Reservations Open Space (Regional)	78.22	6%	0%	0.00
E4 - Environmental Living	0.00	0%	0%	0.00
TOTAL	1252.59	100%	18%	220.60

VEGETATION COMMUNITIES

MAPPED VEGETATION COMMUNITIES

2.7 HECTARES	COASTAL DUNE HEATH
4.5 HECTARES	COASTAL SALTMARSH
20.3HECTARES	KURNELL DUNE FOREST
0.03 HECTARES	KURNELL DUNE FOREST-DEGRADED
0.2 HECTARES	LITTORAL RAINFOREST
1.0 HECTARES	MANGROVES
2.0 HECTARES	SWAMP OAK FLOODPLAIN FOREST
0.7 HECTARES	SWAMP SCLEROPHYLL FOREST
0.1 HECTARES	SYDNEY FRESHWATER WETLAND
6.3 HECTARES	SYDNEY SANDSTONEGULLY FOREST
1.6HECTARES	SYDNEY SANDSTONE RIDGETOP WOODLAND



LEP 2006 SIGNIFICANT VEGETATION

NIL

BUSHLAND RESERVES AND RESTORATION

Reserves

1) Greenweb Core areas

- Weeney Bay
- Taren Point
- Quibray Bay

2) Greenweb Support areas

- Captain Cook Drive
- Lindum Rd
- Sir Joseph Banks Drive
- Chisholm Rd
- Urban perimeter of Kurnell

3) Greenweb Restoration areas

- adjoining Captain Cook Drive opposite Warsop St

Bushcare Groups

- Silver Beach Dunecare

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
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- Decreased baseflows
- Diseases from untreated or poorly treated sewage
- Reduction in water through extraction
- Introduction of invasive species including
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 - Cane Toads
 - Koi Carp (goldfish)

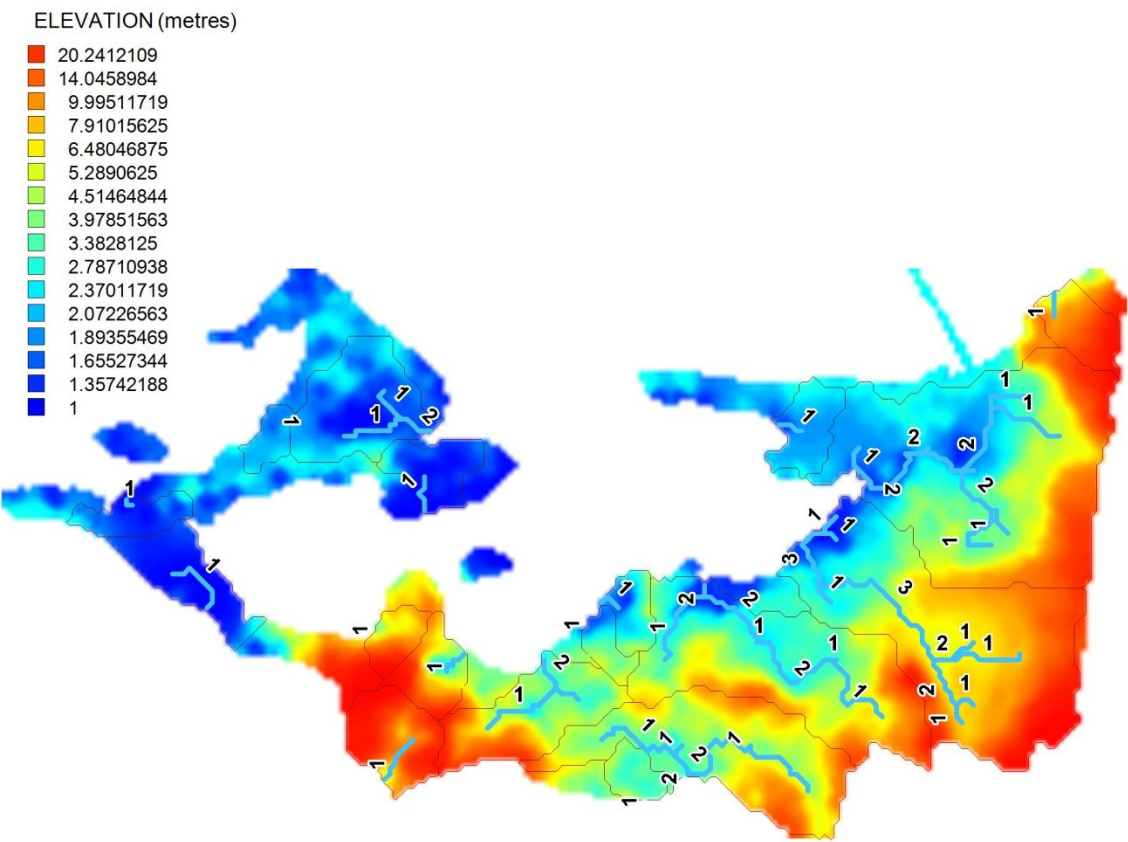
RIPARIAN IMPACTS

- Invasion by weeds
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- 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
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RECREATED WATERWAYS MAP

CATCHMENT ELEVATION MODEL: STREAM ORDERS AND CATCHMENT BOUNDARIES



CURRENTLY MAPPED WATERWAYS AND CATCHMENT BOUNDARY

