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Shoalhaven City Council

1422-02 Mapping Verification of Riparian Land in Verons Estate, Sussex Inlet

Final Report

April 2009

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Executive Summary

Shoalhaven City Council ('Council') currently utilises a set of watercourse maps within the cadastral layers of their Geographical Information Systems (GIS), which for site-scale planning are neither accurate nor field-verified with regards to position and categorisation of riparian value. Site-scale planning is needed for the Verons Estate, in Sussex Inlet, NSW. GHD was therefore commissioned by Council to update and verify the delineation of watercourses and waterbodies (farm dams) within the subject land. The aim of the project was to map watercourses and waterbodies within the subject land to enable the demarcation between land required for effective catchment function and other uses; such as rural residential development.

In order to reflect the environmental significance of each watercourse, categorisation methods defined by the former NSW Department of Natural Resources (DNR, 2006; Department of Infrastructure, Planning and Natural Resources 2004) were used to define the minimum riparian corridor widths required for conservation and management targets. Within and adjacent to the subject land, riparian lands were defined using geospatial data, and field verified using a GPS. In addition, GHD collected information on riparian condition, using a Rapid Appraisal of Riparian Condition (RARC) field survey method (Land and Water Australia, 2005).

This report provides Council with verified mapping of watercourses and categories, and waterbodies within the subject land. GHD suggests Council consider incorporating results into Council's spatial information system, to be used for future strategic planning and environmental management in the subject land.

This Executive Summary should be read in conjunction with the remainder of this report.

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Glossary

APZ – Asset Protection Zone.

Cadastral Map – a map showing legal survey boundaries, portion and plan numbers, parish and county names and boundaries. The cadastral pattern is that arrangement of survey boundaries that defines all separate parcels of land, usually for the purpose of describing and recording ownership and tenure.

CRZ – Core Riparian Zone.

DEM – Digital Elevation Model, a topographic surface arranged in a GIS data file as a set of regularly spaced *x, y,* and *z* coordinates.

DLWC – Department of Land and Water Conservation (NSW).

DIPNR – the former Department of Infrastructure, Planning and Natural Resources (NSW).

DWE – Department of Water and Energy.

Edge Effects – particularly apply to narrow riparian corridors and include altered microclimate, weed invasion and altered interaction amongst species. The effects can be reduced on the core riparian zone by increasing the width of the vegetated riparian corridor.

EEC – Endangered Ecological Community.

Endemic – belonging to, or characteristic of, a particular locality. When used in a botanical context, endemic is more specific to a location than its synonym “native”, which is a more general. For instance one can have “native” Australian garden plants, which are actually considered weeds in some areas.

Euclidean Distance – the straight line distance between two points (x and y) on a plane, (such as a Cartesian plane).

Exotic – in regard to vegetation, this term refers to species coming from another area, not occurring naturally in that area.

Floodplain – area of land that is subject to inundation by floods up to and including the probable maximum flood event. Floodplain is synonymous with flood prone land and flood liable land. Note it is not just land below the flood planning level or 1 in 100 year Average Recurrence Level (ARI) or 1% Annual Exceedance Probability (AEP) flood event.

FM Act – Fisheries Management Act 1994 (NSW).

GIS – Geographical Information System. GIS is a system of hardware and software used for storage, retrieval, mapping and analysis of geographic data.

LEP – Local Environmental Plan.

LGA – Local Government Area.

Locally indigenous – with a long history of occurrence in a defined local area.

NPWS – NSW National Parks and Wildlife Service.

NW Act – Noxious Weeds Act 1993 (NSW).

NV Act – Native Vegetation Act 2003 (NSW).

Protected land – is the bank, bed, shore or land within 40 metres of the top of the bank of protected waters, as defined under the RFI Act.

Protected waters –a river or lake, into or from which, a river flows, coastal lake or lagoon (including any permanent or temporary channel between a coastal lake or lagoon and the sea), as defined under the RFI Act.

Remnant vegetation – means any patch of native vegetation around which most or all of the native vegetation has been removed.

Revegetation – involves the planting or establishment of plants on a site.

Riparian condition – refers to the degree to which human-altered ecosystems diverge from local semi-natural ecosystems in their ability to support a community of organisms and perform ecological functions (Land and Water Australia, 2005).

Riparian land – riparian land has been defined as land which adjoins, directly influences, or is influenced by, a body of water, including:

- land alongside small creeks and rivers including the river banks itself;
- gullies and depressions that sometimes run with surface water;
- areas surrounding lakes; and
- wetlands on river floodplains which interact with the river in times of flood (DNR, 2004).

Riparian vegetation – means any vegetation (native or exotic species) which is located on riparian land.

RFI Act – Rivers and Foreshores Improvement Act 1948 (NSW).

s.94 planning – Section 94 of the *Environmental Planning and Assessment Act 1979* , enables local councils or other consent authorities to levy contributions for public amenities and services required as a consequence of development.

Stream order – is a measure of the position of a stream in the hierarchy of tributaries and ranks the relative sizes of streams within a drainage basin (Gordon *et al*. 1994). Using Strahler's (1952) method, first order streams are defined as the small intermittent and/or perennial exterior streams, which have no tributaries. Second order streams form where two first order streams join together; third order streams form where two streams of order 2 join, and so on.

Based on Strahler's method only one stream segment is designated the highest order number, rather than the whole parent stream. Streams with order numbers 1-3 are low order streams and are often referred to as upland or headwater streams. Streams with order numbers 4-6 are mid order streams, while streams with order numbers greater than 6 are referred to as high order or lowland streams.

Subject land – land in Deposited Plan 9897, known as "Verons Estate" as displayed in Figure 1-1.

Top of bank – The point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break.

TSC Act – Threatened Species Conservation Act 1995 (NSW).

SCC – Shoalhaven City Council.

SEPP 14 – State Environmental Planning Policy 14 – Coastal Wetlands.

SEPP 58 – State Environmental Planning Policy 58 – Protecting Sydney's Water Supply.

VB – Vegetated Buffer.

Watercourse / waterway –

(a) any watercourse, whether perennial or intermittent and whether comprising a natural channel or a natural channel artificially improved; and

(b) any tributary, branch or other watercourse into or from which a watercourse referred to in (a) flows.

WM Act – Water Management Act 2000 (NSW).

1. Introduction

1.1 Overview

GHD Pty Ltd (GHD) was engaged by Shoalhaven City Council (Council) to undertake riparian mapping of defined tributaries, other waterways and waterbodies within the Verons Estate, which is located near Sussex Inlet in the Shoalhaven Local Government Area (LGA), New South Wales. This verified data will provide important baseline information for use in strategic planning and environmental management of riparian lands, and waterbodies.

1.2 Background

The subject land, Verons Estate, is comprised of 32 eight hectare lots in Deposited Plan number 9897 in the Shoalhaven Local Government Area, NSW. It is located approximately 42 km south of Nowra and 3.5 km northwest of Sussex Inlet. The subject land is approximately 1.6 km x 1.6 km within an area of approximately 2.7 km^2. The northeast corner of the land extends almost to Sussex Inlet Road. The subject land is bounded to the south and west by the Lake Conjola National Park; to the east and north by rural and rural residential land.

In 1920, when the subdivision was registered, legislation did not require roads and service infrastructure to be provided at current day standards. The subdivision was undeveloped when land use zoning was first introduced in 1964.

The subject land is currently zoned Rural 1(d) (General Rural) under the Shoalhaven LEP 1985, except for an area comprising of approximately 5.7 ha in the south west corner that is zoned Environmental Protection 7(a) (Ecology) under the provisions of SLEP 1985.

In 1993 Council resolved to investigate the zoning of the subject land:

"with the objective of allowing for the erection of a dwelling on each allotment, the cost of the environmental study and draft plan being met by the individual landowners…and Council re-iterate to the affected landowners that all costs involved with the provision of acceptable services to the area must be borne by the landowners"

In 1995, a draft environmental study was prepared which examined the major environmental attributes of the land and its capability to accommodate dwelling houses.

At the time, NSW National Parks and Wildlife Service (NPWS) was opposed to rezoning that part of the subject land which drains to Swan Lake due to concerns about impacts on water quality. Correspondence from NSW NPWS at the time indicated that properties in the subject land which drain to Swan Lake were referenced for inclusion in Cudmirrah National Park.

In 1994 the NSW Government placed a moratorium on rezoning of rural land in the Sussex Inlet area pending completion of a broader strategy or plan. This was initially to be in the form of a second stage of the Jervis Bay Regional Environmental Plan (JBREP), and when this did not eventuate, in the form of a South Coast Planning Strategy, which also did not eventuate.

Correspondence to Council from NSW NPWS dated 3 July 2002 (Appendix A) indicated that while NSW NPWS did not intend to proceed with purchase of the land proposed previously referenced for inclusion in Cudmirrah National Park, the area of subject land that drains to Swan Lake is unsuitable for rural residential development due to the potential impacts to Swan Lake caused by increased sedimentation

and nutrient inputs. As such, requirements for specific environmental studies to be undertaken as part of the rezoning investigation process were provided (Refer Appendix A). The ecologically sensitivity of the western Swan Lake catchment section of the subject land was highlighted, and Council was requested to pay particular attention to this in any environmental studies of the wetland and sedgeland areas. These wet areas were noted as being important for their role in the natural drainage network around Swan Lake and Bagdee Lagoon acting as a filtering system.

To enable the moratorium on development to be lifted, Council began discussions with NSW Government regarding preparation of a Sussex Inlet Settlement Strategy (SISS). In 2004, the NSW Government agreed to fund preparation of the SISS. The SISS was completed by Council and endorsed by the NSW Department of Planning (DoP) in August 2007.

The current zoning generally restricts Council's ability to approve dwellings on individual lots within the subject land. However, the subject land is covered by the SISS, which states that the potential for one dwelling per lot will be investigated.

1.3 NSW priorities for riparian land

"*The importance of improved vegetation management in achieving healthier rivers cannot be overstated. It is the key to ameliorating land degradation problems and to achieving biodiversity*."

Healthy Rivers Commission – Independent Inquiry into the Shoalhaven River System

Riparian lands form the transition between terrestrial and aquatic environments, and are defined as the part of the landscape adjoining rivers and streams that have a direct influence on the water and aquatic ecosystems within them (DNR, 2006; Land and Water Australia, 2005). Riparian lands are important for the maintenance of stream water quality and for providing opportunities for biodiversity connectivity (SCC, 2006). Therefore removing or disturbing riparian vegetation can alter the physical and chemical properties of the adjacent water body, potentially adversely affecting aquatic organisms and riverbank stability. Riparian environments are particularly prone to both natural and human-induced disturbance, including road construction, flooding, water regulation, fire, vegetation clearance, rising groundwater, salinity and the introduction of exotic plant species and livestock.

In 2004, the former NSW Department of Infrastructure Planning and Natural Resources (DIPNR) undertook a Riparian Corridor Objective Setting (RCOS) study in order to assess and map the streams in NSW. This information aimed to identify riparian objectives for the long-term protection of riparian function in relation to individual watercourses' environmental significance and location within the catchment (DIPNR, 2004). Three categories of riparian environmental objectives were developed that reflect their order of importance, defined as:

- **Category 1** *Environmental Corridor* – provide biodiversity linkages ideally between one key destination to another;
- **Category 2** *Terrestrial and Aquatic Habitat* – provides basic habitat and preserves the natural features of a watercourse (not necessarily linking key destinations); and
- **Category 3** *Bank Stability and Water Quality* – has limited (if any) habitat value but contributes to the overall basic health of a catchment.

For each of the above categories, the recommended minimum width of the riparian zone and management objectives vary depending on the defined function. A definition of these categories is provided in Table 1-1 and the recommended Core Riparian Zone (CRZ) width for each category is

provided in Table 1-2. A 10 m vegetated buffer (VB) is recommended around the CRZ. Further details on each of the categories are provided in Appendix B.

Table 1-1 Riparian objectives (DIPNR, 2004)

Category	Definition
1 Environmental corridor	The overarching objective is to provide biodiversity linkages by maintaining connectivity for the movement of aquatic and terrestrial species along the riparian corridor and between key destinations (e.g. between bottom and top of catchment, between wetlands and large nodes of vegetation, etc). This category is coloured red when mapped, and builds upon Category 2 and 3.
2 Terrestrial and aquatic habitat	The overarching objective is to provide basic habitat and preserve or emulate as much as possible a naturally functioning stream (not necessarily linking key destinations). While accepting the width of the riparian corridor will not fully satisfy the requirements of a Category 1 – Environmental Corridor, the width must still be sufficient to provide long term robust habitat and refuge for native fauna. This Category is coloured green when mapped and builds upon Category 3.
3 Bank stability and water quality	As implied, the overarching objectives are to prevent accelerated rates of soil erosion and to enhance water quality. This Category may have limited habitat value but contributes to the overall basic health of a catchment. While an open watercourse emulating some natural stream function is the preferred option, it is recognised, for example, that the practicality and economics of developing urban land may make this difficult. It is this Category of watercourses where it may be possible to negotiate trade-offs. This category is coloured blue when mapped.

Table 1-2 Core riparian zone (CRZ) buffers (DIPNR 2003)

Category 1 Watercourse	Category 2 Watercourse	Category 3 Watercourse
CRZ 40 m from top of bank	CRZ 20 m from top of bank	CRZ 10 m from centreline

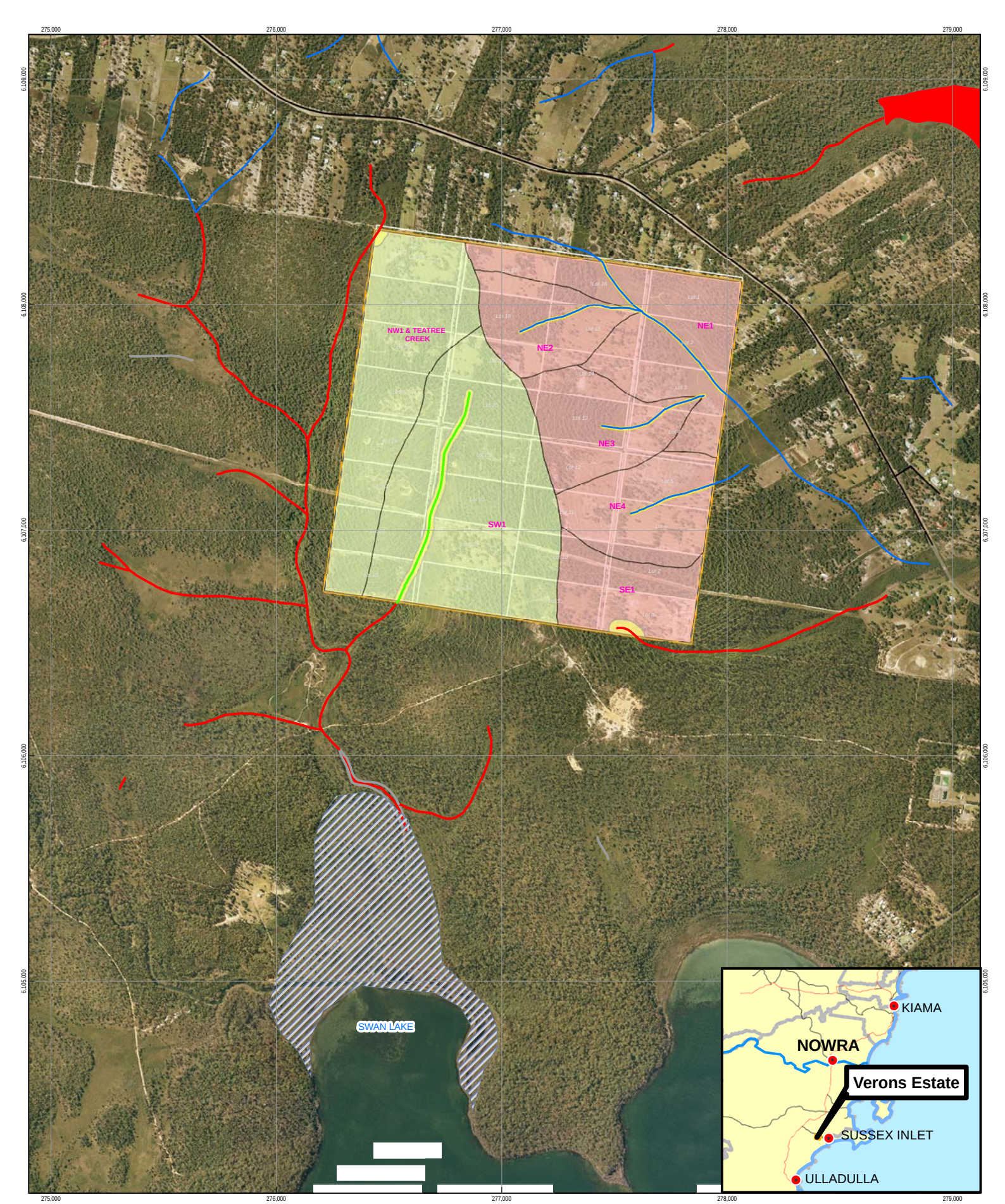
In 2004, a riparian study was completed by DIPNR for the South Coast Region, including the subject land. Watercourses defined in the 1:25,000 topographic map series were classified using the above categories and riparian corridors mapped based on the respective CRZ and VB widths, as shown in Figure 1-1.

The accuracy and position of the watercourse mapping in the 1:25,000 topographic map series is inherently limited by the accuracy and precision of contour information (the contour interval in this map series is 10 m). Previous DIPNR (DWE) mapping of watercourses in the subject land showed eight unnamed watercourse reaches which intersected with the subject land's boundary; and no waterbodies. Figure 1-1 illustrates the previous DIPNR mapping and riparian categorisation.

More detailed contour information (1 m contour interval) was derived from a LiDAR (light detection and ranging) survey over the subject land commissioned by Council in 2006. This new contour information is

overlaid on the previous riparian mapping completed by DIPNR in 2004 and highlights the need to review the mapping.

Having completed a riparian verification project for Council in 2008 in relation to the Nowra Bomaderry Structure Plan, GHD was commissioned by Council to prepare riparian mapping for the subject land. The purpose and scope of the project is discussed in Section 1.5.



LEGEND

- Subcatchment of SEPP 14 wetland at Swan Lake intersecting with Verons Estate
- Subcatchment of Badgee Lagoon intersecting Verons Estate
- SEPP 14 (NTS digitised from hardcopy maps)
- SEPP 14 (provided by SCC- and clipped to 1km buffer around Verons Estate)

DWE Watercourses

Riparian Category

- 0
- 1
- 2
- 3

DWE Core Riparian Zone

- CRZ Buffer
  40m for Cat 1
  20m for Cat 2
  10m for Cat 3
- Contour (1m interval, SCC)
- Sussex Inlet Road
- Cadastre (Verons Estate DP 9897)
- Verons Estate Boundary

1:15,000

0 100 200 300 400 500

Meters at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Shoalhaven City Council
SCC Mapping Riparian Land in Verons Estate

Verons Estate
Watercourse Position & Category & CRZ Buffer-DWE
Swan Lake (SEPP 14) subcatchment

Job Number 23-12965
Revision E
Date 16 Apr 2009

Figure 1-1

G:\23\12965\CADD\GIS\Projects\2312965_Z004_SubcatchSEPP_A3P_RevE.mxd
1/51 Graham Street Nowra NSW 2541 Australia T 61 2 4424 4900 F 61 2 4424 4999 E noamail@ghd.com.au W www.ghd.com.au

Data source: Shoalhaven City Council, NSW Dept of Natural Resources, Department of Environment & Water. Created by: L Carpenter & C Charalambou

1.4 Description of the subject land

1.4.1 Terrain, catchments and watercourses

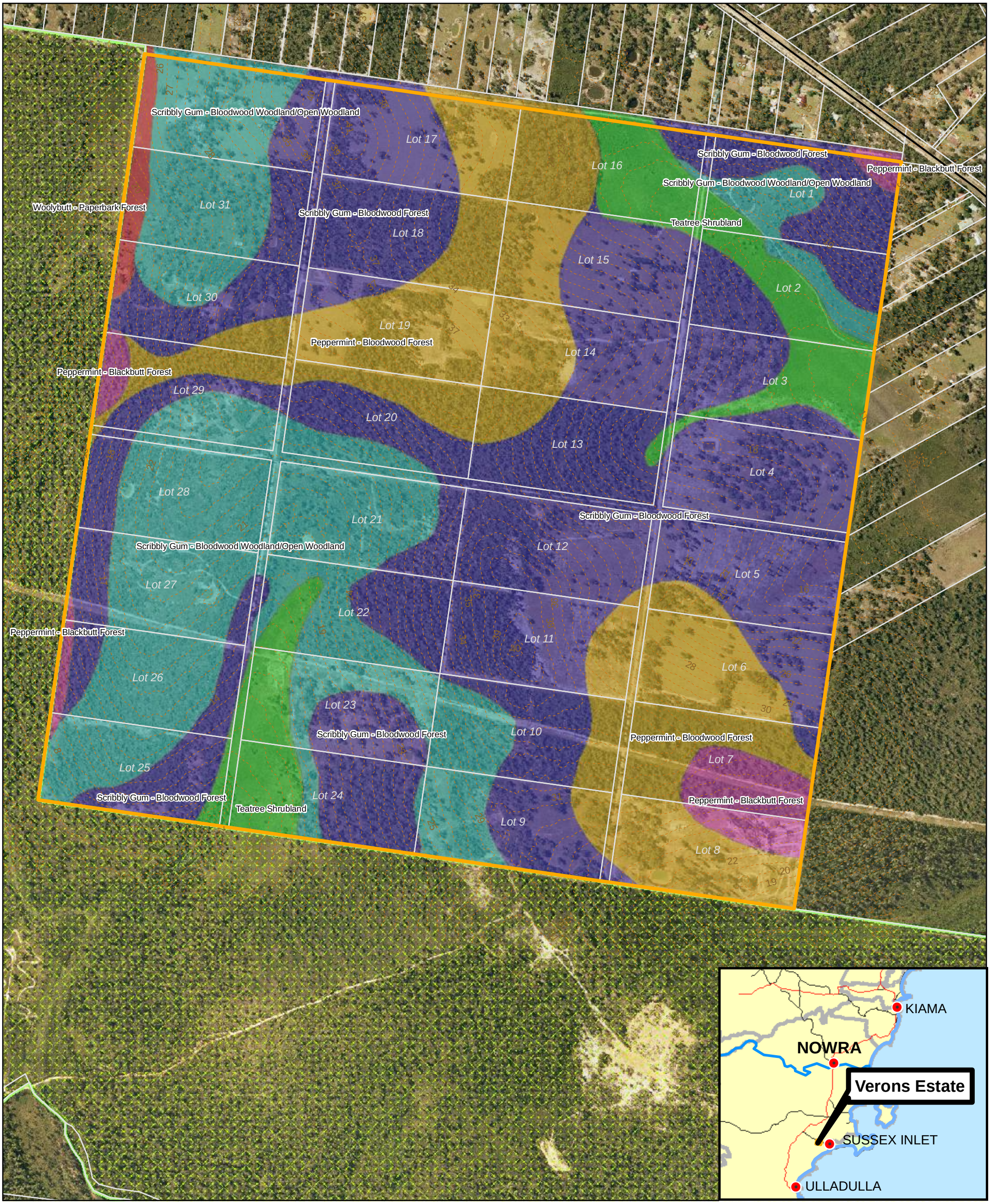
LiDaR spatial data, a new technology which uses airborne radar to collect detailed terrain data over large areas, was commissioned by Council for the subject land. The data was used to generate 1 m contour maps as shown in Figure 1-2. The landform pattern is best described as gently undulating rises with slopes predominantly ranging from 1 to 5^{o} (gently inclined).

The subject land comprises headwaters of tributaries that drain to wetland systems associated with Badgee Lagoon to the east and Swan Lake to the south (refer to Figure 1-1). The area draining to Swan Lake comprises two sub-catchments: the western most fringe drains directly to Teatree Creek and one of its tributaries; and the south-eastern fringe drains to Tea Tree Creek via an unnamed watercourse, referred to herein as unnamed tributary SW1. The land draining to Badgee Lagoon does so via multiple unnamed watercourses.

1.4.2 Vegetation

Recent flora and fauna investigations have included vegetation mapping (Bushfire and Environmental Services, 2008). The vegetation of the subject land is shown in Figure 1-2. Vegetation maps show a wide diversity in ecological communities including:

- Sandstone Sedgeland;
- Scribbly Gum - Bloodwood Woodland/Open Woodland;
- Peppermint - Blackbutt Forest;
- Peppermint - Bloodwood Forest;
- Scribbly Gum - Bloodwood Forest; and
- Woollybutt - Paperbark Forest.



LEGEND

Bushfire and Environmental Services (2008) Data

Vegetation Class

- Teatree Shrubland
- Peppermint - Blackbutt Forest
- Peppermint - Bloodwood Forest
- Scribbly Gum - Bloodwood Forest
- Scribbly Gum - Bloodwood Woodland/Open Woodland
- Woolybutt - Paperbark Forest

- Contours (1m interval, SCC)
- National Park

- Verons Estate Boundary
- Roads
- Cadastre

1:7,500

0 25 50 100 150 200 250

Meters at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Shoalhaven City Council
SCC Mapping Riparian Land in Verons Estate

Verons Estate Vegetation Classes (BES 2008) and Contours (1m)

Job Number	23-12965
Revision	A
Date	16 Apr 2009

Figure 1-2

G:\23\12965\CADD\GIS\Projects\2312965_Z006_VegetationBES_A3P_RevA.mxd
1/51 Graham Street Nowra NSW 2541 Australia **T** 61 2 4424 4900 **F** 61 2 4424 4999 **E** noamail@ghd.com.au **W** www.ghd.com.au

Data source: Bushfire and Environmental Services, 2008 Shoalhaven City Council, NSW Dept of Natural Resources . Created by: L Carpenter

1.4.3 Aerial photography

High resolution aerial photography was flown over the Shoalhaven LGA in 2006. This has been orthorectified and is available for use as a set of tiles in .ecw format within a Geographic Information System. The aerial photography is overlaid on Figure 1-1 and Figure 1-2.

1.5 Purpose and scope of study

Shoalhaven City Council regularly updates spatial data and information for planning and mapping biodiversity values across the LGA. Currently, Council is in the process of gathering land and environmental constraint information as part of the rezoning investigation process for the subject land. The primary purpose of this assessment is to identify and categorise watercourses riparian land to facilitate its protection, conservation and enhancement.

The scope of GHD's study included the following tasks:

- Review of existing watercourse locations and categorisation undertaken by the former DNR (DIPNR, 2004);
- Desktop review of watercourses, riparian areas and waterbodies within the subject land using contour maps, vegetation surveys, aerial photography and other spatial information;
- Field survey verification of watercourses using GPS units (Trimble GeoXT);
- Field survey assessment of riparian condition following the 'River Score' assessment method; and
- Provide Council with detailed verified mapping of specific riparian corridor boundaries within the subject land to form the basis for riparian corridor zoning boundaries, and of waterbody boundaries.

2. Legislation and policies

This section provides an overview of relevant legislation and policies.

2.1 State legislation

2.1.1 Water Management Act 2000

The *Water Management Act 2000* (WM Act) provides for the protection, conservation and ecologically sustainable development of the State's water sources, which includes rivers, lakes, estuaries and aquifers. It controls the extraction and use of water, the construction of works such as dams and weirs, and the carrying out of activities in or near water sources, their associated ecosystems, ecological processes and biological diversity and water quality. The Act recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with more secure access to water and greater opportunities to trade water.

The WM Act repealed the *River and Foreshore Improvement Act 1948* (RFI Act) on 4 February 2008 (Schedule 7 of the WM Act) which addressed approvals for activities undertaken within 40 m of *protected land* and/or in *protected waters* (Part 3A) .

There are two kinds of activity approvals under the WM Act: controlled activity approvals and aquifer interface approvals.

The following activities require a controlled activity approval where the legislation applies:

- Erecting a building or work within the meaning of the *Environmental Planning and Assessment Act 1979* on, in or under waterfront land;
- Removing or depositing any material, including sand, gravel or vegetation from the bed of any river, lake or estuary or within 40 m of the river, lake or estuary; and
- Carrying out any other activity that affects the quantity or flow of water in a water source.

An aquifer interference approval is required for activities that are likely to interfere with an aquifer, for example, activities such as sand mining, extractive operations, road construction and many other large scale activities that involve extraction.

2.1.2 Fisheries Management Act 1994

Threatened species, populations and ecological communities of fish and marine vegetation are addressed in the *Fisheries Management Act 1994* (FM Act). The degradation of riparian vegetation is listed as a Key Threatening Process under the FM Act. The objectives of the FM Act are to:

- conserve biological diversity of fish and marine vegetation and promote ecologically sustainable development and activities;
- prevent the extinction and promote the recovery of threatened species, populations and ecological communities of fish and marine vegetation;
- protect the critical habitat of those threatened species, populations and ecological communities that are endangered;

- eliminate or manage certain processes that threaten the survival or evolutionary development of threatened species, populations and ecological communities of fish and marine vegetation;
- ensure that the impact of any action affecting threatened species, populations and ecological communities of fish and marine vegetation is properly assessed; and
- encourage the conservation of threatened species, populations and ecological communities of fish and marine vegetation by the adoption of measures involving co-operative management.

2.1.3 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* (NW Act) is a NSW government instrument outlining the definition, declaration, and control of noxious weeds throughout the State. Local government bodies have the responsibility to ensure that the Act is complied with within their boundaries.

For a plant to be declared a Noxious Weed it must be considered to pose a serious threat to humans, agriculture and/or the environment. Consideration must also be given to the feasibility of control and enforcement of those methods. Plants may be declared noxious by order of the Minister for Agriculture.

Landowners or occupiers have obligations under the Act to control any declared weed on their property. Council is required to conduct inspections of private properties to check compliance with the Act and Noxious Weed Officers have the authority to issue control notices for any breach. The weeds currently listed as noxious in the Shoalhaven local control area are listed in the declaration.

2.1.4 Native Vegetation Act 2003

The *Native Vegetation Act 2003* (NV Act) encourages and promotes the management of native vegetation on a regional basis in the social, economic and environmental interests of the State and prevents broad-scale clearing unless it improves or maintains environmental outcomes.

The Act also aims to protect high conservation value native vegetation, protect high conservation value native vegetation, improve the condition of existing native vegetation and encourage the rehabilitation of land with appropriate native vegetation. Clearing of vegetation on non-urban land requires approval under this Act unless it falls under an exemption for a ‘routine agricultural management activity’.

2.2 State policies, strategies and programs

State Planning policies aim to balance the demands of future growth with the need to protect and enhance environmental values.

2.2.1 State Rivers and Estuaries Policy

The objective of the policy is to manage the rivers and estuaries of NSW in ways which:

- slow, halt or reverse the overall rate of degradation in their systems;
- ensure the long term sustainability of their essential biophysical functions; and
- maintain the beneficial use of these resources.

2.2.2 NSW Wetlands Management Policy

The NSW Wetlands Management Policy aims to promote the ecologically sustainable use, management and conservation of wetlands in NSW for the benefit of present and future generation. The policy aims to

protect wetlands in good condition, minimise any further loss or degradation of wetlands and, where possible, restore degraded wetlands.

2.2.3 NSW Biodiversity Strategy – National Parks and Wildlife

Components of the Biodiversity Strategy (NPWS 1999) address the need to conserve biodiversity across NSW by:

- Minimising the modification of natural ecosystems, habitat loss and fragmentation;
- Developing and implementing policies and management practices to achieve ESD and conserve biodiversity; and
- Implementing ecologically sustainable urban and coastal management practices

2.2.4 SEPP 14 – Coastal Wetlands

The aim of the State Environment Planning Policy (SEPP) policy is to ensure that coastal wetlands are preserved and protected in the environmental and economic interests of the State.

The subject land drains to two SEPP 14 wetlands; wetland #302 Swan Lake to the south-west; and wetland #306 Badgee Lagoon to the east towards St Georges Basin/Sussex Inlet. Therefore any development within the subject land should be undertaken with the aim of preserving or enhancing the value of those downstream SEPP 14 wetlands. The net effect of development in the subject land should not negatively impact the biodiversity of environmental values of the wetland.

2.2.5 State Water Management Outcomes

Long term environmental outcomes for “healthy productive and diverse water dependent ecosystems”:

- Target 28 – percentage cover of native riparian vegetation increased on waterfront land; and
- Target 29 – no net decrease in the length of natural river corridors through urban areas.

2.2.6 South Coast Regional Strategy – NSW Department of Planning, 2006

The Regional Strategy is an initiative of the NSW Government to guide sustainable growth throughout the South Coast over the next 25 years. The Strategy has identified that the push for population growth and the resulting demand for new housing and employment lands could lead to increased pressure on regional biodiversity, water supply catchments, soil, riparian corridors, coastal lakes and waterways. Specific to riparian land, the Strategy aims to:

- Protect high value environments including **pristine coastal lakes**, estuaries, aquifers, threatened species, vegetation communities and habitat corridors by ensuring that no new urban development occurs in these important areas and their catchments; and
- Limit development in places constrained by coastal processes, flooding, wetlands, important primary industry resources and significant scenic and cultural landscapes.

Protecting the highly significant diverse natural assets and associated biodiversity is a key challenge for the Strategy, and includes:

- Improved protection and enhancement of natural environments, including biodiversity, coastal lakes and estuaries and landscape values;

- Improved understanding of Aboriginal cultural heritage values and incorporating this information within land planning and resource management processes;
- Ensuring sustainable management and access to natural resources and protection of rural landscapes from increased settlement; and
- Better understanding and management of natural hazards, namely flooding, coastal erosion and inundation (including the impacts of climate change on these), land instability, bushfire hazard and acid sulphate soil.

In order for managers to implement environment protection, the Strategy states that;

"Local environmental plans will not include further residential or rural residential zoning in the catchments of the coastal lakes and estuaries…[includes Swan Lake]…unless it is demonstrated that a neutral or beneficial effect on water quality as measured at the boundary of the proposed new zoning can be achieved."

and Councils;

"Require local environmental plans to zone all coastal wetlands identified in SEPP 14 to achieve environmental protection, through zones such as 'E2 Environmental Conservation' or 'W1 Natural Waterways'. Future development in these catchments will need to demonstrate no net impact on the hydrology, water quality or ecology of these wetlands."

2.2.7 Southern Catchment Blueprint – Department of Land and Water Conservation, 2003

The Southern Rivers Catchment Management Board prepared an Integrated Catchment Management Plan or Catchment Blueprint with the former Department of Land and Water Conservation (DLWC 2003), with five first order objectives. Of these, four are particularly relevant to this study. They are to have:

- Rivers, streams and wetlands with healthy, vegetated riparian corridors and stable riverbanks and beds that support good water quality, provision of habitat and sustainable production;
- Healthy coastlines and estuaries with non-polluted waters, diverse aquatic ecosystems, foreshore vegetation and ample opportunities for sustainable public enjoyment;
- Protection of native biological diversity and maintenance of the integrity of ecology processes and systems; and
- Healthy urban environments, which provide for a sustainable balance between natural systems and social, cultural and economic interests.

2.2.8 Healthy Rivers Commission – Independent Inquiry into the Shoalhaven River System

The former Healthy Rivers Commission (Natural Resources Commission as of 1994) recognised the importance of riparian land and native vegetation within the Shoalhaven. In its report the Commission stated that the improvement of the condition of native vegetation along drainage lines and river corridors is the most important 'element of river health' to be addressed.

In its recommendation the Commission stated:

"*This Inquiry has highlighted the crucial role that vegetation plays in river health, especially vegetation in the riparian zone. Its importance cannot be over-emphasised. In some situations, evidence from this Inquiry suggests that the protection and maintenance, or the rehabilitation, of a suitable native vegetation*

cover in the riparian zone is more important to river health than the provision of flows or enhancement of water quality."

2.2.9 Healthy Rivers Commission – Independent Inquiry into Coastal Lakes, 2002

The Commission established an Inquiry into Coastal Lakes that are highly sensitive ecological systems with many threats impacting on their values. The commission recommended that the government adopt a comprehensive and over-arching approach to the protection of Coastal wetlands. Coastal Wetlands in NSW were registered, and ranked by various attributes such as Natural Sensitivity (Risk), Existing Condition, Recognised Conservation Value Significant Other Factors, and then given a Lake Classification.

Swan Lake was found to have an 'Extreme Risk', and needing 'Significant Protection' (Table 2-1). As a result, Swan Lake was identified as a sensitive coastal lake in the South Coast Regional Strategy (refer to Section 2.2.6).

Table 2-1 Classification of Coastal Lakes (from Healthy Rivers Commission 2002)

Coastal Lake	Natural Sensitivity (Risk)	Catchment Condition	Lake Condition	Recognised Conservation Value	Significant Other Factors	Lake Classification
Swan Lake	Extreme	Largely Unmodified	Slightly affected	High	c,e,g*	Significant Protection

*Key for (relevant) Significant Other factors

1. Existing patterns of regional settlement, natural resources use, recreation and tourism and their sustainability

2. Potential for restoration of natural ecosystem processes

3. Potential implications of a classification of a coastal lake with regard to those assigned to nearby lakes, as well as consideration of the likely capability, condition and pressures on other estuaries

2.3 Local strategy

2.3.1 Sussex Inlet Settlement Strategy, 2007

The Sussex Inlet Settlement Strategy (SISS) was completed by Council and endorsed by the NSW Department of Planning (DoP) in August 2007. The SISS is not a legal document and does not itself rezone land for development. It does however identify broad potential areas that will be investigated and outlines issues that will be addressed in rezoning investigations for particular areas.

In relation to the subject land the SISS states that the provision of one dwelling per lot will be investigated. The SISS also provides specific requirements for riparian areas as outlined below (SCC; 2007, pg. 45).

Riparian Areas

Objective: To ensure that riparian areas are conserved and sustainably managed, in order to provide for natural ecological and hydrological processes and to avoid detrimental impacts on habitat values and water bodies immediately adjoining and downstream.

Actions

1. The design and location of new development in the area (including infrastructure) will seek to protect riparian habitat values and their ecological and hydrological function (including flood risk reduction)

as defined in DIPNR's *Setting Riparian Objectives for Water Courses in Sussex Inlex, Cudmirrah and Berrara, 2004*;

2. Riparian areas will be identified in future planning instruments affecting St Georges Basin, Swan Lake and Badgee Lagoon and their associated watercourses to provide a degree of certainty for future development and landuse changes in the area. This identification will use DIPNR's 2004 Assessment Report;
3. Riparian areas will be protected from ancillary detrimental uses (e.g. clearing/underscrubbing) that undermine habitat values and their ecological and hydrological function in the landscape. Planning instruments should also seek to encourage the rehabilitation and repair of areas subject to detrimental impacts caused by past landuse practices;
4. Policies for providing incentives to conserve and enhance riparian corridors throughout the areas will be investigated.

2.3.2 Swan Lake Berrara Natural Resources Management Strategy

The Swan Lake Berrara Natural Resources Management Strategy was developed by Shoalhaven City Council and sought to define the environmental, economic, recreational and social values of the Sawn lake Berrara region, investigate the competing demands on the resources and devise management actions necessary to help balance competing demands.

Strategies outlined in the document (SCC 2002, pg. 44) include:

- *"(ER1) Accommodate natural processes of lake and creek bank erosion and accretion, but reduce human-induced erosion."*

Actions associated with this strategy include:

- *"Ensure new developments comply with development control plan for foreshores and statutory requirements", and*
- *"Disallow further development that would cause lake or creek bank erosion and retain and/or re-establish riparian vegetation along creek banks"*

2.4 Summary

In summary, there is a range of legislative and policy requirements relevant to the management of riparian land and associated catchment management issues. Of particular relevance is the requirement of the South Coast Regional Strategy (SCRS) that any proposed rezoning in the catchment of Swan Lake be able to demonstrate a 'neutral or beneficial effect' on the Lake as measured from the boundary of the subject land. This stems from the overall requirement that no net detriment to environmental values of SEPP 14 wetlands should result from future developments. There are 12 lots proposed within the subject land that are totally within the Swan Lake subcatchment area which and eight lots proposed which partly drain to it (refer Figure 1-1). The future zoning of lots in the catchment of Swan Lake is important, as development has the potential to cause detrimental effects to the water quality. The protection of SEPP 14 wetlands at Badgee Lagoon and Swan Lake is also an important consideration for the subject land as a whole.

3. Methods

3.1 Desktop review

3.1.1 Literature review

A review of all the available riparian land mapping for the subject land, literature, aerial photographs, relevant ecological studies (such as the effects of roads on biota) and database records pertaining to the ecology and environmental features of the selected subject land, was undertaken to provide important background information. Information reviewed included:

- Consultants Brief for Rezoning Investigations of Land at Verons Estate, Sussex Inlet, Aboriginal and European Archaeological & Cultural Heritage Assessment, Shoalhaven City Council -Strategic Planning Group 2008;
- Chapter 8, Ocean Shores to Desert Dunes – The Native Vegetation of New South Wales and the ACT, Keith, D. 2004;
- Riparian Corridor Management Study covering all of the Wollongong Local Government Area and Calderwood Valley in the Shellharbour Local Government Area. Prepared for Wollongong City Council by DIPNR, March 2004;
- Riparian Corridor Management Studies An overview – South Coast Region, DNR, August 2006;
- Rapid Appraisal of Riparian Condition (RARC), Land and Water Australia, 2005;
- South Coast Regional Strategy prepared by the Department of Planning, January 2007;
- Southern Catchment Board Blueprint, An integrated management plan, prepared by Department of Land and Water Conservation, February 2003;
- Swan Lake and Berrara Ck Natural Resources Management Strategy, Shoalhaven City Council, 2002;
- Healthy Rivers Commission of New South Wales, Independent Inquiry into Coastal Lakes, Final Report, April 2002;
- Healthy Rivers Commission of New South Wales, Independent Inquiry into Shoalhaven River System, Final Report, July 1999; and
- Online Statement of Environmental Effect Vegetation Mapping, Shoalhaven City Council, 2004.

3.1.2 Data review

GHD's Spatial Technology Group has developed methods for watercourse classification using a suite of Geographical Information Systems (GIS) analysis tools in the ArcGIS software platform.

GIS is a system of hardware and software used for storage retrieval, mapping and analysis of geographical data. Spatial features are stored in a coordinate system that references locations on earth. Multiple spatial datasets can be layered together for mapping and analysis. GIS is increasingly used for scientific investigations, resource management and development planning. The fundamental building blocks of data in a GIS are: points, lines and polygon vector layers; and raster grids. Analytical procedures can be applied to data in a GIS which can include spatial and attribute information.

GHD used the following data layers to build a spatial model in order to accurately map the watercourses within the subject land:

- Subject land boundary, supplied by Shoalhaven City Council (SCC);
- Vegetation communities (supplied by SCC and created by Bushfire Environmental Services 2008);
- Contours 1m (supplied by SCC uses LiDaR);
- Contours 10m (supplied SCC);
- Aerial photography, (supplied by SCC - Orthorectified);
- 1:25,000 scale watercourses (former DIPNR); attributed with current DWE riparian categorisation;
- SEPP 14 wetlands;
- Cadastral (supplied by SCC); and
- Roads (supplied by SCC).

3.1.3 Aerial photographs and other data

High resolution aerial photography is an important dataset for use in catchment planning and natural resource management. Aerial photography in .ecw format was provided by Council for analysis in ArcGIS. This phase of the desktop review involved the identification and digitisation of, watercourse centrelines and watercourse 'top of bank' and waterbodies. Inaccuracies in current watercourse layers provided by DNR were identified. GIS layers were loaded into ArcGIS platform and using editing tools at a 1:500 map-scale, the current waterway centrelines and waterway 'top of bank' and watercourses were adjusted and exported in a file format suitable for field survey.

3.1.4 Draft revisions

Errors in spatial data found in the previous phase were revised in draft form using ArcGIS prior to field survey. Draft waterway centreline; 'top of bank' and waterbody polyline layers were used in the field survey verification phase.

Once created in the appropriate spatial data format, the ArcGIS layers and auxiliary information were transferred to the Trimble GeoXT GPS Computers, and used as the basis for the field survey verification.

3.2 Field survey

Field surveys were undertaken on 20 and 21 October and 13 November 2008 to ground-truth the riparian land categorisations of each of the watercourses within the subject land. As shown in Figure 3-1, the six or so months prior to fieldwork were drier than the long-term average, which suggests that any sections of flowing water found in the subject land during the survey would be less extensive in comparison to wetter years. Additionally, within the months of October and November, fieldwork was undertaken in drier days as shown by Figure 3-2 which shows rainfall (mm) at St Georges Basin and Ulladulla stations, (the closest sites to subject land). The three fieldwork days are shown in Figure 3-2 by arrows.

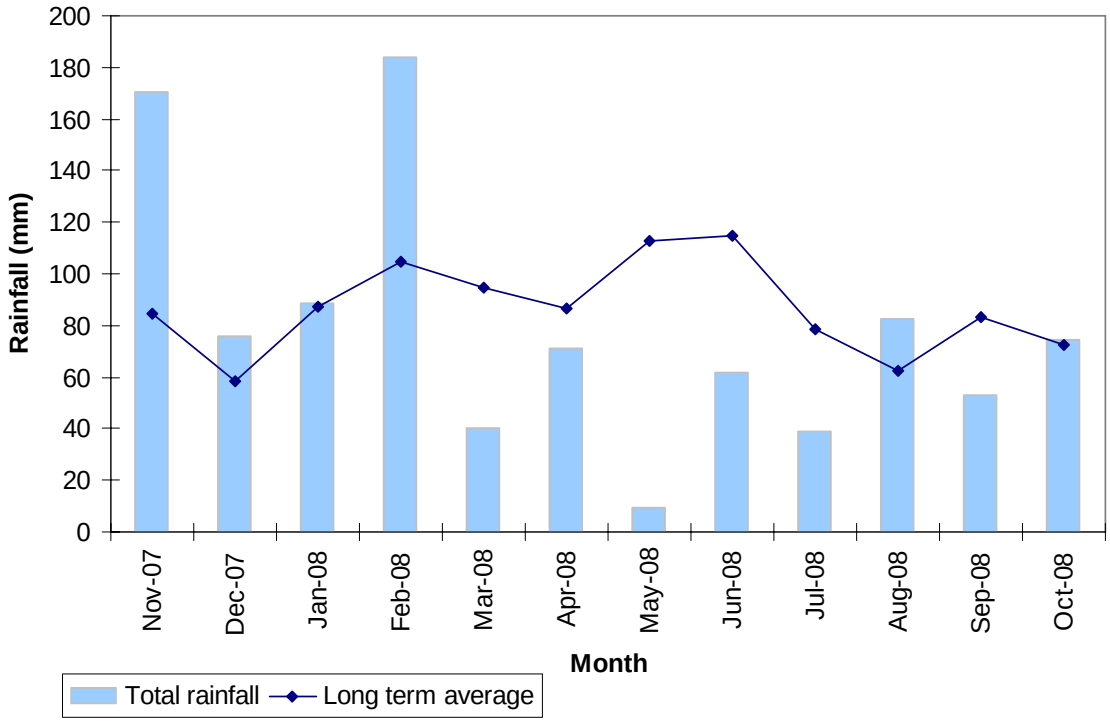


Figure 3-1 Rainfall at Ulladulla Nov 2007 to Oct 2008 showing relatively dry antecedent period in from March 2008 to Oct 08 in comparison to long term average.

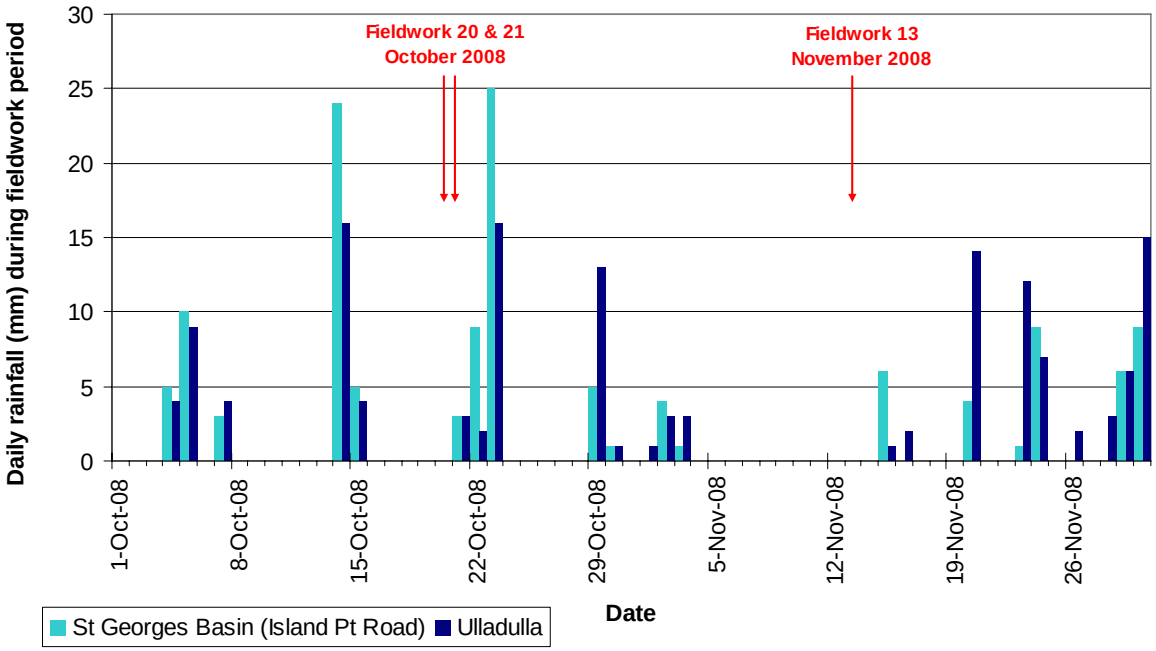


Figure 3-2 Rainfall at St Georges Basin and Ulladulla stations, (closest sites to subject land) July to Nov 2008.

3.2.1 'Top of bank' alignment verification

Field surveys were undertaken to ground-truth the location of the 'top of bank' for the Category 1 and Category 2 watercourses within the subject land. For the purposes of this study the 'top of the bank' is defined as (DIPNR, 2004):

'The point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 15 metres measured perpendicularly from the break. (Refer to Figure 3-3).'

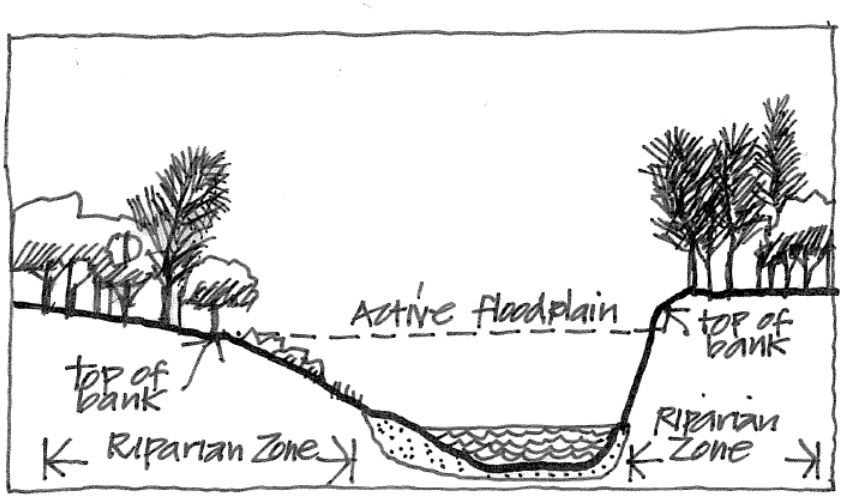


Figure 3-3 Cross-section diagram of a typical stream, indicating top of bank

3.3 Method of data capture

GHD captured the 'centreline' and 'top of bank' alignment using advanced Trimble® GeoXTs from the GeoExplorer 2005 series, handheld Global Positioning Systems (GPS) units. These units have sub-meter accuracy and were used to record 'top of bank' position directly over a digital aerial photograph and map layers using ArcMap.

3.3.1 Riparian Condition Assessments

GHD used the 'River Score' system, a quantitative method specifically developed for the assessment of riparian condition. The River Score system uses a combination of the percent of vegetation cover, the extent of indigenous species throughout the vegetation stratum and the level of weed infestation, with three basic categories. Each category then includes two different sub categories based on the level of weed infestation. The parameters of each category and sub category are adaptable depending on site conditions.

The three broad categories are:

- Good Condition;
- Average Condition; and
- Poor Condition.

The width of the riparian vegetation to be assessed is also project specific and adaptable. Generally, River Score uses three riparian widths, dependent on the size of the watercourse. These are:

- 20 metres either side from ‘top of bank’ (Small drainage lines and tributaries);
- 50 metres either side from ‘top of bank’ (Creeks and small river systems); and
- 100 metres either side from ‘top of bank’ (Large river systems).

Category Descriptions

The following categories and parameters were set for this watercourse condition assessment.

1. Good Condition

- Riparian vegetation greater than 80% coverage;
- Vegetation community indicative of indigenous vegetation; and
- Vegetation present contains indigenous plants representative of each ‘layer’ of the vegetation structure.

Class A – Less than 15% weed infestation.

Class B – Greater than 15% and less than 30% weed infestation.

2. Average Condition

- Riparian vegetation greater than 50% and less than 80% coverage;
- Native species present in riparian vegetation; and
- Vegetation present contains indigenous plants representative of at least 2 ‘layers’ of the vegetation structure.

Class A – Less than 25% weed infestation.

Class B – Greater than 25% and less than 50% weed infestation.

3. Poor Condition

- Riparian vegetation less than 50% coverage; and
- Vegetation present contains indigenous plants representative of only one ‘layer’ (usually emergent trees) of the vegetation structure.

Class A – Less than 50% weed infestation.

Class B – Greater than 50% weed infestation.

3.4 Digital watercourse and waterbody mapping

Two methods were utilised in the GIS digitisation of the watercourse layers; 1) Field survey data digitisation and 2) Aerial photography analysis. Field survey data provided the main information set, however the aerial photography provided an additional guide. The GIS platform used was ArcGIS 9.2.

The digitisation work included a data preparation phase, including:

- **Field survey data correction:** The .ssf files were sent to Ultimate Positioning Pty Ltd for differential correction, then subsequent .cor files translated to .shp format and uploaded into an ArcGIS 9.2 ArcMap .mxd project;
- **Building a spatial model:** All auxiliary watercourse layers were uploaded in the mxd project; and

- **Digitisation using ArcMap Editor:** The verified watercourse centreline, alignments and waterbody layers were digitised and smoothed at a 1:500 map scale.

4. Results & discussion

4.1 Watercourses and riparian areas

Following completion of the field survey and review of digital elevation data, it is concluded that the subject land contains little in the way of clearly defined, 'top of bank' watercourses. This is attributed to a combination of factors such as catchment area, soil profiles, gently sloping terrain and vegetation which define the surface water flow on the subject land.

As noted in Section 3, only limited rainfall occurred prior to the field survey and the previous months were drier than average. There were some areas where flowing water was observed: in small man-made channels and drains and in wide and shallow depressions within the Sandstone Sedgeland.

During field survey, GHD noted the presence of a semi-aquatic understorey vegetation layer generally within the Sandstone Sedgeland vegetation community. These semi-aquatic species included sedges, rushes and reeds with hollow stems; all of which are indicative of periodic inundation.

Sandstone Sedgeland is a form of 'Coastal heath swamp' which has an association with perched water tables and extended periods of saturation at or near the ground surface. 'Coastal heath swamps' are defined by Keith (2004, pg 208) as mosaics of different plant communities dominated by water tolerant species such as sedges and aquatic herbs with an open layer of emergent sclerophyllous shrubs.

A conceptual diagram of Sandstone Sedgeland within the subject land is shown in Figure 4-1. Given this association with periodic inundation, the two areas of Sandstone Sedgeland vegetation in the subject land are considered to act as watercourses and provide important hydrological and water quality functions for downstream ecosystems.

Figure 4-2 illustrates both the riparian land areas as designated by the Sandstone Sedgeland vegetation classification as well as flowing water identified during field survey (20 and 21 October and 13 November 2008).

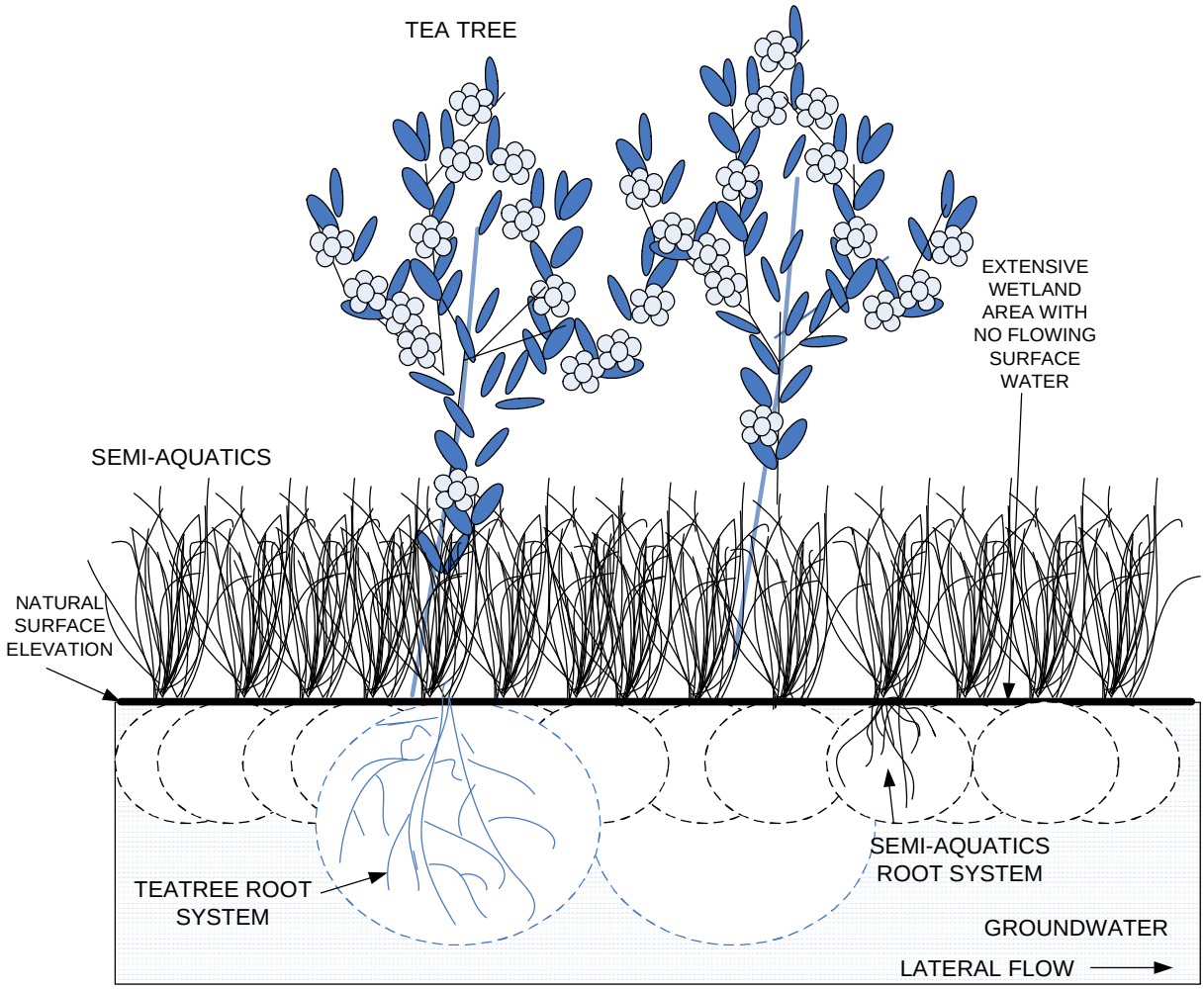
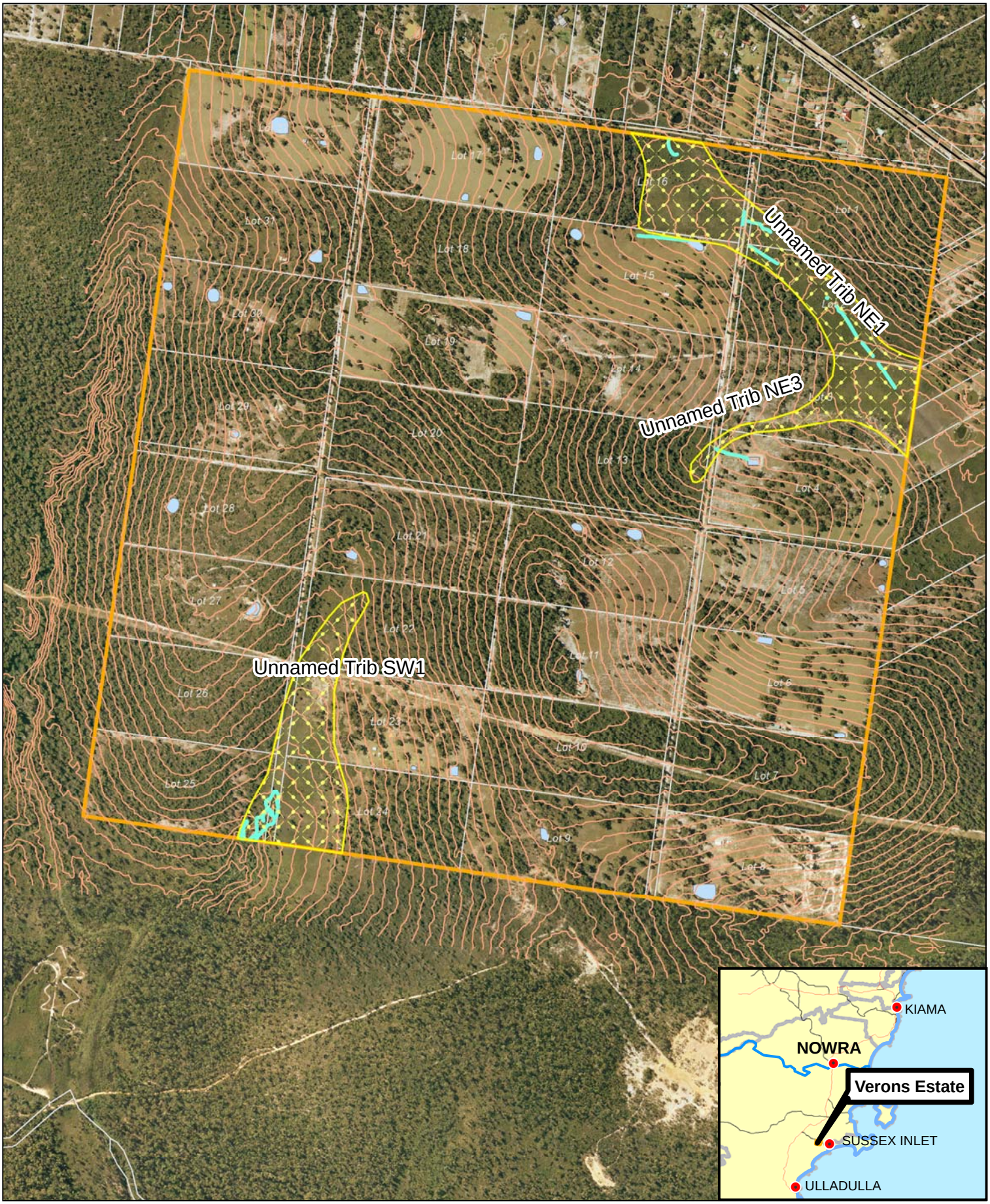


Figure 4-1 Conceptual diagram of Sandstone Sedgeland within the subject land.

The groundwater table is high although there is little running surface water. Both the Teatree and the semiaquatic species such as sedges soak up surface water and act as a filter for high water quality downstream assets (SEPP 14 wetlands).



LEGEND

GHD Watercourse

- Riparian Land
- Flowing Water (20th - 21st Oct, 13th Nov, 2008)
- Verons Estate Boundary
- Sussex Inlet Road
- Contour (1m interval, SCC)
- Cadastre (Verons Estate DP 9897)
- Waterbodies (farm dams)

1:7,500

0 30 60 120 180 240 300

Meters at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Shoalhaven City Council
SCC Mapping Riparian Land in Verons Estate

Verons Estate
Waterbody, watercourses and Riparian land within sungject land

Job Number	23-12965
Revision	D
Date	16 Apr 2009

Figure 4-2

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Data source: Shoalhaven City Council, NSW Dept of Natural Resources. Created by: L Carpenter

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4.1.1 Riparian condition assessments

The riparian land associated with Unnamed Tributaries NE1 and SW1 were assessed as 'Good A'. There was a high level of diversity of native plant species along SW1 and very few weeds.

A relatively small area of SW1 had been partially impacted by vehicle use and stock grazing and such activities should be excluded from this area and revegetation works implemented.

Unnamed NE Tributary 1 (NE1) had been impacted by a recent fire, and is regenerating well. Its average rapid assessment score is 'Good A', and it has surprisingly few exotic weeds.

Unnamed NE Tributary 3 (NE3) is really an extension of the same vegetation community, but had been more affected by recent vegetation clearing, road construction and farm dam construction. Its rapid assessment score is 'Good A'; however continued influences on the tributary may result in further degradation of the riparian condition.

The roads have fragmented the remnant vegetation and altered the natural hydrology. The construction of several upstream farm dams has also altered the hydrology. The more significant man-made channels are shown in Figure 4-2

4.1.2 Riparian land categorisation

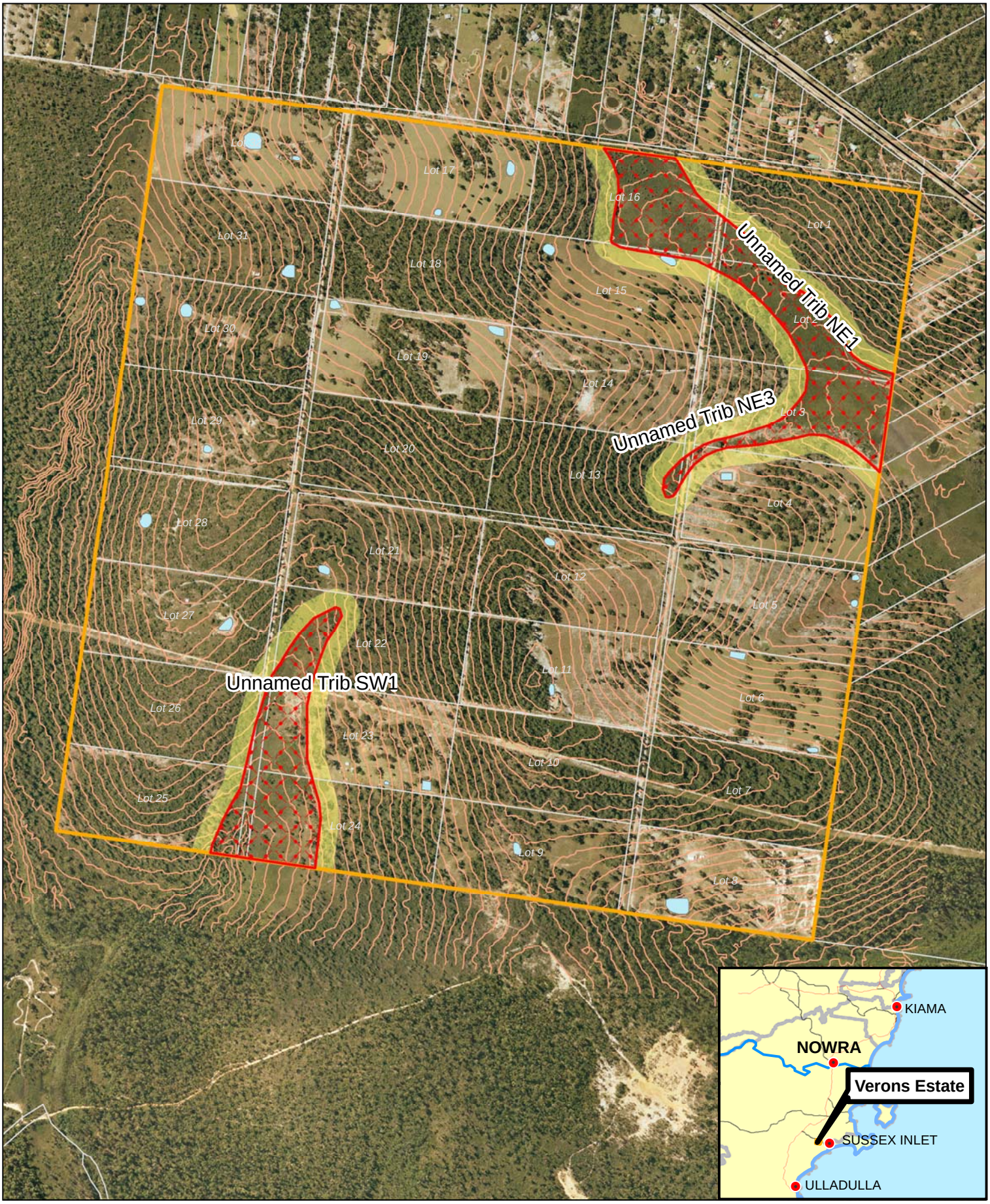
Both areas of riparian land in the subject land were classed Category 1 to reflect:

- The quality and diversity of native vegetation and the relative absence of weeds;
- Their important hydrological and water quality functions for maintaining the health and condition of SEPP 14 wetlands and Swan Lake;
- The role of these areas in providing habitat connectivity for various fauna.

The vegetated buffer (VB) width is recommended by the Department of Water and Energy (DWE) is generally 10 m but can be varied depending on the merits of the situation. In this case, protecting water quality in Swan Lake and avoiding any adverse impacts on the SEPP 14 wetlands is imperative. The simplest way to achieve this while still providing one dwelling per lot is to increase the width of the VB substantially and to minimise the amount of clearing of native vegetation generally.

Therefore a VB of 40 m is recommended, as shown in Figure 4-3. In some cases, a reduction in this buffer may be appropriate if the objective of the buffer is not compromised. Conversely, larger buffers should be provided where possible, particularly in areas of intact native vegetation within the Swan Lake catchment.

A map of the CRZs and 40 m vegetated buffers is illustrated in Figure 4-3. Both riparian areas were classed as Category 1.



LEGEND

GHD Watercourse

Riparian Category

- **Category 1**
- **CRZ Buffer (40m for Cat 1)**
- **Verons Estate Boundary**
- **Sussex Inlet Road**
- **Contour (1m interval, SCC)**
- **Cadastre (Verons Estate DP 9897)**
- **Waterbodies**

1:7,500

0 30 60 120 180 240 300

Meters at A3

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

Shoalhaven City Council
SCC Mapping Riparian Land in Verons Estate

Verons Estate
Riparian Corridor Objective Setting Categories - GHD and Core Riparian Zone Buffers

Job Number 23-12965
Revision D
Date 06 Mar 2009

Figure 4-3

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Data source: Shoalhaven City Council, NSW Dept of Natural Resources. Created by: L Carpenter & C Charalambou

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4.2 Waterbodies (farm dams)

Twenty-seven farm dams were identified within the 32 lots in the subject land. In comparison, no dams are shown on the 1:25,000 topographic map sheet.

While most of the dams are small, the amount is significant and may have altered the site hydrology. Potential hydrological impacts of these dams include:

- A reduction in the frequency and volume of runoff;
- Concentration of flow at dam outlets; and
- Realignment of flow paths.

Most of the dams were digitised using aerial photography, while some were digitised using the GPS. If these dams are removed during future development, there would be value in redigitising the watercourse flow path. Table 4-1 summarises the number of farm dams identified in this assessment compared to current mapping.

(Note - The farm dams have been digitised into a GIS layer. This is an addition to the suite of GIS datasets within Council. Council should consider digitising farm dams throughout the Shoalhaven LGA from currently available aerial photography for consistency.)

Table 4-1 Comparison of number of farm dams identified in current and GHD mapping

Study site	Current	GHD
Verons Estate	0 Farm dams	27 Farm dams

4.3 Comparison with DWE (formerly DIPNR) riparian mapping

A spatial analysis of the area of riparian land (sq m) identified as CRZs was undertaken using ArcGIS by comparing the DEW (formerly DIPNR) mapping (Figure 1-1) and GHD mapping (Figure 4-3).GHD has compared the area (sq m) of CRZ only. A graphical comparison is provided in Figure 4-4.

Despite the significant reduction in total watercourse length, the area of riparian land identified in this assessment is considerably larger than indicated by DWE's mapping.

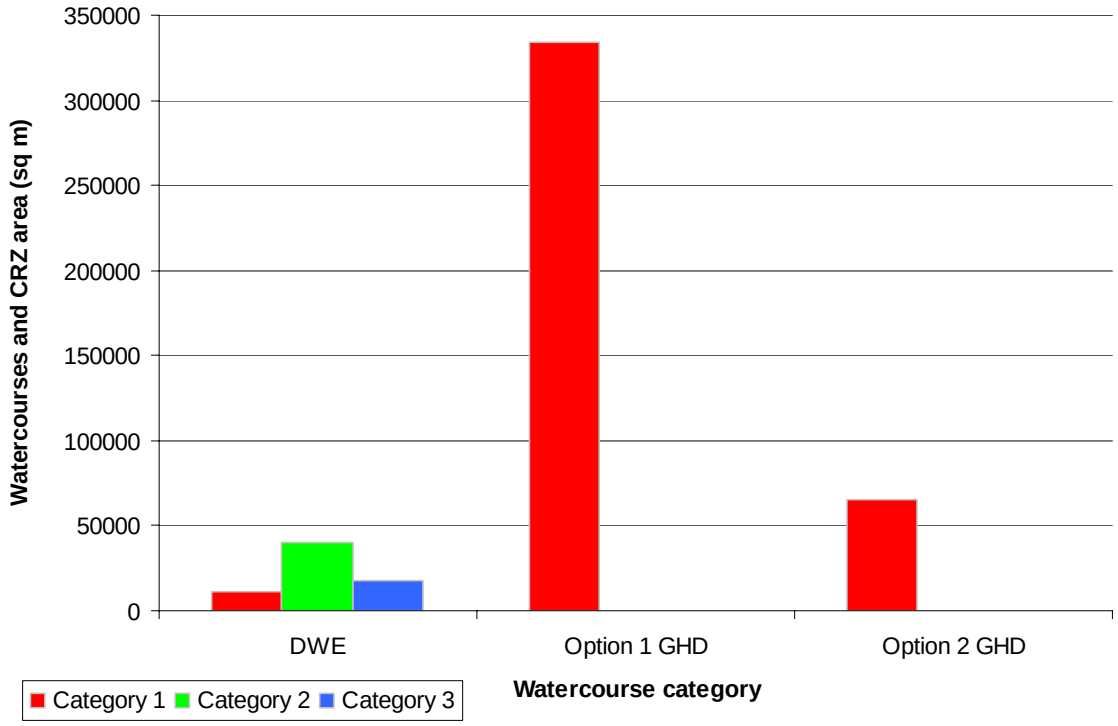

Figure 4-4 Comparison of the area (sq m) of watercourse and CRZ buffer areas identified in the DNR and GHD mapping by watercourse category.

Results show that the DWE (formerly DIPNR) riparian mapping would exclude about 68,946 sq m of land from a development footprint based on the CRZ buffer widths. The total area of riparian land identified in this assessment is 333,875 sq m.

4.4 Summary of findings

A summary of the findings of the assessment are presented in Table 4-2.

Table 4-2 Summary of Findings

Attribute	Verons Estate
Area (hectares)	265.37 Ha
Catchments	Swan Lake, Badgee Lagoon which then drains to Sussex Inlet

Attribute	Verons Estate
DWE (DIPNR) watercourses and categorisations within subject site	Swan Lake catchment SW1 – Category 2 NW1 – Category 1. Head of watercourse and buffer overlap onto NW tip of subject land Badgee Lagoon catchment NE1 – Category 3 NE2 – Category 3 NE3 – Category 3 NE4 – Category 3 SE1– Category 1. Head of watercourse overlaps onto SE tip of subject land
GHD watercourse position and categorisations	Swan Lake catchment SW1 – Category 1. Watercourse poorly defined. Riparian area defined by sedgeland vegetation. NW1 – watercourse does not overlap onto subject land. Vehicle track within National Park separates riparian area from pasture in subject land. Badgee Lagoon catchment NE1/NE2/NE3/NE4 – Category 1. Watercourse poorly defined. Riparian area defined by sedgeland vegetation. SE1 - watercourse does not clearly define on subject land. Significant disturbance. Riparian area not identified.
River Score Condition	Class 'Good A'
Topography	Gently undulating terrain in two catchments.
Vegetation	Riparian areas are mainly Sandstone Sedgeland. Surrounding vegetation consists of various forest and woodland communities. (Table continued next page)
Riparian and catchment attributes	Forms part of catchment for SEPP 14 wetlands and Swan Lake. Forms part of catchment for SEPP 14 wetlands at Badgee Lagoon. Riparian vegetation is in good environmental condition. Large areas of the subject land contain native vegetation in good condition, particularly the Swan Lake side. There are few weeds and robust and diverse native vegetation communities. Riparian areas and native vegetation provide important water quality and hydrology functions. Water quality likely to be high with low concentrations of nutrients and sediment, but potentially lower in degraded areas. Highly erodible and infertile soils.

Attribute	Verons Estate
Threats to riparian and catchment function	**Current** Clearing and burning of native vegetation, under-scrubbing, grazing. Erosion of areas where vegetation has been disturbed and/or flow concentrated. Evident along informal vehicle and trail bike tracks, and table drains along constructed roads. Erosion of imported soils. Delivery of eroded sediments, nutrients and other pollutants to downstream assets from unsealed road erosion. Weed dispersal associated with agricultural and other uses. Habitat destruction and fragmentation. Modification of hydrology by farm dams. **Future** Increased sediment and nutrient pollution from clearing and landuse change, onsite effluent disposal and activities associated with residential development. Changes to hydrology from road construction. Impacts on biodiversity from removal of habitat. Edge effects to riparian land. Introduction of weeds and feral animals. Fauna road kill.

4.5 Discussion of potential impacts on riparian lands and associated values

The discussion below summarises some of the relevant riparian land management issues such as the impact of road construction, stock management, habitat restoration and riparian buffer establishment.

4.5.1 Summary riparian land management

Key riparian land management issues and potential management strategies are outlined in Table 4-3.

Table 4-3 Riparian land management issues and potential management strategies

Riparian land management issues	Potential management strategies
Road construction – erosion and associated pollution, and impacts on hydrology	◗ Minimise roads within the SEPP 14 wetland subcatchments. ◗ Provide flow dissipation structures and appropriate stormwater treatment facilities. ◗ Provide smaller culverts at closer intervals rather than a few large ones to minimise impacts on hydrology. ◗ Raise surface elevation of roads above natural ground surface.
Land management	◗ Develop appropriate development controls for stormwater and sewerage management. ◗ Provide fencing to exclude stock from riparian buffer areas and other areas of vegetation where development is inappropriate. ◗ Maintain sustainable stock numbers/avoid overstocking. ◗ Minimise clearing and where possible, allow cleared areas to rehabilitate.
Soil erosion, sedimentation, nutrient runoff and other pollution issues	◗ Maximise vegetation cover and avoid bare ground. Provide erosion control measures where appropriate. ◗ Utilise WSUD practices to control surface water flows and minimise pollution entering riparian areas. ◗ Avoid concentrating flow. ◗ Establish riparian buffers.
Clearing and burning of native vegetation	◗ Monitor condition of native vegetation remnants. ◗ Minimise area allowed to be cleared. Where possible, site development to occur only on previously cleared land. Where vegetation removal is necessary, rehabilitate and offset elsewhere within the subject land.
Reduced water quality and in stream habitat conditions	◗ Protect riparian and associated buffer areas from disturbance. ◗ Habitat restoration.

Riparian land management issues	Potential management strategies
Access for stock watering	◗ Fencing, provision of alternative watering sources, restoration sites with disturbed soil.
Irrigation and domestic use	◗ Riparian buffer establishment.
Effluent disposal	◗ Maximise separation between effluent disposal areas and riparian areas. ◗ Assess site and soil constraints and design accordingly. ◗ Provide secondary level treatment systems which maximise nutrient removal. ◗ Apply treated effluent via subsurface irrigation.
Habitat for endangered and rare species	◗ Habitat restoration/preservation.
System of high diversity in aquatic flora and fauna	◗ Riparian buffer establishment and protection. ◗ Stock management and land planning. ◗ Stream erosion control works.
Wildlife corridors	◗ Establish riparian buffers and link to adjoining/remnant vegetation. ◗ Utilise legislation to ensure protection.
Colonisation of invasive weed species	◗ Remove weeds and restore habitat.

4.5.2 Impact of road construction on riparian lands

There is a growing body of scientific literature on the negative effects of roads and traffic on ecological systems (Spellerberg 1998; Findaly & Bourdages 2000). Effects include altered hydrology, changes in species composition, reduction of species biodiversity, fragmentation of habitat, edge effects, and the introduction of noxious weeds and pest animals. Direct and indirect, and short term and long term impacts of roads on wetlands are summarised in this section. Particular attention is drawn to 'altered hydrology' effects, due to its impact on the wetland vegetation communities in the subject land.

The impacts of road construction on wetlands can have a direct (often evident in the short term) and /or an indirect effect (commonly evident in the longer term). For instance, a direct effect of road construction might be the removal of vegetation within the construction footprint. An indirect effect might be an increase in proportion of weed species in an area of a radius of several kilometres over several years, due to new roads acting as a "weed vectors".

Studies also suggest that pollutants (such as light, noise, sand, dust, other particulates, metals, and gases such as CO and NO_2) can impact on biota both directly and indirectly. Pollutants may wash into downstream water bodies, directly creating sediment plumes. An indirect effect might be that run-off pollutants cause physiological stress in aquatic plants, making them more susceptible to pest attack.

Spellerberg (1998), in his review of negative effects of roads and traffic on wetlands, has divided effects into three categories; 'Construction', 'Short term' and 'Long term' effects (Table 4-4). Spellerberg notes that the short term effects of road construction can include habitat loss and physical disturbance, plant mortality and animal kills.

A substantial lag time has also been shown before some serious effects of road construction on wetlands can be measured (Findlay & Bourdages, 2000). In the long term, 'fragmentation of habitat' is known to have a detrimental impact on ecological systems. Fragmentation of wetland habitat has been measured by various means- for example the rate of reduction in total habitat area, increasing the number of fragments, extent of isolation of fragments, areas of edge, shape of fragments, and degree of spatial heterogeneity. Habitat fragmentation is linked to the viability of species using the habitat. The full effect of road construction on 'species richness' may not be evident for several decades. In order to accurately estimate the true impacts, both historical and present effects can be combined into an integrated 'cumulative impact assessment' (Findlay and Bourdages, 2000).

Within the subject land, 'altered hydrology' due to road construction is an important long-term vegetation management issue. The gently undulating terrain of Verons Estate, together with its sandy soils, has given rise to an ecosystem which may be disrupted by seemingly small changes in surface elevation levels. The native vegetation is dependant on the groundwater being available to the root zone of the semi-aquatic species, such as sedges. Semi-aquatic root systems are shallow (less than 1m) compared with the root system of neighbouring tea trees. However some tea trees also have fairly shallow root systems, and some rely on periodic inundation for seedling establishment.

Unsealed and deeply eroding road surfaces may inadvertently drain away the water needed to replenish the groundwater system (refer Figure 4-5), leaving the semiaquatic vegetation dry. Prolonged changes in hydrology may lead to permanent changes in the vegetation species composition as well as the soil fauna composition (Flower, 2008 pers. comm.).

If unsealed roads are deemed unnecessary, consideration could be given to removing them and restoring any existing areas of degraded riparian land, ensuring that endemic species are chosen during revegetation. If roads are required, many small culverts rather than a few large ones may better protect the vegetation.

A concentration of surface water runoff in locations where the roads or tracks exist below the natural ground surface has resulted in erosion. Raising the surface elevation of the road may assist to restore hydrological balance to the vegetation (Figure 4-6).

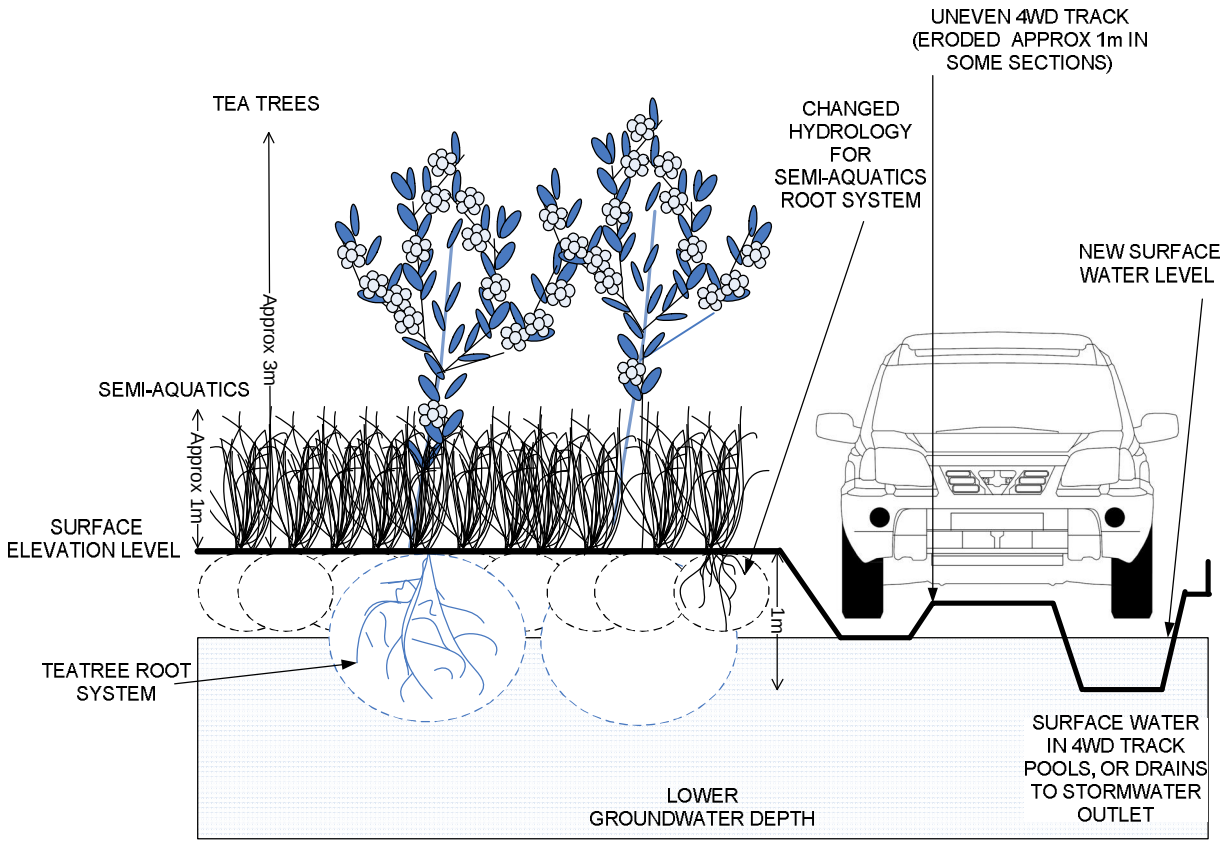

Figure 4-5 Current unsealed roads at Verons Estate. This conceptual diagram illustrates possible negative groundwater/vegetation interactions currently at work within Sandstone Sedgeland communities at Verons Estate. The 4WD tracks are acting as drainage line because of unchecked soil erosion. The root systems of the semi-aquatic species may be affected by the lowered groundwater.

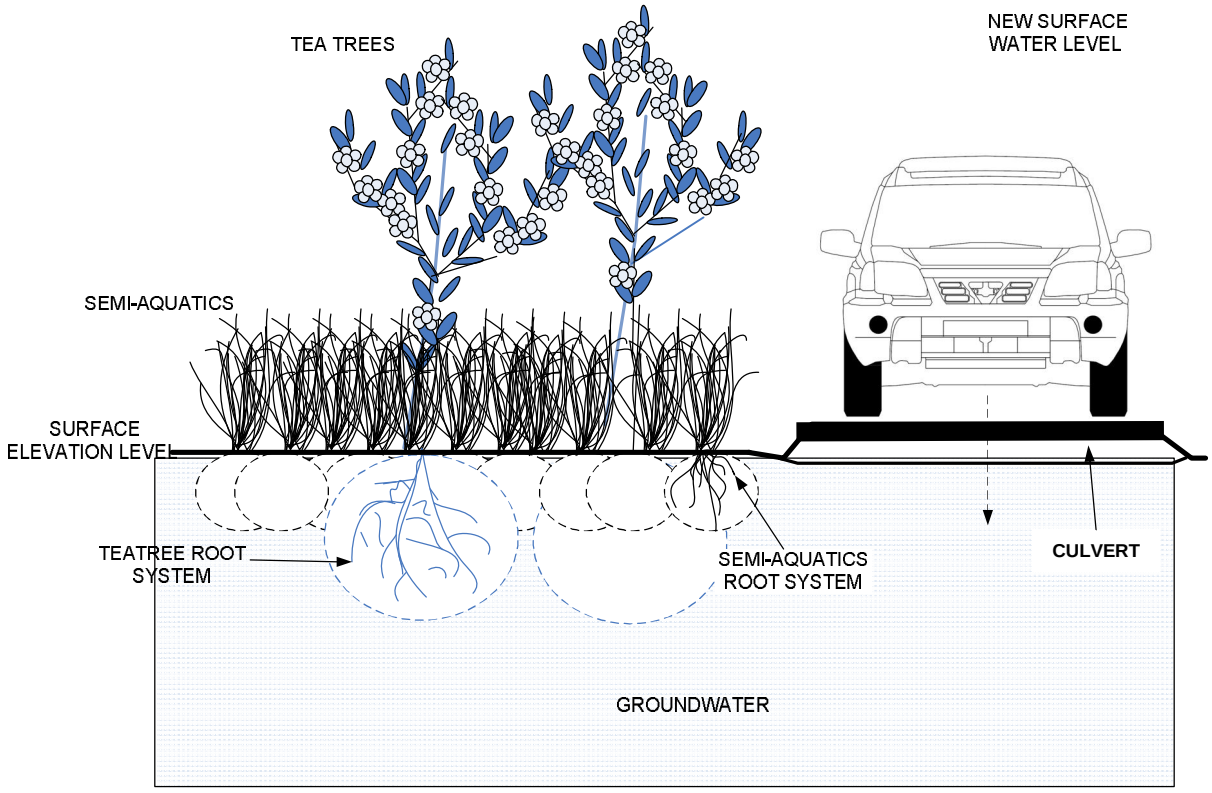

Figure 4-6 Future sealed roads at Verons Estate. This conceptual diagram shows groundwater/vegetation interactions at Verons estate after road construction. The sealed roads are no longer acting as drainage line. The root systems of the semiaquatic species remain within reach of groundwater and a culvert conveys water flow under the road surface.

Table 4-4 A summary of ecological effects of roads (Spellerberg, 1998)

Time period	Effects
Effects during Construction	◗ Direct loss of habitat and biota ◗ Effects may occur beyond the immediate vicinity of the road such as changes in the hydrology
Short term effects (of a new road)	◗ A new linear surface may create an altered microclimate and a change in other physical conditions for some distance from the road edge ◗ Creation of a road edge may provide habitat for edge species such as weeds ◗ Plant mortality increases along the edge: and such mortalities may extend from the road edge for varying distances. ◗ The mortality of plants has direct and secondary effects on other organisms ◗ Some fauna will move from the area of the road as a result of habitat loss and physical disturbance ◗ Animals are killed by traffic
Long term effects	◗ Animals continue to be killed by traffic ◗ The road kill have secondary effects as carrion (e.g a source of food for scavenger species) ◗ The loss of habitat and change in habitat extends beyond the edge of the road ◗ The changes in the biological communities may extend for varying distance from the road edge ◗ There is fragmentation of the habitat and this in turn has implications for habitat damage and loss, for dispersal and vagility of organisms, and for isolation of populations ◗ The edge habitat (or ecotone) and traffic on the road may facilitate dispersal for some taxa, including pest species ◗ This dispersal of pest species via ecotones or traffic may have secondary effects on biological communities ◗ Associated structures such as bridges and tunnels may provide habitats for some taxa ◗ The run-off from the roads affects aquatic communities ◗ Emissions, litter, noise and other physical disturbances may extend into the roadside vegetations for varying distances and result in changes in species composition

4.5.3 Impact of stock on riparian lands

Within the subject land there is a range of land uses, including stock grazing, which was observed to have impacted the sandstone sedgeland vegetation community. Livestock can also have negative impacts upon soils, vegetation and water quality within wetland and riparian areas. Riparian area protection could be improved through grazing management such as fencing additional regions to exclude or minimise access by cattle to defined riparian zones.

The following critical factors have been identified for the development of sustainable long-term approaches to livestock grazing practices within subject land:

- Fencing of riparian areas; and
- Provision of off-river stock watering points.

4.5.4 Restoration of degraded land

During the field survey GHD noted some instances of recent illegal clearing of vegetation, 'cleaning up', and burning of fallen eucalypts logs.

These processes have the capacity to directly impact on distribution, abundance, composition and sustainability of terrestrial and aquatic flora and fauna. Consideration could be given to undertaking the following to assist with habitat restoration:

- 'Policing' of illegal clearing;
- Monitoring and control of infestations of noxious and environmental weeds;
- Pest animal control as required; and
- Native and endemic plantings in suitable locations.

4.5.5 Riparian buffer establishment

The implementation of the core riparian zones and vegetated buffers is a tool by which restoration initiatives for water quality, habitat protection and maintenance of community use values could be instigated. Management recommendations are provided in Section 5.

5. Recommendations

5.1 Verified riparian watercourses and categories

Based on the outcome of the study, GHD recommend that Council incorporate the findings and recommendations of the assessment, as presented in Section 5.2, into the local environment study and environmental plan for the subject land. GHD has delineated the new alignments into a GIS layer for this subject land, reducing the level of inconsistency and inaccuracy of the mapping currently used.

It is also recommended that the new watercourse categories be incorporated into the SCC Geographical Information System in order to provide Council with more accurate data on which to base informed planning decisions.

5.2 Planning and land management

Ongoing management of Category 1 watercourses will maintain and enhance their environmental values. Management activities and actions should seek to achieve the following:

- Protection of water quality;
- Provision of a continuous corridor width for the movement of flora and fauna;
- Provision of extensive habitat (and connectivity between habitat nodes) for terrestrial and aquatic fauna;
- Maintenance of the viability of native riparian vegetation;
- Minimising edge effects at the riparian/urban interface; and
- Provision of bank stability.

Management actions to achieve the above could include:

- Minimising the number of road crossings in riparian areas;
- Provision of a CRZ with a minimum width of 40 m from the defined watercourse (‘top-of-bank’);
- Provide a vegetated buffer of 10 m minimum width to protect the CRZ from edge effects;
- Provision of sufficient (additional) riparian corridor width based on geomorphological and environmental considerations;
- Provision of a suitable environmental protection zoning to the riparian land that recognises its environmental significance;
- Restoration/rehabilitation of the riparian zone by returning as far as practicable the vegetation, geomorphic structure, hydrology and water quality of the original (pre-European) condition of the stream;
- Ensure vegetation in the CRZ is at a density that would occur naturally;
- Location of services (power, water, sewerage, and water quality treatment ponds) outside of the CRZ and vegetated buffer areas (encroachment into the non core riparian area may be possible if unavoidable and the impact on riparian functions is minimal and integrity maintained);
- Maintenance of riparian connectivity by using piered crossings in preference to pipes or culverts;

- using ecologically informed design principles to minimise the impact of walkways, cycleways and general access points;
- Location of flood compatible activities (playing fields) outside of the CRZ; and
- Treatment of stormwater runoff outside of the CRZ (and buffer) before discharge into the watercourse.

5.3 Additional assessments

The scope of the assessment did not include analysis of impacts of the proposal on hydrology and water quality as required by the South Coast Regional Strategy. This will require further assessment. Consideration should be given to utilising appropriate hydrological and water quality modelling tools. One possible approach would be to use of 3D Modelling (GHD, 2008) using Flow Accumulation tools in the ArcGIS extension ArcHydro.

Consideration should be given to monitoring water quality during wet-weather run-off under existing catchment conditions to allow calibration of model(s) and allow an informed assessment.

Soil sampling should be undertaken across the subject land with particular attention given to the erodibility of the soil horizons to enable model calibration. An assessment of onsite disposal will also be required to ensure riparian areas are not adversely impacted by development.

6. References

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Appendix A

NSW National Parks and Wildlife Service communication to Shoalhaven City Council July 2002 regarding Verons Estate

4 1420

NSW NATIONAL PARKS AND WILDLIFE SERVICE

ABN 30 841 387 271

PLANNING SERVICES
09 JUL 2002
RECEIVED

The General Manager
Shoalhaven City Council
PO Box 42
NOWRA NSW 2541

Shoalhaven City Council
Received SR
08 JUL 2002
File No.. 1422-02
Referred to: G Ann

3 July, 2002

Our reference: *ZF0470:mb*
Your reference:

Dear Sir,

s.34A & s.62 Consultation – Proposed LEP LP 167, DP 9897 Verons Estate, Sussex Inlet

I refer to your letter of 15 April 2002 and the subsequent letter of 22 May 2002 providing additional information on threatened species issues as requested. Also relevant is the meeting between Council representatives and Government agencies on the 15 May 2002.

The NPWS is particularly interested in the Aboriginal cultural heritage, flora and fauna values of the site, its role in habitat connectivity in the area and any impacts on the adjoining National Park lands.

Current Position

It is noted Council proposes to prepare a Local Environmental Study in conjunction with the draft plan to investigate the impacts of the erection of a dwelling on each of the 32 allotments within the Estate. At the agency meeting the stated NPWS position was that it considered there was already enough information and planning recommendations in place to indicate that the Swan Lake catchment section of the estate is unsuitable for rural residential development.

This view has been reinforced since that time by the additional information provided by Council on the studies carried out to date on the land and the release of the final report of the Independent Inquiry into Coastal Lakes, against which this proposal appears contrary to the recommendations. NPWS supports the recommendations of the draft Mills Report (1994) that development of the estate for rural residential development is likely to have a detrimental impact on Swan Lake through increased sedimentation and nutrient inputs (Page 13) and that it is likely to have an adverse impact on threatened species (Page 12). Also in the intervening time NPWS staff carried out a site visit on 7 June 2002 which confirmed that the Swan Lake Catchment section, despite some clearing overall still predominantly retains its natural values.

It is noted that the relevant environmental planning instrument already distinguishes between the land on catchment boundaries with the western Swan Lake section identified as land of ecological sensitivity in Shoalhaven LEP 1985.

NPWS consider that in a planning process of this nature, on an individual site basis and not underpinned by any wider strategic planning, areas should not be included where the existing data indicates land is not suitable in the first instance. This avoids giving unrealistic expectations especially where the study costs are to be met by the individual landowners.

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The previous referencing by NPWS of the Swan Lake Catchment section of the land as a potential addition to Cudmirrah National Park does not preclude the LEP amendment process proceeding. The rezoning proposal has to be considered on its inherent site values. The referencing is still valid and if approached by landowners NPWS would consider purchase in the context of its State wide acquisition priorities and budget. There are no immediate plans to purchase the lands at this time as indicated in previous correspondence to Council.

Environmental Study

Notwithstanding the above if Council proceeds with the preparation of the environmental study for the site the following points are relevant:

- A full archaeological study should be carried out in accordance with the NPWS "Aboriginal Cultural Heritage: Standards and Guidelines 1998". Studies in the adjoining national park have found a high number of sites. The local Aboriginal community should be consulted in this process. As requested at the planning meeting, attached are NPWS reports on studies carried out in the adjoining Cudmirrah National Park.

- Mapping of the vegetation communities should be carried out. This could include reviewing the mapping carried out to date for the site. Kevin Mills also carried out mapping in the area for NPWS in 1995. Recommendations should be made to regional significance and habitat values of the various communities. Cleared areas should also be assessed in relation to disturbance and ability to regenerate.

- An assessment should be made on how the rezoning may affect threatened species, populations or ecological communities, or their habitat and recommendations made for the lands suitability for development in this regard. Allowance should be made in the any assessment for the area that was burnt in the recent fires.

- Threatened fauna species that may be affected by vegetation clearance in this area but not limited to the following include: Glossy Black Cockatoo, Long-nosed Potoroo, White-footed Dunnart, Yellow-bellied Glider, a range of bat species (including Large Bentwing Bat, East Coast Freetail Bat, Large footed Myotis, Eastern False Pipistrelle, Greater Broad-nosed Bat), Powerful Owl, Masked Owl, and Square-tailed Kite. A range of water birds could use the wet areas intermittently and may be affected by changes in water quality and hydrological regimes within the wetland.

- The Leafless Tongue Orchid has been recorded in close proximity to the subject lands. It is considered that the species may occur on the subject lands, however in order to determine this survey during the appropriate time of year, ie. December-January. If this species is present, zoning as environment protection would assist the conservation of this species.

- Particular attention should be made to the wetland and sedgeland areas. As stated in the Mills Report they are important for their role in the natural drainage network around Swan Lake and Badgee Lagoon acting as a filtering system. Adequate buffers and setbacks should be delineated.

- Bushfire considerations should be considered in accordance with the NSW Governments "Planning for Bushfire Protection" December 2001. Particularly, the requirement that the location of Asset Protection Zones for new development should be located within the boundaries of the development and not placed on adjacent lands.

- Impacts on the adjoining National Park both direct and indirect should be considered. Adjacent rural residential development has lead in the past to problems with the keeping of domestic dogs and cats potentially impacting on a range of native fauna. There are also greater risks for the

spread of noxious weeds and introduced garden plants. Where the areas directly drain into National Parks there is potential hazards with pollution (from pesticides, etc.); nutrient enrichment from increased salt levels in soil or water; changes to drainage patterns; increased acid runoff from acid sulphate soils and contamination from on site effluent disposal that can impact on native vegetation. Sediment loads can increase significantly especially in the construction phase with roads, houses and dams being built. Adjoining vegetated areas also are important in minimising edge affects to flora and fauna communities. Adequate setbacks should be defined to avoid the above.

Critical Points for consideration

It should be recognised in any assessment of the suitability of rural residential on the land will lead to the loss of the majority of natural and biodiversity values on site and it should be assessed as such. Studies indicate that rural residential has a high incidence of clearing associated with its development.[1] The establishment of a dwelling site, associated buildings, roads, electricity lines, dams, effluent disposal fields, fuel reduction zones and associated agricultural uses mean most vegetation is lost in the long run or its values compromised.

The potential extent of clearing is clearly evident from the existing development on site. It is noted that in the draft Mills Report for the site it was concluded for rural residential development such as proposed, virtually all vegetation is removed overtime. If important values are found this should not rely on enforcement of caveats on the title once the development is established. It is better at the rezoning stage to exclude development all together.

The illegal clearing that has taken place should not be seen as justification for the development. From the site visit, particularly in the Swan Lake catchment, often only the canopy species have been removed and there is a lack of weeds. So the area would have a strong ability to regenerate naturally. This should be facted in to the consideration of natural values. There is a need to control clearing on the land in the interim while the zoning is being resolved or the natural values will be further eroded.

The western side of the land adjacent to Sussex Inlet urban area would appear more suitable for the type of development proposed from flora and fauna values. It generally displays a higher level of disturbance with the instance of built structures, agricultural activities and introduced vegetation is much greater. Protection of the sedgelands and wetland areas of the Badgee catchment will be a critical consideration.

If you would like to discuss the matter or require further information, please contact, Miles Boak, Conservation Planning Officer at the Southern Directorate Office, on telephone (02) 6298 9708.

Yours sincerely,

Michael Hood
Manager, Conservation Planning
Southern Directorate

1. **Edols-Meeves M. and Knox S. (1996). Rural Residential Development, At What Cost ?.** ***Australian Planner*** **Vol 33: 25-29.**

Appendix B

Riparian management requirements for riparian land (DIPNR 2004)

Table 6-1 Summary of riparian management requirements in relation to the three relative riparian categories (DIPNR, 2004)

Management Requirements and Minimum Environmental Objectives for Riparian Land	Category 1 Environmental Corridor	Category 2 Terrestrial & Aquatic Habitat	Category 3 Bank Stability & Water Quality
Delineate riparian zone on a map and zone appropriately for environmental protection	Yes	Yes	If resources are available
Provide a minimum Core Riparian Zone (CRZ) width	40 m from the top of bank	20 m from top of bank	Usually 10 m from the bank
Provide additional width to counter edge effects on the urban interface (i.e. Vegetated Buffer)	10 m	10 m	Generally not required
Provide continuity for movement of terrestrial and aquatic habitat	Yes (including piered crossings)	Yes (with appropriate crossing design)	Where appropriate
Rehabilitate/re-establish local provenance native vegetation	Yes	Yes	Where appropriate
Locate services outside the Core Riparian Zone wherever possible	Yes	Yes	Merit Consideration
Locate playing fields and recreational activities outside Core Riparian Zones	Yes	Yes	Merit Consideration
Treat stormwater runoff before discharge into the riparian zone or the watercourse	Yes (outside CRZ and buffer)	Yes (outside CRZ and buffer)	Yes

Definitions:

Core Riparian Zone (CRZ) is that area of land contained within and adjacent to the channel. The CRZ is to remain or become fully vegetated with local provenance native vegetation (including aquatic groundcovers, shrubs and other species) to a minimum width from the banks of the river. The minimum width from the banks is determined by the stream category which draws upon contemporary scientific literature to determine minimum spatial requirements for riparian functionality. Merit issues can also determine the width (e.g. extra widths of vegetation exist).

Vegetated Buffer (VB) is required to protect the environmental integrity of the CRZ from edge effects form adjacent lands, such as weed invasion, micro-climate changes, litter, trampling and pollution. The minimum width from the CRZ is 10 m but is also dependent upon merit issues

Asset Protection Zone (APZ) is required (by NSW Rural Fire Services) to protect assets from potential bushfire damage and should be measured from the outer edge of the vegetated buffer to the asset. It should never be considered to be part of or contained within the VB or the CRZ (i.e. APZ not to result in clearing of the CRZ or VB). APZ required cleared land that manes that it cannot be considered as part of the CRZ or VB.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
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0	L. Carpenter	J. Earle				08/12/08
1	L. Carpenter	J. Earle		J.Earle		02/02/09
2	K. Clulow	J. Earle		J Earle		21/04/09