Department of Primary Industries
Water

Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources

Background document

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More information

Rural Water Planning

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Introduction

Water sharing plans are being progressively developed for rivers and groundwater systems across New South Wales following the introduction of the *Water Management Act 2000* (WMA 2000). These plans protect the health of our rivers and groundwater while also providing water users with perpetual access licences, equitable conditions, and increased opportunities to trade water through separation of land and water.

The first round of water sharing plans commenced on 1 July 2004. The development of these plans resulted in around 80 per cent of the water use in NSW being managed under the WMA 2000. By the end of 2012, over 95 per cent of all water extracted in NSW was covered by a water sharing plan. By the end of 2016 it is anticipated that all extraction in NSW will be covered by a water sharing plan.

Water sharing plans for the majority of unregulated[1] rivers and groundwater systems have been completed using a broad scale 'macro' approach based on whole river catchment or aquifer systems. Each macro plan covers a large river basin rather than a single subcatchment, or in the case of groundwater systems, cover a particular type of aquifer (for example fractured rock). These river basin or aquifer macro plans generally apply to catchments or aquifers where there is less intensive water use.

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* (the plan) covers all coastal sand groundwater sources between the NSW/Queensland border and the Hawkesbury River. The plan also includes groundwater sources previously covered by the *Water Sharing Plan for the Stuarts Point Groundwater Source* and the *Water Sharing Plan for the Tomago Tomaree and Stockton Groundwater Sources* which both commenced in 2004. The merging of these plans into the North Coast Coastal Sands plan reduces the number of plans for the region (reducing resourcing requirements over time) and enhances consistency between groundwater sources for water users.

This document provides background to the development of the rules in the water sharing plan. It includes information on the purpose of the plan and the policy framework that supports it, a description of the NSW north coast coastal sands including land and water use, and the process of developing the various water sharing rules in the plan. This document is part of a range of material available specifically on the plan including:

- the *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* - a legal instrument written in its required statutory format; and
- Rule summary sheets for each groundwater source providing an overview of the water sharing rules.

General information on the macro planning process is available in the water sharing plans section of the NSW Department of Primary Industries Water (DPI Water) website www.water.nsw.gov.au. This includes:

- *Macro water sharing plans – the approach for groundwater. A report to assist community consultation* – explains the method used to classify and set water sharing rules for groundwater across the state;
- *Macro water sharing plans* – the approach for unregulated rivers. A report to assist community consultation – explains the method used to classify and set water sharing rules for unregulated streams across the state

[1] The supply of water in unregulated rivers is typically not controlled by releases of water from dams but rather is dependent solely on rainfall and natural river flows.

Why are water sharing plans being prepared?

Expansion of water extraction across NSW in the 20th century has placed most valleys and many aquifers at or close to the limit of sustainable water extraction. This has seen increasing competition between water users (towns, farmers, industries and irrigators) for access to water. This has also placed pressure on the health and biological diversity of our rivers and aquifers.

In December 2000, the NSW parliament passed the Water Management Act 2000 (WMA 2000) which has the overall objective of "sustainable and integrated management of the State's water" (DLWC 2001). Water sharing plans play a major role in achieving this objective by providing a legal basis for sharing water between the environment and consumptive water users.

Under the WMA 2000, water sharing plans must protect water sources and their dependent ecosystems, and must protect the basic rights of landholders to extract water. In this way, environmental water and basic landholder rights are afforded priority over licensed water extractions. Among licensed water users, priority is given to local water utilities and major utilities, and licensed stock and domestic use, ahead of commercial purposes such as irrigation and other industries.

Water sharing plans also recognise the economic benefits that commercial users such as irrigation and industry can bring to a region. When a plan commences, access licences held under the *Water Act 1912* are converted to access licences under the WMA 2000 which separates the water licences from land tenure. This facilitates the trade of access licences and encourages more efficient use of water resources. It also allows new industries to develop as water can move to its highest value use.

In conjunction with the WMA 2000, water sharing plans also set rules so that commercial users can continue to operate productively. In general, commercial licences under the WMA 2000 are granted in perpetuity, providing greater commercial security of water access entitlements. Water sharing plans define the access rules for commercial users for 10 years providing all users with greater certainty regarding sharing arrangements.

Benefits for water users

The introduction of water sharing plans will benefit water users by providing:

- greater certainty by setting water sharing arrangements for a 10 year period;
- clear trading and access rules which will help foster trading; and
- greater security with existing water licences converted to perpetual water access licences under the WMA 2000.

Environmental considerations

An aquifer is an underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt or clay) from which groundwater can be extracted. Aquifers can store large volumes of water, often accumulated over thousands, or tens of thousands of years. Water enters (or recharges) aquifers via rainfall, surface flows from rivers and lakes or flow from adjacent aquifers.

Water sharing plans are required to reserve water for the overall health of the groundwater sources and to protect specific ecosystems that depend on groundwater, such as wetlands. This share of water reserved for the environment is also intended to sustain the aquifer system's aquatic fauna and flora.

In all of the groundwater sources covered by the plan, 100% of groundwater storage is reserved as planned environmental water. The water sharing plan also defines a proportion of rainfall recharge that is available for extraction with the remainder of recharge reserved for the environment. Limiting the volume of extraction to a proportion of recharge is intended to reduce the risk of unsustainable groundwater extraction in the long term.

The water sharing plan also includes rules on the location of new works and extraction from existing works to protect high priority groundwater-dependent ecosystems, high priority karst systems and other environmentally sensitive areas such as rivers or streams.

Replacement of first round water sharing plans

The *Water Sharing Plan for the Stuarts Point Groundwater Source* and the *Water Sharing Plan for the Tomago Tomaree and Stockton Groundwater Sources* were amongst the first water sharing plans that commenced in NSW in 2004.

Water sharing plans apply for a period of 10 years from their commencement. At the end of the 10 years the Minister determines if the water sharing plan is to be replaced or extended for a further 10 years[2]. The Minister's decision is informed by reports from the Natural Resources Commission (NRC) and DPI Water. Extension does not allow changes to be made to the water sharing plan. If changes are required then a replacement water sharing plan needs to be made.

When reviewing the plans the NRC and DPI Water undertook joint consultation and collected submissions from stakeholders on the performance of the first round of water sharing plans. The NRC used this consultation to inform their recommendation to the Minister on whether the water sharing plans should be replaced or extended. DPI Water used this process to examine whether the plan rules were appropriate, practical to implement and to identify if there were any ways to improve the plans' outcomes. Both the NRC and DPI Water recommended that all first round water sharing plans be replaced. After reviewing reports provided by the NRC and DPI Water, the Minister supported the replacement of the first round water sharing plans which expired in 2014. Although the plans were required to be replaced prior to July 2015 an extension was granted to allow for sufficient consultation to be undertaken and the plans were replaced in July 2016.

The Minister directed that any changes to inland plans should be limited due to the impending Basin Plan, but determined that more significant changes may be made to coastal plans if warranted. Proposed changes must be permitted under the WMA 2000 and also need to consider the significant amount of consultation that was undertaken in their initial development.

Changes to the provisions of both the *Water Sharing Plan for the Stuarts Point Groundwater Source* and the *Water Sharing Plan for the Tomago Tomaree and Stockton Groundwater Sources* as part of the replacement process have been informed from a number of sources including: changes to policy, updates to legislation, updated data, outcomes of audits, and stakeholder requests. As provisions in both of these plan areas have been operating for over a decade, and the initial plans were developed in close consultation with stakeholder groups, DPI Water has been keen to avoid unnecessary changes and instead focussed on improving provisions based on the information sources listed above.

[2] Extension refers to the extension of plans for a further 10 year term without change. Replacement refers to replacement of the plan with a new plan where changes to the existing plan are proposed.

A water sharing plan for the North Coast Coastal Sands

This water sharing plan formalises water sharing arrangements in the North Coast Coastal Sands Groundwater Sources and provides a consistent approach to managing water across the plan area.

Objectives of the plan

The objectives of the water sharing plan are to:

(a) protect, preserve, maintain and enhance the important high priority groundwater-dependent ecosystems of these groundwater sources;

(b) protect, preserve, maintain and enhance the Aboriginal, cultural and heritage values of these groundwater sources;

(c) protect basic landholder rights;

(d) manage these groundwater sources to ensure equitable sharing between users;

(e) provide opportunities for enhanced market based trading of access licences and water allocations within environmental and system constraints;

(f) provide water allocation account management rules which allow sufficient flexibility in water use;

(g) contribute to the maintenance of water quality;

(h) provide recognition of the connectivity between groundwater sources;

(i) adaptively manage these groundwater sources;

(j) recognise the importance of these groundwater sources to the supply of local water utilities and major utilities;

(k) support viable and sustainable water-dependent industries, including agriculture and horticulture, over the long-term; and

(l) contribute to the "environmental and other public benefit outcomes" identified under the "Water Access Entitlements and Planning Framework" in the *Intergovernmental Agreement on a National Water Initiative (2004)*.

Water management units

Aquifers in water sharing plans can be divided into two hydrological units for management purposes. These are groundwater sources and management zones.

The highest level of management unit described in the water sharing plan is the **groundwater source**. There are 14 groundwater sources established in the plan (as listed below). A groundwater source is a geographic area over which long-term average annual extraction limits (LTAAELs) and available water determinations (AWDs) are applied, growth in use is assessed and managed, and water can be traded.

A **management zone**, representing a portion of a groundwater source, may be specified where more refined implementation of access or trading rules is required. The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* establishes management zones only in the Tomago Groundwater Source for the purpose of managing Hunter Water Corporations extraction.

Area to which the plan applies

For the purposes of water planning in NSW, aquifer types have been grouped into four basic categories:

- porous rock aquifers found in rock formations such as sandstone or limestone, where groundwater occurs within the pore space in the rock matrix;
- fractured rock aquifers found in rock formations such as granite or basalt, where groundwater occurs mainly within the fractures and joints;
- coastal sand aquifers, where groundwater is contained in the pore spaces in the unconsolidated sand sediments; and
- alluvial aquifers, where groundwater is contained in the pore spaces in the unconsolidated floodplain material.

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* covers 14 coastal sand aquifers dispersed across several groundwater management areas including the Northern Rivers, Upper North Coast, Mid North Coast, Lower North Coast, Hunter and Central Coast. The legal plan map can be found at www.legislation.nsw.gov.au. An overview map showing the groundwater sources in this plan is detailed in Appendix 1: Map of the North Coast Coastal Sands Water Sharing Plan area and groundwater sources'. The groundwater sources in the plan include:

- the Bellinger–Nambucca Coastal Sands Groundwater Source;
- the Clarence Coastal Sands Groundwater Source;
- the Coffs Harbour Coastal Sands Groundwater Source;
- the Great Lakes Coastal Sands Groundwater Source;
- the Hastings Coastal Sands Groundwater Source;
- the Hawkesbury to Hunter Coastal Sands Groundwater Source;
- the Macleay Coastal Sands Groundwater Source;
- the Manning–Camden Haven Coastal Sands Groundwater Source;
- the Richmond Coastal Sands Groundwater Source;
- the Stockton Groundwater Source (replacement groundwater source);
- the Stuarts Point Groundwater Source (replacement groundwater source);
- the Tomago Groundwater Source (replacement groundwater source);
- the Tomaree Groundwater Source (replacement groundwater source); and
- the Tweed–Brunswick Coastal Sands Groundwater Source.

Connectivity between coastal sand aquifers and surface water is high as described in Table 1. This information is based on the principles and recommendations in *Towards a National Framework for Managing the Impacts of Groundwater and Surface Water Interaction in Australia* (Sinclair Knight Merz 2006).

Table 1: Connectivity characteristics of coastal sands aquifer

Aquifer type	Groundwater source	Level of connection between surface and groundwater	Level of impact on in-stream values	Travel time between groundwater and surface water
Coastal sands	All groundwater sources listed above	Significant (tidal section only)	Low due to connection with saline water	Days to months

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* does not include any of the alluvial aquifers within the plan area.

Groundwater sources associated with fractured and porous rock formations within the plan area will be managed through the *Water Sharing Plan for the North Coast Fractured and Porous Rock Groundwater Sources*.

Policy and planning framework

Water Management Act 2000

The overall objective of the WMA 2000 is "sustainable and integrated management of the State's water" (DLWC 2001). Water sharing plans are the main tool through which the WMA 2000 achieves its objective. Prior to the commencement of the WMA 2000, the *Water Act 1912* was the key piece of legislation governing extraction of water. The WMA 2000 was a significant shift in the approach to water management in NSW and as a result it has been progressively implemented as the *Water Act 1912* has been phased out.

The latest copy of the *Water Management Act 2000* is available from the NSW government legislation website.

Access Licence Dealing Principles

The *Access Licence Dealing Principles Order 2004* (the Dealing Principles) draws on the objects and principles of the WMA 2000 and provides state-wide guidance and rules for applications to undertake water dealings including trade.

The principles specify that dealings must consider:

- the impacts on other water users;
- the impacts on the water source;
- the impacts on indigenous, cultural, heritage and spiritual matters; and
- maximising social and economic benefits.

The Dealing Principles specify rules for different types of dealings (such as conversion to a new category, subdivision, consolidation, assignment of rights or allocation, changing water sources, amending extraction components and interstate dealings). They specify the requirements that must be met for a dealing to be permitted, and the conditions under which a dealing is prohibited.

Water sharing plans must be consistent with the Dealing Principles. Water sharing plans can contain additional rules such as restricting trade into a particular area due to its environmental values or hydrologic stress.

National Water Initiative

The National Water Initiative (NWI) was signed by the Council of Australian Governments (COAG) in June 2004. Through the NWI, governments across Australia, including NSW, have agreed on actions to achieve a more cohesive national approach to managing, measuring, planning, pricing and trading water. The NWI recognises the continuing need to increase the productivity and efficiency of Australia's water use, whilst servicing rural and urban communities, and ensuring the health of river and groundwater systems.

Until the end of 2014 the NWI was implemented and monitored by the National Water Commission. Its responsibility for assessing each state's progress with the NWI and providing independent advice to the Commonwealth Government has now been taken over by the Commonwealth Productivity Commission.

Natural Resource Commission targets

The Natural Resource Commission (NRC) was established in 2003 to provide the NSW Government with independent advice on natural resource management issues. To achieve this, the NRC has developed a Standard for Quality Natural Resource Management, along with 13 state-wide targets for natural resource management which have been embedded in the NSW State Plan. The standard is designed to apply to natural resource management at all scales including at the state, regional, catchment and local level.

As with the NWI, the NRC's standard requires the use of the best available knowledge, use of appropriate information management systems, delivery of integrated outcomes, engagement of the community and regular monitoring, measuring, evaluation and reporting to specify how delivery of the targets is progressing. The NRC reviews water sharing plans against this standard and its associated targets. In 2013 the NRC reviewed 31 water sharing plans that were due to expire in 2014 and provided advice to the Minister regarding: the extent of the water sharing plans' contribution to the state-wide standard and targets for natural resource management in the relevant region; and whether changes to water sharing plan provisions could achieve greater alignment of water and natural resource management planning.

In 2012 the NRC reviewed the state-wide standard and targets, including monitoring, evaluation and reporting arrangements in NSW. They recommended five new state-wide targets that provide a sharper focus on the key long-term issues of concern to the Government and community and revised the monitoring, evaluation and reporting strategy to support the implementation of the new targets.

Catchment Action Plans

Catchment Action Plans are statutory, non-regulatory plans that were previously prepared by the state's catchment management authorities under the *Catchment Management Authorities Act 2003* (now repealed). In January 2014 the NSW Government established Local Land Services and transferred the functions of catchment management authorities into this new organisation to provide agricultural support, natural resource management and emergency management to rural communities through a single organisation. The North Coast, Hunter, and Greater Sydney Local Land Services are responsible for continuing the delivery of natural resource management programs on the north and central coast, including the development of catchment action plans.

Each Local Land Services jurisdiction has developed a Catchment Action Plan 2023, which is a 10-year strategic plan that sets the direction for the sustainable use and care of the natural resources in their region. The implementation of water sharing plans is one of the key strategies to be implemented in supporting land and water managers to maintain or improve the condition of priority freshwater, marine, estuarine and groundwater resources.

Water planning policies and considerations

A number of policies and guidelines have been developed since commencement of the WMA 2000. These policies have arisen in response to specific water management issues that need to be considered during the development of water sharing plans. These policies directly influence the planning process and the formulation of water sharing rules.

The document *Macro water sharing plans – the approach for groundwater. A report to assist community consultation* is a key document that contains information about the principles used to develop water sharing rules for groundwater sources.

Managing surface water and groundwater connectivity

A key objective of the NWI is 'recognition of the connectivity between surface and groundwater resources and connected systems managed as a single resource'. Most alluvial aquifers have a relatively high degree of connectivity with their associated surface water sources. Accordingly, most alluvial water sources are included in a water sharing plan that covers both surface water and its connected alluvial groundwater. Conversely, most porous rock, fractured rock and coastal sands aquifers are considered to have a lesser degree of connectivity and are included in groundwater-specific plans.

Protecting basic landholder rights

Under the WMA 2000, basic land holder rights (BLR) are made up of domestic and stock rights, harvestable rights and native title rights. Water may be extracted under these rights without the need for a water access licence; although where groundwater is accessed under a domestic and stock right, the bore must still be approved by DPI Water.

The WMA 2000 requires that water sharing must protect BLR. The plan does this by identifying the volumes required for domestic, stock and native title rights at the start of the plan and taking these requirements into consideration when designing the rules for licensed water extraction. The access rules for licensed extraction do not apply to BLR due to the higher priority of access for those users.

Native Title has been granted in several of the groundwater sources covered by the plan. Under these determinations native title holders have the right to take and use water in accordance with their native title rights. The plan allows for additional rights should more determinations be made during the plan's 10 year term.

The plan provides an estimate of the water requirements for BLR within each groundwater source, noting that these rights may increase during the life of the plan. The plan cannot limit or restrict these rights, but the WMA 2000 provides for restrictions on BLR through a 324 Order.

Protecting town water supply access

Of all licenced entitlement categories town water supply and stock and domestic licences have a higher priority for access to water than all other licences. Water sharing plans recognise this priority by ensuring that a full share of water is allocated for annual town water supplies except where exceptional drought conditions prevent this. The WMA 2000 allows for temporary trade but not permanent trade between local water utility access licences.

Protecting Aboriginal values

Aboriginal people have a spiritual, customary and economic relationship with land and water that provides an important insight into natural resource management. The NSW Government established the Aboriginal Water Initiative (AWI) in 2012 to facilitate effective engagement with Aboriginal communities in the water sharing process and ensure that measurable Aboriginal water outcomes are achieved. The AWI aims to build Aboriginal peoples' capacity to participate as water users, protect their rights to water, maintain a healthy environment and take full advantage of economic opportunities.

Water sharing plans recognise the importance of surface and groundwater to Aboriginal cultures. The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* allows Aboriginal communities to apply for a water access licence for cultural purposes as well as community development licences. An Aboriginal Cultural Access Licence is to be used for manufacturing traditional artefacts, hunting, fishing, gathering, recreation and for cultural and ceremonial purposes. An Aboriginal Cultural Access Licence can also be used for drinking, food preparation, washing and watering domestic gardens. These licences are limited to 10 ML/yr per application. Aboriginal Community Development Access Licences are available in all groundwater sources in the plan area except the Tomago Groundwater Source. These licences are available to support commercial enterprises owned by Aboriginal people.

For further information refer to *Our Water Our Country, An information manual for Aboriginal people and communities about the water reform process* which is available from the DPI Water website www.water.nsw.gov.au.

Description of the plan area

The area covered by the plan (Appendix 1: Map of the North Coast Coastal Sands Water Sharing Plan area and groundwater sources) comprises the coastal sand aquifers of the North Coast of NSW covering an approximate 2477 km^2. The plan area includes the major towns of Newcastle, Foster/Tuncurry, Coffs Harbour, Byron Bay and Tweed Heads.

The plan introduces 10 new groundwater sources not previously covered by a water sharing plan. The plan also includes four groundwater sources previously established through water sharing plans for the Stuarts Point Groundwater Source and the Tomago, Tomaree, Stockton Groundwater Sources.

The coastal sand aquifers within this plan typically consist of fine to medium grained quartz sands with occasional interbedded clay layers and iron indurated layers (known as coffee rock). These iron and clay layers can form partial barriers to vertical flow within the aquifers and as such can form perched aquifers when the water table falls. The water table is relatively close to the surface and is often expressed in the form of wetlands and sand dune back barrier swamps that sustain numerous coastal groundwater-dependant ecosystems.

The water quality within the coastal sand aquifers is typically fresh however water quality issues may arise due to high iron content and the ingress of saline water from adjoining estuarine bodies. The Holocene aged coastal sands also contain areas of potential acid sulphate soils which if exposed to oxygen can cause acidification events.

New groundwater sources

Bellinger–Nambucca Coastal Sands Groundwater Source

The Bellinger – Nambucca Coastal Sands Groundwater Source is located on the mid North Coast of NSW. It covers an area of 53 km^2 and is bounded by the Bellinger River to the north and the town of Scotts Head to the south. Yields within this groundwater source are typically low to moderate. The dominant use of groundwater is for domestic purposes accessed through basic spear point extraction systems. Around 11% of the groundwater source is classified as high environmental value[3]. These areas include Gaagal Wanggaan National Park and Jaagan National Reserve.

Clarence Coastal Sands Groundwater Source

The Clarence Coastal Sands Groundwater Source is located on the far North Coast of NSW. It is bounded by the towns of Evans Head to the north and Arrawarra to the south covering an area of 447 km^2. Yields within this groundwater source are typically low to moderate. The dominant use of groundwater is for domestic purposes accessed through basic spear point extraction systems. Areas of high environmental value account for 58% of the groundwater source area and include Bundjalung and Yuraygir National Parks and Iluka Nature Reserve.

Coffs Harbour Coastal Sands Groundwater Source

The Coffs Harbour Coastal Sands Groundwater Source is located on the mid North Coast of NSW. It is bounded by the towns of Mullaway to the north and Mylestrom to the south and covers an area of 35 km^2. Of this area, 43% is of high environmental value including Bongil Bongil National Park and Moonee Beach National Nature Reserve. Yields within this groundwater source are typically low to moderate. The dominant use of groundwater is for domestic purposes accessed through basic spear point extraction systems.

[3] High environmental value areas include national parks, nature reserves, historic sites, Aboriginal sites, State conservation areas and karst conservation areas.

Great Lakes Coastal Sands Groundwater Source

The Great Lakes Coastal Sands Groundwater Source is located on the lower North Coast of NSW covering an area of 419 km^2. It is bounded by the towns of Old Bar to the north and Tea Gardens to the south with 50% of the groundwater source of high environmental value. Such areas include Khappinghat, Booti Booti and Myall Lakes National Parks and Darawank Nature Reserve.

Yields within this groundwater source are typically moderate to high, with thick sand sequences giving rise to yields of up to 30 L/s. Groundwater is used predominantly for domestic purposes accessed through basic spear point extraction systems. This groundwater source has been developed by Mid Coast Water to augment a town water supply at Tea Gardens and a new borefield is proposed at Nabiac to supplement the Forster–Tuncurry town water supply.

Hastings Coastal Sands Groundwater Source

The Hastings Coastal Sands Groundwater Source covers an area of 239 km^2 on the mid North Coast of NSW. It is bounded by the town of Crescent Head to the north and Port Macquarie to the south. Yields are typically moderate to high, with thick sand sequences giving rise to yields of up to 20 L/s. Groundwater is predominantly used for domestic purposes with some irrigation use on the northern side of the Hastings River. Areas of high environmental value include Limeburners Creek Nature Reserve and Goolawah National Park and account for 40% of the groundwater source.

Hawkesbury to Hunter Coastal Sands Groundwater Source

The Hawkesbury to Hunter Coastal Sands Groundwater Source is located on the lower North Coast of NSW between the Hunter River to the north and the Hawkesbury River to the south. The area of the groundwater source is 138 km^2 of which 19% is of high environmental value. These significant areas include Munmorah Conservation Park, Wyrrabalong National Park and Wamberal Lagoon Nature Reserve.

Yields within this groundwater source are typically moderate to high, with thick sand sequences giving rise to yields of up to 20 L/s. Groundwater is typically accessed through a basic spear point extraction system for domestic use. This groundwater source has been developed to augment a town water supply at Woy Woy Peninsula.

Macleay Coastal Sands Groundwater Source

The Macleay Coastal Sands Groundwater Source is located on the mid North Coast of NSW between the towns of Stuarts Point to the north and Crescent Head to the south. The groundwater source covers an area of 179 km^2. Areas of high environmental value such as Hat Head National Park and Yarrahapinni Wetlands National Park cover 50% of the groundwater source.

Yields within this groundwater source are typically moderate to high, with yields of up to 30 L/s. The dominant use of groundwater in this area is for town water supply with the towns of South West Rocks, Hat Head, and Crescent Head utilising groundwater from bores within the coastal sands.

Manning–Camden Haven Coastal Sands Groundwater Source

The Manning-Camden Haven Coastal Sands Groundwater Source covers an area of 229 km^2 on the lower North Coast of NSW. It is bounded by the town of Port Macquarie to the north and Old Bar to the south. Yields are typically low to moderate, although higher yields can be achieved with excavations. The dominant use of groundwater in this area is for domestic purposes accessed through a basic spear point extraction system. High environmental value areas comprise 43% of the groundwater source. These areas include Crowdy Bay National Park and Lake Innes Nature Reserve.

Richmond Coastal Sands Groundwater Source

The Richmond Coastal Sands Groundwater Source is located on the far North Coast of NSW and is bounded by the towns of Lennox Head to the north and Evans Head to the south. The area of the groundwater source is 360 km^2. Of this area, 16% is comprised of high environmental value areas such as Broadwater National Park, Richmond River National Reserve and Ballina Nature Reserve.

Yields within this groundwater source are typically moderate. Higher yields can be achieved with excavations or in areas where thick sand sequences are present. The dominant use of groundwater in this area is for domestic purposes accessed through a basic spear point extraction system. Minor use of groundwater for commercial and irrigation purposes also occurs.

Tweed–Brunswick Coastal Sands Groundwater Source

The Tweed-Brunswick Coastal Sands Groundwater Source is located on the far North Coast of NSW, covering an area of 160 km^2 and lies between the town of Tweed Heads to the north and Suffolk Park to the south. Yields within this groundwater source are typically low to moderate. Groundwater is used predominantly for domestic purposes through basic spear point extraction systems.

Seventeen percent of the groundwater source area is of high environmental value. This includes Brunswick Heads, Marshalls Creek, Stotts Island, Ukerebagh, Billinudgel, Cudgen, Wooyung, Cumbebin Swamp and Tyagarah Nature Reserves and Arakwal National Park.

Replacement groundwater sources

Stockton Groundwater Source

The Stockton Groundwater Source is located on the Lower North Coast between the villages of Stockton and Anna Bay. It consists of a series of parallel small dune ridges with intervening lowland swales tending to swamps. The Stockton Groundwater Source is located between the coastline and Tilligerry Creek. It extends from the Hunter River at Stockton in the south, to the drainage complex of Bobs Farm Creek, Fenninghams Island Creek, and Murrumburrimbah Swamp near Anna Bay in the north. The area of the Stockton Groundwater Source has been updated since the plan was first developed as a result of improved mapping methods. The area now totals approximately 113 km^2.

Groundwater is used predominantly for domestic purposes accessed through basic spear point extraction systems. Some entitlement is also used for irrigation and commercial purposes.

Located within the groundwater source are the Worimi Conservation Lands which cover the Worimi National Park, Worimi State Conservation Area, and Worimi Regional Park.

Stuarts Point Groundwater Source

The Stuarts Point Groundwater Source is located on the Mid North Coast, about 45 km north-east of Kempsey. It covers an area of unconsolidated sand on the western side of the Macleay Arm, between Grassy Head and the Macleay River estuary. The area includes the town of Stuarts Point and the villages of Fishermans Reach and Grassy Head.

The surface of the groundwater source is a gently undulating flat sand plain with a maximum elevation of 10.5 m above sea level. The area is covered by heaths, woodlands, forests and wetlands that are dependent on groundwater. The Fishermans Bend Nature Reserve protects a small area of woodland immediately south of Stuarts Point. Portions of the Clybucca Aboriginal Area/Historic Site and the Yarrahapinni Wetlands National Park are also located within the groundwater source.

Groundwater is extracted for domestic, town water supply and irrigation purposes with avocados the main crop. The area of the Stuarts Point Groundwater Source has been updated since the

initial development of the plan as a result of improved mapping methods. The area now totals slightly more than 15 km².

Tomago Groundwater Source

The Tomago Groundwater Source is located between the Hunter River and Tilligerry Creek extending from: the Hunter River at Hexham and across to Williamtown in the south; to Raymond Terrace and across to Medowie on the southern margin of Grahamstown Dam in the north; and to Lemon Tree Passage in Port Stephens to the east.

The Tomago Groundwater Source is an exposed sand body of accumulated beach, dune and near-shore shelly sands overlying the Medowie Clay Member. There are a significant number of groundwater-dependent ecosystems in the area, including terrestrial vegetation and wetlands. The bulk of extraction is for the purpose of town water supply. The groundwater source is an important source in Hunter Water Corporation's municipal water supply scheme with the borefields located in the Tilligerry State Conservation Area which covers approximately 45 km^2. This area is closed to public access to insure the protection of extraction infrastructure and to maintain groundwater quality. Additionally the groundwater source is utilised for domestic extraction and provides important base flows to surface rivers, tidal creeks and tidal wetlands.

The area of the Tomago Groundwater Source has been updated since the initial development of the plan as a result of improved mapping methods. The area now totals approximately 183 km².

Tomaree Groundwater Source

The Tomaree Groundwater Source is a sand plain. It extends between: Tilligerry Creek and the coastline from the drainage complex of Bobs Farm Creek; Fenninghams Island Creek and Murrumburrimbah Swamp near Anna Bay in the south; and the mouth of Tilligerry Creek at Taylors Beach around the margin of Port Stephens to Tomaree Head at Shoal Bay to the north.

The sand deposits are variable in thickness consisting of an upper layer of uniform dune sand 2-20 m thick overlying a lower layer commonly more than 40 m thick which is characterised by the localised presence of clay lenses, charcoal fragments and peat. The sand deposits are consistently underlain by a dark grey to black organic clay, presumed to be the Medowie Clay Member.

Approximately a third of the groundwater source is covered by Tomaree National Park. There are a number of groundwater-dependent ecosystems in the area, including terrestrial vegetation and wetlands. The groundwater source also provides important base flows to rivers and tidal creeks.This groundwater source is critical to the town water supply for the Tomaree Peninsula. Extraction for domestic purposes is also common.

The area of the Tomaree Groundwater Source has been updated since the initial development of the plan as a result of improved mapping methods. The area now totals approximately 62 km².

Groundwater studies and information

Bell and Driscoll (2006a and 2006b) completed an extensive study of the Tomago and Tomaree groundwater sources, identifying vegetation types and then determining their level of groundwater dependence. The study was to inform management decisions relating to water extraction with a view to minimising impacts on biodiversity. The study concluded that 80% of the vegetation in Tomago had some level of dependency on groundwater and in the Tomaree aquifer around 50% of the vegetation had some level of groundwater dependence.

Numerous vegetation communities that were identified in the Tomago and Tomaree groundwater sources were not present in comparative landscapes between Taree and Lennox Head, nor in the Myall Lakes region. This suggests that these communities are endemic to the Tomago and Tomaree sand deposits and should be regarded as regionally significant (Bell and Driscoll 2006a).

Adams *et al* (2011) looked at the impacts of groundwater extraction on vegetation associated with coastal sands aquifers including the Tomago sand aquifer, and sand aquifers around Tea Gardens and South West Rocks. The study estimated evapotranspiration rates for vegetation communities relative to groundwater pumping locations, and compared this to evapotranspiration rates for similar communities outside the extraction zone. Results showed reduced evapotranspiration rates in vegetation communities close to groundwater pumps within a large proportion of the vegetation communities.

Punthakey and Woolley (2012) examined the management of the Macleay Coastal Sands aquifer. Modelling showed that current levels of extraction for average, low and high rainfall conditions are not having a significant impact on the level of the water table as the water levels in the aquifer respond rapidly to rainfall recharge. However, modelling showed that if production bores were operating at 100% of allocation there was likely to be a significant decline in the watertable. Pumping at these rates would result in lowering of water levels in the upper Macleay aquifer and, in certain areas, the drying out of the aquifer in the vicinity of major production bores. Significant impacts on groundwater-dependent ecosystems (GDEs) could also be expected at full production levels.

Sinclair Knight Merz has summarised the pertinent findings of recent groundwater studies in a report to the National Water Commission (NWC) as part of the NWC Coastal Groundwater Dependent Ecosystem Project (SKM 2012). The report reviews a range of technical reports that have analysed aspects of the coastal GDE environment including:

- the application of spatial geophysics to assist in identifying terrestrial GDEs;
- scientific techniques to understand plant water relations in groundwater-dependent species;
- groundwater modelling to assess pumping induced watertable drawdown and the implications for aquifer salinisation; and
- methods for site selection and construction of observation bores to provide early warning data on the advance of the freshwater/salt water interface.

In 2013, GeoScience Australia conducted a national review of the vulnerability of different groundwater aquifers to seawater intrusion (Ivkovic et al 2013). Coastal sand aquifers were found to be particularly vulnerable to excessive pumping due to the low amounts of groundwater storage relative to rainfall recharge. This therefore makes them vulnerable to vertical or lateral seawater intrusion. The assessment included coastal sand aquifers at Hat Head (Macleay Coastal Sands Groundwater Source), Stuarts Point Groundwater Source and the Tomago, Tomaree, Stockton groundwater sources and made the following conclusions:

- Pumping within the Hat Head area had not created a decline in water level in any part of the aquifer, however some of the deep bores do have higher salinities and ionic ratios suggesting a risk of seawater intrusion resulting from high extractions (Woolley 2011).
- Water has migrated southward through the Tomago, Tomaree, and Stockton sand beds from Tilligerry Creek, probably as a result of an extensive drainage network on the southern banks of the estuary, however, there has been no increase in salinity observed at the seaward coastline (SKM 2012).
- There is clear evidence of seawater intrusion at Stuarts Point based on observed salinity increases however the cause is unclear (drought, extraction or both?). Modelling of the Stuarts Point aquifer (SKM 2012) showed that based on an extraction rate of 60 ML/day for 100 years, the saline TDS concentrations could potentially reach 1000 mg/L in less than 20 years - a level unfit for human and animal consumption and detrimental to

groundwater-dependent ecosystems. Sea level rise and changes in the seasonal rainfall pattern were found to have little impact on the salt water intrusion compared to changes induced by groundwater extraction.

A study is currently being conducted in the Tomago and Tomaree groundwater sources investigating the impacts of groundwater extraction on the ecophysiology of Australian trees. The study is being conducted by Professor Derek Eamus, in collaboration with industry partners Hunter Water Corporation, Mid Coast Water and DPI Water. The study aims to identify suitable early warning indicators of water stress which will support the adaptive management of sustainable groundwater extraction. The results will provide information on a safe limit to groundwater extraction without negative impacts on GDEs, which will assist in defining where a cease-to-pump level should be set.

DPI Water monitors groundwater level and quality through its network of groundwater observation bores across NSW. This includes telemetered bores at Stuarts Point for which data is available on a daily basis, and a number of other bores throughout the region which are monitored manually.

Aboriginal heritage and values

The high diversity and abundance of natural resources available to the Aboriginal people of the NSW north coast resulted in a high density of Aboriginal occupation, particularly around the northern rivers. The marine environment and the lush vegetation along the coast provided the people with much of what they needed to subsist. To supplement what the sea provided, birds, bats and land mammals were caught while ferns, fruits and wild spinach added vitamins (Hoskins 2013).

Six different Aboriginal nations occupied the NSW north coast prior to European settlement.

The Tweed and Northern Rivers region is the traditional home of the **Bundjalung** Nation. The Byron Bay area has a number of coastal sites that are significant to the local Arakwal tribe. Currenba (Palm Valley) was a special meeting place where tribes camped by the natural channels in the valley and ate pipis, fish and other sea foods. The surviving midden and campsite at Palm Valley is the oldest in the region, being around 1500 years old. Cumbebin Swamp (connected to Belongil estuary) is another important site for hunting and gathering. Men would catch birds, eels, turtles and snakes while women would gather bush tucker, ferns for basket weaving and paperbark to build their homes (Arakwal people of Byron Bay 2011).

The **Gumbaynggirr** nation stretches from the Nambucca River in the south to the Clarence River in the north and west to the Great Dividing Range. Historic recollections indicate that there was at least some seasonal movement in any given year. Coastal visits occurred in late autumn and early winter when the mullet were running and lily-pilly trees were fruiting.

The areas around Boambee and Bonville Creeks were especially rich sources of food providing pigeons from the forest, fish and oysters from the streams and pipis from the beach (Yeates 1990). North of Woolgoolga the Arrawarra Headland is an area where traditional knowledge of ceremonial places is passed down. It includes stone fish traps and associated rock platforms which are used for collecting shellfish and other marine resources. The fish traps are still used for special occasions and fishing remains an integral part of the Gumbaynggir way of life (NSW Marine Parks Authority 2006).

The Macleay Valley is the heartland of the **Dunghutti** people. Significant sites remain in the Macleay Valley including middens and a fish trap in Limeburners Creek Nature Reserve and a Bora Ring north of Crescent Head. In the Clybucca area there are ancient camp sites up to 11,000 years old with shell mounds up to two metres high. Within the valley various stone implements have been found, as well as spears, boomerangs, shields, digging sticks, and water and food carriers (Kempsey Shire Council 2005).

The **Biripi** (or Birpai) people lived in settled villages along the rivers and lakes of the Hastings and Manning regions. They camped in substantial huts of timber and bark which were able to accommodate 8-10 people. Their environs were rich in seafood and bush foods and they had an intimate knowledge of the coastal forests. Some descendants suggest that there was an annual cycle of movement from the river flats and coast during the summer to the upper catchments and mountain ranges in the winter. Around Easter time the Biripi waited for schools of mullet to move into the rivers by watching for changes in the wind which would bring the fish closer to shore (Mathews 2005).

The **Worimi** are the traditional owners of the Great Lakes and Port Stephens area between the Hunter and the Manning rivers. The landscape includes an abundance of Aboriginal cultural sites including burials, campsites and middens. Traditionally, the Worimi people used the beaches to travel between the northern and southern parts of their country. The area known as Stockton Bight has a special significance because it retains a large amount of cultural history. The Worimi people manage the Stockton Bight area (known as Worimi Conservation Lands) through a joint agreement with NSW National Parks and Wildlife Service (OEH 2014).

The **Awabakal** are the traditional owners of land from the Hunter River in the north to Tuggerah Lake in the south. The Awabakal were people of the coast, estuaries, lakes and wetlands, but also had an attachment to the rugged sandstone country of the Sugarloaf and Watagan Ranges. They lived on fishing and gathering of shellfish, as well as hunting animals and collecting fruits and tubers (Lake Macquarie City Council 2015a).

Belmont Lagoon is a place of cultural and spiritual significance being the site of a major annual corroboree and the subject of a traditional story about the formation of the lagoon (Lake Macquarie City Council 2015b). Jewells Swamp near Redhead provided a rich food source including emus, waterbirds, kangaroos, shellfish and fruit from the burrawang palms which were roasted and pounded. Middens in the area provide evidence of thousands of years of Aboriginal occupation (Lake Macquarie City Council 2015c).

European settlement and development of the North Coast

The North Coast was colonised by Europeans settlers over a period of about 60 years from 1800 to 1860. Settlement initially spread north from Sydney into the Hunter region, and later fanned out from an isolated prison settlement at Port Macquarie.

The presence of coal in the Hunter Valley was discovered in 1797 and the settlement of Newcastle was established at the mouth of the Hunter River in 1804. It operated as a penal colony for 20 years with prisoners employed in coal mining and timber cutting. The Hunter Valley was opened to free settlers in 1820 (HO and DUAP 1996).

In 1826 the Australian Agricultural Company established a settlement on the northern shore of Port Stephens. Initial agricultural pursuits included wheat, tobacco and cattle grazing. In 1833-34 the company exchanged the eastern section of their property for land on the Liverpool Plains, opening up the coastal land to private settlers as far north as the Hastings River (Great Lakes Shire Council 2007).

Around this time the cedar cutters who had been working the forests along the lower Hunter River turned their attention further north. They reached the Macleay valley in 1837, the Clarence in 1838 and the Richmond in 1842 (HO and DUAP 1996). The rivers provided easy transport for the logs and the first settlements developed along their banks including Tumblegum and Teranora on the Tweed, Ballina on the Richmond, and Grafton on the Clarence River.

Land around Port Macquarie was granted to free settlers in 1830 following closure of the penal station that had been established there in 1821. Settlement moved progressively northwards into the Clarence and Richmond valleys until 1845 when most of the fertile land along the northern rivers was occupied. Maize was one of the most commonly grown crops for self-sufficiency,

stock fodder and trade. The pastoral economy was initially based around sheep however by 1850 the high rainfall and incidence of footrot resulted in the emergence of the cattle industry in the region (HO and DUAP 1996).

Grazing and boat building industries commenced in the Myall Lakes area around 1840 and growth in the timber industry encouraged rapid development of the Myall valley after 1860. A second wave of settlement occurred along the Great Lakes coast as the search for agricultural land spread south from the Manning River (Great Lakes Shire Council 2007).

The North Coast opened up to large scale agricultural development following land reforms in 1861 that allowed selection of holdings up to 320 acres. A variety of tropical crops were tried without success including mangoes, tobacco, cotton and rice (HO and DUAP 1996). The only tropical crop which proved successful was sugarcane which became established as a major industry in the Clarence, Richmond and Tweed valleys. In the 1880s dairying emerged as an alternative industry that was climatically more robust than sugarcane. Dairy factories and creameries sprang up throughout the coastal valleys to process the milk supplies and dairying remains an important agricultural industry today.

Current land use and community profile

The plan area supports a wide range of land uses including beef cattle grazing, dairying, horticulture, turf production, forestry, fishing, tourism and recreation. Commercial and tourism development dominate the coastal fringe particularly on the Far North Coast. Large areas of the hinterland and coastline are conserved in National Parks and conservation areas and many of the high environmental value areas associated with the coastal sand groundwater sources lay within these parks and reserves.

The North Coast is a popular location for retirees and people seeking an alternative “sea-change” or rural lifestyle. The population of the Far North Coast is expected to increase at a rate of 2400 people over the next 15 years (DoP 2006a) while the mid North Coast is expected to grow by 3700 people per year making this one of the fastest growing regions in NSW (DoP 2009). The population is also ageing with the number of people aged 65 and over expected to double by 2031 (DoP 2006a, DoP 2009).

The population of the Hunter region is currently growing by 6400 people per year and this rate is expected to be maintained over the next 15 years. Population growth has been focussed on the coastal areas, particularly Newcastle, Lake Macquarie and Port Stephens, with people attracted by the combination of economic opportunity, affordability and the lifestyle benefits of the surrounding rural and coastal landscapes (DoP 2006b).

The largest employment sectors for people of the North Coast are education, health, and social services. Other important employment sectors include retail, hospitality, construction, manufacturing and tourism. Less than five percent of the population are employed in agriculture, forestry and fishing (ABS 2011).

Climate

The North Coast of NSW experiences a warm sub-tropical climate. Rainfall is highest during the summer and autumn months between December and June. The pattern of summer dominance is strongest in the north with less variation in monthly rainfall obvious in the Hunter and Central Coast. Average annual rainfall also increases northwards, ranging from 1300 mm at Gosford to 1100 mm at Newcastle to 1400 mm at Port Macquarie and 1700 mm at Coffs Harbour, Ballina and Tweed Heads.

Summers are warm to hot with maximum average temperatures ranging from 26°C in the south to 28°C in the north for January. Winters are mild with maximum average temperatures of 16°C in the south and 19°C in the north for July.

Entitlement and water use

There are approximately 404 groundwater licences in the plan area, totalling 52,123.5 ML/year of entitlement (see Table 2). The majority of licences are used for domestic and town water supply purposes (see following section). There is some limited irrigation use. Detailed water use is not available in these groundwater sources. NSW is exploring this issue through the Water Use Monitoring Program.

Table 2: Total entitlement, number of licences and key uses by groundwater source

Groundwater Source	Entitlement (ML/year)	Number of licences	Key uses
Bellinger–Nambucca Coastal Sands	86	7	Domestic
Clarence Coastal Sands	76	7	Domestic
Coffs Harbour Coastal Sands	115	13	Domestic
Great Lakes Coastal Sands	2204	34	Town water supply, domestic
Hastings Coastal Sands	1143	32	Domestic, irrigation
Hawkesbury to Hunter Coastal Sands	7680	103	Town water supply, domestic
Macleay Coastal Sands	3333	7	Town water supply, domestic
Manning–Camden Haven Coastal Sands	191	11	Domestic
Richmond Coastal Sands	1335	53	Town water supply, domestic
Stockton	1008.5	30	Sand mining, domestic and irrigation
Stuarts Point	3735	25	Domestic, irrigation, town water supply
Tomago	26,090	17	Town water supply, domestic
Tomaree	4582	19	Town water supply, domestic
Tweed–Brunswick Coastal Sands	545	46	Domestic
Total	**52,123.5**	**404**	

Local water utility requirements

Five water utilities hold entitlements for the coastal sand aquifers as shown in Table 3. Further details on each of these water supply schemes are provided below.

Table 3: Town water supplies, groundwater source entitlement volume and towns supplied

Water supplier	Groundwater source	Entitlement (ML/yr)
Gosford Council	Hawkesbury to Hunter Coastal Sands	1325
Hunter Water Corporation	Tomago	25,300
	Tomaree	3700
Mid Coast Water	Great Lakes Coastal Sands	1460
Macleay Water (Kempsey Shire Council)	Stuarts Point	300
	Macleay Coastal Sands	3312
Rous Water	Richmond Coastal Sands	630

Gosford Council

Gosford Shire Council manages a borefield at Woy Woy in the Hawkesbury to Hunter Coastal Sands Groundwater Source to supply the Woy Woy Peninsular. The Woy Woy treatment plant was built in 2007 as an emergency water supply during drought. It treats water extracted from the bore field and can supply up to five million litres per day to residents (Gosford City Council and Wyong Shire Council 2013).

Hunter Water Corporation

Hunter Water Corporation provides drinking water to over half a million people in the Lower Hunter region. Part of this supply is accessed from the Tomago and Tomaree ground water sources.

The Tomago sandbeds provide about 20 per cent of the Lower Hunter's drinking water. An extensive network of bores and vacuum stations draws groundwater from the sandbeds and pumps it to Grahamstown Water Treatment Plant. The sandbeds are strategically important for both ongoing and backup water supply in times of drought or water quality issues in the dams. After treatment, water is piped to consumers in Newcastle and the Lower Hunter regions. A smaller volume of water is extracted and treated by the Lemon Tree Passage Water Treatment Plant and piped to Karuah, Lemon Tree Passage and Tanilba Bay (Hunter Water 2011a).

Hunter Water also maintains 21 bores within the Tomaree sandbeds, which make up the Tomaree Groundwater Source. The groundwater is treated at the Anna Bay and Glovers Hill Water Treatment Plants which have the capacity to treat and deliver up to 12 ML/d. Water quality is very high so the bore water only requires minimal treatment (Hunter Water 2011b). The Tomaree sandbeds are the primary water source for the Tomaree Peninsula which includes the towns of Nelsons Bay, Fingal Bay and Anna Bay.

Mid Coast Water

Mid Coast water provides Tea Gardens and Hawks Nest residents with groundwater from a borefield in the Great Lakes Coastal Sands Groundwater Source. The borefield was developed in 1962, and has been expanded and upgraded several times, the most recent being the construction of a new water treatment plant (Mid Coast Water 2015).

MidCoast Water is planning to develop a new borefield south east of Nabiac which will be serviced by a new water treatment plant. This borefield is also located within the Great Lakes Coastal Sands Groundwater Source. This plant will transfer water into the existing Manning scheme to reduce the volume of water extracted from the Manning River. Some infrastructure has already been constructed, including much of the borefield works.

Macleay Water

Groundwater is an important water supply for Kempsey Shire Council. All coastal towns within the shire are supplied by groundwater from the Macleay Coastal Sands Groundwater Source (Kempsey Shire Council 2006).

These groundwater supplies include:

- Crescent Head water supply – 3 bores at Maguires Crossing
- Hat Head water supply – 3 bores in Hat Head National Park
- South West Rocks water supply – 12 bores in Hat Head National Park
- Stuarts Point water supply – 3 bores in Fishermans Bend Nature Reserve

The Hat Head, Crescent Head and South West Rocks bores are all located within national parks that support groundwater-dependent ecosystems.

Rous Water

Rous Water extracts groundwater from the coastal sands at Woodburn near Ballina in the Richmond Coastal Sands Groundwater Source. These bores are currently only used during drought periods.

As part of its long-term water strategy, Rous Water is assessing this borefield to determine whether it should be maintained, or upgraded or in fact replaced with better located and more productive bores. Investigations into new bore sites will be both the Richmond and Tweed-Brunswick Coastal Sands groundwater sources and will include exploratory drilling and testing, and environmental assessment including sustainability of supply, effects on local groundwater levels and implications for groundwater-dependant ecosystems (Rous Water 2015).

The process of developing the water sharing plan

This section describes the interagency panels and outlines the process of developing the *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* including the risks and values classification, refining the indicative rules, and the specific outcomes of panel deliberations, targeted consultation and public exhibition.

DPI Water is responsible for implementing the WMA 2000, including developing water sharing plans for the state's water resources. DPI Water established interagency panels to assist with the development of water planning policies and water sharing plans. The role of each of these panels is discussed below.

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* was initially prepared based on:

- the indicative rules generated by a risk and values classification (explained later);
- the deliberations of the DPI Water Working Group and the Interagency Regional Panel; and
- feedback from stakeholders during targeted consultation.

The draft plan was then publicly exhibited throughout the plan area. Feedback received during the public exhibition period was considered by the DPI Water Working Group and the Interagency Regional Panel in finalising the plan.

Full details of the macro-planning approach and the classification method can be found in *Macro water sharing plans – the approach for groundwater. A report to assist community consultation.* This document is available on the DPI Water website www.water.nsw.gov.au

Role of the technical and interagency panels

The preparation of the plan was guided by three panels:

- the State Groundwater Panel;
- the North Coast Coastal Sands Working Group; and
- the North Coast Interagency Regional Panel.

State Groundwater Panel

The State Groundwater Panel provided a senior level forum for discussing and resolving a wide range of water planning and policy issues specific to groundwater. While no longer functional, the State Groundwater Panel played a major role in the development of the groundwater manual: *Macro water sharing plans – the approach for groundwater. A report to assist community consultation.* The State Groundwater Panel was also responsible for developing the state-wide set back distance rules for water supply works approval, as well as the default rules for the percentage total extraction in the risk assessment process.

The panel was chaired by DPI Water and had representatives from the Office of Environment and Heritage (OEH), DPI Agriculture and DPI Fisheries.

North Coast Coastal Sands Working Group

The North Coast Coastal Sands Working Group (the Working Group) comprises a range of officers representing the various functions of DPI Water such as planning and policy development, licensing and compliance, hydrogeology, hydrometrics and environmental protection. The Working Group was responsible for collating information and developing recommendations to be considered by the Interagency Regional Panel.

North Coast Interagency Regional Panel

Interagency Regional Panels were established across NSW to develop water sharing plans. The North Coast Interagency Regional Panel (NCIRP) comprises representatives from DPI Water, OEH, DPI Agriculture and the North Coast Local Land Services (previously Northern Rivers Catchment Management Authority) as an observer.

The key responsibilities of the Regional Panel are to:

- ensure water sharing rules are consistent with state policy;
- review the water management units provided by DPI Water;
- assign economic, social and environmental values and undertake risk and value assessments to classify each groundwater source;
- review existing and generic water sharing rules as to their applicability, appropriateness, and potential impacts and benefits;
- review future water estimates to inform extraction limits;
- make recommendations on the water access and dealing (trading) rules for each groundwater source; and
- review submissions from targeted consultation and public exhibition and make necessary amendments.

The Regional Panel used local knowledge and expertise in developing and recommending the water sharing rules through a consensus decision-making approach.

Along with the State Groundwater Panel, the Regional Panel played a significant role in relation to the new method for determining the long-term average annual extraction limit that was used in this plan (see section on methods for establishing limits to extraction).

The names of the Regional Panel representatives and their areas of expertise, and relevant support staff who provided specific technical and scientific information to the panel are provided in Appendix 11: Interagency Regional Panel and support staff.

Consultation and public exhibition

During the development of water sharing plans the risk assessments, proposed extraction limits and recommended rules may undergo targeted consultation with water users and specific interest groups before the plan is drafted. Targeted consultation refers to informal consultation held with key stakeholders to test the suitability of the proposed water sharing rules and obtain feedback on the rule's potential impacts. Targeted consultation with Hunter Water Corporation was undertaken during the development of this plan due to the large proportion of entitlement held in the Tomago and Tomaree groundwater sources. Targeted consultation was also undertaken with licence holders in the Stuarts Point Groundwater Source to ensure users were well informed about any proposed plan changes.

Public exhibition of draft water sharing plans provide an opportunity for wider public consultation. Public exhibition is the formal exhibition of a draft water sharing plan where the Minister invites submissions on the draft plan and in particular will seek comment on a range of key issues.

DPI Water managed the public consultation process and ensured that all stakeholders and interested parties had opportunity to examine and comment on the proposed water sharing rules. In particular, DPI Water encouraged stakeholders to provide:

- local knowledge and expertise, for example, there may be other natural or socio-economic values that have not yet been considered by the Regional Panel;
- feedback on the practical elements of the proposed water sharing rules to ensure they are easily implemented by the licence holders;

- confirmation that there are no unintended outcomes from the plan; and
- specific comments on the Minister's notes included in the draft water sharing plan.

Public exhibition of the draft plan was held in the plan area from 8 January 2016 to 22 February 2016. Key documents were displayed at 11 locations, four information sessions were held for councils and local water utilities, one-on-one consultation sessions were offered in Ballina, Nambucca, Taree and Erina and a public meeting was held in Stuarts Point.

The objectives of this consultation were to:

- provide information to stakeholders as to why the plan was being developed, how it had been developed to date, what rules were proposed in the various areas and how stakeholders could provide feedback;
- formally consult with a broad range of stakeholders to explain the proposed water sharing rules and how they will be implemented; and
- seek feedback from stakeholders and the general community about the proposed water sharing rules.

Submissions were required to be made in writing and submitted prior to the exhibition closing date. Comments and enquiries made at the public meetings were noted. A total of 17 submissions were received. A summary of the key issues raised and the response can be seen in Appendix 2: Summary of key issues raised during public exhibition and response.

Methods for establishing limits to extraction

Development of the extraction limit for the new groundwater sources in the plan is based on the calculation of a number of key components including groundwater recharge, risk assessments, planned environmental water, current and future water requirements. In the replacement groundwater sources, an extraction limit has already been in place for 10 years. The following section outlines the methodology used to determine the limit on extraction for each groundwater source within the plan.

Groundwater recharge

Recharge is the volume of water that infiltrates into an aquifer each year. In the macro planning method for less highly-connected groundwater sources which includes the coastal sands, only recharge from rainfall is considered when determining extraction limits. The rainfall recharge calculation is the basis for determining the volume of groundwater reserved as planned environmental water and the volume that is potentially available for extraction.

When calculating recharge, the following equation is used:

> Average Annual Rainfall Recharge (ML/yr) = Groundwater source area (km^2) x mean rainfall (mm/yr) x % Infiltration rate / 100

In the new groundwater sources recharge is calculated for both high environmental value areas and non-high environmental value areas. High environmental value areas include national parks, nature reserves, historic sites, Aboriginal sites, State conservation areas and karst conservation areas.

When the water sharing plans for the Stuarts Point and Tomago Tomaree Stockton groundwater sources were originally developed, recharge was calculated for the groundwater source as a whole area rather than being divided into high environmental value and non-high environmental value areas. Due to management arrangements having been in place for 10 years, it was determined that only the data inputs to the recharge calculation, e.g. rainfall, be updated where new information was available.

Estimating recharge for an entire groundwater source is not an exact science due to variations in geology, rainfall distribution and sources of recharge. Consequently, DPI Water has taken a precautionary approach to calculating recharge. In addition DPI Water's policy is that in all coastal sands groundwater sources, recharge volumes are rounded to two significant figures. For example 213,820 ML/year is rounded down to 210,000 ML/year and 8,787 ML/year is rounded up to 8,800 ML/year.

An estimate of average annual rainfall recharge for each of the North Coast Coastal Sands groundwater sources is shown in Table 4.

Full details of recharge calculations are provided in Appendix 3A: Recharge calculations for the new groundwater sources.

Table 4: Average annual rainfall recharge for all coastal sands groundwater sources

Groundwater source	Estimated recharge in high environmental areas (ML/yr)	Estimated recharge in non-high environmental areas (ML/yr)	Total recharge in groundwater source (ML/yr)
Bellinger–Nambucca Coastal Sands	2500	21,000	23,500
Clarence Coastal Sands	110,000	81,000	191,000
Coffs Harbour Coastal Sands	7200	11,000	18,200
Great Lakes Coastal Sands	83,000	78,000	161,000
Hastings Coastal Sands	39,000	63,000	102,000
Hawkesbury to Hunter Coastal Sands	8,900	40,000	48,900
Macleay Coastal Sands	31,000	39,000	70,000
Manning–Camden Haven Coastal Sands	42,000	56,000	98,000
Richmond Coastal Sands	28,000	190,000	218,000
Tweed–Brunswick Coastal Sands	15,000	84,000	99,000
Stockton	n/a	n/a	21,000
Stuarts Point	n/a	n/a	7600
Tomago	n/a	n/a	36,000
Tomaree	n/a	n/a	10,000

Recharge volumes for replacement groundwater sources

Since the development of the first round of water sharing plans the method for calculating recharge has been reviewed. DPI Water has acquired new rainfall data, new information to inform infiltration rates and new methods for calculating area. Rainfall figures were sourced from the Bureau of Meteorology (BOM) model which uses 1900-2011 average annual rainfall data from their monitoring sites. The data resolution is approximately 5km^2.

Tomago, Tomaree, and Stockton groundwater sources

A number of site-specific recharge studies have been completed on the Tomago and Tomaree groundwater sources (Bish and Ross, 2001; Crosbie, 2003; and Woolley, et al 1995). This information supports an infiltration rate of 25% for the Tomago Groundwater Source and 20% in the Tomaree Groundwater Source.

An estimate of 22% was used in the 2004 Plan for Stockton. This is similar to the range of infiltration rates from the relevant recharge studies for the adjoining Tomago and Tomaree groundwater sources. While the site-specific studies have not focused on the Stockton Groundwater Source, there was no justification for changing the infiltration rate from the 2004 estimate.

Stuarts Point Groundwater Source

Submissions received during the public exhibition period of the plan suggested that the rainfall figures produced by the BOM model was not appropriate for the Stuarts Point Groundwater Source as it didn't reflect local conditions. In response to submissions, DPI Water has used

rainfall data from the Smokey Cape and Fishermans Reach rainfall stations to inform groundwater recharge calculations for the Stuarts Point Groundwater Source.

Full details of the recharge calculations for the replacement areas can be found in Appendix 3: Recharge calculations for groundwater sources.

New groundwater source risk assessment and ratings

The groundwater macro planning risk assessment process has been used to determine the risk ratings for each new groundwater source in the plan and is described in *Macro water sharing plans – the approach for groundwater. A report to assist community consultation*[4]. This process is used as the starting point for determining the limit on extraction for each groundwater source (the Long Term Average Annual Extraction Limit - LTAAEL).

It should be noted that this risk assessment process has only been completed for new groundwater sources. As this process is used to determine the LTAAEL it was not applied to the replacement groundwater sources which already have LTAAELs that were set during the initial development of the plans (pre 2004). As the risk assessment process was not available at the time, the stakeholder committee responsible for the development of water sharing plans used a different process to account for risk.

The macro approach is a relative risk-based approach based on best available information. The process generates a sustainability index for new each groundwater source which sets the limit of extraction. The process determines 'high', 'moderate' and 'low' levels of aquifer and socioeconomic risk. This approach identifies a range of values and risks, indicating where the optimal balance might be between extraction in an aquifer and preservation of groundwater recharge to meet environmental needs. In some areas, high value natural assets need strong protection; in others there is a high level of socio-economic dependence on groundwater for extraction.

Environmental values were weighed against the socio-economic dependence, and consideration was given to any actions that could be taken to mitigate the risk to the environmental values. The aquifer risk (environmental) assessment considers the risk that groundwater extraction places on the groundwater source and its high priority groundwater-dependent ecosystems (GDEs) and identifies risks to ecological, water quality and aquifer integrity assets. The socio-economic risk assessment looks at the dependence of local communities on groundwater extraction in terms of the risk to financial and sociological assets.

From these assessments, a risk rating is determined which is equal to the highest rating attained for any one criterion. Consideration was given to mitigation measures that can be applied through rules in the water sharing plan to reduce the impact of extraction on a groundwater source. For example, a groundwater source which is at high environmental risk may have its risk reduced to medium if the effect of extraction can be successfully mitigated. None of the groundwater sources in the plan had mitigation measures applied due to the relatively low initial risks.

The risk ratings (high, moderate or low) are then charted on a matrix (as shown in Table 5) which then indicates the sustainability index for that groundwater source. The sustainability index determines the percentage of recharge in non-high environmental areas that can be used for extraction in a specific groundwater source. For example, if a groundwater source has a sustainability index of 25%, then 25% of the recharge occurring in non-high environmental value areas may be made available for extraction, thus the remaining 75% of recharge is reserved for the environment. The percentage of recharge available for extraction in high environmental areas is a standard 5% for all new groundwater sources.

[4] This report is available for viewing or downloading from the DPI Water website at www.water.nsw.gov.au

Table 5: Sustainability index matrix

Aquifer Risk	**High**	5%	25%	50%
	Medium	25%	50%	60%
	Low	50%	60%	70%
		Low	**Medium**	**High**
		Socio-Economic Risk		

The results of the risk assessments for each of the new groundwater sources are shown in Table 6. More detail on the considerations informing the risk assessments for the new groundwater sources can be found in Appendix 4: Risk assessments.

Table 6: Risk ratings for all new groundwater sources

Groundwater source	Risk rating socio economic	Risk rating aquifer risk	Sustainability index
Bellinger–Nambucca Coastal Sands	Low	High	5%
Clarence Coastal Sands	Low	High	5%
Coffs Harbour Coastal Sands	Moderate	High	25%
Great Lakes Coastal Sands	Moderate	High	25%
Hastings Coastal Sands	Moderate	High	25%
Hawkesbury to Hunter Coastal Sands	High	High	50%
Macleay Coastal Sands	Moderate	High	25%
Manning–Camden Haven Coastal Sands	Moderate	High	25%
Richmond Coastal Sands	Moderate	High	25%
Tweed–Brunswick Coastal Sands	Moderate	High	25%

Managing extraction

At the completion of the risk assessment process it became apparent that in many groundwater sources, current levels of water requirements made up a very small proportion of the total water available for extraction (LTAAEL). A similar situation became apparent when determining the LTAAELs for the fractured and porous rock groundwater sources on the north coast.

This circumstance raised concerns that the significant volumes of ‘spare water’ may raise community expectations that large amounts of water will be released in the future. In addition, although the recharge calculations are based on the most up to date data, the calculations assume homogeneity in aquifer geology and rainfall across the groundwater source. Given the absence of detailed recharge studies it was determined by DPI Water that the current recharge figures should be treated with caution.

Therefore, a revised approach for determining the LTAAEL was devised to address these concerns, which was endorsed by the State Groundwater Panel. This process was applied to all new groundwater sources in coastal NSW (excluding upland alluvial aquifers).

The new process involved taking the LTAAEL ascertained by the risk assessment process and then determining whether or not a more conservative volume could be set as the LTAAEL whilst ensuring that future water requirements will be met. In this process the LTAAEL can be increased in the future to the higher volume as ascertained by the risk assessment method (referred to as the upper extraction limit).

Upper extraction limit

The upper extraction limit (UEL) is determined by summing the percentage of recharge potentially available for extraction generated over non-high environmental value areas (based on the sustainability index) and the percentage of recharge potentially available for extraction generated over high environmental value areas (5% for coastal sands).The upper extraction limits for the new groundwater sources are shown in Table 7.

Long-term average annual extraction limit for new groundwater sources

As endorsed by the State Groundwater Panel, the new method for determining the LTAAEL for the new coastal sands groundwater sources takes into consideration current water requirements plus estimated future water requirements and compares this with the upper extraction limit.

Table 7: Upper extraction limit for new groundwater sources

Groundwater source	Water available for extraction from high environmental value areas (ML/yr)	Water available for extraction from non-high environmental value areas (ML/yr)	Upper Extraction Limit (ML/yr)
Bellinger–Nambucca Coastal Sands	2,500	21,000	1175
Clarence Coastal Sands	110,000	81,000	9550
Coffs Harbour Coastal Sands	7200	11,000	3110
Great Lakes Coastal Sands	83,000	78,000	23,650
Hastings Coastal Sands	39,000	63,000	17,700
Hawkesbury to Hunter Coastal Sands	8900	40,000	20,445
Macleay Coastal Sands	31,000	39,000	11,300
Manning–Camden Haven Coastal Sands	42,000	56,000	16,100
Richmond Coastal Sands	28,000	190,000	48,900
Tweed–Brunswick Coastal Sands	15,000	84,000	21,750

Upper extraction limit = Recharge for non-high environmental value area (ML/year) x sustainability index + Recharge for high environmental value area recharge* (ML/year) × 5%

Current requirements for water

The plan defines the current licensed entitlements for each groundwater source included in the plan area. In addition, basic landholder rights (comprising domestic and stock, and native title rights) must be provided for and protected within the plan.

The plan provides an estimate of the water requirements for domestic and stock rights within each groundwater source. Two methodologies for estimating the groundwater taken for domestic and stock purposes have been developed by DPI Water, taking into account different groundwater usage between coastal and inland regions and urban and rural areas.

The methods used for determining stock and domestic requirements are included in Appendix 3 of the document *Macro water sharing plans – the approach for groundwater. A report to assist community consultation.* This document is available on the DPI Water website www.water.nsw.gov.au.

The total current water requirements for each groundwater source at the plan's commencement are shown below in Table 8. It should be noted that the BLR volumes do not include volumes for Native Title rights due to the difficulty in predicting current use volumes.

Table 8: Current water requirements

Groundwater source	Basic landholder rights (ML/yr)[5]	Town water supply (ML/yr)	All other licensed entitlement (ML/yr)	Total requirements (ML/yr)
Bellinger–Nambucca Coastal Sands	19	0	86	105
Clarence Coastal Sands	74	0	76	150
Coffs Harbour Coastal Sands	13	0	115	128
Great Lakes Coastal Sands	41	1460	744	2245
Hastings Coastal Sands	26	0	1143	1169
Hawkesbury to Hunter Coastal Sands	25	1325	6355	7705
Macleay Coastal Sands	28	3312	21	3361
Manning–Camden Haven Coastal Sands	45	0	191	236
Richmond Coastal Sands	120	630	705	1455
Stockton	254	0	1008.5	1262.5
Stuarts Point	20	300	3435	3755
Tomago	421	25,300	790	26,511
Tomaree	433	3700	882	5015
Tweed–Brunswick Coastal Sands	168	0	545	713
TOTAL	**1687**	**36,027**	**16,096.5**	**53,810.5**

[5] These do not include volumes for Native Title rights

Future requirements for water

Estimated future water requirements are required in the calculation of the LTAAEL for the new groundwater sources. They are not required for replacement groundwater sources.

Information relating to future water requirements was collated for each new groundwater source. This included estimating volumes for:

- expected increases in BLR (associated with residential developments);
- dewatering associated with potential residential and commercial developments;
- future augmentation of town water supply;
- expected increases in agricultural water requirements; and
- possible future other large scale developments which may require water.

Basic landholder rights

To estimate the future requirements for basic landholder rights (BLR), water currently accessed under BLR is multiplied by projected population growth over the life of the plan. Population projections were estimated for each local government area and were based on information from the Department of Planning (2006a, 2006b, 2009). The key assumption for this methodology is that BLR requirements would increase proportionately to population growth. It should be noted that these do not include volumes for Native Title rights due to the difficulty in predicting future volumes. For details see Appendix 5. Estimated future BLR requirements for new groundwater sources.

Town water supplies

Future town water supply requirements have been determined using relevant strategic planning documents provided by local water utilities and in collaboration with urban water staff from DPI Water. Volumes estimated for groundwater sources were confirmed with local councils and local water utilities as part of the consultation process. Currently, the majority of coastal sands groundwater sources are not heavily developed for town water supply. This however, may change in the future with the ongoing population growth on the north coast of NSW and the diminishing options for other water supplies. For further information see Appendix 6. Estimated future town water supply requirements.

Dewatering

Dewatering Estimates for Future Residential and Commercial Developments

As groundwater in the coastal sands often occurs at shallow depths, dewatering is often required during and sometimes after construction of either residential or more commonly commercial developments. Dewatering activities associated with smaller developments usually involves extracting smaller volumes of water on a temporary basis during construction in order to create a stable, safe and trafficable environment. Small volumes of temporary dewatering are also commonly undertaken by councils for emergency works on water supply pipelines etc.

More substantial developments, for example during the construction phase of large buildings and underground car parks, usually involve the extraction of larger volumes of water to ensure the site is adequately dewatered. Recent examples based on metering estimates has shown that underground car parks, sewerage treatment plants and other major construction developments require allocations ranging typically from 100 to 500 ML/year.

DPI Water licensing and hydrogeology staff have provided estimated dewatering volumes based on their local knowledge of current and potential future development in each groundwater source.

Dewatering Estimates for Future Sand Mining Developments

Sand is mined on the north coast primarily for development purposes (raising ground levels of a future development area) rather than for mineral sands. Significant volumes of dewatering are associated with sand mining.

The majority of these sand mines which are operated for the delivery of fill sand create a window into the water table and produce a groundwater pond. The material sands require a significant amount of water for transportation via a pipeline and dredge water is recirculated as a return flow.

Based on the potential for significant development in the future, it is recommended that a significant allocation for future sand mining developments is required. The future dewatering requirements for sand mining have been estimated by DPI Water licensing and hydrology staff based on local knowledge of current and future potential for sand mining along the north coast.

Estimates for future dewatering for all new groundwater sources are shown in Appendix 7. Estimated future dewatering requirements for new groundwater sources

Agriculture

The use of coastal sands groundwater for agricultural purposes is minimal in most of the coastal sands groundwater sources. This is primarily due to the limited availability of agricultural land, large areas of National Parks and Nature Reserves, presence of groundwater-dependent ecosystems, and presence of potential acid sulfate soils. Given these limiting factors together with the unpredictable future fluctuations in the market, it is very difficult to estimate the future agricultural requirements. As a result, the future water requirements for agriculture have been estimated for each groundwater source by doubling the current level of entitlement associated with agricultural production. Estimates for future agricultural requirements for all new groundwater sources are shown in Appendix 8. Estimated future agricultural requirements for new groundwater sources

Future water estimates for all new groundwater sources are summarised in Table 9.

Table 9: Estimated future water requirements for new groundwater sources

Groundwater source	BLR (ML/yr)	Town water supply (ML/yr)	Residential/ commercial dewatering (ML/yr)	Sand mining dewatering (ML/yr)	Agriculture (ML/yr)	TOTAL (ML/yr)
Bellinger–Nambucca Coastal Sands	1	500	500	500	31	1532
Clarence Coastal Sands	4	0	2000	2000	52	4056
Coffs Harbour Coastal Sands	2	0	2000	1000	42	3044
Great Lakes Coastal Sands	6	5000	3000	5000	508	13,514
Hastings Coastal Sands	3	0	2000	3000	927	5930
Hawkesbury to Hunter Coastal Sands	3	0	10,000	5000	208	15,211
Macleay Coastal Sands	1	1000	1000	5000	18	7019
Manning–Camden Haven Coastal Sands	4	0	1000	2000	40	3044
Richmond Coastal Sands	9	10,000	2000	5000	373	17,382
Tweed–Brunswick Coastal Sands	30	10,000	3000	5000	311	18,341

Although estimates are made for each category this does not mean that this category is restricted by the volume assigned to it. For example, during the term of the plan agricultural water requirements may be substantially higher than the volume anticipated whereas water requirements for dewatering activities may be less. Overall, the purpose of these estimates is to determine a more realistic LTAAEL for each new groundwater source whilst providing for growth in industries/water supplies.

Final long-term average annual extraction limits for new groundwater sources

The final determination of the LTAAEL is based on the following method:

1. If the volume of current requirements + future requirements < 10% of the UEL, then LTAAEL = 10% of UEL
2. If the volume of current requirements + future requirements > 10% of the UEL, then LTAAEL = volume of current requirements + future requirements
3. If the volume of current requirements + future requirements > UEL, then LTAAEL = UEL

If the LTAAEL is less than the UEL (scenarios 1 or 2 above), an amendment provision is included in the plan to allow the LTAAEL for that groundwater source to be increased up to the UEL in the event that more water is required. The estimates for future requirements are regarded as being generous, thus the likelihood that an increase would be required is minimal. For an amendment to occur sufficient evidence in the form of development applications, new socio-economic information or other growth indicators would be required to warrant an increase in the LTAAEL.

The LTAAEL and UEL values are shown in Table 10 for each new groundwater source. Given that the future water requirements are an 'estimate' the volumes for current plus future water requirements have been rounded to two significant figures.

Table 10: Final LTAAEL and UEL volumes for the new groundwater sources.

Groundwater source	Current + future (ML/yr)	10% of UEL (ML/yr)	UEL (ML/yr)	Final LTAAEL	Comment on final LTAAEL
Bellinger–Nambucca Coastal Sands	1637	117.5	1175	1175	= UEL
Clarence Coastal Sands	4206	955	9550	4200	= current +future (rounded)
Coffs Harbour Coastal Sands	3172	311	3110	3110	= UEL
Great Lakes Coastal Sands	15,759	2365	23,650	16,000	= current +future (rounded)
Hastings Coastal Sands	7099	1770	17,700	7100	=current +future (rounded)
Hawkesbury to Hunter Coastal Sands	22,916	2044.5	20,445	20,445	= UEL
Macleay Coastal Sands	10,380	1130	11,300	11,300	= UEL
Manning–Camden Haven Coastal Sands	3280	1610	16,100	3300	= current +future (rounded)
Richmond Coastal Sands	18,837	4890	48,900	19,000	= current +future (rounded)
Tweed–Brunswick Coastal Sands	19,054	2175	21,750	19,000	= current +future (rounded)

LTAAEL volumes in the replacement groundwater sources

The current process for establishing the long-term average annual extraction limit (LTAAEL) for groundwater sources has changed significantly since the first round of water sharing plans commenced. Setting the LTAAEL in the first round of plans was the subject of considerable debate among interagency panels/committees and often relied heavily on local knowledge.

DPI Water's policy, as supported by the Minister, was to replace these plans with 'minimal change'. Minimal change maintains the intent of the plans, while incorporating common datasets. This ensures minimum risk of impact to users and the environment.

In line with the 'minimum change' approach, the LTAAELs for the Tomago, Tomaree and Stockton groundwater sources remain unchanged. However, the LTAAEL for the Stuarts Point Groundwater Source has been revised since the 2004 plan.

The revision of this LTAAEL was prompted by the Stuarts Point water users who during public exhibition requested that the rainfall estimate be revised. Water users suggested that local rainfall data should be used to inform the recharge estimate as they believed that the modelled rainfall data was not appropriate and did not reflect local conditions. DPI Water reviewed the appropriateness of the modelled rainfall data for the Stuarts Point Groundwater Source and recommended that the rainfall records from the local rainfall stations (Smokey Cape and Fishermans Reach) be used as they are a more accurate reflection of conditions in the local area. The North Coast Interagency Regional Panel (IRP) supported this recommendation which resulted in a larger recharge estimate than that in the 2004 water sharing plan. The IRP recommended that the additional water be shared between the environment and water users, which resulted in an increase to the LTAAEL from the 2004 water sharing plan. The final LTAAEL volumes for the replacement groundwater sources are shown in Table 11.

Table 11: Final LTAAEL for the replacement groundwater sources.

Groundwater source	Final LTAAEL
Stockton	14,000
Stuarts point	4180
Tomago	25,000
Tomaree	6000

Identification of high priority groundwater-dependent ecosystems

Groundwater-dependent ecosystems (GDEs) are ecosystems which have their species composition and natural ecological processes determined to some extent by the availability of groundwater. GDEs can include cave systems (karsts), springs, wetlands and groundwater-dependent endangered ecological communities.

GDE are identified through a desktop exercise assembling all known records of GDEs and includes interrogating known data bases, GIS records and other studies followed by the identification of the high priority GDEs. This is undertaken by an interagency group with staff from the Office of Environment and Heritage (OEH) and DPI Water. This is equivalent to Step 1 and Step 2 set out in the 'Rapid Assessment Process for Groundwater Dependent Ecosystems' described in the *NSW State Groundwater-Dependent Ecosystem Policy* (DLWC 2002).

The desktop assessment allows the plan to protect GDEs of known high conservation value from year 1 of the plan where time and resources are not available to conduct detailed field studies and analyses. These GDEs, along with GDEs that have been identified through other processes

as having important conservation significance are listed in a schedule to the plan and rules are developed to protect them. For example, GDEs listed under the Directory of Important Wetlands, RAMSAR listed wetlands, communities listed under the *Threatened Species Act 1995* and Karst Conservation Reserves listed under the *National Parks and Wildlife Act 1974* by the Karst Conservation Unit of OEH are added to the GDE schedule for the commencement of the plan.

The Interagency Regional Panel has the opportunity to review and amend the GDE list prior to its inclusion in the plan. The list of high priority GDEs can either be amended after year 5 of the plan as further GDEs are identified or during the life of the plan following approval by the Minister.

Identified GDEs are shown in Appendix 9. Overview maps of high priority groundwater-dependent ecosystems.

The locations of high priority GDEs that occur in the plan area are also shown on the legal map which can be found at http://www.legislation.nsw.gov.au/.

Water sharing rules

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* establishes a framework for water sharing that defines:

- environmental water provisions;
- requirements for water for basic landholder rights;
- requirements for water for extraction under access licences;
- long-term average annual extraction limits and available water determinations for each groundwater source;
- rules for granting access licences;
- rules for water allocation accounts;
- rules for water supply work approvals; and
- access licence dealing rules to control the trade of water within or into other groundwater sources.

The following section provides further background on each of these components.

Planned environmental water

The plan identifies and protects water for environmental purposes in each groundwater source. This is defined as 'planned environmental water' and consists of water that is remaining within the aquifer after water has been taken for BLR and access licences in accordance with the rules of the plan. Planned environmental water is delivered through reservation of:

- groundwater storage volume; and
- a portion of groundwater recharge.

Groundwater systems can store large volumes of water, often accumulated over thousands, or tens of thousands of years. This is referred to as 'storage'. For the groundwater sources covered by this plan 100 percent of groundwater storage is reserved as planned environmental water.

Recharge is the addition of water to a groundwater system expressed as a volume in megalitres per year (ML/year). Recharge usually comes from rainfall and surface water, such as rivers, but may also come from adjacent groundwater systems. In all of the groundwater sources covered by the plan, recharge is shared between the environment and extractive users.

Planned environmental water in the new groundwater sources

The proportion of recharge reserved for the environment has been determined for each of the new groundwater sources using the method outlined in previous sections. The proportion varies between areas of high and non-high environmental values in the new groundwater sources as described in 'Methods for establishing limits to extraction'. Planned environmental water is equal to total recharge minus the LTAAEL, plus storage.

Planned environmental water volumes for new groundwater sources are shown in Table 12.

Planned environmental water in replacement groundwater sources

Recharge estimates have been updated for all of the replacement groundwater sources (see Appendix 3). As a result, the proportion of recharge reserved for the environment has been updated. The macro method for determining the LTAAEL was not applied retrospectively to the replacement plan areas. As a result, the planned environmental water equals total recharge minus the LTAAEL, plus storage. Planned environmental water for these groundwater sources are shown below in Table 12.

Table 12: Planned environmental water (PEW) volumes in groundwater sources

Groundwater source	Recharge total (ML/yr)	LTAAEL (ML/yr)	PEW (ML/yr)
Bellingen-Nambucca Coastal Sands	23,500	1175	22,325
Clarence Coastal Sands	191,000	4200	186,800
Coffs Harbour Coastal Sands	18,200	3110	15,090
Great Lakes Coastal Sands	161,000	16,000	145,000
Hastings Coastal Sands	102,000	7100	94,900
Hawkesbury to Hunter Coastal Sands	48,900	20445	28,455
Macleay Coastal Sands	70,000	11,300	58,700
Manning-Camden Haven Coastal Sands	98,000	3300	94,700
Richmond Coastal Sands	218,000	19,000	199,000
Tweed-Brunswick Coastal Sands	99,000	19,000	80,000
Stockton	21,000	14,000	7000
Stuarts Point	7600	4180	3420
Tomago	36,000	25,000	11,000
Tomaree	10,000	6000	4000

Requirements for water

The plan defines all of the licensed and unlicensed requirements for water within the 14 groundwater sources.

At the start of the plan, the requirements for groundwater were estimated at:

- 1687 ML/yr for BLR;
- 0 ML/yr for Domestic and Stock access licences;
- 36,027 ML/yr for Local Water Utility and Major Utility access licences; and
- 16,096.5 ML/yr for Aquifer access licences.

The distribution of these requirements by groundwater source has been shown previously in Table 8.

Limits to the availability of water

Water usage by individual licence holders is managed through water allocation accounts. Water is credited to the account when an available water determination (AWD) is made at the start of the water year, and debited as water is extracted throughout the year. A licence holder's account is not permitted to go into debit.

The AWD for aquifer access licences in these groundwater sources will be 1 ML/unit share, unless a growth in use response is required. The AWD is used to manage growth in extractions above the LTAAEL. If growth is assessed to have increased more than 5% above the LTAAEL extraction limit over a 3 year period, AWDs can be reduced to less than 1 ML/unit share.

The compliance trigger of 5% over a 3 year period is commonly applied to non-alluvial groundwater sources in NSW.

Unassigned water at plan commencement

When the sum of entitlements within a groundwater source is less than the LTAAEL, the remaining volume of water is referred to as unassigned water. This unassigned water may be made available for any type of new access licences through controlled allocation orders made under section 65 of the WMA 2000. This is a decision made by the Minister. The volume of unassigned water will change throughout the life of the plan.

The volume of unassigned water for each groundwater source at the commencement of this plan is shown in Table 13.

Table 13: Unassigned water at plan commencement

Groundwater source	Total requirements (BLR plus licences) (ML/yr)	Long-term average annual extraction limit (ML/yr)	Unassigned water (ML/yr)
Bellinger–Nambucca Coastal Sands	105	1175	1070
Clarence Coastal Sands	150	4200	4050
Coffs Harbour Coastal Sands	128	3110	2982
Great Lakes Coastal Sands	2245	16,000	13,755
Hastings Coastal Sands	1169	7100	5931
Hawkesbury to Hunter Coastal Sands	7705	20,445	12,740
Macleay Coastal Sands	3361	11,300	7939
Manning–Camden Haven Coastal Sands	236	3300	3064
Richmond Coastal Sands	1455	19,000	17,545
Stockton	1262.5	14,000	12737.5
Stuarts Point	3755	4180	425
Tomago	26,511	25,000	0
Tomaree	5015	6000	985
Tweed–Brunswick Coastal Sands	713	19,000	18,287

Granting new access licences

In these groundwater sources, access licences may be granted in accordance with the categories defined under the WMA 2000.

In a groundwater source where there is no unassigned water, aquifer access licences and ‘Aboriginal community development’ licences cannot be granted.

Aboriginal cultural access licences

An Aboriginal cultural access licence of up to 10 ML per year may be granted to an Aboriginal person or Aboriginal community for any personal, domestic or communal purpose such as drinking, washing, gardening, making traditional artefacts, or for recreation or ceremonial purposes. The plan allows for the granting of these licences in all groundwater sources covered by this plan.

Aboriginal community development access licences

An aquifer (Aboriginal community development) access licence may be granted to an Aboriginal person or Aboriginal community for commercial purposes in all groundwater sources in the plan, except the Tomago Groundwater Source due to entitlement being greater than the LTAAEL. Aboriginal community development licences are a specific purpose access licence and can only be traded if the trade is consistent with the purpose for which the licence was granted.

Rules for managing access licences

The WMA 2000 provides for the keeping of water allocation accounts for access licences. Part 8 of the plan imposes restrictions on the volume of water that may be taken by individual licence holders over a specified period of time. These restrictions are in addition to any other limits on access licences for the taking of water.

Water allocation accounts

Water usage by individual licence holders is managed through water allocation accounts. Water is credited to the account when an available water determination (AWD) is made at the start of the water year, and debited as water is extracted throughout the year. A licence holder's account is not permitted to go into debit. In some groundwater sources at the end of the water year, unused water allocation may be carried over from one water year to the next. Carryover of unused water is permitted in the Tomago, Tomaree and Stockton groundwater sources (up to 20% of entitlement). This carryover rule was developed for the original plan and was retained for consistency with the Ministers' direction for minimal change to rules in the replacement groundwater sources. No carryover of entitlement from one year to the next is allowed in all other groundwater sources in the plan area. Given there is little known about the storage and buffering capacity of each groundwater source, it is appropriate that these groundwater sources are managed conservatively in order to reduce the potential of water level and quality impacts.

Water supply works approvals

In accordance with the principles of the WMA 2000, distance rules may be applied when granting or amending water supply works approvals and managing existing works. These rules take into account local impacts on other water users, contaminated sites, potential acid sulfate soils, GDEs and groundwater-dependent culturally significant sites. The rules are intended to prevent unacceptable or damaging levels of drawdown of water occurring in the local vicinity of other water users and significant sites.

For new works the plan includes rules to:

- minimise interference between neighbouring works;
- locate works away from contaminated sites[6];
- protect water levels that support high priority GDEs;
- protect groundwater dependent culturally significant sites;
- manage surface and groundwater connectivity;
- locate works away from potential acid sulfate soils[7]; and
- protect water levels in National Parks.

Existing works must have a water supply works approval, but are not required to make changes to the work to satisfy the distance rules for new works.

Most replacement works are subject to different rules which ensure changes to the work do not result in any adverse impacts.

[6] Also applies to replacement works

[7] Also applies to replacement works except stock and domestic

The distance rules apply to new and in some cases replacement bores by defining a buffer zone around the feature to be protected. Existing bores are not affected by the buffer zones and are able to continue operating within the existing conditions of their access licences.

Standard distance rules were developed for groundwater macro plans by the State Groundwater Panel which included regional groundwater experts and representatives from NSW DPI and OEH to incorporate a socio-economic and environmental perspective. This panel compiled sets of distance criteria based on previous studies and substantial local knowledge and experience. A consistent set of rules for the common groundwater aquifer types (fractured rock, porous rock, alluvium and coastal sands) was produced by comparing the various rules proposed by the regional panels based on what has worked in the past in similar geological provinces.

Groundwater flow modelling was used to calculate water balances and also provide water table drawdown at different distances under a 24 hour/day pumping regime for one year. The modelling was undertaken to test the distance criteria produced by the regional panels to protect regulated stream flow and base flow in the unregulated systems. The modelling indicated that the water table fluctuation due to pumping was not above natural variations if the access rules in the plan are implemented. For high priority GDEs, the distances were set so that overall ecosystem health would remain the same and any impacts on drawdown would be within seasonal groundwater level movements.

Based on this modelling, a set of distance criteria were submitted to the State Groundwater Panel for approval. In finalising a standard set of distance rules the State Groundwater Panel weighed the social, environmental and economic impacts of extraction on the groundwater sources. Since then, the standard rules were further tailored during the development of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*.

The plan development process allows for further changes to the distance rules by the North Coast Interagency Regional Panel (IRP) to cater for local conditions. The distance rules may be altered due to factors such as unusual lot sizes, aspects of the local hydrogeology and the level of groundwater dependence of community and/or town water supplier.

For the development of this plan, the IRP made the final decision as to the appropriate distance rule to be adopted, striving to remain consistent with the standard rules where possible while being sensitive to any unique attributes of the coastal sand groundwater sources. For all groundwater sources, all the standard distances were adopted by the IRP. For the replacement plans this resulted in some changes to the distance rules compared to the original plan to bring them into line with the state-wide standard provisions. Following comments received during public exhibition, two changes were made to the setback distance rules. Details of the changes and the reasons for them are detailed in Appendix 2: Summary of key issues raised during public exhibition and response, with the full details of the distance rules covered in Appendix 10: Minimum distances for water supply works approvals.

Given that the distance rules in the plan may not always be warranted due to on-ground local variations/situations the plan allows for these rules to be altered. For example, a rule in the plan allows the distance to minimise interference with other works to be reduced if a proponent can demonstrate in a hydrogeological study that at a lesser distance no more than minimal impact will occur on groundwater levels at the nearby existing works. For distance rules relating to GDEs, the plan allows for these to be reduced if the proponent provides hydrological evidence that no drawdown of water will occur at the outside edge of the perimeter of any high priority GDE listed.

Access licence dealing rules

The objective of dealing rules (trading rules) is to allow the development of a water market whilst recognising and protecting the needs of the environment and third party interests. The National Water Initiative has established guidelines for water trading. Trading can occur either on a permanent or temporary basis. Trading of water entitlement within the plan area needs to maximise the flexibility for users to be able to use water to its highest value without having an adverse impact on the groundwater sources or existing users.

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* prohibits trading between the coastal sands groundwater sources due to the lack of strong hydrologic connection. Trading within the groundwater sources is permitted; however each trade application will be subject to a minimal harm assessment.

Aquifer interference

Activities which intersect or 'interfere with' an aquifer may involve:

- the extraction of groundwater that flows into a void to allow an activity to operate safely. This is often called dewatering, and the water extracted is often referred to as 'incidental take of groundwater'; and
- other impacts resulting from the intersection of the aquifer, such as changes to groundwater flow paths and gradients, subsidence, compaction of the aquifer structure, and artificial aquifer recharge.

Volumes of water incidentally taken in the course of aquifer interference activities, such as the water intercepted during mining operations, have previously required a licence under the *Water Act 1912*. Operators of these activities are now required to hold an access licence under the WMA 2000 and sufficient account volume to account for incidental water taken. They are also required to comply with the *NSW Aquifer Interference Policy*, which was released in September 2012.

Adaptive management

Adaptive management refers to the practice of change in response to new information that is received during the life of a water sharing plan. This may include data collection and monitoring or some other improvement in understanding. In the case of water sharing plans, such information could include socio-economic studies, hydrological modelling, ecological studies and information about Aboriginal cultural sites.

Amendment provisions

Adaptive management is a requirement of both the WMA 2000 and the National Water Initiative, and has been allowed for during the life of this plan through the inclusion of amendment provisions. These provisions allow some aspects of the plan to be changed.

The *Water Sharing Plan for the North Coast Coastal Sands Groundwater Sources* includes amendment provisions that allow for:

- the modification or addition of groundwater sources or management zones;
- variation to the amount of recharge reserved as planned environmental water;
- increases in the long-term annual extraction limit;
- the establishment of rules for managing major utility access licences or other aquifer access licences;
- addition or removal of contamination sources;
- addition, removal or modification of distance rules in relation to groundwater works;
- amendments to the map of high priority groundwater-dependent ecosystems;
- inclusion of rules pertaining to managed aquifer recharge schemes and other interception activities; and
- changes to recognise the granting of a native title claim or the identification of Aboriginal cultural assets.

Monitoring, evaluation and reporting

Monitoring, evaluation and reporting are key components to adaptive management. DPI Water is developing a Monitoring, Evaluation and Reporting Framework in collaboration with key stakeholders. The framework conforms to NSW and Commonwealth government guidelines for monitoring, evaluation and reporting, and demonstrates an adaptive management approach to water planning required under the principles of the WMA 2000.

The evaluation framework aims to inform the community of the outcomes of water sharing plans, and to collate the results of various legislatively required evaluations and relevant knowledge to inform the review of the water sharing plans. The framework will assess the inputs, outputs and outcomes of the water sharing plans and their operations. The assessment will consider:

- the process of plan development (appropriateness);
- the performance of the plan during operation (efficiency); and
- the socio-economic, environmental and cultural outcomes of the plan (effectiveness).

The main strategies in place to assist in evaluating water sharing plans include:

- assessment of performance indicators;
- an audit of plans; and
- review of each plan at the end of its 10 year term.

Performance indicators

Part 2 of the plan includes a number of performance indicators. These include groundwater extraction, water quality and ecological condition of groundwater sources. It is not practicable to monitor all issues in all groundwater sources. Monitoring will be undertaken for specific issues in key groundwater sources. The actual procedure for monitoring each indicator may change over the period of the plan as improved methods are developed.

Plan review

At the end of the plan's 10 year life the Minister may, on recommendation from the Natural Resources Commission (under section 43A of the WMA 2000), extend the plan for another 10 years or replace the plan. An extension does not allow for any changes to the plan. If any changes are proposed then a replacement water sharing plan needs to be prepared.

The WMA 2000 requires that when deciding whether to extend or replace an existing water sharing plan, the Minister must consider:

- the most recent audit of the water sharing plan conducted under section 44; and
- a report from the Natural Resources Commission prepared within the previous five years, on the extent to which the water sharing plan has contributed to relevant state-wide natural resource management standards and targets or the relevant Local Land Services catchment action plan.

Under the WMA 2000 a water sharing plan may be extended for 24 months past the expiry date of the plan to allow for a replacement plan to be prepared.

Glossary

Many of the terms in this document are defined in the *Water Management Act 2000* or in the plan and are therefore not redefined here. In some cases, some terms defined in these documents and are redefined here to provide a more plain English explanation. In addition, there are some terms that are not defined in these documents and have therefore been defined below to assist with understanding the plan and this background document.

Account water: The balance in an access licence water allocation account at a particular time. An access licence water allocation account records water allocations accrued under the licence as well as water allocations taken, assigned or re-credited. The operation of the account is also governed by rules for the carrying over of credits from one accounting period to the next and rules for the maximum credit that may be allowed to accumulate in the account as established in a water sharing plan.

Alluvial, alluvium: Sediment deposited by a stream of running water, in particular along river beds or flood plains.

Aquifer: An underground layer of water-bearing permeable rock or unconsolidated materials (gravel, sand, silt or clay) from which groundwater can be extracted. The volume of water stored in an aquifer, the rate at which water can recharge, the volume of water extracted from it, and the rate at which water can move through the aquifer are all controlled by the geologic nature of the aquifer.

Ecological values: The intrinsic or core attributes associated with naturalness, diversity, rarity and special features (but excluding representativeness) used to classify water sources for apportioning water management rules.

Extraction of water: Removal of water from a river or aquifer for off-stream storage or consumptive use.

Extraction management unit (EMU): A group of water sources; defined for the purpose of managing long-term annual average extraction.

Groundwater: The water beneath the earth's surface that has filtered down to the zone where the sediment or rocks are fully saturated.

Groundwater-dependent ecosystems (GDEs): Ecosystems that rely on groundwater for their species composition and their natural ecological processes.

Long-term average annual extraction limit (LTAAEL): The limit set for the total extraction within a groundwater source.

Macro water sharing plans: Plans which apply to a number of water sources across catchments or aquifers.

Upper extraction limit: The maximum annual volume to which the LTAAEL can be raised following a plan amendment.

Water sharing plan (Plan): A plan made under the WMA 2000, which sets out the rules for sharing water between the environment and water users within whole or part of a water management area or water source.

Water year: The 12 months running from 1 July to 30 June.

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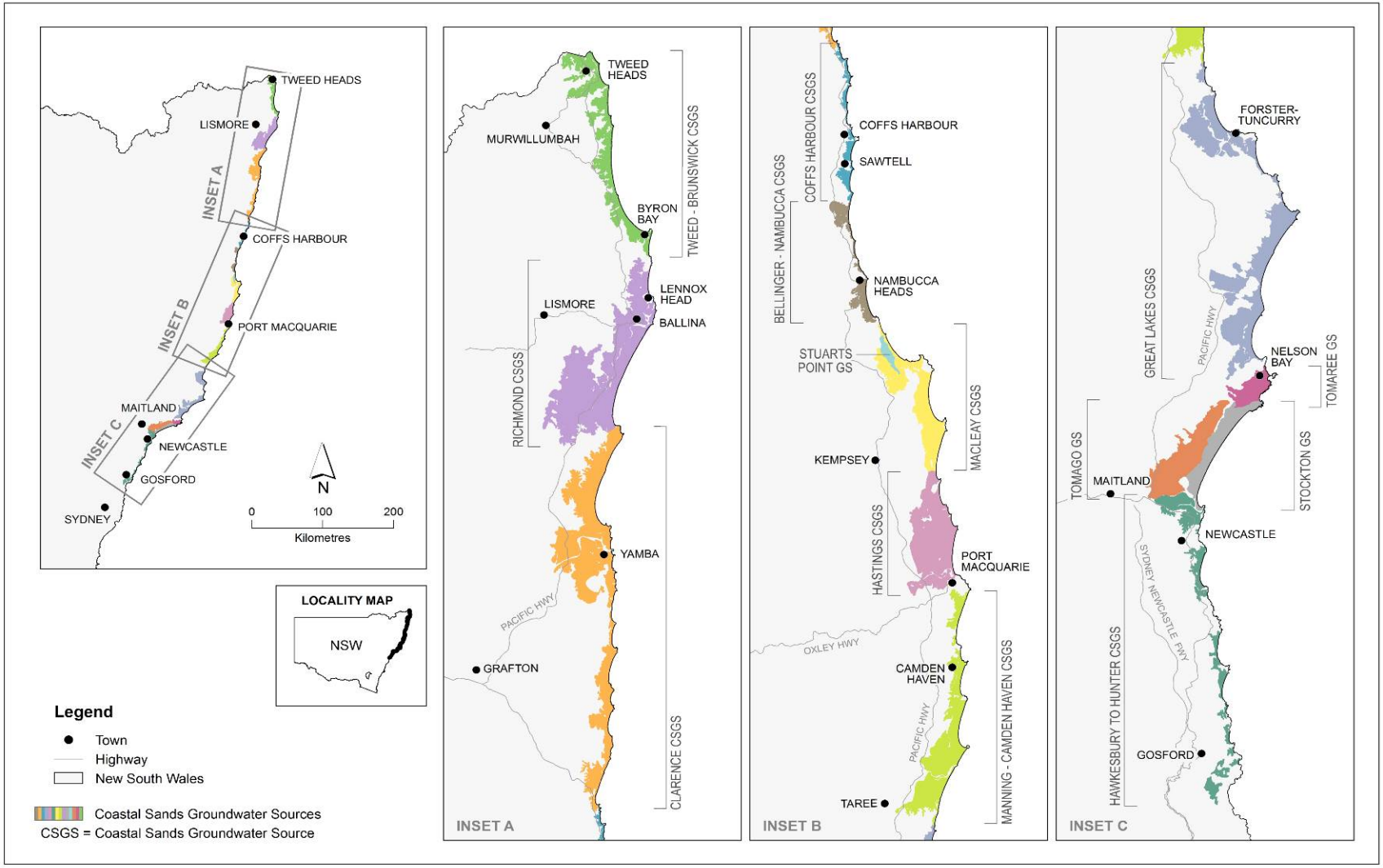
Appendices

Appendix 1: Map of the North Coast Coastal Sands Water Sharing Plan area and groundwater sources



Note: This map is an overview only. The legal plan map can be found at www.legislation.nsw.gov.au

Appendix 2: Summary of key issues raised during public exhibition and response

Issue raised	Draft plan rule	Final plan rule	Justification
The draft plan does not recognise the importance of agriculture and horticulture to the local economy of Stuart Point. Groundwater levels should be included as a performance indicator as they are an important indicator of the sustainability of extraction.	The plan lists a standard set of objectives, strategies and performance indicators for all groundwater sources	A specific objective stating that the plan supports viable and sustainable water-dependent industries, including agriculture and horticulture has been included. A performance indicator relating to groundwater levels has been included.	Irrigated industries are important to the social and economic values of the whole plan area. Groundwater level data is an important information source in managing these groundwater sources.
The average annual rainfall figure used to calculate the recharge estimate for the Stuart Point Groundwater Source is lower than what is indicated at local weather stations.	Recharge estimate calculated using Bureau of Meteorology modelled data.	Recharge estimate calculated using local rainfall station data for the Stuarts Point Groundwater Source. This resulted in an increase to the recharge estimate. The additional water was split between the environmental and consumptive pool resulting in an increase to planned environmental water and the extraction limit.	Due to the small area, and unique geographic features, local rainfall station data provides a more accurate rainfall estimate.
Septic systems are numerous in the Stuarts Point Groundwater Source. Bores also require regular replacement. These factors combined with the fact that farming enterprises are on relatively small parcels of land means that operations may have to be abandoned if bores are not permitted to be replaced within the setback distances from contamination sources.	Replacement bores are subject to setback distances from contamination sources.	Replacement bores in the Stuarts Point Groundwater Source are exempt from setback distances from contamination sites.	Agricultural/Horticultural enterprises occur on relatively small parcels of land in the Stuarts Point Groundwater Source. Septic systems are a contamination source and these are numerous in the Stuarts Point Groundwater Source. Proximity to a septic system is highly likely. No contamination issues have been identified to date and a case-by-case assessment is undertaken for all replacement applications.
Many cane growers in the Richmond and Tweed groundwater sources have stock and domestic bores on their properties which also contain acid sulphate soils.	Replacement bores will not be granted in an area classed as having a high probability of occurrence of acid sulfate soils.	Replacement stock and domestic bores may be granted in an area classed as having a high probability of occurrence of acid sulfate soils.	Low level risk of oxidation associated with S&D bores which have low volumes of extraction. No acidification issues have been identified to date and a case-by-case assessment is undertaken for all replacement applications.

The setback distances from GDE's and National Parks are too conservative and there is no evidence of impacts on GDEs during the last 10 years. There should be no exclusions to the setback distances from GDE's.	Default setback distances from GDEs and National Parks apply to all bores except replacement, major utility or local water utility, monitoring, remedial or environmental management bores.	No change	Default setback distances including exclusions were developed using a "hot-spot" model which was based on the Stuarts Point coastal sands aquifer. All bore applications are subject to a case-by-case assessment. The plan contains an exemption clause to allow bores to be placed within the restricted distances if it will not result in an impact.
The Anderson's Inlet Wetlands is a salt water system, not a GDE. The Clybucca Historic Site protects a midden and is not a GDE.	Default setback distances apply to GDEs and National Parks including Clybucca Historic Site and Yarrahapinni Wetlands National Park	No change	DPI Water and external expert advice has advised of the presence of GDEs in these areas including Swamp Oak and Sub-tropical Coastal Floodplain Forest endangered ecological communities.
The estimated contribution from Yarrahapinni Mountain runoff to total recharge of the Stuarts Point Groundwater Source is inaccurate and far too low. Should more entitlement be allocated in the future to higher priority uses than farming, this will likely impact irrigators. Should this scenario become reality, the runoff estimate should be reinvestigated.	Standard amendment provision allowing for the adjustment of planned environmental water and extraction limit as a result of new information.	No change to provisions however a note has been added to this standard amendment provision to indicate that if total entitlement reaches 100% of the long-term average annual extraction limit for the Stuarts Point Groundwater Source, a review of the Yarrahapinni runoff recharge may be undertaken to determine if the long-term average annual extraction limit should be modified.	The amendment clauses allow for planned environmental water and the extraction limit to be reviewed as a result of new recharge studies.

Appendix 3: Recharge calculations for groundwater sources

Appendix 3A: Recharge calculations for the new groundwater sources

		Non-high environmental value areas							High environmental value areas		
		Area excluding drains			Drains			Total recharge (ML/yr)*			
Groundwater source	Infiltration rate	Area (m^2)	Mean rainfall (mm/yr)	Recharge (ML/yr)	Area (m^2)	Mean rainfall (mm/yr)	Recharge (ML/yr)		Area (m^2)	Mean rainfall (mm/yr)	Recharge (ML/yr)*
Bellinger - Nambucca Coastal Sands	0.3	46,491,945	1482	20,675	573,977	1612	278	21,000	5,897,000	1399	2500
Clarence Coastal Sands	0.3	180,555,783	1317	71,362	26,058,144	1286	10,054	81,000	268,951,000	1351	110,000
Coffs Harbour Coastal Sands	0.3	19,994,223	1557	9338	2,454,332	1613	1188	11,000	15,227,000	1571	7200
Great Lakes Coastal Sands	0.3	207,453,430	1249	77,748	477,847	1238	177	78,000	205,328,000	1310	83,000
Hastings Coastal Sands	0.3	142,948,168	1320	56,603	15,252,666	1313	6006	63,000	97,374,000	1343	39,000
Hawkesbury to Hunter Coastal Sands	0.3	112,136,326	1167	39,254	1,111,438	1197	399	40,000	20,031,000	1142	8900
Macleay Coastal Sands	0.3	94,794,722	1286	36,572	5,834,181	1279	2239	39,000	87,143,000	1291	31,000
Manning - Camden Haven Coastal Sands	0.3	130,385,804	1352	52,875	8,617,197	1352	3494	84,000	99,006,000	14 25	42,000
Richmond Coastal Sands	0.3	302,298,391	1512	137,165	124,062,780	1536	57,174	30,000	61,551,000	1507	28,000
Tweed - Brunswick Coastal Sands	0.3	132,203,623	1752	69,478	27,140,272	1762	14,348	39,000	28,403,000	1759	15,000

*Recharge rounded to two significant figures

Appendix 3B: Recharge calculations for Tomago, Tomaree and Stockton Groundwater Sources

Groundwater Source	High environmental value areas							Non-high environmental value areas							Total Recharge (ML/yr)*
	Mean Rainfall (mm/yr)	Sand aquifer			Residual aquifer[8]			Mean Rainfall (mm/yr)	Sand aquifer			Residual aquifer			
		Area (km2)	Infiltration rate	Recharge (ML/yr)	Area (km2)	Infiltration rate	Recharge (ML/yr)		Area (m2)	Infiltration rate	Recharge (ML/yr)	Area (m2)	Infiltration rate	Recharge (ML/yr)	
Stockton	1190	42.10	0.22	11,020	3.09	0.02	74	1171	36.39	0.22	9375	30.09	0.02	705	21,000
Tomago	1122	43.87	0.25	12,305	17.14	0.02	384	1100	81.45	0.25	22,399	54.89	0.02	1208	36,000
Tomaree	1288	15.40	0.20	3966	7.03	0.02	181	1261	22.88	0.20	5770	16.65	0.02	420	10,000

Appendix 3C: Recharge calculation for the Stuarts Point Groundwater Source

Groundwater Source	Infiltration Rate	Area (m^2)	Mean Rainfall (mm/yr)	Rainfall Recharge (ML/yr)	Recharge from Yarrahapinni Mountain (ML/yr)[9]	Total Recharge (ML/yr)*
Stuarts Point	0.30	15,078,939	1494	6758	816	7600

[8] Those water bearing units that for reasons of yield, depth to water and/or water quality are separated from the primary coastal sands aquifer. Groundwater extraction occurs predominantly from the coastal sands aquifer.

* Recharge rounded to two significant figures

[9] Runoff from the adjacent Yarrahapinni Mountain contributes to the recharge of the groundwater source. This estimate was including in the 2004 water sharing plan following negotiation with the community and has been retained in the replacement water sharing plan.

Appendix 4: Risk assessments

Socio-economic risk assessment - Bellinger-Nambucca Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?			×	large volume of water available		
What is the risk to groundwater usage?			×	low entitlement		
What is the risk to dependence on Town Water Supply?			×	no TWS		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×	low entitlement		
What is the risk to investment in agriculture/industry?			×	low entitlement		
Sociological asset						
What is the risk to employment in agriculture or industry?			×	low entitlement		
Risk Valuation			×			
Risk	***LOW***					

Aquifer risk assessment - Bellinger-Nambucca Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			GDEs in Bongil Bongil and Warrell Creek NPs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			GDEs in Bongil Bongil and Warrell Creek NPs		
What will be the risk to changing base flow conditions on GDEs?			×	catchment flows sands do not substantially contribute to base flows		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?		×		acid sulphate soils		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?		×		acid sulphate soils		
Aquifer Integrity Asset						
What is the risk to substrate compaction?			×			
Risk Valuation	×					
Mitigation Effect on Sustainability Factor	×			no mitigation warranted		
Risk	***HIGH***					

Socio-economic risk assessment - Clarence Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?			×	Shannon Creek Dam access		
What is the risk to groundwater usage?			×			
What is the risk to dependence on Town Water Supply?			×	potential growth		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×			
What is the risk to investment in agriculture/industry?			×			
Sociological asset						
What is the risk to employment in agriculture or industry?			×			
Risk Valuation			×			
Risk	***LOW***					

Aquifer risk assessment - Clarence Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			GDE database, direct contact with GDEs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			GDE database, vegetation moderate impact, fish high impact		
What will be the risk to changing base flow conditions on GDEs?		×		GDE database		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?	×			pH and heavy metals due to acid sulphate soils		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?		×				
Aquifer Integrity Asset						
What is the risk to substrate compaction?			×			
Risk Valuation	×					
Mitigation Effect on Sustainability Factor	×					
Risk	***HIGH***					

Socio-economic risk assessment - Coffs Harbour Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?			×	alternate water supplies		
What is the risk to groundwater usage?		×		usage unknown, but conceivable that moderate % of entitlement is used		
What is the risk to dependence on Town Water Supply?			×	no TWS		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×	low industry development		
What is the risk to investment in agriculture/industry?			×	low industry development		
Sociological asset						
What is the risk to employment in agriculture or industry?			×	low industry development		
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Coffs Harbour Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	x			to nth and sth of town – likely some areas discharge into GDE habitat		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	x			as above		
What will be the risk to changing base flow conditions on GDEs?			x	sands do not substantially contribute to base flows		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?		x		temporary change		
What is the risk to the water source by a change in the freshwater/salt water interface?		x		close to coast, small aquifer units result in little buffer		
What is the risk to a change in beneficial use of the water source?		x		acid sulphate soils		
Aquifer Integrity Asset						
What is the risk to substrate compaction ?			x	no change		
Risk Valuation	x					
Mitigation Effect on Sustainability Factor		x		no mitigation warranted		
Risk	***HIGH***					

Socio-economic risk assessment - Great Lakes Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?		×				
What is the risk to groundwater usage?		×		No risk to TWS usage		
What is the risk to dependence on Town Water Supply?		×		TWS used for Nabiac		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×			
What is the risk to investment in agriculture/industry?		×			tourism	
Sociological asset						
What is the risk to employment in agriculture or industry?		×				
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Great Lakes Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			Myall Lakes NP lakes have significant gw input		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			Myall Lakes NP lakes have significant gw input		
What will be the risk to changing base flow conditions on GDEs?		×				
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?	×			iron/arsenic		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?		×		acid sulphate soils		
Aquifer Integrity Asset						
What is the risk to substrate compaction?			×			
Risk Valuation	×					
Mitigation Effect on Sustainability Factor	×					
Risk	***HIGH***					

Socio-economic risk assessment - Hastings Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?		×		limited alternate supplies		
What is the risk to groundwater usage?		×		moderate usage		
What is the risk to dependence on Town Water Supply?			×	no TWS		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×			
What is the risk to investment in agriculture/industry?		×				
Sociological asset						
What is the risk to employment in agriculture or industry?			×			
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Hastings Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			large NPs with GDEs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			large NPs with GDEs		
What will be the risk to changing base flow conditions on GDEs?	×			gw discharge major contributor to base flows		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?		×		acid sulphate soils		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?	×			acid sulphate soils		
Aquifer Integrity Asset						
What is the risk to substrate compaction ?			×			
Risk Valuation	×					
Mitigation Effect on Sustainability Factor	×					
Risk	***HIGH***					

Socio-economic risk assessment - Hawkesbury to Hunter Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?			×	surface water, reticulated supply, some potential for development of gw		
What is the risk to groundwater usage?		×		Considerable use, industrial and dewatering significant		
What is the risk to dependence on Town Water Supply?		×		Woy Woy TWS		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×	generally residential area, some commercial eg golf courses		
What is the risk to investment in agriculture/industry?	×			Considerable industrial use		
Sociological asset						
What is the risk to employment in agriculture or industry?	×			Considerable Industrial use		
Risk Valuation	×					
Risk	***HIGH***					

Aquifer risk assessment - Hawkesbury to Hunter Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			permanent loss likely - some sections remain with linkages to GDEs	distance conditions	
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			as above		
What will be the risk to changing base flow conditions on GDEs?			×	no baseflow out of sand dunes		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?			×	likely to be low - depends on location of extraction - some areas already disturbed by sand mining		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?		×		BU: ecosystem protection, raw water for drinking - likely to be able to manage system as to not change BU	bore location, extraction rates and depths	
Aquifer Integrity Asset						
What is the risk to substrate compaction ?			×	coastal sands		
Risk Valuation	×			no mitigation warranted		
Mitigation Effect on Sustainability Factor	×					
Risk	***HIGH***					

Socio-economic risk assessment - Macleay Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?		×		limited alternate options		
What is the risk to groundwater usage?		×		TWS mainly. Council looking to connect supply up to alternate supplies via pipeline		
What is the risk to dependence on Town Water Supply?		×		TWS for Hat Head, South West Rocks, Crescent Head. Council looking to connect supply up to alternate supplies via pipeline		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×	stock grazing, some pasture irrigation, limited irrigation and industrial use		
What is the risk to investment in agriculture/industry?			×	as above		
Sociological asset						
What is the risk to employment in agriculture or industry?			×			
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Macleay Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			GDE database, direct contact with GDEs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs	×			GDE database, vegetation moderate impact, fish high impact, ephemeral wetlands eg Limeburners Nature Reserve		
What will be the risk to changing base flow conditions on GDEs?		×		GDE database		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?		×		pH and heavy metals due to acid sulphate soils		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?	×					
Aquifer Integrity Asset						
What is the risk to substrate compaction ?			×			
Risk Valuation	×			no mitigation warranted		
Mitigation Effect on Sustainability Factor	×					
Risk	***HIGH***					

Socio-economic risk assessment - Manning-Camden Haven Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?		×		limited alternate options		
What is the risk to groundwater usage?			×			
What is the risk to dependence on Town Water Supply?			×	no TWS		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×	construction, industrial purposes		
What is the risk to investment in agriculture/industry?			×	limited investment		
Sociological asset						
What is the risk to employment in agriculture or industry?			×	limited employment		
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Manning-Camden Haven Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			permanent loss likely - gw discharge supports high value GDEs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			as above		
What will be the risk to changing base flow conditions on GDEs?		×		baseflow to lakes and rivers		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?		×		high risk to acid sulphate soils and salinity		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?	×			acid sulphate soils		
Aquifer Integrity Asset						
What is the risk to substrate compaction?			×	beach dune sands		
Risk Valuation	×			no mitigation warranted		
Mitigation Effect on Sustainability Factor	×					
Risk	***HIGH***					

Socio-economic risk assessment - Richmond Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?		×		limited alternate supplies due to estuaries/ocean + BLR		
What is the risk to groundwater usage?			×			
What is the risk to dependence on Town Water Supply?		×		includes Woodburn borefield supply to Evans Head		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×			
What is the risk to investment in agriculture/industry?		×		sugar mill		
Sociological asset						
What is the risk to employment in agriculture or industry?			×	sugar mill		
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Richmond Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	✗			GDE database, direct contact with GDEs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	✗			GDE database, vegetation moderate impact, fish high impact		
What will be the risk to changing base flow conditions on GDEs?		✗		GDE database		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?	✗			pH and heavy metals due to acid sulphate soils		
What is the risk to the water source by a change in the freshwater/salt water interface?	✗			sea water intrusion		
What is the risk to a change in beneficial use of the water source?		✗				
Aquifer Integrity Asset						
What is the risk to substrate compaction?			✗			
Risk Valuation	✗					
Mitigation Effect on Sustainability Factor	✗			no mitigation warranted		
Risk	***HIGH***					

Socio-economic risk assessment - Tweed-Brunswick Coastal Sands

	Risk			Method and Source of Analysis	Other Management Tools	Relevant WSP Rules
	High	**Moderate**	**Low**			
Financial asset						
What is the risk to security of access from extraction?		×		farm dams and spearpoints		
What is the risk to groundwater usage?			×			
What is the risk to dependence on Town Water Supply?			×	no TWS development		
What is the risk to dependence on groundwater related activities (irrigation, industry)?			×			
What is the risk to investment in agriculture/industry?			×	little gw development		
Sociological asset						
What is the risk to employment in agriculture or industry?			×	little gw development		
Risk Valuation		×				
Risk	***MODERATE***					

Aquifer risk assessment - Tweed-Brunswick Coastal Sands

	Risk			Method and Source	Mitigation/Management Action	Relevant WSP Rules
	High	Moderate	Low			
Ecological Asset						
What will be the risk of a change in groundwater levels on GDEs?	×			GDE database, direct contact with GDEs		
What will be the risk to a change in the timing of groundwater level fluctuations on GDEs?	×			GDE database, vegetation moderate impact, fish high impact		
What will be the risk to changing base flow conditions on GDEs?		×		Belongil Creek		
Water Quality Asset						
What is the risk to changing the chemical conditions of the water source?	×			pH and heavy metals due to acid sulphate soils		
What is the risk to the water source by a change in the freshwater/salt water interface?	×			sea water intrusion		
What is the risk to a change in beneficial use of the water source?	×					
Aquifer Integrity Asset						
What is the risk to substrate compaction?			×			
Risk Valuation	×					
Mitigation Effect on Sustainability Factor	×			no mitigation warranted		
Risk	***HIGH***					

Appendix 5. Estimated future BLR requirements for new groundwater sources

Groundwater Source	Current BLR (ML/yr)	Population growth (%) [10]	Estimated future BLR requirement (ML/yr)
Bellinger–Nambucca Coastal Sands	19	3.7	1
Clarence Coastal Sands	74	5.4	4
Coffs Harbour Coastal Sands	13	15.1	2
Great Lakes Coastal Sands	41	14.3	6
Hastings Coastal Sands	26	9.9	3
Hawkesbury to Hunter Coastal Sands	25	10.5	3
Macleay Coastal Sands	28	4.7	1
Manning–Camden Haven Coastal Sands	45	10.1	4
Richmond Coastal Sands	120	7.5	9
Tweed–Brunswick Coastal Sands	168	17.6	30

[10] Population growth figures for a groundwater source with a number of LGSs are averaged

Appendix 6. Estimated future town water supply requirements

- 500 ML/yr for the Bellinger–Nambucca Coastal Sands Groundwater Source
- 0 ML/yr for the Clarence Coastal Sands Groundwater Source
- 0 ML/yr for the Coffs Harbour Coastal Sands Groundwater Source
- 5000 ML/yr for the Great Lakes Coastal Sands Groundwater Source
- 0 ML/yr for the Hastings Coastal Sands Groundwater Source
- 0 ML/yr for the Hawkesbury to Hunter Coastal Sands Groundwater Source
- 1000 ML/yr for the Macleay Coastal Sands Groundwater Source
- 0 ML/yr for the Manning–Camden Haven Coastal Sands Groundwater Source
- 10,000 ML/yr for the Richmond Coastal Sands Groundwater Source
- 10,000 ML/yr for the Tweed–Brunswick Coastal Sands Groundwater Source

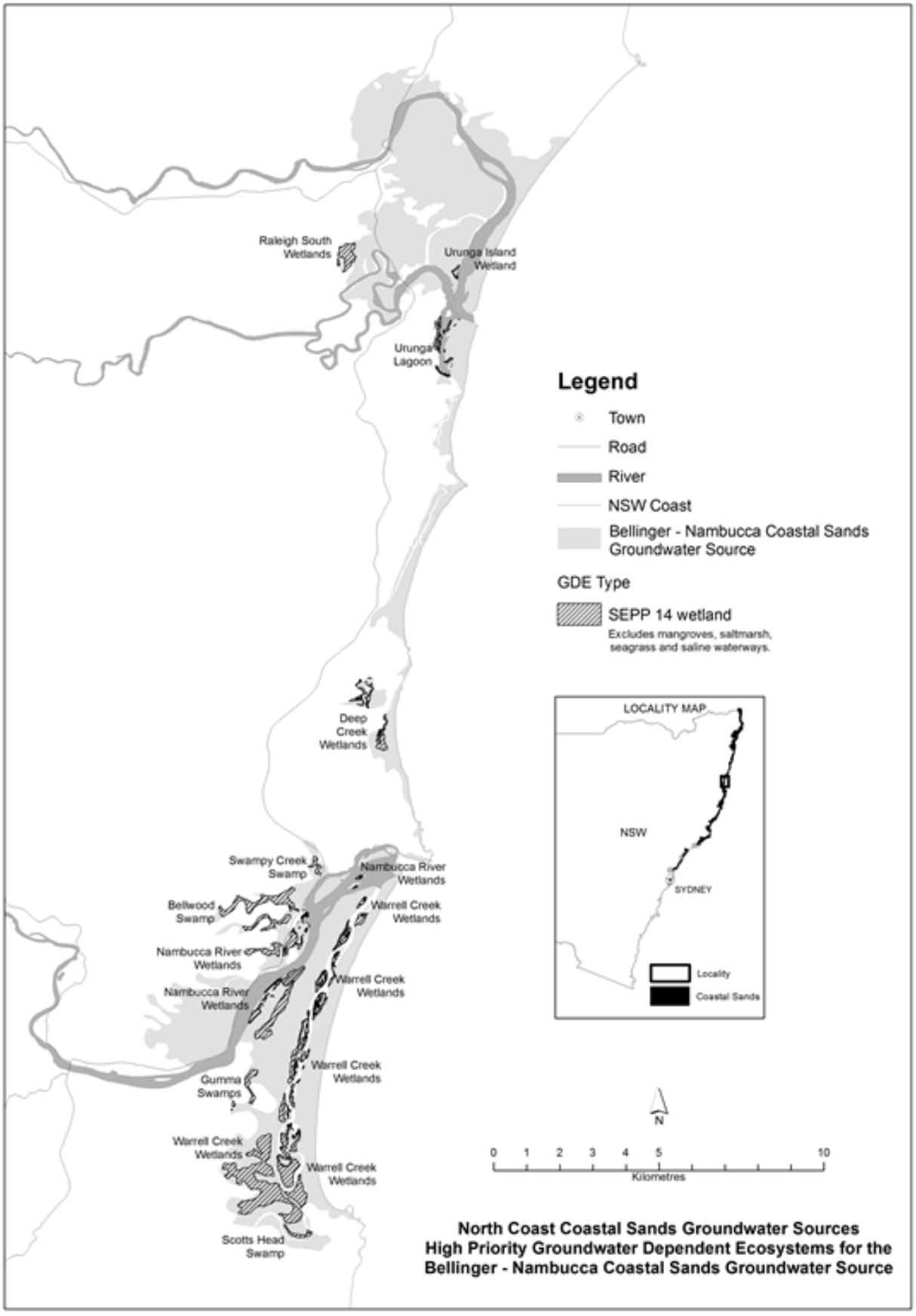
Appendix 7. Estimated future dewatering requirements for new groundwater sources

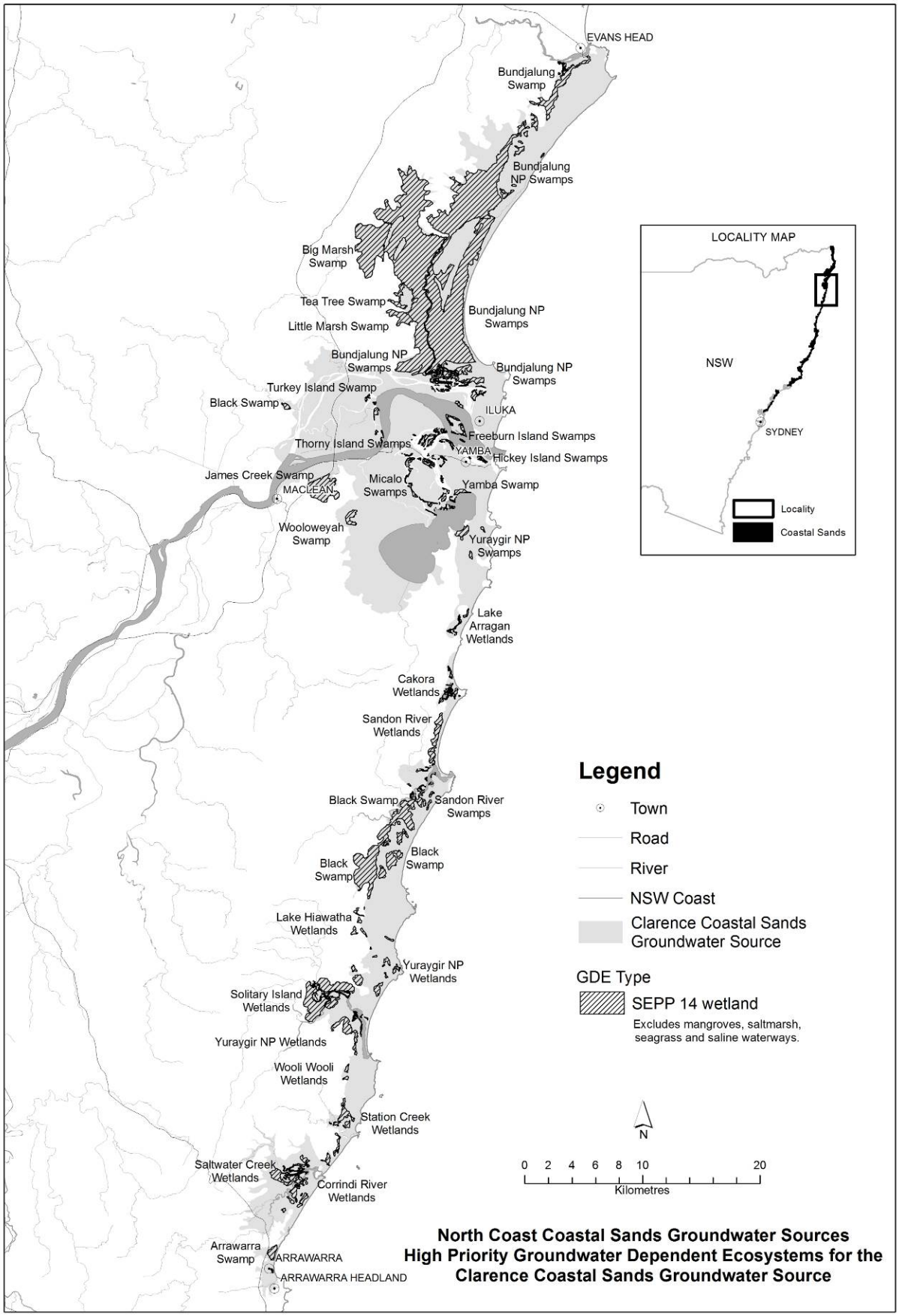
Groundwater source	Dewatering for future residential and commercial developments (ML/yr)	Dewatering estimates for future sand mining developments (ML/yr)	Total estimated future dewatering requirement (ML/yr)
Bellinger–Nambucca Coastal Sands	500	500	1000
Clarence Coastal Sands	2000	2000	4000
Coffs Harbour Coastal Sands	2000	1000	3000
Great Lakes Coastal Sands	3000	5000	8000
Hastings Coastal Sands	2000	3000	5000
Hawkesbury to Hunter Coastal Sands	10,000	5000	15,000
Macleay Coastal Sands	1000	5000	6000
Manning–Camden Haven Coastal Sands	1000	2000	3000
Richmond Coastal Sands	2000	5000	7000
Tweed–Brunswick Coastal Sands	3000	5000	8000

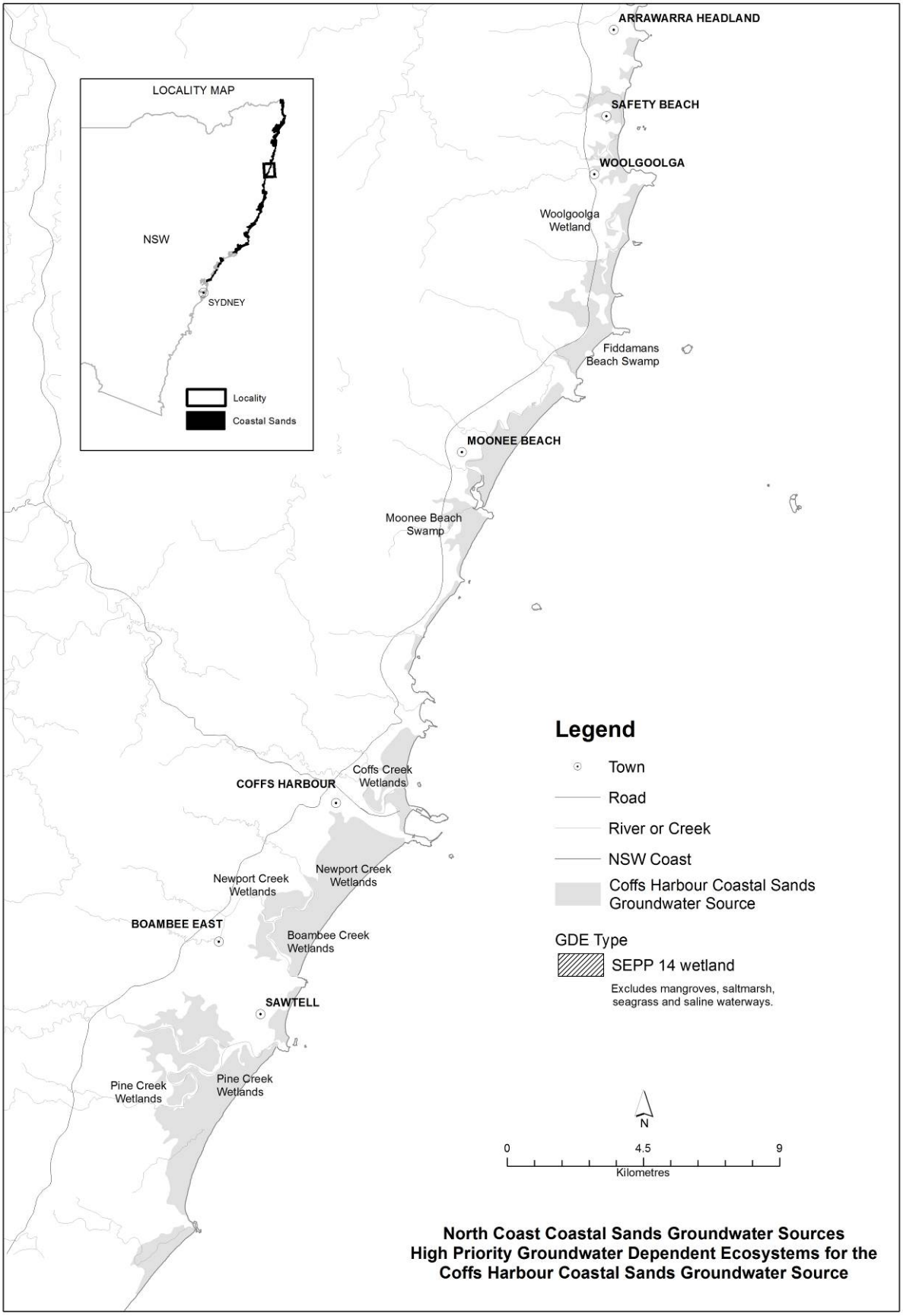
Appendix 8. Estimated future agricultural requirements for new groundwater sources

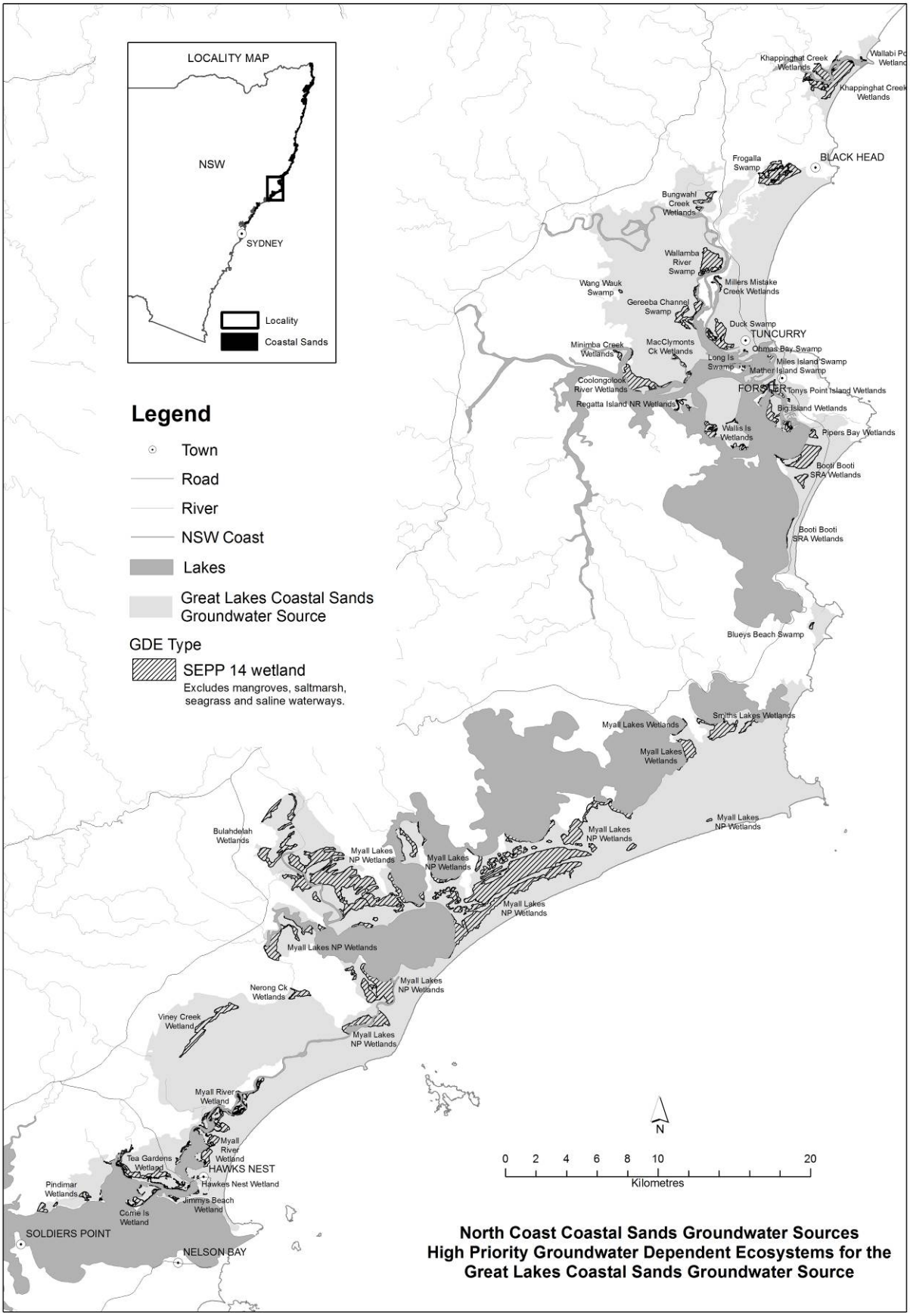
- 31 ML/yr for the Bellinger–Nambucca Coastal Sands Groundwater Source
- 52 ML/yr for the Clarence Coastal Sands Groundwater Source
- 42 ML/yr for the Coffs Harbour Coastal Sands Groundwater Source
- 508 ML/yr for the Great Lakes Coastal Sands Groundwater Source
- 927 ML/yr for the Hastings Coastal Sands Groundwater Source
- 208 ML/yr for the Hawkesbury to Hunter Coastal Sands Groundwater Source
- 18 ML/yr for the Macleay Coastal Sands Groundwater Source
- 40 ML/yr for the Manning–Camden Haven Coastal Sands Groundwater Source
- 373 ML/yr for the Richmond Coastal Sands Groundwater Source
- 311 ML/yr for the Tweed–Brunswick Coastal Sands Groundwater Source

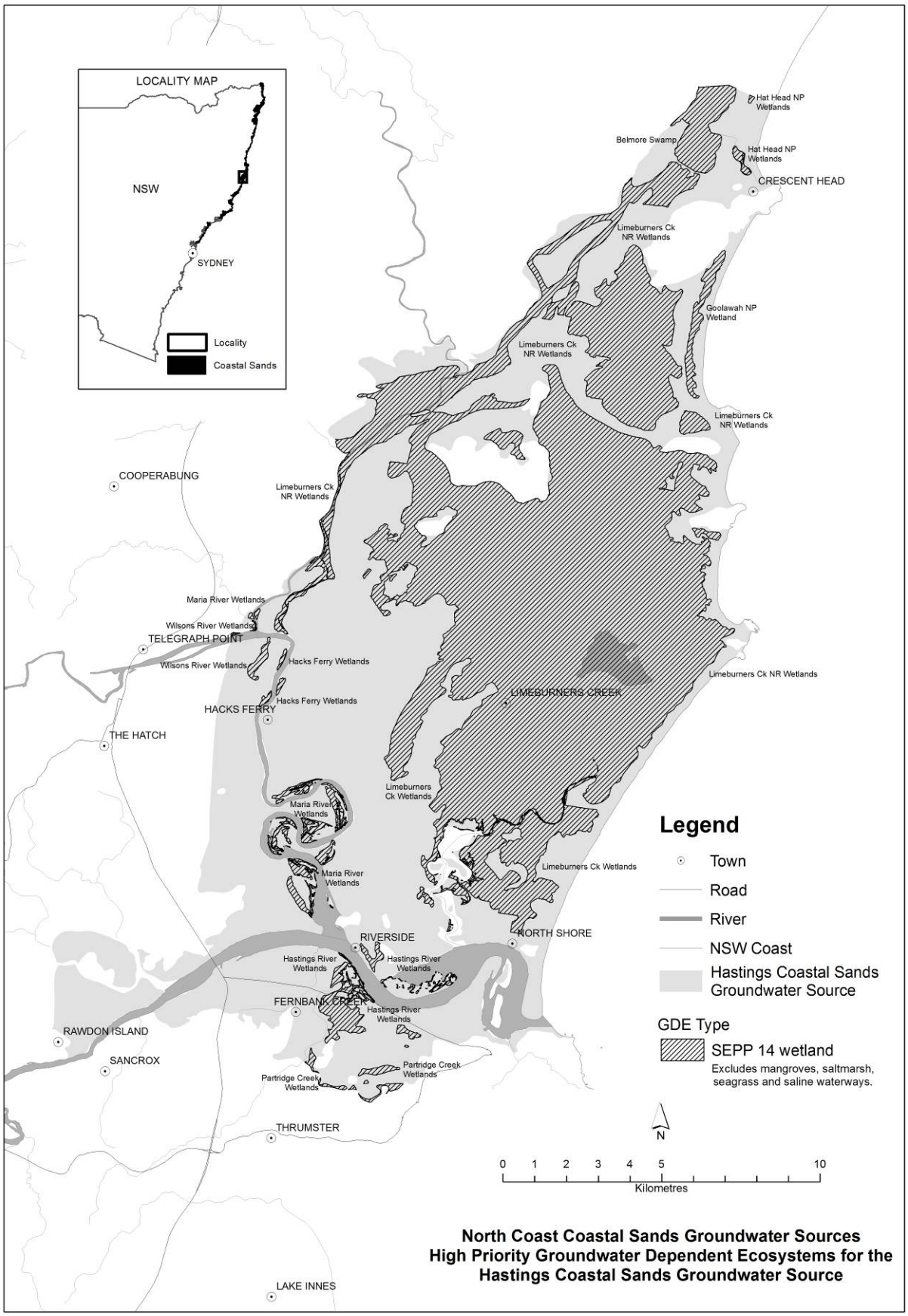
Appendix 9. Overview maps of high priority groundwater-dependent ecosystems

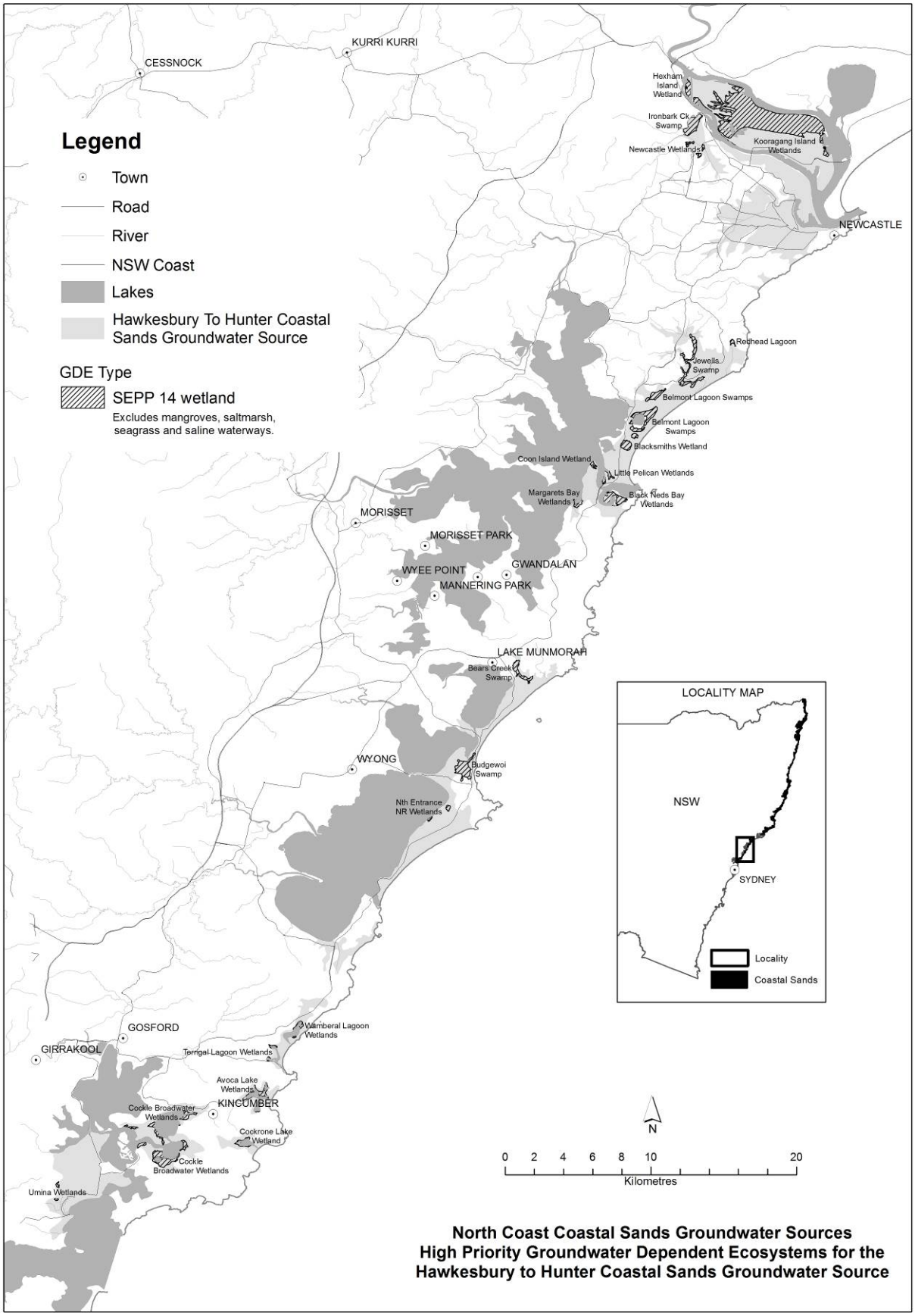


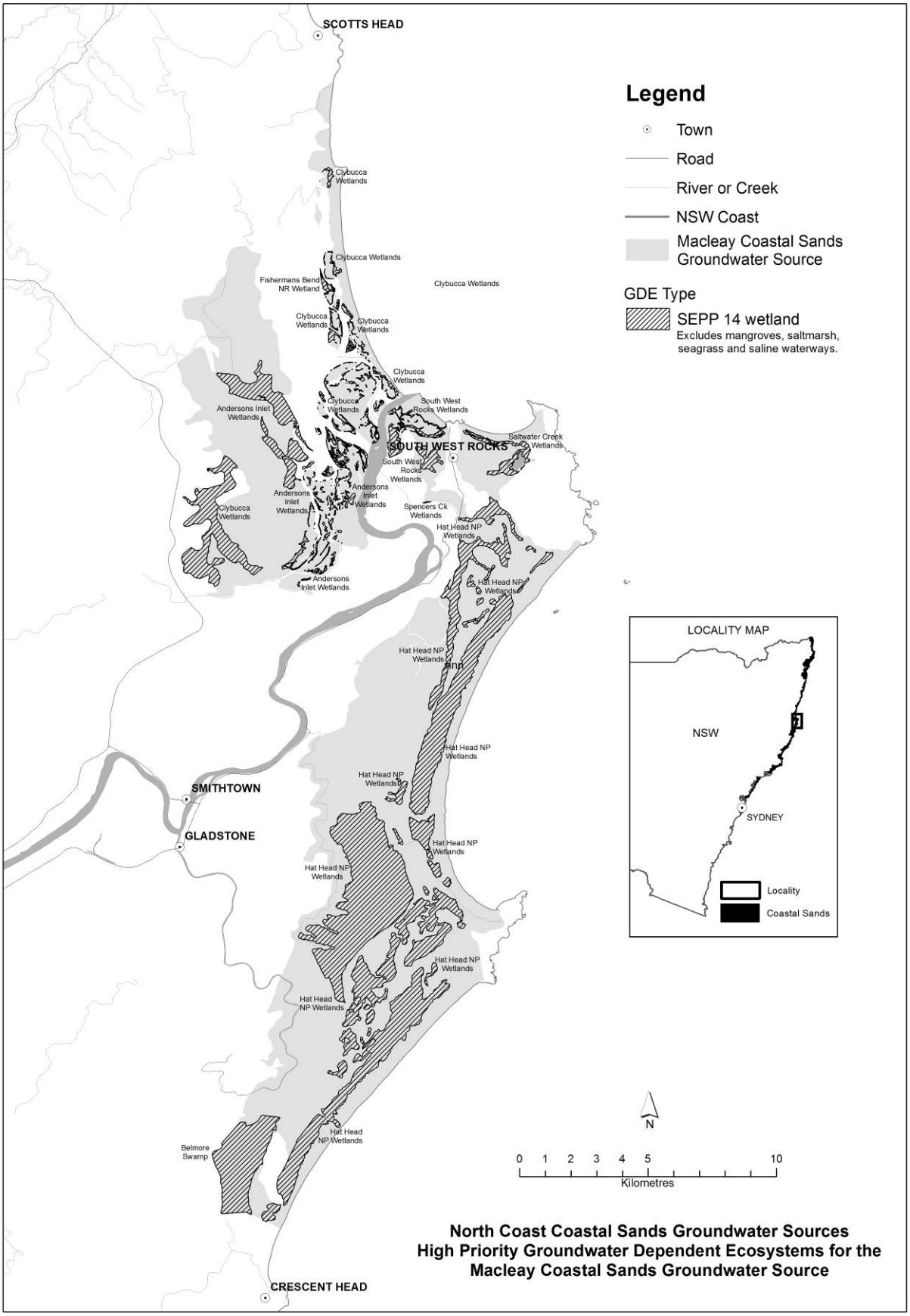

EVANS HEAD
Bundjalung Swamp
Bundjalung NP Swamps
Big Marsh Swamp
Tea Tree Swamp
Little Marsh Swamp
Bundjalung NP Swamps
Bundjalung NP Swamps
Bundjalung NP Swamps
Turkey Island Swamp
Black Swamp
ILUKA
Freeburn Island Swamps
Thorny Island Swamps
YAMBA
Hickey Island Swamps
James Creek Swamp
MACLEAN
Micalo Swamps
Yamba Swamp
Wooloweyah Swamp
Yuraygir NP Swamps
Lake Arragan Wetlands
Cakora Wetlands
Sandon River Wetlands
Black Swamp
Sandon River Swamps
Black Swamp
Black Swamp
Lake Hiawatha Wetlands
Yuraygir NP Wetlands
Solitary Island Wetlands
Yuraygir NP Wetlands
Wooli Wooli Wetlands
Station Creek Wetlands
Saltwater Creek Wetlands
Corrindi River Wetlands
Arrawarra Swamp
ARRAWARRA
ARRAWARRA HEADLAND
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Legend
Town
Road
River
NSW Coast
Clarence Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0 2 4 6 8 10 20
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Clarence Coastal Sands Groundwater Source

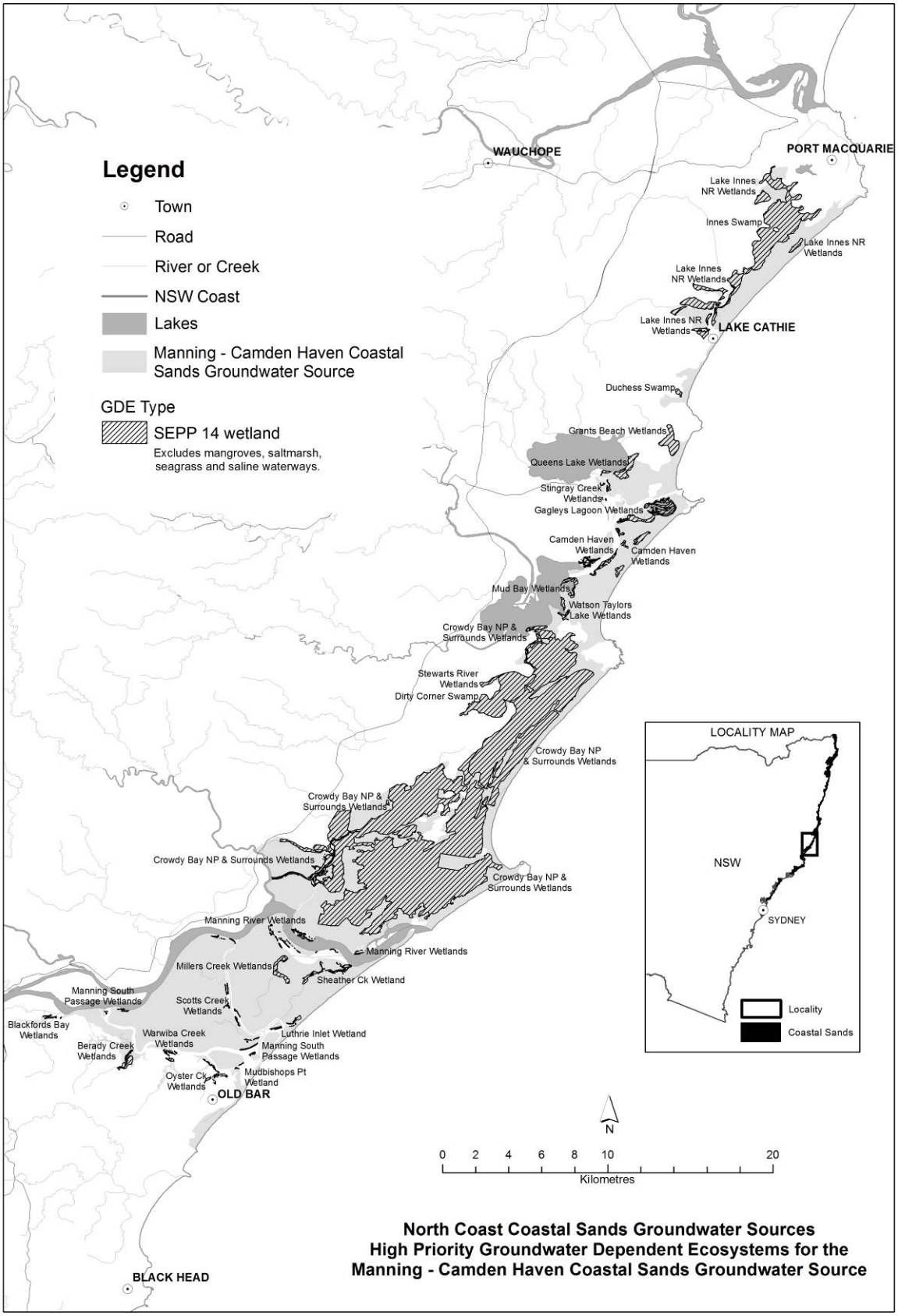

ARRAWARRA HEADLAND
SAFETY BEACH
WOOLGOOLGA
Woolgoolga Wetland
Fiddamans Beach Swamp
MOONEE BEACH
Moonee Beach Swamp
COFFS HARBOUR
Coffs Creek Wetlands
Newport Creek Wetlands
Newport Creek Wetlands
BOAMBEE EAST
Boambee Creek Wetlands
SAWTELL
Pine Creek Wetlands
Pine Creek Wetlands
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Legend
Town
Road
River or Creek
NSW Coast
Coffs Harbour Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0
4.5
9
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Coffs Harbour Coastal Sands Groundwater Source

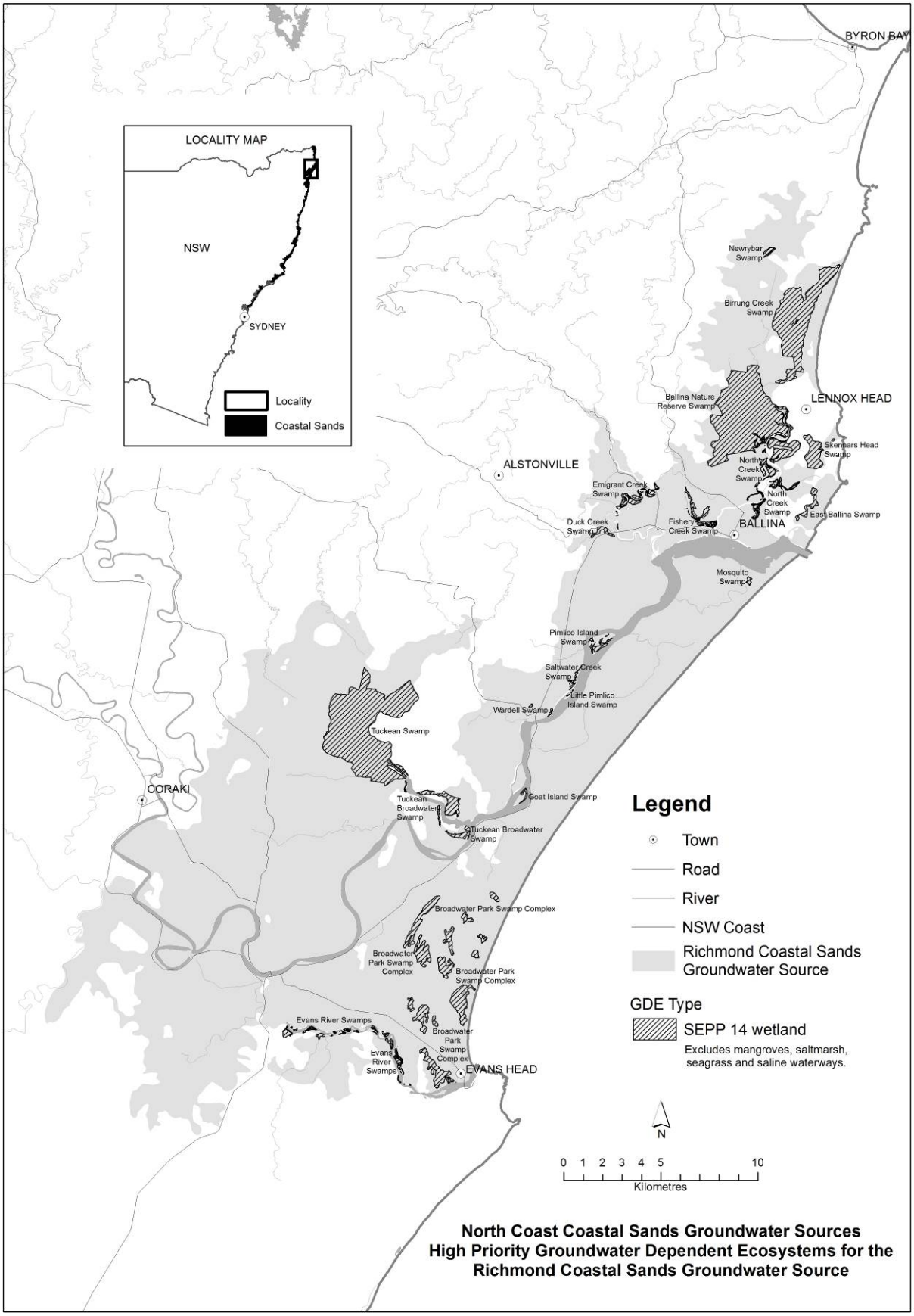

LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Legend
Town
Road
River
NSW Coast
Lakes
Great Lakes Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
Khappinghat Creek Wetlands
Wallabi Pt Wetland
Khappinghat Creek Wetlands
Frogalla Swamp
BLACK HEAD
Bungwahl Creek Wetlands
Wallamba River Swamp
Millers Mistake Creek Wetlands
Wang Wauk Swamp
Gereeba Channel Swamp
Duck Swamp
TUNCURRY
Minimba Creek Wetlands
MacClymonts Ck Wetlands
Ohmas Bay Swamp
Long Is Swamp
Miles Island Swamp
Mather Island Swamp
Coolongolook River Wetlands
FORSTER
Tonys Point Island Wetlands
Regatta Island NR Wetlands
Big Island Wetlands
Wallis Is Wetlands
Pipers Bay Wetlands
Booti Booti SRA Wetlands
Booti Booti SRA Wetlands
Blueys Beach Swamp
Myall Lakes Wetlands
Smiths Lakes Wetlands
Myall Lakes Wetlands
Myall Lakes NP Wetlands
Bulahdelah Wetlands
Myall Lakes NP Wetlands
Myall Lakes NP Wetlands
Myall Lakes NP Wetlands
Myall Lakes NP Wetlands
Myall Lakes NP Wetlands
Nerong Ck Wetlands
Myall Lakes NP Wetlands
Viney Creek Wetland
Myall Lakes NP Wetlands
Myall River Wetland
Myall River Wetland
Tea Gardens Wetland
HAWKS NEST
Hawkes Nest Wetland
Pindimar Wetlands
Jimmys Beach Wetland
Corrie Is Wetland
SOLDIERS POINT
NELSON BAY
N
0 2 4 6 8 10 20
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the
Great Lakes Coastal Sands Groundwater Source

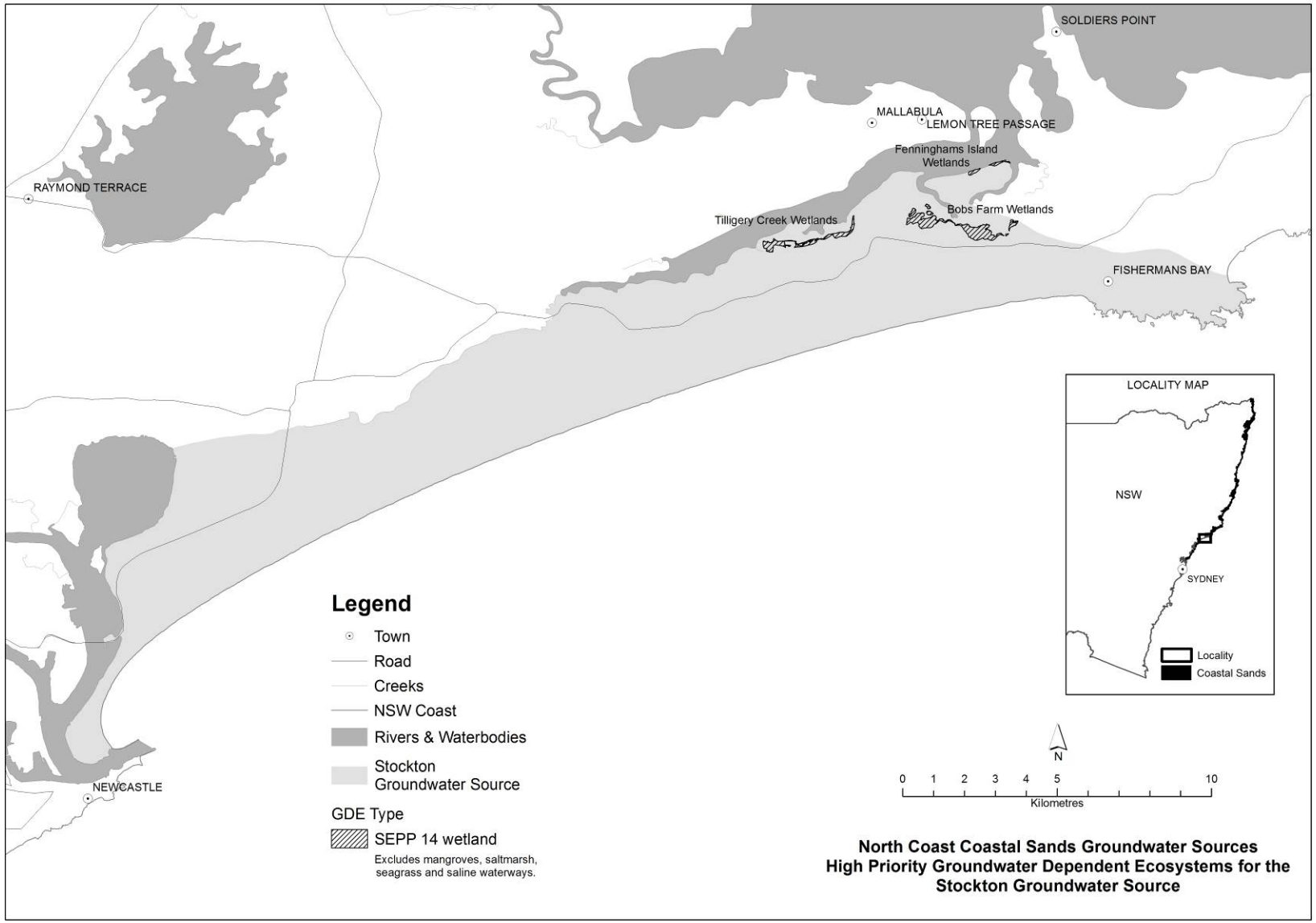

LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Hat Head NP Wetlands
Belmore Swamp
Hat Head NP Wetlands
CRESCENT HEAD
Limeburners Ck NR Wetlands
Goolawah NP Wetland
Limeburners Ck NR Wetlands
Limeburners Ck NR Wetlands
COOPERABUNG
Limeburners Ck NR Wetlands
Maria River Wetlands
Wilsons River Wetlands
TELEGRAPH POINT
Wilsons River Wetlands
Hacks Ferry Wetlands
Limeburners Ck NR Wetlands
LIMEBURNERS CREEK
Hacks Ferry Wetlands
HACKS FERRY
THE HATCH
Limeburners Ck Wetlands
Maria River Wetlands
Limeburners Ck Wetlands
Maria River Wetlands
RIVERSIDE
NORTH SHORE
Hastings River Wetlands
Hastings River Wetlands
FERNBANK CREEK
Hastings River Wetlands
RAWDON ISLAND
SANCROX
Partridge Creek Wetlands
Partridge Creek Wetlands
THRUMSTER
LAKE INNES
Legend
Town
Road
River
NSW Coast
Hastings Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0 1 2 3 4 5 10
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the
Hastings Coastal Sands Groundwater Source

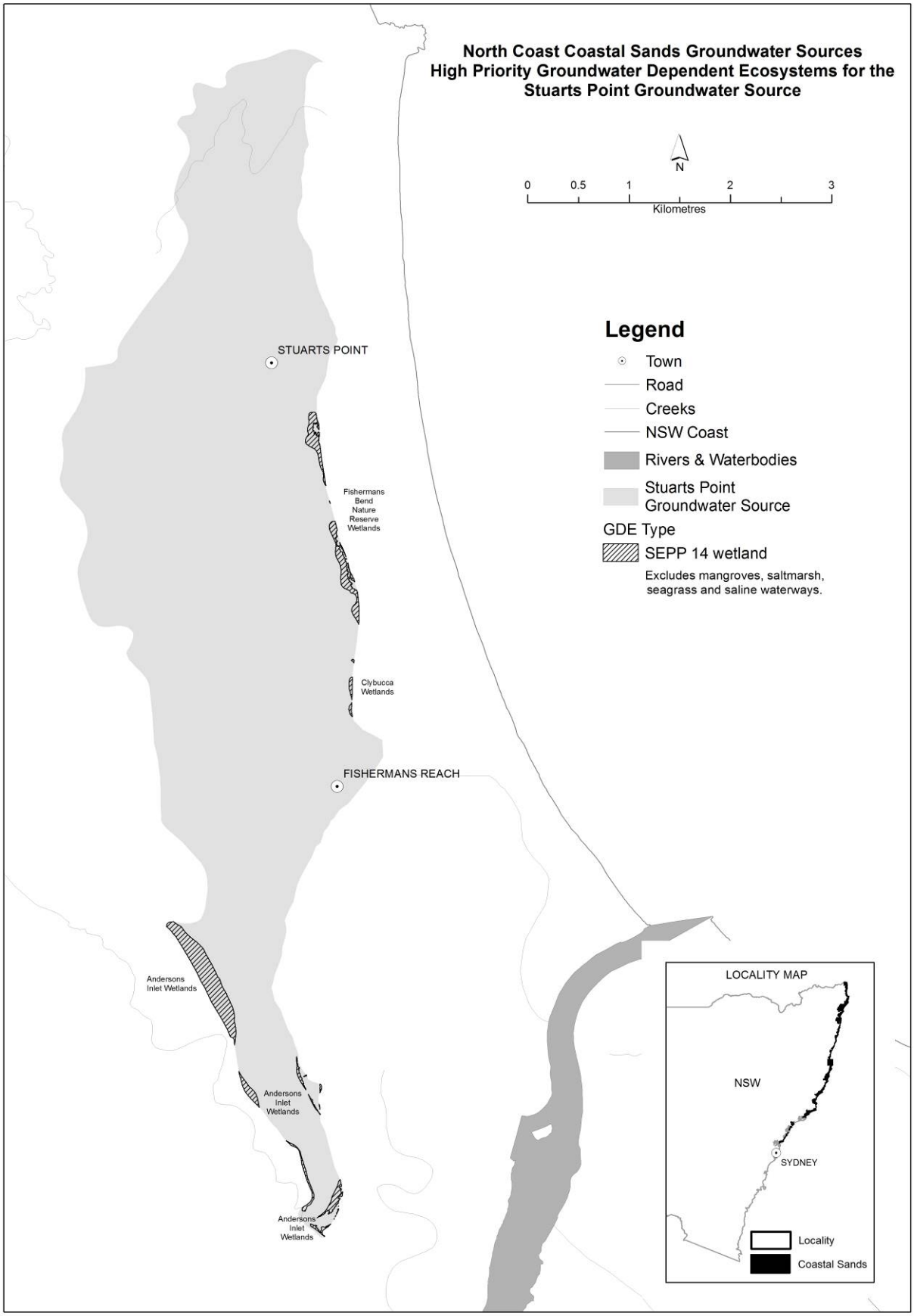

Legend
Town
Road
River
NSW Coast
Lakes
Hawkesbury To Hunter Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
CESSNOCK
KURRI KURRI
Hexham Island Wetland
Ironbark Ck Swamp
Newcastle Wetlands
Kooragang Island Wetlands
NEWCASTLE
Redhead Lagoon
Jewells Swamp
Belmont Lagoon Swamps
Belmont Lagoon Swamps
Blacksmiths Wetland
Coon Island Wetland
Little Pelican Wetlands
Margarets Bay Wetlands 1
Black Neds Bay Wetlands
MORISSET
MORISSET PARK
WYEE POINT
GWANDALAN
MANNERING PARK
LAKE MUNMORAH
Bears Creek Swamp
WYONG
Budgewoi Swamp
Nth Entrance NR Wetlands
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
GOSFORD
GIRRAKOOL
Wamberal Lagoon Wetlands
Terrigal Lagoon Wetlands
Avoca Lake Wetlands
KINCUMBER
Cockle Broadwater Wetlands
Cockrone Lake Wetland
Cockle Broadwater Wetlands
Umina Wetlands
N
0 2 4 6 8 10 20
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Hawkesbury to Hunter Coastal Sands Groundwater Source

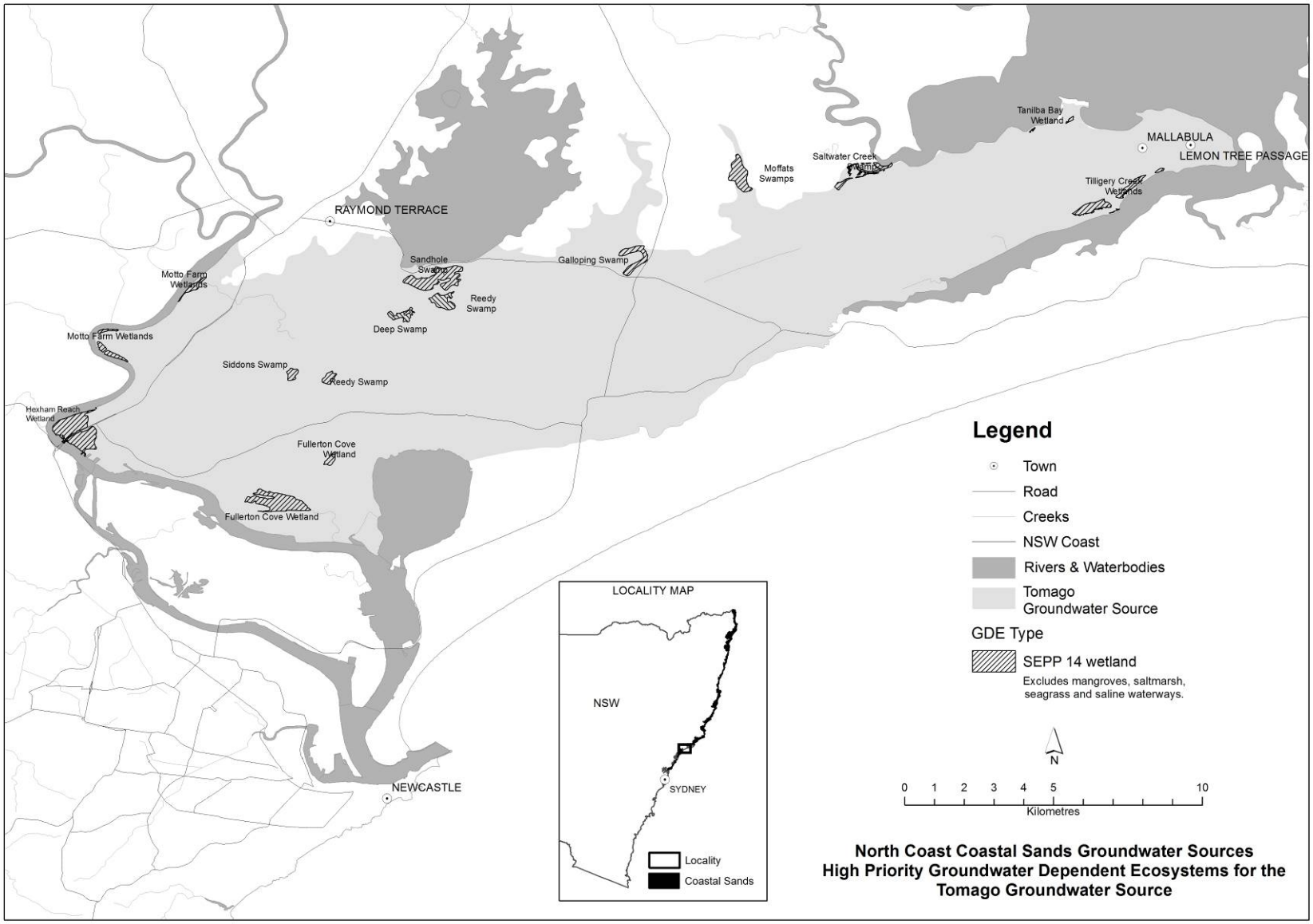

SCOTTS HEAD
Legend
Town
Road
River or Creek
NSW Coast
Macleay Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
Clybucca Wetlands
Fishermans Bend NR Wetland
Andersons Inlet Wetlands
South West Rocks Wetlands
SOUTH WEST ROCKS
Saltwater Creek Wetlands
Spencers Ck Wetlands
Hat Head NP Wetlands
SMITHTOWN
GLADSTONE
Belmore Swamp
CRESCENT HEAD
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
N
0 1 2 3 4 5 10
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the
Macleay Coastal Sands Groundwater Source

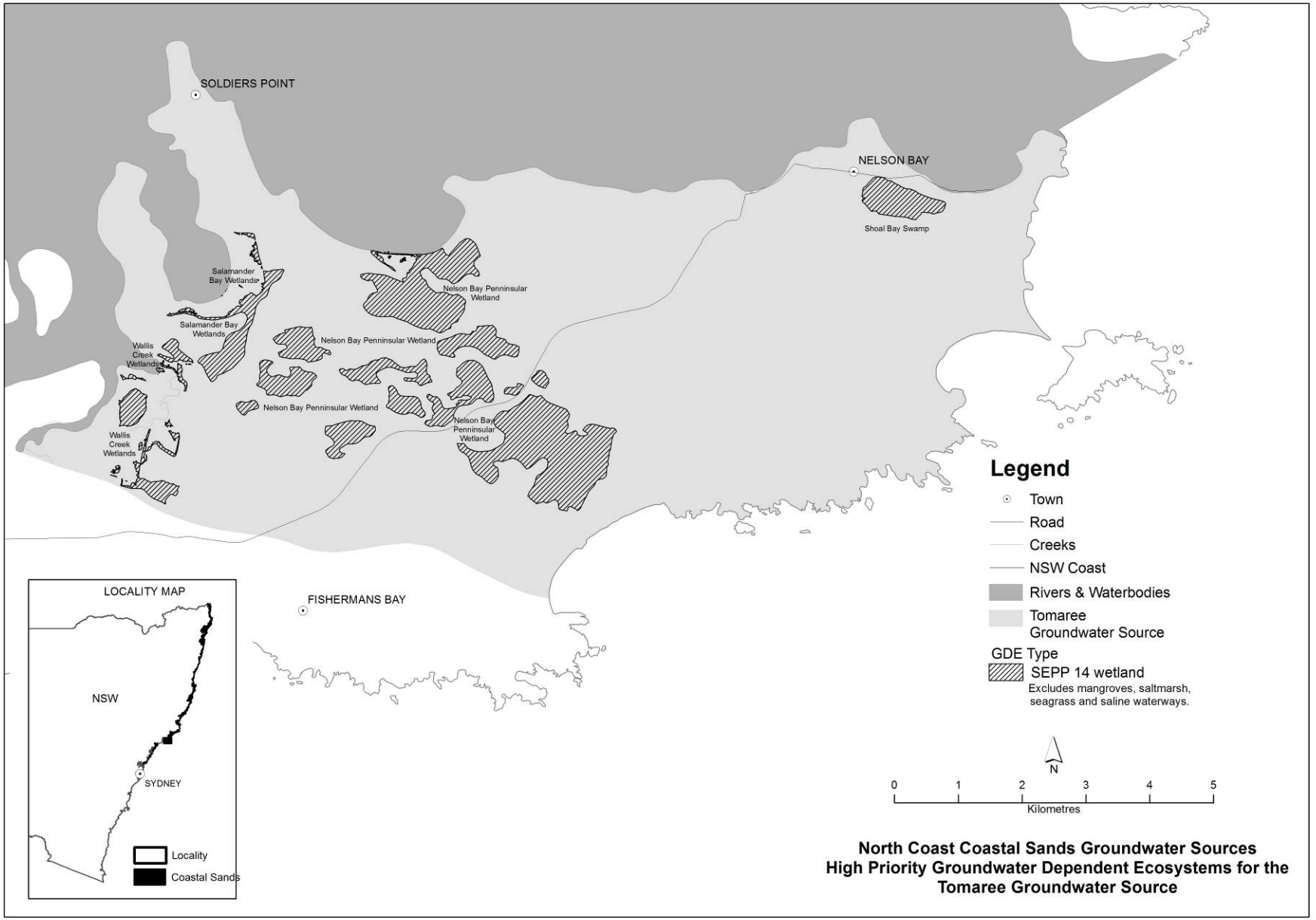

Legend
Town
Road
River or Creek
NSW Coast
Lakes
Manning - Camden Haven Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
WAUCHOPE
PORT MACQUARIE
LAKE CATHIE
OLD BAR
BLACK HEAD
Lake Innes NR Wetlands
Innes Swamp
Duchess Swamp
Grants Beach Wetlands
Queens Lake Wetlands
Stingray Creek Wetlands
Gagleys Lagoon Wetlands
Camden Haven Wetlands
Mud Bay Wetlands
Watson Taylors Lake Wetlands
Crowdy Bay NP & Surrounds Wetlands
Stewarts River Wetlands
Dirty Corner Swamp
Manning River Wetlands
Millers Creek Wetlands
Sheather Ck Wetland
Manning South Passage Wetlands
Scotts Creek Wetlands
Blackfords Bay Wetlands
Warwiba Creek Wetlands
Luthrie Inlet Wetland
Berady Creek Wetlands
Manning South Passage Wetlands
Oyster Ck Wetlands
Mudbishops Pt Wetland
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
N
0 2 4 6 8 10 20
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the
Manning - Camden Haven Coastal Sands Groundwater Source

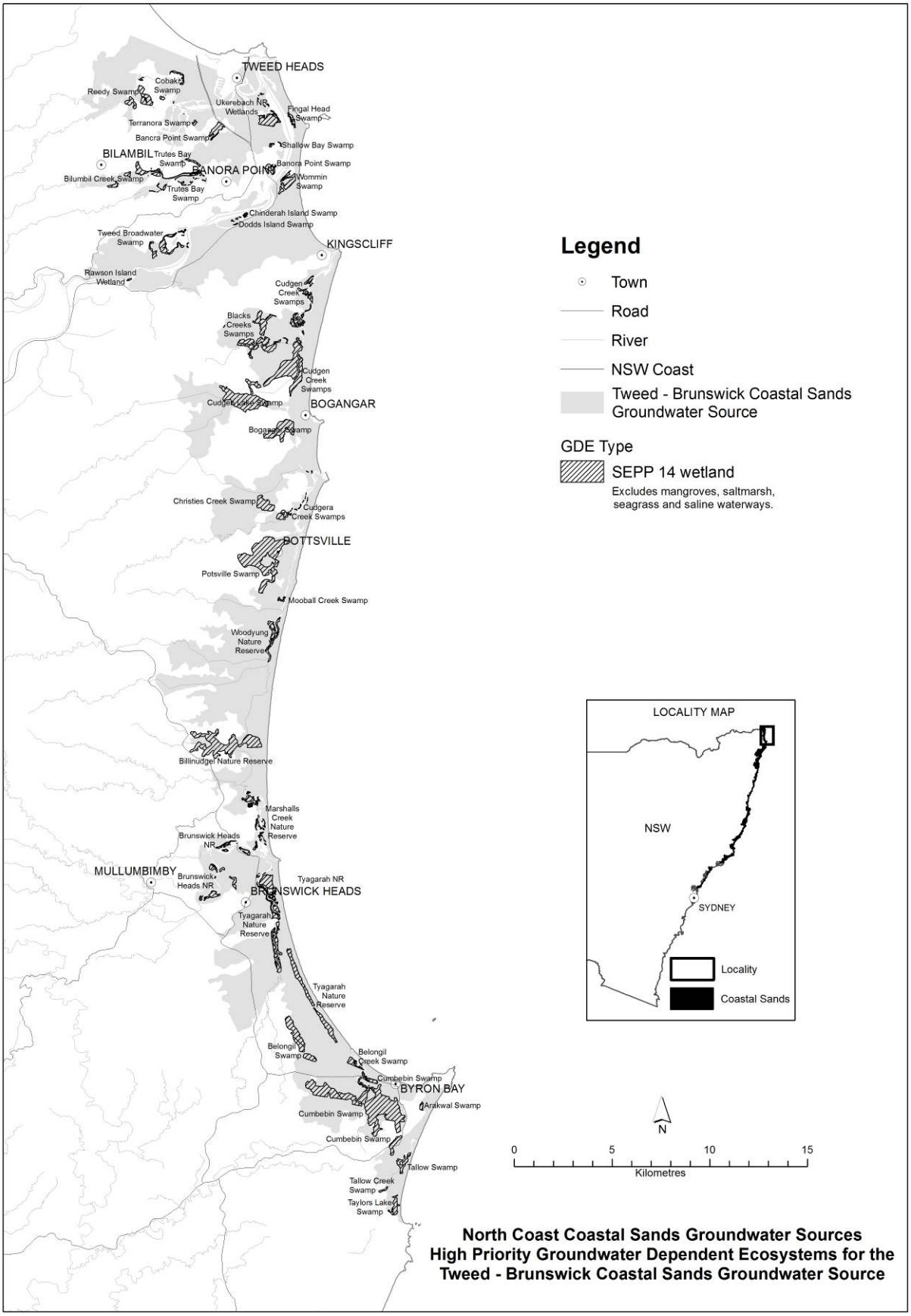

LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
BYRON BAY
LENNOX HEAD
ALSTONVILLE
BALLINA
CORAKI
EVANS HEAD
Newrybar Swamp
Birrung Creek Swamp
Ballina Nature Reserve Swamp
Skennars Head Swamp
North Creek Swamp
Emigrant Creek Swamp
Duck Creek Swamp
Fishery Creek Swamp
East Ballina Swamp
Mosquito Swamp
Pimlico Island Swamp
Saltwater Creek Swamp
Little Pimlico Island Swamp
Wardell Swamp
Tuckean Swamp
Goat Island Swamp
Tuckean Broadwater Swamp
Broadwater Park Swamp Complex
Evans River Swamps
Legend
Town
Road
River
NSW Coast
Richmond Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0 1 2 3 4 5 10
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Richmond Coastal Sands Groundwater Source


SOLDIERS POINT
MALLABULA
LEMON TREE PASSAGE
Fenninghams Island Wetlands
RAYMOND TERRACE
Tilligery Creek Wetlands
Bobs Farm Wetlands
FISHERMANS BAY
NEWCASTLE
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Legend
Town
Road
Creeks
NSW Coast
Rivers & Waterbodies
Stockton Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0 1 2 3 4 5 10
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Stockton Groundwater Source


North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the
Stuarts Point Groundwater Source
N
0
0.5
1
2
3
Kilometres
Legend
Town
Road
Creeks
NSW Coast
Rivers & Waterbodies
Stuarts Point
Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh,
seagrass and saline waterways.
STUARTS POINT
Fishermans
Bend
Nature
Reserve
Wetlands
Clybucca
Wetlands
FISHERMANS REACH
Andersons
Inlet Wetlands
Andersons
Inlet
Wetlands
Andersons
Inlet
Wetlands
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands


RAYMOND TERRACE
NEWCASTLE
MALLABULA
LEMON TREE PASSAGE
Tanilba Bay Wetland
Saltwater Creek
Moffats Swamps
Tilligery Creek Wetlands
Galloping Swamp
Sandhole Swamp
Reedy Swamp
Deep Swamp
Motto Farm Wetlands
Motto Farm Wetlands
Siddons Swamp
Reedy Swamp
Hexham Reach Wetland
Fullerton Cove Wetland
Fullerton Cove Wetland
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Legend
Town
Road
Creeks
NSW Coast
Rivers & Waterbodies
Tomago Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0 1 2 3 4 5 10
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Tomago Groundwater Source


SOLDIERS POINT
NELSON BAY
Shoal Bay Swamp
Salamander Bay Wetlands
Nelson Bay Penninsular Wetland
Salamander Bay Wetlands
Nelson Bay Penninsular Wetland
Wallis Creek Wetlands
Nelson Bay Penninsular Wetland
Nelson Bay Penninsular Wetland
Wallis Creek Wetlands
FISHERMANS BAY
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
Legend
Town
Road
Creeks
NSW Coast
Rivers & Waterbodies
Tomaree Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
N
0 1 2 3 4 5
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the Tomaree Groundwater Source


TWEED HEADS
Cobaki Swamp
Reedy Swamp
Ukerebach NR Wetlands
Fingal Head Swamp
Terranora Swamp
Bancra Point Swamp
Shallow Bay Swamp
BILAMBIL
Trutes Bay Swamp
Banora Point Swamp
BANORA POINT
Bilumbil Creek Swamp
Wommin Swamp
Trutes Bay Swamp
Chinderah Island Swamp
Dodds Island Swamp
Tweed Broadwater Swamp
KINGSCLIFF
Rawson Island Wetland
Cudgen Creek Swamps
Blacks Creeks Swamps
Cudgen Creek Swamps
Cudgen Lake Swamp
BOGANGAR
Bogangar Swamp
Christies Creek Swamp
Cudgera Creek Swamps
BOTTSVILLE
Potsville Swamp
Mooball Creek Swamp
Woodyung Nature Reserve
Billinudgel Nature Reserve
Marshalls Creek Nature Reserve
Brunswick Heads NR
MULLUMBIMBY
Brunswick Heads NR
Tyagarah NR
BRUNSWICK HEADS
Tyagarah Nature Reserve
Tyagarah Nature Reserve
Belongil Swamp
Belongil Creek Swamp
Cumbebin Swamp
BYRON BAY
Arakwal Swamp
Cumbebin Swamp
Cumbebin Swamp
Tallow Swamp
Tallow Creek Swamp
Taylors Lake Swamp
Legend
Town
Road
River
NSW Coast
Tweed - Brunswick Coastal Sands Groundwater Source
GDE Type
SEPP 14 wetland
Excludes mangroves, saltmarsh, seagrass and saline waterways.
LOCALITY MAP
NSW
SYDNEY
Locality
Coastal Sands
N
0
5
10
15
Kilometres
North Coast Coastal Sands Groundwater Sources
High Priority Groundwater Dependent Ecosystems for the
Tweed - Brunswick Coastal Sands Groundwater Source

Appendix 10: Minimum distances for water supply works approvals

Appendix 10A: Rules to minimise interference between bores

These rules apply to new bores not existing or replacement bores.

New bores cannot be located within the following distance (metres) of an existing bore that is not used for basic rights	**200**
New bores cannot be located within the following distance (metres) of an existing bore that is used for basic rights	**50**
New bores cannot be located within the following distance (metres) from the boundary of the property (unless consent gained from neighbour)	**50**
New bores cannot be located within the following distance (metres) from a local or major water utility bore	**300**
New bores cannot be located within the following distance (metres) from a bore used by the dept. for monitoring purposes	**200**
The above distance restrictions do not apply if: the bore is used solely for basic rights; the bore is a replacement bore; the bore is used for monitoring, environmental management or remedial works; or the Minister is satisfied that the location of the bore would result in no more than minimal impact on existing extractions within the water source.	

Appendix 10B: Rules to minimise contamination

These rules apply to new bores and replacement bores not existing bores

New and replacement bores cannot be granted or amended within the following distances (metres) of the plume associated with a contamination source.	**< 250**[11] **250 - 500 (unless drawdown will not occur within 250 m of plume)** **> 500 (if required to protect the groundwater source, environment or public safety)**
These distances may be varied if an applicant can demonstrate that the distance is adequate to protect the groundwater source, its dependent ecosystems and public health and safety. These distances do not apply if the bore is used for monitoring, environmental management or remedial works. These rules do not apply if it is a replacement work in the Stuarts Point Groundwater Source.	

[11] The distance of 250 m is the distance recommended for on-site sewage systems in the NSW Government report Environment and Health Protection Guidelines. On-site sewage management for single households.

Appendix 10C: Rules to protect environmentally sensitive areas

These rules apply to new bores not existing or replacement bores

New bores that are used for basic rights cannot be located within the following distance (metres) of a high-priority GDE[12]	**100**
New bores that are not used for basic rights cannot be located within the following distance (metres) of a high-priority GDE or the outside perimeter of a National Park estate.	**100 (for bores < 20 ML/yr)** **400 (for bores 20 - 100 ML/yr)** **800 (for bores > 100 ML/yr)**
New bores that are not used for basic rights cannot be located within the following distance (metres) of a river or stream (1st, 2nd or 3rd order)	**40**
• These rules do not apply to water supply works (bores) used for monitoring, environmental management purposes or remedial work. • The distance from a GDE may be varied for an applicant if a hydrogeological study is undertaken which demonstrates no drawdown of the groundwater at the outside edge of the GDE listed in the Plan. • The distance from the outside perimeter of a National Park estate may be varied or waivered if the Minister is satisfied that no more than minimal impact will occur to any groundwater dependent vegetation in the nearby National Park estate. • These specified distances may be amended, or high-priority GDEs identified within the plan may be added or removed, based on further studies of groundwater ecosystem dependency undertaken by the Minister.	

Appendix 10D: Rules for water supply works located near potential acid sulfate soils

These rules apply to new bores not replacement bores used for Basic Landholder Rights or existing bores.

A water supply work approval must not be granted within an area classed as having a high probability of occurrence of acid sulfate soils as shown on the Acid Sulfate Soil Risk Map maintained by the NSW Office of Environment and Heritage if, in the Minister's opinion, granting the water supply work approval would result in a significant risk of acidification of the groundwater source.
The Minister may require the applicant to submit a study to demonstrate that construction of a water supply work within an area classed as having a high probability of occurrence of acid sulfate soils would not, in the Minister's opinion, result in acidification of the groundwater source and that the works have been constructed according to industry best practice guidelines.

[12] GDE = groundwater dependent ecosystems – see below for list of Stage 1 GDEs present in this groundwater source.

Appendix 10E: Rules to protect groundwater dependent culturally significant sites

These rules apply to new bores not existing or replacement bores

New bores that are used for basic rights cannot be located within the following distance (metres) of a groundwater dependent culturally significant site	**100**
New bores that are not used for basic rights cannot be located within the following distance (metres) of a groundwater dependent culturally significant site	**200**
• Where a culturally significant site is also a high-priority GDE, the more restrictive distance restriction applies to the granting or amendment of a water supply work approval. • These distances restrictions do not apply if: the bore is used for monitoring, environmental management or remedial works or if the Minister is satisfied that the location of the bore at a lesser distance would result in no greater impact on the groundwater source and its groundwater dependent culturally significant sites.	

Appendix 10F: Rules for amending water supply work approvals for replacement groundwater works

The existing water supply work must have a water supply work approval

- the replacement groundwater work must be constructed to extract water from the same water source as the existing water supply work
- the replacement groundwater work must be constructed to extract water from:
  - the same depth as the existing water supply work; or
  - a different depth if the Minister is satisfied that doing so will result in no greater impact on a water source or its dependent ecosystems
- the replacement groundwater work must be located:
  - within 20 metres of the existing water supply work; or
  - a distance greater than 20 metres of the existing water supply work if the Minister is satisfied that doing so will result in no greater impact on a water source or its dependent ecosystems
- if the existing water supply wok is located within 40 metres of the high bank of a river, the replacement groundwater work must be located:
  - within 20 metres of the existing water supply work but no closer to the high bank of the river; or
  - more than 20 metres of the existing water supply work, but no closer to the high bank of the river, if the Minister is satisfied that doing so will result in no greater impact on a water source or its dependent ecosystems
- the replacement groundwater work must not have a greater internal diameter or excavation footprint than the existing water supply work, except where the internal diameter of the casing of the existing water supply work is no longer manufactured, in which case the internal diameter of the replacement groundwater work is to be no greater than 110 per cent of the internal diameter of the existing water supply work it replaces.

Appendix 11: Interagency Regional Panel and support staff

Appendix 11A: Interagency Regional Panel membership and expertise

Name	Agency	Role	Expertise
Dave Miller	Department of Primary Industries, Water	Agency Representative	Natural resource management and water management
Toong Chin	Office of Environment and Heritage	Agency Representative	OEH regional input to water reforms, conservation issues
Rik Whitehead	Department of Primary Industries, Agriculture	Agency Representative	NSW DPI regional input to water reforms, agriculture, catchment management and landuse / strategic planning.
Jai Sleeman	North Coast Local Land Services	Observer	Catchment management, local knowledge
Nigel Blake	North Coast Local Land Services	Observer	Catchment management, local knowledge

Table 11B: Support staff membership and expertise

Name	Agency	Role	Expertise
Nicky Smith	Department of Primary Industries, Water	Plan Coordinator	Groundwater management, facilitation and consultation
Bethany Hanson	Department of Primary Industries, Water	Plan Coordinator/Plan Support	Groundwater management, facilitation and consultation
Sally Hunt / Frances Guest	Department of Primary Industries, Water	Plan Writer	Water planning and policy
Peter Hackett	Department of Primary Industries, Water	Water Regulation	Groundwater licensing
Chris Rumpf	Department of Primary Industries, Water	Hydrogeological support	Groundwater Management
John Williams	Department of Primary Industries, Water	Hydrogeological support	Groundwater Management
Richard Green	Department of Primary Industries, Water	Hydrogeological support	Groundwater Management
Georgina Spencer	Department of Primary Industries, Water	Geographic Information System support	Map production
Cathy Cole	Department of Primary Industries, Water	Lower Hunter Water plan Project Manager	Regional Water Strategies
Eddie Harris	Department of Primary Industries, Water	National Water Initiative	Regional Water Strategies