Hydrosphere Consulting

Richmond River Estuary Coastal Management Program - Protecting our Estuary and its Catchment

Stage 1: Scoping Study

Final

March 2023

ballina shire council

lismore city council

Richmond Valley Council

ROUS COUNTY COUNCIL

Byron Shire Council

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Acknowledgement of Country:

Hydrosphere Consulting acknowledges the Bundjalung and Githabul Nations, traditional custodians of the lands discussed in this Scoping Study and pay tribute and respect to the Elders both past, present and emerging.

Cover page photos: clockwise from top left: Richmond River Headwaters (RCC), Upper Wilsons River, riparian restoration community tree planting (RCC), Wilsons River at Wyrallah, lower Emigrant Creek, bank erosion – mid-Richmond (RCC)

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JOB 21-016: RICHMOND RIVER ESTUARY COASTAL MANAGEMENT PROGRAM SCOPING STUDY

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EXECUTIVE SUMMARY

Rous County Council, Ballina Shire Council, Lismore City Council and Richmond Valley Council are partnering with the NSW Government to deliver the Richmond River Estuary Coastal Management Program (CMP). The aim of the CMP is to update the 2011 *Coastal Zone Management Plan for the Richmond River Estuary* in line with the NSW Coastal Management Framework and establish a management approach that will address issues and activities impacting the health of the estuary including catchment issues that are critical to estuary health. This approach means the CMP also includes the participation of all local councils with local government areas within the Richmond River catchment including Kyogle Council and Byron Shire Council.

Stage 1 of the CMP development (this document) is a Scoping Study which sets out the remainder of the coastal planning process for the Richmond River estuary:

- Stage 2 – determine risks, vulnerabilities and opportunities.
- Stage 3 – identify and evaluate options.
- Stage 4 – prepare, exhibit, finalise, certify and adopt the CMP.
- Stage 5 – implement, monitor, evaluate and report.

The study area includes the entire Richmond River catchment from the freshwater upper reaches to the estuary, excluding urban areas and the coastline at Ballina and Evans Head which are the subject of separate CMPs. The study area includes areas mapped in Chapter 2 (Coastal Management) of the *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP) as coastal wetland and littoral rainforest areas, coastal environment areas and coastal use areas within the estuarine extent of the river.

The people of the Bundjalung and Githabul Nations are the traditional custodians of the Richmond River estuary and its catchment. Their original occupation and custodianship of the lands and waters of the study area dates back many thousands of years. First Nations heritage and connection to land and water country are inseparable aspects. Healthy waterways and “sea country” are essential for First Nations people for health, wellbeing and culture as they allow kinship, connection, stories, song lines and healing. The ongoing use and relationship to country by First Nations people is recognised with their successful Native Title determinations over lands and waterways within the catchment.

The Richmond River estuary and its catchment encompasses a broad range of natural features ranging from elevations of over 1,100 m above sea level in the Border Ranges, Richmond Ranges and Nightcap National Parks, through mid-catchment valleys to the estuary flowing to the Pacific Ocean at Ballina. The eastern part of the catchment is defined by a very large coastal floodplain, which covers an area of over 1,000 km^2. The Richmond River is within an area of extremely high biodiversity, resulting from the wide range of soil types, climate and topography across the region. The region has the third highest level of biodiversity in Australia and contains significant ecological features. Locals and visitors place a high value on the abundance of natural resources, uncrowded areas for nature-based recreation and scenic amenity. Waterways provide a place for recreation, social interaction, tourism activities and economic benefits for the local community.

Despite the high value placed on the natural attributes of the Richmond River estuary by the community, the majority of the system and particularly the upper and mid estuary are in a degraded state. Environmental monitoring and assessment have repeatedly reported poor aquatic ecosystem health across a number of indicators including water quality, riparian and bank condition and the diversity, abundance and physical condition of living organisms. Major fish kills have occurred repeatedly at various locations in the estuary during episodes of extremely poor water quality often following floods in 2001, 2008 and to a lesser extent in 2020 and 2022.

Stakeholders regard the health of the Richmond River estuary as the central most important aspect that influences other factors such as cultural connection, on-going commercial use and social enjoyment of the estuary. Protecting the health of the estuary is a pre-requisite for protecting these uses and values of the estuary. The major ecosystem health challenges facing the estuary are linked to its inherent physical characteristics coupled with the significant catchment, waterway and floodplain modifications that have occurred since European settlement. Broadscale clearing of native forests, draining of wetland areas and conversion of natural areas to agricultural and urban lands occurred and was historically supported by the Commonwealth and state governments through a range of incentive schemes to improve productivity and economic prosperity at that time. Urban development has affected estuarine processes through changes to hydrologic characteristics and vegetation and the discharge of pollutants through stormwater runoff and point source pollution such as treated sewage discharges. Agricultural land within the catchment has been shown to contribute significant sediment, chemical and nutrient loads to the estuary primarily during runoff (rain) events. The natural physical and climatic characteristics of the catchment that interact with and exacerbate the impact of human pressures include the highly erodible soils and moderate to steep slopes in the mid and upper catchment, acid sulfate soils (ASS) on the floodplain/ tidal flats, high annual rainfall and regular occurrence of flood events as a result of ex-tropical cyclones and east coast lows that occur close to the coast. Climate change impacts including sea level rise and increases in the frequency and severity of extreme weather events will exacerbate and intensify many current issues affecting estuary health.

The key threats to the Richmond River estuary have been prioritised in this Scoping Study. Due to the large geographical area and the range of environmental and social values of the study area, there are several key management threats to be considered in the CMP. The locations and threats with a high risk in the current timeframe are summarised as follows:

- Lowest lying areas of the Richmond River Floodplain (e.g. Tuckean Swamp, Rocky Mouth Creek and Bungawalbin/ Sandy Creek) – acid sulfate soil runoff, blackwater events, hydrological modification of wetlands and floodplain drainage works, floodgate design, operation and maintenance.
- Various locations across the rural areas of the catchment – agricultural diffuse source runoff, clearing of riparian and adjacent habitat, uncontrolled stock access to and grazing within the riparian zone, dominance of invasive weeds, catchment flooding, modified freshwater flows.
- Freshwater tidal pool of Richmond River between Woodburn and Lismore and the Richmond River near Casino – potentially toxic cyanobacteria blooms.
- All areas – bushfire, increase in extreme weather events (e.g. flood and drought), lack of suitable buffer zones between land use and waterways, bank erosion, damage to cultural heritage items/ sites, lack of comprehensive, integrated ecosystem monitoring strategy and reporting system,

inadequate, inefficient regulation (agencies), licensed industrial point sources (e.g. quarries, food processing etc.) and insufficient public land available to establish stewardship sites to offset loss of native vegetation through land development.

Emerging threats (next 50 years) are:

- Tidal extent of the Richmond River including the Richmond River Floodplain, Tuckean Swamp, Emigrant and Maguires Creek, Bungawalbin, Myrtle and Sandy Creek – increasing tidal inundation, man-made barriers to migration of fringing vegetation communities (e.g. mangrove, saltmarsh) with sea level rise and increased salinity in the upper estuary.
- All areas – increase in extreme weather events (e.g. flood and drought), increased bushfire risk, increasing population and demand for water resources and land development, increase in mosquito-borne diseases.

Accurate and detailed information about risk and consequence is necessary to assist decision makers generate effective management strategies which identify and prioritise future actions and investment. Stakeholder consultation undertaken as part of this Scoping Study has identified significant support for on-ground works and less support for further studies. However, some strategic planning is recommended to focus efforts and ensure cost-effectiveness.

The task of improving the health of the Richmond River estuary continues to be substantial, complex and multi-faceted and the difficulties in implementing the previous CZMP actions due to ineffective governance and administration reflect these complexities. The key challenge for the Richmond River Estuary CMP will be to identify and implement targeted on-ground works that will result in significant improvements in estuary health.

There is a growing community sentiment towards actively addressing environmental issues and improving the health of the Richmond River estuary and this has been reflected in state, regional and local planning policy as well as some local industry guidelines. Implementation of on-ground actions is occurring across the catchment as a part of many different local and state government supported projects, community programs and industry-led initiatives. Actions aim to improve soil health, revegetate and rehydrate landscapes and riparian zones, remove stock access to waterways, address bank erosion, improve management of floodplain infrastructure to reduce ASS and blackwater impacts and better manage stormwater and wastewater systems in urban areas. Some local councils and industry groups have had success offering ‘opt-in’ incentive programs for landholders to carry out on-ground works, highlighting the co-benefits of farm productivity improvements and positive environmental outcomes.

Despite the high level of technical knowledge and growing community support for addressing the identified issues, there remains several barriers to effective implementation of the recommended on-ground works at a sufficient scale to significantly improve the health of the Richmond River estuary. Community and stakeholder feedback indicates there is frustration with repeated studies and plans with limited on-ground change.

The majority (73%) of the Richmond River catchment is freehold land under private ownership and effective change in estuary health will require active engagement and participation of landholders. A major impediment is the perceived loss of income and reduction in resale value that is expected to result from the changes to land use and management practices required to achieve environmental benefits. As there are no policy, regulatory or financial mechanisms in place to encourage or enforce changes to land use and

management practices, landowner goodwill and desire is required to implement these changes. A focus on engaging landholders in catchment management solutions is required to continue to build on the work already undertaken and the growing support for sustainable land use practices and improved environmental outcomes. Other barriers to achievement of river health improvements are related to the difficulties in regulating diffuse water pollution, the long-term acceptance of current land uses, the lack of positive environmental outcomes required by some industries and the expectation that restoration of private land will be funded by governments.

A number of studies are currently being undertaken in parallel with the CMP process and these are expected to address many knowledge gaps associated with priority threats to river health. Additional studies are required in Stage 2 to fill remaining data gaps and allow progression of the CMP to Stage 3. The identified studies include strategic planning for on-ground works, development of an estuary health monitoring strategy, development of cultural recognition/ awareness projects, identification of funding options, and assessment of tidal inundation risks.

The CMP process represents an opportunity to focus on strategic on-ground actions that are rationalised and prioritised. The CMP will set a long-term strategy for the coordinated management of the Richmond River estuary, including actions within the catchment that impact on estuary health and seek to improve the values of the study area for current and future generations. RCC will coordinate the development of the CMP on behalf of the estuary and catchment councils. The estuary and catchment councils will collaborate with land managers, state government agencies, industry and community representatives to provide effective coastal management outcomes. The CMP development will continue over the next three years with the estimated costs and timing to deliver stages 2 to 4 of the CMP development as follows:

- Stage 2: between $520,000 and $1,205,000 (21 months: July 2023 – March 2025).
- Stage 3: between $70,000 and $100,000 (4 months: July 2025 – December 2025).
- Stage 4: between $65,000 and $90,000 (6 months: January 2026 – June 2026).

The estuary and catchment councils will seek funding from the NSW Department of Planning and Environment Coastal and Estuaries Grants Program to ensure affordability of the CMP development. Ongoing stakeholder liaison will be a key component of the CMP development.

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1. INTRODUCTION

Rous County Council (RCC), Ballina Shire Council (BaSC), Lismore City Council (LCC) and Richmond Valley Council (RVC) are partnering with NSW Government to prepare a Coastal Management Program (CMP) for the Richmond River estuary in collaboration with Kyogle Council (KC), Byron Shire Council (BySC) and catchment stakeholders. The current CZMP for the Richmond River estuary will be updated and incorporated into the CMP in accordance with the NSW Coastal Management Framework. Stage 1 of the CMP development (this document) is a Scoping Study which sets out the remainder of the coastal planning process for the Richmond River. This Scoping Study has been prepared by the local councils within the Richmond River catchment with assistance from the NSW Department of Planning and Environment (DPE). The development of the Scoping Study involved collaboration with a range of stakeholders involved in the management of the estuary, floodplain and waterways of the Richmond River.

This Scoping Study:

- Sets out the strategic, environmental, social, cultural and management context for the CMP.
- Identifies issues and opportunities affecting the study area now, and those that are considered likely in the future.
- Includes review of existing plans and documents to identify actions and strategies which have been completed, and outstanding actions that will be considered for inclusion in the CMP.
- Assesses the adequacy of existing management arrangements including current and planned actions.
- Includes a first-pass risk assessment and an analysis of knowledge gaps to inform decisions specified in a preliminary business case addressing the need for, and scope of detailed studies to be undertaken.
- Includes a forward program for subsequent stages of the CMP.

The Scoping Study has been compiled from existing studies and data sets, stakeholder consultation activities, reports/studies and spatial data sets. Supporting information is available to provide further details on specific topics:

- *Richmond River CMP Stakeholder Feedback* (Hydrosphere Consulting, 2021a).
- *Richmond River CMP Stage 1: Status of Existing Management Actions* (Hydrosphere Consulting, 2021b).
- *Richmond River CMP Stage 1: Literature Review* (Hydrosphere Consulting, 2021c).

1.1 The Coastal Management Framework in NSW

The *Coastal Management Act 2016* establishes the framework and overarching objectives for coastal management in NSW and supports the aims of the *Marine Estate Management Act 2014* to provide for strategic and integrated management of the whole marine estate – marine waters, coasts and estuaries. The *Coastal Management Act 2016* communicates the NSW Government's vision for coastal management and reflects the vital natural, social, cultural and economic values of our coastal areas and promotes the principles of ecologically sustainable development in managing these values. The legislative and policy framework recognises natural coastal processes and the local and regional dynamic character of the coast and promotes land use planning decisions that accommodate them. The framework promotes coordinated planning and management of the coast and supports public participation in these activities (Figure 1).

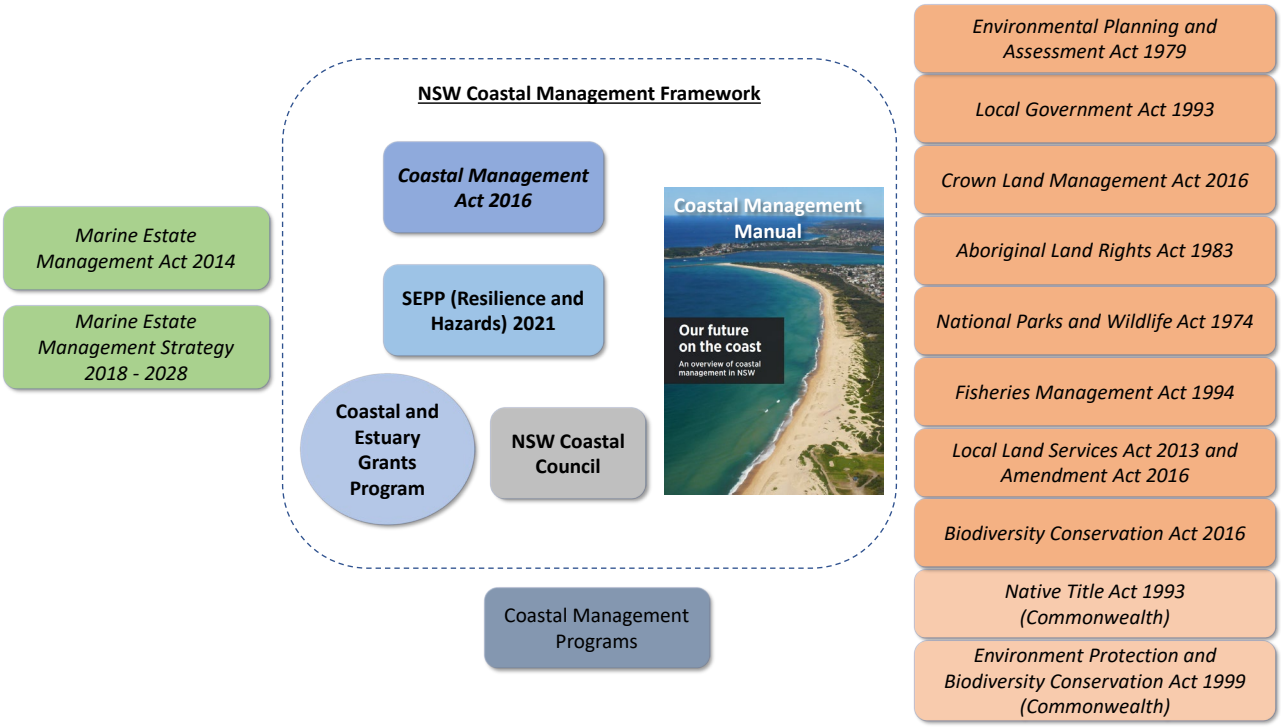

Figure 1: NSW coastal management framework

The *NSW Coastal Management Manual* (OEH, 2018a and 2018b, the Manual) provides guidance for developing a CMP and assists councils in addressing the requirements of the *Coastal Management Act, 2016*. The Manual outlines the mandatory requirements and provides guidance on the preparation, development, adoption and content of a CMP. It includes a process for councils to follow when identifying and assessing coastal environmental, social and economic values and evaluating management actions. It also contains guidance on the integration of a CMP into Council's Integrated Planning and Reporting (IP&R) framework and land use planning. The Manual outlines a five-stage process for developing and implementing a CMP (Figure 2). This report addresses Stage 1 of the CMP process for the Richmond River.

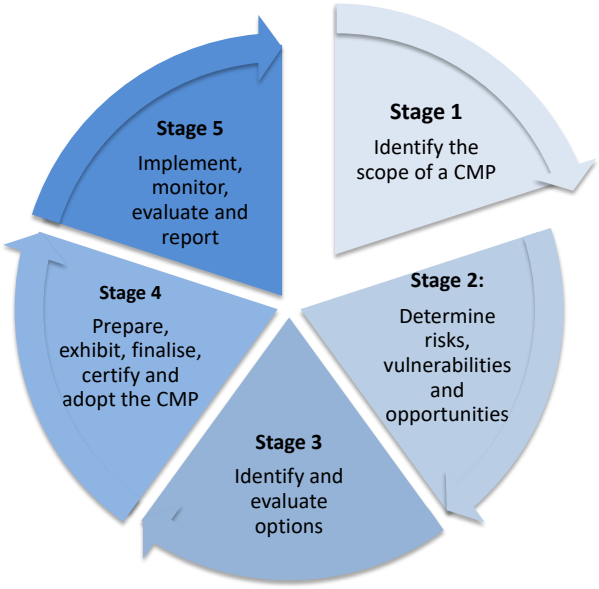

Figure 2: The five-stage process for developing a coastal management program

Source: Adapted from OEH (2018a)

1.2 Richmond River Catchment

The Richmond River catchment extends from the Queensland border in the north, Tenterfield Shire and Clarence Valley Council areas in the west to the Clarence River catchment at its south-eastern border. The headwaters of the Richmond River originate in the Border Ranges National Park, Nightcap Ranges and Richmond Ranges and flow through the catchment valleys and floodplains, entering the Pacific Ocean at Ballina. The main tributary of the Richmond River is the Wilsons River, which enters the Richmond River on the coastal plain at Coraki. The tidal influence extends upstream of Tatham on the Richmond River and upstream of Lismore on the Wilsons River. Eden Creek, Shannon Brook and Bungawalbin Creek are significant tributaries draining the western and southern areas of the Richmond River catchment. The estuary includes all tidal waters of the Richmond River and incorporates river foreshores and adjacent lands.

The key ecosystem health challenges facing the Richmond River estuary are linked to its physical characteristics including the large catchment area (6,850 km^2), large floodplain (> 1,000 km^2) and small water surface (19 km^2) relative to the catchment area, coupled with the significant catchment modifications that have occurred since European settlement. With this substantial catchment area and land use modifications, the management of the Richmond River catchment has a significant impact on the health of the estuary and coastal zone. While there are a number of localised management plans and on-ground catchment management actions currently being implemented within the Richmond River catchment, there is not currently a whole-of-catchment management plan or similar document cognisant of the diverse nature of existing catchment characteristics, linkages and current actions to comprehensively guide future management and investment in the region.

Plate 1: Richmond River waterways

Clockwise from top left: Roseberry Creek in the upper catchment; Wilsons River at Boatharbour mid-catchment; Wilsons River at Wyrallah on the upper floodplain; Lower Richmond River estuary at West Ballina

Through stakeholder consultation, the *Richmond River Governance and Funding Framework* (Alluvium, 2019a) identified the need for a whole-of-catchment approach to ensure inclusive and equitable governance, recognising the interests of the large number of stakeholders and the need to support and promote collaboration and effective communication. While governance barriers exist, stakeholders agree on the need to focus on whole-of-catchment protection and enhancement of these values. Collaboration relies on a shared catchment understanding of the whole-of-system needs. The Richmond River Estuary CMP will provide a whole-of-catchment perspective for the coastal management planning process which recognises the influence of the catchment issues and activities on the health of the coastal zone.

1.3 Study Area

The study area for the CMP Scoping Study is defined by the catchment boundary of the Richmond River to the Richmond River and Evans River estuaries but not including the urban areas or coastline at Ballina and Evans Head. The study area excludes detailed consideration of the coastal zone areas that are covered in existing plans that are either certified or planned to be certified (CZMPs and CMPs) or as part of the future coastline CMPs as discussed below. The spatial extent of the study area is illustrated on Figure 3.

The study area includes areas mapped in Chapter 2 (Coastal Management) of the *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP) as coastal wetland and littoral rainforest areas (CWLRA) mostly within Ballina and Richmond Valley LGAs with a small component in the Byron and Lismore LGAs. The coastal environment area (CEA) and coastal use area (CUA) cover the estuarine extent of the river within Ballina, Richmond Valley and Lismore LGAs with a small component in the Byron Shire. The CUA, CEA and CWLRA as mapped in the Resilience and Hazards SEPP and the marine areas (below low water mark within estuaries) included in the study area are shown on Figure 4. The coastal vulnerability area (CVA) is not yet mapped in the SEPP. Coastal management areas mapped within the study area are discussed further in Section 5.1.

Figure 3: Study area for the Richmond River Estuary CMP

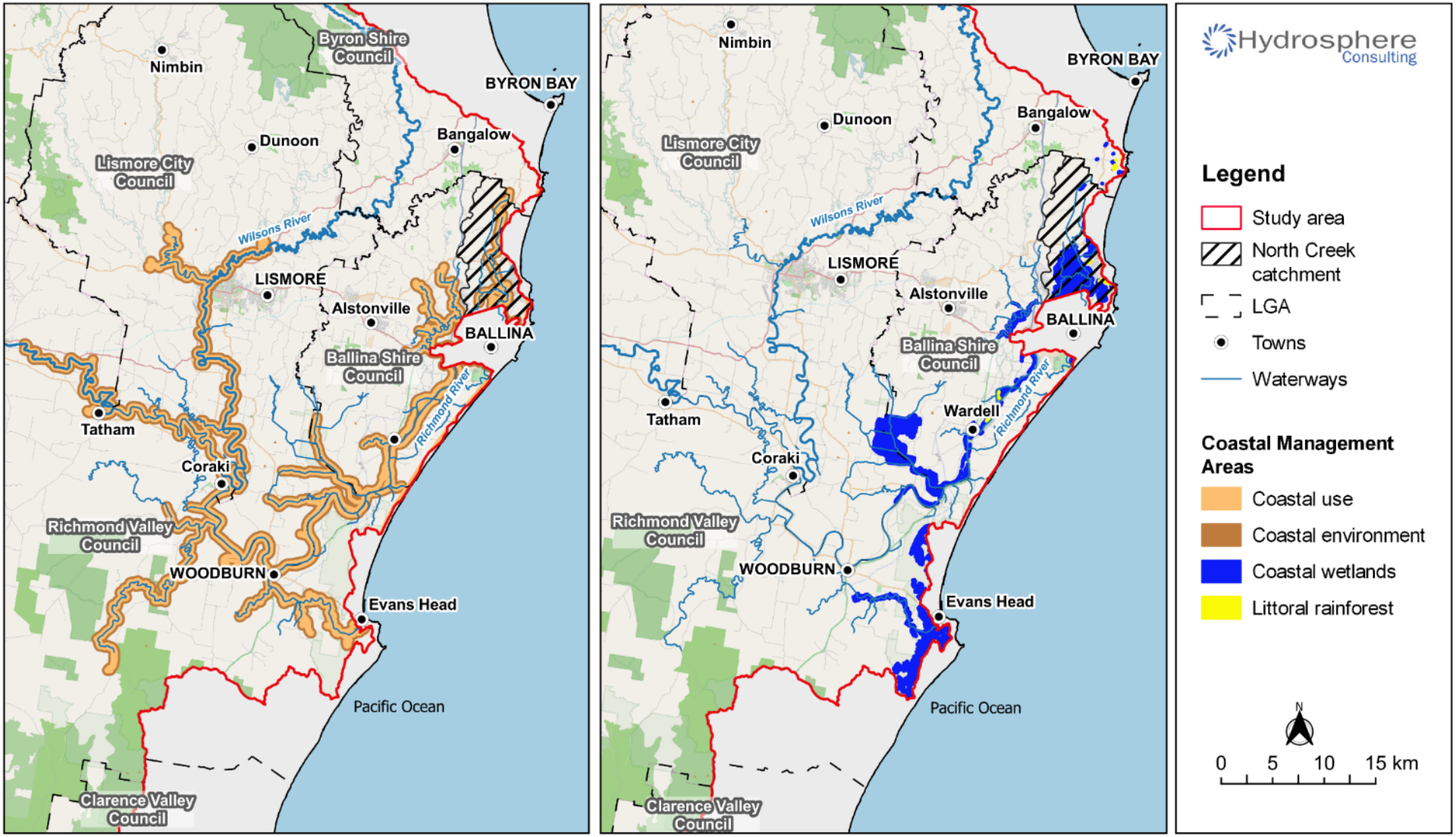

Figure 4: Coastal management areas as identified in the Resilience and Hazards SEPP

Source: Mapping data provided by NSW DPE (2022). Note: CMA mapping may not reflect the full geographical extent of ecological communities.

1.4 Coastal Management Planning Approach

The Richmond River estuary is situated within three local government areas (Ballina Shire, Lismore City and Richmond Valley). RCC is the flood mitigation authority, with responsibility for associated natural resource management activities. The Richmond River catchment also lies within the LGAs of Kyogle and Byron with a small portion in the south-east within the Clarence Valley LGA.

The Richmond River coastal zone includes the open coastline inland from Broken Head in the north to Evans Head in the south and extends along the Richmond River estuary to 1 km beyond the tidal limits near Tatham on the Richmond River and upstream of Lismore on the Wilsons River. The various local councils have developed or are planning to develop coastal management planning documents (in accordance with the *Coastal Management Act 2016*) for the other estuaries and coastline areas within the Ballina, Byron, Richmond Valley and Clarence Valley LGAs (separate to the CMP for the Richmond River estuary). To avoid overlap of separate CMP areas the following coastal management areas have been excluded from the study area for the Richmond River Estuary CMP:

- Ballina Shire:
    - BaSC has prepared the *Coastal Zone Management Plan for Shaws Bay, Ballina* (certified, Hydrosphere Consulting, 2014) which will be converted to a CMP.
    - BaSC has prepared the *North Creek Coastal Management Program – Stage 1 Scoping Study* (Alluvium, 2019b) and commenced Stage 2 studies. BaSC will prepare a CMP for North Creek.
    - BaSC has prepared a *Coastal Zone Management Plan for the Ballina Shire Coastline* (GeoLINK, 2016) which will be converted to a CMP. BaSC has recently completed the *Stage 1 Scoping Study for the Ballina Shire Coastline Coastal Management Program* (Water Technology, 2022).
    - BaSC has prepared the *Coastal Management Program for Lake Ainsworth* (certified, BaSC, 2020). Lake Ainsworth is hydrologically independent of the Richmond River.
- Byron Shire:
    - BySC has prepared the *Coastal Management Program – Scoping Study for Cape Byron to South Golden Beach* (BMT, 2020) and will prepare a CMP for these areas.
    - BySC has prepared the *Coastal Management Program Scoping Study (Stage 1) for the Southern Byron Shire coastline and Belongil Estuary* (Rhelm and Bluecoast, 2021) and their catchments. BySC will prepare CMP(s) for these areas.
        - BySC will commence preparation of the CMP process for the Brunswick River estuary as a future priority.
- Richmond Valley:
    - RVC has prepared the *Coastal Zone Management Plan for Evans Head Coastline and Evans River Estuary* (Evans River CZMP, Hydrosphere Consulting, 2013).

  - The smaller estuaries of Salty Creek, Salty Lagoon and Jerusalem Creek located within the RVC coastal zone are hydrologically independent of the Richmond River.

- Clarence Valley:
  - Clarence Valley Council (CVC) will prepare a CMP for the Clarence River estuary. CVC is currently preparing a Scoping Study for the Clarence River Estuary CMP.
  - CVC has prepared the *Clarence Valley Coastline and Estuaries Coastal Management Program Stage 1: Scoping Study* (Hydrosphere Consulting, 2021d) and will prepare a CMP for the coastline and smaller estuaries.
  - The proportion of the Richmond River catchment within the CVC LGA is small and mostly State Conservation Area. There are no identified issues in the LGA to be addressed in the Richmond River Estuary CMP.

2. CMP PURPOSE, VISION AND OBJECTIVES

2.1 Purpose

The CMP will provide a long-term coordinated strategy for managing the Richmond River estuary. An integrated whole-of-government and community approach is required to implement the CMP, with RCC, the estuary and catchment councils, state government agencies, stakeholders, community and interest groups and local residents working together to achieve the CMP objectives.

The primary purposes of this Scoping Study are to:

- Review progress made in managing issues in the marine estate.
- Develop a shared understanding of the current status of estuary management issues.
- Identify the focus of the new CMP.

This Scoping Study addresses the requirements of the Manual:

- Establish the purpose, vision and objectives (Section 2).
- Identify the community and stakeholders (Section 3). A *CMP Community and Stakeholder Engagement Strategy* has been prepared (Hydrosphere Consulting, 2022).
- Determine the strategic context for coastal management (Section 4).
- Review current coastal management arrangements and establish roles, responsibilities and governance (Section 5).
- Determine where action is required, the key coastal management issues and the spatial extent of management areas through a first-pass risk assessment. Identify knowledge gaps and information needs (Section 1).
- Determine whether a planning proposal will be prepared to amend coastal management area maps and the Local Environmental Plan (Section 6.1).
- Prepare a preliminary business case and forward program for subsequent stages of the CMP (Section 7).

The CMP will incorporate management actions and strategies to address key threats and support a diversity of natural values and human uses into the future. The CMP will consider the range of timeframes (immediate, 20 years, 50 years, 100 years) where appropriate as required by the *Coastal Management Act 2016*. This Scoping Study presents the scope of the CMP, the forward program and costs to implement Stages 2 to 4 of the CMP. Recommended management actions will be developed in the CMP to help balance and manage uses so that they are compatible with the environmental, social and economic values of the study area and to ensure short-term actions are compatible with issues and threats in the longer term. The actions for this CMP will be developed with reference to a ten-year management timeframe reflecting the implementation phase of the CMP. Longer term pressures such as climate change and sea level rise will be considered in the formulation of management actions to best plan for resilience against future threats and the conservation of the environmental, social and economic values for future generations.

In July 2022 DPE released formal guidelines/advice about the inclusion of catchment issues and actions in a CMP (DPE, 2022a). The advice recognises that issues in catchment areas can lead to downstream impacts and the consideration of these broader catchment drivers is an important issue for a number of councils. The discussion of the broader catchment-based drivers and their impacts on the coastal zone can be provided in the CMP to provide context to understanding the whole of catchment effects on areas within the coastal zone. The advice states that the principal focus of any implementation actions included in a CMP (Stage 4) should be directed towards areas included in the coastal zone. However, CMP actions outside of the coastal zone may be included in a CMP by expanding the coastal zone area through a planning proposal or by including these actions as a separate document or addendum to the CMP. Councils can apply for Coast and Estuary Grant funding for actions outside the coastal zone providing that it can be demonstrated that the action will significantly benefit the coastal zone and satisfy the program criteria. Other funding programs may also be available (e.g. Fisheries, LLS, MEMA, flood recovery, Environment Trust). This Scoping Study includes discussion of catchment-based drivers and their impacts on the coastal zone and estuary which is considered appropriate and in line with the recent DPE advice.

2.2 Vision

A CMP vision statement has been developed from community and stakeholder feedback to articulate the main goal of the CMP (Plate 2). The vision is consistent with the objects of the *Coastal Management Act 2016*, the management objectives for the coastal management areas and each council's vision and objectives as identified in their Community Strategic Plans.

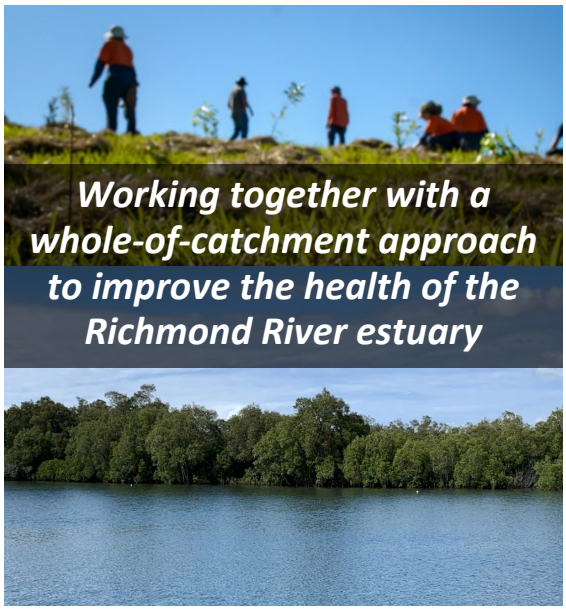

Plate 2: Richmond River Estuary CMP vision statement

Photo source: RCC

2.3 Objectives

Section 12 of the *Coastal Management Act 2016* states that: "*The purpose of a coastal management program is to set the long-term strategy for the coordinated management of land within the coastal zone with a focus on achieving the objects of this Act*."

The objects of the *Coastal Management Act 2016* (Section 3) are to manage the coastal environment of NSW in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people of the State, and in particular:

> *(a) to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience, and*
>
> *(b) to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety, and*
>
> *(c) to acknowledge Aboriginal peoples' spiritual, social, customary and economic use of the coastal zone, and*
>
> *(d) to recognise the coastal zone as a vital economic zone and to support sustainable coastal economies, and*
>
> *(e) to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making, and*
>
> *(f) to mitigate current and future risks from coastal hazards, taking into account the effects of climate change, and*
>
> *(g) to recognise that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea (including estuaries and other arms of the sea), and to manage coastal use and development accordingly, and*
>
> *(h) to promote integrated and co-ordinated coastal planning, management and reporting, and*
>
> *(i) to encourage and promote plans and strategies to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events, and*
>
> *(j) to ensure co-ordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities, and*
>
> *(k) to support public participation in coastal management and planning and greater public awareness, education and understanding of coastal processes and management actions, and*
>
> *(l) to facilitate the identification of land in the coastal zone for acquisition by public or local authorities in order to promote the protection, enhancement, maintenance and restoration of the environment of the coastal zone, and*
>
> *(m) to support the objects of the Marine Estate Management Act 2014.*

The CMP will also ensure that the objectives for the four coastal management areas (CWLRA, CEA, CUA and CVA) as described in the Resilience and Hazards SEPP are achieved.

The CMP objectives may be refined as the CMP is developed to reflect local issues and values and remain consistent with state government objectives. The CMP will include the development of performance indicators where relevant, for inclusion in the CMP monitoring, evaluation and reporting framework.

3. STAKEHOLDER AND COMMUNITY ENGAGEMENT

Stakeholder engagement is a vital component which spans all stages in the production of a CMP. A key role of the Scoping Study is to involve stakeholders and ensure ongoing commitment for the CMP development and implementation. The previous consultation activities and community information and feedback are documented in *Richmond River CMP Stakeholder Feedback* (Hydrosphere Consulting, 2021a) and summarised below.

As part of the development and implementation of previous coastal and estuary management planning documents, the councils have engaged with stakeholders and the community. Targeted consultation was also carried out for the Scoping Study to update previous information and engage catchment and estuary stakeholders in the Richmond River Estuary CMP process. The aims of the Stage 1 engagement activities were to inform, consult and involve stakeholders by bringing all interested parties on board early to share information and ideas and identify stakeholders to be involved in the remaining CMP stages. The consultation activities undertaken during Stage 1 were designed to obtain the following information:

- Estuary values and usage.
- Areas of interest/responsibilities.
- Issues to be addressed in the CMP.

The Richmond River estuary is highly valued by the community for its natural ecosystems, rich biodiversity, and a range of human land uses and activities. The area is also the traditional home of the Bundjalung and Githabul Nations and has spiritual and cultural significance. There is a growing community sentiment towards actively addressing environmental issues and improving the health of the Richmond River. The feedback received as part of this Scoping Study highlights the consultation fatigue resulting from the various strategic planning programs undertaken for the Richmond River. There is also frustration with repeated studies and plans with limited significant on-ground change. This is noted in the consultation feedback from most stakeholder groups.

Plate 3: Boating and fishing are popular uses of the estuary

4. STRATEGIC CONTEXT

Detailed information on the strategic context for the CMP is provided in the *Richmond River CMP Stage 1: Literature Review* (Hydrosphere Consulting, 2021c) and summarised in the following sections.

4.1 Statutory and Planning Context

The study area is currently managed in accordance with various regional and local level planning instruments, strategies and management plans implemented by the councils and other stakeholders. The key regional plans and local plans relevant to coastal management are shown on Figure 5. Other relevant management plans include Crown Reserve plans of management and floodplain risk management plans. The *Coastal Zone Management Plan for the Richmond River* (Hydrosphere Consulting, 2011b) has been certified under the (former) *Coastal Protection Act 1979*.

The strategic direction for management of the Richmond River is established through the following:

- The NSW Coastal Management Framework (Section 1.1).
- The *Marine Estate Management Strategy 2018 - 2028.*
- Regional and local plans (Figure 5).
- The IP&R Framework - the Community Strategic Plans, Delivery Programs and Operational Plans of RCC and the estuary and catchment councils.

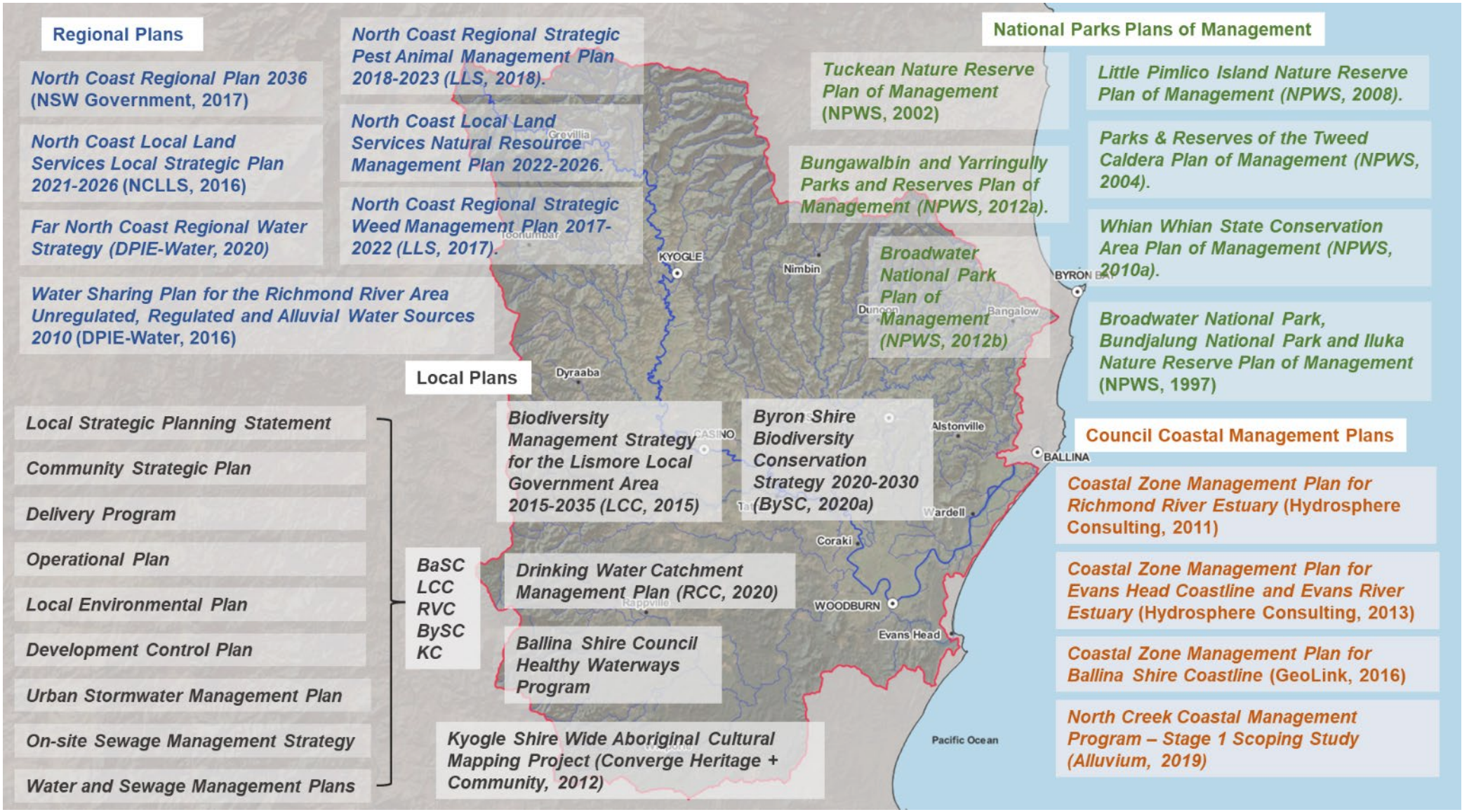

Figure 5: Regional and local strategies and management plans for the Richmond River

4.2 Culture and Heritage

The original occupation and custodianship of the lands and waters comprising the Richmond River Estuary CMP study area by First Nations people dates back many thousands of years. The Bundjalung and Githabul Nations people are the traditional custodians of the Richmond River catchment. First Nations heritage and connection to nature are inseparable aspects. First Nations people continue to contribute to the management of the landscape and natural resources of the region and have previously expressed that they would like more direct input into water management decision making (DPIE, 2020). In recent decades First Nations people have formed their own organisations and peak bodies to ensure the continuation of their connection to the land through cultural and land management practices. The ongoing use of and relationship to the land is legally recognised in Native Title determinations and Indigenous Land Use Agreements (ILUA) over various parts of the study area as detailed in Hydrosphere Consulting (2021c).

Plate 4: "Binging" (turtle) diving, Richmond River, Gullibul Country (left). Minyumai Indigenous Protection Area Bandjalang Ranger team performing asset protection burns (left)

Source: Left: McClean (2013), Right: Minyumai IPA (2019)

The first Europeans to arrive in the region in the mid-1800s were runaway convicts, followed by the cedar getters who came to harvest red cedar (*Toona ciliata*). This in turn opened the way for land selection in the area. Most of the lowland subtropical rainforest was cleared for agriculture by 1890. Broadscale clearing of native forests, draining of floodplain wetlands and conversion of natural areas to agricultural and urban lands occurred and was historically supported by the Commonwealth and state governments through a range of incentive schemes to improve productivity and economic prosperity at that time. These major landscape modifications and the ongoing land use in the catchment continue to have a significant impact on the health and function of the Richmond River estuary.

4.3 Environmental Context

The Richmond River is one of the major coastal drainage systems in northern NSW with a catchment area of approximately 6,850 km^2 (Figure 6). The upper catchment areas include the Nightcap Ranges to the north-east, the Border Ranges to the north and the Richmond Ranges to the west with elevations up to 1,100 m above sea level. The eastern part of the catchment is defined by a very large coastal floodplain, which covers an area of over 1,000 km^2 in major floods. Approximately 12% of the floodplain consists of land that is less than 1 mAHD (1 m above mean sea level). Figure 7 highlights low-lying floodplain land from 0-1 m AHD within the study area including large areas of the Tuckean Swamp, Rocky Mouth Creek and floodplain areas in close proximity to Emigrant Creek and Maguires Creek to the north.

The Northern Rivers region experiences a subtropical climate, with warm humid summers and mild winters. There is a high degree of seasonal variation in rainfall demonstrating a clear wet/dry seasonal pattern, which is typical of a subtropical environment. The highest rainfall typically occurs during summer and in early autumn (approximately 65% of average yearly rainfall total) with the lowest rainfall occurring in late winter and early spring. Subsequently, catchment stream flows are typically highest from December to June and lowest from July to November. Richmond River flows fluctuate from year to year with an average annual stream flow of 1,920,000 ML (DPIE-Water, 2016). The waterways located in the north and north-eastern part of the catchment where rainfall is typically higher, exhibit markedly higher flows than those in the western and south-western parts of the catchment which experience lower rainfall.

Plate 5: Richmond River headwaters to ocean

Clockwise from top left: Richmond River headwaters; Wilsons River at Lismore in the mid-catchment; deep inundation of the Richmond River Floodplain during the 2008 flood; flood waters entering the ocean at the Richmond River mouth in Ballina.
Photo source: RCC

Figure 6: Study area elevation

Source: Mapping data provided by Geoscience Australia (2020)

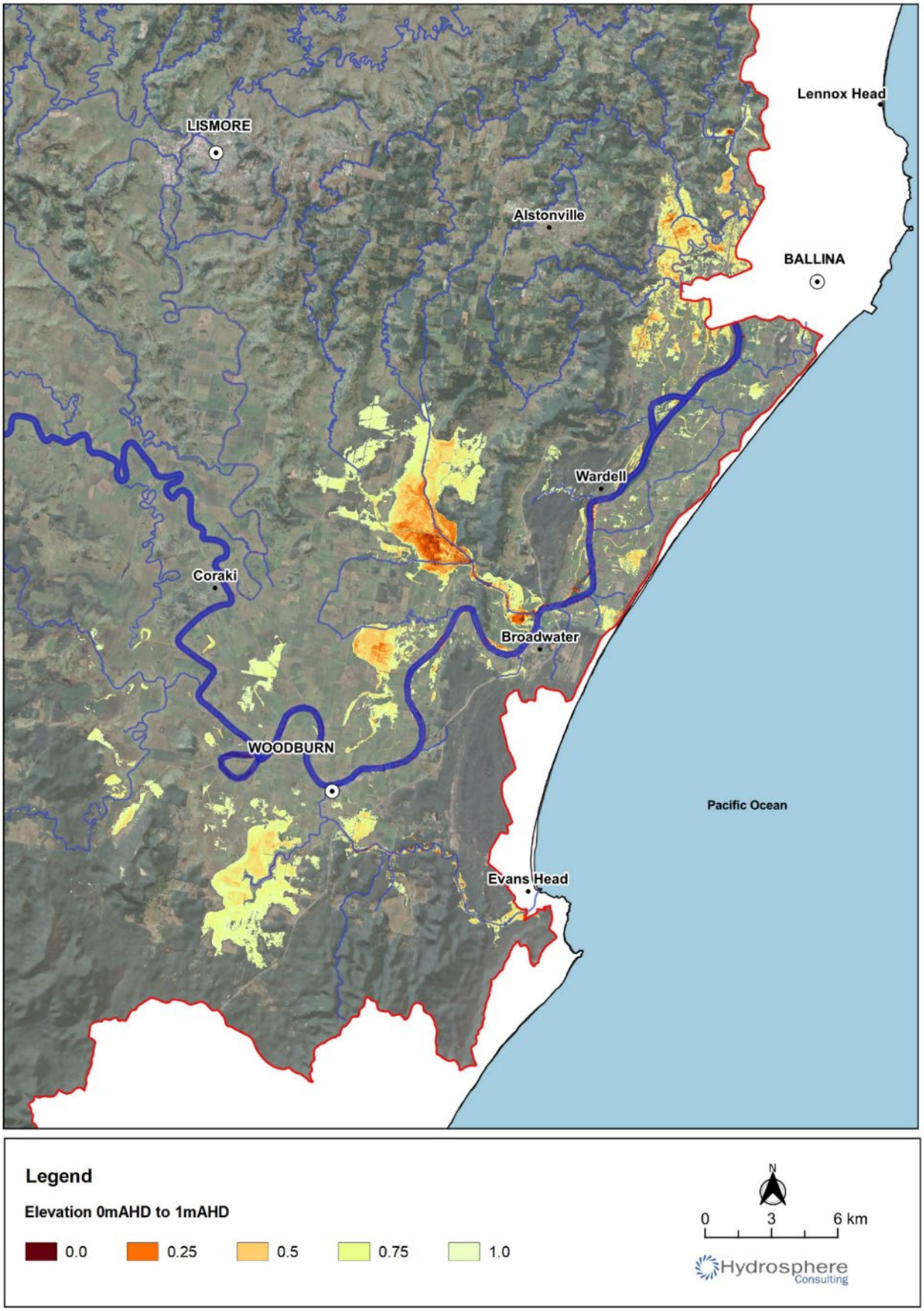

Figure 7: Low-lying floodplain areas, below 1 mAHD

Source: Mapping data provided by Geoscience Australia (2020), excluding waterways

4.3.1 Environmental values

The environmental values of the study area are associated with its landscape amenity (i.e. geographical features, scenic amenity and views), healthy and diverse natural environments and biodiversity values. The North Coast region of NSW is renowned as one of the most biologically diverse areas in Australia. The study area is an area of extremely high biodiversity, resulting from the wide range of soil types, climate and topography across the region. The region contains significant ecological features including:

- Nightcap National Park, Border Ranges National Park, Richmond Range National Park and Toonumbar National Park in the upper catchment form parts of the Gondwana Rainforests of Australia which was inscribed on the UNESCO World Heritage list in 1986 for its outstanding biological and geomorphic values (UNESCO, 2020).
- The Lower Bungawalbin catchment wetland complex and the Tuckean Swamp are listed in the *Directory of Important Wetlands in Australia* (Department of Agriculture, Water and the Environment, 2021).
- A number of rare and threatened coastal plant communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* such as Littoral Rainforest and Coastal Vine Thickets of Eastern Australia (critically endangered), Lowland Rainforest of Subtropical Australia (critically endangered), Coastal Swamp Oak (*Casuarina glauca*) Forest of Floodplain (endangered), and Subtropical and Temperate Coastal Saltmarsh (vulnerable).
- The waterways, wetlands and forests of the Richmond River are important habitat for vulnerable and endangered fauna species including the Eastern Freshwater Cod, Oxleyan Pygmy Perch, Giant Barred Frog, Spotted-tailed Quoll, Grey-headed Flying-fox, Wompoo Fruit-dove, and a significant number of threatened migratory waders, shorebirds and other marine bird species.
- The Richmond River estuary is considered one of the two most important estuaries for shorebird locations in northern NSW with 38 different species being recorded within the Richmond River estuary over a 23-year period.
- The Richmond River estuary is also home for a number of iconic Australian species highly valued by the community including saltwater turtles, Indo-Pacific bottlenose dolphins and whales.

The *Regional State of the Environment Report 2016* for the North Coast states that "*appropriate management of pressures on biodiversity and vegetation is essential to ensure current condition is maintained or improved"*. The main pressures on the region's biodiversity are habitat loss, land clearing, habitat modifications, invasive species and loss of genetic diversity (North Coast Region State of the Environment Report Working Group, 2016; NPWS, 2010b).

Plate 6: Headwaters in the Border Ranges (left). Richmond River reach downstream of Kyogle (right)

4.3.2 Geology, soils and geomorphology

The study area has a complex geology with significant areas of volcanic (basalt) rocks, with older layers of sedimentary rocks resulting in a variety of soil types, depending on location. The two major underlying soil characteristics present in the catchment that contribute to poor estuary health are highly erodible soils in the mid and upper catchment and acid sulfate soils (ASS - the common name given to naturally occurring sediments and soils containing iron sulfides) on the floodplain/ tidal flats (refer Section 4.3.5). There are substantial sediment inputs from top soil erosion into the Richmond River, which impacts water quality and aquatic ecosystem health by increasing suspended sediment concentrations in water (creating murky water) and degrading benthic aquatic habitats by smothering the river bed with sediment. When ASS is exposed to air it can generate acid runoff, acidifying soil water, groundwater and, eventually, surface waters. Acid runoff can mobilise toxic metals and other contaminants from soil and transport them to waterways.

River geomorphology refers to the understanding of river forms, processes, evolution, condition and trajectory. The geomorphic condition for the Richmond River is typically better in the upper freshwater reaches (i.e. headwaters), particularly those in conservation reserves. Geomorphic condition typically declines with distance downstream to moderate and poor condition in the mid-catchment and estuarine reaches with evidence of active erosion.

The catchment contributes fluvial sediment to the estuary and ocean and the estuary is also subject to marine sediment inputs. Sediment compartments (referred to in Schedule 1 of the *Coastal Management Act 2016*) are used to compartmentalise sections of the Australian coastline and marine areas with similar characteristics and processes. A sediment compartment is a section of coast (extending into rivers) which shares a common sediment resource with clearly defined physical boundaries (Short, 2018). The coastal extent of the study area lies within the temperate province, south-east division and central eastern region and is within the primary coastal sediment compartments which extends from the Clarence River to Point

Danger (Tweed Heads). The secondary sediment compartments within the study area are Cape Byron to Richmond River (Cape Byron to Ballina), Richmond River to Evans Head (Broadwater), Evans Head to Yamba Point (Bundjalung), which are described in Table 2 and illustrated on Figure 8. These sediment compartments cover the council areas of BySC, BaSC, LCC, RVC and CVC.

Table 1: Secondary sediment compartments

Compartment	Bundjalung	Broadwater	Cape Byron to Ballina
Extent	Evans Head to Yamba Point	Richmond River to Evans Head	Cape Byron to Richmond River
LGA	RVC, CVC	BaSC, RVC	BySC, BaSC, LCC, RVC, CVC
Geomorphology	Sandstone and conglomerate headlands, zeta-form bays, large and small embayed beaches, extensive Pleistocene prograded beach ridge plain, dunes, Holocene prograded barriers.	Zeta-form sandy beach, Pleistocene indurated sand, transgressive dunes, backbarrier flats.	Volcanic and metasedimentary headlands, zeta-form bays, sandy beaches, and narrow foredune ridges, few active blowouts, Richmond River mouth and estuary.
Sensitivity rating[1]	Sensitivity rating is a 4, with several sections already 5.	Sensitivity rating is a 4.	Sensitivity rating is a 4, with several sections likely to be 5. The southern end of one beach is eroding and Pleistocene dune sands are exposed in places.
Confidence rating[2]	Medium to high.	Medium	Medium

1. Relevant sensitivity rating from 1 (low) to 5 (high): 3 - Relatively stable shorelines which may be subject to periodic erosion followed by recovery (accretion), but no long-term recession expected in the next few decades since the sediment budget remains sufficiently balanced over time from offshore, alongshore or terrestrial sources. 4 - Shorelines that currently do not show evidence of long-term recession but are likely to begin receding with continuing sea-level rise (based on sediment availability onshore and offshore). 5 - Shoreline recession is occurring now (typically documented by historical shifts in shoreline position) and the shoreline is likely to continue to recede as sea level rises (possibly at a faster rate depending on local conditions).
2. Confidence rating: Medium - Some information is available on changes to landforms, from multiple sources, which may include recent landform change from site descriptions and irregular aerial photographs over the past decade. High - detailed information is available identifying changes to coastal landforms spanning the historical period and includes regular remotely sensed information over the past 30 years or more.
Source: CoastAdapt (2017a, 2017b)

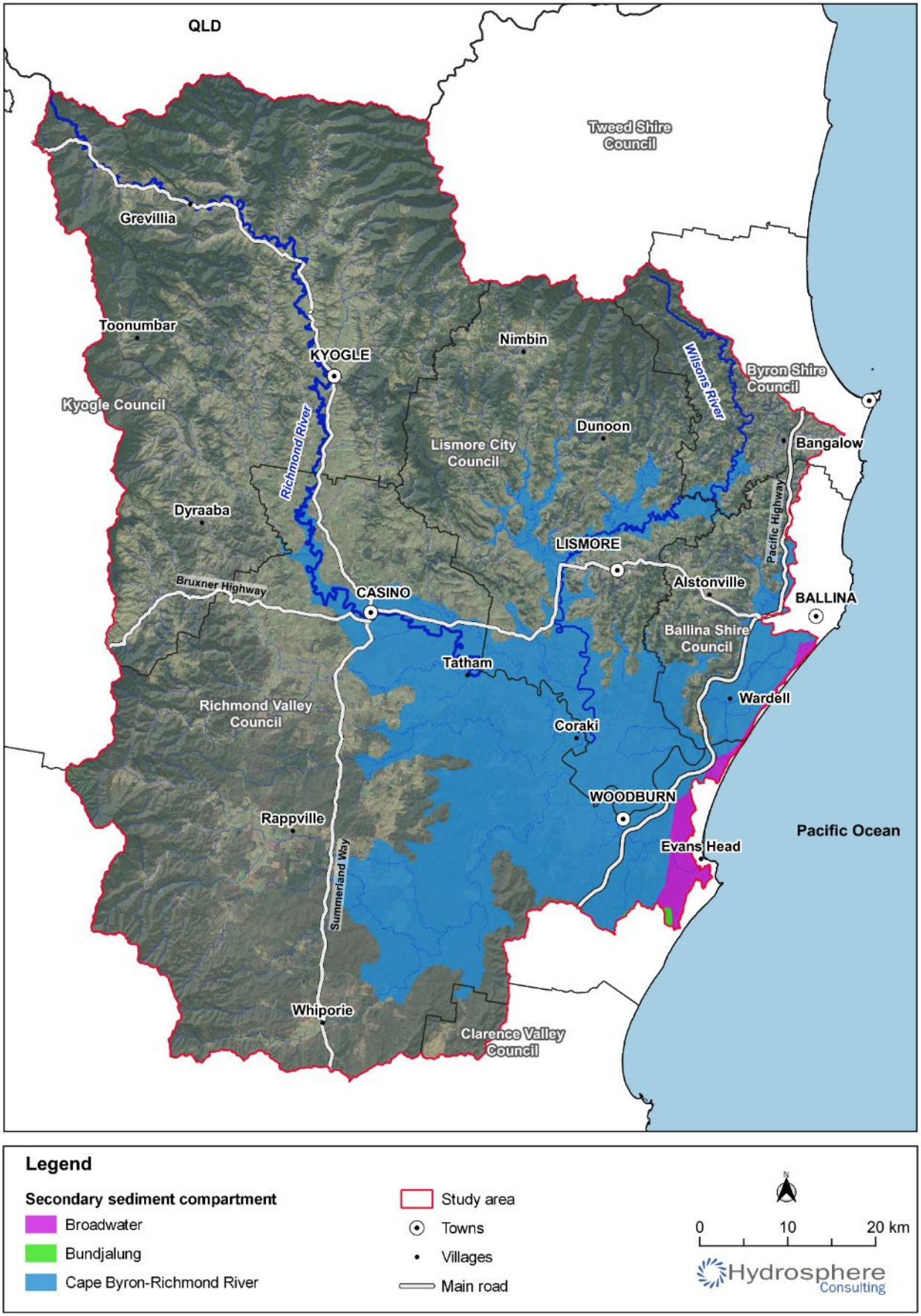

Figure 8: Coastal sediment compartments

Source: Mapping data provided by Geoscience Australia (2015)

4.3.3 Catchment modifications

Since European settlement of the Far North Coast region, the Richmond River catchment has been significantly modified from its natural state with grazing land now dominating the catchment (Section 4.5.1). These major landscape modifications and the ongoing land use in the catchment continue to have a significant impact on the health and function of the Richmond River estuary. Urban development has affected estuarine processes through changes to hydrologic characteristics and vegetation cover, the discharge of pollutants through stormwater runoff and point source pollution such as treated sewage discharges. Agricultural land has been shown to contribute significant sediment, chemical and nutrient loads to the estuary primarily during runoff (rain) events. There are also natural physical and climatic characteristics of the catchment that interact with and exacerbate the impact of human pressures. These include the highly erodible soils and moderate to steep slopes in the mid and upper catchment, acid sulfate soils (ASS) on the floodplain/ tidal flats, high annual rainfall and regular occurrence of flood events as a result of ex-tropical cyclones and east coast lows that occur close to the coast. Together these factors contribute to the degradation of the estuary and occurrence of undesirable events such as poor water quality episodes and fish kills, particularly following some flood events.

Plate 7: Urban development at Lismore

Photo source: RCC

4.3.4 Waterway modifications and water extraction

Significant modifications to Richmond River waterways have occurred since European settlement including construction of major instream dams and weirs in the upper reaches and extensive floodplain modifications in the form of drains, levees, floodgates and other structures. These hydrological modifications affect natural flow regimes and functions of waterways with impacts on aquatic ecosystem health indicators such as water quality, fish passage and aquatic habitat values. Table 2 provides a summary of major waterways and the considerable hydrological modifications that have occurred since European settlement within the eight Richmond River sub-catchments shown in Figure 9.

Water extraction in the Richmond River catchment occurs in many forms for a variety of purposes including town water supply, irrigation of agricultural crops and for stock and domestic use. The *Water Sharing Plan for the Richmond River Area Unregulated and Alluvial Water Sources 2010* set the limits on the amount of water that can be extracted from surface water and groundwater sources. The annual sharing of water is managed through long-term average annual extraction limits, while daily sharing is managed through cease-to-take rules, which can vary for different categories of licence. By 2016 there were approximately 2,345 water licences in the area covered by the Water Sharing Plan totalling 97,407 ML of entitlement (approximately 5% of the average annual flow of 1,920,000 ML in the Richmond River).

Plate 8: Hydrological modifications in the Richmond River catchment

Clockwise from top left: Toonumbar Dam (photo source: WaterNSW); V-shaped rock ramp fishway at Kyogle Weir on the Richmond River (photo source: Matt Gordos); Floodgate at South Ballina; Bagotville Barrage and floodplain drainage channels, Tuckean Swamp (photo source: MEMA).

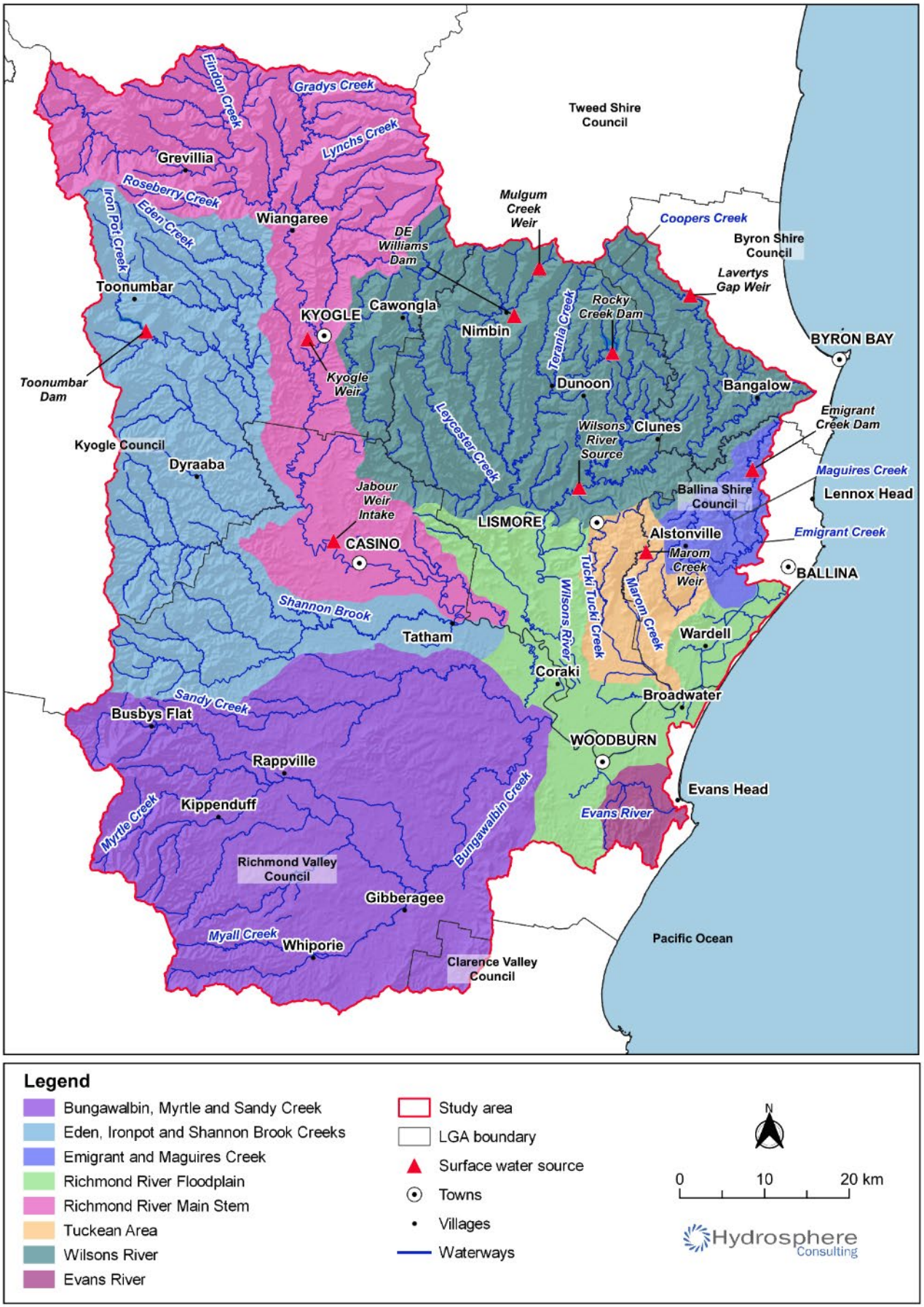

Figure 9: Richmond River Estuary CMP sub-catchments and major waterways

Table 2: Richmond River sub-catchments, waterways and key characteristics

Sub-catchment	Location	Major waterway	Major tributaries	Major instream structures/ modifications	Area (km^2)	% of catchment
Richmond River Main Stem	Flows from headwaters in the Border Ranges (Kyogle LGA) extending downstream through Kyogle and Casino to the tidal limit near Tatham.	Richmond River	Gradys Creek, Roseberry Creek, Findon Creek and Lynches Creek, Eden Creek	Jabour Weir at Casino, Kyogle Weir at Kyogle with an off-stream storage	1,354	19%
Wilsons River	Flows from the upper reaches of Wilsons Creek in the Nightcap Range (Byron and Lismore LGAs) and flows to the sub-catchment outlet at Lismore.	Wilsons River	Terania Creek, Coopers Creek, and Leycester Creek. The tidal pool extends to approximately 5 km upstream from Lismore	Rocky Creek Dam on Rocky Creek, Mulgum Creek Weir and DE Williams Dam at Nimbin and Laverty's Gap Weir on the upper Wilsons River	1,384	20%
Eden, Ironpot and Shannon Brook Creeks	Flows from the Richmond Range on the western side of the Richmond River catchment, meeting the Richmond River Main Stem at the tidal limit near Tatham.	-	Eden Creek, Ironpot Creek and Shannon Brook	Toonumbar Dam in the upper reaches of Iron Pot Creek	1,284	18%
Bungawalbin, Myrtle and Sandy Creeks	Comprises the southwest portion of the Richmond River catchment, with tributaries flowing into the Richmond River tidal pool in the mid estuary.	-	Sandy Creek, Myrtle Creek, Myall Creek and Bungawalbin Creek	Many lower floodplain areas have been modified with floodplain drainage infrastructure.	1,778	26%
Emigrant and Maguires Creeks	Located in the north east of the Richmond River catchment draining the Alstonville Plateau. Maguires Creek joins Emigrant Creek at Teven which flows to the lower Richmond River estuary just upstream of Ballina.	-	Emigrant and Maguires Creeks	Emigrant Creek Dam on Emigrant Creek. Many lower floodplain areas have been modified with floodplain drainage infrastructure.	284	4%

Sub-catchment	Location	Major waterway	Major tributaries	Major instream structures/ modifications	Area (km^2)	% of catchment
Tuckean Swamp	Drains the Alstonville Plateau to the Tuckean Swamp floodplain	-	Marom Creek and Tucki Tucki Creek	Marom Creek Weir on Marom Creek. Extensive drainage works have been carried out on the floodplain. The Bagotville Barrage is a major instream structure.	220	3%
Richmond River Floodplain	Floodplain areas in the mid to lower estuary.	Richmond River estuary and Wilsons River tidal pool	Bungawalbin Creek, Sandy Creek, Rocky Mouth Creek, and the Tuckean Broadwater	Extensively modified with a network of drains, floodgates, levees and other structures.	632	9%
Evans River	Extends from the Tuckombil Weir at Woodburn to the upstream extent of urban areas in Evans Head.	Evans River	Richmond River and Rocky Mouth Creek during large flood events (when flood water level exceeds the Tuckombil Weir).	Tuckombil Canal constructed to connect the Richmond River to the Evans River. Tuckombil Weir constructed to prevent tidal ingress into Rocky Mouth Creek.	78	1%

The Richmond River floodplain has been extensively modified by a complex network of constructed drains, modified canals, artificial levee banks and floodgates. Installation of floodplain drainage channels began in the late 1800s and accelerated in the early 1900s for the purpose of draining wetlands for agriculture and for flood mitigation. Floodgates were installed to prevent back-flooding of drains, creeks and tributaries and subsequently the inundation of agricultural land on the floodplain during minor flood events or by salt water from high tides. Harrison *et al.* (2020) refers to the misleading use of the term 'flood mitigation', but in reality, the 1950-70s 'flood mitigation' schemes were overwhelmingly swamp drainage schemes. The impacts of historical and on-going drainage works are known to have significant environmental impacts on the estuary. These include the exposure and oxidation of ASS, formation of mono-sulfidic black ooze, the formation of blackwater (dark water that contains little or no oxygen forming from the rapid biological breakdown of plant material in water), drainage providing a conduit to convey pollutants more effectively to the estuary and disruption of tidal flushing regimes affecting water quality and ecological processes (refer Section 4.3.5). The floodplain infrastructure managed by RCC is shown on Figure 10 although there is also an extensive network of privately managed drainage infrastructure.

4.3.5 Waterway health

The *Richmond River Ecohealth Project 2014* (Ryder *et al*., 2015) was the first comprehensive catchment-wide assessment of waterway health in the Richmond River. The project was conducted over a 12-month period in 2014 covering 48 sites (23 freshwater and 25 estuarine sites) providing a snapshot of ecosystem health across the catchment (excluding the Evans River). A report card was generated for the project and was summarised as follows:

"The overall grade for the Richmond catchment was D-, ranging from an F in the Wilsons River and upper Richmond estuary to a C in the headwater streams of the catchment. Twelve of the 17 river systems recorded a score of D or less. The upper freshwater reaches of the Richmond catchment had better water quality, aquatic macroinvertebrates and geomorphic condition than the lower freshwater reaches, but no better riparian condition. The upper estuary (upstream of Woodburn) was consistently in the poorest condition, with very high nutrient concentrations, turbidity and algal biomass. Scores were consistent among indicators within each system, highlighting that the issues with water quality, biota and physical condition are affecting short and long-term condition of the streams."

Figure 11 shows the sub-catchment grades for the Richmond River catchment.

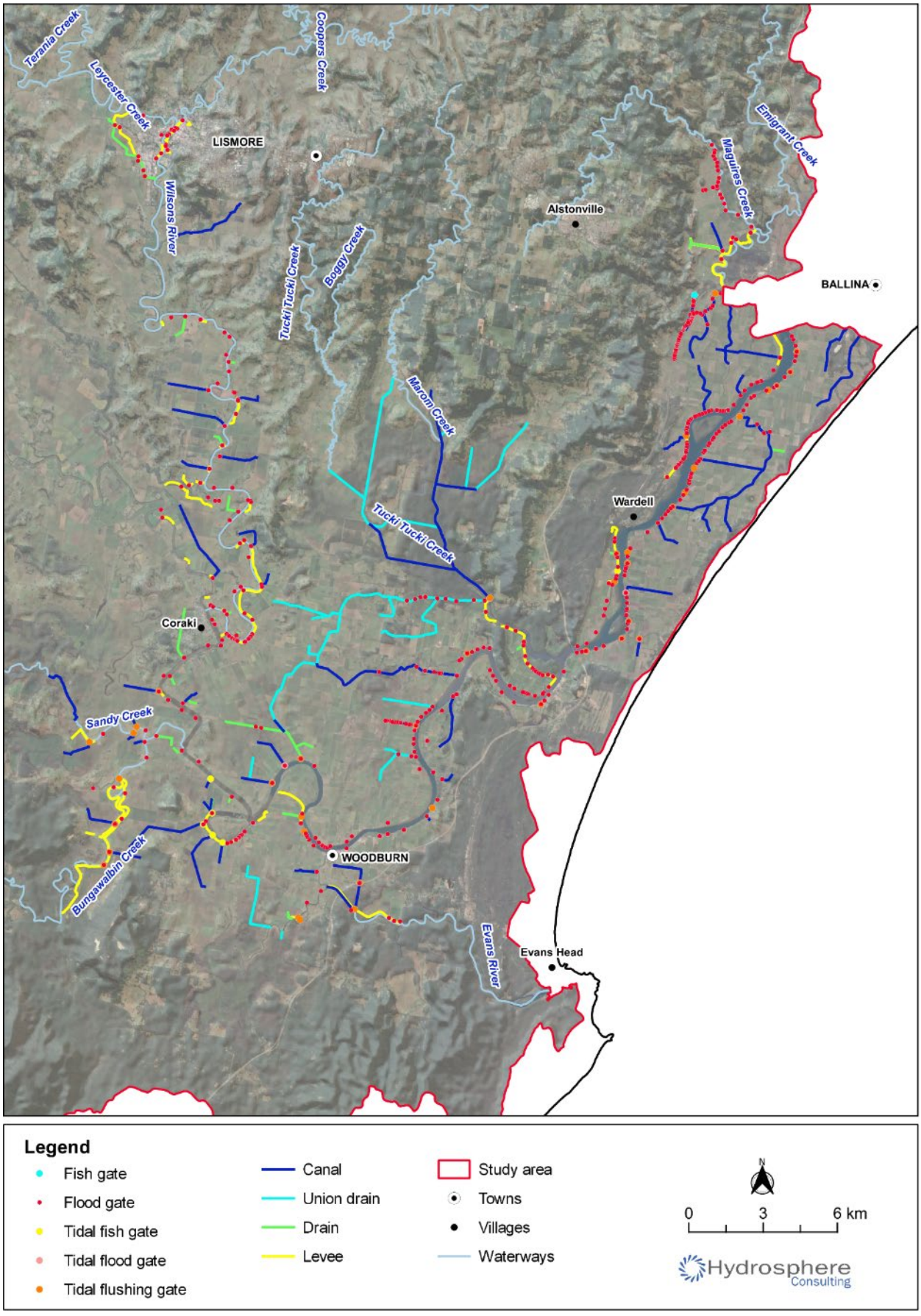

Figure 10: RCC floodplain infrastructure

Source: GIS data supplied by RCC

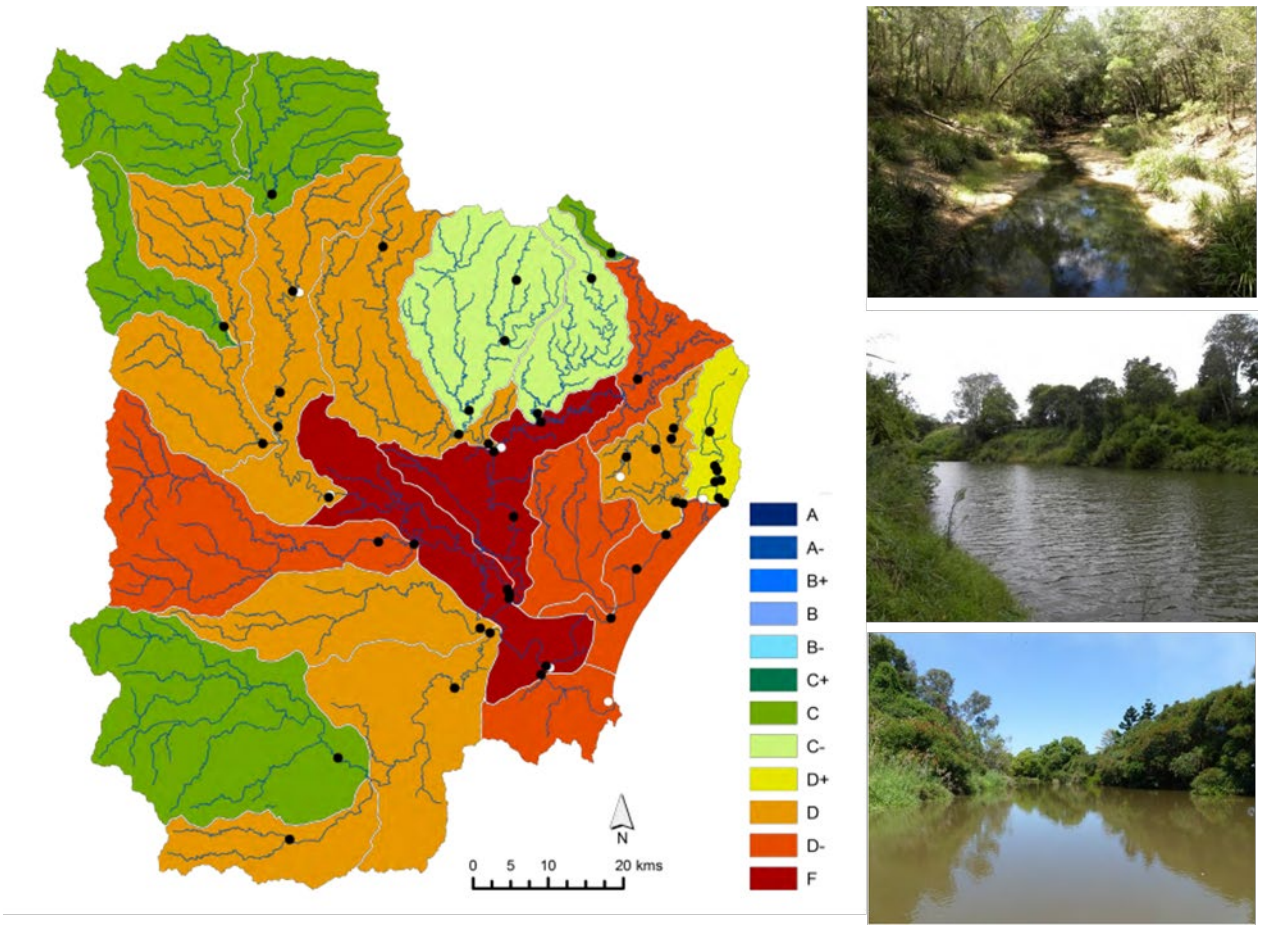

Figure 11: Overall Ecohealth grades for sub-catchments in the Richmond and site photos showing range of environments sampled

Source: Ryder *et al*. (2015)

Ryder *et al.* (2015) highlighted management priorities based on the findings of the study including:

- A need for significant investment in reducing diffuse sources of fine sediments and associated nutrients. Priorities are:
    - Improve riparian and bank condition throughout the catchment. Active restoration of riparian vegetation and reducing bank erosion as long-term actions are required for improvement across all indicators. This requires a holistic approach to remove stressors (e.g. invasive weeds, stock access to banks, clearing etc.) and undertake assisted regeneration and/or revegetation of riparian zones.
    - Reduce stock access to the steep and fine-grained banks in the upper reaches and revegetating those riparian zones to increase their buffering capacity for terrestrially derived nutrients.
- The poorest water quality was recorded from the sites closest to the tidal limit, highlighting these locations as depositional environments for both freshwater and estuarine contaminants, generally poor tidal flushing and the importance of this zone as a focal point for future monitoring programs.

Water quality is one of the most important estuarine health indicators and clean waterways are highly valued by the community. Many of the key economic industries in the local area rely on good water quality including

tourism, aquaculture (oyster production), agriculture and commercial fishing. The sources of water quality degradation are wide and varied but can broadly be categorised into:

- Diffuse sources (pollutant inputs from varied sources over a large area).
- Point sources (defined locations of pollutant input to waterways).

Diffuse source pollution

Poor water quality specifically originating from diffuse sources has been identified as one of the highest priority threats to the environmental assets within NSW estuaries in the *Marine Estate Management Strategy Threat and Risk Assessment* (MEMA TARA, BMT WBM, 2017). Major sources of poor estuarine water quality result from diffuse sediment and nutrient runoff from catchments, ASS discharge and low oxygen blackwater runoff from coastal floodplains. Excess nutrients in waterways, known as eutrophication, can lead to an increase in primary productivity (excessive plant and algal growth) that degrades water quality including the depletion of dissolved oxygen levels and increasing the risk of potentially toxic blooms of cyanobacteria (i.e. blue green algae).

Nutrient and sediment pollution

DPE - Environment and Heritage (DPE – E&H) developed an estuary health risk dataset for each estuarine catchment in NSW (Dela-Cruz, *et al.*, 2019) to support development of CMP Scoping Studies under the NSW Risk-based Framework. The intent of the dataset is to help identify strategic priorities for managing nutrient and sediment runoff throughout a catchment so that estuary health is protected, maintained and/or improved. The dataset provides an overview of broadscale risk to estuarine health from catchment export of nutrients and sediment on a sub-catchment scale but it does not provide high resolution at a local level. When used as part of CMP Scoping Studies, the dataset can be used to help map where further studies and/or management actions in a catchment would contribute to achieving some of the management objectives relating to nutrient and sediment load reduction. Risks from other pressures such as ASS, blackwater events, bank erosion, pesticides, point source pollution and other catchment contaminants are not considered in the risk assessment. The current estuary health risk results are mapped for the catchment on Figure 12. The results for the Richmond River catchment are broadly summarised as follows:

- Very high risk (score of 16 out of 16) was assigned to several catchments in the upper Wilsons River catchment upstream of Lismore, the upper Richmond River catchment upstream of Kyogle, the lower Wilsons River below Lismore and the mid Richmond River downstream of Casino. This indicates that runoff from these sub-catchments poses the greatest risk to the ecological health of the Richmond River estuary. Use of the risk-based framework would require more detailed investigations on the causes of these risks (i.e. as part of Stage 2 of developing the Richmond River Estuary CMP).
- High risk (scores of 9 - 12) were assigned to approximately half of the catchment incorporating the majority of the Richmond River main stem, and upper, mid and lower catchment areas.
- Moderate risk (scores 6 - 8) were assigned to large areas of the Eden and Iron Pot Creeks, Shannon Brook hydrological unit as well as small sub-catchments in the upper mid and lower estuaries.
- Low risk (scores 3 - 4) were assigned to the majority of Bungawalbin, Myrtle and Sandy Creeks hydrological unit and the Richmond River floodplain.

- Minimal risk (scores 1 - 2) were assigned to two small sub-catchments on the floodplain downstream of Coraki and the lower Tuckean Swamp area.

The Risk-based Framework has recently been used as part of a Marine Estate Management Strategy (MEMS) Stage 1 pilot project in the Richmond River catchment to identify priority areas for bank stabilisation, riparian restoration and road sealing by Local Land Services (LLS). The aim of the pilot project was to develop a modelling methodology to support, and provide an evidence base for, spatial prioritisation of natural resource management investments (Barrett, 2018). Key findings of this work included:

- The two biggest land-based contributors to total nitrogen, phosphorus and suspended solids loads in the waterways are perennial horticulture and grazing.
- Macadamia plantations make up the largest proportion of perennial horticulture and don't cover a very large area of the catchment, but this land use has very high predicted export rates and often occur in areas with high rainfall and surface runoff.
- Grazing land use doesn't have high export rates but generates large loads due to the extensive area it covers.

The key project output was a high-resolution catchment model to assess the risk of impact of nutrients and sediment on the marine estate. The higher resolution generated through this process has more clearly defined priority areas for targeted works (i.e. riparian restoration, bank stabilisation and road sealing). The Emigrant Creek catchment was identified as the priority catchment and LLS have been implementing on-ground works to improve waterway health as part of the MEMS in collaboration with landholders.

Figure 12: Richmond River estuary health risk assessment results

Data source: Dela-Cruz *et al.* (2019)

Acid sulfate runoff

ASS naturally occurs on the Richmond River Floodplain, and when left undisturbed and not exposed to oxygen, the level of acid discharge is minimal. However, disturbance of ASS through floodplain modifications including drainage of low lying backswamp areas has led to widespread oxidation of ASS and generation of high levels of acid runoff which under certain hydrologic conditions is exported to the estuary. Acid discharges along with blackwater events from the Richmond River floodplain have been identified as the key causative factors for fish kill events such as major fish kills occurring in 2001, 2008 and to a lesser extent in 2020 and 2022 (WBM, 2006; ABER, 2007; Wong *et al.,* 2010; Hydrosphere Consulting, 2011b; DPI Fisheries, 2021).

A recent study assessed the risk of poor water quality associated with ASS discharge and blackwater runoff (Harrison *et al*., 2020). The study identified priority locations across the Richmond River floodplain where the greatest improvements in water quality can be achieved through strategic management actions that reduce the impacts of ASS and blackwater runoff. In terms of ASS risk, the study ranked the five highest priority sub-catchments for acid drainage as Tuckean Swamp (1), Rocky Mouth Creek (2), Bungawalbin Creek/Sandy Creek (3), North Creek (4) and Emigrant Creek/Maguires Creek (5). Figure 13 shows the location of these sub-catchments which were estimated to contribute over 90% of the total acid risk to the estuary. Prioritisation of sub-catchments according to blackwater risk are discussed separately below.

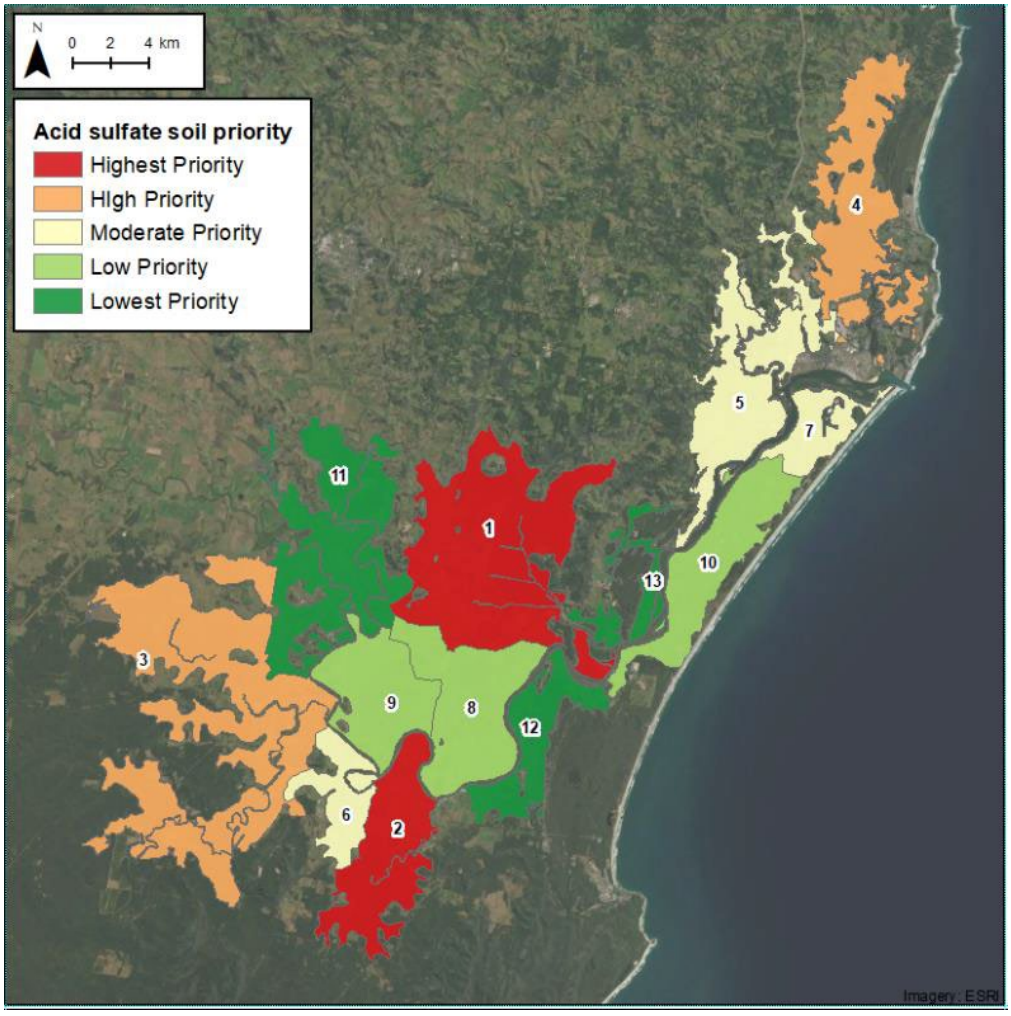

Figure 13: Richmond River floodplain sub-catchment ASS prioritisation

Source: Harrison (2021)

Monosulfidic black ooze (MBO) accumulates in ASS environments and typically occurs at the base of poorly flushed tidally influenced drains. When disturbed and transported during flow events, MBOs have the capacity to rapidly deoxygenate water and severely disrupt the ecology of waterways. MBOs are known to occur in the Richmond River estuary and have also been identified as a factor in fish kills (ABER, 2007). The Tuckean Swamp has one of the highest recorded concentrations of MBOs in the world (Bush *et al.,* 2003). A state-wide study of ASS in 1999 (Tulau, 1999) identified five priority areas within the Richmond River to focus management of ASS (Tuckean Swamp, Rocky Mouth Creek, Sandy Creek – Bungawalbin Creek, Maguires Creek - Emigrant Creek, and Newrybar - North Creek).

Blackwater

Blackwater is formed from the decomposition of plants and organic matter in water during prolonged inundation. Blackwater is usually dark in colour and contains little or no oxygen. The organic matter in blackwater can consume large amounts of dissolved oxygen and if mixed into rivers and creeks can deoxygenate waterways and can cause fish kills as was seen in the 2001 and 2008 floods. Less severe/ more localised blackwater events can cause fish to be more susceptible to disease, kill smaller and more sensitive animals that some fish feed on and interrupt breeding cycles. Blackwater formation is part of the natural carbon cycling process however drainage of the floodplain has increased blackwater risk by encouraging flood intolerant plant/pasture species to establish in low-lying areas (these species are more likely to die and decompose when inundated for long periods e.g. after flooding), accelerating and prolonging the transport of blackwater to the river (Clay *et al*., 2020).

Harrison *et al.,* (2021) ranked the sub-catchment blackwater risk as: Bungawalbin Creek/Sandy Creek (1), Rocky Mouth Creek (2), Tuckean Swamp (3), East Coraki (4) and Swan Bay (5) (Figure 14). These sub-catchments were estimated to contribute over 80% of the total blackwater generation risk to the estuary.

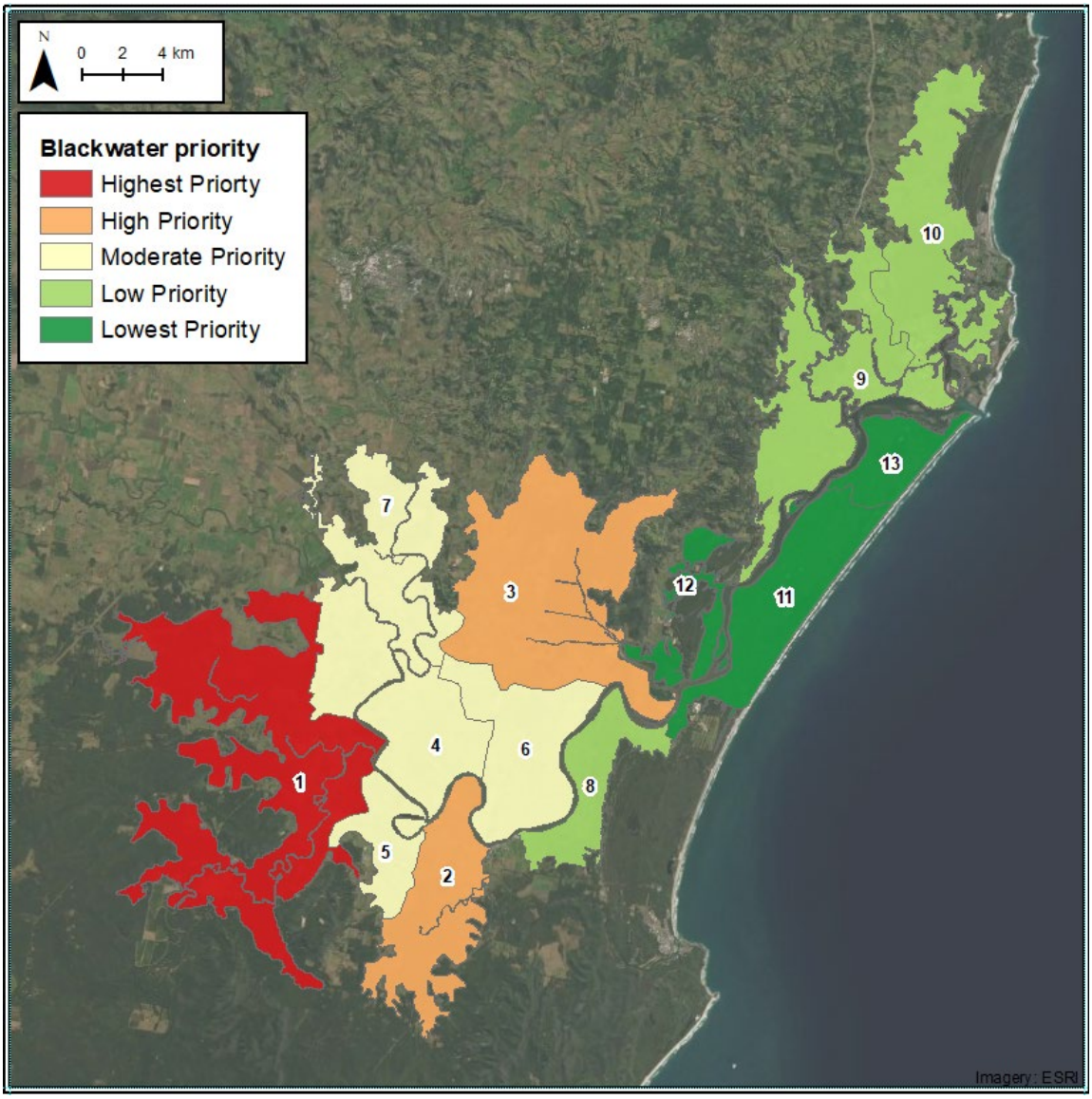

Figure 14: Richmond River floodplain sub-catchment blackwater prioritisation

Source: Harrison (2021)

Point source pollution

Point source pollution originates at a defined location such as a discharge point from a sewage treatment plant (STP) or other industrial premises that have a wastewater discharge, a cattle dip site or contaminated land.

Licensed sites

The NSW Environment Protection Authority (EPA) issues environment protection licences to the owners or operators of various industrial premises under the *Protection of the Environment Operations Act 1997* (POEO Act). Within the study area, local councils operate centralised sewerage collection and treatment systems at urban centres with STPs discharging treated effluent to Richmond River waterways and managed in line with Environmental Protection Licences issues by the NSW EPA. An abattoir at Booyung, Corndale quarry and the Norco Co-operative milk processing facility at Lismore are also licensed discharge points which discharge to Richmond River waterways.

Pollutant loads from point sources become relatively more important to estuary water quality during the dry season when the dilution from other catchment inputs is low. During rainfall events, nutrient concentrations within the estuary increase by several times as a result of diffuse loads from the catchment. WBM (2006) noted that the impact of nutrient loads from urban runoff and STPs on water quality was negligible in comparison to the impact of diffuse loads.

Wastewater from all unsewered villages, rural properties and National Park campgrounds are managed using on-site wastewater management systems (e.g. septic systems). Poorly designed or located on-site wastewater management systems, or those that are not functioning adequately (e.g. through site constraints, lack of maintenance, age etc.) can contaminate groundwater and downstream waterways. Potential pollutants from on-site wastewater management systems include pathogens, faecal bacteria, nutrients, suspended solids, pharmaceutical compounds and household detergents and chemicals. On-site Wastewater Management Strategies are implemented by local councils including risk assessment and monitoring activities to manage the risk from these systems and are regulated under the *Local Government Act 1993*.

Cattle dip sites

Cattle dip sites are sites used to apply chemicals to cattle to control parasites, particularly ticks. The NSW Department of Primary Industries (DPI) maintains an online register of known locations of dip sites and has an ongoing interest in the location and status of each site. Information is updated as provided by public land managers. There are hundreds of cattle dip sites within the study area, the majority of which are either decommissioned, demolished or remediated. Dip sites now pose a low risk to estuary water quality as high-risk sites have already been addressed by DPI (Hydrosphere Consulting, 2020).

EPA notified contaminated land sites

There are various EPA notified contaminated sites within the study area, predominantly in the vicinity of Lismore and Casino, associated with petroleum storage, gasworks, landfill and other industry. If land is declared as 'significantly contaminated', it is regulated under the *Contaminated Land Management Act 1997* and will receive notices relating to the management of this contamination.

Riparian condition

A riparian zone is land alongside waterways and wetlands. These areas are important for many reasons and can support diverse vegetation, protect against bank stability, support cleaner water, provide better habitat for wildlife and help to retain important nutrients and soil.

Australian Wetlands (2010) assessed the riparian vegetation of the Richmond River finding that the riparian vegetation bordering the estuary and tributaries was degraded for much of the area. The width of the bank vegetation was often <5 m and few native trees remained. Serious weed invasion was occurring on the banks as there was no natural vegetation to inhibit the growth of weeds. There are some areas of remnant vegetation with good native canopy and mid-storey trees, particularly mid to upper Bungawalbin Creek and tributaries, mid North Creek and parts of the lower estuary, but these are relatively rare within the estuary as a whole. The poor condition of the riparian zone is a key issue affecting overall estuary health.

The Richmond River Ecohealth Report (Ryder *et al.* 2015) included a rapid assessment of riparian condition at selected sites throughout the catchment. Riparian condition scores were poor throughout all regions of the

Richmond River catchment, with 10 of the 17 river systems recording a score of “D” or lower. Figure 15 provides an overview of the riparian condition grades assigned to each sub-catchment.

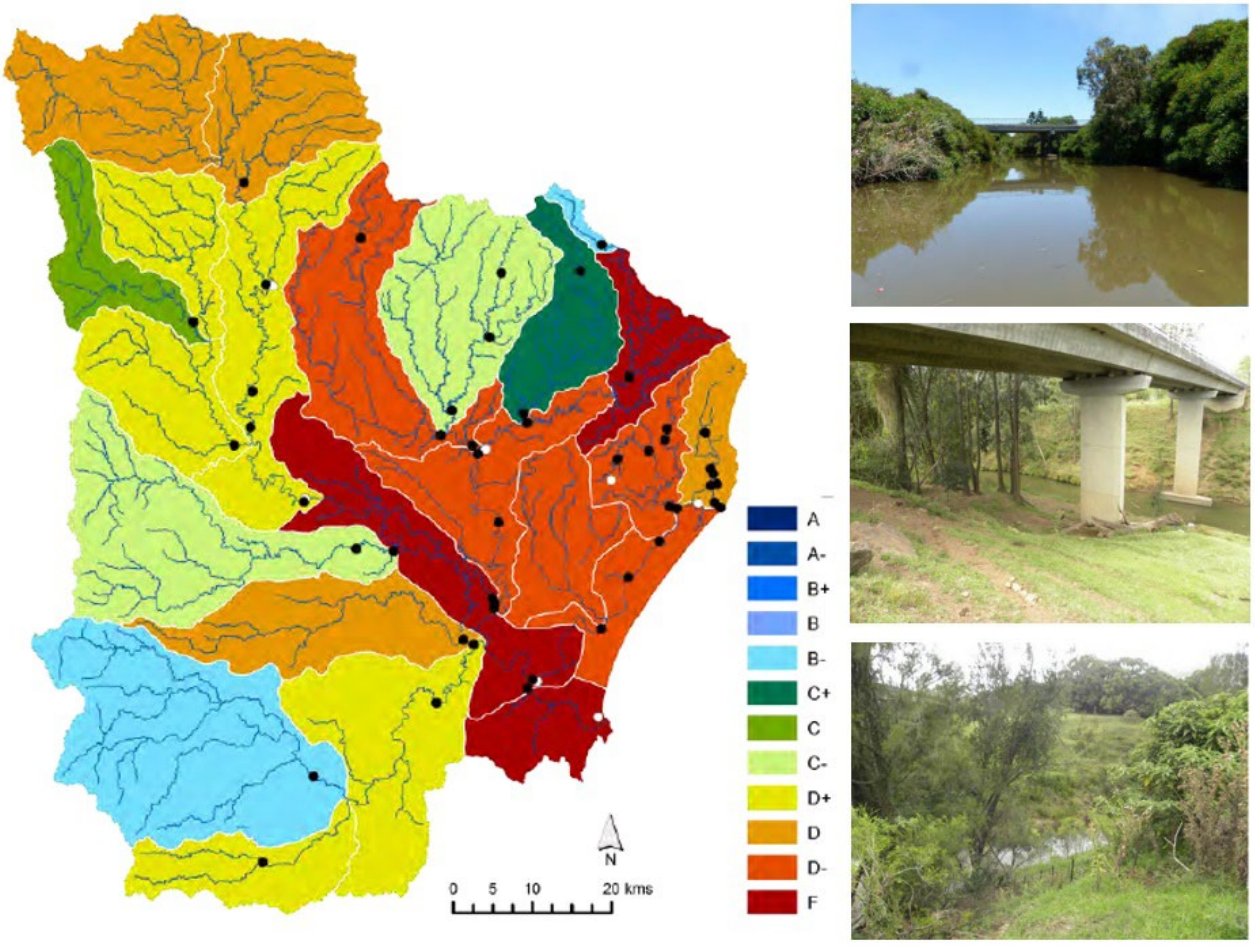

Figure 15: Sub-catchment riparian condition grades and photographs from Ecohealth project field assessments

Source: Ryder *et al.* (2015)

Weeds

Weeds are one of the most significant and costly environmental threats in Australia. Once a weed species is established it can place ongoing pressure on biodiversity and the current fragmentation of native vegetation in the Richmond River estuary makes it susceptible to invasion by weeds. Weeds can impact the environment and the community by (LLS, 2021; LCC, 2015):

- Impacting the landscape amenity which can impact the community’s enjoyment of natural areas.
- Disrupting the structure and function of both terrestrial and aquatic ecosystems.
- Invading native vegetation and habitats by out-competing native plants for light, nutrients and water.
- Destroying or degrading native habitats placing pressure on native flora and fauna.
- Causing or influencing bank erosion along waterways.
- Impacting First Nations communities’ connection to Country and the ability to undertake cultural activities.

The *North Coast Regional Strategic Weed Management Plan 2017-2022* (LLS, 2021) outlines the primary objectives and strategies for managing priority weeds for the NSW North Coast and the responsibilities of the various stakeholders. Despite ongoing weed management on the NSW North Coast region, the number and extent of priority weed species in the region continues to increase as resources have not been adequate to eradicate all new reported weeds (LLS, 2021). Favourable climatic conditions allow rapid establishment and reproduction of weeds. Weed management resources are not adequate to address weed management priorities in the catchment (pers. comm. P. Courtney, 2021; LLS, 2021).

Pest Animal Species

In the Richmond River estuary, pest animals have a significant impact on threatened species and ecological communities, primary production and rural communities (LLS, 2018). Under the *Biosecurity Act 2015*, pest animals can be considered as any species (other than native species) that present a biosecurity threat. Priority pest species on the North Coast are Cane Toad, Feral Cat, Wild Deer, Red Fox, Feral Goat, Wild Horse, Indian Myna, Feral Pig, Wild Rabbit and Wild Dog (LLS, 2018). Pest species impact the health of waterways by contributing to loss of biodiversity, alteration/degradation of native habitats, damage to fences and other infrastructure that may be used to protect riparian zones, increased erosion and bank erosion, aquatic habitat disturbance and water quality impacts from the introduced fish species (e.g. *Cyprinis carpio*, carp). The introduced Mosquitofish (*Gambusia holbrooki*) is widespread throughout the study area, including brackish waters and is known to impact on ecosystem health through direct predation and competition with small native fish.

Pest animal management is undertaken by various agencies and local government under the *Biosecurity Act 2015*, *North Coast Regional Strategic Pest Animal Management Plan 2018-2023* (LLS, 2018), *National Parks and Wildlife Act 1974* and plans of management for specific parks and reserves, state and local biodiversity strategies.

Bushfire

Bushfires cause devastating damage to terrestrial flora and fauna. Aquatic environments can also be affected during bushfire events through increases in temperature, instream pH and increase in nutrients from smoke and ash inputs (Lyon *et al*., 2008). The largest water quality impacts occur due to high magnitude erosion events soon after a fire (such as high intensity rainfall events and flash floods) which mobilise soil and organic matter to waterways. Increased suspended sediment is the most frequently reported impact on water quality post-fire. Chemicals from fire suppression and retardants may also cause impacts to water quality and the construction of earth fire breaks can leave areas of soil exposed and susceptible to erosion which may further increase sediment loads and yields in waterways (Smith *et al*., 2011). Aquatic ecosystems may remain impacted by fire for extended periods following a bushfire due to changes in the landscape. The potential changes to the landscape and water cycle post-fire are depicted in Figure 16.

Bushfire events in NSW are predicted to increase in frequency in the future while drought and rainfall events are forecast to become more extreme hence, the impacts of bushfires on aquatic ecosystems will become increasingly serious and hence responding to these threats is becoming more urgent.

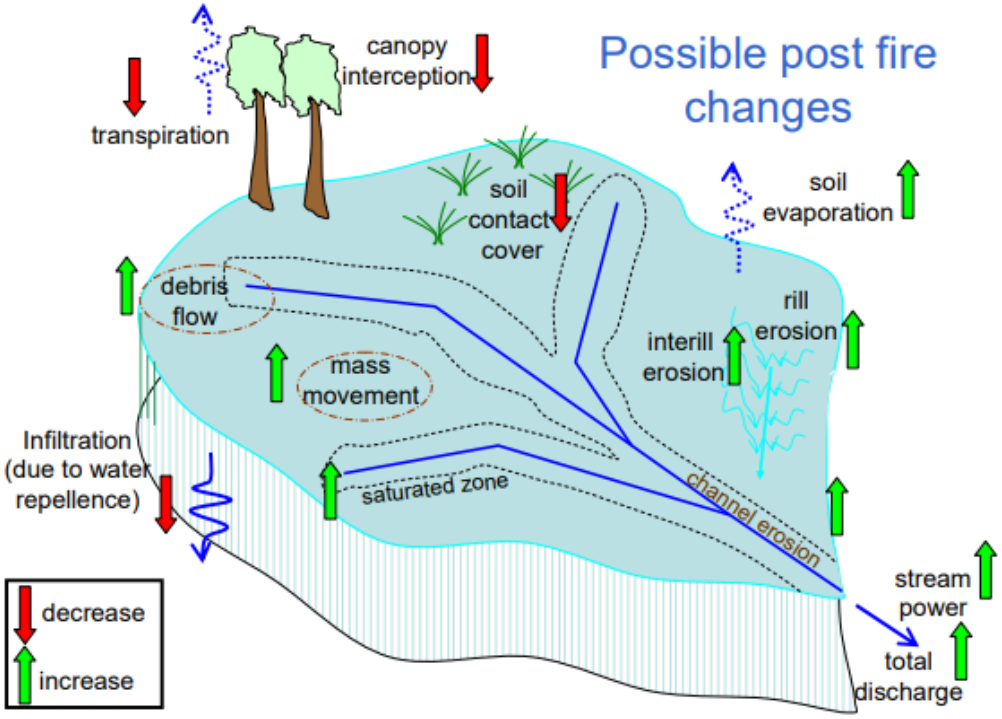

Figure 16: Potential impacts resulting from changes in the landscape post-fire

Source: Smith *et al.* (2011)

4.3.6 Water quality monitoring

A number of monitoring initiatives have been implemented however they have typically been short-term or location specific and a comprehensive, integrated ecosystem monitoring strategy and reporting system as not yet been established. The *Richmond River Ecohealth Project 2014* (Ryder *et al.,* 2015) provided the first comprehensive snapshot assessment of ecosystem health in the Richmond River catchment (Section 4.3.5). Other ongoing water quality monitoring initiatives within the catchment include:

- RCC Water Quality Monitoring Program.
- RCC Drinking Water Catchment Water Quality Monitoring.
- NSW state-wide estuarine water quality monitoring and report cards.
- DPE has prepared a draft *Richmond River Water Quality Monitoring Strategy* (Ferguson, 2021) providing a framework for a staged water quality monitoring program in the Richmond River catchment, initiated as part of the MEMS. The strategy is intended to fulfil and coordinate the anticipated needs of local government stakeholders, the MEMS, CMPs and the NSW Natural Resource Monitoring Evaluation and Reporting program.
- A review is currently being undertaken to update community and environmental values, assess land use changes and the suitability of indicators used in the water quality objectives as part of the MEMS (DPIE, 2021).

- DPE - E&H has developed a preliminary Richmond River ecosystem response model comprising coupled catchment-hydrodynamic-biogeochemical models, representing the entire Richmond River catchment (Ferguson, 2021). The model is currently restricted to assessing the impacts of suspended sediment and nutrients on the receiving waters, however it is intended that sub-models representing blackwater and ASS runoff processes will be developed.

4.4 Coastal Processes and Hazards

The CMP will address the tidal inundation hazards relevant to environmental values (i.e. bank erosion and migration of estuarine vegetation) within the estuary. Other coastal hazards are being addressed in separate coastline management plans for Ballina and Evans Head.

4.4.1 Tidal inundation

The tidal influence extends upstream of Tatham on the Richmond River and upstream of Lismore on the Wilsons River. Eden Creek, Shannon Brook and Bungawalbin Creek are significant tributaries draining the western and southern areas of the Richmond catchment.

Tidal inundation of the stormwater network in Ballina currently occurs with ‘king’ tides but no serious threats to public safety or built assets have been identified. Similarly, tidal inundation risk in the Evans River is currently not considered significant. Although these lower estuary areas are outside the study area, the coastal hazards of tidal inundation and erosion within estuaries caused by tidal waters are expected to increase in severity and extent under climate change impacts, particularly sea level rise. Estuary bank erosion risks to development and infrastructure adjacent to the estuary is expected to increase in extent and severity under sea level rise scenarios (Hydrosphere Consulting, 2011a).

The Federal government’s online tidal inundation model (Coastal Risk Australia, 2021) provides a visual indication of those places at risk from tidal inundation in the present day and at 2100 (example shown on Figure 17). The mapping indicates that large areas of the study area may be at risk of tidal inundation, most notably the Richmond River floodplain and adjacent lands. This mapping is a coarse assessment that was completed across Australia to provide a broad overview of predicted tidal inundation risk and does not consider local conditions such as tidal flows in coastal waterways that will result from different coastal configurations in some locations (i.e. floodgates, drains etc.). Nor does the model take account of the effects of catchment flooding from coincident extreme rainfall events. More detailed local study is required to ensure that particular local circumstances and dynamics are adequately considered in any adaptation response to sea level rise.

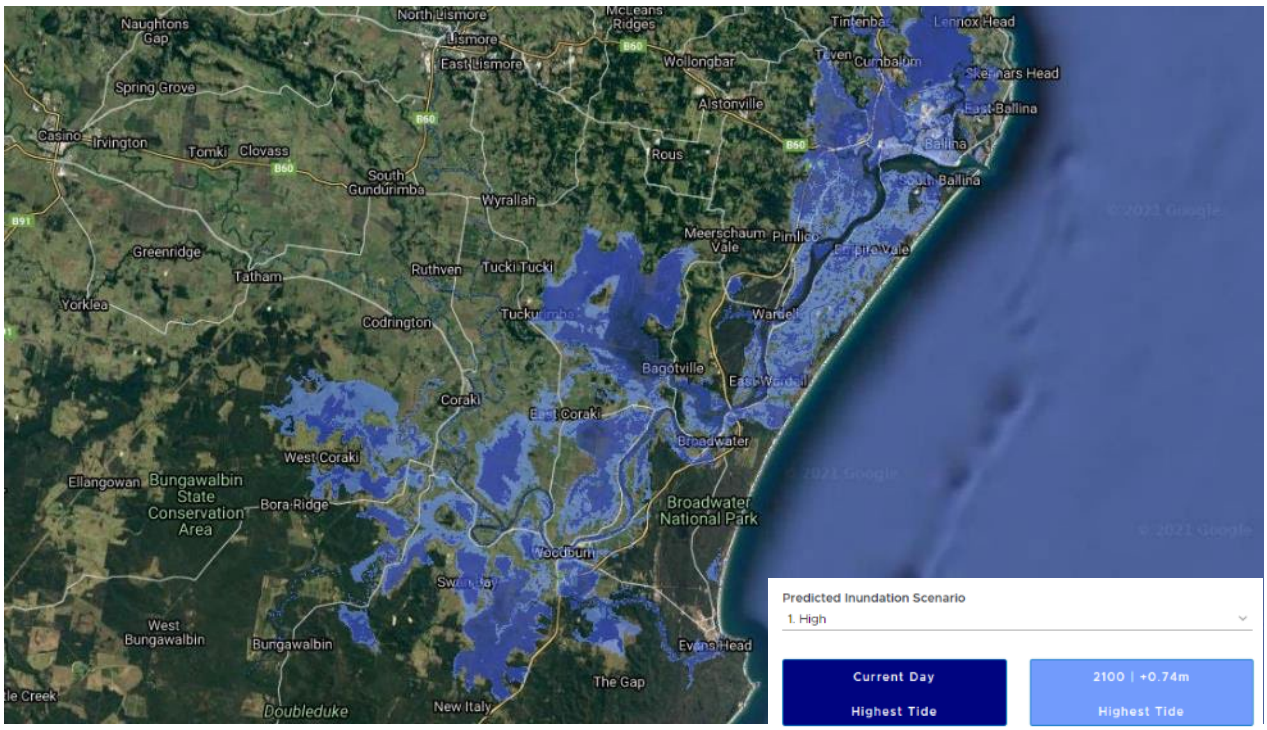

Figure 17: First-pass mapping of present-day and 2100 risk from tidal inundation

Source: Coastal Risk Australia (2021)

4.4.2 Bank erosion

Bank erosion can lead to a range of environmental, social and economic problems such as the loss of riverfront property and infrastructure, water quality degradation, destruction of natural and artificial levees, loss or destabilisation of native trees and the destruction of habitat and aquatic plants and animals. Water quality issues associated with erosion include high turbidity and the mobilisation and transportation of nutrients and contaminants associated with sediment from land to waterways. Sedimentation in the main river channel is not considered to be a significant issue as most of this sediment is thought to be transported to the ocean during major events, with very little evidence of sedimentation or infilling of the river channel detected in 2007 river surveys documented in ABER (2007). However, sediment build up and erosion can occur in some locations through fluvial reworking during major floods such as was observed during major flood events in February and March 2022. Sediment can be a major issue in the lower energy creeks where channels have become infilled with sand, such as Six Mile Swamp Creek in the Bungawalbin catchment. Sediment transported from drains can also build mud flats and smother seagrass in the lower estuary (ABER, 2007).

Bank erosion is prevalent in many areas within the estuary and catchment. Bank erosion occurs mainly because of loss of vegetation in key riverbank areas where water velocities are high and banks scour, resulting in undercutting and bank slumping. Additionally, riparian areas can become susceptible to erosion as a result of trampling by stock, vehicle access, boat wash (e.g. Emigrant Creek and North Creek) and unlicensed access to the river. The significance of these impacts varies according to the location along the river system. Large stretches of the Richmond River and its tributaries have been reported as being devoid of good quality riparian vegetation which in many instances coincides with areas of active bank erosion (WBM, 2006). Riparian vegetation is critical for maintaining bank stability and channel integrity as well as decreasing sediment run-off.

Predicted sea level rise due to climate change may increase erosion due to increased estuary water levels and the interaction of tidal waters with catchment floodwater. Climate change impacts are discussed in Section 4.7.2).

Plate 9: Severe bank erosion and degraded riparian zone on the Richmond River near Casino

Source: Hydrosphere Consulting (2011b)

The Richmond River Ecohealth Report (Ryder *et al.,* 2015) included an assessment of geomorphic condition (bank and bed condition) at selected sites throughout the catchment. Geomorphic condition scores ranged from good to poor throughout the Richmond River catchment with generally good to moderate condition in the upper freshwater reaches and poor condition and evidence of active erosion occurring in the estuarine reaches (Figure 18). The areas of poorest geomorphic condition were in the estuary where the riparian zone had been completely cleared for agriculture and cropping. In the freshwater reaches, poor geomorphic condition was associated with cattle grazing and stock access to the river.

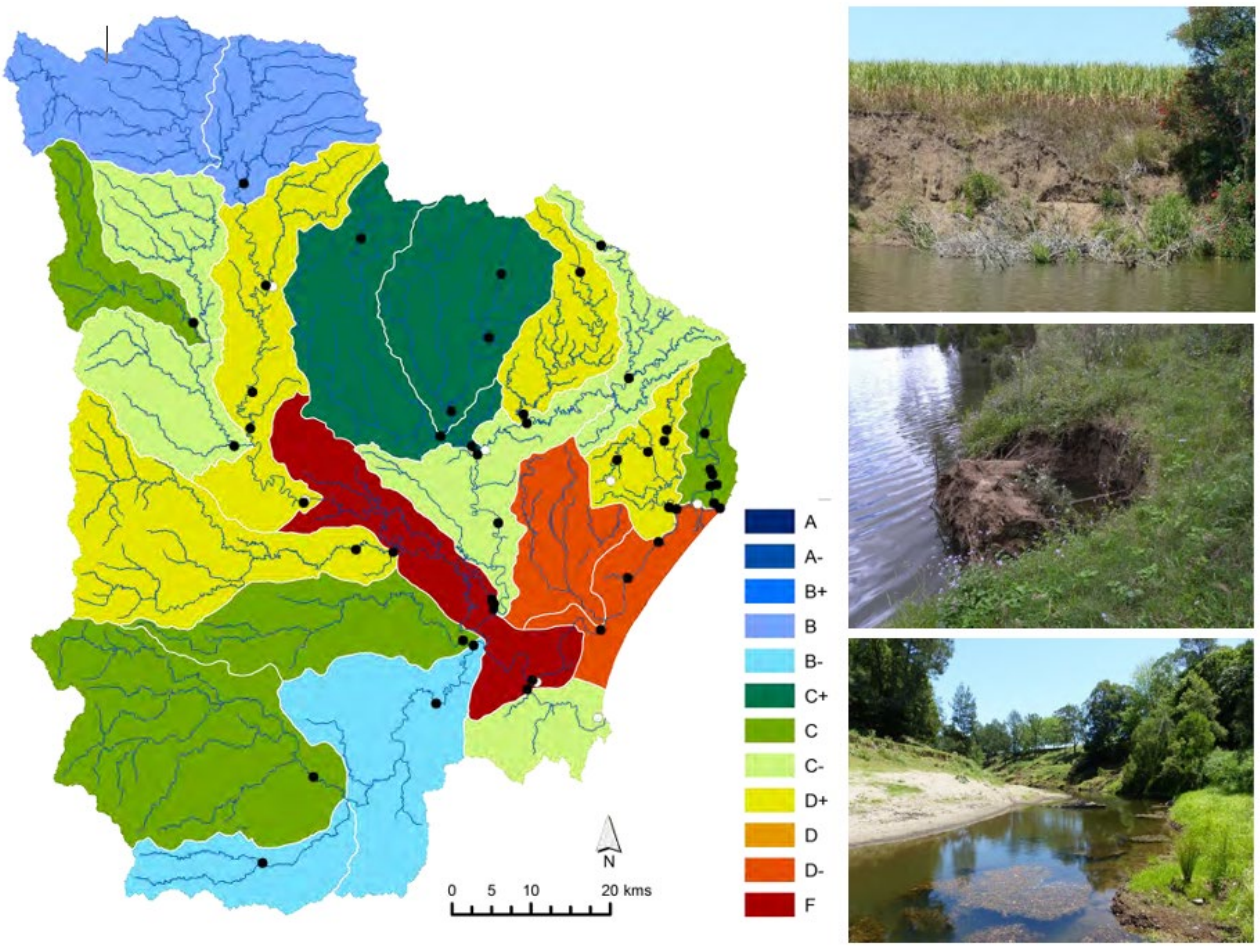

Figure 18: Sub-catchment geomorphic condition grades and photographs from Ecohealth project field assessments

Source: Ryder *et al.* (2015)

A bank erosion decision support tool (DST) prototype and accompanying bank assessment methodology is currently being developed by DPI Fisheries to assist the development of bank management strategies. The approach is aimed at reducing 'red tape' in gaining approvals and in prioritising environmentally friendly approaches to bank management. A draft DST and interactive web-based map categorising erosion severity, and best practice management practices along the foreshores of two priority estuaries - Tweed and Brunswick Rivers, have been developed (MEMA, 2021). Additional pilot studies in other catchments are underway to test and refine the tool. Estuary-wide maps are being prepared to illustrate erosion risk overlayed with best practice erosion control. The project is being undertaken through the MEMS and the tool should be available for use in later stages of the Richmond River Estuary CMP.

4.5 Social Context

4.5.1 Land use

The dominant land use within the study area is grazing, comprising approximately 44% of the catchment (Figure 19 and Table 3) occurring mostly on the dryland floodplains of the mid to upper north and west parts of the catchment. Parks and reserves, comprising 29% of the area and forestry plantations (12%) are found in the upper ranges of the north and south of the catchment. Cropping activities comprise 4% of the study area and dominate the floodplains of the lower catchment and also some areas of the mid catchment. Sugarcane is the predominant crop cultivated on the floodplain in the lower catchment. Horticultural activities comprise approximately 2% of the catchment and include macadamia, avocado, stone fruit, coffee plantations and other mixed horticultural such as vegetables and herbs. Table 3 also provides a breakdown of the land uses on land <1 mAHD (refer Figure 7). Rivers and drainage occupy over half (52%) of this land. Dominant land uses are cropping (primarily sugarcane/soybean) occupying approximately 19%, grazing makes up 15%, followed by parks and reserves comprising 12% of low-lying land. Horticulture occupies approximately 1.4% of low-lying land and this has expanded in recent years with an increase in Macadamia farming on the floodplain.

Table 3: Land use within the study area

	Study area		Low-lying floodplain land (< 1 mAHD)	
Land use	**Area (ha)**	**Area (% of total)**	**Area (ha)**	**Area (% of total)**
Grazing	300,900	43.9%	1,868	15%
Parks and reserves	201,000	29.3%	1,525	12%
Forestry	83,400	12.2%	1	0.01%
Cropping	29,600	4.3%	2,473	19%
River and drainage	23,200	3.4%	6,630	52%
Non-urban residential	18,200	2.7%	18	0.1%
Horticulture	16,800	2.4%	178	1.4%
Infrastructure	8,700	1.3%	61	0.5%
Urban residential	3,400	0.5%	2	0.01%
Quarrying and mining	500	0.1%	0.1	0.001%
Animal production	400	0.1%	-	-
Total	*686,100*	*100%*	*12,756*	*100%*

Source: DPIE (2020)

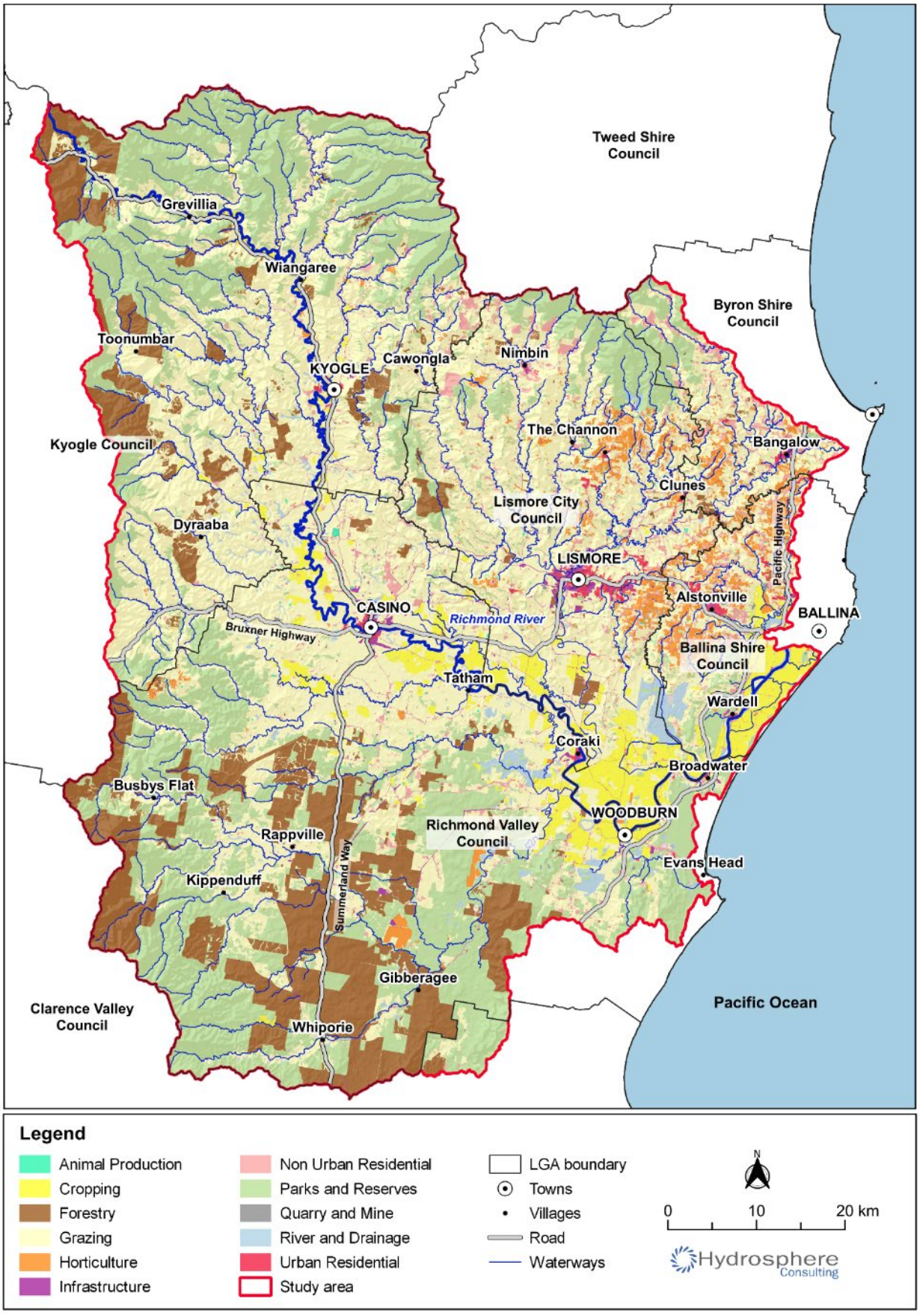

Figure 19: Land use within study area

Source: Mapping data provided by DPIE (2020)

4.5.2 Population and demographics

The estimated resident population of the combined LGAs was 121,162 in 2020. The resident population is estimated to have increased by 1,677 people (1.4% p.a.) since the 2016 Census. From 2011 to 2016, the combined LGA population increased by 2,136 people (1.8% p.a.). Aboriginal and Torres Strait Islanders made up 4.8% of the combined LGA population (5,558) in 2016. The most common ancestry is Australian and English. The combined LGA populations are generally older than other regional areas with 30% of the population aged 60 years and over. Household income and rent are generally lower than other areas of NSW (.id Consulting, 2021).

4.5.3 Community uses and values

The Richmond estuary has high cultural and spiritual significance to local First Nations people. There are many sites of heritage significance around the estuary and their recognition and protection is of high importance to the community. Healthy waterways and “sea country” are essential for Aboriginal people for health, wellbeing and culture as they allow kinship, connection, stories, song lines and healing. To First Nations people, mythological sites are part of a complex holistic knowledge system which is an integral part of their culture (Neale and Kelly, 2020; LCC, 2021; Department of Planning, 1988). The many features which make up the landscape are viewed by First Nations people as inseparable and makeup what is known as “Country” to First Nations people (NPWS, 2007).

Connection to Country is explained in a statement from the Widjabul Elders featured on LCC’s website (LCC, 2021):

"*As Aboriginal people we have different ideas and views about our existence to that of non-Aboriginal people. We view the world in a holistic manner, seeing people and nature as part of the whole, connected by their very existence and descended from our creator ancestors. The key to our very survival is cooperation and coexistence with the forces of nature, the spirit world, and with our fellow man. We are all part of the natural order and our cultural beliefs and practices should not be subject to Western scientific analysis. In other words, our culture should never be broken down and compartmentalised. If you can’t see the interconnections and interrelations that dominate our culture, then you aren’t looking with an open mind*."

Plate 10: Githabul Country – Sheep Station Creek, Border Ranges National Park

Previous community consultation undertaken as part of the development of the Richmond River CZMP (Hydrosphere Consulting, 2011a) identified other values as follows:

- The estuary and foreshore areas are highly valued by the community and visitors for recreational activities. Activities include fishing, boating, swimming, surfing, walking and bird watching.
- Scenic amenity is valued highly by the local community and visitors.
- The river and estuary provide opportunities for both formal and informal education.
- A number of historic (non-indigenous) cultural heritage sites and items exist in and around the estuary and their acknowledgement and protection is important to the community.

Recreational uses constitute the dominant human uses of the estuary. Commercial boats also utilise the estuary for fishing and tourism activities which are also important in the region although activities are concentrated in the lower estuary (outside the CMP study area). Boating forms a vital component of the tourism sector of the Richmond River communities and is a significant lifestyle activity enjoyed by a large proportion of its residents. Many of the communities, particularly those in coastal areas, are reliant on tourism to drive their local economies. The availability of suitable river access points and appropriate and complimentary marine infrastructure is critical to the enjoyment of recreational boating in the estuary. Providing appropriate boating facilities to meet growing demand, ensuring cooperative use of the waterway between various forms of recreational and commercial users while protecting the ecological values of the estuary are key challenges for successful holistic management of the estuary (Hydrosphere Consulting, 2011a).

Public access to foreshore areas is highly valued by the community. Existing access facilities including waterfront licences (for jetties, wharves, boatsheds, boat ramps, pontoons and slipways), boat harbours, mooring areas, parks and reserves. Informal access to the foreshore causes bank erosion and trampling of vegetation which are likely to be exacerbated by the potential climate change impacts of sea level rise and increased storminess.

Plate 11: Pontoon in lower Emigrant Creek

4.6 Socio-Economic Context

The Richmond River study area includes an array of coastal and hinterland communities. Lismore and Ballina are the major strategic centres that provide a range of services to local residents and the wider regional community. Casino and Kyogle fulfil the local service needs of residents in the western portion of the catchment. Major infrastructure such as Lismore Base Hospital, Ballina-Byron Gateway Airport and Southern Cross University provide significant employment opportunities and services for the community. Investment in projects like the Pacific Highway upgrade have significantly enhanced regional connectivity and have provided new economic opportunities.

The Richmond River catchment has several favourable characteristics related to economic opportunities in the coastal zone including coastal, riverine and hinterland amenity, arable soils, favourable climate and access to Sydney and Brisbane via the Pacific Highway. The *North Coast Regional Plan 2036* (NSW Government, 2017) provides an outline of future economic development in the region. The plan outlines the economic sectors which are expected to be the basis of future economic growth in the area, and which are related to or have the potential to influence the study area including tourism, farming, and high-quality infrastructure. The plan also highlights the importance of land use planning to protect the benefits of the regions outstanding natural environment.

4.6.1 Agriculture

Agriculture is a major driver of the local economy, employing approximately 6.6% of the working population within the study area (including Ballina, Richmond Valley, Lismore City LGAs, the Bangalow and Rural South West of the Byron Shire LGA and Kyogle Council - excluding the Bonalbo – Woodenbong district). Local forms of agriculture include cattle grazing, sugar cane cropping and horticulture. The Alstonville Plateau area has been designated state significant farmland as part of the Northern Rivers Farmland Protection Project. Areas designated as regionally significant farmland include parts of North Creek, Empire Vale and Woodburn (DPI, 2005).

In 2019/20 the agriculture industry accounted for 6.1% of total employment across the four predominant LGAs of the study area (LSC, RVC, BaSC and KC) and the value of agriculture production in these LGAs was over $500 million (.id Consulting, 2021).

4.6.2 Fishing

Recreational fishing is a popular lifestyle choice for residents and visitors with flow-on economic implications for local commerce including boat supplies, bait/tackle shops and tourism (Hydrosphere Consulting, 2011b). Results from a 2013/14 recreational fishing survey indicated that recreational fishing is mostly shore-based and concentrated in estuarine waters followed by inshore coastal waters (West *et al.,* 2015). Fishing activities and practices have spiritual, social and customary significance for First Nations people. ‘Aboriginal Cultural Fishing’ is recognised under the *Fisheries Management Act 1994.* Where native title is recognised over marine waters, rivers, lakes and estuaries, native title holders can exercise their rights to fish for personal, domestic or non-commercial needs in line with the provisions of the *Native Title Act 1993* (DPI Fisheries, 2017; DPI Fisheries, 2019).

The Richmond River estuary has regionally important commercial and recreational fisheries. Commercial fishers target a wide range of species in particular Bully mullet, School prawn, Long-finned eel and Luderick

(WBM, 2006). The Rock Oyster was grown and harvested within the Richmond River up until the mid-1970s (OzFish, 2021). Since that time, full-cycle (spat to harvest) oyster farming has not occurred on the Richmond due to poor water quality and the incidence of QX disease. Commercial fishing and oyster farming are important economic activities in the lower reaches of the estuary and ocean (outside the study area) and fishery sustainability is influenced by catchment health.

Natural oyster reefs were once spread throughout the lower Richmond River estuary providing food and habitat for fish and other animals, improving water quality through filtration, protecting shorelines from wave erosion and providing an important cultural food resource (NSW Government, 2022). Oyster reef loss can be attributed to poor water quality, historical estuarine dredging, habitat modification, disease and over-harvesting.

4.6.3 Tourism

The study area is a popular tourist destination for activities such as camping, kayaking, swimming, wildlife appreciation, food and dining experiences and sightseeing with many camping and accommodation options. National Parks with campgrounds include Whian Whian State Conservation Area, Toonumbar and Richmond Ranges National Parks. Tourism and recreation are also major economic drivers for the North Coast Region. Tourism activities include outdoor recreation and sports and nature-based experiences. Popular activities include recreational fishing, boating, swimming, holidaying, day trips, ecotourism, bird watching and nature appreciation.

4.7 Future Context

4.7.1 Population growth and land development

The economy and population of the Far North Coast regional centres are expected to grow in coming years. Economic growth in the region will be driven by the growing population as well as by tourism, agriculture and industry. Growth is expected to largely occur in the existing urban growth centres including existing major towns (NSW Government, 2017). Population growth in the region is expected to be higher along the coastal fringe, particularly in the Ballina local government area. In recent years, inland parts of the region have grown very little and some areas have seen a decrease in population. More recently, population growth in regional areas is increasing with the Northern Rivers one of the fastest growing parts of regional NSW.

4.7.2 Climate change

The Richmond River estuary and its catchment will experience broadscale climate change impacts as well as interrelated localised impacts into the future. Climate change impacts expected within the estuary and throughout the catchment are broad ranging and are summarised in the following sections.

Sea level rise

It is expected that sea level rise will result in changes to the study area including:

- Increased tidal propagation into estuaries resulting in changing tidal velocities, storm tide inundation, changed geomorphology (shoaling, bank instability and erosion) and migration of estuarine vegetation communities (where land gradient and adjacent land use does not prevent migration).

- Existing coastal gravity drainage, stormwater infrastructure, sewerage systems and some roads potentially becoming compromised over time as the mean sea level increases.
- A substantial reduction in drainage of constructed flood mitigation and drainage systems on the floodplain throughout the full tidal range. Rising sea levels influence the tidal range and heights within the estuary, which impact on how floodgates operate and the efficiency of drainage systems behind them. Constructed flood mitigation and drainage systems function throughout the tidal range, providing protection from high water levels while draining excess catchment flows to the low water level. However, drainage can only be achieved under gravity when suitable water levels are available for discharge. Waddington *et al.* (2021) recently examined the effects of sea level rise on estuarine drainage systems in the Clarence River and Hastings River floodplains which provides comparative data for the Richmond River floodplain. The 'drainage window' concept was defined as the temporal period of the '*tidal cycle where a positive hydraulic head is available to facilitate gravity discharge to the receiving waters at a selected elevation'* (Waddington *et al.,* 2021). The results of the study showed that sea level rise may substantially reduce the opportunity for discharging many estuarine floodplain drainage systems and drainage systems will be particularly vulnerable to changes in the low tide (Waddington *et al.,* 2021). Reduced drainage creates many chronic problems that may necessitate changes to existing land uses.
- Decrease in the level of protection afforded by existing seawalls and other hard engineering structures due to the increasing threat from larger storm surges and inundation at higher projected water levels.
- The effects of sea level rise may be magnified as freshwater inflows reduce due to climate change.
- Storms and rainfall events are predicted to become increasingly intense in both the near and far future (IPCC, 2022) and combined with sea level rise, this will have major implications for the severity of flooding in estuaries. Increased salinity in the upper estuary reaches and subsequent impacts on vegetation communities, agricultural productivity (i.e. impacts on salt intolerant crops, stock water etc.) and distribution of fauna species.
- Increasing salt concentrations in the coastal lowland ASS (CLASS) found in Rocky Mouth Creek and Tuckean swamp and increase in the short-term release of acidity and trace metals (aluminium, iron, nickel and zinc) (Wong *et al*., 2010). This is likely to result in rapid, substantial, short-term declines in water quality in backswamp basins containing CLASS following seawater inundation. The interconnectedness of these backswamps to estuaries via artificial drainage channels makes them highly susceptible to surface inundation by seawater as a result of climate change induced sea level rise (Wong *et al*., 2010). High hydraulic conductivity in the sulfuric horizons is found in some of the CLASS floodplains within the Richmond River estuary (including near Rocky Mouth Creek and Tuckean Swamp) (Johnston *et al.*, 2009), which may further enhance lateral seawater intrusion and consequently enhance the mobilisation of acidity and metals.
- Increases in the salinity of coastal groundwater aquifers may also occur.

Rainfall patterns

Extreme rainfall events are associated with storms and flooding. The Far North Coast is likely to be subject to more intense storm events, although it is uncertain if the severity of associated flooding will increase.

Climate modelling undertaken for the development of regional water strategies (DPIE - Water, 2020) has found that droughts may be more severe in the future. The region is also likely to see seasonal shifts in rainfall patterns, higher rates of evaporation and more hot days.

Climate modelling also projects a decrease in the number of small to moderate east coast lows (ECLs) in the cool season with little change in these storms during the warm season. However extreme ECLs in the warmer months may increase in number but extreme ECLs in cool seasons may not change (AdaptNSW, 2019a). The severity and frequency of flood-producing rainfall events, such as ECLs as well as impacts due to rising sea levels, may increase. These aspects can increase the risk of flooding particularly in low lying floodplains where ocean influences can also significantly impact flood behaviour. They may also have impacts on blackwater and fish kill events. As sea levels rise and flood producing rainfall events increase in severity, this will increase the exposure of communities to flooding.

Stream flows

Water extraction from waterways to meet community and industry demands is likely to increase due to decreases in rainfall and greater evaporative losses. Producers are highly dependent on regular rainfall and therefore highly susceptible to drought. Many of the region's rivers and creeks are already under stress, particularly during low flow periods. Climate modelling shows these pressures could increase, with reductions forecast for river flows and inflows into estuaries, a decrease in the magnitude of both high and low flow events and more cease-to-flow events (DPIE - Water, 2020).

The maximum high tide footprint is expected to increase significantly with sea level rise, potentially putting water extraction in coastal parts of the region at risk. Saline intrusion will make some supplies unfit for use and affect sewage treatment plant operations. Irrigators in tidal pool areas will be affected.

The magnitude of high flow events could decrease in the unregulated rivers which may limit the number of events that trigger fish movement and spawning and also reducing the larger tributary flows that stimulate riverine productivity by transporting dissolved carbon and organic detritus, micro-organisms, plankton and small animals into the system. There could be an increase in the number of years in which a cease-to-flow event occurs across all regulated, unregulated and estuary inflow systems (DPIE - Water, 2020).

Related environmental impacts

Biodiversity will be impacted by climate change induced rising temperatures, sea levels, fire regimes, water quality and ocean chemistry. This will exacerbate degradation of native communities and expansion of invasive species (e.g. Tilapia) (DECCW, 2010). Increased temperatures and competition may cause stress or even localised extinctions for some species. Studies suggest climate change could surpass habitat destruction as the greatest threat to biodiversity (Leadley *et al*. 2010). Some of the most vulnerable ecosystems are found within the study area including coastal floodplains and wetlands and saltmarshes and mangroves (EPA, 2021a).

A recent study by Scanes *et al*., (2020) found that in response to climate change the temperature of Australian estuaries has increased on average approximately 2ºC and they have acidified at a rate of 0.09 pH units over the last 12 years. These changes are orders of magnitude faster than predicted in earlier studies. Projected lower flows, higher temperatures and sea level rise may further reduce water quality.

Average and severe fire weather is projected to increase in NSW in the future. Increases in average and severe fire weather are projected to occur mainly in summer and spring, with the largest increases by 2070 to occur in spring (AdaptNSW, 2019b).

The location of estuarine habitats such as mangrove forests and saltmarsh are controlled principally by tidal range and salinity influence and will gradually respond to changes in increases in average water levels and salinity due to sea level rise. There is a risk that natural upslope migration of these wetlands will be curtailed by anthropogenic constraints such as roads, levees, agriculture and urban development on the landward side. Under these conditions the landward side of these important habitats will be fixed but the lower margin will gradually be pared away, leading to a loss of habitat area. Increased estuary water levels will affect riparian and other low-lying vegetation in the freshwater reaches of the estuary in a similar way. Waterlogging will gradually kill off the lower vegetation, whereas the upper boundary may be restricted.

The potential changes in salinity regime and implications for estuarine ecosystems and adjoining land uses has not been fully explored. There may be increasing pressure to reduce saline intrusion into low-lying farm lands and long-term floodgate management policies will need to consider the implications of sea level rise and potential salinity increases. Similarly, more frequent flooding of low-lying urban areas, such as much of Ballina, creates risks for the estuary in terms of managing urban drainage impacts, potential effects on sewerage infrastructure and overflows.

5. CURRENT COASTAL MANAGEMENT ARRANGEMENTS

5.1 Coastal Management Areas

The coastal use area (CUA), coastal environment area (CEA) and coastal wetlands and littoral rainforest area (CWLRA) within the study area have been mapped as part of the Resilience and Hazards SEPP and are presented in Figure 4. Resilience and Hazards SEPP mapping is currently not available for the coastal vulnerability area (CVA). The SEPP gives effect to the objectives of the *Coastal Management Act 2016* from a land use planning perspective, by specifying how development proposals are to be assessed if they fall within the coastal zone. This becomes relevant to the preparation of the CMP with regards to the intent and description of recommended actions and their intended approval pathways (if required) under the SEPP.

The *Coastal Management Act 2016* definitions and objectives of the coastal management areas are discussed in Hydrosphere Consulting (2021c). The management of these areas is discussed in the following sections. Also refer to Section 5.7 and Appendix A for discussion of the status of past management actions.

5.1.1 Coastal wetlands and littoral rainforests

The CWLRA supports high value biodiversity that is particularly sensitive to development. This management area is defined in the *Coastal Management Act 2016* as land which displays the hydrological and floristic characteristics of coastal wetlands or littoral rainforests and land adjoining those features. This area focusses on protecting well established and more extensive vegetation communities.

Littoral rainforest within the study area is mapped at two discrete locations in the lower estuary just downstream of Wardell at Pimlico Island and Little Pimlico Island. The littoral rainforest on Pimlico Island is located on private land and zoned as Deferred Matter under the Ballina Council Local Environmental Plan 2012 (Ballina LEP). The littoral rainforest on Little Pimlico Island is within the Little Pimlico Island Nature Reserve. The reserve is managed by NPWS under the *Little Pimlico Island Nature Reserve Plan of Management* (NPWS, 2008).

Coastal wetlands are mapped along the lower Richmond River estuary with a total area of approximately 3,142 ha as follows:

- From Ballina to Rileys Hill along the lower Richmond River estuary. Most of the mapped areas are either on private or Crown land and the majority are zoned as W1 Natural Waterways, Deferred Matter (Environmental Protection) or RUI Primary Production.
- Lower Emigrant and Duck Creeks from the confluence with the Richmond River at West Ballina to Teven. Most of the mapped areas are either on private or Crown land and the majority are zoned as W1 Natural Waterways, Deferred Matter (Environmental Protection) or RUI Primary Production.
- A large area of the Tuckean Swamp, primarily within the Tuckean Nature Reserve and managed by NPWS under the *Tuckean Nature Reserve Plan of Management* (NPWS, 2002). Other coastal wetland areas surrounding the nature reserve are on privately owned land zoned as either W1 Natural Waterways, Deferred Matter (Environmental Protection) or RUI Primary Production.

- The majority of wetland areas in the Evans River estuary, downstream of Tuckombil Weir are mapped as coastal wetlands. These areas are generally within the Bundjalung National Park and are managed by NPWS under the *Broadwater National Park, Bundjalung National Park and Iluka Nature Reserve Plan of Management* (NPWS, 1997). Other areas are located on private or Crown land and are zoned as W1 Natural Waterways, E2 Environmental Conservation or E3 Environmental Management under the Richmond Valley Council LEP 2012.

The Resilience and Hazards SEPP defines the requirements for approval of development and clearing of native vegetation within the CWLRA. The estuary and catchment Councils will ensure that the mapping provides adequate protection for coastal wetlands and littoral rainforests as well as identifying any areas devoid of native vegetation that are included in the mapping. Detailed contemporary state-wide vegetation mapping was released by the NSW Government in 2022. It is recommended that the adequacy of CWLRA mapping within the study area is be reviewed against the state-wide vegetation mapping as part of future stages of the Richmond River Estuary CMP.

Plate 12: Coastal wetlands, lower Duck Creek

5.1.2 Coastal environment area

The CEA is characterised by natural coastal features such as coastal lakes, wetlands and estuarine waters. Within the study area the CEA is mapped over 31,660 ha from the downstream extent of the study area at West Ballina and Evans Head upstream to one km beyond the highest astronomical tide in all tidal waterways:

- Approximately 5 km upstream of Lismore on the Wilson River and Leycester Creek.
- Approximately 3 km downstream of Casino on the Richmond River.

- 1 km beyond the tidal limit in all tidal tributaries of the Richmond River including Bungalwalbin Creek, Sandy Creek, Rocky Mouth Creek, Dungarubba Creek, Hendersons Drain, Emigrant Creek, Maguires Creek and Duck Creek.

The majority of the CEA mapped within the study area is on private land mapped as RUI Primary Production under the relevant LEPs. These areas are typically managed for agricultural production which is often inconsistent with the objectives of the CEA within the *Coastal Management Act 2016* which aim to protect and enhance coastal environmental values and enhance natural character, scenic value, biological diversity and ecosystem integrity.

A smaller proportion of the mapped CEA area is located on private land or Crown land mapped as W1 Natural Waterways, or environmental protection zoning under relevant LEPs. Additionally, some areas are located within National Parks or Reserves and managed by NPWS under various Plans of Management which are generally consistent with the CEA objectives.

5.1.3 Coastal use area

The CUA is defined as land adjacent to coastal waters, estuaries and coastal lakes and lagoons where impacts of development on the use and enjoyment of these areas need to be considered. The CUA has a similar longitudinal extent to the CEA described above covering all tidal waterways to one km beyond the highest astronomical tide. However, the CUA area does not include the waterway itself, typically starting at the low water mark of tidal waters and extending to 250 m landward on either side of the waterway. There is approximately 15,948 ha of CUA mapped within the study area. Management of land within the CUA is similar to that described for the CEA above.

Plate 13: Richmond River at Wardell within the CUA

5.1.4 Coastal vulnerability area

The CVA is land which is subject to current and future coastal hazards. The CVA with the Richmond River is not yet mapped in the Resilience and Hazards SEPP.

Coastal hazards within the Richmond River to be addressed in the CMP include the following (OEH, 2019):

- Tidal inundation - inundation of land by tidal action under average meteorological conditions. Tidal inundation may include shorter-term incursion of seawater onto low-lying land during an elevated water level event such as a king tide or more permanent inundation due to land subsidence, changes in tidal range or sea level rise.
- Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

LCC and RVC will consider the need to map the tidal and coastal inundation hazards as part of the CVA through the development of the Richmond River Estuary CMP, with consideration of the outcomes of the Richmond River Storm Tide and Tidal Inundation Study (Stage 2 of the *Ballina Shire Coastline Coastal Management Program*).

5.2 Land Tenure

Land tenure within the study area is illustrated on Figure 20. Most of the study area is freehold land under private ownership (73%). Approximately 12% of land is managed as National Park/Reserve with 9% managed as State Forest primarily in the upper catchment areas of the Kyogle, Lismore and Richmond Valley LGAs with some pockets in the mid catchment and floodplain areas. Crown land that is not managed as part of state forest comprises 0.8% (5,774 ha) of the study area of which 0.02% (138 ha) is managed by local councils and is typically located around urban centres and villages. Council owned land comprises 0.5% (3,608 ha) of the study area. Waterways and riparian land that is not privately owned comprises approximately 1.1% (7,542 ha) of the study area. The beds of most tidal waters and non-tidal waters include Crown land (DPIE-Crown Land, 2021a) however, some private property ownership extends to the middle thread of some waterways, particularly in non-tidal systems.

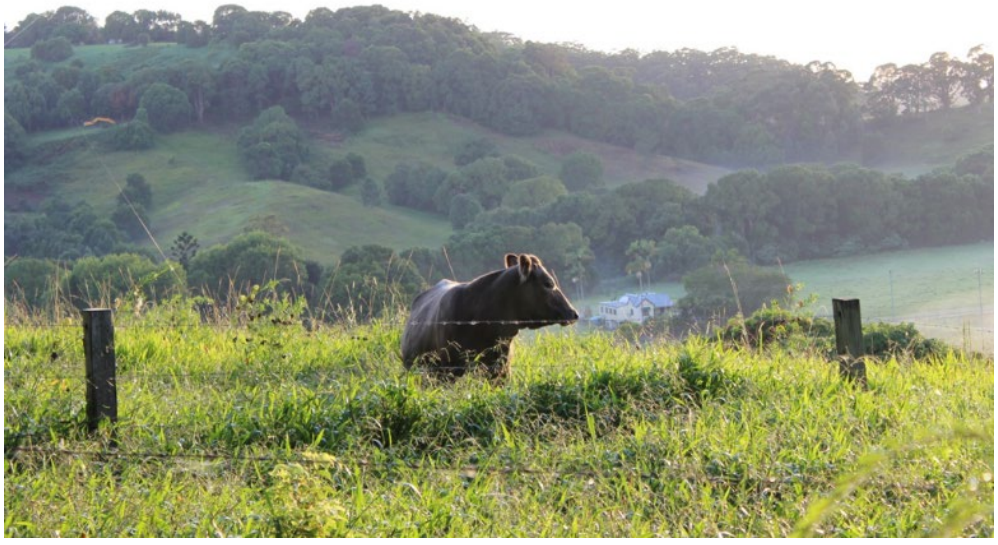

Plate 14: Grazing is the dominant land use on freehold land

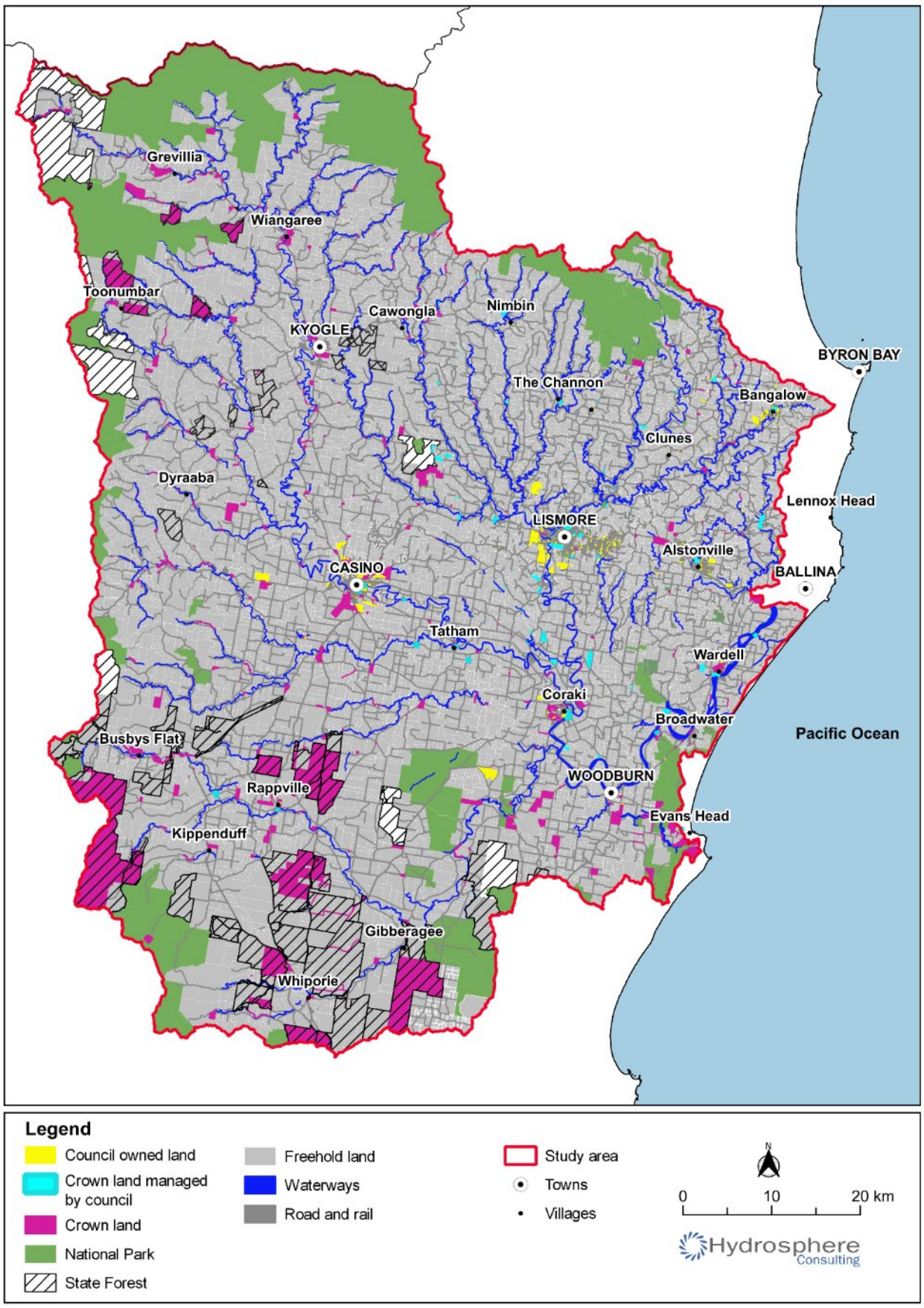

Figure 20: Land tenure within study area

Source: Mapping data supplied by councils and DPE

5.3 Native Title and Indigenous Land Use Agreements

Australia's native title laws recognise the traditional rights and interests to land and water of First Nations people. Native title holders can take and use water for personal, domestic and non-commercial communal purposes. Native title holders often have water-related aspirations, such as the protection of water, water allocations and advising on water management practices in a determinations area (DPIE, 2020).

The *Native Title Act 1993* (Commonwealth) provides a legal process for recognising the rights and interests of Aboriginal and Torres Strait Islander people in land and waters. Several successful native title determinations and indetermined native title claims exist over parts of the study area (refer Figure 21). All Crown land is considered to be subject to native title rights unless native title is considered to be extinguished (i.e. through granting of freehold estate, mining leases etc., DPIE - Crown Land, 2021b; DPIE, 2019). Any activity that impacts on native title is considered to be a 'future act' (specific proposals to deal with land in a way that affects native title and interests) under the *Native Title Act 1993*. Some activities require a notice to be forwarded to the native title claimants' representative body.

BySC has developed a memorandum of understanding with the Bundjalung of Byron Aboriginal Corporation (Arakwal) recognising the status of the Bundjalung of Byron Bay Arakwal people as traditional owners as established through the Native Title Act and processes. The purpose of this agreement is to establish a clear process and timetable for the delivery of priority projects, participation in governance, cultural and economic development and caring for Country (Byron Shire Council, 2013).

Indigenous Land Use Agreements (ILUAs) are voluntary agreements between native title holders and other people or bodies about the use and management of areas of land and/or waters and act as a contract between the parties. The ILUAs in place within the study are shown on Figure 21.

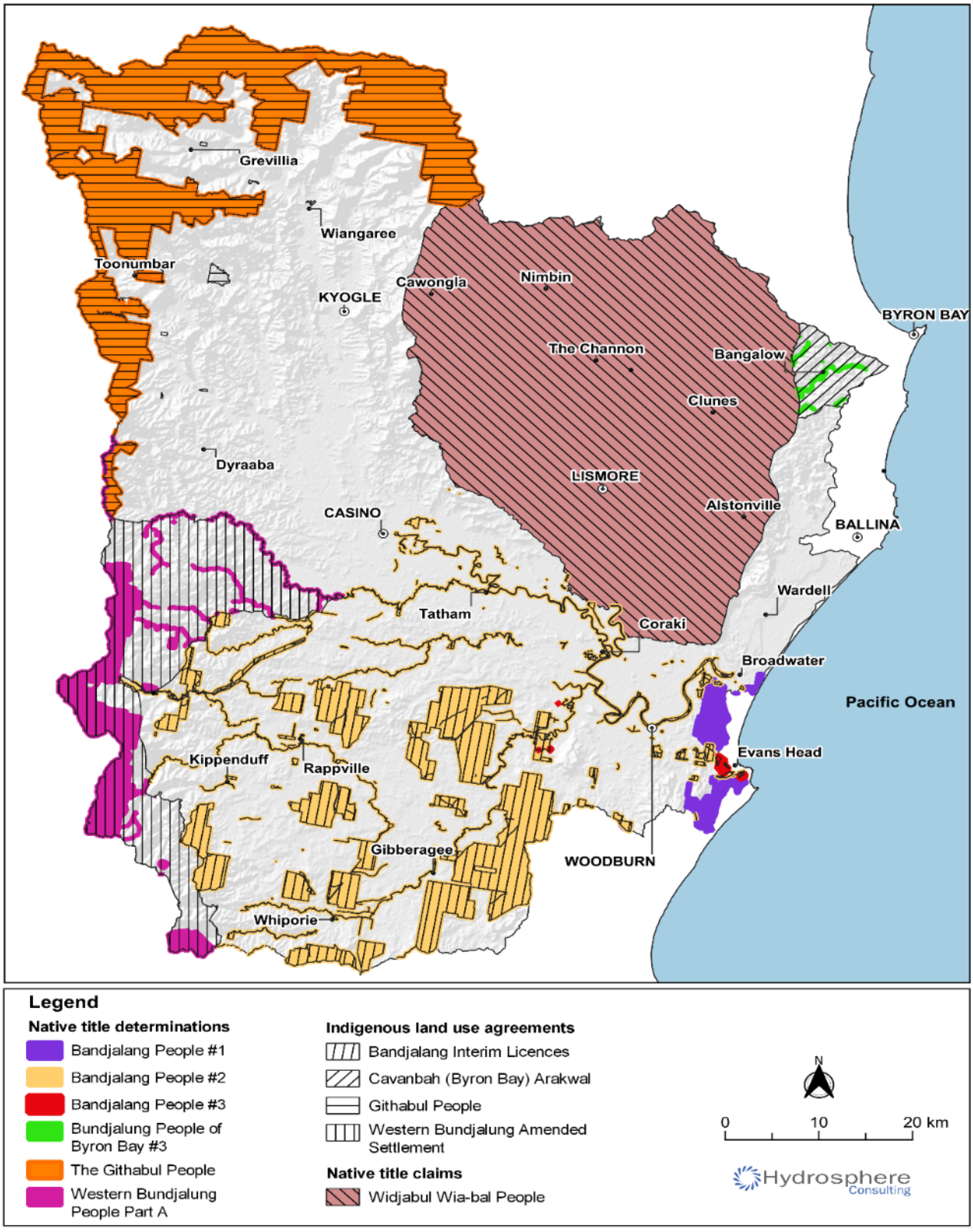

Figure 21: Native title determinations, claims and Indigenous Land Use Agreements

Data source: National Native Title Tribunal (2021)

5.4 Management Roles and Responsibilities

The study area is managed by local councils, various state government agencies, First Nations groups and private landholders (Table 4). Relevant legislation, regional and local management plans and strategies are discussed in Section 5.7. Guidelines and resources relevant to the catchment and estuary are discussed in the *Richmond River CMP Stage 1: Literature Review* (Hydrosphere Consulting, 2021c).

Table 4: Management roles and responsibilities

Agency	Role
BaSC, LCC, BySC, KC, RVC	Local councils have a central role in managing the waterways, foreshores and catchments of the study area. The councils are responsible for the management of estuarine and catchment assets that include stormwater and drainage infrastructure, waste and wastewater management, open space assets and river foreshore and estuary access points. The councils also manage a range of issues across the study area including cultural heritage, community events, recreational use of foreshore areas, estuary and floodplain management, catchment management and flora and fauna protection and conservation. The councils are also responsible for development planning and controls across the respective LGAs. The objective of these controls is to achieve development that is consistent with the social, economic and environmental values of the study area and to manage the cumulative impact of development in a sustainable manner.
RCC	RCC is a county council set up to provide the following functions: • Flood mitigation authority and associated natural resource management activities. • Provide water in bulk to the Council areas of Ballina (excluding Wardell), Byron (excluding Mullumbimby), Lismore (excluding Nimbin) and Richmond Valley (excluding land to the west of Coraki). • A wide range of activities to combat the spread of noxious weeds across the local government areas of Ballina, Byron, Lismore and Richmond Valley as well as Kyogle and Tweed Shire as part of a fee for service arrangement, administration of the *Biosecurity Act 2015*, working with landholders and the community throughout the region to address weed biosecurity matters
Native title holders and claimants	Native title exists over many areas of the study area and several claims remain active (Section 5.3). Native title holders have traditional ownership of land and waters according to their traditions, laws and customs.
Local Aboriginal Land Councils (LALCs)	The LALCs are constituted under the *Aboriginal Land Rights Act 1983*. LALCs represent their Aboriginal community and aim to protect their interests and further their aspirations. Land is vested in representative land councils who work to deliver tangible economic, social and cultural benefits to Aboriginal communities in NSW. The following LALCs operate within the study area: Tweed Byron LALC; Gugin Gudduba LALC, Muli Muli LALC, Casino – Boolangle LALC, Bogal LALC, Ngunlingah LALC, Tweed Byron LALC and Jali LALC. There are areas of Crown land within the study area, subject to outstanding claims lodged under the *Aboriginal Land Rights Act 1983*.

Agency	Role
NPWS	NPWS is responsible for management of National Parks and reserves across the study area. NPWS responsibilities across these areas includes a wide range of activities such as active conservation and habitat protection, fire management, management of tourism and visitation, research and education.
DPE – E&H	DPE – E&H works closely with local councils and communities to reduce threats from flood risk and coastal storms and ensures that people in NSW are well informed about these risks and better equipped to adapt to climate change. DPE – E&H also works with local councils and communities to maintain or improve the health of estuaries/ lakes and enhance the recreational experience. DPE - E&H provides technical support and funding to councils for the development and implementation of CMPs through the Coast and Estuaries Grant Program. DPE - E&H has provided funding to RCC for the development and preparation of this CMP Scoping Study.
DPE – Crown Lands	DPE - Crown Lands is responsible for the administration and/or management of Crown land under *the Crown Land Management Act 2016*. Crown land includes submerged Crown land, seabed and subsoil to three nautical miles from the coastline of NSW that is within the limits of the coastal waters of the State. Crown land includes much of the submerged land within the estuaries and their associated intertidal areas (below mean high water mark). DPE – Crown Lands is responsible for the following activities on Crown land: • Crown land management, compliance, bush fire management/ planning, leasing and licensing and reserve administration functions in accordance with the objects and principles outlined in the Act. • Domestic waterfront structures - assessing applications for landowner's consent for domestic waterfront facilities on Crown land, assessing licence applications and issuing licences for the occupation of Crown land for domestic waterfront facilities and ongoing administration, management and regulation of the use and occupation of domestic waterfront facilities on Crown land. • Direct Crown land management responsibilities including activities such as access management, pest plant and animal management. • There are several Council managed Crown land parcels within the study area. There are also many non-Council Crown Land Managers within the study area.
DPE - Water	DPE – Water is responsible for surface and groundwater management including: • Ensuring equitable sharing of surface and groundwater resources and that water entitlements and allocations are secure and tradeable through water sharing plans. • Ensuring water security for NSW. • Managing NSW's water resources through planning, policy and regulation.

Agency	Role
Marine Estate Management Authority (MEMA)	MEMA advises the NSW Government on the management of the NSW marine estate. The Authority brings together the heads of the NSW Government agencies with key marine estate responsibilities (Department of Primary Industries (DPI), DPE (E&H and Planning and Assessment) and Transport for NSW. MEMA ensures policies and programs address priority issues, are well coordinated, efficient, evidence based and result in positive outcomes and undertakes threat and risk assessments, develops management strategies, promotes collaboration between public authorities and fosters consultation with the community. MEMA is responsible for the implementation of the *Marine Estate Management Strategy 2018 - 2028* (MEMS) (MEMA, 2018). The MEMS provides an overarching strategic approach to the coordinated management of the NSW marine estate, i.e. the coastal waters, estuaries, lakes, lagoons and coastal wetlands. The Strategy considers the ten MEMA management principles as well as priority threats for the marine estate as identified in the NSW marine estate threat and risk assessment (TARA, BMT WBM, 2017).
DPI – Fisheries	DPI-Fisheries administers the *Fisheries Management Act 1994* and the *Marine Estate Management Act 2014* and has jurisdiction over all fish (including oysters, crustaceans, polychaetes), and marine vegetation (saltmarsh, mangroves, seagrass and macroalgae) in State Waters including 'water land' below HAT in the estuaries and extending up to 3 nautical miles offshore. Under the *Fisheries Management Act 1994*, DPI-Fisheries: • Supports economic growth and sustainable access to aquatic resources through commercial and recreational fisheries management, research, aquaculture development, habitat protection and rehabilitation, regulation and compliance. • Mitigates and manages risks from use of land and water. Under the *Marine Estate Management Act 2014*, DPI-Fisheries is responsible for: • Ensuring strategic and integrated management of the whole marine estate – marine waters, coasts and estuaries. • Fisheries and aquaculture management, marine biodiversity, marine protected areas, biosecurity, marine estate research, fisheries compliance, marine estate communications and community engagement.
Heritage NSW	Heritage NSW is responsible for the management and protection of Aboriginal cultural heritage and European heritage in NSW.
EPA	EPA is the primary environmental regulator for NSW. The local councils and other organisations hold environment protection licences issued by the NSW EPA under the *Protection of the Environment Operations Act 1997* for the operation of EPA licensed operations (e.g. sewerage systems, landfill, quarries and other industry etc.).

Agency	Role
Transport for NSW – Maritime (TfNSW – Maritime)	TfNSW – Maritime is the key agency with statutory and policy responsibilities related to the safety and accessibility of NSW waterways for recreational and commercial vessels. The Maritime Infrastructure Delivery Office (MIDO) are a part of TfNSW responsible for state owned coastal infrastructure such as river entrance break walls, regional harbours, the NSW Coastal Dredging Strategy, NSW Boating Now Program and the NSW Boating Access Dredging program. Most activities under these programs are outside the study area (along the coastline and lower estuary areas).
Community/ interest groups and organisations	Community groups and organisations which encourage and support sustainable natural resource management. The organisations undertake a range of projects with landholders, volunteer groups and government agencies including river restoration, farm planning, bush regeneration and some pest control. Local examples include volunteer Landcare, Coastcare Groups, Conservation Volunteers Australia and OzFish (Richmond River Chapter).
Natural Resources Access Regulator (NRAR)	NRAR was established in 2018 as an independent regulatory body to oversee water management in NSW. NRAR is responsible for compliance and enforcement of NSW water law and determines when to commence prosecutions or uses other enforcement tools in the event of non-compliance. NRAR also prepares policies and procedures relating to the enforcement powers under natural resources management legislation.
WaterNSW	WaterNSW is the NSW bulk water supplier and operational manager of surface water and groundwater resources. WaterNSW develops and operates infrastructure solutions for water supply security and reliability.
State Emergency Service (SES)	The SES is responsible for provision of emergency and rescue services during times of natural hazard emergencies and disasters, including flooding, storms (including storm tide and severe erosion events) and tsunami events.
North Coast Local Land Services (NCLLS)	North Coast LLS plays a key role in supporting adoption of best practice land management by landholders and partnering with key stakeholders to deliver waterway and coastal environment health outcomes. • North Coast LLS provides a certification and advisory role in relation to vegetation management/ clearing in non-urban areas with NSW DPE - EES providing a compliance role. • LLS is also responsible for approval and extension services for private native forestry with the EPA responsible for compliance and enforcement. • North Coast LLS also is a current Regional Service Provider on behalf of the Federal Government to meet their legislative and programmatic requirements and aspirations in the North Coast region. • LLS directions and priorities are set by the recently completed *North Coast Local Land Services Natural Resource Management Plan 2022-2026*. The North Coast LLS region extends from Tweed Shire Council in the north to Port Macquarie-Hastings Council in the south.

Agency	Role
CZMP Implementation Reference Group (IRG)	Oversees implementation of the Richmond River CZMP. The IRG consists of local councils and relevant State Government Agencies.

5.5 The Role of Local Government

Local government is leading the CMP process and is collaborating with land managers, state government agencies, industry and community representatives to provide effective coastal management outcomes. Figure 3 shows the LGAs within the Richmond River Estuary CMP study area. The Richmond Valley LGA makes up the greatest proportion of the catchment comprising 42% of the study area, followed by Kyogle LGA (29%), Lismore LGA (19%), Ballina LGA (5%), Byron LGA (4%) and Clarence Valley LGA (1%).

The local councils are responsible for land use allocation and development in the catchment. The councils also have significant planning and development powers as consent authorities under the *Environmental Planning and Assessment Act, 1979.* Together with other government agencies, councils act as an interface between the community and state authorities. As the sphere of government closest to the community, local government is responsible for good governance and the care and protection of local communities within a framework of sustainable development. The Integrated Planning and Reporting Framework established in the *Local Government Act 1993* is the main mechanism by which councils comprehensively plan for and report on their asset management and service delivery responsibilities within the LGA.

As managers of public land and land use planners, local government is responsible for policy development and implementation of land use planning as well as regulating a wide range of activities that may impact upon natural resource management. Local government also has a key role to play in translating the policies of Commonwealth and state governments into on-ground projects.

Local Government has a range of functions, powers and responsibilities at its disposal to influence natural resource management - on both private and public land. These include:

- Strategic planning through land use zoning and statutory controls on all freehold land and locally managed public open space.
- Development control of activities and works on land as specified by Local Environmental Plans (LEPs).
- Enforcement powers for development consent conditions, waste management and unauthorised land uses (e.g. land clearing, drainage, and filling).
- Administrative responsibility for state agency coordination through integrated planning, licensing and development concurrence.
- Stormwater management and control, sewerage and drainage works and flood control.
- Pest, plant and animal risk control measures.
- Influence over land clearance patterns through incentive programs (planning amendments, rate differentials, levies, rural fire management and developer contributions).
- Management of local open space to restore remnant vegetation and recreate habitat.

- Primary advocate for and coordinator of local community groups and interests.

Despite these functions and responsibilities, local government is constrained by the current planning and legislative framework and by the funding and resources available to implement actions that will significantly improve the health of the Richmond River. Due to the large size of the Richmond River catchment combined with the range of complex and often competing threats to be addressed in the study area, the implementation of management actions can be hampered by the lack of financial and human resources. As with many regional council areas, the Richmond River LGAs have relatively small rate payer bases to fund improvement actions. The councils rely on external grant funding (e.g. from the NSW Government) to supplement Council revenue although this does not fully overcome the funding limitations faced by some councils. Funding must also be balanced against the many other responsibilities of councils and requirements for funding.

There are many other stakeholders involved in the management of the Richmond River Estuary CMP study area. This can create competing interests and priorities and the other agencies involved in catchment, estuary and coastal management are also constrained by the available funding and resources. However, the CMP objectives of integrated and coordinated coastal management between state and local government still needs to be pursued. The councils have established working relationships with other agencies, particularly NPWS, DPE - E&H, MEMA, NCLLS, DPE - Crown Lands and DPI – Fisheries through the CZMP Implementation Reference Group and ongoing management. The councils have also established working relationships with industry and community groups with the joint funding and implementation of a range of actions within the catchment.

5.6 Governance

The governance of the Richmond River estuary is complicated with no overriding body responsible for its management as a whole. Management activities are currently carried out through a range of different programs, by the various stakeholders and through various sources of funding. The existing estuary management governance model is disjointed due to the multi-agency and multi-council responsibility, lack of a holistic approach, financial constraints and inefficiencies in the delivery of management programs. The lack of coordination between the various management entities has been identified as a significant barrier to successful estuary management. Community confusion about the role of the various local and state departments in estuary management was also identified as an issue during the community consultation phase of this study. Improved governance arrangements will rely on clearly defined responsibilities and adequate funding to implement these responsibilities. Current legislated responsibilities do not allow any one party to provide a holistic governance and administration role. However, it is intended that the development of a CMP will provide a mechanism for multi-agency/ stakeholder coordination of management and activities within the catchment for the purpose of addressing impacts to the Richmond River estuary.

A Catchment Governance and Waterway Health (Richmond River) project has been funded through the Stage 2 MEMS to focus on the health of the Richmond River using governance and other frameworks to address some of the issues faced (over a 12-month period in 2020-21). The objective of this role is to respond to the recommendations of the Richmond River Governance and Funding Project and the collective commitment of the councils in recognising the benefits of a coordinated approach to improving the health of the catchment and its waterways. This role will aid the CMP process but also work on other complementary projects intended to improve governance and river health outcomes in the catchments including the *Risk-*

based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions (Dela-Cruz, *et al.*, 2019). The key focus of this project is to develop and seek to establish a preferred governance framework for the Richmond River catchment in collaboration with local councils and key stakeholders. The project will seek to define and establish a governance strategy within the Richmond River catchment to improve management of agricultural diffuse source run-off.

5.7 Status of Existing Management Actions

The current management plans for the study area are the *Coastal Zone Management Plan for the Richmond River Estuary (Richmond River CZMP*) and the *Coastal Zone Management Plan for the Evans Head Coastline and Evans River Estuary (Evans River CZMP*). The management actions recommended within the current plans are collated in Hydrosphere Consulting (2021b) and summarised in Appendix A with the current status of each action. Not all management actions have been completed since the adoption of the CZMPs. Some additional actions have been implemented under related programs, which although were not explicit actions within the CZMPs, contribute to overall catchment and waterway health. In addition, MEMA has undertaken studies relating to the Richmond River and its catchment. Ineffective governance and administration arrangements and the lack of a clear funding pathway continue to be the main roadblocks to successful implementation of the CZMP actions. Similarly, many of the actions in the Evans River CZMP have not been funded.

There continues to be a significant amount of effort and funding applied to studies and projects (mostly through the MEMS) although much of this does not fully meet the scope and intentions of the CZMP actions. Many of the strategies included initial investigations or prioritisation studies designed to guide investment and effort. Although this was an important component of the CZMP actions, progress has been slow. Some of these initial studies have only recently been undertaken (or are in progress) and the benefits of the studies including targeted on-ground actions are yet to be realised.

The task of improving the health of the Richmond River continues to be substantial, complex and multi-faceted and the difficulties in implementing the CZMP actions due to ineffective governance and administration reflect these complexities. The key challenge for the Richmond River Estuary CMP will be to identify and implement targeted on-ground works that will result in improvements in estuary health. While the councils are working with agencies, community groups such as Landcare and some private landholders to implement restoration works, these projects rely on limited internal and external funding, are generally small scale, do not necessarily target priority areas and are limited to areas where landowners and engaged and are willing to complete works on their land. In addition, while some studies identify priority actions, there is a lack of detail on the steps required for successful implementation including funding.

A key gap in the existing investment and studies to date appears to be consultation with affected landholders and the development of mechanisms to ensure acceptance and successful implementation of identified priority actions. A significant challenge in implementing any on-ground change in rural farmland is landowner willingness. Actions within the CMP relating to native vegetation, riparian zones and backswamps may have a negative impact on the agriculture that occurs there or may be too costly for landowners to implement or maintain. There is currently no regulatory mechanism to require landowners to undertake any of these actions although many agencies are working with landowners including providing funding incentives.

The CMP process represents an opportunity to develop a more manageable suite of coastal management actions across the catchment with a focus on strategic on-ground actions that are rationalised and prioritised.

The CMP represents an opportunity to improve the funding and resources available for coastal management through the NSW Coastal and Estuary Grants Program, the IP&R Framework and other available funding and grant programs.

5.8 Marine Estate Management Strategy Actions

The MEMS focuses on addressing the most severe threats to the health of the marine estate, particularly water pollution, which was identified as the greatest threat to the marine estate by the NSW community and through the evidence-based TARA (BMT WBM, 2017). Some MEMS actions have included pilot projects in Stage 1 and Stage 2 (current stage to June 2022) in the Richmond River and other management actions have state-wide benefits. There is significant overlap between the MEMS and the NSW Coastal Management Framework in terms of aims and objectives, issues to be addressed and proposed management actions. This is particularly evident in the Richmond River catchment where a large number of MEMS projects are currently underway to address threats to the Richmond River. In addition to these on-ground projects, a number of state-wide projects being undertaken by MEMA are also relevant to the management of the Richmond River catchment.

The implementation of the MEMS since 2018 in the Richmond River catchment aims to address many of the key issues impacting on the health of the Richmond River and there appears to be many opportunities for integrating the MEMS with the CMP to draw on the work done to date and collaborate with future projects.

6. SCOPE OF THE CMP

6.1 CMP Area

The councils within the Richmond River catchment will prepare a CMP for the Richmond River. The spatial extent of the CMP is shown in Figure 3. The CMP for the Richmond River catchment and estuaries will be developed for the coastal management areas (CUA, CEA and CWLRA) shown in Figure 4, Section 1.3.

The existing mapping for the CUA, CEA and CWLRA is considered suitable for management of the estuary and no changes to existing Resilience and Hazards SEPP mapping are proposed for this CMP. However, it is noted that there is no detailed recent mapping of the wetland and littoral rainforest communities in the study area available at this time. Detailed contemporary vegetation mapping is expected to be released by the NSW Government in 2021/22. Once this revised mapping is available, the adequacy of CWLRA mapping will be reviewed (potentially as a Stage 5 CMP action).

There is currently insufficient information available on coastal hazards to map the CVA (bank erosion and tidal inundation) as part of the Resilience and Hazards SEPP or LEPs. Tidal inundation studies will be undertaken as part of the Ballina Coastline CMP and BaSC will consider whether the CVA should be mapped and included in the Resilience and Hazards SEPP or LEP (via a planning proposal) as part of the CMP development process.

6.2 First Pass Risk Assessment and Gap Analysis

Following the identification of the current threats and issues within the study area, a first pass (or preliminary) risk assessment and gap analysis was completed to prioritise risks and identify those that should be further investigated in subsequent stages of the CMP.

The objectives of the first pass risk assessment and information gap analysis are:

1. Identify potential management issues/ threats within the study area and assess the risk to known values and assets.
2. Identify gaps in knowledge relating to each issue and assess the importance of addressing each knowledge gap to allow for effective future management.
3. Establish if the risk and gap in knowledge warrants further investigation or detailed assessment.

The risk assessment and gap analysis were combined into one process to streamline the investigation and identify where gaps in knowledge will hinder successful future management of issues.

6.2.1 Methodology

The risk assessment process identifies credible risks, the likelihood of the risk event occurring given existing controls, the consequences to environment, social and economic values and public safety should the event occur and applies a risk rating. The risk assessment is consistent with AS/NZS ISO 31000: *Risk Management – Principles and Guidelines*. The methodology uses the risk assessment process and qualitative scales outlined in the following tables to assess the risk of identified issues impacting the values and assets of the study area under current management practices (based on the framework adopted for the TARA for the Marine Estate). The consequence of each threat considered potential impacts as listed in Table 5. The likelihood of each threat (Table 6) was based on existing studies and observations where available.

Table 5: Qualitative measures of consequence or impact

Consequence	Description
Catastrophic	Significant on-going and/or permanent negative impacts on the environmental, social or economic values, and where these values are endangered either permanently or irreversibly.
Major	Substantial measurable and/or ongoing negative impacts on the environmental, social or economic values.
Moderate	Measurable and/or on-going negative impacts on the environmental, social or economic values.
Minor	Discernible and/or temporary negative impacts on the environmental, social or economic values.
Insignificant	No or barely discernible negative impacts on the environmental, social or economic values.

Source: Adapted from MEMA (2015)

Table 6: Qualitative measures of likelihood under current management practices

Likelihood	Description
Almost certain	A very large certainty that this will occur in this situation within the timeframe.
Likely	Expected to occur in this situation within the timeframe.
Possible	Some clear evidence exists to suggest this is possible in this situation within the timeframe.
Unlikely	Uncommon, but has been known to occur elsewhere. Expected to occur here only in specific circumstances within the timeframe.
Rare	Never reported for this situation, but still plausible within the timeframe.

Source: Adapted from MEMA (2015)

Table 7: Qualitative risk estimation

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Minimal (Min)	Low	Moderate (Mod)	High	High
Likely	Minimal (Min)	Low	Moderate (Mod)	High	High
Possible	Minimal (Min)	Minimal (Min)	Low	Moderate (Mod)	High
Unlikely	Minimal (Min)	Minimal (Min)	Minimal (Min)	Low	Moderate (Mod)
Rare	Minimal (Min)	Minimal (Min)	Minimal (Min)	Low	Moderate (Mod)

The risk assessment evaluates the current day risk and also considers how the risk level is likely to change in the future (i.e., over 20, 50 and 100 years). This includes assessment of it how factors such as climate change, increasing development pressures and population increase will impact these risks. Where available, future risk levels have been assigned based on data for these risks. In other cases, a qualitative assessment has been undertaken considering the expected future changes.

The first-pass risk assessment considers the risk to catchment values from categories of issues and key threats in the specified sub-catchments. Although it is acknowledged that the threat will vary across the catchment. The assessment typically focusses on the detrimental, rather than the beneficial impacts of the threat, unless otherwise indicated. The potential highest consequence level to any asset or value was used for the assessment.

A Risk Assessment Workshop was held in August 2021 with council and agency representatives to discuss the first-pass risk assessment. At the workshop, a draft risk assessment was presented and discussed. The main aim of the workshop was to gain concurrence on the risk rating of the identified threats, data gaps and recommended Stage 2 studies.

6.2.2 Risk Assessment Outcomes

The management issues and threats affecting the study areas and results of the first-pass risk assessment and gap analysis are provided in Appendix B. The risk assessment outcomes identify the key threats to be addressed in the Richmond River Estuary CMP. Due to the large geographical area, environmental and social values of the study area, there are several key management threats to be considered in the CMP. Based on the existing information, the threats with a high risk in the current timeframe are listed Table 8.

Table 8: Key management issues (current timeframe)

Category	Key threats	Locations	Potential impacts
Water quality	T1: Acid sulfate soil (ASS) runoff	Richmond River Floodplain. Highest priority ASS areas - Tuckean Swamp, Rocky Mouth Creek and Bungawalbin/ Sandy Creek.	Increased acidity of river (lower pH). Release of heavy metals (e.g. aluminium, iron, arsenic etc.). Reduced ecosystem health (e.g. fish kills, red spot disease etc.). Human health risks due to poor water quality. Stock health risks due to poor water quality. Reduced commercial aquaculture/ oyster farming viability/ value Reduced commercial fishing viability/ value. Reduced tourism value.
	T2: Blackwater events	Lowest lying areas of Richmond River Floodplain. Highest priority areas: Bungawalbin/ Sandy Creek, Rocky Mouth Creek and Tuckean Swamp.	Extremely low (near zero) oxygen concentration in water. Reduced ecosystem health (e.g. fish kills, disease etc.). Human health risks due to poor water quality. Stock health risks due to poor water quality. Reduced commercial aquaculture/ oyster farming viability/ value. Reduced commercial fishing viability/ value. Reduced tourism value.
	T3: Agricultural diffuse source runoff (MEMS TARA priority threat)	All – various locations	Export of sediment and associated pollutants to waterways. Increased suspended sediment in waterways (i.e., high turbidity/ 'dirty' water). Nutrient export. Eutrophication. Fertiliser/pesticide contamination. Faecal contamination. Human health risks due to poor water quality. Stock health risks due to poor water quality. Reduced commercial aquaculture/ oyster farming viability/ value. Reduced commercial fishing viability/ value. Reduced tourism value.

Category	Key threats	Locations	Potential impacts
Water quality (cont.)	T9: Other licensed industrial sources (e.g. quarries, food processing etc.)	All – various locations	Export of pollutants to waterways (e.g., nutrients, harmful chemicals, pathogens, organics etc.). Human health risks due to poor water quality. Stock health risks due to poor water quality.
	T13: Potentially toxic cyanobacteria blooms	Freshwater tidal pool of Richmond River between Woodburn and Lismore. Richmond River near Casino.	Death of livestock, domestic animals, and wildlife (including fish kills). Harmful human health effects (recreational use and/or drinking water exposure). Algae scums. Odours.
	T14: Bushfire	All – particularly bushland areas	Increased erosion risk. Increased nutrient and sediment load to waterways. Related social and economic factors.
Hydrology, connectivity and water extraction	T17: Modified freshwater flows (MEMS TARA priority threat)	All areas (weirs, dams, water extraction etc.)	Water quality impacts (related to reduced flushing/ hydrological stress). Altered flow-dependent cues for fish migration affecting breeding etc. Increased sedimentation. Aquatic habitat degradation.
	T18: Hydrological modification of wetlands and floodplain drainage works (MEMS TARA priority threat)	Tuckean Swamp, Richmond River Floodplain, Bungawalbin, Myrtle and Sandy Creek.	Acid sulfate soil impacts (refer T1) Blackwater impacts (refer T2) Aquatic habitat modification and degradation. Fish passage impacts
	T19: Floodgate design, operation and maintenance		

Category	Key threats	Locations	Potential impacts
Riparian condition	T20: Clearing of riparian and adjacent habitat (MEMS TARA priority threat)	All	Loss of or reduced value of riparian and estuarine vegetation and habitat. Reduced buffering capacity of riparian land to protect water quality. Conditions favour introduced fish species. Loss of ecosystem services. Bank instability. Siltation. Reduced amenity. Reduced tourism value.
	T21: Lack of suitable buffer zones between land use and waterways	All	
	T22: Dominance of invasive weeds	All	
	T23: Uncontrolled stock access to and grazing within the riparian zone	All	
Coastal hazards - bank erosion	T24: Catchment flooding	All	Bank and bed instability. Loss of land. Erosion to and loss of riparian and estuarine vegetation and habitat. Siltation. Degraded water quality. Navigation hazards. Aquaculture/ oyster degradation. Reduced amenity. Reduced tourism value. Council liability and legality issues.
	T27: Historic clearing of riparian vegetation and adjacent habitat (MEMS TARA priority threat)	All	
	T28: Stock grazing of riparian and marine vegetation (MEMS TARA priority threat)	All	
Cultural heritage	T39: Damage to cultural heritage items/ sites	All – various locations	Loss of or damage to items of heritage significance or cultural heritage values. Lack of protection of Aboriginal/Native Title rights.

Category	Key threats	Locations	Potential impacts
Climate Change	Increase in extreme weather events (e.g. prolonged dry periods and increased frequency and magnitude of storms/ flood events).	All	Increased flooding risk. More severe droughts. Increased number of hot days and higher rates of evaporation. Reduced stream flows. Increased bushfire risk. Loss of biodiversity (particularly coastal floodplains, wetlands, saltmarsh and mangroves). Increased water temperatures. Increased acidification of estuaries. Enhanced mobilisation of acidity and metals.
Biodiversity	T40: Clearing of riparian and adjacent habitat (MEMS TARA priority threat)	All	Loss of or reduced value of riparian and estuarine vegetation and habitat. Reduced buffering capacity of riparian land to protect water quality. Reductions in food sources for native aquatic fauna. Conditions favour introduced spp. Bank instability. Siltation. Reduced amenity. Reduced tourism value.
	T41: Invasion by exotic plants (MEMS TARA priority threat)	All	Loss of biodiversity. Displacement of native species. Alteration of native habitats. Reduced recruitment of native riparian vegetation. Reduced habitat availability. Reduced resilience. Water quality impacts. Reduced amenity. Related social and economic factors.

Category	Key threats	Locations	Potential impacts
Biodiversity (cont.)	T47: Bushfire	All – particularly bushland areas	Fauna mortality. Reduced vegetation cover. Displacement of native species. Alteration of fauna habitats. Increased erosion risk. Increased nutrient and sediment load to waterways. Water quality impacts. Related social and economic factors.
Governance and funding	T51: Insufficient land available to establish stewardship sites to offset loss of native vegetation through land development	All	Net loss of biodiversity from the region.
	T59: Lack of comprehensive, integrated ecosystem monitoring strategy and reporting system	All	Decision makers do not have reliable information to support management activities and to best direct investment into catchment health. Reduced community understanding/ awareness of river health issues and management actions.
	T60: Inadequate, inefficient regulation (agencies) (MEMS TARA priority threat)	All	Lack of alignment of plans/policies. Lack of collaboration, cooperation and resource support. Differing opinions, values, policies and management approaches. Conflict and delays in implementing management approaches. Inability to address some of the key threats with meaningful solutions such as land use change for low lying areas. Poor public perception.
	T62: Lack of funding for catchment and coastal management	All	Inadequate management action to address issues. Lack of resources to support management activities and enforce regulations.

Category	Key threats	Locations	Potential impacts
Governance and funding (cont.)	T65: Lack of compliance with regulations (by users) (MEMS TARA priority threat)	All	Erosion and sediment export from development sites. Chemical/pollutant export from industrial sites. Land clearing. Littering. Damage to sensitive environments. Over-extraction of water.

In terms of local issues, the highest risk threats (current timeframe) are:

- Lowest lying areas of Richmond River Floodplain (e.g. Tuckean Swamp, Rocky Mouth Creek and Bungawalbin/ Sandy Creek - ASS runoff and blackwater events, hydrological modification of wetlands and floodplain drainage works, floodgate design, operation and maintenance.
- Various locations - agricultural diffuse source runoff, clearing of riparian and adjacent habitat, uncontrolled stock access to and grazing within the riparian zone, dominance of invasive weeds, catchment flooding, modified freshwater flows.
- Freshwater tidal pool of Richmond River between Woodburn and Lismore and the Richmond River near Casino - potentially toxic cyanobacteria blooms.
- All areas – bushfire, increase in extreme weather events, lack of suitable buffer zones between land use and waterways, damage to cultural heritage items/ sites, insufficient public land available to establish stewardship sites to offset loss of native vegetation through land development, lack of comprehensive, integrated ecosystem monitoring strategy and reporting system, inadequate, inefficient regulation (agencies), licensed industrial point sources (e.g. quarries, food processing etc.).

Emerging threats (next 50 years) are:

- Tidal extent of the Richmond River including Richmond River Floodplain, Tuckean Swamp, Emigrant and Maguires Creek, Bungawalbin, Myrtle and Sandy Creek – tidal inundation, anthropogenic barriers (i.e. physical barriers, land use and planning constraints) to migration of vegetation communities (e.g. mangrove, saltmarsh) with sea level rise, increased salinity in the upper estuary.
- Urban areas - foreshore development and land clearing
- All areas - increase in extreme weather events, increase in mosquito-borne diseases.

6.2.3 Information gaps

Accurate and detailed information about risk and consequence is necessary to assist decision makers generate effective management strategies which identify and prioritise future actions and investment or justify a business-as-usual approach. The risk assessment completed as part of this Scoping Study considered existing information and identified remaining knowledge gaps related to each issue. The importance/priority of resolving each knowledge gap to allow for effective future management of the issue was also assessed using the scale outlined in Table 9. The gap analysis considered the level of existing

information, the current studies underway or planned to address key knowledge gaps as well as stakeholder feedback.

Table 9: Importance of knowledge to management of the Richmond River

Priority	Description
Low	This knowledge is not required for management decisions/ actions/ planning – academic interest only.
Moderate	The knowledge would improve the effectiveness of management.
High	Management action required within the timeframe of this CMP cannot proceed effectively without this knowledge.
Unknown	Unknown importance of knowledge for management decisions/ actions/ planning.

There is currently a high level of understanding of the nature and extent of environmental issues, causative factors and the management actions required to address the majority of issues affecting the health of the Richmond River. Many strategies have been implemented over the past 25 years by landowners, industry and councils. However these actions have been small scale and have not resulted in appreciable improvements to the health of the river. If further improvements to river health are desired, further co-ordinated changes are required on a larger scale. Information gaps exist for implementing further large-scale strategies in specific areas. These include the environmental, social and economic impacts of different strategies, detailed costing and community perspectives and landholder interests in contributing to change. Support from landholders/ land managers and the community has not been established for further large-scale changes in priority areas. Existing studies do not currently provide the level of detail required to implement on-ground actions.

Stakeholder consultation undertaken as part of this Scoping Study has identified significant support for on-ground works and less support for further studies. However, some strategic planning is recommended to focus efforts and ensure cost-effectiveness. The gap analysis identified several further studies required to fill gaps in current understanding and to inform the optimum approaches to address key threats. Resolving immediate priority knowledge gaps in Stage 2 allows for the identification of appropriate management options/actions that address identified issues. An initial list of potential Stage 2 studies was presented and discussed during the Risk Assessment Workshop held in August 2021. This list was refined with council and agency representatives during a subsequent workshop in September 2021. Stakeholders indicated a strong preference for all studies to have clearly defined aims and objectives and to be directly linked to on-ground actions that result in improved river health and community values.

Further details of recommended Stage 2 studies including desired outcomes required to progress the CMP are provided in the Forward Plan (Table 10, Section 7.5).

6.2.4 Knowledge gaps to be addressed separately to Stage 2 of the Richmond River Estuary CMP

The gap analysis identified a number of studies currently being undertaken in parallel with the CMP development that will address a number of knowledge gaps associated with priority threats to river health (e.g. floodplain management issues). Further investigation of these threats as part of the CMP is not recommended.

A large number of technical studies and investigations have been carried out in the Richmond River over the last few decades and particularly in recent years with the roll out of the MEMS and a large number of MEMS pilot projects focusing on the Richmond River catchment. A significant proportion of this work has been focused on the technical assessment of floodplain management options in priority locations to address ASS and blackwater issues. There is currently a substantial body of ongoing work to address knowledge gaps associated with ASS and blackwater issues on the floodplain including:

- Stakeholder consultation as part of the next phase of the Floodplain Prioritisation Study through the MEMS.
- Tuckean Swamp Project Implementation Toolkit (commenced by OzFish in mid - 2021) including design and costing of infrastructure changes and ongoing maintenance costs, a comprehensive values assessment, landholder incentives/ change and options.
- Keith Hall Drainage Options Study implemented by RCC in collaboration with BaSC and the University of NSW to improve understanding of the system and sources of poor water quality to the lower Richmond River estuary.
- NPWS is also planning to undertake a values assessment for the Tuckean Nature Reserve.

The gap analysis undertaken as part of this Scoping Study recommended that no additional investigation of ASS and blackwater be completed as part of Stage 2 of the Richmond River Estuary CMP. The CMP will draw on the work done by other agencies and stakeholders and collaborate with future projects.

Other research and programs have focused on water quality monitoring and modelling, reducing fertiliser use, estuarine vegetation management, riparian revegetation, bank stabilisation and fisheries enhancement.

In terms of coastal hazard risk, a higher level of understanding/detail of local tidal inundation extent and frequency with climate change, and the associated risk for the Richmond River estuary is required. Inundation modelling and mapping will be undertaken collaboratively through the *Ballina Coast CMP Stage 2 Richmond River Storm Tide and Tidal Inundation Study* to the full tidal range (which extends to Tatham on the Richmond River and to approximately 5 km upstream of Lismore on the Wilsons River). The Ballina Coast CMP Stage 2 will assess tidal/ coastal inundation risks within the Ballina LGA. This Richmond River Estuary CMP Stage 2 task will assess tidal inundation risks within the Lismore and Richmond Valley LGAs using the outcomes of that tidal inundation study.

Results of the current and proposed studies are expected to be available for Stage 3 of the Richmond River Estuary CMP to enable stakeholders to assess the available options for inclusion in the CMP. Stage 3 of the Richmond River Estuary CMP will consider results of ongoing MEMS and coastline CMP studies to determine and assess appropriate management options for inclusion in the CMP.

7. PRELIMINARY BUSINESS CASE AND FORWARD PLAN

7.1 Benefits of CMP Development

The Richmond River provides a high level of ecosystem services (e.g. provision of food, carbon sequestration, habitat provision and aesthetic value) integral to the region's continuing ecosystem health, social and economic values. These values are threatened by increasing pressure from land uses, climate change, sea level rise, tourism growth and urban development.

There are many organisations from the federal, state, regional and local level that are involved and have responsibilities in governing and managing the study area. Collaboration, cooperation and resource support amongst the landowners and managers is required to provide effective coastal management outcomes.

The estuary and catchment councils have developed significant knowledge of catchment processes and estuarine dynamics and threats to the Richmond River estuary. Engagement and consultation with the local community and key stakeholders conducted as part of this Scoping Study has highlighted the expectations of the community to progress with catchment and estuary management. In addition, key stakeholders and public authorities are willing to participate in a coordinated and collaborative approach to management of the study area. This collaboration will provide additional benefits to all stakeholders.

The challenges of limited resources, significant threats to coastal values and multiple land managers have been documented in this Scoping Study. The CMP process provides a mechanism for effective management of short-term risks and development of adaptation pathways for longer-term or increasing risks. Continuing with the development of the CMP will assist with:

- Strengthening stakeholder relationships responsible for management in the coastal zone and the shared understanding of the values, risks and management priorities for each of those stakeholders.
- Obtaining funding for coastal management actions through the NSW Coastal and Estuary Grants Program (refer Section 7.2).
- Protecting, conserving and promoting the sustainable integrated management of ecosystem services and other social, cultural, environmental and economic values of the study area, now and for future generations.
- Collaboration with relevant First Nations representatives i.e. Traditional Owners and LALCs as well as aboriginal advisory committees and other community organisations.
- Early identification of opportunities to reduce and adapt to future risks and to reduce associated future financial costs (e.g. disaster management costs), particularly in a climate of emerging coastal, climatic and political risks.
- Limiting liability of the estuary and catchment councils and the under Section 733 of the *Local Government Act 1993* with respect to land in the coastal zone through acting in "good faith", i.e. by preparation of a CMP "*substantially in accordance with the principles and mandatory requirements set out in the current coastal management manual under the Coastal Management Act 2016*".

The CMP will set the long-term strategy for the coordinated management of the coastline and estuaries and ensure that the values and benefits of the study area are enhanced and maintained for future generations. In

continuing with the preparation and implementation of a CMP, RCC and the estuary and catchment councils should consider:

- The obligation to implement a certified CMP under the *Coastal Management Act 2016*.
- The immediate financial cost of CMP preparation (though these are considered negligible in comparison to the future financial risk of not preparing a CMP as discussed below).
- Competing needs for internal council resources (funding, staff and equipment etc.).
- Competing needs for external stakeholder resources (funding, staff and equipment etc.). Early engagement with stakeholders required to collaborate on the CMP will ensure these risks are minimised.
- Changing external agency priorities and responsibilities.
- Community expectations regarding expected actions. Transparency in the CMP and community engagement process may help to minimise unrealistic expectations from the community.

There are a number of risks associated with not developing a CMP. These include:

- A lack of understanding of key threats to estuary values and areas exposed to coastal hazards can result in inadequate or ineffective management practices and development controls.
- The lack of an adequate risk management process can result in a diminished ability to effectively evaluate and prioritise management actions - reducing the cost-effectiveness of government efforts and resources.
- Timely intervention is required before estuary health issues become more intractable.
- A lack of engagement with the local community can result in a lack of support or even opposition amongst the community and key user groups. This can result in a deficit of credibility and trust between the councils and the community and can derail the implementation of future management actions. A lack of engagement can also result in an incomplete understanding of local community values and therefore a misdirection of management effort and resources. Despite this, the level of community support can vary based on the issues experienced by individual community members in different areas, regardless of the level of engagement.
- No contemporary plan to guide management actions and investment of resources to effect good coastal management.

In support of this preliminary business case, it is evident that the benefits of continuing with the development and implementation of this CMP significantly outweigh the alternative financial costs as well as the costs to coastal and estuary values.

7.2 Funding

The development of the CMP and subsequent actions are expected to be funded through council and state government contributions, monetary grants and volunteer works by community members and organisations. Some actions are funded under normal council operating budgets or through existing programs and grants. The estuary and catchment councils operate an annual budget primarily through rates and charges as well as fees, investment revenues, loans, property management and operating grants. It will not be possible for

RCC and the estuary and catchment councils to implement all actions without additional sources of funding. As such, identification of grants and the submission of successful funding applications will be an important component of the CMP and the development stages.

The NSW Government's Coastal and Estuary Grants Program provides technical and financial support to local government to help manage the coastal zone. The program supports coastal and estuary planning projects and the implementation of works identified in certified CZMPs or CMPs. Grant offers are subject to state-wide priorities and availability of funds each financial year.

Funding (at 2:1) is available under 5 funding streams - a planning stream and four implementation streams:

- Planning stream: funding is available for planning projects that aim to:
    - Develop a CMP.
    - Transition a coastal zone management plan (CZMP) to a CMP.
    - Undertake investigations and designs or cost-benefit analyses for infrastructure works recommended in a certified CZMP or CMP.
- Implementation streams: funding is available for implementation of actions identified in a certified CZMP or CMP.

RCC and the councils will be ineligible for funding under the NSW Governments' Coast and Estuary Grant Program (implementation stream) if it does not have a certified CMP by 31 December 2023. Schedule 3 (Part 2) (4) of the *Coastal Management Act 2016* enables a certified CZMP/EMP to remain valid until the 31 December 2021 and the Minister for Local Government has recently introduced legislation (October 2021) to extend this timeline by two years to 31 December 2023. While planning work is underway for a new CMP, on-ground implementation of the CZMP actions will continue in accordance with the existing CZMP and other related management plans. Funding for implementation of CZMPs remains at a ratio of 1:1.

Other funding opportunities include the NSW Environment Trust, Crown Reserves Improvement Fund (CRIF), partnerships with local community groups, research institutions and universities. The MEMS also includes targeted projects which may provide useful information for the CMP (Section 5.8).

7.3 Forward Plan

RCC will coordinate the development of the CMP on behalf of the estuary and catchment councils. The councils will collaborate with land managers, state government agencies, industry and community representatives to provide effective coastal management outcomes.

The forward plan outlines the next four stages of the CMP process. The requirements for Stages 2 - 5 of the CMP process are detailed in the *NSW Coastal Management Manual* and summarised in the following sections. The CMP will be developed over the next three years.

7.3.1 Stage 2 – determine risks, vulnerabilities and opportunities

Stage 2 involves undertaking detailed studies that will help to identify, analyse and evaluate risks, vulnerabilities and opportunities. Studies prepared in Stage 2 provide information to support decision-making

in later stages of the planning process. The additional information assists communities to better understand coastal management issues and to analyse and evaluate coastal risks and opportunities.

Stage 2 of the CMP for the Richmond River will include:

- Continuing engagement with the community and stakeholders.
- Refining understanding of key management issues (where there are knowledge gaps) as described in Section 6.2.3.
- Analysing and evaluating current and future risks (detailed risk assessment) building on the first-pass risk assessment (Section 6.2) and outcomes of Stage 2 detailed studies.
- Identification of opportunities to reduce risks and enhance the environmental, social and economic values.

Concurrent with Stage 2, the estuary and catchment councils will consider whether planning controls should be updated with any new information available.

7.3.2 Stage 3 – response identification and evaluation

Stage 3 involves the identification and evaluation of management options. Stage 3 of the CMP for the Richmond River will include:

- Development of a strategic approach to risk management: alert, avoid risks, active intervention, planning for change, emergency response.
- Identifying and collating information on management options.
- Evaluating management actions, considering:
    - Feasibility (is it an effective and sustainable way to treat the risks?).
    - Viability (economic assessment).
    - Acceptability to stakeholders.
- Engaging public authorities about implications for their assets and responsibilities.
- Preparing a business plan for implementation - capital and operational costs, distribution of costs and benefits, funding and delivery.

Stage 3 will consider all findings from Stage 1, Stage 2, stakeholder engagement activities and discussions with relevant agencies and land managers. It is envisaged that a large component of this stage will involve combining and prioritising actions to address key issues and threats as identified during Stages 1 and 2.

Formal consultation will take place with each agency with either a responsible or supporting role for each action. A cost-benefit analysis will be undertaken for any options requiring detailed analysis to determine socio-economic viability (potentially required for very high-cost options).

7.3.3 Stage 4 – finalise, exhibit and certify the CMP

Stage 4 will involve the preparation of the draft CMP document, review by the councils and Government agencies, placement of the draft CMP on public exhibition and consideration of feedback from all

stakeholders. RCC, the estuary and catchment councils and DPE- E&H will then review and approve the final CMP for certification and implementation (Stage 5).

The CMP for the Richmond River will include:

- Coastal management actions (10 years) for RCC, councils and other public authorities where applicable.
- Links to the IP&R framework and land use planning system.

7.3.4 Stage 5 – implementation, monitoring and reporting

The CMP will be implemented by RCC and the estuary and catchment councils following certification, in accordance with the IP&R framework, land use planning system and partnerships. This framework will guide the implementation of the CMP, ensure all required monitoring and reporting is completed and will provide a framework for the review and assessment of CMP outcomes.

7.4 CMP Engagement Strategy

A shared understanding of the risks and opportunities and stakeholder and community support for resulting actions included in the CMP will be beneficial during implementation phases. A stakeholder engagement strategy for the preparation of the CMP has been developed (Hydrosphere Consulting, 2022). This strategy was developed from the previous stakeholder consultation outcomes and the outcomes/ findings of consultation activities undertaken for this Scoping Study.

The Community and Stakeholder Engagement Strategy describes how the councils will engage with stakeholders during the preparation of the CMP. The Strategy has been prepared to:

- Identify the context, scope, purpose and organisational commitment to engagement.
- Identify and understand stakeholders and community networks and their interest in the issues and the process, motivations, values and capacity to engage.
- Determine the level of community and stakeholder participation that is appropriate to each stage of the CMP development.
- Describe engagement objectives, opportunities, barriers and risks.
- Identify engagement methods that are suited to different stakeholders and stages.
- Identify the process for implementation, evaluation and review.

Coastal management planning will include community engagement, including with First Nations people, from the outset and will continue to occur throughout the process from development to implementation.

The aim of the strategy is to inform all key stakeholders of the project and provide them with the opportunity to contribute to the development of the CMP through a variety of methods. The key stakeholders targeted as part of this strategy include relevant agencies responsible for the implementation of management actions, the councils, businesses, special interest groups and local residents. The stakeholder engagement strategy lists each activity to be undertaken as well as the aim/ objective of the activity, content to be delivered, target stakeholders, delivery method, timing, frequency and who is responsible for delivering the activity.

7.5 CMP Development

RCC will lead the development of the CMP for the Richmond River estuary. RCC will collaborate with the estuary and catchment councils, land managers, state government agencies, industry and community representatives to provide effective coastal management outcomes. RCC and the estuary and catchment councils will rely on funding from the Coastal and Estuaries Grants Program to ensure affordability of the CMP development. Ongoing stakeholder liaison will be a key component of the CMP development.

The Forward Plan (including responsibilities, costs and timing) for Stages 2 – 4 of the Richmond River Estuary CMP is provided in Table 10. The tasks listed in the Forward Plan have been developed using the information available during the preparation of this Scoping Study.

The Stage 2 tasks are proposed to address knowledge gaps identified through the risk assessment and gap analysis (Appendix B). Tasks listed in Table 10 include reference to the relevant risk assessment recommendation(s). The Stage 2 tasks have been prioritised using information gathered as part of the first-pass risk assessment and gap analysis (Appendix B) as follows:

- Critical – tasks that are required for the development of the CMP and particularly the identification and evaluation of potential responses in Stage 3.
- Recommended – tasks that are recommended for completion as soon as possible as they would assist in the identification and evaluation of potential responses in Stage 3 of the CMP development.
- Desirable – tasks that address data gaps identified through the risk assessment process but may be undertaken during CMP Stages 3 - 5 if funding/ resources are not available during Stage 2.

Outcomes from the Stage 2 tasks and other information that becomes available during Stages 2 – 3 may identify further tasks which may also be required to better inform the CMP development.

Preliminary cost estimates have been developed for each stage of the CMP development. In-kind costs across the life of the CMP (e.g. liaison with internal council departments and councillors, compilation and synthesis of relevant data, fulfilling data requests, coordination with stakeholders and consultants) have not been included. Individual councils will ensure that staff resources are adequate to deliver this project. CMP implementation costs will be identified in the CMP.

It is noted that the Draft *Far North Coast Regional Water Strategy* (being prepared by the NSW Government) identifies overlaps with the CMP priorities and development. The CMP process may need to adapt to any further detail on the Regional Water Strategy implementation, timing, funding and responsibilities once this is available. This may include revision of the forward plan considering any commitments made by the NSW Government relating to actions that are consistent with the CMP. Similarly the scope of Stage 2 studies may be revised with additional stakeholder feedback or outcomes of other related studies e.g. addressing river recovery, flood recovery, bushfire recovery and improvements in community capacity to cope with natural disasters.

Table 10: Forward Plan for the CMP for Richmond River estuary – Stage 2: determine risks, vulnerabilities and opportunities

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
Critical tasks								
2.1 - Strategic planning for on-ground works	Implement a risk-based methodology to prioritise investment in future on-ground river restoration works (i.e. riparian zone restoration, stock exclusion fencing and off-stream watering, bank management, on-farm erosion control, road sealing etc.). Complete ground-truthing of priority areas to assess condition and confirm priority. Outcomes: A high-resolution catchment model based on the Risk-Based Framework to assess the risk of impact of nutrients and sediment on the estuary. Include consideration of practical factors (e.g. landholder willingness, relationship to other on-ground works, funding opportunities, regulatory requirements etc.). Identification of priority areas and planning for on-ground works. Project descriptions to include priority, responsibility, partnerships, costs, approval requirements, funding, ongoing maintenance requirements. Identification of potential showcase sites e.g. on Council-managed land.	S1: Identification of priority diffuse pollution sources/ locations of on-ground works. S3: Identification of priority point source pollution sources/ locations for on-ground works S5: Identification of priority riparian restoration projects/ locations of on-ground works. S6: Bank management strategy	$330,000	$410,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H, LLS, Landcare, industry, community groups, First Nations reps	12 months	6 months

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
2.2 – Develop an estuary health monitoring strategy	Develop an agreed monitoring program design that provides catchment - wide assessment of priority threats to estuarine water quality, ongoing ecosystem health and the effectiveness of management and investment in catchment actions. Outcomes: A program that is cost-effective and targeted and capitalises on existing and ongoing monitoring (e.g. Ecohealth, RCC monitoring, MEMS monitoring). Develop resource requirements and opportunities including citizen science as well as methods of presenting monitoring outcomes to the community.	S10: Develop an ecosystem monitoring strategy.	$40,000	$60,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	6 months	
2.3 – Cultural recognition/ awareness project(s) communicating cultural values of the river and connection to Country	Build on existing engagement with Aboriginal communities and foster new relationships around waterway health across the Richmond. Build engagement now with intent to develop ongoing voices for culture, Caring for Country and engagement between Aboriginal communities and all other stakeholders. Outcomes: Encourage development of culturally appropriate programs by and with Aboriginal community/ies for inclusion in the CMP.	S7: Cultural recognition/ awareness projects(s) communicating cultural values of the river and connection to Country.	$30,000	$40,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	6 months	

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
2.4 – Establish community priorities for waterway health, willingness to pay and potential funding options	Identification of potential community funding models. Community consultation to gauge level of support for Councils to direct funds and resources into waterway health projects and identify Council, landholder and other stakeholder responsibilities. Outcomes: Potential community funding options and investment priorities.	Not assessed as a direct risk to estuary health in the risk assessment but identified as a key task to progress the CMP development and implementation.	$20,000	$30,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	12 months	
2.5 – Assessment of tidal inundation hazard risk	Inundation modelling and mapping will be undertaken collaboratively through the Ballina Coast CMP Stage 2 *Richmond River Storm Tide and Tidal Inundation Study* to the full tidal range (which extends to Tatham and along the Wilsons River to approx. 5 km upstream of Lismore). The Ballina Coast CMP Stage 2 will assess tidal/ coastal inundation risks within the Ballina LGA. This Richmond River Estuary CMP Stage 2 task will assess tidal inundation risks within the Lismore and Richmond Valley LGAs and the remaining affected area of the Ballina LGA using the outcomes of that tidal inundation study. Outcomes: Assessment of risks to public land/assets and private land relating to tidal inundation in LCC and RVC LGAs (excl. Evans River).	Detailed tidal inundation assessment of the estuary for a variety of future sea level rise scenarios (through Ballina Coastline CMP), with a risk assessment to estuary assets and infrastructure.	$40,000	$50,000	RCC, BaSC, LCC, RVC	DPE - E&H		6 months
2.6 – Detailed risk assessment	Analysis and evaluation of current and future risks (updated preliminary risk assessment).	-	$20,000	$30,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H		2 months

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
2.7 – Stage 2 documentation	Documentation, feedback and concurrence.	-	$10,000	$15,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H		1 month
2.8 – Stakeholder engagement	Refer Community and Stakeholder Engagement Strategy.	-	$30,000	$40,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	Ongoing	Ongoing
Stage 2 total – critical tasks			*$520,000*	*$675,000*	*21 months (July 2023 – March 2025)*			
Recommended tasks								

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
2.9 – Develop a database of on-ground works/ resource tool kit	Collaboration with stakeholders to collate details and map locations of completed and proposed on-ground works. Outcomes: Live, publicly accessible online database including resources (e.g. restoration guidelines, past lessons learnt, study findings, species lists etc.) Document long-term database maintenance arrangements.	S11: Develop a database of on-ground works.	$30,000	$60,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	3 months	Ongoing update
2.10 – Cultural mapping to promote protection of cultural heritage	Consultation and co-design/development of cultural mapping project in collaboration with Aboriginal groups. Determine who will be involved, how it will work and how the information will be used. Linked to cultural recognition/ awareness projects – consultation could be carried out for both projects simultaneously. Outcomes: Cultural mapping projects across the catchment to locate and conserve sites and items and provide input into planning and development controls.	S8: Cultural mapping	$30,000	$40,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H, First Nations, Heritage NSW.	6 months	6 months
2.11 – Implementation of estuary health monitoring strategy	Implement the estuary health monitoring strategy developed through task 2.2. Outcomes: Better understanding of issues/locations and effectiveness of management actions.	Water quality monitoring to assess current impacts and to track changes over time.	$50,000 ($50,000 p.a.)	$100,000 ($100,000 p.a.)	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H		Ongoing

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
2.12 – Confirm accuracy of Coastal Wetland and Littoral Rainforest Area mapping	Desktop comparison of CWLRA mapping and contemporary vegetation type mapping to identify potential inconsistencies to improve ecological protection mechanisms and ensure appropriateness of planning requirements for routine works such as asset maintenance (outside Conservation areas). On-ground assessments where required to ground truth vegetation type and determine vegetation boundaries. Outcomes: Recommendations for potential modifications to CWLRA mapping.	-	$25,000	$30,000	BaSC, RVC, BySC	DPE - E&H		6 months
Desirable tasks								
2.13 – Development of urban stormwater management plans	Review/ update/ prepare urban stormwater management plans and identify priority water quality improvement actions. Outcomes: Improved water quality discharging from urban stormwater to downstream receiving environments/ the Richmond River estuary.	S2: Development/ review of urban stormwater management strategies	$150,000	$200,000	BaSC, LCC, RVC, KC, BySC	DPE - E&H		12 months
2.14 – Assess scale of litter and microplastics issues	Undertake an assessment of the scale of litter and microplastics issues across the coastal zone using available tools such as the EPA Litter Prevention Kit and Local Litter Check.	S4: Investigate scale of litter and microplastics issues	$10,000	$20,000	BaSC, LCC, RVC, KC, BySC	EPA, DPE - E&H	3 months	

CMP task	Scope and expected outcome	Risk assessment recommendation[1]	Cost (low)[2]	Cost (high)[2]	Primary responsibility	Support agencies	2023/24	2024/25
2.15 - Identify options for improved recreational access to waterways	Review and assess recreational/access needs and requirements for the coastal zone addressing foreshore access, waterfront structures, ecological protection, cultural heritage recognition and protection, usage conflicts and erosion. Identify potential projects for consideration in Stage 3 of the CMP.	S9: Identify options for improved recreational access to waterways	$40,000	$80,000	BaSC, LCC, RVC	DPE - E&H, TFNSW		6 months
Stage 2 total – recommended and desirable tasks			*$335,000*	*$530,000*	-			

1. Refer Risk Assessment and Gap Analysis, Appendix B. In some cases multiple recommended studies required to fill knowledge gaps from the risk assessment have been combined into single Stage 2 tasks to optimise efficiency and streamline delivery of Stage 2.
2. Not including Council or other agency staff costs.

Table 11: Forward Plan for the CMP for Richmond River estuary – Stage 3 and Stage 4

CMP task	Scope and Expected Outcome	Cost (low)[1]	Cost (high)[1]	Primary responsibility	Support agencies	2025/26
Stage 3 – response identification and evaluation						
Options assessment[2]	Development of strategic response to risks, identification and evaluation of management options	$30,000	$40,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	3 months
Business Plan	Development of business plan for implementation - capital and operational costs, distribution of costs and benefits, funding and delivery	$10,000	$20,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	1 month
Stakeholder engagement	Refer Community and Stakeholder Engagement Strategy.	$30,000	$40,000	-		4 months
Stage 3 total		*$70,000*	*$100,000*	*4 months (July 2025 – December 2025)*		
Stage 4 – finalise, exhibit and certify the CMP						
CMP documentation	Documentation, feedback and concurrence	$40,000	$50,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H, NPWS, DPE - Crown Lands and other relevant agencies	3 months
CMP exhibition	Public comment	$5,000	$10,000	RCC, BaSC, LCC, RVC, KC, BySC	-	2 months
CMP finalisation	Final CMP document	$5,000	$10,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	1 month
Stakeholder engagement	Refer Community and Stakeholder Engagement Strategy.	$15,000	$20,000	RCC, BaSC, LCC, RVC, KC, BySC	DPE - E&H	6 months
Stage 4 total		*$65,000*	*$90,000*	*6 months (January 2026 – June 2026)*		

1. Not including Council or other agency staff costs.
2. Not including detailed assessment of costs and benefits of high risk and complex options (if required).

7.6 Potential for Fast-Tracking

The *NSW Coastal Management Manual* describes cases where it may be appropriate for councils to 'fast-track' from stage 1 to 4, or only complete parts of stages 2 to 3 of a CMP. Generally a fast-track process for the preparation or review of a CMP is appropriate where the first-pass risk assessment indicates that the vulnerability is low and the risks are acceptable, issues are not complex and are already appropriately managed and funded, and where there are few stakeholders and/or there is an existing, successful management partnerships between stakeholders. The opportunity to fast-track components of the CMP will be considered during Stage 2.

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GLOSSARY AND ABBREVIATIONS

Acid sulfate soils (ASS)	ASS is the common name given to soils containing iron sulfides. When the iron sulfides are exposed to air and produce sulfuric acid, they are known as actual ASS. The soil itself can neutralise some of the sulfuric acid. The remaining acid moves through the soil, acidifying soil water, groundwater and, eventually, surface waters.
AHD	Australian Height Datum
Amenity	A desirable or useful feature or facility of a building or place
Aquatic	Living or growing in water, not on land.
BaSC	Ballina Shire Council
Blackwater	Blackwater is formed from the decomposition of plants and organic matter in water during prolonged inundation during floods. Blackwater is usually dark in colour and contains little or no oxygen. The organic matter in blackwater can consume large amounts of dissolved oxygen and if mixed into rivers and creeks can deoxygenate waterways and can cause fish kills.
BySC	Byron Shire Council
CEA	Coastal Environment Area (as defined by the Resilience and Hazards SEPP)
CLASS	Coastal lowland acid sulfate soils
CMP	Coastal Management Program
Coastal hazard	Either or a combination of the following: beach erosion; shoreline recession; coastal lake or watercourse entrance instability; coastal inundation; coastal cliff or slope instability; tidal inundation; erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.
CSP	Community Strategic Plan
CUA	Coastal Use Area (as defined by the Resilience and Hazards SEPP)
CWLRA	Coastal Wetland and Littoral Rainforest Area (as defined by the Resilience and Hazards SEPP)
CVA	Coastal Vulnerability Area (as defined by the Resilience and Hazards SEPP)
CZMP	Coastal Zone Management Plan
DECCW	Former (NSW) Department of Environment, Climate Change and Water (now DPE)
DCP	Development Control Plan
Dissolved Oxygen	Oxygen dissolved in the water (oxygen saturation).
DPE	Department of Planning and Environment
DPI	(NSW) Department of Primary Industries
DPIE	Former (NSW) Department of Planning, Industry & Environment (now DPE)
DPI Fisheries	NSW Department of Primary Industries – Fisheries

Ecosystem	Refers to all the biological and physical parts of a biological unit (e.g. an estuary, forest, or planet) and their interconnections.
E&H	Environment and Heritage Group (a Division of DPE)
EPA	(NSW) Environmental Protection Agency
Estuarine	Part of the river channel with a mix of fresh water and salt (tidal) water
Foreshore	That part of the shore that lies between the mean high tide mark and the mean low tide mark
GIS	Geographic Information System
Geomorphology	Characteristics, origin and development of landforms.
Ha	Hectares
HAT	Highest Astronomical Tide
Holocene	The current geological epoch which began approximately 11,700 years ago.
Hydrology	The study of water and its properties, including precipitation onto land and returning to oceans
ILUA	Indigenous Land Use Agreement
Inundation	Rising and spreading of water over land
IP&R	Integrated Planning and Reporting
KC	Kyogle Council
LALC	Local Aboriginal Land Council
LCC	Lismore City Council
LEP	Local Environmental Plan
LGA	Local Government Area
Littoral	Related to or near the coastline.
LLS	Local Land Services
MEMA	Marine Estate Management Authority
MEMS	Marine Estate Management Strategy
MBO	Monosulfidic Black Ooze - organic oozes enriched in iron monosulfides. MBOs can exert a high oxygen demand when mobilised into the water column following flood events. Other hazards associated with MBO accumulation include severe acidification, and the release of toxicants (for example heavy metals, metalloids such as arsenic, and high levels of nutrients) from MBOs subsequent to disturbance of these materials.
NPWS	National Parks and Wildlife Service
OEH	Office of Environment and Heritage
RLI	Rural Landholder Initiative
Riparian	Of, on or relating to the banks of a watercourse

RCC	Rous County Council
RVC	Richmond Valley Council
Salinity	The level of salt dissolved in the water
Sediment	Sediment is solid material that is moved and deposited in a new location. Sediment can consist of rocks and minerals, as well as the remains of plants and animals. It can be as small as a grain of sand or as large as a boulder. Sediment moves from one place to another through the process of erosion.
Sedimentation	The deposition or accumulation of sediment
SEPP	State Environmental Planning Policy
SoE	State of the Environment (report)
STP	Sewage Treatment Plant
TARA	Threat and Risk Assessment
Terrestrial	Living or growing on land (not aquatic)
TfNSW	Transport for NSW
Turbidity	A measure of the amount of light-attenuating particles in a water body

Appendix A. STATUS OF MANAGEMENT ACTIONS

This Appendix outlines the status of relevant management actions from previous relevant management plans.

All management actions have been allocated a status (i.e. complete, incomplete, ongoing, in progress, not commenced).

Status:

Not commenced - No progress has been made toward completing this action. Not started.

In progress - Progress is being made toward completing this action. Work has started and is currently being undertaken. The action is currently being completed or in some cases will be completed following the outcome of another action or external factor.

Ongoing - Works are undertaken to fulfill this action periodically, as required or a part of an ongoing works/maintenance program. The status of 'ongoing' refers to the nature of the action requiring constant implementation (i.e. weed and pest management).

Incomplete - Progress has been made toward completing this action however progress has halted and unlikely to continue. Work started or was being undertaken but has stopped (e.g. funding finished).

Complete - Work towards fulfilling this action is complete. Action is complete, no further work/action required.

Note:

The functions of the former Office of Environment and Heritage (OEH) are now undertaken by DPE and the functions of the former North Rivers Catchment Management Authority (NRCMA) are now undertaken by Local Land Services (LLS). The following tables reflect these changes.

Table 12: Status of actions: CZMP for the Richmond River Estuary

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
Strategy 1 – Administration and Governance							
1a	Form a CZMP Implementation Committee	BaSC, LCC, RVC, RCC	-	Estuary-wide	CZMP Implementation Committee formed by October 2011	Complete	• CZMP Interim Implementation Group (IIG) formed in 2012 and restructured in 2014 to include multi-agency representation. A committee (now Implementation Reference Group, IRG) has been formed and last met in June 2020 and March 2021.
1b	Review estuary governance and administration	CZMP Implementation Committee	BaSC, LCC, RVC, RCC, OEH, DPI Fisheries, LLS, DPI, Crown Lands	Estuary-wide	Completed review by June 2013.	Complete	There have been various studies reviewing governance arrangements but new governance arrangements are not yet in place: • *Review of Governance and Administration Models for the Richmond River – North Eastern NSW* (Stephen Fletcher and Associates, 2013) – identified the effectiveness of the current governance and administration arrangements for the management of the Richmond River estuary and identified the range of governance models being applied to river management. • 2014 – ten-year forward program of priority works developed by RCC on behalf of estuary and catchment councils and grant application (not successful). • *Richmond River Governance and Funding Framework* (Alluvium, 2019a) – the report identified two possible transition pathways towards a more effective governance of the Richmond River. The recommended pathway was that a "Richmond River Coordinator" be appointed to work with stakeholders to create an independent Collaborative Partnership. The councils either endorsed the report recommendations or recommended alternative pathways. • DPE working on implementing improved governance arrangements through new 12-month position (Senior Project Officer – Catchment Governance and Waterway Health (Richmond River)).
					New governance arrangements in place by June 2015.	Incomplete	
Strategy 2 – Climate Change							
2a	Assessment and mapping of tidal inundation extent including potential sea level rise	BaSC, RVC	OEH, DPI	Zones 1, 2, 3, 4, 6	Sea-level rise tidal inundation maps produced and available by December 2012.	Complete	Much of the tidal inundation extent is outside the study area for the Richmond River Estuary CMP Scoping Study. Actions related to the study area include: • *Predicted Coastal Flooding Resulting from Climate Change* (Coastal Risk Australia, 2021) is an online interactive map showing coastal inundation associated with sea level rise. The mapping indicates that large areas of the study area may be at risk of tidal inundation, most notably the Richmond River Floodplain and adjacent lands. • *NSW Estuary Tidal Inundation Exposure Assessment Report* (OEH, 2018c) assessed the exposure of properties to tidal inundation resulting from sea level rise using modelling and mapping. Richmond River was found to be the fifth most exposed estuary due to the number of properties exposed to inundation. However, it is noted that the majority of properties identified as being at risk are located in the urban centre of Ballina which lies outside of the study area for the Richmond River Estuary CMP.

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
2b	Planning for sea level rise and climate change impacts incorporating Government policy and guidelines, current research and best-practice management	BaSC, LCC, RVC, RCC	OEH, DPI Fisheries, LLS, DPI Crown Lands, SCU	Estuary-wide	Estuarine habitat transgression in response to sea level rise identified and strategic plan to cater for habitat migration developed by June 2014.	In progress	Much of the tidal inundation extent is outside the study area for the Richmond River Estuary CMP Scoping Study although this study will address bank erosion and the migration of estuarine vegetation due to sea level rise within the study area. • BaSC and RVC have adopted sea level rise planning benchmarks and flood risk policies. • BaSC and LCC have developed a draft Climate Change Policy and draft Climate Resilience Policy respectively. • BySC have adopted a Climate Change Strategic Planning Policy which provides climate change flood planning scenarios for the years 2050 and 2100. • Relevant MEMS projects currently in progress: ○ Action 2.3 (refer MEMA, 2020): DPI Fisheries: A spatial modelling methodology has been developed to model macrophyte potential now and in the future. Estuary specific model for the Richmond River estuary was completed in mid-2020, together with a 200m grid overlay providing natural resource managers with a quick overview/summary of the area (i.e. the current and historic distribution of macrophytes, summary of the geomorphic condition, summary of the anthropogenic exposure, likelihood of future macrophytes under two scenarios of sea-level rise, land ownership and the proximity to the reserved estate). Results not yet published. ○ Action 3.1 (refer MEMA, 2021): DPI Fisheries: Mapping the distribution of and structure of mangroves and saltmarsh and adjacent foreshores structures in areas vulnerable to sea level rise is underway; and a state-wide first-pass assessment of wetland vulnerability to sea level rise for estuaries with significant areas of mapped wetland. Results not yet published. ○ A state-wide Bank Management Strategy template is in development to provide a tool to support selection of best practice bank management. Results not yet published.
					Risks and projected extent of bank erosion identified and mitigation measures identified by June 2014.	Not commenced	
					Richmond River estuary climate change resource base developed and made available to decision makers within the catchment by June 2014.	Not commenced	
					Review and update of resource base on an annual basis.	Not commenced	

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
Strategy 3 – Monitoring, Evaluation and Review							
3a	EcoHealth monitoring program	CZMP Implementation Committee	BaSC, LCC, RVC, RCC, OEH, DPI Fisheries, LLS, DPI Crown Lands, SCU	Estuary-wide	Design of the Richmond River EcoHealth monitoring program by March 2013.	Complete	The *Richmond River Ecohealth Project 2014* was the first comprehensive catchment-wide assessment of waterway health in the Richmond (excluding the Evans River). The project was conducted over a 12-month period in 2014 covering 48 sites (23 freshwater and 25 estuarine sites) across the catchment. A report card was generated for the project assigning an overall grade for the Richmond catchment of D- (Ryder *et al.,* 2015). Other relevant and related actions include: • RCC monthly water quality monitoring 01/2010 – 12/2014 (reporting available online). • *Review of Rous County Council Water Quality Monitoring* (WRL, 2020) reviewed the efficacy of data collected from automated water quality monitoring stations in the lower Richmond River since 2004 and found that the datasets lacked reliability. WRL (2020) provided a suite of recommendations for a revised program. • RCC's Floodplain Water Quality Monitoring Network is an online platform which provides data from continuous real-time monitoring at 5 stations - Wardell, North Creek, Tuckean Swamp (upstream and downstream of Bagotville Barrage) and Rocky Mouth Creek. This network is part of the revised program based on recommendations from WRL (2020). • RCC's Richmond River Water Quality Monitoring Program was updated in 2019/20. • DPE has prepared a draft *Richmond River Water Quality Monitoring Strategy for the Richmond River* (Ferguson, 2021). • RCC has prepared drinking water Catchment Management Plans for Rocky Creek Dam, Wilsons River Source and Emigrant Creek Dam catchments. RCC monitors water quality in the drinking water catchments in accordance with the Australian Drinking Water Guidelines (NHMRC, 2011). • RCC has developed a pesticide monitoring program and catchment surveillance program for the drinking water catchments (updated in 2020).
					Program commenced by June 2013.	Complete	
					Annual reports and community report cards prepared for each year of the program.	Complete	
3b	Develop catchment/water quality modelling tool to support decision making	CZMP Implementation Committee	BaSC, LCC, RVC, RCC, OEH, DPI Fisheries, LLS, DPI Crown Lands, SCU	Estuary-wide	Modelling tool available by June 2013.	Complete	• DPE - E&H developed an estuary health risk dataset for each estuarine catchment in NSW (Dela-Cruz, *et al.*, 2019) to support development of CMP Scoping Studies under the NSW Risk-based Framework. The dataset provides a broad assessment of relative risk to estuarine health from catchment export of nutrient and sediment. It does not factor in other sources of risk (e.g. acid sulfate soils, blackwater, contamination etc.). The current dataset is based on 2008 climate data and DPE - E&H have indicated they plan to update the model with more recent data shortly (pers. comm. J. Dela-Cruz, 2021). The Evans Head Catchment is not included within the Richmond River model but is available as a stand-alone catchment. • Richmond River Ecosystem Response Model (RR-ERM) currently being developed by DPE in collaboration with an SCU PhD student. The PhD program is focussed on filling primary knowledge gaps impeding the development of an ecosystem response model to underpin a Risk Based Framework of the Richmond River. One of the key aims of this work is to calibrate the model with real-world data from the Richmond River to improve reliability. The PhD program is on track to deliver this model by June 2022.
					Review and update every three years.	Not commenced	
3c	Review of CZMP progress and monitoring of KPIs	BaSC, LCC, RVC, RCC	OEH, DPI Fisheries, LLS	Estuary-wide	Review and reporting undertaken as part of SoE reporting – 2016, 2020.	Complete	With the introduction of the Integrated Planning and Reporting (IP&R) framework, the requirements for council's SoE reporting changed to make it part of the corporate planning and reporting process. • Mid-term review completed in 2017. • A regional SoE report was prepared in 2016.

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
3d	Ten-year review of CZMP	CZMP Implementation Committee	BaSC, LCC, RVC, RCC, OEH, DPI Fisheries, DPI Crown Lands, LLS	Estuary-wide	Review and reporting undertaken by year 10.	In progress	• Richmond River Estuary CMP Scoping Study currently being prepared will provide a comprehensive review of the status of CZMP implementation and set the scope for the future stages of the Richmond River Estuary CMP.
					Adoption and gazettal of the amended CMP as required.	Not commenced	
Strategy 4 – Floodplain Infrastructure Management							
4a	Identify, prioritise and optimise drains and levees	RCC	BaSC, LCC, RVC, DPI Fisheries, LLS, DPI Crown Lands, OEH, landholders, relevant agricultural industry bodies	Estuary-wide	Prioritisation study and 5 year works program completed by June 2013.	Complete	Prioritisation studies are complete but actions are not yet implemented: • MEMS project – *Draft Floodplain Prioritisation Study* is currently being undertaken by DPI Fisheries to develop and apply multi-criteria prioritisation methodologies to rank major coastal floodplains by their contribution to acid and blackwater generation and discharge, to determine the subsequent risks to the estuarine waterways, and to guide the future management of coastal floodplains. The draft study has been provided to Richmond River stakeholders for review. • *Tuckean Swamp Hydrologic Options Study* (Rayner *et al.,* 2020) improves the overall understanding of the hydrology of Tuckean Swamp and floodplain through extensive field data collection and numerical modelling. The study investigated six drainage management options to mitigate issues associated with acid sulfate soils. The study was developed with input from the Tuckean Steering Committee, consisting of representation from OzFish, RCC Council, BaSC, LCC, RVC, NPWS, DPE, LLS, Jali LALC, DPI-Fisheries and the Nature Conservancy. Funding was provided by the Saltwater Recreational Fishing Trust Flagship Fish Habitat Action Plan. Other related actions include: • *Flood Mitigation Assets – Review of Management Methodology* (Seaboard, 2014) documented the uncertainty of flood mitigation asset ownership, environmental impacts of assets, investment of public funds in private works, maintenance funding requirements and resourcing and uncertainty regarding benefits of flood mitigation works. Recommendations from this report have not been implemented as it is one interpretation of this complex regulatory and management environment and further investigations are required to resolve issues with floodplain drainage. • RVC developed an MOU with Broadwater sugar Mill Co-op regarding drain management and Farm Drain Management Plans. This is a standard arrangement facilitated through an amendment within the LEP that applies to self-regulation of disturbance of acid sulfate soils from routine farm practices in the sugar cane industry. BaSC and LCC also have this arrangement. • *Reference paper - Cane Drain Maintenance Approvals* (Hydrosphere Consulting, 2018) was prepared to provide information and advice to BaSC on current legislative process for maintenance of cane farm drains and opportunities to streamline approvals. • Review of service level agreements (including flood mitigation services) currently being undertaken. • Keith Hall Drainage Options Study is a collaborative project between BaSC, RCC and local landowners to investigate options for on-ground works to address water quality, drainage and maintenance requirement issues. While outside the study area for the Richmond River Estuary CMP, the study could act as a pilot for other areas on the Richmond River Floodplain. The study is in progress with the stakeholder group selecting options to progress to be explored in detail.
					Annual target(s) for optimisation works is suggested at 10 sites, although this should be confirmed by the prioritisation study.	Not commenced	

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
4b	Review floodgate management protocols	RCC	BaSC, LCC, RVC, DPI Fisheries, LLS, DPI Crown Lands, OEH, landholders, relevant agricultural industry bodies	Estuary-wide	Review and recommendations by June 2013.	Ongoing	• RCC currently has 52 Active Floodgate Management Plans (AFMP). The most recently reviewed and updated plans are available on the website. The AFMPs detail how active management can assist in reducing the floodgate's environmental impact whilst not impacting on current land use. • RCC has conducted trials and drain invert surveys e.g. at Keith Hall Drainage System and Dungarubba Canal to inform the review and update of protocols. *Empire Vale Pilot and Rocky Mouth Creek Emergency Fish Escape in the Richmond River Catchment* (RRCC and FRDC, 2013) documents pilot studies involving floodgate modifications undertaken using a grant from the Fisheries Research and Development Corporation (FRDC). • Keith Hall Drainage Options Study (as above). • The *Tuckean Swamp Hydrologic Options Study* (Rayner *et al.,* 2020b) (as above).
Strategy 5 – Farm management							
5a	Scientific investigations: strategies for retention of water on backswamp areas	DPI	BaSC, LCC, RVC, RCC, SCU, LLS, OEH, landholders, relevant agricultural industry bodies	Zones 7, 10, 11	Implementation Plan completed by June 2013.	Not commenced	The aim of the CZMP action was to investigate strategies for retention of water on backswamp areas and conduct scientific trials to fill gaps in understanding about the on-ground implementation of water retention on backswamp land to enable recommendations for broad-scale implementation which has not been undertaken. Related studies include: • In 2013 GHD undertook a cost benefit analysis of backswamp management options which assessed two scenarios: 1) adjustable drainage and wetland pastures; and 2) buy-back of the backswamp. The results indicate that adjustable drainage and wetland pasture is the preferred option from a benefit-cost ratio perspective however buy-back is the preferred option based on the net present value (NPV) (GHD, 2013). • As part of the LLS funding, RRCC committed to carry out projects involving the remediation of ASS and riparian vegetation including protection of 200 ha under voluntary agreements, rehabilitation/enhancement of 200 ha of wetland including 100 ha of ASS, restoration of 1 km of riparian zone through weed control and plantings, building the capacity of 20 land managers/farmers, development of concept plans and aquatic weed management plans, development of a demonstration site and media articles and field days. Scientific analysis of the effectiveness of these works has not been undertaken (Hydrosphere Consulting, 2017). • DPI also completed works restoring wetland vegetation and groundwater and surface water levels at 5 sites near the Bungawalbin and Sandy Creek areas (Hydrosphere Consulting, 2017). • In 2012 RCC in collaboration with SCU undertook research on geochemistry of coastal floodplain blackwaters (Hydrosphere Consulting, 2017). • Rogers *et al*. (2016) investigated the decline of coastal wetlands and fish habitat as a result of floodplain drainage and identified opportunities to reverse this decline through management actions that restore natural drainage and reinstate tidal exchange. • SCU paper on Floodplain Ecosystem Services has been prepared (abstract only available). • In 2019 the Northern Rivers Joint Organisation endorsed the Northern Rivers Watershed Initiative to restore the Tweed, Brunswick, Richmond and Evans River systems to minimise flood impacts by naturally restoring hydrologic functions (which would also improve stream bank and riparian zone condition).
					Completion of on-ground trials by June 2015.	In progress	
					Recommendations completed by December 2015.	Not commenced	

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
5b	Farm management planning	DPI	BaSC, LCC, RVC, RCC, SCU, LLS, landholders, relevant agricultural industry bodies	Estuary-wide	Prioritisation Report by December 2012. Farm Management Plans adopted and implemented (e.g. 2 high priority farms per annum).	Not commenced Not commenced	While actions relating to farm management improvements have been undertaken, prioritisation of farm management planning, review of alternative options for farm management, CBA of farm management activities at priority farms, the preparation of farm management plans and the provision of support and incentives for land holders has not been provided as required by the CZMP action. Actions undertaken include: • Rural Landholder Initiative implemented by LCC as part of its Biodiversity Management Strategy to conserve biodiversity hotspots on private land. There is very high demand from landholders to participate in the program. • NRCMA (now LLS) and North Coast Weeds Integrated sustainable floodplain farming stage 1 & 2 – landholders were encouraged to understand and implement best-practice management on their properties through attending floodplain grazing courses, field days, educational events and extension activities. Landholders were then encouraged to enter into funding agreements for actions to improve soil and wetland health and overall biodiversity (Hydrosphere Consulting, 2017). • In 2013/14 WetlandCare Australia engaged RCC to work with landholders to undertake on-ground works to improve the health of the floodplain on the Kilgin Road, Bora Codrington, Swan Bay and Wilsons River sites under Land Management Agreements (as part of the Floodplain Management Priorities – Richmond River Estuary project) (Hydrosphere Consulting, 2017). • Incentive grants have been provided to 50 macadamia farms in the Richmond region for the completion of integrated orchard management works to reduce soil and nutrient loss through erosion as part of the MEMS. • The Wollongbar Blueberry Nutrition Research Facility being established to research erosion treatments. • RCC has provided off-stream stock watering water infrastructure as part of the Wilsons River Reach Plan. • North Coast LLS is currently providing grants to livestock holders via The Stock Water Recovery project to improve stock water infrastructure such as troughs, tanks, and dams. The project was funded by the NSW government as part of the Bushfire stimulus project. • North Coast LLS are currently have grants available to Blueberry, blackberry, raspberry, and greenhouse vegetable growers within the North Coast region to fund on-farm infrastructure to reduce nutrient and sediment runoff as part of the Clean Coastal Catchments project (funded through the MEMS).

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)

5c	Liaise with agriculture industry bodies to improve education and ensure estuary friendly practices are incorporated into industry guidelines	DPI	BaSC, LCC, RVC, RCC, SCU, LLS, OEH, relevant agricultural industry bodies	Estuary-wide	Prioritisation identification of relevant industry bodies and associated guidelines, certification criteria, etc. by 2013.	In progress	Some industry guidelines have incorporated estuary friendly practices. Farm Management Plans have not been prepared as required by the CZMP action. Related actions include:
							• RCC has conducted ongoing consultation with cane, macadamia and oyster industries regarding floodplain and natural resource management issues, issues with floodgates, drains and levees and water quality management.
							• Macadamia Industry Best Practice Management Guidelines.
							• BySC appointed an Agricultural Extension Officer to work with industry groups and farmers to improve farming productivity and practices.
							• LCC will host training in landscape rehydration involving projects on five properties. The LCC Floodplain Management Committee are interested in undertaking further investigation into flood mitigation using “Nature Based Solutions” including landscape rehydration.
							• WaterNSW, Rivers of Carbon and Australian River Restoration Centre developed a guide (Stock & Waterways – A NSW Manager’s Guide) in conjunction with farmers and practitioners in different parts of New South Wales to improve the on-farm management of riparian land (the land that runs alongside waterways) (Australian River Restoration Centre, 2019).
							• RCC Landholder’s Guide to Looking after Waterways in the Richmond Catchment (RCC, 2017).
							• North Coast Meat Company (NCMC) leading project to improve grazing management through off stream water supply and farm planning.
							• Through the Rural Landholder Initiative, LCC undertakes collaborative industry projects focussed on developing and embedding practice improvements. Projects to date include:
							  ○ Restoring native vegetation to support native bee populations that enhance pollination of macadamias.
							  ○ Healthy soil and water in the grazing industry.
							  ○ Benefits of deep-rooted riparian vegetation in the essential oils industry.
							• LCC has also developed and published a series of four educational booklets for rural landowners:
							  ○ Healthy landscapes and waterways (includes farm health assessment tool).
							  ○ Beef grazing and dairying.
							  ○ Macadamias and other orchards.
							  ○ Floodplain cropping.

					Review and successful incorporation of estuary-friendly practices in industry documentation by 2014.	In progress	
					Identification and promotion of industry incentives (grants, accreditation, support services) that may assist landholders in implementing positive change (On-going). Report by December 2012.	In progress	
					Farm Management Plans adopted and implemented (e.g. 2 high priority farms per annum).	Not commenced	

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
Strategy 6 - Riparian Zone Management and Erosion							
6a	Identify priority riparian areas and rehabilitate	CZMP Implementation Committee	BaSC, LCC, RVC, DPI Crown Lands, LLS, RCC, OEH, landholders, relevant agricultural industry bodies	Estuary-wide	Prioritisation study completed by December 2012.	Not commenced	LCC, RCC, NRCMA and OEH - GIS assessment undertaken to characterise the riparian zone restoration priority (Landmark Ecological Services and Peter Hall, 2013). The study was GIS-based with no ground truthing and only covered the estuary management zones. The quality of mapping data available was variable in the three LGAs and mapping scale/resolution was coarse. The project focussed on water quality and bank stabilisation but prioritisation categories are not indicative of the ecological health of the riparian zones or administrative/political considerations. The study recommended ground-truthing and establishment of a single, comprehensive, catchment-wide GIS dataset. Some components of the CZMP action/tasks were not addressed e.g. coastal hazards, habitat connectivity, weeds, aesthetic qualities, landowner willingness and development of a 10-year work schedule. This project also included a landowner survey and education kit for riparian landowners including best practice guidelines for relevant industries and an introduction to the project. Many riparian restoration projects have been undertaken by RCC, estuary and catchment councils, state government organisations and community groups e.g.: • Three-year NSW Environmental Trust project 'Protecting the Richmond' initiated by RCC in 2014 to improve farm and environmental outcomes resulting in stock fencing, weed control and regeneration and plantings of riparian vegetation being undertaken across eight project sites. • Habitat Action grants (DPI fisheries) for projects which improve fish habitat, fish passage and/or water quality have been used on for various projects including 5 sites rehabilitating 10.9 ha. • The Border Ranges and Richmond Valley Landcare Network (BRRVLCN) have undertaken many riparian restoration projects including weed control as part of the *North Coast Regional Strategic Weed Management Plan 2017-22*. • Various riparian restoration and management projects undertaken by various Landcare groups, WIRES, friends of the koala, SCU and local schools. • Between 2012 and 2015 LCC restored 16.5 ha of riparian area (including wetlands) (Hydrosphere Consulting, 2017). • LCC and RVC have identified suitable public sites for remediation which may be incorporated into ongoing and future maintenance works. • LCC *Urban Green Corridors Plan* (LCC, 2017) identifies priority urban areas for bush regeneration and revegetation. • LCC undertakes restoration of riparian vegetation along about 1.7 – 2.0 km of the Wilsons River in the urban area annually. • DPI Fish Habitat Action Grants application for riparian rehabilitation works in Coraki (awaiting result) • BaSC in conjunction with OzFish Richmond River Chapter have undertaken riparian plantings at Chickiba, Maguires, North Creek and Emigrant Creek as part of BaSC's Healthy Waterway Program. • RCC have completed riparian improvements on the Wilsons River and Emigrant Creek as part of River Reach Plans. Approximately 67 ha of River Reach Plan areas have been rehabilitated including 33 ha in the Emigrant Creek Dam catchment and 34 ha in the Wilsons River Catchment. On-ground works included weed control, cattle exclusion fencing, vegetation planting and erosion control works (Hydrosphere Consulting, 2020). Both River Reach Plan areas are planned to be extended further upstream. New projects are under development including rehabilitation along Tucki Tucki Creek in collaboration with Kadina High School. • In 2016 RCC held a riparian zone and erosion management field day in Goonengerry with interpretive materials and film.
					Target rehabilitation of 5 ha per year.	In progress	
					Annual review of work schedule and project costing.	In progress	

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
							• KC (outside estuary) collaborates with Landcare, community and other agencies on river restoration projects but this is *ad hoc*, relies mostly on external funding (which is time consuming and not guaranteed), small scale and not necessarily targeting priority areas requiring restoration but working in areas where landowners are interested and want to be involved e.g. Fawcetts Creek/Kyogle Recreation Reserve weed control, revegetation, footpaths etc., Fisheries Habitat Action Grant and Crown Reserve Improvement Fund are being used to undertake riparian restoration activities and stormwater improvements. Roseberry Creek is the focus of riparian restoration activities with involvement from Landcare, LLS, Soil Con, DPI-Fisheries (approvals) and RCC (weed funding). • MEMS Action 1.3 (refer MEMA, 2020): North Coast LLS: o Riparian enhancement works have been undertaken at 32 sites, predominantly with macadamia farmers and Ballina Shire Council managed land along 35 kms of streamline / 61 ha of riparian area within Emigrant Creek catchment. o Soil Conservation Service have constructed 1,690 m of works in Stage 1. Works include an innovative mangrove embayment approach to erosion control. Works were undertaken on a priority reach within Emigrant Creek (in the Richmond River).
6b	Riparian buffer establishment (planning).	BaSC, LCC, RVC	DPI Crown Lands, OEH	Estuary-wide	Review completed by June 2013.	Not commenced	Riparian buffer zones have not been established as required by the CZMP action. However, the councils have considered the protection of riparian areas in land use planning: • BaSC included riparian buffers in the preparation of the 2012 LEP however this was deferred by the state government. The riparian buffers are not formally included in 2012 LCC LEP. The inclusion of overlays will be reviewed during the implementation of the outcomes of the E-Zone review. • RVC has included extensive riparian zone overlays into LEP mapping for consideration for proposed developments. The LEP clause applies to land identified as Key Fish Habitat on the Riparian Land and Waterways Map.
Strategy 7 - Vegetation Management							
7a	Retain, rehabilitate and conserve existing native floodplain vegetation.	BaSC, LCC, RVC, LLS	OEH-NPWS, RCC, DPI Crown Lands, landholders, relevant agricultural industry bodies	Estuary-wide	Prioritisation Study by December 2012.	Not commenced	The estuary-wide prioritisation study and rehabilitation of priority floodplain vegetation areas have not been undertaken as required by the CZMP action. Related actions include: • RVC floodplain wetland areas are designated E2 – Environmental Conservation zone in the LEP. • Similar planning controls have not been implemented by BaSC or LCC as these are subject to the state government E-zone review. However, the planning controls associated with the previous LEP apply for those locations, many of which are specific to natural areas and their management. Some urban locations within Ballina Shire are subject to a Natural Areas overlay within the 2012 Development Control Plan.
					Target for rehabilitation of 2 ha per year.	In progress	• LCC Biodiversity Management Strategy 2015-2035 (BMS) provides a plan for LCC to build partnerships with the community to protect and enhance biodiversity on public and private land in both urban and rural landscapes. (includes Council's environmental management, Development Assessment, Funding opportunities, Rural Landholder Initiative (see below and action 5b), • LCC undertakes Koala habitat restoration as part of BMS implementation (funded by Council levy on public or private land). This is on top of DA and REF offset requirements identified for projects. • LCC's Rural Landholder Initiative (refer action 5b) also targets rural landholders on the floodplain although take-up of the initiative within the floodplain has been limited (pers. comm. L Walsh) although beef graziers from one 36ha property at Monaltrie have become champions for floodplain grazing management through the initiative.

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
7b	Aquatic weed management.	RCC	BaSC, LCC, RVC, DPI Fisheries, OEH, landholders	Estuary-wide	Adequate maintenance of drainage infrastructure to ensure correct function.	Ongoing	• RCC carries out weed control under the *Biosecurity Act 2015* and follows a regional risk-based approach contained in the *NSW Weeds Action Plan* (WAP). The WAP aims to control new problem weeds, thus preventing them becoming established in the region. It is funded by State Government. Aquatic weeds have been targeted by RCC (e.g. Alligator weed) but many problems experienced that have made efforts largely unsuccessful (e.g. weed harvester performance, water hyacinth issues). • RCC carries out regular aquatic weed management in flood mitigation drains and ex-drainage union drains that it has management responsibility. • In 2011 and 2019, aquatic weeds were mechanically removed from Swan Bay by RCC using aquatic weed harvesters, excavators, a traxcavator and floating booms. Following mechanical removal of 10 ha of floating weed, RCC initiated an ongoing maintenance spray program. Similar weed control programs have been implemented at other locations as part of flood asset maintenance works (e.g. Bora Creek and Mynumai Lagoon). • RCC has completed weed biosecurity communications and engagement material for outreach activities and formed a partnership with Landcare groups within the region through a pilot program which engaged Landcare groups to complete on ground weed control.
					Control of serious aquatic weed outbreaks as they occur.	Ongoing	
Strategy 8 - Education							
8a	Estuary-wide community education and consultation program.	CZMP Implementation Committee	BaSC, LCC, RVC, DPI Crown Lands, LLS, RCC, DPI Fisheries, OEH, relevant agricultural industry bodies	Estuary-wide	Improved community understanding of issues demonstrated through follow-up survey results.	Ongoing	There has been no estuary-wide program implemented although localised programs and activities related to particular topics have been implemented e.g.: • RCC implements a range of community engagement projects across all catchments aimed at enhancing community understanding of the value of water. Activities range from information booklets, guides, films, information sheets to school education programs, cultural heritage projects, educational walking trails, landholder field days, community tree plantings, guided rainforest walks, science and ecology talks, and fun family activities. • Big Scrub Rainforest Landcare Group in partnership with RCC holds annual Big Scrub Rainforest Day delivering community education and workshops and engagement. RCC's relationship with the Big Scrub Rainforest Day was recently recognised through an 'Innovation in Special Events' award at the state-wide RH Dougherty Awards in 2019. • Litter education is undertaken by North East Waste. • LCC has implemented various community education programs (including Kadina Park healthy creek path, litter control, weed control, Wilsons River Catchment Schools Education and Restoration Project, and the resource kit for riparian landholders) • BaSC "Love it or lose it" media campaign focusses on protecting the health of the Richmond River and associated waterways. It is funded under the Health Waterways Special Rate Variation. • RCC's catchment trailer is a hands-on education tool that demonstrates how agricultural, urban and industrial activities impact water quality.
Strategy 9 - Waterway usage							
9a	Develop strategic plan for estuary usage	CZMP Implementation Committee	BaSC, LCC, RVC, NSW Maritime, DPI Crown Lands, DPI Fisheries	Estuary-wide	Strategic Plan developed by June 2015	Not commenced	A Strategic Plan addressing foreshore access, waterfront structures, ecological protection, usage conflicts and erosion has not been prepared as required by the CZMP. Waterway usage within the urban areas of Ballina and Evans Head will not be addressed in the Richmond River Estuary CMP Scoping Study. MEMA is developing a domestic structure foreshore strategy and mapping for the Richmond River.

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
Strategy 10 - Wastewater Management							
10a	Sewerage system risk assessment and prioritisation study	CZMP Implementation Committee	OEH, BaSC, LCC, RVC	Estuary-wide	Review completed by June 2014.	Incomplete	A risk assessment and prioritisation study has not been undertaken however sewerage systems are licensed under the *Protection of the Environment Operations Act 1997* and are regulated by NSW EPA through licences and potentially pollution reduction programs. • Ballina and Lennox Head STPs have been upgraded to recycled wastewater treatment plants for urban reuse. • LCC has recently upgraded the South Lismore STP. • Bangalow STP has been recently upgraded to a new membrane filtration plant producing high quality wastewater with reuse onsite.
10b	On-going on-site sewerage management inspections and improvements	BaSC, LCC, RVC	-	Estuary-wide	Council On-site Wastewater Management Strategies are fully implemented.	Ongoing	• BaSC, BySC, LCC and RVC implement on-site sewage management (OSSM) inspection programs in accordance with the *Local Government (General) Regulation 2005* when resources permit. • LCC has reviewed and updated its *Strategic Business Plan for Wastewater Services* (2015) which includes consideration of the adequacy of OSSMs. Other councils have not updated strategic plans for sewerage services. • Broadwater and North Woodburn backlog sewerage systems were constructed by RVC between 2011 and 2012, connecting these areas to the recently upgraded Woodburn/Evans Head STP which discharges outside of the study area. Other urban areas within the estuary management zones are sewered. • RVC has prepared a feasibility study for a centralised sewerage system at Rappville.
					Review of all unsewered areas completed by 2020	In progress	
Strategy 11 - Urban Runoff							
11a	Stormwater management	BaSC, LCC, RVC	OEH	Estuary-wide	Stormwater Management Plans are reviewed every 3 years.	In progress	LCC and BaSC have prepared urban stormwater management plans and actions are reviewed periodically: • LCC *Urban Stormwater Management Plan 2016-2026*: Approximately 50% of actions completed. Other actions are ongoing and the remaining are to be actioned within 5 years. • BaSC *Urban Stormwater Management Plan* (BSC, 2012) - works undertaken include: Tanamera Drain rehabilitation, North Lakes stormwater rectification, Chickiba Wetlands restoration. • RVC has not reviewed stormwater management activities within the LGA.
Strategy 12 - Cultural Heritage							
12a	Identification and recording of cultural sites available to council planners	CZMP Implementation Committee	OEH, BaSC, LCC, RVC, Aboriginal representatives/ groups	Estuary-wide	Identification and recording of sites by June 2019.	Not commenced	Cultural sites are not formally recorded as required by the CZMP action although the councils have established consultation pathways with First Nations representatives: • *RCC Reconciliation Action Plan* (RAP, RCC, 2016) to enhance workforce awareness, understanding and respect for Aboriginal and Torres Strait Islander cultures and lay foundations to increase Aboriginal and Torres Strait Islander employment and procurement in the organisation. So far there has been one trainee employed, participation in Close the Gap and NAIDIC week activities, support for Dungarimba Wandarahn a multi-sensory experience of Bunjalung language, history and story, collaboration and relationship building with Ngulingah Local Aboriginal Land Council. • LCC has developed an “Innovate” RAP for 2020-2022. It has been submitted to Reconciliation Australia for review and approval and includes actions to “*Work with the Ngulingah Local Aboriginal Land Council and Aboriginal Advisory Group to develop guiding principles for future community engagement” (LCC 2020).* • KC (outside estuary) Cultural Mapping Project identifies significant sites for planning and development control.

Strategy and action		Lead organisation	Support organisation	Management zone	KPI	Status	Progress (relevant to the scope and study area for the Richmond River Estuary CMP Scoping Study)
12b	Cultural site management plans	BaSC, LCC, RVC	OEH, Aboriginal representatives/ groups	Estuary-wide	Cultural Site Management Plans for identified sites completed as required. The number of Management Plans developed will be dependent on the outcomes of the first 3 stages of this strategy.	Not commenced	No progress.
Strategy 13 - Fishery Management							
13a	Ensure key research findings in the fishing and aquaculture sector are communicated to the public	DPI Fisheries	BaSC, LCC, RVC, RCC, SCU	Estuary-wide	Identification of personnel responsible for maintaining communication links between agencies and reviewing public discussion boards by 2013.	Not commenced	The intent of this CZMP action is to provide information to CZMP stakeholders about research activities being undertaken that are relevant to the Richmond River. While DPI Fisheries publishes information for NSW fisheries, the information relevant to the Richmond River fisheries from all agencies is not communicated to the general public and other stakeholders in a coordinated manner. • DPI Fisheries publishes research reports on its website. • The *Fisheries NSW Strategic Research Plan 2014-2018* (Department of Trade and Investment, 2014) identifies research priorities throughout NSW. • DPI Fisheries has prepared mapping and data related to fish communities and threatened species distribution. These data enable the public to consider the expected and actual fish communities and threatened species in the Richmond River at a sub-catchment and reach-based level. • MEMA provides limited information to the public on their website regarding progress of the MEMS. • Projects by the Richmond OzFish Chapter including scientific research on disease resistant oysters published on their website. • A fishway was installed at Kyogle weir (outside estuary) to provide fish passage. KC provides information on the project via their webpage including a project video.
					On-going provision on information and incorporation into public information sources (e.g. newsletters) as appropriate.	Ongoing	

Appendix B. FIRST-PASS RISK ASSESSMENT AND GAP ANALYSIS

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
Water Quality												
T1. Acid sulfate soil (ASS) runoff	Richmond River Floodplain. Highest priority ASS areas - Tuckean Swamp, Rocky Mouth Creek and Bungawalbin/ Sandy Creek.	Increased acidity of river (lower pH). Release of heavy metals (e.g. aluminium, iron, arsenic etc.). Reduced ecosystem health (e.g. fish kills, red spot disease etc.). Human health risks due to poor water quality. Stock health risks due to poor water quality. Reduced commercial aquaculture/ oyster farming viability/ value Reduced commercial fishing viability/ value. Reduced tourism value.	Remediation practices for ASS and blackwater associated with floodplain drainage has been the focus of many scientific journal articles. General management principles are summarised in various documents. Implementation of the remediation principles and prioritisation of areas in the Richmond is being undertaken in many current initiatives e.g. Harrison *et al*., (2020) Floodplain Prioritisation Study, Rayner *et al*., (2020) Tuckean Swamp Hydrologic Options Study, NPWS Reserve Plan of Management (Tuckean Nature Reserve), Keith Hall Drainage Options Study, RCC active floodgate management plans, Sugar cane industry best-practice guidelines, LEP planning constraints for new disturbance.	Major	Almost certain	High	High	High	High	Remediation strategies for ASS and blackwater generated from floodplain drainage are well known, understood and accepted. Many strategies have been implemented over the past 25 years by landowners, industry and councils. However these actions have been small scale and have not reduced the impact of acid and blackwater on the estuary. If further improvements to water quality are desired, further changes to current drainage systems are required. Information gaps exist for implementing further large-scale strategies in specific areas. These include the environmental, social and economic impacts of different strategies, detailed costing and community perspectives and interests in contributing to change. Support from landholders/ land managers and the community has not been established for further large-scale changes in priority areas. Existing studies do not currently provide the level of detail required to implement on-ground actions. Implementing some large-scale strategies in priority areas may require a strategic approach to guide potential land acquisition or compensation when current land use cannot continue. Stakeholder consultation is currently underway as part of the next phase of the Floodplain Prioritisation Study through the MEMS. There is a need to identify the currently available tools to facilitate land use change in the lowest lying backswamps including the role of land zoning in the priority management areas. OzFish is commencing the Tuckean Swamp Project Implementation Toolkit (mid- 2021) including design and costing of infrastructure changes and ongoing maintenance costs, a comprehensive values assessment, landholder incentives/change and options. NPWS is also planning to undertake a values assessment for the Tuckean Nature Reserve.	High	Additional investigation of T1 and T2 knowledge gaps is not recommended as part of Stage 2 of the Richmond River Estuary CMP. Results of the current and proposed studies (MEMS, OzFish and NPWS) are expected to be available for Stage 3 of the Richmond River Estuary CMP to enable CMP stakeholders to assess the available options for inclusion in the CMP. These include the environmental, social and economic impacts of implementing further strategies, the detailed costing of these and landowner support.
T2. Blackwater events	Lowest lying areas of Richmond River Floodplain. Highest priority areas: Bungawalbin/ Sandy Creek, Rocky Mouth Creek and Tuckean Swamp.	Extremely low (near zero) oxygen concentration in water. Reduced ecosystem health (e.g. fish kills, disease etc.). Human health risks due to poor water quality. Stock health risks due to poor water quality. Reduced commercial aquaculture/ oyster farming viability/ value. Reduced commercial fishing viability/ value. Reduced tourism value.		Major	Almost certain	High	High	High	High			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T3. Agricultural diffuse source runoff (MEMS TARA priority threat)	All	Export of sediment and associated pollutants to waterways. Increased suspended sediment in waterways (i.e. high turbidity/ 'dirty' water). Nutrient export. Eutrophication. Fertiliser/pesticide contamination. Faecal contamination. Reduced commercial aquaculture/ oyster farming viability/ value. Reduced commercial fishing viability/ value. Reduced tourism value.	MEMS/LLS programs targeting priority areas (e.g. agricultural extension, workshops, stock exclusion, riparian rehabilitation, bank stabilisation, road sealing). Other programs include LCC Rural Landholder Initiative, Casino Food Co-op Livestock Infrastructure Project, BaSC Healthy Waterways Program, RCC River Reach Plans, MEMS review of *NSW Diffuse Source Water Pollution Strategy* (DECC, 2009).	Major	Almost certain	High	High	High	High	There is no agreed catchment-wide prioritisation of areas to target works and provide a strategic approach to address agricultural diffuse runoff. The Estuary Health Risk Dataset identified sub-catchments with high sediment and nutrient runoff. Work undertaken by LLS as part of the MEMS used the dataset to develop a higher resolution catchment model (MCAS-S) assessing the risk of impact of nutrients and sediment on the marine estate. It is unclear whether this model will be available for future stages of the CMP or how it can be utilised in other prioritisation studies.	High	**S1. <u>Identification of priority diffuse pollution sources/ locations for on-ground works</u>** Utilise a high-resolution catchment model to assess the risk of impact of nutrients and sediment on the estuary and to assist in prioritising works in the CMP building on and updating previous work. Following the same approach and capitalising on the existing modelling work for this purpose would provide a detailed and consistent approach to management. Identify potential projects and partnerships for consideration in Stage 3 of the CMP. Projects/locations to be identified for potential demonstration/ showcase rehabilitation sites. <u>Links to:</u> S10: Develop an ecosystem monitoring strategy (T58). S11: Develop a database of on-ground works (T60).
T4. Urban stormwater discharges (MEMS TARA priority threat)	Wilsons River, Richmond River Main Stem, Richmond River Floodplain (particularly urban areas of Lismore, Casino, Kyogle)	Refer T3	Council urban stormwater management plans (not fully implemented), DCPs	Mod	Almost certain	Mod	Mod	Mod	Mod	Urban stormwater impact and relative contribution of pollution compared to other catchment sources is unknown. The effectiveness of stormwater management actions has not been assessed. WSUD improvements have not been developed/ implemented.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58). **S2. <u>Development/review of urban stormwater management strategies</u>** Review and update existing urban stormwater management plans and identify water quality improvement strategies.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T5. Treated sewage effluent (MEMS TARA priority threat)	Urban areas with centralised sewage systems Wilsons River, Richmond River Main Stem, Richmond River Floodplain	Nutrient export. Eutrophication. Faecal contamination.	Licensed discharges regulated by EPA. Monitoring and reporting undertaken in accordance with licence. Breaches of licence conditions are addressed by licence holders in accordance with EPA directions.	Major	Possible	Mod	Mod	Mod	Mod	Current level of impact of treated effluent on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).
T6. Septic runoff (e.g. failing septic systems) (MEMS TARA priority threat)	All non-urban areas	Nutrient export. Eutrophication. Faecal contamination.	On-site Sewage Management Strategies implemented by local councils. Feasibility studies for sewering villages (e.g. Wiangaree).	Mod	Likely	Mod	Low	Low	Low	Current level of impact of on-site sewerage systems on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).
T7. Sediment runoff from land clearing, construction/ development sites	All	Export of sediment to waterways. Increased suspended sediment in waterways (i.e. high turbidity/ 'dirty' water).	DA conditions, erosion and sediment control requirements in DCP. MEMS construction sediment project aims to reduce run-off from construction sites into NSW waterways.	Mod	Likely	Mod	Mod	Mod	Mod	Current level of impact on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58). MEMS construction sediment project is expected to provide guidance on standard planning conditions for controlling run-off.
T8. Sediment runoff from unsealed roads	All	Export of sediment to waterways. Increased suspended sediment in waterways (i.e. high turbidity/ 'dirty' water).	MEMS/LLS programs targeting priority areas (e.g. road sealing). Council road sealing programs (although generally prioritised for safety rather than environmental reasons).	Mod	Likely	Mod	Mod	Mod	Mod	Current level of impact on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58). <u>Links to:</u> S1. Identification of priority diffuse pollution sources/ locations for on-ground works.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T9. Other licensed industrial sources (e.g. quarries, food processing etc.)	All – various locations	Export of pollutants to waterways (e.g. nutrients, harmful chemicals, pathogens, organics etc.).	Licensed discharges regulated by EPA. Monitoring and reporting undertaken in accordance with licence. Breaches of licence conditions are addressed by licence holders in accordance with EPA directions.	Major	Likely	High	High	High	High	Current level of impact of industrial point source pollution on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58). **S3. <u>Identification of priority point source pollution sources/ locations for on-ground works</u>** Identify potential projects and partnerships for consideration in Stage 3 of the CMP.
T10. Contaminated land (e.g. landfills, petrol stations etc.)	Wilsons River, Richmond River Main Stem, Richmond River Floodplain, Bungawalbin, Myrtle and Sandy Creek, Emigrant and Maguires Creek	Export of pollutants to waterways (e.g. harmful chemicals, hydrocarbons, nutrients, organics etc.).	EPA register of contaminated land, regulated under the *Contaminated Land Management Act 1997.*	Major	Possible	Mod	Mod	Mod	Mod	Current level of impact on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).
T11. Cattle dip sites	All – various locations	Export of pollutants to waterways (e.g. pesticides).	Managed by the DPI (dip decommission team). High risk sites being addressed.	Mod	Possible	Low	Low	Low	Low	Some local studies indicate that most dip sites are located on heavier textured soils that adsorb chemicals and pose negligible risk to waterways. Dip sites on sandy textured soils pose a greater risk to waterways. Previous studies have not comprehensively assessed all potential contaminants.	Low	Water quality monitoring design to consider assessment of current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T12. Pesticide and herbicide pollution	All – particularly for cropping areas with high pesticide use near waterways.	Export of pollutants to waterways (e.g. pesticides and herbicides).	Chemicals regulated by EPA and NSW government under *Pesticides Act 1999.* Monitoring undertaken in RCC drinking water catchments in accordance with ADWG. Comprehensive assessment of pesticide residue in RCC drinking water catchments (e.g. Emigrant Creek, Wilsons River) raw water undertaken in 2009/2010. DPE Ecotox/ SCU has done some preliminary work in the Richmond using passive sampler program to detect pesticides.	Major	Possible	Mod	Mod	Mod	Mod	The level of current pesticide and herbicide pollution and impacts throughout the catchment waterways is unknown. DPE - E&H Stage 3 MEMS bid for passive sampler program to assess pesticide/ herbicide prevalence in catchment.	Mod	Pesticide/herbicide monitoring strategy to establish a catchment-wide baseline and ongoing monitoring to track changes over time to be undertaken as part of MEMS or S10: Develop an ecosystem monitoring strategy (T58). This should also include the intensive catchment pesticide program in drinking water catchments as recommended in the RCC Catchment Management Plan.
T13. Potentially toxic cyanobacteria blooms	Freshwater tidal pool of Richmond River between Woodburn and Lismore. Richmond River near Casino.	Death of livestock, domestic animals and wildlife (including fish kills). Harmful human health effects (recreational use and/or drinking water exposure). Algae scums. Bad odours.	Some monitoring undertaken by councils and NSW Health during outbreaks.	Major	Almost certain	High	High	High	High	Current level of impact on receiving environments and current contribution compared to other sources is unknown.	Mod	Water quality monitoring to assess current impacts and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T14. Bushfire	All – particularly bushland areas	Increased erosion risk. Increased nutrient and sediment load to waterways. Related social and economic factors.	Emergency response RFS, NPWS fire management plans, planning controls. Some research is available on water quality impacts post-bushfire.	Catastrophic	Likely	High	High	High	High	Existing knowledge is considered adequate for future management.	-	-
T15. Chemical/ fuel spills	All – particularly road crossings	Export of pollutants to waterways (e.g. hazardous chemicals, hydrocarbons etc.).	HAZMAT clean-up by first responders (e.g. RFS), EPA monitoring and assessment/ reporting.	Major	Possible	Mod	Mod	Mod	Mod	Existing knowledge is considered adequate for future management.	-	-
T16. Litter, solid waste and microplastics (MEMS TARA priority threat)	All	Visual pollution Harm to wildlife through ingestion, choking, suffocating etc. Habitat structure modifications. Leaching of toxic chemicals (e.g. from breakdown of plastics).	*Protection of the Environment Operations Act 1997* regulates littering in NSW. Education programs include EPA's Litter Prevention Program, container deposit scheme, rubbish bins, community clean up days (e.g. annual clean up Australia day), public education campaigns (e.g. Don't be a tosser!). NE Waste conducts local education programs.	Mod	Likely	Mod	Mod	Mod	Mod	Documented occurrence/scale of litter and microplastics issues in the Richmond River catchment.	Low	**S4. <u>Investigate scale of litter and microplastics issues</u>** The EPA Litter Prevention Kit and Local Litter Check provide tools to carry out assessments.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
Hydrology, connectivity and water extraction												
T17. Modified freshwater flows (MEMS TARA priority threat)	All areas (weirs, dams, water extraction etc.)	Water quality impacts (reduced flushing). Altered flow-dependent cues for fish migration affecting breeding etc. Increased sedimentation. Aquatic habitat degradation.	Management of water extraction is addressed in the Richmond River Water Sharing Plan (RRWSP) administered by NRAR and DPE - Water. Regional Water Strategy being developed by DPE includes options for waterway health improvements. Council IWCM Strategies being developed to address town water supply requirements.	Major	Almost certain	High	High	High	High	RRWSP was published in 2016 and requires update with current catchment/streamflow and usage information (review planned for 2021/22). Limited monitoring of water licensing compliance. Landholders can now capture and store up to 30% of the average annual regional rainfall from their landholding as harvestable rights water, up from 10% previously. Impacts on stream flows from these amendments to coastal harvestable rights in coastal draining catchments have not been assessed.	Mod	CMP to include consultation with agencies responsible for managing extraction regarding progress and implications for waterway health.
T18. Hydrological modification of wetlands and floodplain drainage works (MEMS TARA priority threat)	Richmond River Floodplain, including Tuckean Swamp, Rocky Mouth Creek and Bungawalbin/ Sandy Creek	Acid sulfate soil impacts (refer T1) Blackwater impacts (refer T2) Aquatic habitat modification and degradation.	RCC drainage and floodgate management plans. Industry best-practice management guidelines. Keith Hall Drainage Options Study (RCC). Planning controls for new developments and ASS management.	Major	Almost certain	High	High	High	High	Refer T1. Acid sulfate soil (ASS) runoff and T2. Blackwater events.	High	Additional investigation of T18 and T19 knowledge gaps is not recommended as part of Stage 2 of the Richmond River Estuary CMP. CMP Stage 3 to consider the application of options to site specific locations (relevant to all land owners/managers across the floodplain) with reference to outcomes of the MEMS prioritisation study and local projects such as the Keith Hall study. This may include the identification of any further studies required to manage the natural resource management impacts associated with flood mitigation activities (e.g. detailed survey, hydrological options studies).
T19. Floodgate design, operation and maintenance	Richmond River Floodplain, including Tuckean Swamp, Rocky Mouth Creek and Bungawalbin/ Sandy Creek			Major	Likely	High	High	High	High			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
Riparian Condition												
T20. Clearing of riparian and adjacent habitat (MEMS TARA priority threat)	All	Loss of or reduced value of riparian and estuarine vegetation and habitat. Reduced buffering capacity of riparian land to protect water quality. Bank instability. Siltation. Reduced amenity. Reduced tourism value.	Various riparian revegetation/ rehabilitation programs at some locations by agencies, community and industry groups.	Major	Almost certain	High	High	High	High	Lack of comprehensive, up to date riparian condition assessment and rehabilitation prioritisation study for the entire catchment. Lack of reporting of riparian restoration projects and monitoring of improvements. Work undertaken by LLS as part of the MEMS used the risk-based framework dataset to develop a higher resolution catchment model (MCAS-S) to prioritise riparian restoration works. It is unclear whether this model will be available for future stages of the CMP or how it can be utilised in other prioritisation studies for future stages of the CMP. Other prioritisation projects in the catchment include GIS-based *Riparian Prioritisation and Education Project* for estuarine reaches (Landmark, 2014) and Hobbs (2017) prioritisation work expanding the Landmark (2014) approach to whole catchment.	High	**S5. <u>Identification of priority riparian restoration projects/ locations of on-ground works</u>** Utilise a high-resolution catchment model (such as MCAS-S) to assess the risk of impact of riparian condition on the estuary and to assist in prioritising works in the CMP building on and updating previous work. Following the same approach and capitalising on the existing modelling work for this purpose would provide a detailed and consistent approach to management. Detailed and current data are required to provide meaningful modelling outcomes. Identify potential projects and partnerships for consideration in Stage 3 of the CMP. Projects/locations to be identified for potential demonstration/ showcase rehabilitation sites. <u>Links to:</u> • S1: Identification of priority diffuse pollution sources/ locations for on-ground works (T3). • S6: Bank management strategy (T24 – T28). • S10: Develop an ecosystem monitoring strategy (T58). • S11: Develop a database of on-ground works (T60).
T21. Lack of suitable buffer zones between land use and waterways	All		LEPs and DCP planning controls in some areas. NRAR policy and guidelines and related legislation. State Forestry protocols.	Major	Almost certain	High	High	High	High			
T22. Dominance of invasive weeds	All		Riparian revegetation/ rehabilitation programs underway at some locations. RCC management of priority weeds.	Major	Almost certain	High	High	High	High			
T23. Uncontrolled stock access to and grazing within the riparian zone	All		Stock exclusion (fencing and watering) at some locations.	Major	Almost certain	High	High	High	High			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
Coastal hazards – bank erosion (MEMS TARA priority threat)												
T24. Catchment flooding	All	Bank and bed instability. Loss of land. Erosion to and loss of riparian and estuarine vegetation and habitat. Siltation. Degraded water quality. Navigation hazards. Aquaculture/ oyster degradation. Reduced amenity. Reduced tourism value. Council liability and legality issues.	Flood studies and floodplain management plans. Some bank management works. Boating speed limits and Maritime NSW regulation. Riparian revegetation/ rehabilitation programs at some locations. Stock exclusion (fencing and watering) at some locations.	Major	Almost certain	High	High	High	High	Lack of comprehensive, up to date bank stability and riparian condition mapping including for previous unmapped areas of the catchment. Lack of robust, repeatable, evidence-based approach to selection of best practice management bank treatments. Ryder *et al.* (2015) included an assessment of geomorphic condition (bank and bed condition) at selected sites throughout the catchment (Ecohealth). Bank erosion study undertaken for Evans River in 2012. A bank management decision support tool (DST) prototype and accompanying bank assessment methodology is currently being developed by DPI Fisheries under the MEMS. LLS prioritisation of bank stabilisation and riparian rehabilitation works under the MEMS (refer T20 – T23).	High	**S6. <u>Bank management strategy</u>** Develop a catchment-wide Bank Management Strategy (BMS) considering data and guidance from MEMS work underway and any tool/ guidance included. Identify potential projects for consideration in Stage 3 of the CMP. Projects/locations to be identified for potential demonstration/ showcase rehabilitation sites. <u>Links to:</u> • S10: Develop an ecosystem monitoring strategy (T58). • S1: Identification of priority diffuse pollution sources/ locations for on-ground works (T3). • S5: Identification of priority riparian restoration projects/ locations of on-ground works (T20 – T23). • S11: Develop a database of on-ground works (T60).
T25. Powered vessels and towing	All navigable waterways			Minor	Likely	Low	Low	Mod	Mod			
T26. Wind waves	All			Minor	Almost certain	Low	Low	Low	Low			
T27. Historic clearing of riparian vegetation and adjacent habitat (MEMS TARA priority threat)	All			Major	Almost certain	High	High	High	High			
T28. Stock grazing of riparian and marine vegetation (MEMS TARA priority threat)	All			Major	Almost certain	High	High	High	High			
T29. Gully erosion and bed lowering	All - particularly in areas of highly dispersible soils and steep erodible country (e.g. north and north-west portion of catchment)			Mod	Almost certain	Mod	Mod	Mod	Mod			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
Coastal hazards – tidal inundation and sea level rise												
T30. Tidal inundation	Tidal extent – Richmond River Floodplain, Tuckean Swamp, Emigrant and Maguires Creek, Bungawalbin, Myrtle and Sandy Creek	Degradation or loss of assets and infrastructure. Unsafe or loss of access to waterways. Increased frequency of flooding and inundation. Loss of riparian vegetation. Migration of estuarine and riparian vegetation communities. Loss of amenity. Public safety risks. Reduced tourism value. Damage to cultural heritage sites. Council liability and legality issues. Changing tidal velocities. Storm tide inundation. Changed geomorphology (shoaling, bank instability and erosion). Migration of estuarine vegetation communities. Compromised assets (e.g. stormwater, sewerage, roads, floodgates). Related social and economic factors.	Floodplain infrastructure (e.g. floodgates, levees etc.) prevent tidal ingress in some areas of the floodplain.	Mod	Almost certain	Mod	Mod	High	High	Coarse assessment available from Coastal Risk Australia and OEH (2018c). However, a higher level of understanding/detail of local tidal inundation extent and frequency with climate change, and the associated risk is required.	High	Tidal inundation modelling/ assessment to be considered as part of Stage 2 for the Ballina Coastline CMP and future CMP development for Evans Head coastline. Detailed tidal inundation assessment of the estuary for a variety of future sea level rise scenarios, with a risk assessment to estuary assets and infrastructure is required. Stage 3 Richmond River Estuary CMP to determine impact on assets and management options with reference to other related studies on floodplain management.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T31. Anthropogenic barriers (i.e. physical barriers, land use and planning constraints) to migration of vegetation communities (e.g. mangrove, saltmarsh) with sea level rise	Tidal extent – Richmond River Floodplain, Tuckean Swamp, Emigrant and Maguires Creek, Bungawalbin, Myrtle and Sandy Creek	Loss of marine vegetation.	MEMS state-wide *Marine Vegetation Management Strategy* currently under development	Minor	Likely	Low	Mod	High	High	Locations and extent of barriers to estuarine vegetation migration with sea level rise have not been assessed. The MEMS state-wide *Marine Vegetation Management Strategy* currently under development – assessment and mapping will address knowledge gaps once available.	-	MEMA state-wide *Marine Vegetation Management Strategy* currently under development is expected to guide estuary management planning. To be considered as part of Stage 2 for the Ballina Coastline CMP and future CMP development for Evans Head coastline.
T32. Increased salinity in the upper estuary		Habitat changes and decline in potable/ stock water quality.	Floodplain infrastructure (e.g. floodgates, levees etc.) prevent tidal ingress in some areas of the floodplain.	Mod	Possible	Low	Mod	High	High	RCC has undertaken preliminary investigations into saline intrusion to tidal pool/ Wilsons River Source. Floodplain prioritisation study (T1 and T2) considered sea level rise impacts.	-	Additional investigation of management options as part of the Richmond River Estuary CMP is not recommended.
Climate change (MEMS TARA priority threat)												
T33. Average warming and extreme temperatures	All	Increased flooding risk. More severe droughts. Increased number of hot days and higher rates of evaporation. Reduced stream flows. Increased bushfire risk. Loss of biodiversity (particularly coastal floodplains, wetlands, saltmarsh and mangroves). Increased water temperatures. Increased acidification of estuaries. Enhanced mobilisation of acidity and metals.	Some council climate adaptation programs.	Mod	Almost certain	Mod	Mod	High	High	Comprehensive CSIRO/ BOM climate projections and climate change research studies are available.	-	No additional studies recommended as part of the CMP. CMP to consider outcomes of studies/data to guide management planning.
T34. Increase in extreme weather events (e.g. prolonged dry periods and increased frequency and magnitude of storms/ flood events.				Catastrophic	Almost certain	High	High	High	High			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T35. Increase in mosquito-borne diseases	All	Human health impacts due to increased incidence of mosquito-borne diseases associated with increased temperatures, sea level rise and extreme rainfall events.	NSW Health conducts surveillance of mosquito populations and disease transmission and provides information and advice.	Major	Possible	Mod	Mod	High	High	-	-	-
Cultural heritage – Inadequate social and economic information (MEMS TARA priority threat)												
T36. Lack of recognition of cultural values and connection to Country and specifically to water.	All	Loss of or damage to items of heritage significance or cultural heritage values. Lack of protection of Aboriginal/Native Title rights.	Native Title determinations and Indigenous Land Use Agreements (ILUA) over various parts of the study area. Some council Aboriginal engagement activities. Consultation with local groups, organisations and land managers in developing the CMP. RCC and LCC Reconciliation Action Plans and Memorandum of Understanding between Arakwal and Byron Shire Council.	Major	Possible	Mod	Mod	Mod	Mod	Limited public information/ understanding about Richmond River cultural values/ stories. Lack of knowledge of traditional management practices.	High	**S7. <u>Cultural recognition/ awareness project(s) communicating cultural values of the river and connection to Country</u>** Development of all CMP projects in collaboration with Aboriginal groups to increase involvement in waterway management and increase understanding of cultural values and traditional management practices. Continue and enhance targeted consultation with Aboriginal community and land managers at all stages of the CMP. Identify Aboriginal groups and organisations with capacity and interest to be involved in CMP actions. <u>Links to:</u> • S10: Develop an ecosystem monitoring strategy (T58). • S8: Cultural mapping (T39).
T37. Inadequate consultation with Aboriginal land managers				Major	Possible	Mod	Mod	Mod	Mod			
T38. Lack of involvement of First Nations people in decision making and river management				Major	Possible	Mod	Mod	Mod	Mod			
T39. Damage to cultural heritage items/ sites	All – various locations		Cultural heritage assessment as part of approval processes, AHIMS, Heritage NSW, cultural mapping projects in some LGAs.	Major	Likely	High	High	High	High	Location and nature of cultural heritage items/ sites in the catchment.	Mod	**S8. <u>Cultural mapping</u>** Review, consolidate and update cultural mapping projects across the catchment to locate and conserve sites and items and provide input into planning and development controls.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
Biodiversity												
T40. Clearing of riparian and adjacent habitat (MEMS TARA priority threat)	All	Refer T20 – T23	Refer T20 – T23	Major	Almost certain	High	High	High	High	Refer T20 – T23	Mod	S5: Identification of priority riparian restoration projects/ locations of on-ground works.
T41. Invasion by exotic plants (MEMS TARA priority threat)	All	Loss of biodiversity. Displacement of native species. Alteration of native habitats. Reduced recruitment of native riparian vegetation. Reduced habitat availability. Water quality impacts. Reduced amenity. Related social and economic factors.	Managed by various agencies and local government under *Biosecurity Act 2015*, NSW Weeds Action Program, *National Parks and Wildlife Act 1974*, state and local biodiversity strategies and management plans. Community groups such as Landcare and Bushcare undertake weed management throughout the catchment. The *NSW Biosecurity Strategy 2013-2021* includes broad scale monitoring of pests, diseases and weeds.	Major	Almost certain	High	High	High	High	There is no catchment-wide documented occurrence/scale of invasion by exotic plants in the Richmond River catchment.	Low	The *NSW Biosecurity Strategy 2013-2021* is expected to guide weed management in the region. Links to: S5: Identification of priority riparian restoration projects/ locations of on-ground works.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T42. Invasion by feral animals/pest species	All	Loss of biodiversity. Displacement/predation of native species and livestock. Alteration/degradation of native habitats. Damage fences and other infrastructure. Water quality impacts (e.g. carp). Reduced amenity. Related social and economic factors.	Managed by various agencies and local government under *Biosecurity Act 2015*, *North Coast Regional Strategic Pest Animal Management Plan 2018-2023*, *National Parks and Wildlife Act 1974*, state and local biodiversity strategies.	Mod	Almost certain	Mod	Mod	Mod	Mod	Documented occurrence/scale of invasion by feral animals/pest species in the Richmond River catchment.	Low	Existing regulation and strategies are expected to guide pest management in the region. No additional studies recommended as part of the CMP.
T43. Aquatic weeds	All – known hotspot areas include Tuckean Swamp, Swan Bay.	Water quality impacts (e.g. reduced dissolved oxygen). Degradation of aquatic habitats. Loss of biodiversity. Displacement of native species. Alteration of native habitats. Reduced amenity. Related social and economic factors.	Managed by various agencies and local government under *Biosecurity Act 2015*, NSW Weeds Action Program, *National Parks and Wildlife Act 1974*, state and local biodiversity strategies and management plans. Community groups such as Landcare and Bushcare undertake weed management throughout the catchment.	Mod	Almost certain	Mod	Mod	Mod	Mod	Documented occurrence/scale of invasion by aquatic weeds in the Richmond River catchment.	Low	Links to: S5: Identification of priority riparian restoration projects/ locations of on-ground works.
T44. Foreshore development and land clearing (MEMS TARA priority threat)	All – particularly urban areas	Water quality impacts. Degradation of aquatic habitats. Loss of biodiversity. Reduced amenity. Related social and economic factors.	Vegetation management policies and legislation, development controls, land use planning	Mod	Almost certain	Mod	Mod	High	High	Refer T20 – T23	Mod	Links to: S5: Identification of priority riparian restoration projects/ locations of on-ground works.

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T45. Marine vegetation damage (e.g. mangroves, saltmarsh, seagrass)	Tidal extent	Loss and/or degradation of aquatic habitats/ protected marine vegetation. Loss of biodiversity. Reduced fish stocks.	DPI Fisheries policy and guidelines	Mod	Likely	Mod	Mod	Mod	Mod	Extent of marine vegetation and priority threats have not been identified. MEMS private foreshore structures strategy will help deliver access to waterways while also protecting the public foreshore and sensitive environmental areas. MEMS marine vegetation strategies will identify current and future threats to mangroves and saltmarshes in the Richmond estuary and identify priority areas for the protection of healthy mangrove and saltmarsh areas and rehabilitation of degraded areas.	Mod	MEMS projects currently under development are expected to guide estuary management planning. To be considered as part of Stage 2 for the Ballina Coastline CMP and future CMP development for Evans Head coastline.
T46. Barriers to fish passage	All – various locations	Interrupting spawning or seasonal migrations. Restricting access to preferred habitat and food resources. Increasing the chance of predation and disease. Reduced fish stocks.	DPI Fisheries policy and guidelines. DPI Fisheries projects (e.g. weir removal). Some fishway improvements as part of water supply projects (e.g. Kyogle)	Mod	Likely	Mod	Mod	Mod	Mod	Existing knowledge is considered adequate for future management.	-	-
T47. Bushfire	All – particularly bushland areas	Fauna mortality. Reduced vegetation cover. Displacement of native species. Alteration of fauna habitats. Increased erosion risk. Increased nutrient and sediment load to waterways. Water quality impacts. Related social and economic factors.	NPWS fire management plans	Catastrophic	Likely	High	High	High	High	Existing knowledge is considered adequate for future management.	-	-

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T48. Forestry activities	Forestry operational areas and private native forestry	Loss of biodiversity Reduced vegetation cover. Displacement of native species. Alteration of fauna habitats. Increased erosion risk. Increased nutrient and sediment load to waterways. Water quality impacts.	Forestry Commission NSW operations approval, Private Native Forestry agreements	Moderate	Likely	Mod	Mod	Mod	Mod	Existing knowledge is considered adequate for future management.	-	Water quality monitoring to assess risks to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).
T49. Commercial fishing (estuary general) – e.g. eels, mud crabs (MEMS TARA priority threat)	Mainly lower and mid estuary, Richmond River Floodplain.	Reduced fish stocks. Loss and/or degradation of aquatic habitats/ protected marine vegetation.	Commercial rules and regulations including fishing closures under the *Fisheries Management (General) Regulation 2019*	Minor	Possible	Min	Min	Min	Min	MEMS Initiative 6: Sustainable fishing and aquaculture includes a number of research programs to allow for effective management.	Low	MEMS projects currently under development are expected to guide management planning. No additional studies recommended as part of the CMP.
T50. Recreational fishing – shore-based and boat – based line and trap fishing, hand gathering (MEMS TARA priority threats)	All – particularly lower estuary	Reduced fish stocks Loss and/or degradation of aquatic habitats/ protected marine vegetation. Fishing waste/ litter (e.g. fishing line, hooks, traps, nets sinkers etc.) posing threat to wildlife.	Recreational fishing rules and regulations including fishing closures under the *Fisheries Management (General) Regulation 2019.* Recreational fishing surveys carried out by DPI Fisheries to inform adaptive management. Recreational Fishing Management Strategy and Environmental Assessment undertaken by DPI Fisheries.	Minor	Possible	Min	Min	Min	Min			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T51. Insufficient public land available to establish stewardship sites to offset loss of native vegetation through land development	All	Net loss of biodiversity from the region.	*Biodiversity Conservation Act 2016* and the *State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017.* Biodiversity Offset Scheme.	Major	Likely	High	High	High	High	Impacts of biodiversity legislation reforms have been identified including potential stewardship sites. Existing knowledge is considered adequate for future management.	-	On-ground options to consider opportunities for establishment of stewardship sites. No additional studies recommended as part of the CMP.
Public use and access												
T52. Pathogens present in water affecting human health (primary contact recreation and drinking water supplies)	All – particularly high recreational use areas.	Human health impacts.	Monitoring of pathogens in RCC drinking water catchments. Beachwatch program in lower estuary only (outside study area).	Major	Possible	Mod	Mod	Mod	Mod	Level of human health risk is unknown for many areas.	Mod	Water quality monitoring to assess risks to human health and to track changes over time as part of S10: Develop an ecosystem monitoring strategy (T58).

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T53. Limited or lack of access infrastructure / recreational facilities (MEMS TARA priority threat)	All	Restricted public access. Construction of unauthorised access points. Erosion. Public safety risks. Reduced amenity. Reduced tourism value.	Boating Now program. Some foreshore reserve upgrades by Councils.	Minor	Unlikely	Min	Min	Low	Low	While there is a good understanding of access needs and requirements in the lower estuary in Ballina and Evans Head (outside study area), there is a lack of understanding of recreational access and infrastructure needs in other parts of the study area. MEMS private foreshore structures strategy will help deliver access to waterways while also protecting the public foreshore and sensitive environmental areas.	Mod	**S9. <u>Identify options for improved recreational access to waterways</u>** Review and assess recreational/access needs and requirements addressing foreshore access, waterfront structures, ecological protection, usage conflicts and erosion. Identify potential projects for consideration in Stage 3 of the CMP. Community engagement is considered a key part of all CMP stages. To be integrated with Aboriginal cultural heritage programs.
T54. Conflicting uses of waterways	All – particularly lower estuary	Conflict between different waterway uses (e.g. active and passive boating), residents and land managers. Reduced amenity. Reduced tourism value. Noise disturbance.	Boating speed limits/ regulations enforced by Transport for NSW Maritime.	Mod	Possible	Low	Low	Low	Mod			
T55. Loss of public access (by private development or government area closures) (MEMS TARA priority threat)	All	Restricted public access. Construction of unauthorised access points. Erosion. Public safety risks. Reduced amenity. Reduced tourism value.	Public reserves along foreshore.	Minor	Possible	Min	Min	Min	Min			
T56. Insufficient, or inappropriate public education and signage (e.g. outdated or non-existent)	All	Reduced awareness and compliance with regulations. Public safety risks. Reduced amenity.	Education signage at some locations. Council education campaigns.	Minor	Possible	Min	Min	Min	Min			
T57. Shoaling or siltation affecting navigation	All	Public safety risks. Reduced amenity.	none	Minor	Possible	Min	Min	Min	Min			

Threat	Sub-catchment/ location	Potential impacts	Current management approach	Present day risk			Future Risk			Assessment of Knowledge Gaps		Recommendation for CMP Stage 2 studies
				Consequence	Likelihood	Current Risk	20-year	50-year	100-year	Knowledge gap	Priority	
T58. Anti-social behaviour and unsafe practices (MEMS TARA priority threat)	All	Public safety risks. Reduced amenity. Noise disturbance. User conflict.	Transport for NSW Maritime, NSW Police	Minor	Possible	Min	Min	Low	Low			