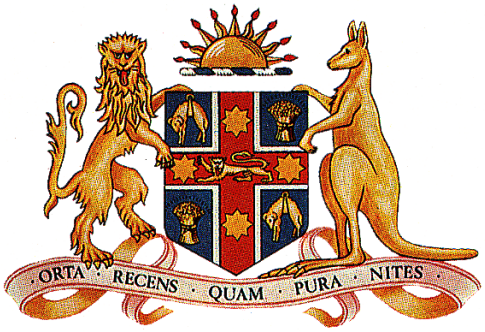

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COUNCIL NOTICES

COFFS HARBOUR CITY COUNCIL

Coastal Protection Act 1979, Section 55H

Gazettal and Commencement of a Coastal Zone Management Plan

COFFS HARBOUR CITY COUNCIL with the certification of the Minister for the Environment, have prepared and adopted the Darkum Creek Estuary Coastal Zone Management Plan in accordance with Section 55 of the *Coastal Protection Act 1979*.

The Plan is a strategic and long term plan developed to provide guidance for achieving a sustainable estuary in the future, giving balanced consideration to environmental, social and economic demands on the estuarine system and its catchment area.

The Plan will remain in force until such time as it is amended or repealed by a coastal management program that replaces it.

The Plan may be viewed on Coffs Harbour City Council's website at www.coffsharbour.nsw.gov.au For more information, call 02 6648 4000.

Steve McGrath
General Manager
Coffs Harbour City Council
Locked Bag 155, Coffs Harbour NSW 2450

Darkum Creek Estuary Coastal Zone Management Plan

COFFS HARBOUR CITY COUNCIL

Coffs Harbour City Council has prepared this document with financial assistance from the NSW Government through the Office of Environment and Heritage. This document does not necessarily represent the opinions of the NSW Government or the Office of Environment and Heritage.

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Coastal Zone Management Plan

Darkum Creek Estuary

Prepared for: Coffs Harbour City Council and
NSW Office of Environment and Heritage

Amended June 2018 for Certification

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UPR	*Description*	*Date Issued*	*Issued By*	*Reviewed By*
1616691	Initial Draft	16/04/2012	Tim Ruge	Cate Walsh
1616107	Final Draft	06/07/2012	Tim Ruge	Cate Walsh
1616615	Draft for Public Exhibition	15/08/2012	Tim Ruge	Cate Walsh
1616-1005	Final Report	31/01/2013	Tim Ruge	Kim Casson

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Executive Summary

This Coastal Zone Management Plan (CZMP) describes proposed actions to be implemented by Coffs Harbour City Council, other public authorities and the private sector to address priority management issues for the Darkum Creek estuary. The area addressed by this CZMP comprises the Darkum Creek waterway and tributaries, foreshores and the catchment draining to the estuary up to the tidal limit of the creek and its tributaries. The CZMP also considers issues associated with the wider catchment upstream of the tidal limit.

Darkum Creek is a relatively small and remote coastal estuary and is part of the Solitary Islands Marine Park. Darkum Creek is an Intermittently Closed and Open Lakes and Lagoon (ICOLL) meaning the entrance naturally alternates between being open or closed to the ocean. The entrance is predominantly closed. There are no records of artificial opening of the entrance being undertaken in the past. Community consultation has not indicated any desire for artificial opening of the creek entrance and there is currently no significant need for artificial opening for the purpose of flood mitigation.

Sea level rise and increased storm events caused by climate change may result in higher flood inundation levels within the estuary in the future which may require mechanical intervention of the ICOLL opening regime. This CZMP incorporates an action to develop a formal entrance management strategy to deal with these potential future impacts.

There is significant water-based activity with kayaking, canoeing and fishing in the creek. The Woolgoolga Returned Services Golf Course adjoins a large section of Darkum Creek. The primary land-based recreational activity aside from golf is generated by the coastal walk which is facilitated by the pedestrian footbridge across the creek. The bridge enables a continuous pedestrian and cycle route which follows the coastline and connects the residential communities of Arrawarra in the north to Woolgoolga in the south. The walk offers an easy, convenient and safe pedestrian corridor through a generally undisturbed and attractive natural coastal setting.

The total catchment area of Darkum Creek is relatively small and comprises State Forest, banana plantations and blueberry farms in the upper limits of the catchment, large areas of cleared agricultural land in the mid-catchment. The Woolgoolga Returned Services Golf Course comprises a large portion of the estuary catchment. The Safety Beach residential area is situated in the southern portion of the estuary catchment. The eastern fringe of the estuary catchment is located in the Coffs Coast Regional Park.

Identification of key estuary management issues and development of management strategies has been undertaken based on technical studies and consultation with the community and key stakeholder organisations. Consultation has included community workshops in 2010 and 2011, a community survey in 2011.

Estuary Management Issues

The key estuary management issues for the estuary relate to:

- management of sediment, nutrient and other pollutant inputs from the catchment;
- protecting the native riparian vegetation from threats such as uncontrolled access and environmental weeds which reduce the ecological value and potentially impact upon bank stability, recreational amenity and aesthetics;
- climate change impacts (particularly sea level rise and consequent lake water level increases) on the estuarine ecology and water quality;
- preserving the natural values of the estuary and maintaining low key recreational activities such as kayaking, fishing, and bush walking with a minimal level of support and infrastructure; and
- increased flooding risks to properties and infrastructure caused by sea level rise.

Estuary Management Strategies

A range of potential management strategies have been developed, prioritised and detailed to address the key issues. These strategies are summarised in the following Implementation Schedule. The key management strategies include:

- continue educational and incentive schemes that address the management of soil resources and pesticide / herbicide / fertiliser use in agricultural activities, encourage establishment of vegetated riparian zones on farm watercourses;
- ensuring grounds management practices at Woolgoolga Returned Services Golf Course are complementary with the creeks natural values. This may involve formalising a defined edge between the fairways and the creek foreshores if necessary to reduce mowing/maintenance impacts on the riparian buffer;
- control significant land modification activities on rural lands by enforcing development consent where required under Council's Local Environmental Plan to enforce erosion and sediment controls for significant earthworks;
- a weed management strategy which targets priority environmental weeds in high value riparian areas;
- raising awareness in the local community of the importance of native riparian vegetation and aquatic habitats along the banks and foreshore of Darkum Creek;
- raising awareness in the local and wider community of the importance of the protection and promotion of the cultural heritage values of the estuary;
- maintain the existing minimum level of access and recreational activity to preserve the natural values of the creek environment by providing simple additional infrastructure where necessary to support and enhance existing low levels of passive recreational activity. Undertake restoration works on an as-needs basis to sustain the significant and dominant natural values of the estuary environment; and
- incorporate discrete interpretive signage to enhance visitor appreciation and enjoyment of the site's natural values.
- implement development control provisions to facilitate upslope migration of mangroves and saltmarsh in response to sea level rise;
- continuing the Ecohealth monitoring program for Darkum Creek; and
- implementing a formal Entrance Management Policy for Darkum Creek with the aim to minimise interference with the natural opening and closing processes of the creek entrance whilst mitigating the impacts of future sea level rise induced flooding of properties and infrastructure.

Review and Reporting

This document will be reviewed every 5-10 years to ensure its effectiveness and consistency with State Government policy. A comprehensive review will be required prior to 31 December 2021 to transition this CZMP into a Coastal Management Plan in order to retain its certification status under the Coastal Management Act 2016. Implementation of the strategies and the associated tasks will be coordinated by Council staff and monitored by the Coast and Estuary Management Advisory Committee (CEMAC) throughout the duration of the CZMP. During the revision phase of this document, any substantial changes to the Plan and strategies will be reported to Council, CEMAC, and State government and appropriate agencies to ensure that all relevant stakeholders are informed.

Throughout the revision process all relevant information will be made available to the community via the Council website and will be open for community feedback as a means of community reporting.

Implementation Schedule

The proposed management strategy actions are detailed in the following Implementation Schedule. Included in the schedule is:

- the lead agency responsible for executing the strategy action (other relevant support agencies are included in the strategy action details in the main body of the CZMP);
- the timeframe for implementing the strategy action. The year relates to the time following adoption of this CZMP eg. "Years 2 – 5" indicates the strategy action should be implemented within 2 to 5 years of

certification of the CZMP (refer to strategy action details in the main body of the CZMP with respect to monitoring of each action);

- The strategy actions are listed in general order of priority with a specific priority assigned to each strategy action in terms of “very high”, “high”, “medium” or “low” priority.

Prior to implementation of the Darkum Creek estuary strategy actions Council will need to review to ensure consistency with the Coastal Zone Management Plan for the Coffs Harbour coastline and consistency with the Regional Park Management Plan.

Implementation Schedule

Strategy Action No.	*Description*	*Lead Agency (refer to strategy details for related agencies)*	*Timeframe*	*Cost*	*Potential Funding Sources*	*Priority*
Strategy 1 - Stormwater Management and Catchment Pollutants						
1.1	Educational strategies to address soil management and pesticide, herbicide and fertiliser use in agricultural activities	DPI – Agriculture NSW	Year 1	$5,000 per workshop for preparation, materials and delivery.	▪ Caring for Our Country ▪ CHCC Environmental Levy ▪ North Coast LLS ▪ OEH - Environmental Education Grants	High
1.2	Encourage horticultural landowners to uptake incentives program for Best Practice Management	North Coast LLS	Years 1 – 5	▪ Staff budget time for coordinating uptake of the incentives program ▪ $20,000 pa for incentives funding from CHCC Environmental Levy (Subject to funding and relevant processes) ▪ $20,000 pa for incentives funding from North Coast LLS (Subject to approval and available funding).	▪ CHCC Environmental Levy ▪ North Coast LLS – Relevant Programs	Very High
1.3	Stormwater management for urban development	CHCC	Review policy and guidelines every 5 years	Part of Council's operational budget	n/a	Medium
1.4	Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with	CHCC	Years 1 – 5	Part of Council's operational budget for initial consultation	Caring for Our Country for any necessary planting / establishment of defined	Very High

Strategy Action No.	*Description*	*Lead Agency (refer to strategy details for related agencies)*	*Timeframe*	*Cost*	*Potential Funding Sources*	*Priority*
	the creeks natural values				maintenance boundary	
1.5	Encourage horticultural landowners to establish vegetated riparian zones on farm watercourses via the incentives program for Best Practice Management	North Coast LLS	Years 1 – 5	Part of cost listed in Strategy Action 1.2.	Same funding as listed in Strategy Action 1.2.	Very High
1.6	Control land modification activities on rural lands	CHCC	Year 1	Unknown additional staffing resources and additional costs to Council's operational budget	n/a	Very High
Strategy 2 - Riparian Vegetation						
2.1	Raise awareness in the local community of the importance of native riparian vegetation and aquatic habitats along the banks and foreshore of Darkum Creek	CHCC	Years 1 - 2	Staff time Minimal cost for distribution of existing materials	▪ CHCC operating budget ▪ MPA - SIMP operating budget ▪ NSW Estuary Management Program	Medium
2.2	Develop a weed management strategy which prioritises riparian areas and priority weeds to be targeted	CHCC	Years 1 - 2	Strategy development ~ $5,000 if done external to CHCC.	North Coast LLS through relevant programs.	Very High
2.3	Undertake primary weed control in priority areas using specialist bush regeneration contractors	CHCC	Years 2 – 5	Subject to Weeds Management Strategy under Strategy Action 2.2 If external contractors are to be	▪ North Coast LLS through relevant programs. ▪ Environmental Trust	Very High

Strategy Action No.	*Description*	*Lead Agency (refer to strategy details for related agencies)*	*Timeframe*	*Cost*	*Potential Funding Sources*	*Priority*
				used, funds required is subject to the Weed Management Strategy but initially estimated at 200 hours per year @ $35/hr ($7,000/yr) over 5 years.	Restoration and Rehabilitation grants. ▪ Grants through NSW Government for Public Reserves Management Fund for weed control works on NSW Department of Industry – Lands & Water (Crown Lands). ▪ CHCC Environmental Levy.	
2.4	Foster a local Bushcare group to undertake the secondary control or follow-up maintenance of areas treated by contractors	CHCC	Long term commitment required to support community groups	Dependent on activities, but generally limited to provision of tools, consumables, and support.	Support available through Coffs Landcare Network. Funding available through North Coast LLS relevant programs	Medium
Strategy 3 – Water Quality						
3.1	Minimise domestic pet faecal inputs to the waterway	CHCC	Years 2 – 3	Staff time Installation of units $1500 p/unit Maintenance of units $1000 per unit p/annum	CHCC Environmental Levy	Low
Strategy 4 - Urban Development - Strategy Action 1.3 (Stormwater management for urban development) is considered adequate to address this issue. No further actions are proposed to address this issue.						
Strategy 5 – Aquatic Habitats - The following actions from other strategies are considered adequate to address the issue of loss of aquatic habitats:						

Strategy Action No.	*Description*	*Lead Agency (refer to strategy details for related agencies)*	*Timeframe*	*Cost*	*Potential Funding Sources*	*Priority*
	▪ Strategy Action 1.4 Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with the creeks natural values; ▪ Strategy Action 2.1 to raise awareness in the local community of the importance of aquatic habitats along the and foreshore of Darkum Creek; ▪ Strategy 1 actions to reduce the inputs of sediment from the catchment to maximise the opportunities for the recruitment of seagrass to the system.					
Strategy 6 – Climate Change Impacts on Water Quality						
	Addressing current issues in accordance with Strategy 1 actions will be the best preparation for the impacts of climate change on water quality. No further actions are proposed to address this issue.					
Strategy 7 - Recreational Use						
7.1	Protect cultural heritage and natural values of the creek and catchment by maintaining the existing minimum level of access and recreational activity	CHCC	Ongoing	Staff time	CHCC operating budget	High
7.2	Incorporate additional interpretive signage within the estuary area to enhance visitor enjoyment and appreciation of the creek's natural and cultural heritage values.	CHCC	Years 1 – 2	$2,000 for signage	▪ CHCC operating budget ▪ Caring for Our Country ▪ CHCC Environmental Levy	Medium
Strategy 8 - Climate Change Impacts on Estuary Ecology						
8.1	Implement development control provisions to facilitate upslope migration of mangroves and	CHCC	Years 1 – 2	Staff time	CHCC operating budget	High

Strategy Action No.	*Description*	*Lead Agency (refer to strategy details for related agencies)*	*Timeframe*	*Cost*	*Potential Funding Sources*	*Priority*
	saltmarsh in response to sea level rise					
Strategy 9 - Water Quality Monitoring						
9.1	Continue to implement the Ecohealth water quality monitoring program for Darkum Creek	CHCC	Ongoing	$20,000 every 4 years	▪ CHCC operating budget ▪ MPA - SIMP: in kind assistance	Medium
Strategy 10 – Visual Amenity -	The following actions from other strategies are considered adequate to address the issue of preserving and enhancing the visual amenity of Darkum Creek estuary: ▪ Strategy Action 1.4 Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with the creeks natural values; ▪ Strategy Action 2.3 to develop a weed management strategy which prioritises riparian areas and priority weeds to be targeted which will assist in maintaining the existing natural character of the estuary; ▪ Strategy Action 7.1 to provide simple additional infrastructure where necessary to support and enhance existing low levels of passive recreational activity and undertake restoration works on an as-needs basis to sustain the significant and dominant natural values of the estuary environment; ▪ Strategy Action 7.2 to address the need for interpretive information to enhance visitor enjoyment and appreciation of the creek's natural values.					
Strategy 11 - Entrance Management						
11.1	Address flooding risks that have the potential to trigger artificial opening of the entrance in the future	CHCC	Years 1 –5 for audit and assessment	Audit and assessment: $10,000	NSW Government Estuary Management Program	Low

Strategy Action No.	*Description*	*Lead Agency (refer to strategy details for related agencies)*	*Timeframe*	*Cost*	*Potential Funding Sources*	*Priority*
			Years 5 – 25 for relocate, replace or modify essential services and assets	Augmentation works: dependant on proposed works		
11.2	Prepare a Review of Environmental Factors for artificial opening of the entrance to Darkum Creek estuary	CHCC	Years 1 – 5	Staff time	CHCC operating budget	Low
11.3	Refine, adopt and implement Darkum Creek Entrance Management Policy	CHCC	Years 1 – 5	Staff time for adoption of policy.	CHCC operating budget	Low
11.4	Raise community awareness of the natural opening and closing regime of Darkum Creek	CHCC	Years 1 – 5	Included in the costs in Strategy Action 7.2	Caring for Our Country	Low
Strategy 12 – Cultural Heritage -	The following actions from other strategies are considered adequate to address the issue of protecting the cultural heritage of Darkum Creek estuary: ▪ Strategy Action 7.1 to support and enhance existing low levels of passive recreational activity within the estuary environment to protect cultural heritage and natural values of the creek and catchment; ▪ Strategy Action 7.2 to address the need for interpretive information to enhance visitor enjoyment and appreciation of the creek's natural and cultural heritage values.					

Introduction

This document presents a Coastal Zone Management Plan (CZMP) for Darkum Creek estuary. The primary purpose of this CZMP is to describe proposed actions to be implemented by Coffs Harbour City Council, other public authorities and the private sector to address priority management issues for the Darkum Creek estuary. These management issues relate to:

- risks to public safety and built assets;
- pressures on estuary health; and
- community uses of the estuary.

The area addressed by this CZMP comprises the Darkum Creek waterway and tributaries, foreshores and the catchment draining to the estuary up to the tidal limit of the creek. The CZMP also considers issues associated with the wider catchment upstream of the tidal limit. The Darkum Creek estuary is shown below and the extents of this area are mapped overleaf in Illustration I.1.

Source: NSW Office of Environment and Heritage

Plate I.1 Aerial Image of Darkum Creek Estuary (in foreground)

Background

In 2010, Coffs Harbour City Council (Council) and Office of Environment and Heritage (OEH) engaged GeoLINK in association with Aquatic Science and Management and GECO Environmental to develop a CZMP for Darkum Creek estuary. Council's Coastal Estuary Management Advisory Committee's goal for the CZMP is to "to assist Council in achieving an integrated, balanced, responsible and ecologically sustainable use of the Darkum Creek Estuary."

Drawn by: RE Checked by: MVE Reviewed by: TIM Date: July 2012
Source of base data: Coffs Harbour City Council

Information shown is for illustrative purposes only

North

0 300

Geographical Extent of Coastal Zone Management Plan

GeoLINK

Coastal Zone Management Plan - Darkum Creek Estuary
1616414

Illustration I.1

Development of this CZMP has included the following preliminary phases: literature and information review; technical study of the relationship between the estuary processes, external influences and issues of concern; community uses assessment and development of key management objectives and issues. These preliminary studies are reported in the following documents:

- *Data Compilation and Estuary Processes Study – Darkum Creek, Woolgoolga Lake and Willis Creek* (GeoLINK *et al.*, 2011a); and
- *Estuary Management Study – Darkum Creek* (GeoLINK *et al.*, 2011b).

Summaries of these preliminary phases are contained in:

- Appendix C – summary of literature and information review and technical study of estuary processes;
- Appendix D – summary of community uses assessment; and
- Appendix E – summary of development of key management objectives and issues.

Consultation

Community and stakeholder consultation was undertaken to gain input to the development of management action for Darkum estuary. Consultation has included community workshops in 2010 and 2011, a community survey in 2011 and liaison with relevant stakeholders.

Addressing Coastal Management Principles

The notes below describe how this CZMP has considered the relevant Coastal Management Principles as detailed in the *Guideline for Preparing Coastal Zone Management Plans* (DECCW, 2010).

***Principle** 1: The Plan will consider the objects of the Coastal Protection Act 1979 and the goals, objectives and principles of the NSW Coastal Policy 1997.*

The NSW Coastal Policy deals with population and economic growth whilst protecting the natural, cultural, heritage and spiritual values of the coastal environment. The policy has a strong focus on the principles of Ecologically Sustainable Development. The NSW Coastal Protection Act 1979 aims to protect, enhance, maintain and restore the environment with concern for both the natural and built environments. These principles formed the basis of development and prioritisation of management strategies for Darkum Creek estuary.

***Principle** 2: Optimise links between plans relating to the management of the coastal zone.*

Development of this CZMP including the literature review component has considered Council's Coastal Processes and Hazard Definition Study and Coastal Zone Management Study for the coastline, Council's Climate Change Mitigation and Adaptation Action Plan and other studies and management plans related to Darkum Creek estuary.

***Principle** 3: Involve the community in decision-making and make coastal information publicly available.*

As indicated above, community consultation was undertaken to gain input to the development of management action for Darkum Creek estuary including community workshops in 2010 and 2011, and a community survey in 2011 and liaison with relevant stakeholders.

***Principle** 4: Base decisions on the best available information and reasonable practice; acknowledge the interrelationship between catchment, estuarine and coastal processes; adopt a continuous improvement management approach.*

The estuary processes study component of the CZMP considered the above issues. Development of management strategies has included a continuous improvement management approach such as the measures outlined in respect to climate change impacts on flooding to minimise the future need for artificial opening events.

Principle 5: The priority for public expenditure is public benefit; public expenditure should cost effectively achieve the best practical long-term outcomes.

Development of strategies and priorities has included consideration of public expenditure.

Principle 6: Adopt a risk management approach to managing risks to public safety and assets; adopt a risk management hierarchy involving avoiding risks where feasible and mitigation where risks cannot be reasonably avoided; adopt interim actions to manage high risks while long-term options are implemented.

This principle is not directly applicable to the issues for the Darkum Creek estuary.

Principle 7: Adopt an adaptive risk management approach if risks are expected to increase over time, or to accommodate uncertainty in risk predictions.

This principle is not directly applicable to the issues for the Darkum Creek estuary.

Principle 8: Maintain the condition of high value coastal ecosystems; rehabilitate priority degraded coastal ecosystems.

Development and prioritisation of strategies has considered the above approach such as management of environmental weeds which has been prioritised for riparian vegetation classified as either 'good' or 'very good' condition.

Principle 9: Maintain and improve safe public access to beaches and headlands consistent with the goals of the NSW Coastal Policy.

This principle is not directly applicable to the issues for Darkum Creek estuary, however, actions under Strategy 7 address the provision of recreational infrastructure.

Principle 10: Support recreational activities consistent with the goals of the NSW Coastal Policy.

Strategy 7 in this CZMP directly addresses recreational activities related to Darkum Creek estuary.

Key Values of Darkum Creek Estuary

The natural settings of the estuaries and coast within the Mid North Coast are a feature that attracts visitors and locals to the area. Darkum Creek is in keeping with this natural setting, and forms part of the network of bushland settings along the coast and estuaries and are of local and broader significance due to its proximity to residential community of Safety Beach. The creek is part of the Solitary Islands Marine Park and is zoned as a Habitat Protection Zone up to the tidal limit.

Darkum Creek is a relatively small and remote coastal estuary and offers the following recreational values:

- significant water-based activity including kayaking, canoeing and fishing in the creek;
- the significant riparian vegetation promotes a sense of seclusion and enhances the natural experience for water-based activities such as canoeing;
- a coastal walk which is facilitated by the pedestrian footbridge over the creek enabling a continuous pedestrian and bicycle route following the coastline and connecting the residential communities of Arrawarra in the north to Woolgoolga in the south; and
- to the east of the footbridge is a corridor of undisturbed natural vegetation following the southern downstream section of the creek to its mouth, which is part of the Coffs Coast Regional Park. This area

comprises dense coastal vegetation and contains no known tracks, and is likely to attract people seeking quiet recreational opportunities such as bird watching and bushwalking.

Darkum Creek offers a predominantly undisturbed natural environment that forms an integral and important component of the natural settings along the coastline. It offers the following scenic values:

- the creek and its foreshores contribute significantly to the character and amenity of the surrounding residential communities;
- the creek has short reaches and heavily vegetated foreshores which offer considerable shelter from prevailing winds. The resulting tranquil water combined with the surrounding riparian vegetation offer considerable scenic amenity;
- the creek itself is largely only visible from the footbridge which offers an excellent vantage point in both upstream and downstream directions;
- an attractive long distant view across a downstream reach of the creek is also available from its mouth at Safety Beach; and
- the creek is also likely to be visible through openings in vegetation from the adjoining golf course.

The ecological health of the Darkum Creek estuary is good with respect to water quality, estuarine habitats, riparian vegetation, structural habitat availability for aquatic fauna and the absence of fish kills and algal blooms. The riparian vegetation is mostly intact with over 85% in either good to very good condition. The creek includes significant mangrove habitat showing active recruitment and a small area of saltmarsh in relatively good condition.

The entrance to the Darkum Creek estuary naturally alternates between being open or closed to the ocean. These types of estuaries are known as an ICOLL's - Intermittently Closed and Open Lakes and Lagoons. The predominant state of the Darkum Creek entrance is closed.

Darkum Creek area is culturally significant with twelve recorded Aboriginal sites located within the catchment area (listed on the Aboriginal Heritage Information Management System). Records also show that artefact finds are located within the catchment. The Woolgoolga area was (and continues to be) inhabited by the Gumbayngirr people prior to European Settlement. The cultural values of these Aboriginal sites within the Darkum Creek catchment area require sensitive consideration and preservation.

The Coffs Harbour Coastal Zone Management Plan includes an action (FS.11) with the purpose of developing a decision framework for managing indigenous and non-indigenous heritage items and places affected by coastal hazards. Once developed, Council will utilise this framework across the entire Coffs Harbour City Council Region, including Darkum Creek. All Aboriginal places and Aboriginal objects are protected under the National Parks and Wildlife Act 1974 (NPW Act).

Key Management Issues

The key estuary management issues that have been identified relate to:

- sediment, nutrient and other pollutant inputs from the catchment;
- protecting the native riparian vegetation (which is generally in good condition) from threats such as uncontrolled access and environmental weeds which reduce the ecological value and potentially impact upon bank stability, recreational amenity and aesthetics;
- climate change impacts (particularly sea level rise and consequent lake water level increases) on the estuarine ecology and water quality;
- preserving the natural values of the estuary and maintaining low key recreational activities such as kayaking, fishing, and bush walking with a minimal the level of support and infrastructure; and
- increased flooding risks to properties and infrastructure caused by sea level rise.

Key Management Strategies

Key management strategies for Darkum Creek estuary include:

- continue educational and auditing strategies that address the management of soil resources and pesticide / herbicide / fertiliser use in agricultural activities in the upper catchment;
- ensuring grounds management practices at Woolgoolga Returned Services Golf Course are complementary with the creeks natural values. This may involve formalising a defined edge between the fairways and the creek foreshores if necessary to reduce mowing/maintenance impacts on the riparian buffer;
- incorporating adequate riparian buffer widths into the planning framework for rural properties;
- a weed management strategy which targets priority environmental weeds in high value riparian areas;
- raising awareness in the local community of the importance of native riparian vegetation and aquatic habitats along the banks and foreshore of Darkum Creek;
- provide simple additional infrastructure where necessary to support and enhance existing low levels of passive recreational activity. Undertake restoration works on an as-needs basis to sustain the significant and dominant natural values of the estuary environment; and
- incorporate discrete interpretive signage to enhance visitor appreciation and enjoyment of the site's natural values.
- assessing available corridors for upslope migration of mangrove and saltmarsh colonies in response to sea level rise and making appropriate changes to planning instruments in order to protect saltmarsh and mangroves from future impacts associated with sea level rise;
- a water quality monitoring program for Darkum Creek; and
- implementing a formal Entrance Management Policy for Darkum Creek with the aim to minimise interference with the natural opening and closing processes of the creek entrance whilst mitigating the impacts of future sea level rise induced flooding of properties and infrastructure.

The management strategies in this document are presented in general order of priority (Strategy 1 being the highest priority). Specific priorities have also been assigned to each strategy action in terms of "very high", "high", "medium" or "low" priority. The priorities and timeframes provided in this CZMP are indicative and are to be used to guide the order of implementation. Priorities were established in response to:

- the degree to which the management strategies will impact on estuary issues;
- timeframe over which the strategy impacts will extend (the longer the better);
- extent of the estuary addressed by each management strategy;
- community rating of issues addressed by each management strategy (based on a community survey); and
- likely cost of effective implementation of the management strategy.

Coffs Harbour 2030 Plan

The Coffs Harbour 2030 Plan (CHCC, 2009), a strategic plan for the Coffs Harbour community ('the 2030 Plan'), was adopted by Council in December 2009. The 2030 Plan is driven by the Community Vision 2030 and outlines the steps needed to create a sustainable future for Coffs Harbour LGA. It is the overarching plan that integrates planning and reporting frameworks, while mapping out the community's aspirations for the future of the Coffs Harbour LGA to 2030 and beyond.

This CZMP is consistent with the aspirations of the Coffs Harbour community as articulated in the 2030 Plan. The 2030 Plan covers five themes including *Moving Around* and *Looking after our Environment* which are more directly applicable to this CZMP. The 2030 Plan outlines outcomes, objectives and actions for each theme. The actions applicable to this CZMP are listed in Table I.1 below. The final two columns of the table list the CZMP strategy actions that address the listed 2030 Plan strategies.

Table I.1 – Coffs Harbour 2030 Plan

Coffs Harbour 2030 Plan			*Related CZMP Strategy*	
Outcome	*Objective*	*Strategy*	*Strategy Action No.*	*Description*
MA2 Many of us walk and cycle from place to place	MA2.2 We have constructed an interconnected network of cycle ways, footpaths and walking tracks that connect our urban communities, hinterland and coastal villages.	MA 2.2.1 Work in partnership to provide cycle ways and footpaths.	7.1	Existing cycleways and footpaths are generally considered adequate – Strategy 7.1 involves maintaining the existing minimum level of access and recreational activity to preserve the natural values of the creek environment
LE1 We understand and value our unique natural environment and its cultural connections	LE1.3 We have many opportunities for nature experiences and learning through improved access to natural areas.	LE1.3.1 Promote connection to the environment through learning in the environment.	2.1 7.2	Raise awareness of the importance of native riparian vegetation and aquatic habitats along the banks and foreshore of Darkum Creek Interpretive signage
		LE1.3.2 Create and extend walking trails and other opportunities for environmental experiences.	7.1	Refer to comments above for MA 2.2.1
LE2 We protect and restore our environment to conserve its unique biodiversity for future generations	LE2.1 Our forests, beaches, headlands, ocean, rivers, forested mountain backdrop, plants and animals are conserved for future generations.	LE2.1.1 Ensure land use management policies and practices conserve the region's unique environmental and biodiversity values.	Strategy 1 actions Strategy 2 actions	Best Practice Management for soil management and pesticide, herbicide and fertiliser use in agricultural activities Ensure golf course maintenance practices are complementary with the creeks natural values Urban stormwater management Environmental weed strategy for riparian corridor
		LE2.1.2 Enhance protection of our marine areas and manage for change.	Strategy 1 actions 8.1	As above with respect to Strategy 1 actions Buffers to enable aquatic habitats to respond to sea level rise
		LE2.1.3 Maintain and conserve biodiversity through protected reserve systems and other land conservation mechanisms.	8.1	Buffers to enable aquatic habitats to respond to sea level rise

Coffs Harbour 2030 Plan			*Related CZMP Strategy*	
Outcome	*Objective*	*Strategy*	*Strategy Action No.*	*Description*
		LE2.1.5 Implement climate change planning, adaptation and mitigation strategies.	8.1 Strategy 11 actions	Buffers to enable aquatic habitats to respond to sea level rise Address increased flooding risks from sea level rise that will impact on artificial entrance openings
	LE2.2 We have active programs to restore and improve our environment.	LE2.2.2 Manage our catchments effectively and adaptably.	Strategy 1 actions	Best Practice Management for soil management and pesticide, herbicide and fertiliser use in agricultural activities Ensure golf course maintenance practices are complementary with the creeks natural values Urban stormwater management
		LE2.2.3 Build ecosystem resilience through a system of local and regional habitat corridors.	Strategy 2 actions 5.1	Management of riparian vegetation Buffers to enable aquatic habitats to respond to sea level rise
LE3 We manage our resources and development sustainably.	LE3.1 We are responsible in the use and management of our natural resources and work to reduce our ecological footprint.	LE3.1.2 Use best practice to prevent pollution impacts on our environment.	Strategy 1 actions	Best Practice Management for soil management and pesticide, herbicide and fertiliser use in agricultural activities Ensure golf course maintenance practices are complementary with the creeks natural values Urban stormwater management

Coffs Harbour Coastal Zone Management Plan

Council is preparing a separate Coastal Zone Management Plan that addresses coastal risks along the Coffs Harbour coastline. This coastline plan will define the level of risk from coastal hazards and provide a co-ordinated approach to management of coastal hazards.

Initial review of draft actions proposed in the coastline plan does not indicate any inconsistencies with the Darkum Creek estuary strategy actions. However, prior to implementation of the Darkum Creek estuary strategy actions Council will need to review to ensure consistency with the Coastal Zone Management Plan for the Coffs Harbour coastline.

Public Land Ownership and Management Arrangements in the Coastal Zone

There are many Crown Land Reserves that are either managed by Council, DoI – Crown Lands, or the various Reserve Trusts for some parcels of Crown Land (e.g. NSW Crown Holiday Parks Trust). Crown Land reserves are required to have a Plan of Management (POM) defining permissible uses of these lands in accordance with the *Crown Lands Act 1996* (or equivalent). When implementing actions in this CZMP for Crown Land Reserves, the applicable POM(s) should be consulted to ensure a consistent, integrated and 'whole of government' approach to coastal zone management.

Council is the manager of the Coffs Coast State Park, which extends from Sawtell to Park Beach, including Woolgoolga Lakeside and Woolgoolga Beach Reserve, and including Boambee Reserve except the section west of the railway bridge and south of the creek that is under a private lease through DoI – Crown Lands.

Council and NPWS jointly manage the Coffs Coast Regional Park (which extends from Diggers Beach to Woolgoolga Headland, and from north of Woolgoolga Lake to 450 m south of Corindi Beach Village) under the *National Parks and Wildlife Act 1974*. The boundary of the park extends seaward to the mean high water mark (MHWM).

Private lands of the coastal zone mainly consist of residential, along with some commercial / business and industrial properties, and some rural lands.

Crown Land Authorisations

Where works or actions are proposed or to be implemented on Crown Land, not under Council Trust management, appropriate authorisations from DoI – Crown Lands are likely to be required prior to the works commencing. Authorisation may be provided by way of licence or potentially the appointment of Council as the reserve manager to streamline future management arrangements.

This issue has specific relevance to the actions in the CZMP regarding actions11.2 and 11.3, but may also be relevant to action 2.3 if the proposed works are to occur within Crown Lands.

Note: 1. Adequate lead time (at least six months) is required for the Department to assess and issue authorisation (licence) works on Crown Land.

Note: 2. The *Crown Land Management Act 2016* is expected to commence in early 2018. This may have implications that will need to be considered when the CZMP actions are implemented.

Coffs Harbour Regional Park Management Plan

Council is also preparing a Regional Park Management Plan. Prior to implementation of the Darkum Creek estuary strategy actions Council will need to review to ensure consistency with the Regional Park Management Plan.

Native Title Act 1993 (Commonwealth) and *Aboriginal land Rights Act 1983* (NSW) Considerations / Obligations

Where actions proposed on Crown Land consideration of Aboriginal Land Claims lodged under NSW *Aboriginal Land Rights Act 1983* will need to be undertaken. Any works will need to be compliant with the Commonwealth *Native Title Act 1993.*

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Strategy 1 - Stormwater Management and Catchment Pollutants

Catchment inputs in the form of stormwater, diffuse runoff and point source inputs are typically the major sources of poor water quality in estuaries and other coastal water bodies. The effects of poor water quality inputs can be magnified in ICOLLs such as Darkum Creek depending on the status of the entrance.

Modelling undertaken during the Darkum Creek Estuary Processes Study (EPS) suggests the major source of sediment and nitrogen inputs is from horticultural and pasture land uses spread throughout the catchment and the golf course. It also suggests that phosphorus input is dominated by horticultural land uses. Careful management of these activities within the catchment may lead to long term improvements in water quality.

Community consultation indicates concern regarding pesticide and herbicide runoff from agricultural activities (mostly blueberry and banana farming). Guidelines for best practice management of soil and water resources on blueberry (NSW DPI 2008a) and banana farms (NSW DPI 2008b) are available and have been used in the past as a basis for workshops and training activities for farmers.

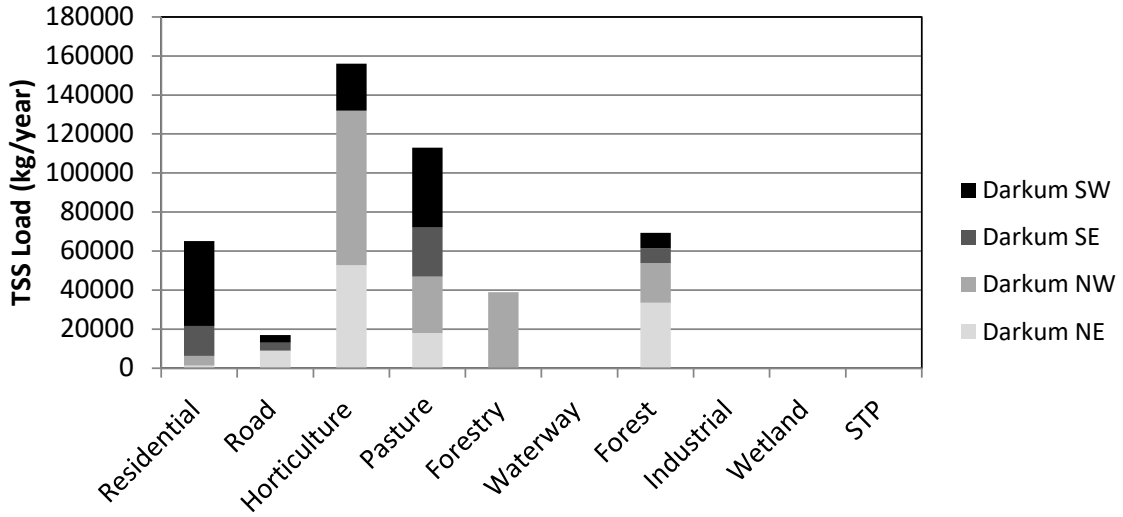


Illustration 1.1 Modelled Total Suspended Sediment Load by Landuse and Subcatchment Area

1.1 Summary of Proposed Actions

- Educational strategies to address soil management and pesticide, herbicide and fertiliser use in agricultural activities.
- Encourage horticultural landowners to uptake incentives program for Best Practice Management.
- Stormwater management for urban development.
- Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with the creeks natural values.
- Encourage horticultural landowners to establish vegetated riparian zones on farm watercourses via the incentives program for Best Practice Management.
- Control land modification activities on rural lands.

1.1.1 Related Strategies

- Strategy 2 Riparian Vegetation
- Strategy 3 Elevated Turbidity, Total Nitrogen and Chlorophyll-a Values
- Strategy 4 Increased Urbanisation of the Darkum Creek Catchment
- Strategy 5 Loss of Aquatic Habitats
- Strategy 6 Water Quality Impacts Associated with Climate Change and Sea Level Rise
- Strategy 9 Lack of Continuity and Detail in Existing Water Quality Data

1.1.2 Objectives Addressed

- Improve Water Quality;
- Protect and Enhance Aquatic Habitats; and
- Restore Terrestrial Habitats of High Ecological or Conservation Value by Removing Threats and Through Targeted Rehabilitation

1.2 Details of Proposed Actions

Strategy Action 1.1 Educational strategies to address soil management and pesticide, herbicide and fertiliser use in agricultural activities.

Background:

Community consultation indicates concern that agricultural activities (mostly blueberry and banana farming) may be negatively impacting water quality in Darkum Creek via inputs of sediment, nutrients and agricultural chemicals.

A campaign of awareness targeting rural landholders is considered an appropriate way of addressing these concerns, improving agricultural practices and having a positive effect on water quality in Darkum Creek. Workshops run by Coffs Harbour Regional Landcare targeting fertiliser use on blueberry farms are an example of recent initiatives that could be expanded upon. Workshops could be based upon existing guidelines (NSW DPI 2008a & b) and utilise the expertise of NSW DPI (Agriculture) staff from the Coffs Harbour region.

Specific Tasks

Develop and deliver a series of workshops aimed at blueberry and banana farmers in the catchment that describe:

- strategies to reduce erosion, such as contour alignment of rows, installation of trafficable cross banks at regular intervals, establishment of groundcovers, adequate riparian buffer widths on rural properties and the use of subsurface drainage;
- strategies to maintain and monitor soil moisture such that irrigation is always used in the most efficient manner;
- strategies to maximise the efficiency of fertiliser, herbicide and pesticide use and application, such that the overall use is minimised and concentrations in runoff can be minimised; and
- strategies to minimise the risk of accidental spillage of fertiliser, herbicides and pesticides such as appropriate storage, transport and disposal.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: DPI – Agriculture NSW Related Agencies: ▪ CHCC; ▪ North Coast LLS; ▪ Landcare.	Year 1	$5,000 per workshop for preparation, materials and delivery.	▪ Caring for Our Country ▪ CHCC Environmental Levy ▪ North Coast LLS ▪ OEH - Environmental Education Grants	Delivery of workshops is an appropriate benchmark.

Strategy Action 1.2

Encourage horticultural landowners to uptake incentives program for Best Practice Management

Background:

Community consultation indicates concern that agricultural activities (mostly blueberry and banana farming) may be negatively impacting water quality in Darkum Creek via inputs of sediment, nutrients and agricultural chemicals.

The North Coast Local Land Services (LLS) provides support for landholders in specific horticultural industries to assist with the adoption of Best Management Practices for soil health in high priority landscapes including the Woolgoolga area. The targeted horticultural industries include blueberry, banana, macadamia, vegetable and coffee growers and growers of other perennial horticulture crops.

Eligible project activities include, but are not limited to improvements to soil condition / soil health through application of mulch, organic matter, compost, cover crops, minimum tillage, use of crop residues etc. or other biological farming techniques; soil conservation works such as runoff controls, diversion banks, waterways or other erosion control earthworks; and, establishment / improvement of ground cover to stabilise soil.

Successful applications use the Best Management Practice techniques outlined in the Horticulture BMP Guidelines (eg. *Soil and Water Management Practices for Blueberry growers in Northern NSW*, 2008) and have in-kind contributions from the landholder with an ongoing commitment to maintaining the project.

Specific Tasks

Council, North Coast LLS and Regional Landcare to promote and coordinate uptake of the incentives program amongst horticultural landowners.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ North Coast LLS Related Agencies: ▪ CHCC; ▪ Landcare; ▪ DPI – Agriculture	Years 1 – 5	▪ Staff budget time for coordinating uptake of the incentives program ▪ $20,000 pa for incentives funding from CHCC Environmental Levy (Subject to funding and relevant processes) ▪ $20,000 pa for incentives funding from North Coast LLS (Subject to approval and available funding).	▪ CHCC Environmental Levy North Coast LLS – Relevant Programs	CHCC to report annually on uptake numbers and implemented measures

Strategy Action 1.3

Stormwater management for urban development

Background:

Existing urban areas do not form a large proportion of the estuary catchment. The newer residential area of Safety Beach drains to a constructed stormwater management control pond. The older areas of Safety Beach include grassed swale drainage systems that provide treatment of road and allotment runoff. While no specific stormwater management improvements are considered necessary for existing areas, it is recommended that contemporary WSUD principles and the treatment benefits of the existing roadside grass swales in the older section of Safety Beach are considered in any strategies relating to potential adoption of kerb and gutter systems.

New development areas have the potential to reduce the quality of catchment runoff during and after the construction phase. It is important that controls placed on new developments are sufficient and enforced to ensure no negative net impact upon water quality.

Council currently has a contemporary policy and associated guidelines addressing stormwater management for new development (Coffs Harbour City Council Water Sensitive Urban Design (WSUD) Policy, 2009). These guidelines are consistent with current best-practice management measures in the industry. Therefore, this estuary management plan recommends continued implementation of Council's policy and guidelines for stormwater management and ongoing updating of the policy and guidelines in line with developments in the stormwater management industry. No additional strategies are considered necessary in respect to controlling stormwater management for new development.

Specific Tasks

- Ongoing updating of Council's Water Sensitive Urban Design (WSUD) Policy (2009) and associated guidelines in line with developments in the stormwater management industry.

Responsible Agencies	*Timeframe1*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Review policy and guidelines every 5 years	Part of Council's operational budget	n/a	Review policy and guidelines every 5 years

Strategy Action 1.4

Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with the creeks natural values

Background:

The Woolgoolga Returned Services golf course adjoins a large section of the Darkum Creek waterway and comprises a large portion of the estuary catchment. Therefore it is important that grounds management practices such as fertiliser application are carefully managed to avoid impacts on the estuary.

Potential water quality impacts associated with runoff from the golf course will also be mitigated with the maintenance of an adequate riparian buffer width between the golf course fairways and the creek. Consideration also needs to be given to drainage lines from the golf course.

Specific Tasks

Liaise with management of the golf course:

- To ensure that grounds management practices such as fertiliser application are carefully managed to avoid impacts on the estuary;
- Recommend the installation new riparian planting and a defined edge between the fairways and the creek foreshores if necessary to reduce mowing/maintenance impacts on the riparian buffer and to protect existing and newly planted riparian vegetation;
- Consider any improvements to drainage lines intersecting the golf course (such as revegetation with native species) to assist with water quality improvements for Darkum Creek.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 – 5	Part of Council's operational budget for initial consultation	Caring for Our Country for any necessary planting / establishment of defined maintenance boundary	After 5 years: audit the riparian edge of the golf course to assess effectiveness of any measures; and liaise with golf course management re: fertiliser application practices

Strategy Action 1.5

Encourage horticultural landowners to establish vegetated riparian zones on farm watercourses via the incentives program for Best Practice Management

Background:

When looked at over the whole state of NSW, water quality data shows that the condition of an ICOLL degrades significantly once natural vegetation is lost from more than half of the catchment (Haines 2008). Clearly increased urban and agricultural development can result in negative impacts on waterways within the catchment. However, making provisions for adequate riparian buffer widths throughout a catchment can result in a number of benefits to receiving waters, such as reduced sediment and nutrient loads. It can also serve greater environmental purposes such as provision of wildlife corridors between alternative habitats.

Generally, the urbanised tributaries of Woolgoolga Lake are provided with vegetated riparian buffers of a minimum of 10 to 20 m width. The Processes Study indicates that riparian vegetation in the study area is predominately in moderate to good condition (GeoLINK *et al*., 2011a). However, some tributaries in the upper catchment in horticultural areas are lacking any vegetated riparian buffer as indicated in the following plate.

NSW DPI recommend a minimum buffer of 50 m between watercourses and greenhouse horticulture in its handbook for managing land use conflict issues on the NSW North Coast (Learmonth, *at. al.*, 2007). The handbook recommends minimum buffer distances between watercourses and grazing land or non-greenhouse horticulture to be based on 'best practice management'.

An indication of what may be considered 'best practice management' is provided in DPI Water recommendations for vegetated riparian zone widths – these widths should contain fully structured native vegetation (including groundcovers, shrubs and trees). These recommended widths are based on watercourse order as classified under the Strahler System of ordering watercourses and based on current 1:25 000 topographic maps (see table below). The width of the riparian zone should be measured from the top of the

highest bank and on both sides of the watercourse. Based on the table below a minimum 10 metre wide vegetated riparian zone on either side of the watercourses is recommended in the upper tributaries.

Watercourse type	**VRZ width** (each side of watercourse)	**Total RC width**
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Source: NSW Office of Water, 2012

It is considered that the best approach to establishing a vegetated riparian zone in the upper tributaries on rural land is via the incentives program for Best Practice Management for horticultural landowners in Strategy Action 1.2. Therefore no additional actions or tasks are proposed.

Responsible Agencies	*Timeframe1*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ North Coast LLS Related Agencies: ▪ CHCC ; ▪ Landcare; ▪ DPI – Agriculture.	Years 1 – 5	Part of cost listed in Strategy Action 1.2.	Same funding as listed in Strategy Action 1.2.	Part of reporting as described for Strategy Action 1.2.

Strategy Action 1.6

Control land modification activities on rural lands

Background:

Land disturbance associated with the construction, installation or maintenance of buildings, roads, or other infrastructure creates the potential for increased levels of soil erosion and consequent sediment pollution of waterways.

There has been significant development of the greenhouse horticulture industry in the rural area of Woolgoolga. Development of this industry can involve significant earthworks associated with the construction of building pads for greenhouse structures. These earthworks create the potential for significant sediment pollution of waterways without proper erosion and sediment control measures.

Past development of the greenhouse horticulture industry has generally proceeded without the requirement for

development consent. There have been reported incidences where significant erosion and sediment control issues have occurred in association with construction of greenhouse structures. These incidences have been addressed under the Protection of the Environment Operations Act 1997. It is considered that a more proactive approach by Council to ensuring implementation of proper erosion and sediment control measures will provide a better outcome. This can be achieved through the development consent approach utilising relevant provisions from the proposed Standard Instrument Local Environment Plan (SiLEP) such as Clause 7.7 Earthworks of the draft SiLEP (2012).

Specific Tasks

- Educate rural land holders about the above provisions / requirement for development consent in timing with the adoption of the proposed SiLEP;
- With respect to enforcing the provisions of the proposed SiLEP relevant to the above issues, Council is to undertake the following tasks when issues are brought to Council's attention:
  - investigate the requirement for consent for development captured by the relevant SiLEP provisions;
  - investigate compliance with development conditions in regard to erosion and sediment control measures;
  - investigate compliance where development has occurred without consent (and not been exempt development under the SiLEP or SEPP (Exempt and Complying Development Codes) 2008; and
  - utilise the provisions of the Protection of the Environment Operations Act 1997 to enforce erosion and sedimentation control where poorly managed earthworks pose a risk to, or have impacted, the environment.

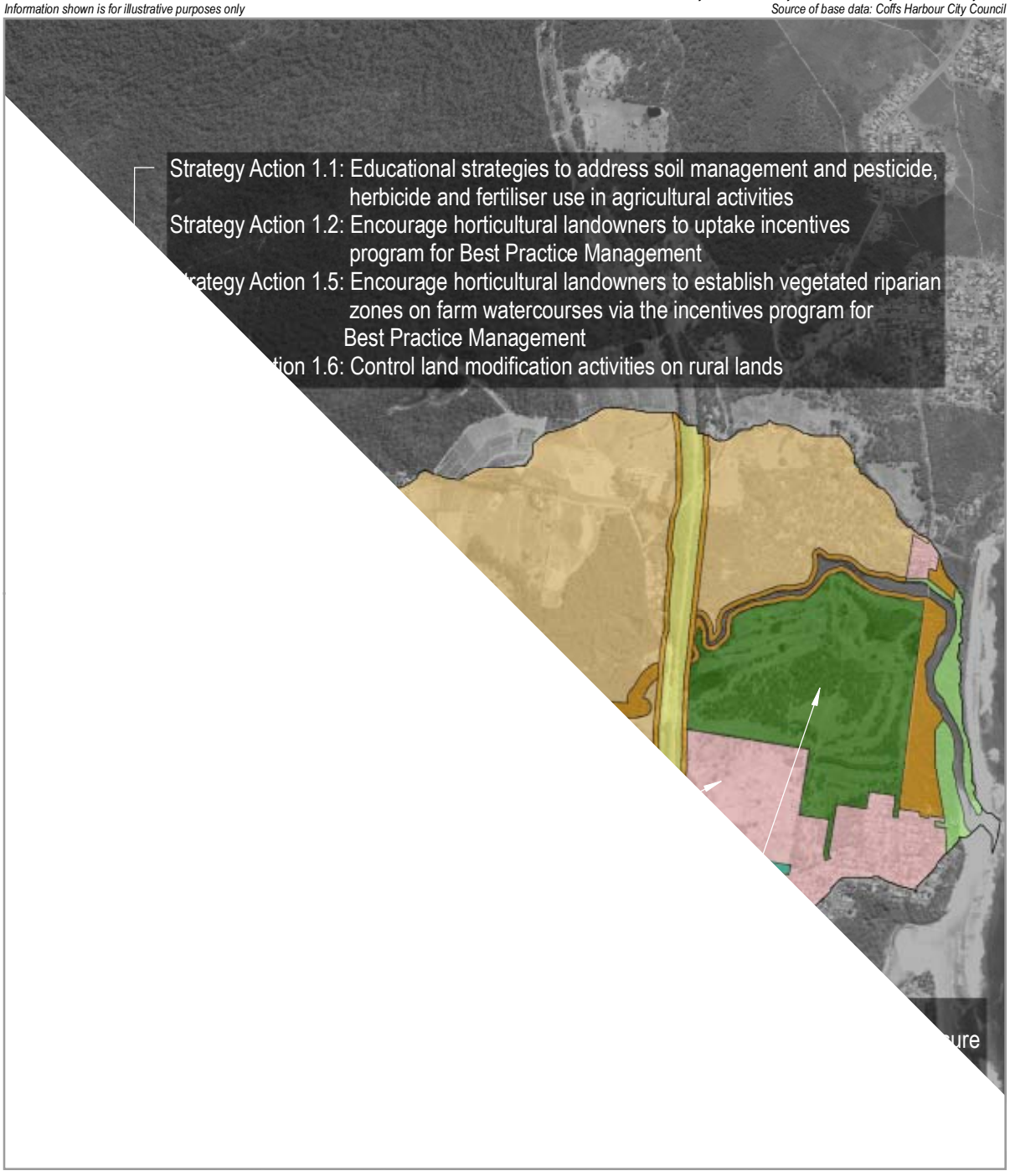
Responsible Agencies	*Timeframe1*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Year 1	Unknown additional staffing resources and additional costs to Council's operational budget	n/a	Review development application / consent numbers and comparison with hothouse development based on aerial imagery

Note: 1. Timeframe: the year relates to the time following adoption of this CZMP eg. "Years 2 – 5" indicates the strategy action should be implemented within 2 to 5 years of adoption of the CZMP

Drawn by: RE Checked by: MVE Reviewed by: TIM Date: July 2012

Information shown is for illustrative purposes only

Source of base data: Coffs Harbour City Council



LEGEND

- Agriculture
- Rural living
- State forest
- Urban
- Business
- Open space and public recreation
- Environmental protection

North

0 500

Strategy 1 - Stormwater Management and Catchment Pollutants

GeoLINK

Coastal Zone Management Plan - Darkum Creek Estuary
1616841

Illustration 1.2

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2

Strategy 2 - Riparian Vegetation

A variety of terrestrial habitats of high conservation value have been identified within the riparian zone of Darkum Creek. These include saltmarsh, mangrove, and casuarinas, melaleuca, and eucalyptus dominated riparian woodlands. The riparian vegetation of Darkum Creek is generally in good to very good condition, however some reaches show signs of disturbance associated with clearing and access mostly in areas adjacent to residential development or the golf course.

Additionally, riparian weed mapping in January 2011 identified the presence of six environmental weed species listed as priority weeds in the *Northern Rivers Invasive Plants Action Strategy 2009-2013* (*NRIPAS*: Oakwood, 2009). Environmental weeds degrade the native riparian vegetation, reducing its ecological value and in some cases potentially impacting upon bank stability and other estuary values including recreational amenity and aesthetics.

The restoration of riparian vegetation is listed among the goals of the North Coast LLS Catchment Action Plan. Weed management along the riparian corridor of Darkum Creek was identified as a goal during community consultation meetings. Additionally, the Coffs Harbour Settlement Strategy lists the enhancement of riparian corridors as a key strategy for the Woolgoolga area to provide ecological links between coast and hinterland (Coffs Harbour City Council, 2011b).

Strategy 2 is aimed at the protection and rehabilitation of native riparian vegetation communities along Darkum Creek by raising community awareness of the importance of native riparian vegetation along estuaries and by rehabilitating reaches of high ecological or conservation value by removing threats such as weed invasion or inappropriate management practices.

2.1 Summary of Proposed Actions

- Raise awareness in the local community of the importance of native riparian vegetation along the banks and foreshore of Darkum Creek.
- Develop a weed management strategy which prioritises areas of riparian foreshore to be treated and priority weeds to be targeted.
- Undertake primary weed control in priority areas using specialist bush regeneration contractors.
- Foster a local *Bushcare* group to undertake the secondary control or follow-up maintenance of areas treated by contractors.

It is noted that management of the existing riparian vegetation along the southern foreshore adjacent to the golf course is adequately addressed by Strategy Action 1.4.

2.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 10 Recreational Use
- Strategy 10 Visual Amenity

2.1.2 Objectives Addressed

- Restore terrestrial habitats of high ecological or conservation value by removing threats and through targeted rehabilitation (e.g. riparian vegetation, endangered ecological communities such as Coastal Saltmarsh, Freshwater Wetlands, etc).
- Improve water quality.
- Enhance public appreciation of the broader and site specific natural values of the creek environment.
- Maintain and Preserve Existing Natural Characteristics.

2.2 Details of Proposed Actions

Strategy Action 2.1

Raise awareness in the local community of the importance of native riparian vegetation and aquatic habitats along the banks and foreshore of Darkum Creek

Background:

There are some residential areas that back onto the Darkum Creek foreshore, particularly around the footbridge. The golf course also adjoins the Darkum Creek foreshore. Landholder actions that may disturb sensitive saltmarsh and mangrove colonies in these areas include mowing, vegetation removal and pruning, creating pathways for access, and drainage activities.

This action addresses issues also identified in Strategy 5. Strategy Action 2.1 is also complimentary to Strategy Action 2.4.

Specific Tasks

- Utilise existing resources (eg. fact sheets developed by NSW Office of Environment and Heritage and the North Coast LLS) to raise awareness in the local community of:
  - Identification of riparian vegetation, mangroves and saltmarsh;
  - The importance of riparian vegetation, mangroves and saltmarsh to estuarine ecosystems;
  - Legislation dealing with watercourses and riparian vegetation, mangroves and saltmarsh;
  - Threats to riparian vegetation, mangroves and saltmarsh;
  - Invasive weeds that affect riparian zones in the Darkum Creek catchment; and
  - Strategies to protect and improve the health, distribution and diversity of riparian vegetation, mangroves and saltmarsh along Darkum Creek. Strategies to include encouraging residents to incorporate locally indigenous vegetation in private gardens and to recognise and avoid installing invasive or inappropriate plants;
- Compile a list of landholders with properties adjoining the Darkum Creek estuarine foreshore and distribute educational materials among landholders.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ CHCC Related Agencies: ▪ North Coast LLS; ▪ Landcare.	Years 1 - 2	Staff time Minimal cost for distribution of existing materials	▪ CHCC operating budget ▪ MPA - SIMP operating budget ▪ NSW Estuary Management Program	The benchmark for this action is the distribution of materials to landholders adjoining Darkum Creek.

Strategy Action 2.2

Develop a weed management strategy which prioritises riparian areas and priority weeds to be targeted

Background:

Weed mapping undertaken in January 2011 identified the presence of environmental weed species throughout Darkum Creek (GeoLINK *et al*., 2011a). The main species identified were groundsel bush, winter cassia, and pink lantana in the mid to upper reaches, and bitou bush, coastal morning glory and ground asparagus in the lower reaches.

According to the *Northern Rivers Invasive Plants Action Strategy 2009-2013* (*NRIPAS*; Oakwood, 2009), groundsel bush is the highest priority (Priority B) invasive weed species mapped during the field assessment. The Strategy also identifies winter cassia and bitou bush (Priority C) and coastal morning glory and ground asparagus (Priority D) as priority weeds in coastal landscapes, and lantana (Priority C) and coastal morning glory (Priority E) in riparian landscapes.

Weed control is a long-term and costly management action and so it is recommended that areas with important estuary values be targeted as a priority.

Illustration 2.1 identifies reaches where the riparian vegetation has been mapped as being in good to very good condition but where environmental weeds identified as either Priority B or C under the *NRIPAS* were also identified (ie. in this catchment: groundsel bush, senna/winter cassia, bitou bush, or lantana). These reaches are considered to be the highest priority for weed control for the next 5 years under this CZMP and should be the focus of the Weed Management Strategy for Darkum Creek.

Specific Tasks

It is recommended to develop a strategy based on existing mapping which:

- Whether the NRIPAS Priorities are appropriate for this catchment, in particular, whether ground asparagus should be considered a higher priority in the lower reaches in this catchment;
- Sets clear objectives for weed management along the estuary over a 5 year timeline;
- Identifies priority areas for control efforts;
- Defines responsibilities for control works;
- Outlines appropriate methods for control works in estuarine environments;
- Estimates the number of hours required for primary control works and estimates hours required for maintenance over the 5 year time period;
- Outlines a strategy for raising community awareness of actions which can contribute to the spread of environmental weeds along the estuary;
- Identifies funding sources;
- Sets monitoring and evaluation criteria.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ CHCC Related Agencies: ▪ North Coast LLS; ▪ Landcare.	Years 1 - 2	Strategy development ~ $5,000 if done external to CHCC.	North Coast LLS	The benchmark for this Action is the development of a recognised NRM Plan for the Management of priority weed species in priority areas of Darkum Creek.

Strategy Action 2.3 Undertake primary weed control in priority areas using specialist bush regeneration contractors				
Background: Estuarine and riparian areas are highly sensitive environments. As such, weed control work in these environments needs to be undertaken by specialist bush regenerators with skills in plant identification and knowledge of appropriate methods of control of weeds near waterways (especially where chemical control methods are to be used). In addition, such areas can be hazardous to workers, so it is essential that appropriate OHS strategies are implemented to ensure control works are undertaken in a safe manner. *Specific Tasks* ▪ Priority areas for weed control, species to be targeted, appropriate methods to be used, total available contract hours, and monitoring and evaluation actions/maintenance are to be defined in the Weed Management Strategy developed in Strategy Action 2.2 above. ▪ Priority works should where possible be scheduled into the operations/works plan of Council's Bush Regeneration team, alternatively specialist contractors could be engaged where funding is available Note. Refer to the Crown Land Authorisations information in the Introduction section if proposed works are to occur within Crown Lands.				
Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ CHCC Weeds Officer to provide oversight Related Agencies: ▪ North Coast LLS; ▪ Landcare	Years 2 – 5	Subject to development of the Weeds Management Strategy under Strategy Action 2.2 above. If external contractors are to be used, funds required is subject to the Weed Management Strategy but initially estimated at 200 hours per year @ $35/hr ($7,000/yr) over 5 years.	▪ North Coast LLS ▪ Environmental Trust Restoration and Rehabilitation grants. ▪ Grants through the NSW Government's Public Reserves Management Fund for weed control works on DoI – Crown Lands.[1] ▪ CHCC Environmental Levy.	The benchmark for this Action is the engagement of specialist contractors to control priority weeds in areas identified in the Weed Management Strategy developed in Strategy Action 2.2

Note: 1. Potential funding through the Public Reserves Management Fund, is only available where the works are managed under the Crown Lands Act 1989 (or equivalent), and subject to a competitive grant application process.

Strategy Action 2.4

Foster a local Bushcare group to undertake the secondary control or follow-up maintenance of areas treated by contractors.

Background:

The effective control of environmental weeds requires a long-term and consistent approach. To be successful, the initial control works undertaken by the CHCC team or specialist contractors needs to be followed by periodic maintenance to ensure areas cleared of weeds do not become re-infested by regrowth or new weed seedlings. A model that has worked in many parts of the North Coast region has been to support local care groups operating under the Landcare umbrella. Small scale funding and support in the form of insurance coverage and tools is often available through the Landcare network. Group activities are also often part funded via North Coast LLS small grants (where a recognised NRM Plan exists), via Council environmental levies, Environmental Trust grants, etc.

Specific Tasks

- Strategy Action 2.1 outlines proposed tasks designed to raise awareness amongst local residents on the sensitivity of the estuary foreshore area and the impact of environmental weeds in the estuarine/riparian environment.
- A small number of landholders along Darkum Creek Road have formed a loosely affiliated care group which may have interests in the creek environment. Further discussions with these community members may assist in establishing an active creek care group, supported by Coffs Landcare, the North Coast LLS, and CHCC.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ CHCC Related Agencies: ▪ North Coast LLS; ▪ Landcare.	Long term commitment required to support community groups	Dependent on activities, but generally limited to provision of tools, consumables, and support.	Support available through Coffs Landcare Network. Funding available through North Coast LLS. Any other grants available from time to time such as Environmental Trust Community Bush Regeneration and/or Restoration and Rehabilitation Grants.	The benchmark for this action is the successful formation of a Darkum Creek Care group which includes as its activities the long term maintenance of high conservation value riparian vegetation communities.

Drawn by: RE Checked by: MVE Reviewed by: TIM Date: July 2012

Information shown is for illustrative purposes only

Source of base data: Coffs Harbour City Council

LEGEND

- Riparian vegetation in good condition but with Bitou Bush present
- Riparian vegetation in good condition but with Groundsel, Winter Cassia and Lantana present
- Riparian vegetation in good condition with Mangrove community but with Groundsel present
- Riparian vegetation in good condition with Mangrove community but with Lantana present
- Riparian vegetation in very good condition but with Bitou Bush present

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North

Strategy 2 - Riparian Vegetation

GeoLINK

Coastal Zone Management Plan - Darkum Creek Estuary
1616446

Illustration 2.1

3

Strategy 3 – Water Quality

It is common practice to compare water quality measurements with guideline values in order to determine the status of water quality in an aquatic system. For the protection of aquatic ecosystems in coastal waterways such as Darkum Creek the most commonly applied guideline values are described by ANZECC (2000) and for the assessment of estuary condition OEH developed a set of guideline values based upon the salinity range in the waterway.

Comparison of existing water quality against guideline values revealed that turbidity, total nitrogen and chlorophyll-a measurements are all slightly elevated in Darkum Creek, based upon a limited set of samples and the available guidelines (GeoLINK *et al*. 2011a).

3.1 Summary of Proposed Actions

Elevated levels of turbidity, nitrogen and chlorophyll-a are most likely to be a result of inputs from urban and non-urban areas in the catchment. As there are no point source inputs of sediments and nutrients into Darkum Creek the main strategy available to reduce these pollutants loads is reducing the concentrations of sediments and nutrients in diffuse runoff from rural areas and in stormwater from urban areas. This is adequately addressed in the Strategy 1 actions of this CZMP. The only additional action proposed is:

- Minimise the input of animal faecal materials into the waterway.

3.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 5 Aquatic Habitats
- Strategy 6 Climate Change Impacts on Water Quality
- Strategy 9 Water Quality Monitoring

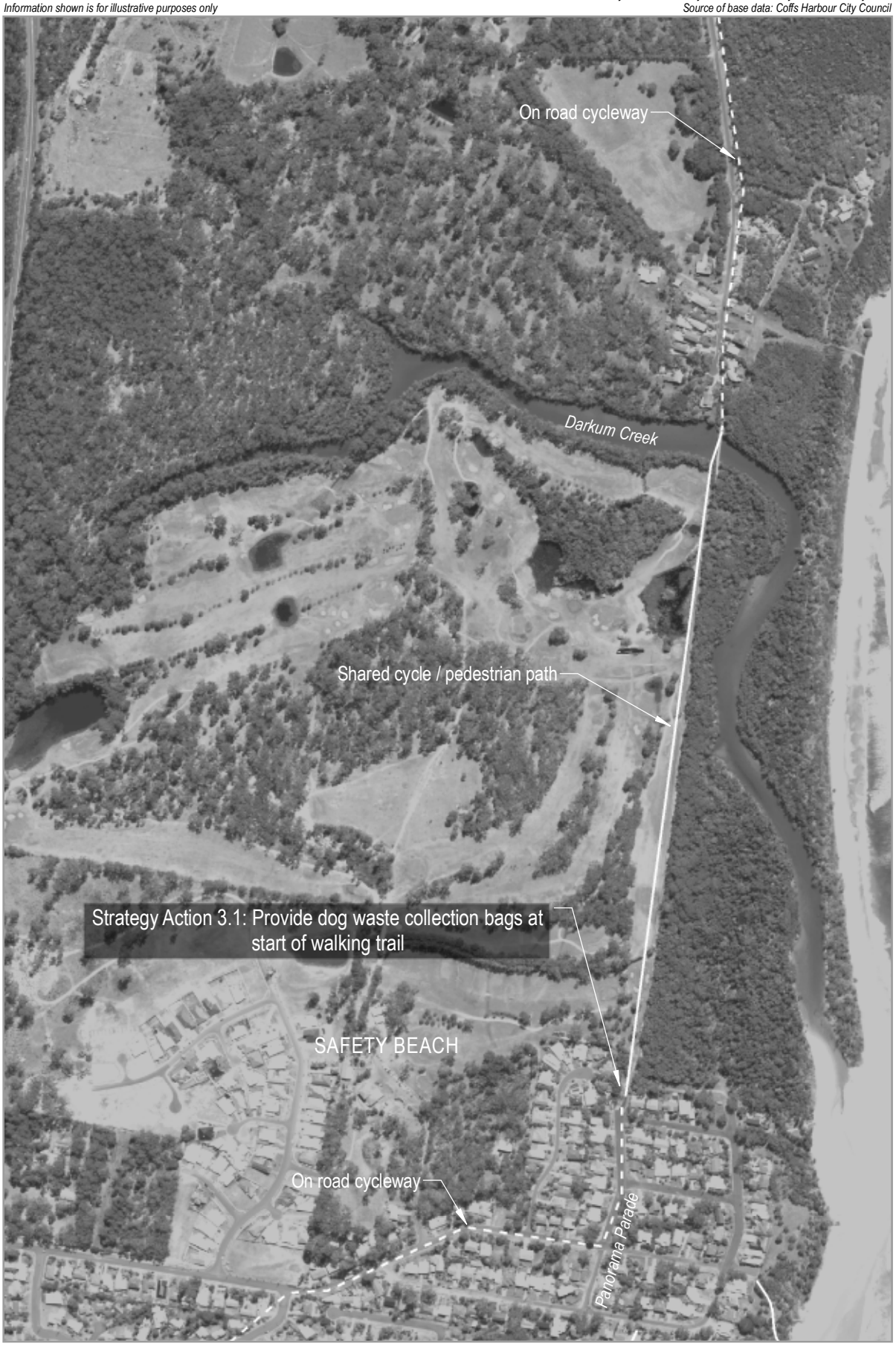
3.1.2 Objectives Addressed

- Protect and Enhance Aquatic Habitats
- Improve Water Quality

3.2 Details of Proposed Actions

Strategy Action 3.1 Minimise domestic pet faecal inputs to the waterway.				
Background: Animal faecal material washed into waterways can contribute significantly to nutrient loads (as well as faecal indicator organism concentrations). Whilst the contribution from native animals such as wading birds and mammals that inhabit the riparian zone cannot be controlled a reduction in nutrient contributions from domestic pets can be achieved by responsible pet ownership. *Specific Tasks* ▪ Provide waste collection bags at the heads of walking trails; ▪ Educate pet owners about the effects of pet faecal materials on waterways in ratepayer newsletters and council newspaper advertisements; and ▪ Police council policies with respect to pet ownership.				
Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 2 – 3	Staff time Installation of units $1500 p/unit Maintenance of units $1000 per unit p/annum	CHCC Environmental Levy	Release of educational materials and installation of waste collection bag units.

Information shown is for illustrative purposes only



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North

Strategy 3 - Water Quality

GeoLINK environmental management and design

Coastal Zone Management Plan - Darkum Creek Estuary
1616846

Illustration 3.1

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Strategy 4 - Urban Development

Residential land is a significant contributor of sediment and nitrogen loads to waterways. This indicates that investment into effective stormwater management could be an effective means of improving overall estuary health. Projected future growth in the Woolgoolga area includes a review of urban expansion potential for future residential area over a portion of the golf course adjoining Darkum Creek for long term growth (beyond 2016) (Coffs Harbour City Council, 2011a) – refer to Plate 4.1 below. There is also possible long term urban expansion area west of the existing highway should population targets be achieved sooner than currently predicted.

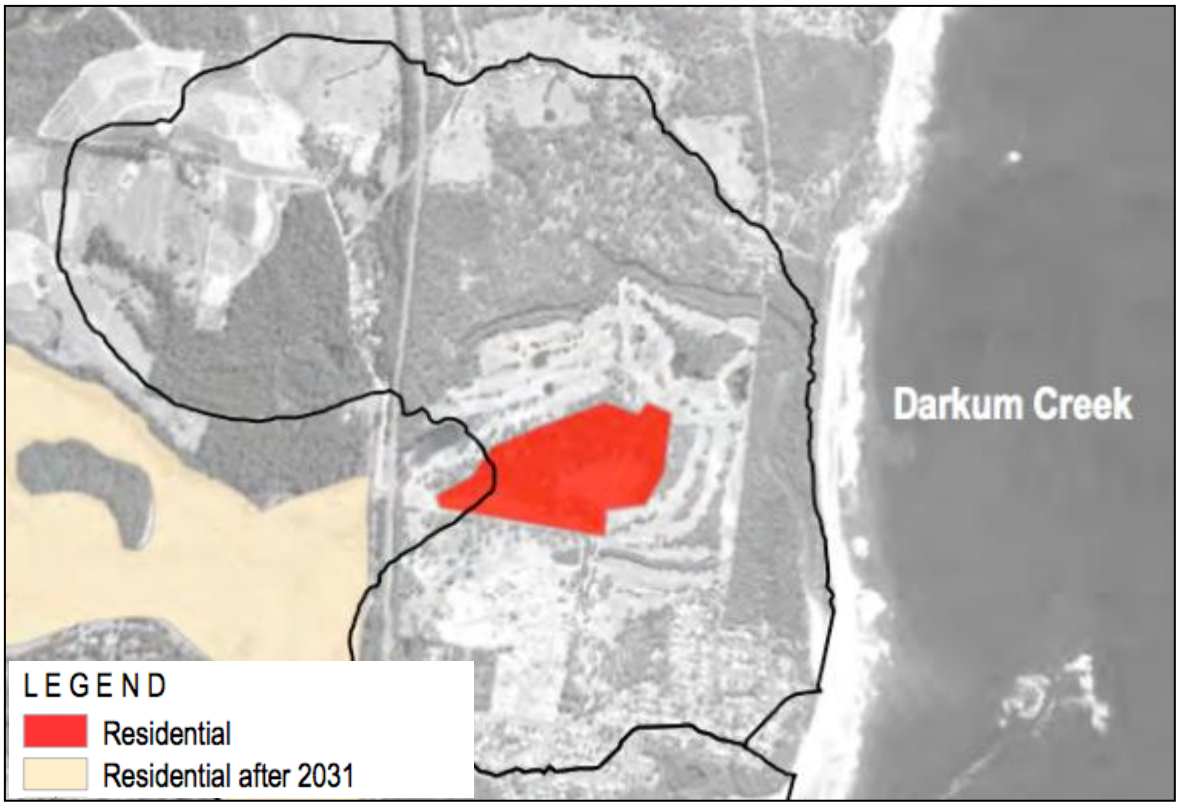

Plate 4.1 Future Growth Areas

New development areas have the potential to reduce the quality of catchment runoff during and after the construction phase. It is important that controls placed on new developments are sufficient and enforced to ensure no negative net impact upon water quality or the hydrology of the catchment.

4.1 Summary of Proposed Actions

Strategy Action 1.3 (Stormwater management for urban development) is considered adequate to address this issue. No further actions are proposed to address this issue.

4.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 3 Water Quality

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5

Strategy 5 - Aquatic Habitats

A decline in the area and condition of seagrass beds, mangroves, saltmarsh and sedge heath communities were identified by CEMAC as possible issues concerning Darkum Creek. Detailed mapping analysis of aquatic habitats (GeoLINK et al. 2011a) shows that seagrass has disappeared from Darkum Creek in recent years and saltmarsh and mangrove habitats show signs of disturbance – refer to Illustration 5.1.

The factors causing the decline in the area of seagrass are uncertain. Natural fluctuations in the area of seagrass are a common characteristic of ICOLLs. However, factors commonly associated with seagrass loss that may be present in Darkum Creek include:

- high suspended sediment loads in catchment runoff; and
- natural fluctuations in the position of the marine tidal delta.

The (North Coast) Local Land Services (LLS) Catchment Action Plan (CAP) lists rehabilitation of aquatic habitats among its goals.

5.1 Summary of Proposed Actions

The following actions from other strategies are considered adequate to address the issue of loss of aquatic habitats:

- Strategy Action 1.4 Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with the creeks natural values;
- Strategy Action 2.1 to raise awareness in the local community of the importance of aquatic habitats along the and foreshore of Darkum Creek;
- Strategy 1 actions to reduce the inputs of sediment from the catchment to maximise the opportunities for the recruitment of seagrass to the system.

No further actions are proposed.

5.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 2 Riparian Vegetation
- Strategy 3 Water Quality
- Strategy 6 Climate Change Impacts on Water Quality
- Strategy 8 Climate Change Impacts on Estuary Ecology

5.1.2 Objectives Addressed

- Protect and Enhance Aquatic Habitats

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6

Strategy 6 – Climate Change Impacts on Water Quality

Forecast climate change and sea level rise scenarios are likely to result in a number of changes to water quality processes in ICOLLs such as Darkum Creek. Some of the impacts will be direct, such as changes to average water temperature, whilst some will be indirect, following on from changes to physical processes such as hydrodynamics (Haines 2006). Climate change scenarios may also result in an intensification of existing issues with water quality. Addressing current issues in accordance with Strategy 1 actions will be the best preparation for the impacts of climate change on water quality. No further actions are proposed to address this issue.

6.1 Summary of Proposed Actions

Addressing current issues in accordance with Strategy 1 actions will be the best preparation for the impacts of climate change on water quality. No further actions are proposed to address this issue.

6.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 3 Water Quality
- Strategy 4 Urban Development
- Strategy 5 Aquatic Habitats
- Strategy 8 Climate Change Impacts on Estuary Ecology
- Strategy 9 Water Quality Monitoring

6.1.2 Objectives Addressed

- Protect and Enhance Aquatic Habitats
- Improve Water Quality

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7

Strategy 7 - Recreational Use

Darkum Creek is a relatively small and remote coastal estuary with a generally undisturbed and attractive natural setting. The creek is a valuable asset for the local community and provides opportunity for a range of low key recreational activities such as kayaking, fishing, bird watching and bush walking. A path and footbridge cuts a significant corridor through the area providing a continuous pedestrian and cycle route connecting the residential communities of Arrawarra in the north to Woolgoolga in the south – refer to Illustration 7.1. Apart from this route there are no other recreational facilities and it is understood that minimal facilities is much favoured by local residents. Accordingly, the objective of this strategy is to preserve the natural and cultural values of the estuary and to minimise the level of support required to sustain the existing level of recreational activity.

7.1 Summary of Proposed Actions

- Maintain the existing minimum level of access and recreational activity to preserve the natural and cultural heritage values of the creek environment by providing simple additional infrastructure where necessary to support and enhance existing low levels of passive recreational activity. Undertake restoration works on an as-needs basis to sustain the significant and dominant natural values of the estuary environment.
- Incorporate discrete interpretive signage to enhance visitor appreciation and enjoyment of the site's natural and cultural heritage values.

7.1.1 Related Strategies

- Strategy 2 Riparian Vegetation
- Strategy 11 Loss of Visual Amenity

7.1.2 Objectives Addressed

- Protect and Enhance Aquatic Habitats;
- Preserve the Quiet, Undeveloped, Natural Setting of the Creek Foreshores

7.2 Details of Proposed Actions

Strategy Action 7.1
Protect cultural heritage and natural values of the creek and catchment by maintaining the existing minimum level of access and recreational activity
Background: Existing recreational use of the estuary environment is very low key and is of secondary significance to the site's natural values. The provision of discrete, low key infrastructure to minimise site impacts will ensure the preservation of the natural and cultural heritage values while maintaining the existing unspoilt setting for the continued enjoyment of users. *Specific Tasks* ▪ Liaise with bush-walkers, recreational walkers/runners within the area to identify issues associated with preferred access routes; ▪ Undertake minor path enhancement work such as steps or retaining wall construction to ensure path

routes cause minimal environmental and visual impact; and

- Undertake weed removal and revegetation work if necessary to restore disturbed areas adjoining the pedestrian and cycle routes

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Ongoing	Staff time	CHCC operating budget	Inspect paths routinely to monitor use levels and possible environmental damage

Strategy Action 7.2

Incorporate additional interpretive signage within the estuary area.

Background

While not a significant issue, there is a lack of interpretive signage which would otherwise provide visitors with a greater sense of orientation and an enhanced understanding of the site's cultural heritage aspects and natural attributes as part of a larger coastal resource.

Specific Tasks

- Install new discrete informational signs and maps at key rest points along the existing shared cycle - footpath and at public vantage points such as the existing footbridge to improve pedestrian legibility, orientation, interpretation and enjoyment of the estuary environment generally. Highlight starting points of tracks with signs or maps for optimal legibility. The design and provision of signs should adopt a consistent theme and form part of a coordinated system developed for all coastal estuaries. Consideration should also be given to incorporating elements from:
  - Strategy Action 2.1 regarding raising awareness in the local community of the importance of native riparian vegetation and aquatic habitats along the banks and foreshore of Darkum Creek. Identification of riparian vegetation, mangroves and saltmarsh; and
  - Strategy Action 11.4 regarding raising awareness of the natural opening and closing regime of Darkum Creek.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 – 2	$2,000 for signage	▪ CHCC operating budget ▪ Caring for Our Country ▪ CHCC Environmental Levy	Check for preventative and corrective maintenance on an ongoing basis once signs are installed.

Drawn by: RE Checked by: MVE Reviewed by: TIM Date: August 2012

Information shown is for illustrative purposes only

Source of base data: Coffs Harbour City Council

LEGEND

Crown land reserves

0 150

North

Strategy 7 - Recreational Use

GeoLINK environmental management and design

Coastal Zone Management Plan - Darkum Creek Estuary
1616848

Illustration 7.1

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8

Strategy 8 - Climate Change Impacts on Estuary Ecology

Under current projections for climate change and associated sea level rise there are likely to be a number of impacts upon estuary ecology. These may include direct impacts upon mangroves and saltmarsh and direct impacts upon fish diversity and abundance.

It is expected that mangroves communities will typically migrate landward in response to higher lake water levels. The distribution and species of mangroves may change due to higher water temperatures (Walsh, 2004a cited in Haines, 2006). Saltmarsh communities are considered to be particularly vulnerable to increases in average lake water levels, as they occupy relatively flat ground near the waters edge. Small changes in sea level will therefore result in extensive inundation (Walsh, 2004a cited in Haines, 2006). Further, landward migration of saltmarsh, mangroves, and other wetland communities in response to rising lake water levels may be restricted by existing development or barriers (e.g. natural elevated banks adjoining the creek) resulting in a loss of habitat (Pittock, 2003; Walsh, 2004b, Gilman, 2004 cited in Haines, 2006).

There may also be indirect impacts upon estuary ecology related to climate change impacts upon water quality. Strategies that will reduce the impacts of forecast climate change scenarios upon water quality are discussed under Strategy 6.

8.1 Summary of Proposed Actions

- Implement development control provisions to facilitate upslope migration of mangroves and saltmarsh in response to sea level rise.

8.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 2 Riparian Vegetation
- Strategy 5 Aquatic Habitats
- Strategy 6 Climate Change Impacts on Water Quality

8.1.2 Objectives Addressed

- Protect and Enhance Aquatic Habitats
- Make Provisions for the Ecological Effects of Climate Change and Sea Level Rise
- Preserve the Quiet, Undeveloped, Natural Setting of the Creek Foreshores

8.2 Details of Proposed Actions

Strategy Action 8.1

Implement development control provisions to facilitate upslope migration of mangroves and saltmarsh in response to sea level rise.

Background:

Currently, mangroves and saltmarsh in Darkum Creek are mostly located below the 1.5 mAHD contour line and all located below the 2 mAHD contour line. The response of mangroves and saltmarsh colonies to sea level rise forecasts is likely to be a mixture of sediment accretion (ie, no migration) and upslope migration. The exact balance will be dependent upon a variety of geomorphic, biogeographic and development factors that will vary significantly by location. However, it can be safely assumed that the future total vertical migration of mangroves and saltmarsh is likely to be closely aligned with future total sea level rise (i.e approx. 0.9m by 2100) as the distribution of saltmarsh and mangroves is strongly defined by tidal heights. In areas where upslope migration is made possible by low sloping land, low development pressure and compatible current landuse careful planning for the future may result in improved outcomes.

In addition to buffers allowing the upslope migration of mangroves and saltmarsh it is important to allow horizontal buffers for landward migration of riparian vegetation so that a suitable riparian strip is maintained under sea level rise scenarios. Current best practice suggests that a 40m riparian buffer is suitable for maintaining the environmental integrity of estuaries (see Strategy Action 1.5 and NSW Office of Water, 2011).

A significant area of the Darkum Creek foreshore where retreat of mangroves and saltmarsh is likely to occur falls within the following areas / zones:

- golf course area which is zoned 6C – Open Space 6C Private Recreation Zone. It is noted that a portion of this area is marked for review for urban expansion potential for future residential area for long term growth (beyond 2016) (Coffs Harbour City Council, 2011a) – refer to Illustration 7.1. The area mapped for urban expansion potential appears to be located beyond a horizontal buffer of 40 m landward from the 3 mAHD contour line;
- an area zoned 1A Agriculture Zone on the northern side of Darkum Creek (approximately 450 m upstream of the footbridge); and
- 6A – Open Space and Public Recreation and 7A – Environmental Protection Habitat and Catchment. This is considered an adequate zoning for the protection of vertical and horizontal buffers for the upslope migration of saltmarsh and mangroves resulting from sea level rise over the near future.

In the case that changes to the current zoning of foreshore land around Darkum Creek be proposed or the Coffs Harbour LEP is reviewed, appropriate horizontal and vertical buffers must be protected to ensure the future integrity of mangrove and saltmarsh habitat in addition to a riparian buffer zone. A vertical buffer incorporating the 3 mAHD contour line and a horizontal buffer of 40 m landward from the 3 mAHD contour line will be adequate to preserve the ecological integrity of the system.

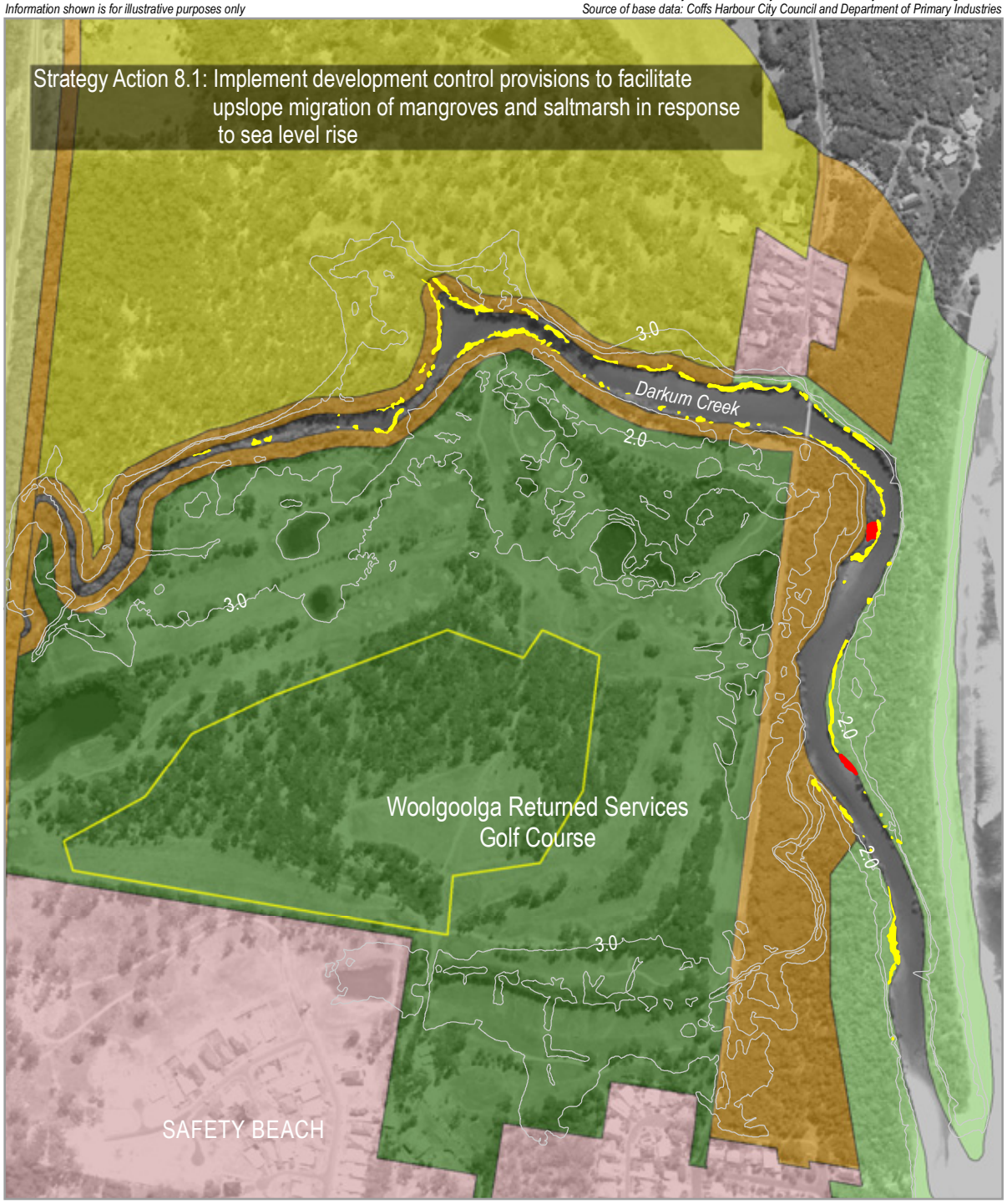
Specific Tasks

- Map a buffer zone around Darkum Creek incorporating all lands currently zoned 1A, 6A, 6C and 7A falling within 40 m landward of the 3 mAHD contour line.
- Develop Development Control Plan (DCP) provisions for the above buffer zone that controls or limits development within the buffer zone such that potential upslope migration of mangroves and saltmarsh is not impeded.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 – 2	Staff time	CHCC operating budget	Prepare report that describes priority potential areas for future colonisation

Information shown is for illustrative purposes only

Drawn by: RE Checked by: MVE Reviewed by: TIM Date: August 2012
Source of base data: Coffs Harbour City Council and Department of Primary Industries



LEGEND

- Saltmarsh (Department of Primary Industries - 2011)
- Mangrove (Department of Primary Industries - 2011)
- Proposed agreed residential growth area
- 1A Rural Agriculture
- 2A Residential Low Density
- 5A Classified Road
- 6A Open Space and Public Recreation
- 6C Open Space Private Recreation
- 7A Environmental Protection Habitat and Catchment
- 7B Environmental Protection Scenic Buffer
- Contour at 2.0 and 3.0 m AHD

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North

Strategy 8 - Climate Change Impacts on Estuary Ecology

GeoLINK environmental management and design

Coastal Zone Management Plan - Darkum Creek Estuary
1616851

Illustration 8.1

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Strategy 9 - Water Quality Monitoring

The collection of water quality data is an important aspect of overall estuary management. When collected in a suitable fashion, water quality data informs managers of:

- natural and unnatural processes occurring in the waterway;
- risks to public safety associated with recreational pursuits;
- risks to public safety associated with the consumption of aquatic foods;
- potential risks to aquatic ecosystems;
- trends with respect to the 'health' of the aquatic system; and
- the effects of soil, water and other management strategies put in place throughout the catchment.

The long term dataset available for Darkum Creek is not detailed or consistent enough to provide clear information about a number of the above listed items.

9.1 Summary of Proposed Actions

- Continue to implement the Ecohealth water quality monitoring program for Darkum Creek.

9.1.1 Related Strategies

- Strategy 1 Stormwater Management and Catchment Pollutants
- Strategy 3 Water Quality
- Strategy 6 Climate Change Impacts on Water Quality

9.1.2 Objectives Addressed

- Improve Water Quality
- Improved Monitoring of Water Quality

9.2 Details of Proposed Actions

Strategy Action 9.1 Continue to implement the Ecohealth water quality monitoring program for Darkum Creek.

Background:

The Ecohealth program outlines a framework for the development of a catchment-based aquatic health monitoring program in the North Coast region to provide consistency in monitoring and reporting, and establish the partnerships required for local and regional participation in the sampling program, identification of appropriate management actions and communication of outcomes. The Ecohealth program integrates information from the NSW Monitoring, Evaluation and Reporting (MER) Program, NSW State of Environment (SoE) reports, and a range of other reporting programs.

Darkum Creek is currently included in the Ecohealth water quality monitoring program. However, the combined water quality dataset for Darkum Creek has been identified as lacking in continuity and detail. Continuation of the Ecohealth water quality monitoring program for Darkum Creek will assist in supplementing the current water quality dataset.

Specific Tasks

- Continue to implement the Ecohealth water quality monitoring program for Darkum Creek with a review of:
  - appropriate temporal and spatial scales for sampling; and
  - a comprehensive list of parameters that will add to the understanding of the health of Darkum Creek;

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
Lead Agency: ▪ CHCC Related Agencies: ▪ North Coast LLS; ▪ OEH; ▪ MPA - SIMP	Ongoing	$20,000 every 4 years	▪ CHCC operating budget. ▪ MPA - SIMP: in kind assistance	Reporting every 4 years in line with SoE reporting

Strategy 10 - Visual Amenity

Darkum Creek offers a predominantly undisturbed natural environment that forms an integral and important component of the natural settings along the coastline. In particular, the creek setting offers the following scenic values:

- the creek and its foreshores contribute significantly to the character and amenity of the surrounding residential communities;
- the creek has relatively short reaches and heavily vegetated foreshores which offer considerable shelter from prevailing winds. The resulting tranquil water combined with the surrounding riparian vegetation offer considerable scenic amenity;
- the creek itself is largely only visible from the footbridge which offers an excellent vantage point in both upstream and downstream directions;
- an attractive long distant view across a downstream reach of the creek is also available from its mouth at Safety Beach; and
- the creek is also likely to be visible through openings in vegetation from the adjoining golf course.

The purpose of this strategy is to ensure that the visual amenity afforded by the natural environment of the creek as described above is preserved and enhanced.

10.1 Summary of Proposed Actions

The following actions from other strategies are considered adequate to address the issue of preserving and enhancing the visual amenity of Darkum Creek estuary:

- Strategy Action 1.4 Woolgoolga Returned Services Golf Course – ensure maintenance practices are complementary with the creeks natural values;
- Strategy Action 2.3 to develop a weed management strategy which prioritises riparian areas and priority weeds to be targeted which will assist in maintaining the existing natural character of the estuary;
- Strategy Action 7.1 to provide simple additional infrastructure where necessary to support and enhance existing low levels of passive recreational activity and undertake restoration works on an as-needs basis to sustain the significant and dominant natural values of the estuary environment;
- Strategy Action 7.2 to address the need for interpretive information to enhance visitor enjoyment and appreciation of the creek's natural values.

No further actions are proposed.

10.1.1 Related Strategies

- Strategy 2 Riparian Vegetation
- Strategy 7 Recreational Use

10.1.2 Objectives Addressed

- Protect and Enhance Aquatic Habitats;
- Preserve the Quiet, Undeveloped, Natural Setting of the Creek Foreshores

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Strategy 11 - Entrance Management

Flood level estimates and inundation mapping associated with elevated ocean levels at Darkum Creek estuary indicates there are no properties or infrastructure currently at risk of flooding with the exception of areas of the Woolgoolga Returned Services golf course that adjoin the creek. However, sea level rise caused by climate change will result in higher flood inundation levels within the estuary in the future.

Current inundation levels are likely to increase by a similar amount as sea level rise increases. Adopted sea level rise estimates for NSW are a 0.4 m increase in sea level by 2050 (relative to 1990 levels) and a 0.9 m increase by 2100. Climate change also has the potential to result in an increased frequency of high rainfall events leading to more frequent flooding events.

Current 1 in 100 year flood levels for Darkum Creek are approximately 2.6 m AHD near the footbridge over Darkum Creek and 3.3 m AHD near Panorama Parade (email: M. Robertson, Coffs Harbour City Council, 10/05/2012). These flood levels will potentially increase in the future in response to sea level rise impacts. The increase may be in the order of +0.4 m by 2050 and +0.9 m by 2100. It is noted that coastal inundation levels (elevated ocean water levels during a storm) as reported in the *Coffs Harbour Coastal Processes and Hazards Definition Study* (BMT WBM, 2011a) are similar to these flood levels. It is also noted that probable entrance berm heights reported in the BMT WBM study are:

- in the range of 1.3 m AHD for an 'almost certain' probability (in which case the higher elevated ocean levels would be the influencing factor on flood levels within the estuary for large flooding events); and
- 2.4 m AHD, 2.8 m AHD and 3.3 m AHD as an 'unlikely' probability for the immediate timeframe and the years 2050 and 2100 respectively. These levels are similar to the above 1 in 100 year flood levels for Darkum Creek (near the footbridge).

In consideration of the above levels, it is considered appropriate for the purpose of this strategy to assume flood levels for the estuary will be in the range of:

- 2.6 m AHD near the footbridge over Darkum Creek and 3.3 m AHD near Panorama Parade in the immediate term; with
- Increases in flood levels by up to +0.4 m by 2050 and +0.9 m by 2100 in response to sea level rise impacts.

Higher flood levels resulting from sea level rise and other climate change impacts may present a risk of backyard flooding to some properties in the lower northern portion of Safety Beach in the vicinity of Panorama Parade, Baroona Street and Ocean Links Close. An indication of the approximate extent of flooding is shown by the 3.5 m AHD contour level in Illustration 11.1 (refer also to Plate C.2 in Appendix C for coastal inundation extent in the year 2050). Some sewage pump stations (eg. PS 6 located to the north of Panorama Parade) may also be at risk of flooding. This would potentially lead to sewage overflows entering the creek system.

The objective of this strategy is to minimise or avoid future flooding of properties and infrastructure by appropriate means such as development controls in flood prone areas; artificial opening of the creek entrance where appropriate; flood-proofing infrastructure; etc. A supplementary objective of this strategy is to develop an entrance management policy for the entrance with the aim of maintaining a natural opening / closing regime for the creek entrance. Interference (artificial opening of the entrance) would only be employed for critical situations such as to mitigate and reduce the impacts of flooding on properties and infrastructure adjoining the creek.

11.1 Summary of Proposed Actions

The following actions are proposed:

- Address future flooding risks that have the potential to trigger artificial opening of the entrance;
- Prepare a Review of Environmental Factors for artificial opening of the entrance to Darkum Creek estuary;
- Adopt and implement the Darkum Creek Entrance Management Policy detailed in this CZMP;
- Raise community awareness of the natural opening and closing regime of Darkum Creek.

11.1.1 Related Strategies

There are no directly related strategies.

11.2 Details of Proposed Actions

Strategy Action 11.1

Address flooding risks that have the potential to trigger artificial opening of the entrance in the future

Background:

Increased flood levels resulting from climate change impacts may present a risk of backyard flooding in the future to some properties in the lower northern portion of Safety Beach in the vicinity of Panorama Parade, Baroona Street and Ocean Links Close – refer to Illustration 11.1. Some sewage pump stations (eg. PS 6 located to the north of Panorama Parade) may also be at risk of flooding. There are also some sewer manholes within the golf course property near Ocean Links Close that may be at risk of flooding which could potentially lead to excessive inflow to the local sewerage system and subsequent sewage overflows entering the creek system.

The need for artificially opening the estuary entrance for future flood mitigation purposes can be avoided by implementing measures such as removing, relocating or otherwise managing items of low-lying infrastructure at risk of flooding which necessitates artificial openings. The intention of this objective is to minimise the need for interference to the natural opening / closing regime of the lake entrance.

Specific Tasks

- undertake and audit of low-lying infrastructure and properties to identify key services and assets vulnerable to sea level rise impacts around Darkum Creek which have the potential to necessitate artificial opening of the entrance (eg. sewer PS 6, sewer manholes within the golf course property near Ocean Links Close and properties in the lower northern portion of Safety Beach in the vicinity of Panorama Parade, Baroona Street and Ocean Links Close). Develop appropriate strategies where necessary for flood-proofing, relocation, replacement or modification of these services, assets and properties.
- Flood-proof, relocate, replace or modify essential services, assets and properties where appropriate to reduce potential for disruption and/or the need for artificial opening of the entrance.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 –5 for audit and assessment Years 5 - 25 for relocate, replace or modify essential services and assets	Audit and assessment: $10,000 Augmentation works: dependant on proposed works	NSW Government Estuary Management Program	Implementation of this action is an appropriate benchmark

Strategy Action 11.2

Prepare a Review of Environmental Factors for artificial opening of the entrance to Darkum Creek estuary

Background:

Darkum Creek is an ICOLL system that is predominantly closed. The entrance opens and closes to the ocean naturally in a constant but irregular cycle depending on fluvial, tidal and wave processes. Artificial opening of ICOLL's can have significant negative impacts on water quality, fish and other ecological communities.

There are no records of artificial opening of the entrance being used in the past. Community consultation has not indicated any desire for artificial opening of the creek entrance. Nor is there currently any significant need for artificial opening for the purpose of flood mitigation. Nevertheless, a formal entrance management policy for Darkum Creek is required in accordance with OEH *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010).

Works / activities for the purpose of flood mitigation or waterway / foreshore management (to address an extreme water quality issue) would be permitted without consent under Clause 50 of the State Environmental Planning Policy (Infrastructure), 2007. However the requirements of Part 5 of the EP&A Act 1979 must be fulfilled and Council is required to prepare a REF for proposed works / activities (e.g. artificial opening of the entrance to Darkum Creek estuary). The REF needs to be consistent with the adopted CZMP and entrance management policy for Darkum Creek estuary.

Specific Tasks

Prepare an REF for artificial opening of the entrance to Darkum Creek estuary in consultation with relevant state government agencies. The REF will confirm the necessary approvals and licences required for artificial opening of the entrance. NB Strategy Action 11.3 will need to be completed prior to preparing the REF.

Note. Refer to the Crown Land Authorisations information in the Introduction section if proposed works are to occur within Crown Lands.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 – 5	Staff time	CHCC operating budget	Implementation of this action is an appropriate benchmark.

Strategy Action 11.3

Refine, adopt and implement Darkum Creek Entrance Management Policy

Background:

The development of an entrance management policy is a requirement for Coastal Zone Management Plans for ICOLL's under the OEH *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010). Therefore a policy has been drafted with the aim to:

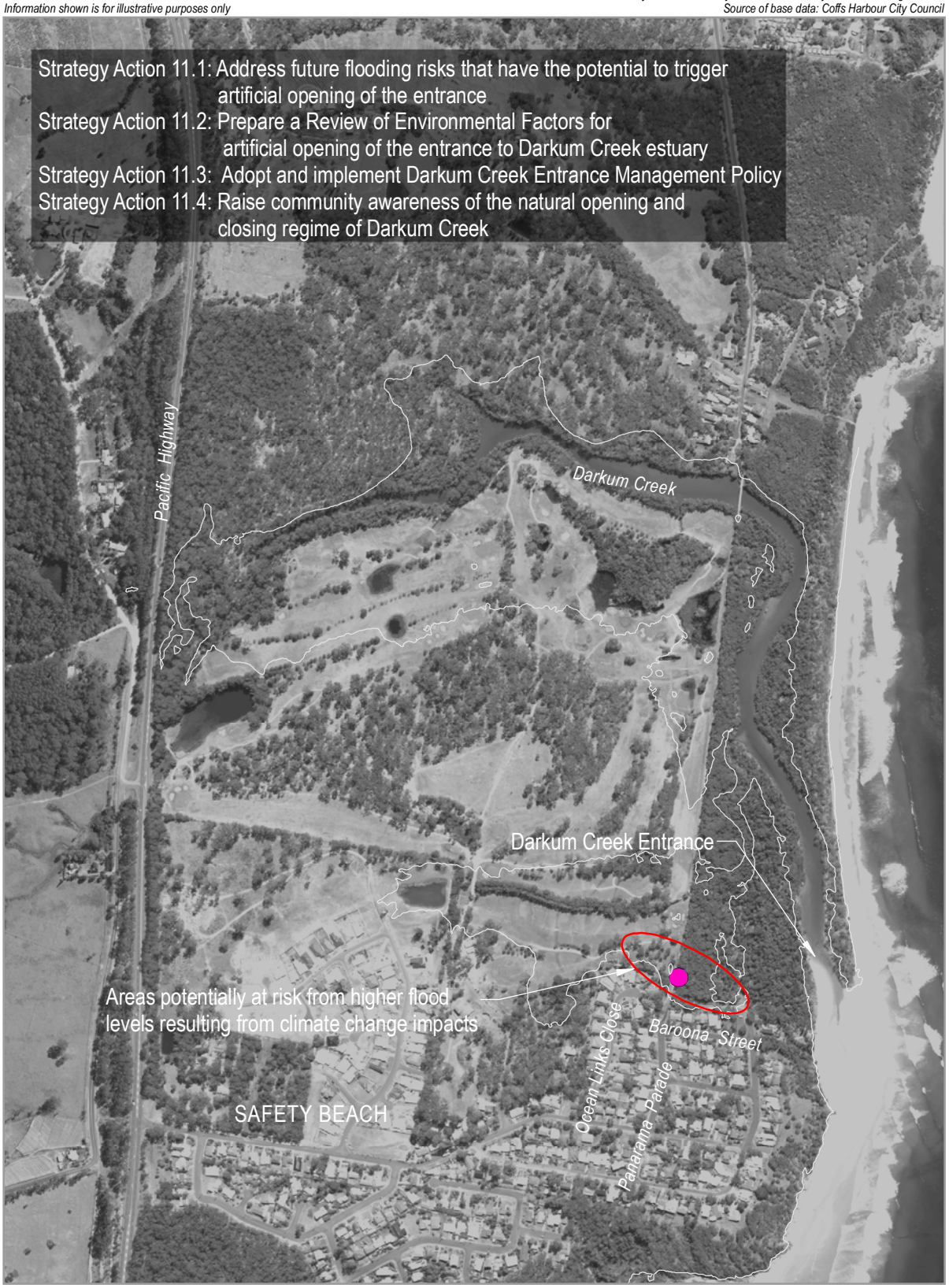
- minimise interference with the natural opening and closing regime for the estuary;
- address extreme water quality issues in the estuary;
- minimise flooding of properties and infrastructure from elevated water levels in the estuary.

Specific Tasks

- Refine the Darkum Creek Entrance Management Policy outlined in this CZMP (refer to Appendix A) based on the outcomes of the REF under Strategy Action 11.1;
- Adopt and implement the Darkum Creek Entrance Management Policy.

Note. Refer to the Crown Land Authorisations information in the Introduction section if proposed works are to occur within Crown Lands.

Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 – 5	Staff time for adoption of policy.	CHCC operating budget	Implementation of this action is an appropriate benchmark.
Strategy Action 11.4 Raise community awareness of the natural opening and closing regime of Darkum Creek.				
Specific Tasks To assist with establishing broad based community understanding and support for the entrance management policy for Darkum Creek it is recommended that development of interpretive signage under Strategy Action 7.2 considers the inclusion of information on the natural opening and closing regime of Darkum Creek.				
Responsible Agencies	*Timeframe*	*Cost*	*Potential Funding Sources*	*Monitoring*
CHCC	Years 1 – 5	Included in the costs in Strategy Action 7.2	Caring for Our Country	Implementation of this action is an appropriate benchmark.



LEGEND

Contour at 3.5 m AHD

Sewer pump station 6

North

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Strategy 11 - Entrance Management

GeoLINK environmental management and design

Coastal Zone Management Plan - Darkum Creek Estuary
1616852

Illustration 11.1

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Acronyms

AHD	Australian Height Datum
ANZECC	Australia and New Zealand Environment Conservation Council
APZ	Asset Protection Zone
ASS	Acid sulfate soils
CAP	Catchment Action Plan
CCA	Comprehensive Coastal Assessment
CEMAC	Coffs Harbour City Council Coastal Estuary Management Advisory Committee
CHCC	Coffs Harbour City Council
CMSS	Catchment Management Support System
DO	Dissolved Oxygen
DoI	NSW Department of Industry
DPI	NSW Department of Primary Industries
EMS	Estuary Management Study
ICOLL	Intermittently Closed and Open Lake and Lagoon
LGA	Local Government Area
MER	Monitoring Evaluating and Reporting
MHL	Manly Hydraulics Laboratory
MPA	Marine Parks Authority
LLS	(North Coast) Local Land Services
NRIPAS	Northern Rivers Invasive Plants Action Strategy 2009-2013
OEH	Office of Environment and Heritage, NSW Department of Premier & Cabinet
OEH – PWG	Office of Environment & Heritage – Parks & Wildlife Group
SIMP	Solitary Islands Marine Park
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WSUD	Water Sensitive Urban Design

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Appendix A

Entrance Management Policy
Darkum Creek Estuary

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Entrance Management Policy

Darkum Creek Estuary

Prepared for: Coffs Harbour City Council and
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Version History				
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1616529	Final Draft	06/07/2012	Tim Ruge	Cate Walsh
1616-1002	Draft for Public Exhibition	15/08/2012	Tim Ruge	Cate Walsh
1616-1008	FINAL	31/01/2013	Tim Ruge	Kim Casson

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Illustrations

Tables

1 Introduction

1.1 Reason for this Policy

The entrance to the Darkum Creek estuary naturally alternates between being open or closed to the ocean. These types of estuaries are known as an ICOLL's - Intermittently Closed and Open Lakes and Lagoons.

Many ICOLL's are manually or artificially opened to the ocean by authorities to 'drain' the estuary for a range of reasons, often to reduce the impacts of flooding around the estuary foreshores. However, artificially opening ICOLL's can impact on estuary health. Therefore a Policy is required to outline to Council if and when the entrance to Darkum Creek estuary should be artificially opened.

1.2 The Purpose of this Policy

The purpose of this Policy is to provide Council with criteria for initiating an artificial opening event and a procedure for artificial opening of the entrance of Darkum Creek estuary.

1.3 Policy Statement

The Darkum Creek Entrance Management Policy aims to:

- minimise interference with the natural opening and closing regime for Darkum Creek estuary;
- minimise flooding of properties and infrastructure from elevated water levels in the estuary; and
- provide a procedure to address extreme water quality issues in the estuary;
- detail procedures and responsibilities for artificial opening of the estuary entrance; and
- detail procedures for monitoring following an artificial opening event.

This Policy will be implemented by Coffs Harbour City Council in consultation with the appropriate NSW Government agencies.

1.4 Area to Which this Policy Applies

The area covered by this Policy is shown in **Illustration 1.1**. This Policy applies to the catchment of the estuary which comprises of the waterway, foreshores and land adjacent to the estuary up to the tidal limit of the tributary creeks and the extent of the drainage catchment directly contributing to the estuary waterways. The area relevant to this Policy also includes the proposed access route along Woolgoolga Beach for excavator access to the estuary entrance.

1.5 Policy Context

This Policy has been prepared as part of the Coastal Zone Management Plan (CZMP) for Darkum Creek estuary. CZMP's for estuaries are prepared in accordance with Part 4A of the *Coastal Protection Act 1979* and the *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010). These guidelines require CZMP's for ICOLL's to include an Entrance Management Policy.

A range of NSW legislation and policies are relevant to estuary management and the establishment of any Entrance Management Policy and subsequent artificial opening procedures.

There may be a range of statutory approvals / licensing requirements that need to be sought in order to undertake entrance management activities, for example artificial opening. A range of approvals may be required due to potentially different land tenures, zonings and statutory provisions. These provisions may include Crown Lands licence under the NSW Crown Lands Act 1989, concurrence from NSW Fisheries for dredge and reclamation work on defined water land under the NSW Fisheries Management Act 1994, or other approvals and licences under the National Parks and Wildlife Act 1974 or the Marine Parks Act 1997.

In addition, the Environmental Planning and Assessment Act 1979 establishes the framework for development control and assessment in NSW. Certain activities may require approval under this Act and associated State Environmental Planning Policies (SEPP) (e.g. SEPP (Infrastructure) 2007). Certain works or activities may either require development consent or be exempt from requiring consent. In the case where works or activities may be exempt from requiring consent, a Review of Environmental Factors (along with all other relevant approvals / licences) would be required under Part 5 of the EP&A Act before works / activities can be carried out. This is addressed more fully in **Section 3** of this Policy.

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Area to Which This Policy Applies

GeoLINK

Darkum Creek Entrance Management Policy
1616533

Illustration 1.1

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2 Background

2.1 Entrance Management Issues

Darkum Creek is an ICOLL system that is predominantly closed. There are no records of artificial opening of the entrance being used in the past. Community consultation has not indicated any desire for artificial opening of the creek entrance. Nor is there currently any significant present need for artificial opening for the purpose of flood mitigation.

However, sea level rise caused by climate change will result in higher flood inundation levels within the estuary in the future. Current inundation levels are likely to increase by a similar amount as sea level rise increases. Adopted sea level rise estimates for NSW are a 0.4 m increase in sea level by 2050 (relative to 1990 levels) and a 0.9 m increase by 2100. Climate change also has the potential to result in an increased frequency of high rainfall events leading to more frequent flooding events.

This may present a risk of backyard flooding to some properties in the lower northern portion of Safety Beach in the vicinity of Panorama Parade, Baroona Street and Ocean Links Close – refer to **Illustration 2.1**. Some sewage pump stations (eg. PS 6 located to the north of Panorama Parade) may also be at risk of flooding. This would potentially lead to sewage overflows entering the creek system.

2.2 Flood Mitigation

2.2.1 Mitigation for Major Flood Events

No flood study exists for Darkum Creek however flood levels for 1 in 100 year event were estimated as part of the Estuary Processes Study (GeoLINK *et al.*, 2011a). The flood level estimates are shown below in **Table 2.1**. **Illustration 2.1** shows the 3.0 m AHD contour level to provide context for the estimated flood levels.

Table 2.1 Estimates of Flood, Ocean, and Berm Levels for Darkum Creek Entrance

	Levels (m AHD)		
	Immediate	***2050***	***2100***
Flood - 1 in 100 year storm event	2.6[1]	3.0[2]	3.5[3]
Elevated Ocean Levels - 1 in 20 year event[4]	2.5	2.9	3.5
Elevated Ocean Levels - 1 in 100 year event[5]	2.7	3.1	3.7
Entrance Berm Height – Almost Certain[5]	1.3	1.3	1.3
Entrance Berm Height – Unlikely[5]	2.4	2.8	3.3

Notes: 1. Flood level at footbridge (email: M. Robertson, Coffs Harbour City Council, 10/05/2012);
2. Immediate flood level plus 0.4m sea level rise. Source: GeoLINK *et al*. (2011a);
3. Immediate flood level plus 0.9m sea level rise. Source: GeoLINK *et al*. (2011a);
4. Source: BMT WBM (2011);
5. Based on Woolgoolga Lake entrance berm heights sourced from BMT WBM (2011). .

It is important to note the flood levels for major events (shown above) are likely to be independent of any artificial entrance opening works. This is due to the effect of the elevated ocean water levels which would 'over-ride' any impact of an open entrance. This can be seen by comparing the elevated ocean levels in **Table 2.1** with the estimated berm heights at the entrance. The data in **Table 2.1** shows the entrance berm heights to be significantly less than the elevated ocean levels. Therefore, artificially opening the estuary entrance will not have any impact on major (1 in 100 year) flood levels.

Therefore, as flood levels for major events are independent of entrance conditions, there is no benefit to artificially opening the estuary entrance for flood mitigation purposes for major events.

2.2.2 Mitigation for Minor Flood Events

No flood study exists for Darkum Creek however it is reasonable to assume that minor flood levels will be less than 2.5 m AHD for present conditions (this equates to a 1 in 20 year elevated ocean level). The extent of inundation at this flood level is indicated by the 2.5 m AHD contour in **Illustration 2.1**. It can be seen that this flood level does not impact on residential properties or sewer pump stations. The only impact on sewer infrastructure at this flood level is potential inundation of sewer manholes within the golf course property near Ocean Links Close, Safety Beach. This latter issue could be rectified by sealing the manhole cover against floodwater inflow or raising the manhole cover. It is noted that sewer pump station No.6 (PS 6) is located at a level of approximately 3.2 m AHD.

Therefore, there is no benefit to artificially opening the estuary entrance for flood mitigation purposes for present conditions to address minor flood events as there are no residential properties or infrastructure presently at risk.

2.3 Water Quality

Artificially opening estuary entrances is often carried out as a 'quick fix' to redress water quality problems stemming from other causes such as inadequate stormwater treatment from urban areas or inadequate erosion control measures in the catchment. Best practice for estuary management is based on addressing the source of the water quality issues rather than treating the symptoms by artificially opening entrances to 'flush' an estuary. The CZMP for Darkum Creek estuary includes strategies to address the source of current water quality issues.

Water quality data examined in the Estuary Processes Study for Darkum Creek (GeoLINK *et al*., 2011) indicates that physico-chemical water quality data collected from Darkum Creek shows a high degree of variability, a common and defining feature of ICOLLs. Comparison of existing water quality against guideline values revealed that turbidity, total nitrogen and chlorophyll-a measurements are all slightly elevated in Darkum Creek, based upon a limited set of samples and the available guidelines (GeoLINK *et al*. 2011a). These slightly elevated readings would not warrant an artificial opening event. Therefore, there is no need for artificial opening of the entrance to improve water quality under 'normal' conditions.

Nevertheless, there may be instances where artificial opening is justified to address extreme water quality issues such as contaminant spills where it may be desirable to provide some 'draining' of the creek system. However, it is not considered practical to include triggers to address a broad range of potential water quality scenarios. A range of factors would need to be considered during a water quality crisis, such as:

- Environmental and public health risks posed by the water quality issue;
- The extent to which artificial opening will mitigate the water quality issue;
- Consequent environmental and public health risks along the adjoining coastline following artificial opening of the creek.

This Policy does not include triggers for water quality issues due to the broad range of potential water quality scenarios and the associated uncertainties. It is recommended that any water quality crisis is assessed on an individual basis.

Drawn by: RE Checked by: MVE Reviewed by: TIM Date: July 2012
Information shown is for illustrative purposes only *Source of base data: Coffs Harbour City Council*

LEGEND

Contour at 2.5 m AHD

Sewer pump station 6

North

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Contour Levels Indicative of Minor Flood Levels

GeoLINK

Darkum Creek Entrance Management Policy
1616533

Illustration 2.1

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3

Approvals

3.1 Statutory Provisions

The area of Darkum Creek and any proposed entrance management works would be located within the Coffs Harbour LGA. The actual water body of Darkum Creek is not zoned, but identified as "Creeks" under the Coffs Harbour Local Environmental Plan (CHLEP) 2000. Land immediately adjacent to and surrounding the defined water body of Darkum Creek is zoned as 6A Open Space and Public Recreation (6A zoning affects land adjoin the entrance) and 7A Environmental Protection Habitat and Catchment under the CHLEP 2000.

Specifically, for the purpose of flooding mitigation works, Clause 50 of the State Environmental Planning Policy (Infrastructure), 2007 (ISEPP) applies, allowing such works to be carried out by or on behalf of a public authority on any land and precludes them from requiring development consent. Clause 50 of ISEPP 2007 states the following:

Development permitted without consent

(1) Development for the purpose of flood mitigation work may be carried out by or on behalf of a public authority without consent on any land.

(2) A reference in this clause to development for the purpose of flood mitigation work includes a reference to development for any of the following purposes if the development is in connection with flood mitigation work:

- *(a) construction works,*
- *(b) routine maintenance works,*
- *(c) environmental management works.*

Specifically, for the purpose of waterway or foreshore management activities, Clause 129 of the State Environmental Planning Policy (Infrastructure), 2007 (ISEPP) applies, allowing such works to be carried out by or on behalf of a public authority on any land and precludes them from requiring development consent.

Waterway or foreshore management activities means:

(a) riparian corridor and bank management, including erosion control, bank stabilisation, resnagging, weed management, revegetation and the creation of foreshore access ways, and

(b) instream management or dredging to rehabilitate aquatic habitat or to maintain or restore environmental flows or tidal flows for ecological purposes, and

(c) coastal management and beach nourishment, including erosion control, dune or foreshore stabilisation works, headland management, weed management, revegetation activities and foreshore access ways, and

(d) coastal protection works, and

(e) salt interception schemes to improve water quality in surface freshwater systems, and

(f) installation or upgrade of waterway gauging stations for water accounting purposes

Clause 129 of ISEPP 2007 states the following:

Development permitted without consent

1) Despite clause 129A, development for the purpose of waterway or foreshore management activities may be carried out by or on behalf of a public authority without consent on any land.

(1A) To avoid doubt, subclause (1) does not permit the subdivision of any land.

(2) In this clause, a reference to development for the purpose of waterway or foreshore management activities includes a reference to development for any of the following purposes if the development is in connection with waterway or foreshore management activities:

- *(a) construction works,*

(b) routine maintenance works,

(c) emergency works, including works required as a result of flooding, storms or coastal erosion,

Note. Emergency coastal protection works within the meaning of the Coastal Protection Act 1979 *are excluded from the operation of the EP&A Act and therefore are not development to which this clause applies.*

(d) environmental management works.

(2A) The following provisions apply in relation to the carrying out of new coastal protection works by or on behalf of a public authority on the open coast or entrance to a coastal lake:

(a) if a coastal zone management plan is in force in relation to the land on which the development is to be carried out—the public authority (or person carrying out the works on behalf of the public authority) must consider the provisions of that plan before carrying out the development,

(b) if a coastal zone management plan is not in force in relation to the land on which the development is to be carried out—the public authority (or person carrying out the works on behalf of the public authority) must:

(i) notify the Coastal Panel before carrying out the development, and

(ii) take into consideration any response received from the Coastal Panel within 21 days of the notification.

(2B) For the purposes of subclause (2A):

new coastal protection works means coastal protection works other than:

(a) the placement of sand (including for beach nourishment) or sandbags, or

(b) the replacement, repair or maintenance of any such works.

Although flood mitigation works and waterway and foreshore management activities would be permitted without consent on any land, the requirements of Part 5 of the EP&A Act 1979 must be fulfilled and Council would be required to prepare a REF for any proposed relevant works or activities, e.g. artificial opening of Darkum Creek. The REF would outline the nature and extent of the proposal, what would be the trigger and determining factors for proceeding with relevant works / activities such as artificial opening and identify and address any potential environmental effects which may result from such works. Hence the REF would also include mitigation measures and safeguards for the protection of the environment during relevant works / activities. The REF would need to be consistent with the adopted CZMP and entrance management Policy for Darkum Creek.

In conjunction with preparation of the REF, Council would be required to consult with and seek any relevant licences and or concurrence from other state government agencies. These would include:

- Crown Lands under the Crown Lands Act 1989;
- Department of Primary Industries - Fisheries under the Fisheries Management Act 1994;
- Marine Parks Authority under the Marine Parks Act 1997;
- NSW Office of Water under the Water Management Act 2000;
- Office of Environment and Heritage (National Parks and Wildlife) under the National Parks and Wildlife Act 1974.

3.1.1 Crown Lands Act 1989

Due to the artificial opening works affecting the waterway of Darkum Creek and the coastline, it is likely that such works would affect Crown Land. Artificial opening of the entrance will require authority by way of licences from the Crown under Part 4, Division1 of the Crown Lands Act 1989.

3.1.2 Fisheries Management Act 1994

The objectives of the Fisheries Management Act 1994 *are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations.* The provisions of Division 3, Part 7 of the Act are likely to be relevant to any works associated with the artificial opening of Darkum Creek. The provisions relate to the protection of aquatic habitat. Although flood mitigation works and waterway or

foreshore management activities would be precluded from requiring consent under ISEPP, the provisions of the Fisheries Management Act 1994 are still applicable and as part of the REF process concurrence from the Department of Primary Industries (Fisheries) would be required for certain activities. **Table 3.1** outlines the relevant provisions of the Act that would apply to the artificial opening of Darkum Creek.

Table 3.1 Activities requiring concurrence under the Fisheries Management Act 1994

Fisheries Management Act 1994	Sections 198-202	Concurrence is required from the Minister, Department of Primary Industries (Fisheries) for dredge and reclamation works on defined water land. The nature of artificial opening would constitute dredge works and also potentially reclamation works in watered land. Hence a permit and concurrence from s required prior to commencement of any works.
	Sections 219-220	Concurrence is required when barriers to the movement of fish including water course crossings are to be constructed or modified. Any proposed artificial opening is unlikely to create a barrier to the movement of fish. However such specifics would need to be confirmed within the REF.
	Sections 204-205	Any artificial opening works would likely be restricted to the sand berm. Any works must not affect mangroves or other protected marine vegetation. If marine vegetation would be harmed by relevant works / activities, a permit must be sought from the Minister before works commence. Clause 205 (2) states that *A person must not harm any such marine vegetation in a protected area, except under the authority of a permit issued by the Minister under this Part.* The REF would need to determine if artificial opening works are likely to affect mangroves or other protected marine vegetation.
	Schedules 4, 4A, 5 and 6	The REF prepared for works associated with artificial opening would need to consider any presence of local threatened aquatic habitat for flora or fauna. Thus Key Threatening Processes (KTPs) would need to be considered in preparation of the REF. The following KTPs may be relevant and required consideration: ▪ *Degradation of native riparian vegetation along NSW water courses*. ▪ *Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.*

3.1.3 Marine Parks Act 1997

As Darkum Creek forms park of the Solitary Islands Marine Park, Council would be required to obtain a permit / concurrence from the Marine Park Authority / the Minister under the Marine Parks Act 1997 in order to undertake any works on land affected by the Marine Park and any associated zoning. Preparation of the REF would need to consider these factors and seek the relevant concurrence / permit.

3.1.4 Water Management Act 2000

A controlled activity approval under the Water Management Act 2000 (WM Act) is required for certain types of developments and activities that are carried out in or near a river, lake or estuary (water land). Under the WM Act, a controlled activity means:

- the erection of a building or the carrying out of a work (within the meaning of the Environmental Planning and Assessment Act 1979), or
- the removal of material (whether or not extractive material) or vegetation from land, whether by way of excavation or otherwise, or

- the deposition of material (whether or not extractive material) on land, whether by way of landfill operations or otherwise, or
- the carrying out of any other activity that affects the quantity or flow of water in a water source.

Artificial opening of Darkum Creek would constitute a controlled activity under the WM Act. However under the Water Management (General) Regulation 2011, Clause 38 Controlled activities—public authorities, states: *A public authority is exempt from section 91E (1) of the Act in relation to all controlled activities that it carries out in, on or under waterfront land.*

Although Coffs Harbour City Council would be exempt from requiring a Controlled Activity Approval, Clause *37, Condition applying to all exemptions under this Subdivision,* of the Regulations states:
An exemption conferred under this Subdivision is subject to the condition that the person by whom the relevant controlled activity is carried out must comply with applicable requirements (if any) of the Minister that are published in the Gazette, or notified in writing to the person, for the purposes of this clause and that are for the protection of:
(a) the waterfront land on which the activity is carried out, or
(b) any river, lake or estuary to which that land has frontage.

3.1.5 National Parks and Wildlife Act 1974

The Darkum Creek system falls within the Coffs Coast Regional Park. The park was created through a partnership of Council and the National Parks and Wildlife Service (now within OEH). The National Parks and Wildlife Act 1974 applies if the park is a reserve made under the Act. The Park's management is guided by a Trust Board. Preparation of an REF for artificial opening works would need to determine whether or not the park is a reserve under the Act and hence consultation / concurrence are required with OEH / National Parks and Wildlife Service. Consultation with the Trust Board would be required whether or not the park is affected by the Act. The REF would also need to consider any management plan that has been prepared for the park.

3.2 Summary of Potential Approvals

Works / activities for the purpose of flood mitigation or waterway / foreshore management (to address an extreme water quality issue) would be permitted without consent under Clause 50 of the State Environmental Planning Policy (Infrastructure), 2007. However the requirements of Part 5 of the EP&A Act 1979 must be fulfilled and Council is required to prepare a REF for proposed works / activities (e.g. artificial opening of the entrance to Darkum Creek estuary). The REF needs to be consistent with the adopted CZMP and entrance management Policy for Darkum Creek estuary.

Preparation of the REF will involve consultation with relevant state government agencies. This will confirm the necessary approvals and licences required for artificial opening of the entrance. Preliminary assessment indicates the following approvals and licences may be necessary:

- a license from the Department of Crown Lands under the Crown Lands Act 1989;
- a permit and concurrence from the Minister, Department of Department of Primary Industries (Fisheries) under the Fisheries Management Act 1994 pursuant to Sections 198-202 for dredge and reclamation works on defined water land (the nature of artificial opening would constitute dredge works and also potentially reclamation works); and
- a permit / concurrence from the Marine Park Authority / the Minister under the Marine Parks Act 1997 as Darkum Creek forms park of the Solitary Islands Marine Park.

The Darkum Creek system falls within the Coffs Coast Regional Park, which was created through a partnership of Council and the National Parks and Wildlife Service. Consultation with the National Parks and Wildlife Service and Trust Board is required to determine if any approvals are required under the National Parks and Wildlife Act 1974.

It is noted that a Controlled Activity Approval under the Water Management Act 2000 is not required due to the Water Management (General) Regulation 2011, Clause 38 Controlled activities - public authorities, which states: *A public authority is exempt from section 91E (1) of the Act in relation to all controlled activities that it carries out in, on or under waterfront land.* However, Council is still required to follow any applicable guidelines of NSW Office of Water under the Water Management Act 2000.

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4

Artificial Opening Procedure

4.1 Decision Making Process

This Policy presently only recommends artificial opening of the Darkum Creek estuary entrance in the event of extreme water quality issues such as contaminant spills where it may be desirable to provide some 'draining' of the creek system. However, the decision to initiate an artificial opening event will be based on assessment of each individual circumstance of an extreme water quality issue with consideration of:

- Environmental and public health risks posed by the water quality issue;
- The extent to which artificial opening will mitigate the water quality issue; and
- Consequent environmental and public health risks along the adjoining coastline following artificial opening of the creek.

As noted in **Section 2.3**, this Policy does not include triggers for water quality issues due to the broad range of potential water quality scenarios and the associated uncertainties. Determining what constitutes an extreme water quality issue would include reference to water quality monitoring results for Darkum Creek to determine if the issue is 'outside' normal water quality variations for the creek system.

The general decision making process / procedure for determining if artificial opening is to be employed to address an extreme water quality issue is shown in the flow chart in **Illustration 4.1** and involves:

- Following warning of potential extreme water quality issues Council's designated officer will alert relevant state government agencies of the issues and potential for an artificial opening event;
- Council's designated officer will then conduct a site assessment and/or review of water quality monitoring data to determine in consultation with relevant state government agencies if artificial opening is an appropriate response;
- If artificial opening is considered an appropriate response Council's designated officer will initiate deployment of Council's personnel and machinery to the entrance and direct when and where artificial opening is to be initiated. Ideally, the artificial opening should be initiated during a falling tide and shortly after the tide turns from high to low (if possible around a spring tide when tidal fluctuations are larger).

4.2 Responsibilities for Artificial Opening

Coffs Harbour City Council is responsible for artificial opening of the entrance.

4.3 Monitoring

When artificial openings have been carried out, monitoring of the entrance should be undertaken to determine the efficiency of the opening. For each artificial opening event, the following data will be tested / recorded:

- prior to opening:
  - testing of water quality parameters relevant to the specific water quality issue;
  - survey water level of creek prior to opening;
- date and time of opening;
- survey water levels of creek over 24 hours following opening;

- testing of water quality parameters relevant to the specific water quality issue over 24 hours and at appropriate intervals following 24 hours after the opening;
- location and length of excavation;
- approximate width and depth of initial channel;
- ocean swell conditions (wave height and direction);
- preceding rainfall;
- date of closure; and
- digital photographs.

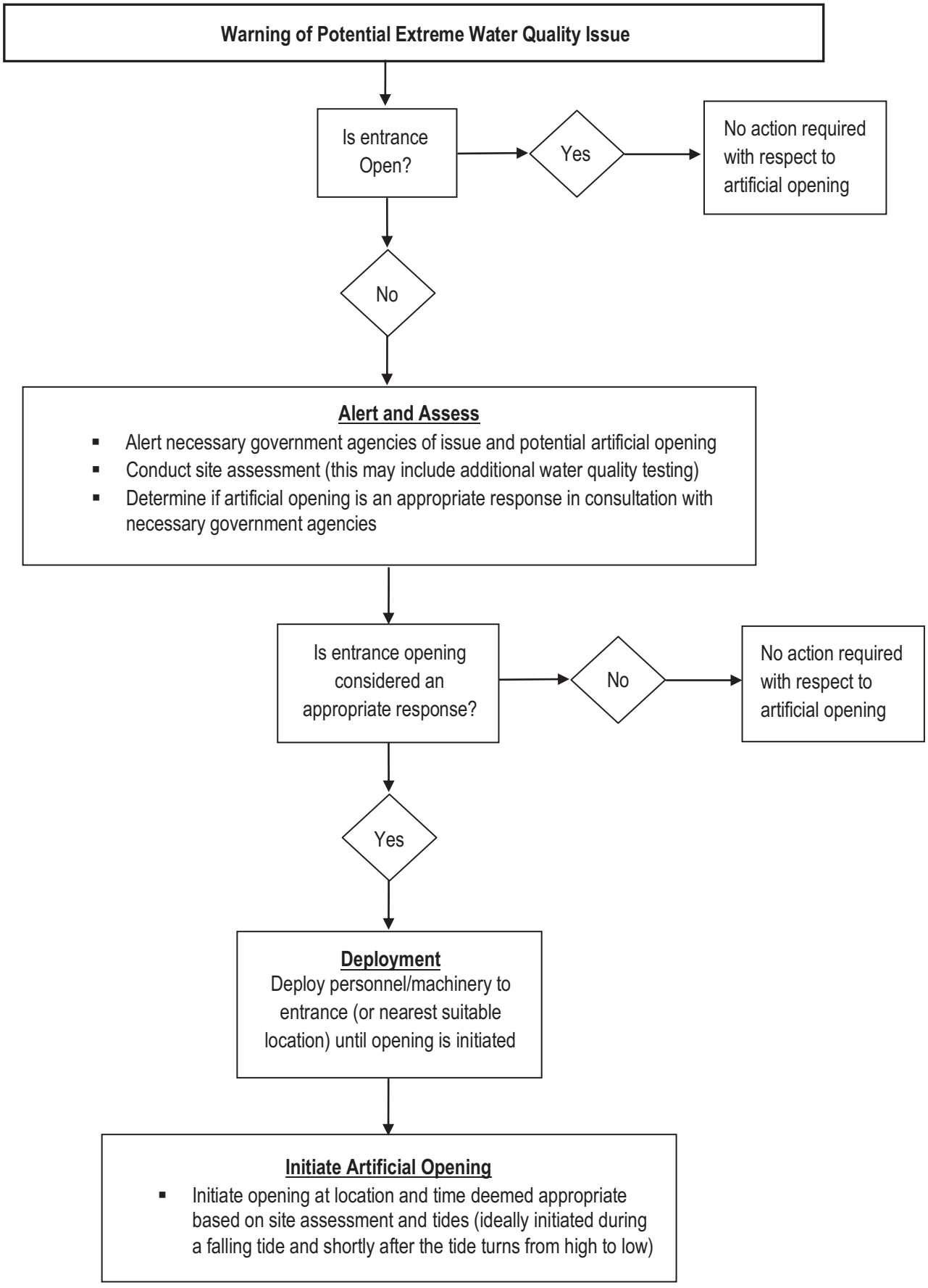

Illustration 4.1 Artificial Opening Decision Making Flowchart

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5

Policy Updates

5.1 Review and Update of this Policy

This Policy and the associated REF should be reviewed every five years or in response to:

- legislation changes; and
- any other significant factors relevant to artificial opening of the entrance of Darkum Creek estuary.

Review of the Policy will include analysis of all monitoring data collected over that period to assess if the assumptions and procedures outlined in the current Policy and REF are correct or appropriate. This will include a review of changes to climate change and sea level rise predictions and consequent impacts to this Policy.

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Project Team

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Acronyms

AHD	Australian Height Datum
CEMAC	Coffs Harbour City Council Coastal Estuary Management Advisory Committee
CHCC	Coffs Harbour City Council
CHLEP	Coffs Harbour Local Environmental Plan
CZMP	Coastal Zone Management Plan
ICOLL	Intermittently Closed and Open Lake and Lagoon
ISEPP	State Environmental Planning Policy (Infrastructure), 2007
LGA	Local Government Area
MHL	Manly Hydraulics Laboratory
PS	Pump Station
REF	Review of Environmental Factors
SEPP	State Environmental Planning Policy

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Appendix B

Funding Sources

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Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Various – jointly administered by North Coast Local Land Services (LLS)	▪ Various – jointly administered by North Coast LLS	▪ Community capacity targets. These include targets with respect to the awareness, knowledge and skills of the community in relation to Natural Resource Management, and the levels of engagement of the community. These are specifically: ▪ CCB1, Awareness knowledge and skills; ▪ CCB2, Community engagement; and ▪ CCB3, Community support. ▪ Land use planning targets. The relevant land use planning targets relate to aboriginal cultural integration in the planning process, environmental assets and significant farmland protection, landuse conflict within and adjacent to key environmental and farming assets and the integration of natural resource assets into planning. They are specifically; ▪ LUP1, Aboriginal cultural integration; ▪ LUP2, Environmental assets/rural production areas; ▪ LUP3, Land use conflict and key natural resources; and ▪ LUP4, Natural resource integration. ▪ Biodiversity targets. These targets relate to the area of land under secure conservation management, habitat connectivity, the mitigation of threats to biodiversity, threatened species management, sustainable management of terrestrial and aquatic ecosystems and habitat rehabilitation and revegetation. The targets are; ▪ B1, Secure conservation management; ▪ B2, Habitat connectivity; ▪ B3, Biodiverstiy threat mitigation; ▪ B4, Threatened species; ▪ B5, Biodiversity management and enhancement; and ▪ B6, Habitat rehabilitation and revegetation.	Funding (General): http://www.northern.cma.nsw.gov.au/get-involved/funding Current Funding Opportunities: http://www.northern.cma.nsw.gov.au/get-involved/funding

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
		▪ Water targets. These targets relate to the integrated management of urban water cycles and community education about and monitoring of water resources. The targets are; ▪ W1, River structure riparian vegetation and fish passage; ▪ W2, Urban water cycle management; ▪ W3, Water information and education; and ▪ W4, Aquifer health and river flow. ▪ ▪ Coastal targets. The relevant coastal targets relate to the management and assessment of coastal lakes and estuaries. The targets are; ▪ C1, Coastline; and ▪ C2, Estuaries and coastal lakes. ▪ ▪ Marine targets. The relevant marine targets relate to management practices that reduce threats to and impacts on the marine environment. The targets are; ▪ M1, Marine research and planning; ▪ M2, Best practice; ▪ M3, Marine protected areas; and ▪ M4, Improved marine environement management practices. ▪ ▪ Soil and land resource targets. The most relevant of the soil and land targets relates to the area of high risk acid sulfate soils under active management. The complete list of targets is; ▪ L1, Soil health; ▪ L2, Acid sulphate soils; and ▪ L3, Soil conservation/remediation.	

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Caring for Our Country	Jointly administered by the Australian Government: ▪ Department of Agriculture, Fisheries and Forestry; and ▪ Department of Sustainability, Environment, Water, Population and Communities	*Objectives:* ▪ to achieve an environment that is healthy, better protected, well-managed, resilient and provides essential ecosystem services in a changing climate. *Priorities:* ▪ the National Reserve System; ▪ biodiversity and natural icons; ▪ coastal environments and critical aquatic habitats; ▪ sustainable farm practices; ▪ natural resource management in northern and remote Australia; and ▪ community skills, knowledge and engagement.	http://www.nrm.gov.au/index.html
Estuary Management Program	NSW Office of Environment and Heritage	*Objectives:* ▪ to provide support to councils to improve the health of NSW estuaries; and ▪ understand the potential risks from climate change. Support provided to councils under these programs includes financial assistance to: ▪ prepare estuary management plans and supporting studies; ▪ carry out projects to improve estuary health. *Priorities:* ▪ updating estuary plans to consider climate change impacts, including sea level rise ▪ estuary health monitoring and improvement ▪ focusing on high-hazard coastal areas and stressed estuaries. Grant offers are subject to availability of funds for each financial year and State-wide priorities. Funding of up to 50% of a project's costs will normally be offered for successful grant applications.	http://www.environment.nsw.gov.au/coasts/InfoCoastEstFloodGrants.htm

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Coastal Management Program	NSW Office of Environment and Heritage	*Objectives:* ▪ to provide support to local councils to manage the risks from coastal hazards such as coastal erosion, ▪ and to restore degraded coastal habitats. Support provided to councils under these programs includes financial assistance to: ▪ prepare coastline, and coastal zone management plans and supporting studies ▪ carry out projects to reduce risks associated with coastal hazards and improve coastal environments.	http://www.environment.nsw.gov.au/coasts/InfoCoastEstFloodGrants.htm
		▪ updating coastal hazard studies to incorporate sea-level rise benchmarks ▪ focusing on high-hazard coastal areas and stressed estuaries. Grant offers are subject to availability of funds for each financial year and State-wide priorities. Funding of up to 50% of a project's costs will normally be offered for successful grant applications.	
Floodplain Management Program	NSW Office of Environment and Heritage	*Objectives:* ▪ to reduce the impacts of flooding and flood liability on communities; and ▪ to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.	http://www.environment.nsw.gov.au/coasts/InfoCoastEstFloodGrants.htm
		Priorities: Provides financial support to councils and eligible public land managers to: ▪ make informed decisions on managing flood risk by preparing floodplain risk management plans (and associated background studies) under the floodplain risk management process; ▪ implement floodplain risk management plans to reduce flood risk to both existing and future development, and reduce losses through a range of property, flood and response modification measures as outlined in the manual; and ▪ provide essential information to the State Emergency Service to enable the effective preparation and implementation of local flood plans to deal with flood emergency response. Assistance is normally State Government providing $2 for every $1 provided by the council.	

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Environmental Trust Grants	NSW Department of Environment and Heritage	▪ to encourage and support restoration and rehabilitation projects; ▪ to promote research into environmental problems of any kind; ▪ to promote environmental education in both the public and private sectors; ▪ to fund the acquisition of land for the national parks estate; ▪ to fund the declaration of areas for marine parks and for related purposes; ▪ to promote waste avoidance, resource recovery and waste management (including funding enforcement and regulation and local government programs); ▪ to fund environmental community groups; and ▪ to fund the purchase of water entitlements for the purpose of increasing environmental flows for the State's rivers and restoring or rehabilitating major wetlands.	http://www.environment.nsw.gov.au/grants/envtrust.htm
		Relevant Programs: ▪ the urban sustainability program funds projects carried out by local councils in partnership with the community that protect and restore the urban environment; ▪ the lead environmental community groups program provides administrative funds for environmental organisations that work with their communities to conserve the environment; ▪ the environmental restoration and rehabilitation program funds projects that restore or rehabilitate degraded areas, or protect important ecosystems and habitats, prevent or minimise future environmental damage and enhance the quality of specific environmental resources; ▪ the environmental education program supports projects that increase commitment to protecting the environment and promoting sustainable behaviour; ▪ the environmental research program funds projects managed by educational institutions and government agencies that research local solutions to environmental problems and ways of operating that are less harmful to the environment; ▪ the eco schools program funds schools so they can involve their students and the community in developing and implementing environmental management projects; ▪ the protecting our places program supports projects that restore or rehabilitate Aboriginal land or land that is culturally significant to Aboriginal people, or that educate Aboriginal and other communities about the environment.	

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Grants to Voluntary Environment Heritage Organisations (GVEHO)	Australian Government: Department of Sustainability, Environment, Water, Population and Communities	*Objectives:* ▪ help eligible community based environment and heritage organisations to value, conserve and protect Australia's natural environment and historic heritage by assisting with their administrative funding. *Priorities:* ▪ funds provided may be used to assist with salaries and salary on-costs for executive and administrative staff; office accommodation rental; electricity, gas, phone and other similar charges; essential office supplies and equipment; staff and volunteer training; photocopying and printing costs; and travel costs incurred on behalf of the organisation.	http://www.environment.gov.au/about/programs/gveho/index.html
NSW Recreational Fishing Trusts	NSW Department of Primary Industries	*Objectives:* ▪ projects that improve recreational fishing in NSW; ▪ anyone can apply for funding from the Recreational Fishing Trusts, including fishing clubs and organisations, universities, councils, community groups, individuals and so on. Joint applications are also encouraged. ▪ funding applications must relate to the improvement of recreational fishing. *Priorities:* ▪ recreational fisheries enhancement; ▪ angler education and information; ▪ research on recreational fishing; ▪ recreational fisheries access and facilities; and ▪ recreational fisheries sustainability	http://www.dpi.nsw.gov.au/fisheries/recreational/licence-fee/apply-for-funds
NSW Maritime Infrastructure Program: Better Boating Program Regional Infrastructure	NSW Transport Maritime	*Objectives:* ▪ the Better Boating Program provides waterways infrastructure for the benefit of the boating community and the marine sector on New South Wales waterways; ▪ the BBP provides individual grant contributions to proponents such as Local Government, State agencies, boating organisations and community groups for the development of public boating infrastructure.	http://www.maritime.nsw.gov.au/mpd/infra_program.html

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Grants		*Priorities:* Consideration for BBP funding will only be given to those projects that are: ▪ principally infrastructure works of a lasting nature; ▪ intended to greatly improve current amenities (or addresses the lack thereof); ▪ located in a readily accessible public area with unrestricted public access; ▪ for use of or available to, a broad cross-section of the public boating community; ▪ situated either on public land or land owned by the Local Council, the Crown or NSW Maritime; ▪ able to be commenced within 6 months of the approval of the grant and be completed within 18 months from this approval date. It should be noted that any funding grants not utilised within that period may be withdrawn; ▪ supported in writing by key stakeholders, including the Local Council; ▪ able to meet the Program's criteria for assessment and are submitted by the nominated closing date.	
Raising National Water Standards Program	Australian Government: National Water Commission	*Objectives:* ▪ support for projects that are improving Australia's national capacity to measure, monitor and manage our water resources.	http://www.nwc.gov.au/www/html/347-introduction-to-rnws.asp
		Priorities: ▪ funds are directed at activities across three strategic investment areas: - advancing the implementation of the National Water Initiative - improving integrated water management across Australia - improving knowledge and understanding of our water resources. ▪ more than 175 Raising National Water Standards projects have been funded under the following themes: - water accounting - emerging water markets - water planning and management - knowledge and capacity building - irrigation and other rural water	

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
		- water-dependent ecosystems - integrated urban water management - groundwater - northern rivers - national assessment of water resources - Northern Australia water futures assessment	
Country Towns Water Supply and Sewage Program	NSW Department of Primary Industries Office of Water	*Objectives:* ▪ a major government reform program that provides management, technical and financial support to local water utilities (LWUs) in the provision of water supply and sewerage services to country towns in NSW.	http://www.water.nsw.gov.au/Urban-water/Country-town-water/default.aspx
		Priorities: ▪ management assistance through the Best-Practice Management of Water Supply and Sewerage Guidelines. ▪ technical assistance through: - regular inspections and advice on water and sewage treatment works operational problems - conducting water supply and sewerage operator training seminars/ courses - pre commissioning inspections of Fluoridation Plants and technical assistance to NSW Health to enable councils to comply with requirements under the Fluoridation of Public Water Supplies Act 1957 and in certification of fluoridation officers. - ongoing LWUs dam safety inspections and mentoring/ training of operators - ongoing LWUs liquid trade waste discharge approvals - conducting regional trade waste regulation courses - providing help desk services. ▪ financial assistance through grants to local water utilities towards the capital cost of works to address the backlog in water supply and sewerage infrastructure.	
Job Services Australia – New	Australian Government: Department of Education,	*Objectives:* ▪ to give young people, aged 17 to 20 years, quality training and experience through	http://www.deewr.gov.au/Employment/JSA/Em

Fund Name	*Funding Body(ies)*	*Objectives and Priorities*	*Web Address*
Enterprise Incentive Scheme (NEIS)	Employment and Workplace Relations	structured and supervised projects that focus on areas where natural environmental conservation work and cultural heritage restoration is required ▪ to contribute to high priority conservation projects, to promote environmental, conservation and natural heritage outcomes and through this benefit the community and the environment and ▪ to contribute to NEIS participants': - personal development, including teamwork and leadership skills - skill development and training through activities that are structured and sequential in their learning outcomes - strengthened connections with the community through relationships, participation and contribution to the community; and - improved career and employment prospects through accredited training and on-the-project training.	ploymentServices/Pages/NEIS.aspx
		Priorities: ▪ DEEWR provides funding for NEIS teams to work on projects which focus on areas where environmental and heritage restoration and conservation are needed ▪ participants in the NEIS programme work in teams from a central or regional location and may undertake projects in remote locations ▪ each project has a community focus and is developed in consultation with community representatives and ▪ participants undertake accredited training which enable them to complete project tasks, and increases their capacity to move into employment or further training at the end of their placement.	
Public Reserve Management Funds Program (PRMP)	NSW Government DoI – Crown Lands	*Objective:* ▪ to maintain, protect and improve Crown Reserves for the entire community	https://www.industry.nsw.gov.au/business-and-industry-in-nsw/news/news/201819-public-reserves-management-funds-program-open
		Priorities: ▪ to support a range of activities, including repairs and maintenance, pest and weed control, new recreational infrastructure and environmental initiatives.	

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Appendix C

Summary of Estuary Processes Study

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Darkum Creek is an Intermittently Closed and Open Lakes and Lagoon (ICOLL). Darkum Creek is a relatively small and remote coastal estuary. There is significant water-based activity with kayaking, canoeing and fishing in the creek. The primary land-based recreational activity is generated by the coastal walk which is facilitated by the pedestrian footbridge across the creek. The bridge enables a continuous pedestrian and bicycle route which follows the coastline and connects the residential communities of Arrawarra in the north to Woolgoolga in the south. The walk offers an easy, convenient and safe pedestrian corridor through an attractive coastal setting.

The total catchment area of Darkum Creek is relatively small at approximately 6 km². The catchment comprises State Forest, banana plantations and blueberry farms in the upper limits of the catchment, large areas of cleared agricultural land in the mid-catchment with some medium to large areas of forested agricultural land in the mid to lower catchment. The tidal limit of Darkum Creek is located near the existing Pacific Highway. The creek is part of the Solitary Islands Marine Park and is zoned as a Habitat Protection Zone up to the tidal limit.

The Woolgoolga Returned Services golf course adjoins a large section of Darkum Creek and comprises a large portion of the estuary catchment. The Safety Beach residential area is situated in the southern portion of the estuary catchment. The eastern fringe of the estuary catchment is located in the Coffs Coast Regional Park.

The key findings and recommendations of the *Data Compilation and Estuary Processes Study – Darkum Creek, Woolgoolga Lake and Willis Creek* (GeoLINK *et al.*, 2011) is summarised below for Darkum Creek.

C.1 Hydrodynamics

C.1.1 Hydrodynamic States and Entrance Behaviour

Darkum Creek generally has a closed entrance. Aerial photography from 1943 to 2011 indicates the entrance is open approximately 40% of the time (it is noted that the interpretation is not precise as the frequency of photographs is inadequate for this task). No artificial opening of the Darkum Creek entrance has been recorded. Council does not have any opening protocol for the creek.

Conductivity levels indicate that Darkum Creek is subject to regular seawater ingress. This is assumed to be related to periods of tidal behaviour restricted to higher stages of the tide during spring tide cycles that wash over the entrance berm. This results in a small rise and fall in water levels in the creek lagoon.

The estuary entrance location is relatively stable based on the aerial photography dating back to 1943.

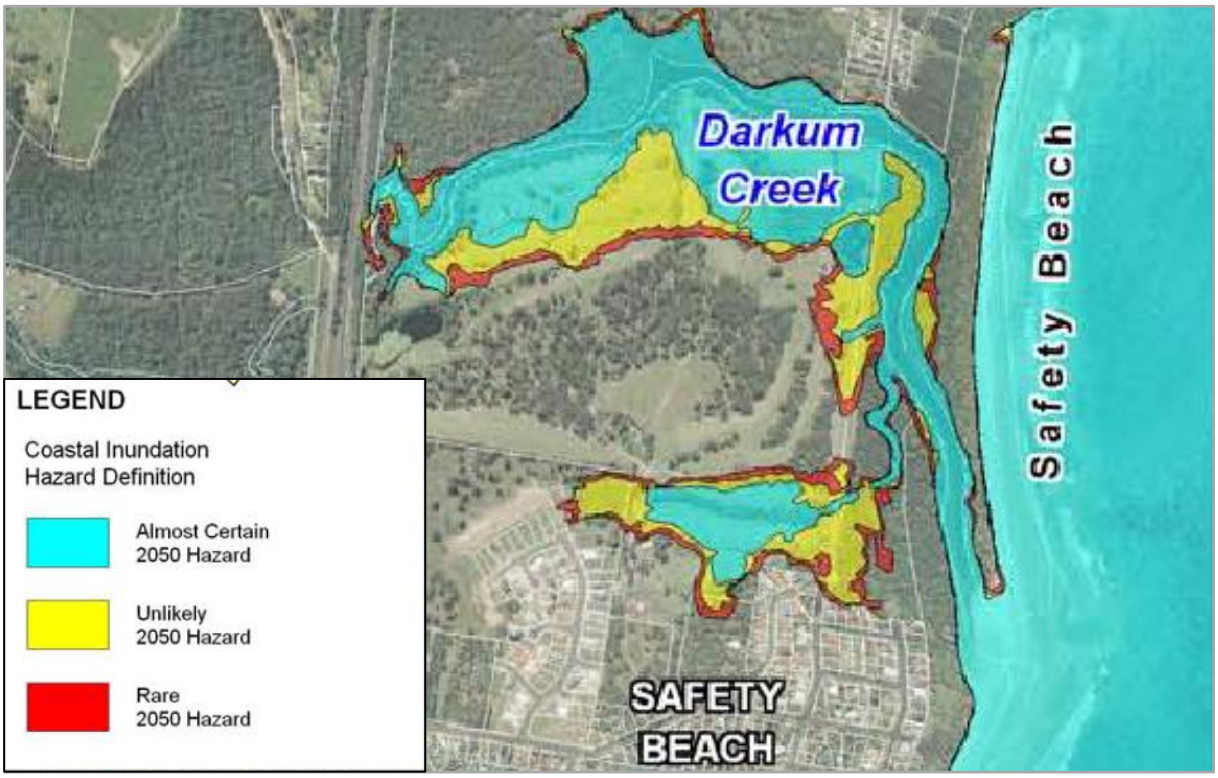
A 2004 hydrographic survey of Darkum Creek indicates the entrance berm height was in the range of 1.7 to 1.9 m AHD. The entrance was closed at the time of the survey.

C.1.2 Coastal Processes and Inundation

The long term shoreline recession on Safety Beach from coastal processes and sea level rise is not likely to be significant (approximately 20 m recession) as indicated in to Plate C.1. The yellow and red dashed lines in Plate C.1 refer to the unlikely and rare scenarios for beach recession for the year 2050.

Flooding within Darkum Creek as a result of elevated ocean levels during storms will be exacerbated by sea level rise – refer to Plate C.2. The inundation extents around Darkum Creek are generally limited to areas of the golf course.

Plate C.1 Beach Erosion and Shoreline Recession Mapping for the Year 2050



Source: BMT WBM (2010b)

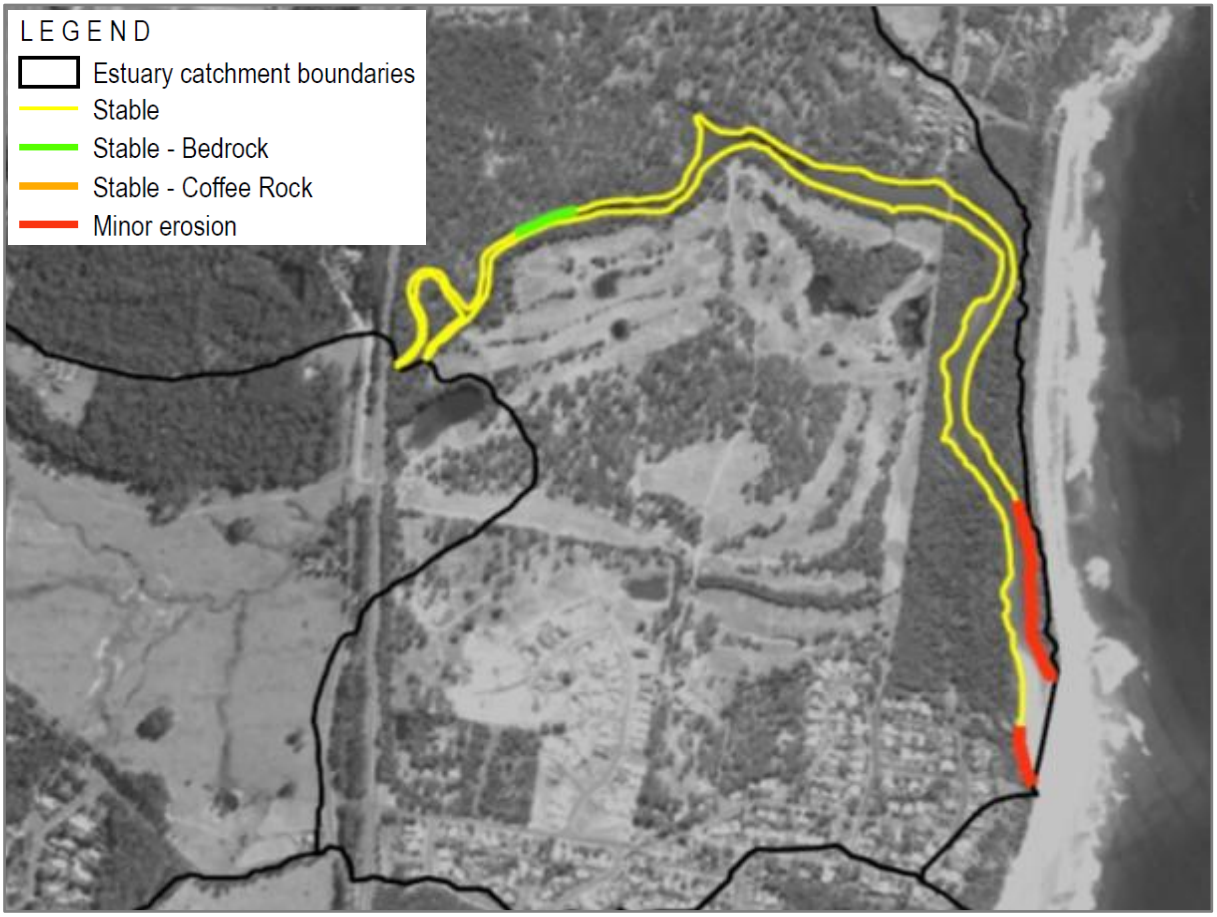
Plate C.2 Coastal Inundation Mapping for the Year 2050

C.2 Geomorphology and Sediment Dynamics

C.2.1 Bank Erosion

Bank erosion is not a significant issue in the Darkum Creek estuary with no moderate or severe erosion identified and minor erosion only occurring on 9% of estuary banks - predominantly in the marine tidal delta (refer to Plate C.3 and C.4). The remaining banks are naturally stable (i.e. stable without the use of erosion protection works).

Plate C.3 Bank Erosion - scour and undercutting, lower Darkum Creek – left bank (looking north)



Source: GeoLINK *et al.* (2011)

Plate C.4 Bank Erosion Severity (mapped January 2011)

C.3 Water Quality Processes

Physico-chemical data collected from Darkum Creek shows a high degree of variability, a common and defining feature of ICOLLs. Median turbidity readings exceed ANZECC (2000) guidelines and OEH MER guidelines.

Chemical water quality is poorly represented in the available dataset for Darkum Creek, however, median concentrations of Total Nitrogen (TN) exceed ANZECC (2000) default guideline values. In both cases Dissolved Organic Nitrogen (DON) is the dominant form present. Darkum Creek does not appear to be phosphorus enriched.

With respect to biological water quality, a large number of faecal indicator organism samples have been collected, but only a small number of chlorophyll-a samples have been collected from Darkum Creek. Faecal indicator organism samples indicate that the waters of Darkum Creek for the period sampled are generally safe for primary contact recreation. Chlorophyll-a concentrations indicate that Darkum Creek has a slightly elevated but not alarming trophic status.

A Catchment Management Support System (CMSS) model was set up to assess nutrient and sediment loads from the Darkum Creek catchment. The results indicate that horticultural land uses are the main contributor of sediment, nitrogen and phosphorus but that land under pasture and residential areas also contribute significant levels of sediment and nitrogen.

C.4 Ecological Processes

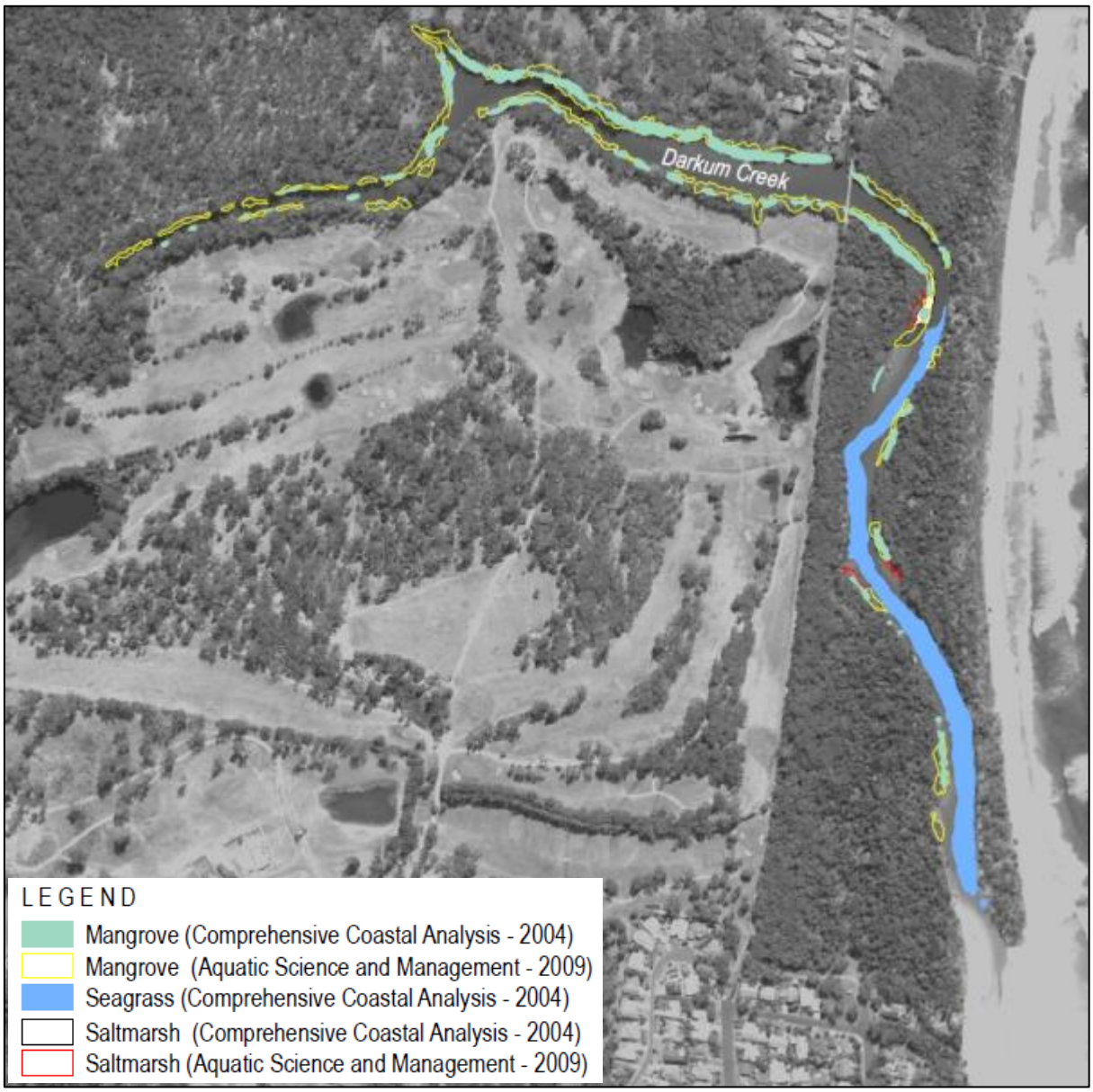
C.4.1 Estuarine Habitat

The entrance area of Darkum Creek offers little structured aquatic habitat. The benthic material is sand. The position of the channel and banks is dynamic in this part of the creek and as a result vegetation is largely absent from these features for most of the time.

The central channel of Darkum Creek (the creek length predominantly shown in Plate C.5) is a long section of relatively homogenous aquatic habitat availability. The following habitat features distinguish the central channel:

- the benthic material is a patchy mixture of sand, mud and gravel. Most of the benthos is below the typical low tide level, meaning intertidal habitats are sparse;
- mixed species of mangroves grow along the creek bank as wide bands and scattered individuals for most of the length of the estuarine region.
- there are two small patches saltmarsh habitat present in the central channel, dominated by marine rush (*Juncus krausii*) and salt couch (*Cynidolon dactylon*);
- there were no submerged aquatic macrophytes, such as seagrass or algae, actively growing at the time of the survey. During the CCA survey (DPI 2006) a significant patch of seagrass (*Halophila sp*.) was mapped at the entrance – refer to Plate C.5. This particular species is known to be dynamic in its occurrence and distribution. It is quite possible that when conditions are optimal that it will reoccur in a similar part of the creek;
- snags are a key habitat type in Darkum Creek, particularly along the central channel. Fallen trees along the bank and logs in the middle of the channel are common occurrences. Along with mangrove pneumatophores and gravel beds, snags represent most of the in-stream structural habitat for fish and invertebrates in Darkum Creek; and
- the other features of the central channel that provide habitat value are reeds and rushes (mostly common reed (*Phragmites australis*) and river club rush (*Schoenoplectus validus*)) and the root balls and overhanging branches of riparian vegetation.

The upper estuary zone of Darkum Creek is limited to the short section where the channel narrows dramatically. The key differences in this zone are the lack of mangroves, narrower channel and steeper banks. Riparian vegetation is dominated by rushes and reeds amongst swamp oak (Casuarina glauca) and paperbark (Melaleuca quinquinerva) forest. Overhanging vegetation and root balls in the bank create structured habitat. The benthic material in this upper part of the creek is a patchy mixture of gravel and mud.



Source: GeoLINK *et al.* (2011)

Plate C.5 Bank Erosion Severity (mapped January 2011)

C.4.2 Aquatic Fauna

The central regions of the creek contain the most diverse and abundant benthic macroinvertebrate fauna. A survey of fish species was undertaken with relatively few animals from a small number of taxa collected. No threatened aquatic species have been individually reported from Darkum Creek.

C.4.3 Riparian Vegetation

Riparian vegetation through the study area is generally in good to very good condition (87% of surveyed banks) – refer to Plate C.6. Saltmarsh and mangrove habitats are in good condition and mangroves are widely dispersed with evidence of consistent recruitment. The riparian corridor is largely intact.

Source: GeoLINK *et al.* (2011)

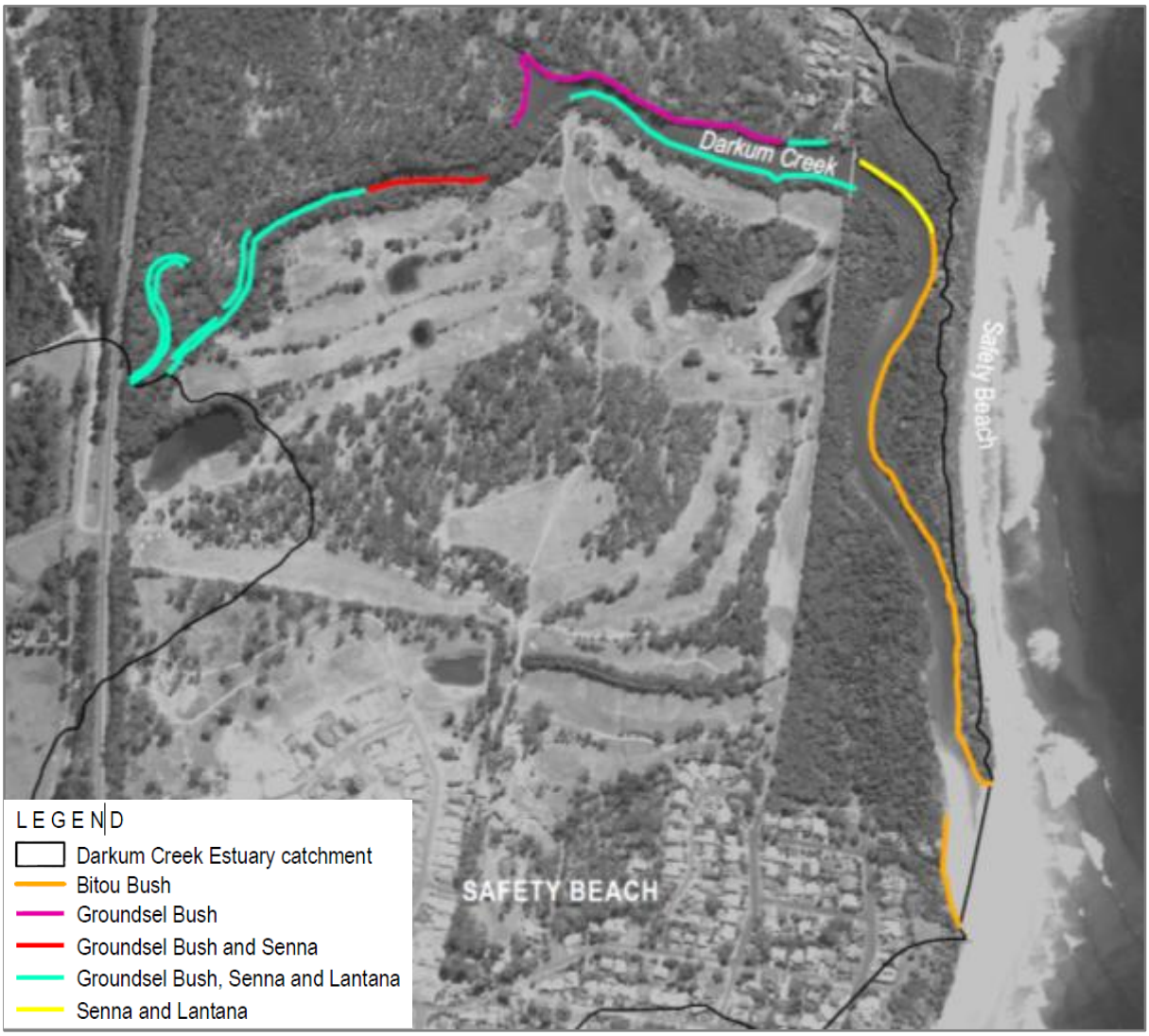
Plate C.6 Riparian Vegetation Condition (mapped January 2011)

The distributions of major weeds along the estuary have been mapped – refer to Plate C.7. Four of the mapped invasive weed species are listed as Priority B or C in coastal or riparian landscapes under the Northern Rivers Invasive Weed Strategy 2009-2013. It is recommended that priorities and appropriate strategies for weed control and riparian regeneration be determined in the EMP.

C.4.4 Estuary Health

In general, the health of Darkum Creek is good:

- water quality is generally acceptable for the protection of aquatic ecosystems;
- saltmarsh and mangrove habitats are in good condition and mangroves are widely dispersed with evidence of consistent recruitment;
- the riparian corridor is largely intact;
- there are many snags throughout the estuary providing valuable structural habitat;
- there is no evidence of fish kills, pest invasions or algal blooms; however
- fish and macroinvertebrate populations are scarce and lack diversity.



Source: GeoLINK *et al.* (2011)

Plate C.7 Distribution of Priority B and Priority C Invasive Weed Species (mapped January 2011)

C.5 Climate Change and Sea Level Rise

Climate change is projected to include an increased frequency of hot days, increased intensity and frequency of extreme daily rainfall events and droughts, changes to sea levels and changes in the occurrence of intense storm events. Climate change projections at the local scale for the Coffs Harbour area are described in a report by BMT WBM (2010a). The climate change projections for the Coffs Harbour area (relative to the 1977 to 2007 period) include the following:

- evaporation: decreases in summer and spring and increases in autumn and winter;
- temperature: decreases in average temperatures for summer, autumn and spring and increases in winter;
- Extreme Hot Days: significant increases in the annual number of extreme hot days;
- Average Rainfall: increases in annual totals and seasonal totals except for decreases in autumn totals for the Coffs Harbour area;
- High Rainfall Events: increases in frequency of high rainfall events in summer and autumn;
- Sea Level Rise: 0.4 m increase in mean sea level by 2050 and 0.9 m increase by 2100 (relative to 1990 mean sea levels); and

- Wave Climate: future wave climate will be similar to the present or within the variability of the existing wave climate. However, the Coffs Harbour Coastal Processes and Hazards Definition Study (BMT WBM, 2010b) investigated the possibility of a permanent shift from the existing south easterly wave climate to a more easterly wave climate with average wave height remaining the same.

C.5.1 Climate Change and Sea Level Rise Impacts on Estuary Processes

General estuary processes that will be impacted by climate change include (after Haines, 2006 and 2008; Mackenzie *et al.*, 2009):

- coastal processes and interactions with estuary entrances: e.g. a landward and upward shift in entrance channels in response to sea level rise;
- hydrodynamics: changes in water level and altered tidal prisms due to changes to entrance conditions; impacts of altered rainfall and evaporation patterns;
- sediment dynamics: changes to ingress of marine sediment due to changes to entrance conditions and changes to sediment derived from catchment runoff in response to an increase in high rainfall events;
- water quality: changes to water temperature and sediment dynamics and subsequent changes to chemical and physical processes in the estuary; and
- ecology: the impacts of increased water levels and altered hydrodynamics, sediment dynamics and water quality on ecological processes.

Appendix D

Summary of Community Uses Assessment

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Community consultation aims to discover community aspirations and gain stakeholder input to the Project to ensure that the Estuary Management Plan is accepted by the community as a coherent, practical and achievable plan.

D.1 Initial Community Workshop

A community workshop was held at Woolgoolga Community Centre on 14 September 2010. The purpose of the Initial Community Workshop was to gain input on community values, issues and objectives for the three estuaries. Approximately 30 people attended the workshop.

Council and the consultant team (GeoLINK / GECO Environmental / Aquatic Science and Management) provided an introduction on the Estuary Management Plan process. The attendees then formed five groups to discuss and compile a list of key issues and goals for the estuaries. Following the group work a representative from each group summarised their key issues and goals. A final question time was undertaken before the workshop concluded.

The key focus of the attendees was generally Woolgoolga Lake, however some specific comments relating to Darkum Creek were provided. The main issues arising from the workshop related to the need for improved water quality and reduced sedimentation in Woolgoolga Lake and an entrance management protocol to assist these two issues.

The various goals and issues developed by the group work are summarised below. A copy of the notes from each group is attached. The comments below refer to Woolgoolga Lake except where noted otherwise.

D.1.1 Goals:

- water quality in Darkum Creek was considered by some attendees as clean and the goal was to maintain this rating;
- a protocol for opening the entrance;
- foreshore management;
- water quality monitoring;
- weeds along riparian corridor;
- improved terrestrial and aquatic habitats;

D.1.2 Issues:

- Address water quality issues associated with runoff from rural lands and urban areas (nutrients, herbicides, pesticides, sediment and organic matter);
- Increased urbanisation in Darkum Creek catchment impacting on estuary health;
- Fire management was expressed as a concern by one group;

Some concerns were also expressed in relation to the estuary management planning process in regard to:

- public availability (and ease of access) of documentation; and
- scepticism as to whether management plan actions will be undertaken and the timeframe of actions.

D.2 Community Survey

A community survey was undertaken over a two month period from April to May 2011, encompassing a school holiday period to provide opportunity to capture input from the widest possible catchment of users. The surveys were located at Council offices, local outlets in the estuary catchments such caravan parks, newsagents and post offices. In addition, a web survey was made available through the website.

The survey data is summarised below. The total number of completed surveys received was 50. Note that Questions 6 and 8 apply to the Woolgoolga Lake Estuary and have therefore not been included.

1. Where are respondents from?

Sixty percent of respondents were from the Woolgoolga area, 22 % from Safety Beach and 16 % from elsewhere in the Coffs Harbour Council area. One respondent was from outside the Coffs Harbour Council area at the time of completing the survey.

2. How often do you visit use Darkum Creek?

94% of total respondents indicated they visit or use the Darkum Creek estuary. Respondents visiting Darkum Creek on a daily basis made up 23% of the total respondents, with a few times a year the next highest response at 22%.

3. Indicate how you use the estuary:

Survey results indicate the main use of the Darkum Creek estuary is walking, with 64% of total respondents identifying this use. Bird-watching, fishing and dog walking were the next most significant uses, identified by 26-28% of respondents. Swimming, picnicking and boating were identified by 12-18% of respondents. 6% of respondents listed other uses including kayaking, biking and hunting.

4. Indicate your level of concern for the following estuary-related issues:

The estuary issues of most concern that apply to Darkum Creek estuary, identified by 66% of respondents was water quality issues associated with runoff from agricultural lands and urban areas. The estuary issue of least concern that apply to Darkum Creek, identified by 24-30% of respondents were:

- loss of foreshore habitat (e.g. seagrass, mangroves, wetlands) due to higher lake/creek water levels from sea level rise; and
- protection of cultural heritage areas on the lake / creek foreshores.

5. Indicate the importance you place on the following estuary related goals:

The estuary goals of most importance, identified by 76-82% of respondents were:

- improved water quality;
- improved aquatic habitat within the lake and creeks to support fish stocks, crustaceans, etc; and
- improved runoff control in urban areas of the catchment.

The estuary goals of least importance that apply to Darkum Creek, identified by 18% of respondents was providing a buffer area around the shorelines to allow for 'retreat' of aquatic habitat (e.g. seagrass, mangroves) in response to rising lake / creek water levels from sea level rise.

7. Use of motor boats in the estuary:

Seventy-six percent of respondents indicated they do not support the use of motor boats, and 22% of respondents indicated they do support the use of motor boats in the Darkum Creek, Woolgoolga Lake and Willis Creek estuaries. 6% of respondents indicated that they would support the use of motor boats in the Darkum Creek estuary, with canoes with a mini outboard motor considered the most suitable.

D.3 Stakeholder Consultation

The organisations listed below were consulted to obtain initial input to the study:

- NSW Department of Environment, Climate Change and Water
- NSW Department of Environment, Climate Change and Water – Environmental Protection Authority
- NSW Department of Environment, Climate Change and Water – Parks and Wildlife Group
- Solitary Islands Marine Park Authority
- Primary Industries (Fisheries) – Industry and Investment NSW
- Northern Rivers Catchment Management Authority - Coffs Harbour

- NSW Department of Planning - Grafton
- NSW Department of Water
- Land and Property Management Authority
- NSW Maritime
- Roads and Traffic Authority
- Coffs Coast Tourism Association
- Local Aboriginal Land Council – Coffs Harbour
- Gumbular-Julipi Elders Council, c/o Coffs Harbour Local Aboriginal Land Council
- Woolgoolga Surf Life Saving Club
- Coffs Harbour Historical Society and Museum Inc.
- Landcare
- Woolgoolga Chamber of Commerce Industry & Tourism Inc
- Let's Save Woolgoolga Lake
- Coffs Harbour City Council
- Garby Elders
- Jim Stevens
- Woolgoolga Returned Services Golf Club

Input received from various organisations has been incorporated into the assessment of the relevant issues in the EMS. The issues are summarised below.

Table D.1 Consultation Correspondence

Stakeholder
NSW Department of Planning (DoP)
The DoP refers to the following documents for consideration in preparing the CZMP: ▪ Mid North Coast Regional Strategy; and ▪ SEPP 71 – Coastal Protection.
The DoP raises the issue of future sea level changes and its consideration in planning for coastal areas. The DoP refers to the following documents and guidelines for consideration in preparing the CZMP: ▪ NSW Coastal Planning Guideline: Adapting to Sea Level Rise; ▪ Coastal Risk Management; and ▪ Flood Risk Management.

D.4 Final Community Workshop – Development of Strategies

A community workshop was held at Woolgoolga Community Centre on 13 October 2011 for the three estuaries (Darkum Creek, Woolgoolga Lake, and Willis Creek). The purpose of the workshop was to gain community input into the development of management strategies to ensure appropriate strategies have been developed, and to assist with identifying priorities. Approximately 30 people attended the workshop.

Council and the consultant team (GeoLINK / GECO Environmental / Aquatic Science and Management) provided an introduction on the key issues for the estuaries. The attendees then formed six groups to develop a list of key management strategies targeting the key issues for the estuaries. The output of the six groups are summarised in the following table. Following the group work a representative from each group summarised their strategies and reasoning. A final question time was undertaken before the workshop concluded.

The key focus of the attendees was generally Woolgoolga Lake, however some strategies such as catchment pollutant strategies related to all three estuaries. The main strategies generally aligned and supported the strategies that were being developed by the consultant team. The main strategies developed by the six groups are included:

- catchment pollutant strategies particularly with respect to rural runoff;
- management of environmental weeds and protection of riparian areas;
- urban stormwater management;
- sewerage overflows;
- dredging of the entrance;
- maintaining and enhancing existing walking trails; and
- prevent new development in areas affected by increased water / flood levels from sea level rise.

Table D.2 Management Strategies Developed in Community Workshop on 13 October 2011

ISSUES	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Stormwater and Catchment Inputs	▪ Education and address policing / fining ▪ Erosion due to building and bad farming practices (eg. Blueberry / bananas) ▪ Sewerage inspections ▪ Dog excrement: place "poo bags" at head of walking tracks and police this / fines ▪ Council and NPWS to enforce "Animals Act".	▪ Eliminate or reduce top soil erosion / runoff from entering Poundyard Creek from construction and rural activities eg. blueberries	▪ Ongoing monitoring of water quality from all waterways and action taken to correct any silt or chemical imbalances ▪ In rural areas ensure a minimum buffer zone of 22 m along all waterways to trap sediment runoff	▪ Address the issue of erosion from orchards ▪ Campaign awareness for residents in the catchment (rural and urban)	▪ Buffer zones to 30 m along waterways ▪ Construct nitrogen traps / filter zones ▪ Address litter from children ▪ Inspection of sewerage especially Poundyard Ck	▪ Stormwater treatment devices implemented on all outlets and regularly serviced ▪ Water quality monitoring ▪ Audit agricultural practices ▪ Fish sampling for water quality monitoring
Impacts to foreshores	▪ Seek funding for protection of riparian areas ▪ Support for volunteer groups for removal of rubbish and regeneration activities ▪ Council implement / supplies facilities (eg. common green skip bins) for landowners / caravan parks to remove green waste to prevent illegal dumping ▪ Wooden barriers / bollards and planting to define boundary to prevent mowing encroachment to native bushland	▪ Removal of noxious weeds eg. mile-a - minute and morning glory	▪ Educate residents and council workers on detrimental effects of mowing and other foreshore gardening activities on native riparian vegetation ▪ Develop and implement a management plan to keep lantana and other environmental weeds out of the foreshore areas ▪ Develop and implement an erosion management strategy	▪ Bollard the western end of the Woolgoolga Lake picnic area to eliminate vehicle access and a sign erected to prohibit cars, bikes onto the lake foreshores ▪ Campaign to control noxious weeds on the edges of Woolgoolga Lake ▪ A campaign to eliminate the camphor laurel problem that is developing along these creeks in the upper reaches	▪ Address illegal mowing, tree removal, and use of fertilisers ▪ Requires more landcare, neighbourhood and weed management groups ▪ Bush regeneration at TAFE ▪ Re-establish buffer zones ▪ Council get rid of green bins and place mulch around trees ▪ Promote / educate community regarding composting / worm	▪ Address weeds – lantana, asparagus fern (CMA, School, Community) – continue spraying; ▪ Mangroves – implement colonisation study (CMA, schools).

ISSUES	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
				▪ Keep natural, no rock walls, no retaining walls, no sandbags	farms	
Flooding	Council to revise: ▪ stormwater planning ▪ level of outlets for sewerage or relocating outlets ▪ relocation of housing at risk from flooding	▪ Address sewerage pumping stations overflow in heavy rains ▪ Keep stormwater drains cleared	▪ Rebuild and vegetate southern dune peninsula (near Caravan Park) by pumping sand from sedimentation area. This should improve any flooding problems in Woolgoolga Lake	▪ Have to maintain vegetation corridors within the catchment to slow run-off and reduce intensity of flooding, particularly when setting up new developments ▪ To alleviate the flooding of foreshore, removing the silt from the estuary mouth (dredging and sand pumping) Council should setup regular maintenance of clearing sand build-up by way of earth moving equipment after dune erosion. Push the sand back onto the southern dune entrance and beachfront ▪ Stop removing branches and tree trunks from waterways	▪ Odour issues from pump station at end of Young Street ▪ Convert kerb and guttering to dish drains and local grasses and plants ▪ Install retention basin and sedimentation traps ▪ Promote stormwater infiltration devices on properties	▪ Manually open Woolgoolga Lake mouth in storm events ▪ Public notification (paper) of water quality following flood events.

ISSUES	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
Sedimentation	▪ Holding ponds higher up the catchment ▪ Do not remove or install large logs (natural damming) to slow water flow, catch sediment and provide fish / aquatic habitat.	▪ Dredging to remove sediment from bottom of lake	Refer to Flooding comments.	▪ Reinstate the natural northern lake entrance by removing the retaining wall ▪ Bulldoze the sand; ▪ Dredge the entrance to remove sand ▪ Return to contour planting in agriculture on the catchment hills (eg. blueberry farms)	▪ Re-establish riparian vegetation using neighbourhood group eg Sunset Lakes ▪ Utilise sediment traps and biological solutions to address sediment runoff ▪ Increase riparian buffer near sports oval by reclaiming 10 – 20 m on east of oval ▪ Increase riparian buffer along Darkum Creek within Golf Course	▪ Runoff and marine silts are considered the issue ▪ Water depth varies depending on mouth status ▪ Dredging is considered to be temporary relief (optic cable maybe impacted by dredging
Recreation	▪ Prevent 4WD entry / damage to environment ▪ No new walking tracks to be put in ▪ Maintain and enhance existing walking tracks so that public stay on tracks ▪ NPWS to prevent and police / fine 4WD's on beach	▪ No further trail networks are needed ▪ Bank erosion at the picnic area of the lake needs to be addressed	▪ Existing trail networks which are retained should be converted to boardwalks to prevent erosion ▪ Where trail (where boardwalks) are set back from waterways, then the land between can be developed as a catchment / erosion control zone for runoffs to ease siltation and erosion	▪ Walking trails on the cemetery side of the lake need fixing as it is washed out and dangerous ▪ Very important to keep and expand the walking trails so residents and visitors can enjoy the waterways	▪ Close off unnecessary trails ▪ Make clear signage – interpretation ▪ Retain only necessary well-walked trails ▪ Stop 4WDs / motorbikes on trails	▪ Pathways – adequate quantity but quality poor (fix steps / drainage – north shore, Safety Beach) ▪ Upgrade to "in-ground", permanent well-constructed eg Port Macquarie Headland Walk.

ISSUES	*Group 1*	*Group 2*	*Group 3*	*Group 4*	*Group 5*	*Group 6*
			▪ Educational signage at key points of each waterway on the importance of these as a natural environment.			
Climate Change and sea level rise	▪ No new developments in flood prone areas as designated by Coffs Coastal Zone Management Plan ▪ Protection (by zoning) of existing native riparian habitat	▪ No comment	▪ Council to identify and publicise those properties which will be affected by climate change and flooding events and develop and implement property prevention measures	▪ No comment	▪ Make retreat areas for animals and plants ▪ Households to use water retention strategies ▪ No new development in river / lake / sea level rise areas.	▪ No comment
Other	▪ More active policing / fining of regulations by NPWS and Council ▪ Use signs and education avenues eg. in schools, social media, tv and papers ▪ Container legislation – 10c for return of bottles and cans to prevent litter	▪ The poor condition of Woolgoolga Lake Bridge is considered an eyesore	▪ No comment	▪ Community Dune Care Groups should have to seek approval from Council and community before performing strategies and so-called improvements to the lake and foreshores, in particular pruning has been done which leaves a lot to be desired ▪ Ugly shade-cloth fences on beach front etc unnecessary and for long periods.	▪ Teach people to look at rivers for health, deterioration and regeneration, street education ▪ All new development to be required to be 40% under indigenous vegetation	No superfluous signage – if a must, eco-friendly and reduce (maintain) education signs to a minimum

Appendix E

Summary of Development of Management Objectives and Issues

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E.1 Values

E.1.1 Local and Regional

The natural settings of the estuaries and coast within the Mid North Coast area are a feature that attracts visitors and locals to the area. Darkum Creek is in keeping with this natural setting, and forms part of the network of bushland settings along the coast and estuaries and are of local and broader significance due to its proximity to residential community of Safety Beach.

Key values of the estuary include its natural setting and recreational opportunities including the walking and cycling track, adjacent golf course, and water based activities including canoeing and fishing.

The creek is part of the Solitary Islands Marine Park and is zoned as a Habitat Protection Zone up to the tidal limit. The eastern fringe of the estuary catchment is located in the Coffs Coast Regional Park, forming a well-defined corridor of undisturbed natural vegetation following the downstream section of the creek to its mouth.

E.1.2 Cultural Heritage

The Woolgoolga area was (and continues to be) inhabited by the Gumbayngirr people prior to European Settlement. Records show that artefact finds are located within the Darkum Creek catchment. The cultural values of these Aboriginal sites within the Darkum Creek catchment area require sensitive consideration and preservation.

Europeans moved into the Woolgoolga area from the 1870s. Aerial photographs indicate rural land use within the upper Darkum Creek catchment commenced between 1943 and 1964. Land clearing and initial development of the Safety Beach residential area also occurred during this period. More significant land clearing for rural land use in the upper catchment (west of the existing Pacific Highway) occurred between 1964 and 1974 whilst residential development of Safety Beach continued to expand. Native vegetation in the current golf course area was cleared between 1974 and 1984, which is the most significantly visual change for the estuary catchment in the aerial photography records. Further land clearing for rural land use continued in the upper estuary catchment up to 1994. Residential development expanded further after 2000. There has also been significant replacement of banana cultivation and grazing land with blueberry farms and controlled environment horticulture ('hothouses') since 2004.

The *Coffs Harbour Coastal Processes and Hazards Definition Study Draft Report*, prepared by WBM, indicates that sand mining leases existed and sand mining may have occurred at Safety Beach (Darkum Creek estuary catchment area).

E.1.3 Recreational Values

Darkum Creek is a relatively small and remote coastal estuary and offers the following recreational values:

- significant water-based activity including kayaking, canoeing and fishing in the creek;
- the significant riparian vegetation promotes a sense of seclusion and enhances the natural experience for water-based activities such as canoeing;
- a coastal walk which is facilitated by the pedestrian footbridge over the creek enabling a continuous pedestrian and bicycle route following the coastline and connecting the residential communities of Arrawarra in the north to Woolgoolga in the south; and
- to the east of the footbridge is a corridor of undisturbed natural vegetation following the southern downstream section of the creek to its mouth, which is part of the Coffs Coast Regional Park. This area comprises dense coastal vegetation and contains no known tracks, and is likely to attract people seeking quiet recreational opportunities such as bird watching and bushwalking.

E.1.4 Scenic Values

Darkum Creek offers a predominantly undisturbed natural environment that forms an integral and important component of the natural settings along the coastline. It offers the following scenic values:

- the creek and its foreshores contribute significantly to the character and amenity of the surrounding residential communities;

- the creek has short distant reaches and heavily vegetated foreshores which offer considerable shelter from prevailing winds. The resulting tranquil water combined with the surrounding riparian vegetation offer considerable scenic amenity;
- the creek itself is largely only visible from the footbridge which offers an excellent vantage point in both upstream and downstream directions
- an attractive long distant view across a downstream reach of the creek is also available from its mouth at Safety Beach; and
- the creek is also likely to be visible through openings in vegetation from the adjoining golf course.

E.1.5 Hydrodynamic Values

The entrance to Darkum Creek is predominantly closed resulting in relatively consistent water levels in the creek. There are small fluctuations associated with over-washing of the entrance berm during higher tides and fluctuations associated with varying inflow from the catchment. The relatively consistent water levels would assist in supporting water-based activities such as canoeing.

E.1.6 Water Quality Values

The water quality measurements collected from Darkum Creek show high variability, particularly the physicochemical aspects. This is a typical feature of ICOLLs. However, in general the waters of Darkum Creek:

- are generally well oxygenated;
- tend to have low to moderate turbidity, which in combination with shallow waters can lead to high productivity and support aquatic vegetation;
- are relatively low in bioavailable nutrients;
- are suitable for primary contact recreation;
- are suitable for protection of aquatic ecosystems (with the exception of slightly elevated chlorophyll-a concentrations, moderate turbidity measurements and slightly elevated TN concentrations); and
- receive a relatively low load of sediment and nutrients from the catchment, according to modelling undertaken as part of the Estuary Processes Study (GeoLINK et al, 2011).

To the knowledge of the author there have been no algal blooms or fish kills reported from Darkum Creek.

E.1.7 Ecological Values

Ecological characteristics of Darkum Creek that can be considered values include:

- the general health of the Darkum Creek estuary is good with respect to water quality, estuarine habitats, riparian vegetation, structural habitat availability and the history of fish kills and alagal blooms;
- The riparian vegetation of Darkum Creek is mostly intact and in good (52%) to very good (35%) condition. Riparian vegetation filters overland flows, stabilises banks, provides structural habitat for fish and contributes to the overall productivity of the estuary;
- Significant (1.4 ha) mangrove habitat made up of three species, some showing active recruitment. Mangroves are an important primary producer driving the overall productivity of the system, provide structural habitat for fish and invertebrates and stabilise banks and sediment;
- A small area of saltmarsh in relatively good condition;
- A variety of structural habitats including snags, root balls and overhanging banks;
- Reeds and rushes are common along the margins of the central channel and upper creek, contributing to productivity, habitat value and bank stability;
- A variety of benthic materials potentially offering habitat for diverse organisms;
- Fish and invertebrates that provide a resource for recreational fishers. Commonly targeted species include flathead and mudcrabs; and
- A pleasant and attractive environment created by the combination of the above features.

E.2 Management Objectives

E.2.1 Entrance Conditions and Hydrodynamics Objectives

E.2.1.1 Promote Natural Entrance Opening / Closing Processes

Darkum Creek is an ICOLL system that is predominantly closed. The entrance opens and closes to the ocean naturally in a constant but irregular cycle depending on fluvial, tidal and wave processes. Artificial opening of ICOLL's can have significant negative impacts on water quality, fish and other ecological communities.

There are no records of artificial opening of the entrance being used in the past. Community consultation has not indicated any desire for artificial opening of the creek entrance. Nor is there currently any significant need for artificial opening for the purpose of flood mitigation. Nevertheless, a formal entrance management policy will be developed for Darkum Creek in accordance with OEH *Guidelines for Preparing Coastal Zone Management Plans* (DECCW, 2010) which requires EMPs for ICOLLS to include such a policy.

The objective of the entrance management policy will be to maintain a natural opening / closing regime for the creek entrance. Interference (artificial opening of the entrance) would only be employed for critical situations such as to mitigate and reduce the impacts of flooding on properties and infrastructure adjoining the creek.

E.2.1.2 Minimise Flooding of Properties and Infrastructure

Flood level estimates for Darkum Creek and inundation mapping associated with elevated ocean levels indicates there are no properties or infrastructure currently at risk of flooding with the exception of areas of the Woolgoolga Returned Services golf course that adjoin the creek system. However sea level rise will result in higher inundation levels within the creek system in the future. Therefore the objective is to minimise or avoid future flooding of properties and infrastructure around the creek by appropriate means such as development controls for future development in flood prone areas; artificial opening of the creek entrance where appropriate; flood-proofing infrastructure; etc.

E.2.2 Bank Stability and Sedimentation Objectives

Bank erosion and estuary sedimentation are not significant issues in the Darkum Creek estuary (GeoLINK *et al*., 2011). Although 9% of banks surveyed were recorded with minor erosion, all such banks occurred in the lower reaches of the estuary where the channel runs adjacent to the beach dune. As the banks in this location are essentially composed of sands with little cohesion they are highly susceptible to wash and, when the entrance is open, tidal flow. The situation in Darkum Creek estuary is somewhat compounded by the degradation of the dune vegetation in the lower reaches, with vegetative cover reduced and significant infestations of bitou bush and ground asparagus, particularly on the seaward bank. It is considered that no specific objectives for addressing bank stability or sedimentation in the Darkum Creek estuary are required. However, the objective for restoring terrestrial habitats (*Section E.2.3.2*) addresses issues related to riparian weed management in this location.

E.2.3 Ecological, Habitat and Biodiversity Objectives

E.2.3.1 Protect and Enhance Aquatic Habitats

The North Coast LLS Catchment Action Plan (CAP) lists rehabilitation of aquatic habitats among its goals. Improving the state of aquatic habitats in Darkum Creek was also raised as a goal during community consultation.

Analysis of estuarine habitat extent indicates a certain species of seagrass (*Halophila*) has disappeared from Darkum Creek in recent years. This species is known to disappear and recolonise more than other species of seagrass. This may have occurred due to normal fluctuations in water quality and the relatively unstable nature of the sand bed in this reach. Nevertheless, the potential for seagrass re-colonisation in Darkum Creek may be enhanced through a variety of strategies.

The significant bands for mangrove and the small saltmarsh habitats in Darkum Creek appear to be in good condition. A further objective of the Darkum Creek Estuary Management Plan is to protect these communities from disturbance.

E.2.3.2 Restore terrestrial habitats of high ecological or conservation value by removing threats and through targeted rehabilitation (e.g. riparian vegetation, endangered ecological communities such as Coastal Saltmarsh, Freshwater Wetlands, etc)

Managing the influence of weeds along the riparian corridor of Darkum Creek was identified as a goal during community consultation. Restoration of riparian vegetation is also listed among the goals of the NRCMA CAP (now LLS). Additionally, the Coffs Harbour Settlement Strategy lists the enhancement of riparian corridors as a key strategy for the Woolgoolga area to provide ecological links between coast and hinterland (Coffs Harbour City Council, 2011b). A variety of terrestrial habitats of high conservation value have been identified within Darkum Creek estuary. The main threat to the integrity and viability of some of these habitats in the Darkum Creek estuary is weed invasion. This management objective is aimed at the rehabilitation of sites with high ecological or conservation value where degradation (such as weed infestation) has occurred.

E.2.3.3 Make Provisions for the Ecological Effects of Climate Change and Sea Level Rise

Some negative ecological impacts are likely to result under current climate change and sea level rise scenarios. These may include changes in the distribution and extent of mangrove and saltmarsh colonies and reductions in the overall productivity of the estuary. Effective planning for future changes will help to mitigate negative impacts.

E.2.4 Water Quality Objectives

E.2.4.1 Improve Water Quality

The perception amongst the community is that water quality in Darkum Creek is generally good. However, analyses against current guidelines suggest that aspects of water quality for the protection of aquatic ecosystems could be improved. The NRCMA CAP (now LLS) also lists an improvement in the condition of coastal zone natural resources as one of its targets. The assembled water quality information indicates that a reduction in the export of nutrients, sediment and other pollutants from the catchment through land and stormwater management would be the most efficient way to improve water quality in Darkum Creek.

E.2.4.2 Improved Monitoring of Water Quality

This is one of the goals identified during community consultation and is also a wish of the Coast and Estuary Management Committee (CEMAC). A suggested water quality monitoring program that meets NSW government reporting obligations will be delivered as part of the Estuary Management Plan.

E.2.5 Recreational Use and Access Objectives

E.2.5.1 Preserve the quiet, undeveloped natural setting of the creek foreshores

The coastal walk including the pedestrian footbridge enables a continuous pedestrian and bicycle route which follows the coastline and connects the residential communities of Arrawarra in the north to Woolgoolga in the south. An absence of other infrastructure and the natural setting is likely to attract people seeking quiet recreational opportunities such as bird watching, bushwalking and canoeing. This objective is accordingly to preserve the quiet undeveloped natural setting of the Darkum Creek waterway and foreshores.

E.2.5.2 Prevent fragmentation or intrusion into the existing undisturbed setting

This objective is to prevent unnecessary disturbance or fragmentation of the existing natural values by minimising the provision of additional recreational infrastructure and formal access routes.

E.2.5.3 Enhance public appreciation of the broader and site specific natural values of the creek environment

The purpose of this objective is partly to develop a sense of custodianship for the area to assist with preserving the existing natural characteristics.

E.2.6 Views and Visual Character

E.2.6.1 Maintain and Preserve Existing Natural Characteristics

This objective is to maintain and preserve the existing natural characteristics of the area as the dominant visual feature.

E.3 Management Issues

E.3.1 Entrance Conditions and Hydrodynamics Issues

E.3.1.1 Impacts of Climate Change on Flooding

Sea level rise caused by climate change will result in higher flood inundation levels within the Darkum Creek system in the future. Current inundation levels are likely to increase by a similar amount as sea level rise increases. Adopted sea level rise estimates for NSW are a 0.4m increase in sea level (relative to 1990 levels) by 2050 and a 0.9m increase by 2100. Climate change also has the potential to result in an increased frequency of high rainfall events leading to more frequent flooding events.

Higher future flood levels may present a risk of backyard flooding to some properties in the lower northern portion of Safety Beach in the vicinity of Panarama Parade, Baroona Street and Ocean Links Close. Some sewage pump stations (sewage pump station no. 6 (PS 6) located to the north of Panorama Parade) may also be at risk of flooding which would potentially lead to sewage entering the creek system.

E.3.2 Bank Stability and Sedimentation Issues

At the date of development of this Estuary Management Study, there were no bank erosion issues or sedimentation issues requiring active management within the Darkum Creek estuary.

E.3.3 Ecological, Habitat and Biodiversity Issues

E.3.3.1 Loss of Aquatic Habitats

A decline in the area and condition of seagrass beds, mangroves, saltmarsh and sedge heath communities was identified by the coast and estuary management committee (CEMAC) as possible issues concerning Darkum Creek. Detailed mapping analysis of estuarine habitats undertaken as part of the Estuary Processes Study shows that a large area of seagrass (1.3ha) has disappeared from Darkum Creek in recent years but that mangroves and saltmarsh habitats have increased in area. The factors causing the decline in the area of seagrass may be naturally occurring, as seagrasses are uncommon in mostly closed ICOLLs such as Darkum Creek. However, opportunities for recolonisation of seagrass into the Darkum Creek estuary could be maximised by a minimisation of suspended sediment loads in catchment runoff.

E.3.3.2 Impacts of Climate Change on Estuary Ecology

Some negative ecological impacts are likely to result under current climate change and sea level rise scenarios. These may include changes in the distribution and extent of mangrove and saltmarsh colonies, reductions in the overall productivity of the estuary and a reduction in feeding and nesting areas for wading birds.

E.3.3.3 Increased Urbanisation of the Darkum Creek Catchment

Increased urbanisation of the Darkum Creek Catchment was raised as an issue during community consultation. In terms of the estuary, the major potential impacts of increased urbanisation would result from changes to the quality of runoff from new urban developments. These are considered under *Section E.3.4.2* of this report.

E.3.3.4 Riparian Vegetation

Weed mapping undertaken in January 2011 identified the presence of environmental weed species throughout Darkum Creek (GeoLINK *et al*., 2011). The main species identified were groundsel bush, senna, and pink lantana in the mid to upper reaches, and bitou bush, coastal morning glory and ground asparagus in the lower reaches. Environmental weeds degrade the native riparian vegetation, reducing its ecological value

and in some cases potentially impacting upon bank stability and other estuary values including recreational amenity and aesthetics. Reaches of high priority for weed control will be determined as part of the Estuary Management Plan.

E.3.4 Water Quality Issues

E.3.4.1 Elevated Turbidity, Total Nitrogen and Chlorophyll-a Values

The assembled water quality data for Darkum Creek triggers ANZECC (2000) interim guidelines for the protection of aquatic ecosystems for turbidity, total nitrogen and chlorophyll-a. The OEH guideline value for turbidity is also exceeded.

The specific cause of elevated turbidity levels in Darkum Creek is uncertain, though the following factors may be contributing:

- re-suspension of fine sediments on the bottom due to tidal flow or during entrance breakout events; and
- elevated suspended sediment loads in catchment runoff.

The median turbidity value is only slightly above the ANZECC (2000) guideline value for estuaries.

All of the samples from Darkum Creek tested for total nitrogen were above the ANZECC (2000) guidelines level for the protection of aquatic ecosystems. Whilst the ANZECC (2000) guidelines are the best currently available measuring stick for water quality they have not been developed specifically for ICOLLs like Darkum Creek and as a result can be misleading. However, the median chlorophyll-a concentration in samples from Darkum Creek also exceeds both the ANZECC (2000) guideline value for the protection of aquatic ecosystems and the OEH guideline value.

Elevated nitrogen concentrations are an indirect threat to an ecosystem. The main problem associated with elevated nitrogen concentrations is that under certain conditions they can lead to algal blooms. Chlorophyll-a concentrations are measured as an indicator of the status of algal populations. Whilst algal blooms have not been reported from Darkum Creek the combination of slightly elevated total nitrogen and chlorophyll-a concentrations constitutes an issue.

E.3.4.2 Stormwater Management and Pollutant Inputs from the Catchment

During community consultation water quality issues associated with runoff from rural and urban lands were raised as a perceived issue. Nutrients, sediments, pesticides and herbicides, and organic matter were all seen as potential contaminants in runoff. A basic modeling exercise was undertaken as part of the Estuary Processes Study using the Catchment Management Support System (CMSS). The CMSS is a method of calculating nutrient and sediment budgets based upon landuse types and their distribution within a catchment.

Rural Landuse

CMSS results indicate horticultural landuses are the largest relative contributor of sediment and nutrients followed by pasture. The CMSS indicated phosphorus input to the lake was largely attributed horticultural land uses. This highlights the importance of erosion and sediment controls for the main agricultural practices in the catchment (eg. banana and blueberry cultivation) and wastewater controls for intensive horticultural practices such as excess fertigation from greenhouse cucumber production.

Urban Development

Residential land is a significant contributor of sediment and nitrogen. This indicates that investment into effective stormwater management could be an effective means of improving overall estuary health.

Projected future growth in the Woolgoolga area includes a review of the golf course adjoining Darkum Creek for urban expansion potential for future residential area for long term growth (beyond 2016) (Coffs Harbour City Council, 2011b). There is also possible long term urban expansion area west of the existing highway should population targets be achieved sooner than currently predicted.

New development areas have the potential to reduce the quality of catchment runoff during and after the construction phase. It is important that controls placed on new developments are sufficient and enforced to ensure no negative net impact upon water quality. It is noted that some older drainage systems based on grassed swales as opposed to kerb and gutter, such as older areas of Safety Beach, provide effective treatment of runoff.

Old on-site sewage management systems (septic systems) on rural and rural-residential properties also have potential to deliver excess nutrients and pathogens to the estuary system.

Golf Course

Due to the significant area of the estuary occupied by the golf course and its location adjacent to the creek it is important that grounds management practices such as fertiliser application are carefully managed to avoid impacts on the estuary.

Pacific Highway Upgrade

An additional and immediate development within the greater catchment area is the construction of the Woolgoolga bypass. It is important that water quality runoff from the construction of this major development is subject to strict controls and does not result in adverse impacts to water quality.

E.3.4.3 Water Quality Impacts Associated with Climate Change and Sea Level Rise

It is difficult to predict precisely how forecast climate change and sea level rise may impact upon water quality in Darkum Creek. It is likely, however, that some existing issues might become more pronounced under climate change and sea level rise scenarios, particularly issues relating to catchment inputs.

E.3.4.4 Lack of Continuity and Detail in Existing Water Quality Data

The conclusions that have been drawn about nutrient and sediment concentrations and trophic status are based upon a limited dataset. In general the available water quality data for Darkum Creek could be described as lacking in continuity and detail.

E.3.5 Recreational Use and Access Issues

E.3.5.1 Damage and loss of amenity from increased use

Increased recreational activity and uncontrolled pedestrian access to riparian areas of Darkum Creek has the potential to damage the natural environment. Additionally, increased recreational activity has the potential to cause a loss of existing recreational amenity and sense of solitude experienced by walkers.

E.3.5.2 Incompatible maintenance practices have the Potential to impact on riparian vegetation and thereby degrade the recreational experience of the creek

Incompatible maintenance practices associated with the adjoining golf course has compromised riparian vegetation.

E.3.6 Views and Visual Character Issues

E.3.6.1 Loss of Visual Amenity

Fragmentation or disturbance of the natural environment by additional and uncontrolled pedestrian movement has the potential to cause a loss of visual amenity.

E.3.6.2 Prevent Loss of Riparian Vegetation

Ensure riparian vegetation is not removed to improve scenic outlook from residential areas. This issue is addressed under *Section E.3.3.4*.

E.4 Ranked List of Issues

Table E.1 shows the ranked management issues in terms of their priority for management over the next five years. Five years is the expected planning timeframe for the Estuary Management Plan before it undergoes review and adjustment. The ranking has been based on the scoring system below. The scoring attributed to each management option is shown in Table E.1.

Priorities have been allocated to management objectives based on a matrix assessment that considers:

- the degree to which the management objectives will impact on estuary issues:
  (scoring: low = 1, moderate = 3, high = 5);
- timeframe over which the impacts are likely to occur:
  (scoring: short (< 3 years) = 1, medium (5-8 years) = 3, long (>10 years) = 5);
- extent of the estuary addressed by the management objective:
  (scoring: lower estuary = 1, middle estuary = 1, upper estuary = 1, whole estuary = 3); and
- community rating of the issues addressed by the management objectives based finding from the community survey): (scoring: not important = 0, important = 3, very important = 5).

Table E.1: Ranked List of Key Estuary Management Issues

Priority	*Key Estuary Management Issue*	*Report Reference*	*Potential for Impact on Estuary Objectives*	*Timeframe over which Impacts Occur*	*Extent of Estuary Addressed*	*Community Rating*	*Priority Score*
1	Stormwater Management and Pollutant Inputs from the Catchment	5.2.4.2	4	5	3	5	17
2	Riparian Vegetation	5.2.3.4	5	5	3	4	17
3	Elevated Turbidity, Total Nitrogen and Chlorophyll-a Values	5.2.4.1	4	5	3	5	17
4	Increased Urbanisation of the Darkum Creek Catchment	5.2.3.3	5	5	3	3	16
5	Loss of Aquatic Habitats	5.2.3.1	3	5	2	3	13
6	Water Quality Impacts Associated with Climate Change and Sea Level Rise	5.2.4.4	3	5	2	3	13
7	Damage and loss of amenity from increased recreational use	5.2.5.1	4	5	2	2	13
8	Impacts of Climate Change on Estuary Ecology	5.2.3.2	3	5	2	2	12
9	Lack of Continuity and Detail in Existing Water Quality Data	5.2.4.5	2	5	2	3	12
10	Incompatible maintenance practices have the potential to impact on riparian vegetation and thereby degrade the recreational experience of the creek	5.2.5.2	3	3	2	3	11
11	Loss of Visual Amenity	5.2.6.1	3	3	2	2	10
12	Impacts of Climate Change on Flooding	5.2.1.1	1	5	2	1	9

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Appendix F

Letters of Support from Agencies for Relevant Actions

Department of Industry

DOC18/127263

Steve McGrath
General Manager
Coffs Harbour City Council
Locked Bag 155
Coffs Harbour NSW 2450

Attn: Sally Whitelaw

By email: sally.whitelaw@chcc.nsw.gov.au
cc: marc.daley@environment.nsw.gov.au

Dear Mr McGrath

Darkum Creek Estuary and Willis Creek Estuary Coastal Zone Management Plans (CZMPs)

The Department of Industry – Lands & Water (DoI Crown Lands) has reviewed the Darkum Creek Estuary and Willis Creek Estuary Coastal Zone Management Plans, as amended for certification June 2018, where relevant to the NSW *Crown Lands Act 1989.*

The review has considered technical, planning and financial aspects of the CZMP as relevant to Crown land management. The review has not considered the adequacy of the CZMP in relation to other legislation or the 'Guidelines for Preparing a Coastal Zone Management Plans', published by the NSW Office of Environment & Heritage (2013).

DoI Crown Lands agrees 'in principle' to the amended CZMPs under section 15(4)(b) of the *Coastal Management Act 2016* (formerly section 55C(2)(b) of the *Coastal Protection Act 1979* - now repealed). This agreement does not exclude or replace the need for authorities to undertake the various planning, regulatory and approval processes that may be required as per the *Crown Lands Act 1989* and as part of implementing the CZMPs.

Should you wish to discuss this matter further, please do not hesitate to contact Ms Catherine Knight, Coastal Management Specialist, on (02) 6620 5511 or by email at catherine.knight@crownland.nsw.gov.au.

Yours sincerely

Glenn Bunny
Director Infrastructure and Land Management
28 June 2018

437 Hunter Street Newcastle NSW 2300
PO Box 2185 Dangar NSW 2309
Tel: 1300 886 235 www.crownland.nsw.gov.au ABN: 72 189 919 072

From:	Tony Broderick
To:	Sally Whitelaw; Jackson Pfister
Subject:	Fwd: Agency support for actions under Estuary Coastal Zone Management Plans
Date:	Monday, 4 December 2017 9:50:13 AM
Attachments:	image001.jpg image001.jpg Attachment 1 - BoambeeNewports CZMP LLS Relevant Strategy Updates.docx Attachment 2 - Darkum Willis Woolgoolga CZMP LLS Relevant Strategy Updates.docx LLS Letter Agency Support for Actions. Follow-up- Local Land Services.pdf

Hi Sally and Jackson,

Thankyou for the opportunity to comment on the revised strategy and actions outlined in the CZMP's for Darkum, Willis and Woolgoolga creeks.

North Coast LLS supports the listed Strategy actions 1.2 and 1.5 for Darkum and Willis Creek CZMP's and the responsibilities attributed to NCLLS as outlined in the attached. Please note that in 171/8 NCLLS will update the "Soil and Water Management Practices for Blueberry growers in Northern NSW, 2008" as part of its current Ecological Sustainable Development: blueberry engagement project.

North Coast LLS also supports Strategy actions 2.2 and 2.6 fo5r Woolgoolga Creek CZMP's and the responsibilities attributed to NCLLS as outlined in the attached.

kind regards
Tony Broderick

Tony Broderick | Team Leader Land Services
North Coast Local Land Services
24-26 Mulgi Drive, South Grafton NSW 2460.
t: 02 6604 1114 | m: 0409 225 798
w: www.lls.nsw.gov.au/northcoast

---------- Forwarded message ----------
From: **Sally Whitelaw** <sally.whitelaw@chcc.nsw.gov.au>
Date: 30 November 2017 at 12:08
Subject: Agency support for actions under Estuary Coastal Zone Management Plans
To: "tony.broderick@lls.nsw.gov.au" <tony.broderick@lls.nsw.gov.au>
Cc: Jackson Pfister <jackson.pfister@chcc.nsw.gov.au>

Hi Tony,

As discussed the other day we are seeking comments from LLS in regards to a number of CZMPs so that we can get them certified and available for grant funds.

A letter is attached explaining this further.

Please give me a call if you have any questions. It would be great to get this sorted before xmas if possible. If not I am on leave for most of January however Jackson is available in

January if you have any questions. He can be reached on 6648 4462.

Regards,

Sally Whitelaw

Senior Biodiversity Officer| Coffs Harbour City Council

P: | 02 6648 4673

E: sally.whitelaw@chcc.nsw.gov.au | W: www.coffsharbour.nsw.gov.au |

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OUT17/16446

27 April 2107

Coffs Harbour City Council
Locked Bag 155
COFFS HARBOUR, NSW 2450

Attn: Marten Bouma
Email address marten.bouma@chcc.nsw.gov.au

Dear Mr Bouma

Support for actions required to be undertaken by DPI Agriculture under Council's adopted Estuary Coastal Zone Management Plans (EMPs)

Thank you for the opportunity to provide comment for the above proposal as per your correspondence dated 23 March 2017.

DPI Agriculture has reviewed the commitments included in the EMPs and agrees to undertake the actions outlined. To assist Council to plan to undertake these actions DPI Agriculture encourages Council in the first instance to contact Mr Mark Hickey Leader Northern Horticulture, Primary Industries Horticulture on telephone (02 6626 1277) or email mark.hickey@dpi.nsw.gov.au to ensure that the relevant industry development officers will be available.

Yours sincerely

E Rogers

Liz Rogers
Manager
Agriculture Landuse Planning

NSW Department of Primary Industries - Agriculture
Locked Bag 21, Orange NSW 2800 | 161 Kite St, Orange NSW 2800
Tel: 02 6391 3391 | Email: landuse.ag@dpi.nsw.gov.au | www.dpi.nsw.gov.au | ABN: 72 189 919 072