ICOLL Entrance Management Policies

Review of Environmental Factors

October 2016

bega valley shire council

Citation

Bega Valley Shire Council ICOLL Entrance Management Policies – Review of Environmental Factors, October 2016. A report prepared by Water Research Laboratory and the Office of Environment and Heritage with assistance from Bega Valley Shire Council. Final report 27/10/2016.

Revision	Date	Prepared by	Reviewed by
Draft	30/10/2012	OEH (Raymond Laine)	OEH (Danny Weicek) and BVSC (Derek Van Bracht)
Draft	13/08/2016	WRL (Matt Blacka)	OEH (Danny Wiecek, Jackie Taylor, Suzie Lamb), BVSC (Kyran Crane, Daniel Murphy), DPI Fisheries (Jillian Reynolds), DPI Lands (Grant Merinuk)
Final	27/10/2016	WRL (Matt Blacka)	OEH (Danny Wiecek, Jackie Taylor, Suzie Lamb), BVSC (Kyran Crane, Derek Van Bracht, Cecily Hancock)

PO Box 492, Bega NSW 2550

P. (02) 6499 2222

F. (02) 6499 2200

E. council@begavalley.nsw.gov.au

W. begavalley.nsw.gov.au

Contents

1 Overview

1.1 Introduction

Bega Valley Shire Council (BVSC) assumes responsibility for the management of entrances at a number of estuaries throughout the Local Government Area that are subject to periods of closure to the ocean. These estuaries are referred to as intermittently closed and open lakes and lagoons (ICOLLs). Entrance management of ICOLLs essentially involves artificially removing or manipulating sand around the entrance berm, to release built-up waters to the sea. This is done typically when water levels within estuaries exceed specific 'trigger' levels as a precursor to potential detrimental impacts on access, infrastructure or industry around the waterways.

Interim Entrance Management Policies have previously been prepared for Wallaga Lake, Cuttagee Lake, Bega River, Back Lake, Curalo Lake and Wonboyn Lake within the Bega Valley Shire. Through a more holistic process including Government and public stakeholder consultation, final Entrance Management Policies have now been developed for the following ICOLLs within BVSC:

- Wallaga Lake;
- Cuttagee Lake;
- Bega River;
- Wallagoot Lake;
- Back Lake;
- Lake Curalo; and
- Wonboyn Lake.

These Entrance Management Policies are reproduced in Appendices A-G. This document outlines specific "trigger" levels, procedures, and respective Review of Environmental Factors (REFs) for artificially opening the above estuaries to the sea as a part of entrance management works. The Review of Environmental Factors (REF) prepared for each estuary outlines the potential impacts of implementing the Entrance Management Policies on the estuary environments, and details the mitigation measures to be adopted in order to minimise potential impacts in accordance with the Environmental Planning and Assessment Act 1979, Part 5.

This document has considered the economic, ecological, social and hydrological impacts of managing estuary entrances to alleviate flooding with the intention to return to a more natural opening regime. It is intended that the Entrance Management Policies and associated REF be reviewed approximately every 5 years.

1.2 Aims and Objectives

The overarching aims and objectives of the Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, Lake Curalo, and Wonboyn Lake Entrance Management Policies are:

- To have minimum interference with natural entrance opening processes and minimise impacts on ecological processes in the long term;

- To accommodate future climate change and sea level rise in particular;
- To minimise risks to public safety associated with excessive inundation of foreshores and associated infrastructure;
- Conserve or enhance the biological diversity and flora and fauna communities of the estuarine lakes systems;
- To determine procedures to be initiated for entrance management operations;
- To determine key responsibilities for management of the entrance; and
- To detail the procedure for monitoring of lake entrances.

In meeting the above aims and objectives, Council will consider the following:

- Facilitate vertical natural migration of riparian and estuarine ecological communities in response to sea level rise;
- Limit opportunities for ingress and establishment of introduced and invasive species to the estuaries;
- Minimise impacts on local fisheries resources and other ecological species, where possible;
- Conserve and protect items and places of historical and cultural value;
- Enable continued existing use of lands for as long as practical;
- Strategically relocating or adapting key assets so as to minimise artificial interference in estuary processes in the future;
- Gain broad based community understanding and support for management of the lake entrances;
- Time requirements for review of entrance management practices.

1.3 Entrance Management Philosophy

The NSW Department of Primary Industries fish habitat management policies and guidelines "support minimal interference with ICOLL entrance barriers and advocates natural processes being allowed to operate to the greatest extent possible". In line with this philosophy, entrance management policies have been prepared that broadly aim for minimal or no opening with the long-term goal to retain or progressively reinstate natural behaviour (i.e. greater adaptation to closed entrances), with consideration to potential impacts of future sea level rise. To achieve this goal Wallaga Lake, Bega River, Back Lake and Lake Curalo require the progressive removal, relocation or modification of assets and activities that are affected by inundation or that may create public health problems when water levels are high (eg. stormwater and sewerage systems). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions in the long term. In the case of Wonboyn Lake, alternative methods for sustaining the oyster farming industry through long periods of drought when the entrance is closed, may be required. Management of the ICOLL entrances will generally accord to the philosophy shown in Figure 1.

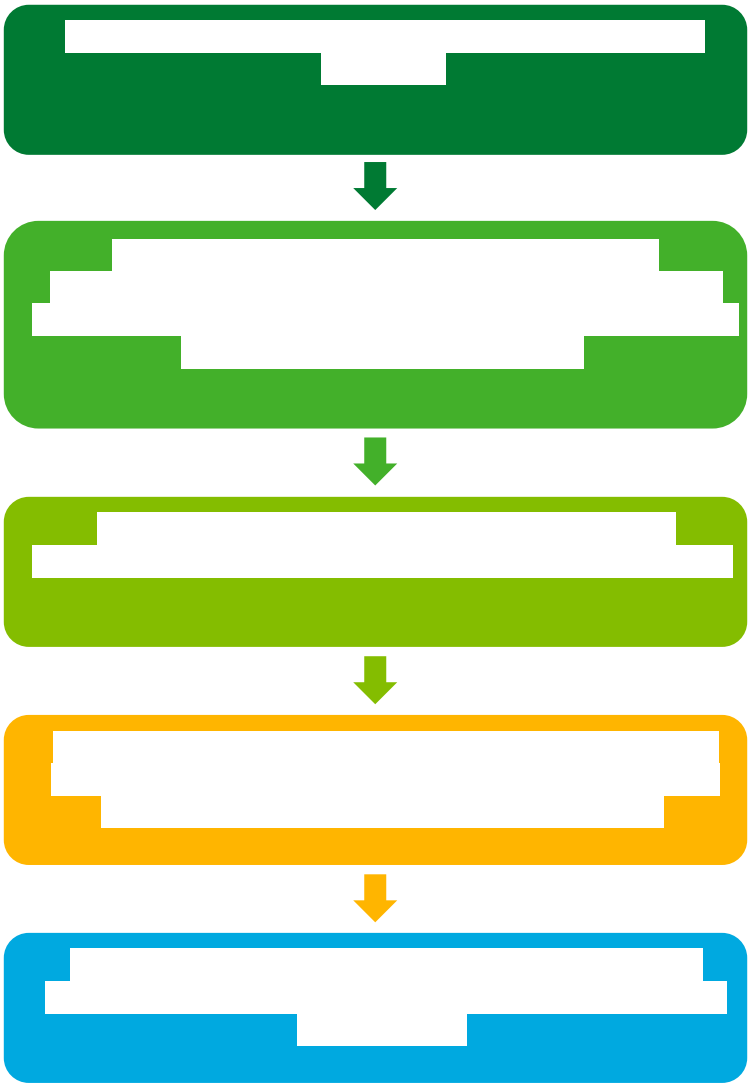

Figure 1: ICOLL Entrance Management Philosophy

1.4 Previous Draft Policies and Assessments

1.4.1 Draft Wallaga Lake Entrance Management Policy

A Draft Wallaga Lake Entrance Management Policy was prepared for the Wallaga Lake Estuary Management Committee in October 2004 (DIPNR). The Draft Policy describes the decision making framework for artificial entrance opening in consideration of social, environmental and economic factors in conjunction with legislative requirements, trigger levels, lake opening procedures, entrance monitoring and future asset recommendations. The Draft Policy details the following conditions under which the lake entrance can be breached:

- If the level of the lake reaches 1.26 m AHD (Australian Height Datum) it shall be opened after 1 day has elapsed to allow sufficient rainfall runoff to enter the lake.
- If the lake level stabilises between 1.10 and 1.26 metres AHD, the decision to open the lake will be governed by other factors that relate to:
    - suitable time of year for threatened species conservation;
    - duration of prior period of wetland and pasture inundation;
    - month of the year.

- No artificial lake openings can take place when the lake water level is less than 1.10 m AHD, as this is likely to be ineffective and result in poor entrance scouring.

The benefits and limitations in summation of the Draft Entrance Management Policy were:

Benefits

- Provides for at least up to 3 months of wetland inundation between the water levels of 1.10 m and 1.25 m AHD. This will allow the lake to function more naturally as an intermittently closed and open estuary, thereby assisting the health of the lake ecosystem;
- Prevents excessive periods of inundation of the main road between Narooma and Bermagui at the Wallaga Lake causeway, by only allowing the road to be flooded for a maximum of 1 day. This 1 day period has been provided to enable runoff from the catchment to enter the lake, thereby creating as high a water level as practical for a successful entrance scour upon opening;
- Prevents ineffective lake openings below a water level of 1.10 m AHD to ensure that Council funds and resources are not expended on regular lake openings;
- Prawn and fish migration to and from the sea could be allowed to occur for some "migratory" months of the year should the water level rise above 1.10 m AHD;
- Little Terns and other threatened nesting shorebirds are likely to be protected from possible disturbance and harm until the lake water level reaches 1.25 m AHD.

Limitations

- 5 low-lying jetties could remain covered by water for some months of the year;
- Some low-lying pasture land and holiday park areas on the lake foreshore could be inundated for periods and access to some pastures made impassable at times.

Recommendations are made for raising or improved management of existing low-lying assets, where possible, to enable the lake to be opened at higher water levels in the future.

1.4.2 Wallaga Lake Estuary Management Study and Plan

The Wallaga Lake Estuary Management Study and Plan (BVSC, 2000), was prepared with the specific management goals; (1) To conserve indigenous terrestrial flora and fauna and enhance habitats; (2) To conserve aquatic habitats and restore more natural water flows; (3) To improve fish stocks and achieve a sustainable recreational and commercial fishery; (4) To recognise and protect natural and cultural heritage; (5) To encourage low impact recreation and tourism; (6) To increase the understanding of the Lake's value and estuarine processes; (7) To reduce the impact of development and human activities on lake water quality; (8) To promote ecologically sustainable development.

Subsequently the plan was reviewed in 2006, in line with the then NSW Estuary Management Manual. The review ensured that the plan and policies of State agencies were consistent with sustainable goals for the management of Wallaga Lake. The reviewed goals of the 2006 and current plan are: (1) To conserve indigenous terrestrial flora and fauna and enhance habitats; (2) To conserve aquatic habitats and restore more natural water flows; (3) To understand and better manage the impact of development and human activities on lake water quality; (4) To promote ecologically sustainable development; (5) To identify and progress Meads Bay as a sensitive area of high conservation significance; (6) To improve fish stocks and achieve a sustainable recreational and commercial fishery; (7) To encourage low impact recreation and

tourism; (8) To increase the understanding of the Lake's values and estuarine processes; and (9) To recognise and protect natural and cultural heritage.

To address human impacts on habitat and related estuarine processes objective, Strategy 2.4 specifically targets entrance management. This strategy aims to manage lake entrance openings to minimise flooding and enhance fringing wetland health and manage lake entrance openings in accordance with the drafted Entrance Management Policy including the monitoring of opening events.

1.4.3 Artificial Opening of Back Lake: Interim Review of Environmental Factors

An Interim Review of Environmental Factors (REF) was prepared for Back Lake in June 2006 (BVSC). The REF was prepared under Part 5 of the Environmental Planning and Assessment Act 1979 (EP&A Act), and examines the significance of likely environmental impacts of artificial opening, and the measures required to mitigate any adverse impacts to the environment under NSW legislation.

The REF contained an overview of the existing environment inclusive of physical characteristics, water quality, flora and fauna, land use and recreational issues as well as an assessment of environmental impact. The REF detailed the decision making framework under which artificial opening would be commenced as established in the Merimbula Lake and Back Lake Estuary Processes Study (WMA, 1995). This framework is to;

- Excavate a trench through the entrance bar when water levels are threatening / or in the process of flooding (at around +1.4 m AHD) :
    - land and buildings along the north side of Munn St, Merimbula and the north-western side of Henwood St, Merimbula;
    - the Berrambool Sporting Complex;
    - lands adjacent to the estuary and Merimbula Creek, with particular attention to the Merimbula Creek in the vicinity of Reid St Bridge; or
    - when water levels are indicating further continued rises in the above locations either due to continued heavy rain, run-off from the adjacent catchment areas into the Merimbula Creek, or continuing steady, high flows into the Back Lake System.

1.4.4 Bega River Estuary Management Study and Plan

The Bega River Estuary Management Study and Plan (BMT WBM, 2011), was prepared to provide a program of strategic actions to assist government and other stakeholder groups to sustain healthy estuaries through appropriate waterway, foreshore and catchment management. The Estuary Management Plan comprises a suite of short and long term strategies for the sustainable management of the Bega River estuary.

Management of the Bega River entrance is one strategy preliminarily addressed and ranked a high priority by the community in the Bega River Estuary Management Study and Plan. The Study and Plan identifies that a formal review of the 1.36 m AHD opening height should be conducted within a 12-18 month period. The review should consider the ecological needs of the estuary as well as inundation of property (including upstream agricultural land) and roads. Based upon the review, a formal Entrance Management Policy is to be developed and adopted

until the flooding issues that trigger entrance opening are more thoroughly addressed in a Flood Study and Floodplain Risk Management Study and Plan.

At present, the Bega River entrance is opened artificially when water levels at Hancock Bridge reach RL 1.36 m AHD. This is undertaken by Council on an as-need basis, and although consultation with some stakeholders usually precedes the works (e.g. check with OEH regarding the status of Little Terns and Hooded Plovers on the entrance sand spit), there is currently no formal policy that has been ratified by Council or State Government that outlines processes and protocols.

1.4.5 Lake Curalo Estuary Management Study and Plan

The Lake Curalo Estuary Management Study and Plan (ESE, 2002), was prepared with the specific management goals to (1) improve water quality within Lake Curalo and its tributaries; (2) ensure entrance opening follows as natural a regime as possible within the constraints of property inundation, flooding, water quality and odour problems; (3) protect and conserve aquatic habitats, fauna and foreshore vegetation; (4) increase opportunities for low-impact recreational use of the lake and foreshores; and (5) ensure future development does not adversely impact on the values of Lake Curalo.

The Estuary Management Plan comprises a suite of actions and management options to achieve these goals for the Lake Curalo estuary. The primary actions include (1) water quality monitoring, particularly for nutrient levels and faecal coliforms during the swimming season; (2) measures to improve stormwater quality; (3) an entrance management policy to improve flushing, while addressing flooding; (4) a path/boardwalk around the lake, incorporating interpretive signs; (5) environmental guidelines for management of foreshore reserves; and (5) development guidelines to protect Lake Curalo, which would be incorporated in existing Development Control Plans and Management Plans.

The development of formal written procedures for entrance breakouts and monitoring, including log sheet management in conjunction with preparing an Interim Review of Environmental Factors for entrance management was ranked a high priority by the community in the Lake Curalo Estuary Management Plan. The Plan identifies that when the water level reaches the top of the green paint (corresponding to a level of about 1.2 m AHD) on the peg in the entrance channel, artificial breakout procedures are initiated. These procedures are as follows:

- pilot channel to be excavated the width of a bucket and of a similar depth to the water depth on the lakeside edge of the beach berm;
- excavation to start from the lakeside edge of the beach berm, as close as possible to the rock boundary on the northern side of the entrance area (length of excavation is usually 50 m);
- breakout to be timed to coincide with the highest tide of the day (pilot channel excavation usually takes two to three hours);
- Aslings Beach Life Guards to be informed of the breakout operation (when patrols are operating).

The Estuary Management Plan further identifies that it appears there is scope to raise the entrance opening level to 1.5 m AHD, while primarily only affecting undeveloped land zoned open space, apart from the foreshores of the Eden Tourist Park.

1.4.6 Merimbula Lake and Back Lake Estuary Management Plan and Summary Study

The Merimbula Lake and Back Lake Estuary Management Plan and Summary Study (WMA, 1997), was prepared under the direction and supervision of Bega Valley Shire Council's Merimbula/Back Lakes Estuary Management Committee. The Estuary Management Plan and Summary Study comprises a suite of management strategies with varying priorities that aim to meet the following objectives for the Merimbula Lake and Back Lake estuaries; (1) Protect and conserve estuarine habitats and ecosystems; (2) Conserve aesthetic values of the estuaries and wetlands; (3) Undertake repair of past damage and prevent future degradation; and (4) Achieve ecologically sustainable use of the estuarine resources.

Developing and implementing a compressive entrance opening strategy for the estuary was ranked by the community, interest groups and government agencies as a high priority strategy as part of the Plan. It was identified that the entrance opening policy for Back Lake in addition to mitigating flooding considers: “the ecological impacts on aquatic birds and estuary flora and fauna, possible adverse effects on recreational users of the estuary and the beach, water quality problems which can develop after long periods of closure and visual and odour problems after opening” (WMA, 1997). Prior to entrance opening in 2006, an Interim REF was prepared for Back Lake in June 2006.

1.4.7 Wonboyn Lake and Estuary Management Plan

The Wonboyn Lake and Estuary Management Plan (WBM Oceanics, 2004), was prepared under the direction and supervision of the Bega Valley Shire Council's Wonboyn Lake and Estuary Management Committee. The principal objectives of this plan were to:

- Provide a process to maintain and improve the environmental values of the lake and estuary; and
- Present management options developed and agreed upon in the Estuary Management Study in the appropriate form, with consideration of associated issues such as: discussion and justification of the option; with whom the responsibility lies for implementing the option (agencies and groups with primary and secondary responsibilities for implementing the recommended options); specific actions required to implement each option (required monitoring works and activities to ensure that the proposed works program is moving towards desired environmental outcomes and to enable the progressive refinement of the works program if necessary); costs of implementation; and timeframe for the completion of option implementation. The result was the prioritisation of all management options, with the top twenty management actions in the Estuary Management Plan being: (1) Environmental strategies in Development Control Plan; (2) EMPs for all development applications; (3) Foreshore reservations;(4) Management Plan for future of oyster leases; (5) Management Plan for flow within estuary; (6) Rezone important habitats; (7) Assess dredging of entrance; (8) Implement Stormwater Management Plan; (9) Maintain riparian vegetation; (10) Walkway along foreshore; (11) Management Plan for recreational use; (12) Reduce sediment flow from road runoff; (13) Restrict future urban development; (14) Cultural interpretative signage; (15) Channel markers and signs; (16) Develop water quality guidelines; (17) Restrict/control foreshore access; (18) Recovery plan for seagrasses; (19) Non-motorised access points; (20) Fish Habitat Protection Plan.

It is of note that Option S-2: Entrance dredging was rejected as a possibility by Bega Valley Shire Council and the local community at the time, due to environmental, social and economic considerations. Reflection on the option by WBM in 2004 found that the benefits of dredging the entrance did not outweigh the detriments of keeping the entrance in its natural state. During their analysis water quality in Wonboyn estuary did not suggest the need for dredging of the entrance, nor did the estuary have a significant need for dredging for navigation purposes. Thus it was recommended by WBM that "the entrance should remain in its natural form and should wait for floods to remove accumulated sand" (WBM Oceanics, 2004).

1.4.8 Wonboyn Lake Entrance Opening: Review of Environmental Factors

A Review of Environmental Factors (REF) was prepared for Wonboyn Lake in October 2004 (BVSC). In early September 2004 the Wonboyn Lake entrance closed for the first time since the 1940's and subsequently the community held an open forum with unanimous support to reopen the estuary to the sea. The primary driver behind this artificial opening was the communities concern that prolonged closure of the lake's entrance would significantly impact the Wonboyn oyster industry, and consequently have flow-on economic effects to the economy of Wonboyn Lake Village.

Unlike most artificial lake openings which are carried out at higher lake water levels to alleviate flooding, the REF was prepared with lake levels around 0.4 m AHD. With such relatively low water lake levels it was documented that "mechanical opening of Wonboyn Lake will be difficult, expensive and have a low chance of achieving a meaningful scouring of the entrance bar" (BVSC, 2004). Fortunately while artificially trenching a channel on the 8th and 9th of December, a storm event over the catchment resulted in the lake levels rising to 1.5 m AHD (gauged at Agnew Wharf), which consequently scoured the remaining entrance bar trench and opened the lake to the ocean.

The prepared REF documented existing biological, cultural, socio-economic issues, the proposal and alternative management options in conjunction with an assessment of environmental impact. The REF details two access options; (1) Shoreline Option – traversing the shoreline, via private property; and (2) Woodland Option – creating a new track east of the powerlines through the sand dunes. The Woodland access option was undertaken for the 2004 opening. The cost of this access option and trenching works was $10,000 and caused moderate damage to mature Melaleuca, Banksia, Acacia, coastal heathlands and coastal foredune vegetation species.

1.5 Relevant Legislation

1.5.1 Environmental Planning and Assessment Act 1979

The objective of the Environmental Planning and Assessment Act 1979 (EPA Act) is to encourage proper management, development and conservation of natural and constructed resources. The Act is the primary legislation controlling development activity in NSW, and is administered by the Minister for Planning. Approval processes for "development" and "works" in NSW are provided for in Part 4 and Part 5 of the EPA Act.

Part 4 of the EPA Act lays out the legislative regime for what is commonly known as the standard process for lodgement and consideration of development applications, and includes development assessment, development contributions and development certification. Essentially Part 4 processes apply where the local authority (Council) is the consent authority.

The issue of permissibility is generally found in the Local Environment Plan (LEP) relevant to the Council. The controls for development of particular sites or use are found in Councils LEP and DCP.

Part 5 of the EPA Act establishes an environmental assessment system for certain activities that do not require development consent under Part 4. Part 5 only applies to those proposals which are permissible without requiring development consent and are often infrastructure proposals approved by local councils or State agencies which are undertaking them. Part 5 focuses on the obligation of the "determining authority" to consider the environmental impact of any "activity". This involves considering the likely environmental impacts of the activity and to consider the appropriate level of environmental assessment that is required. For the opening of Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, Lake Curalo and Wonboyn Lake, this is in the form of a Review of Environmental Factors, but if the potential impacts were considered significant, an Environmental Impact Statement (EIS) or Species Impact Statement (SIS) would have been required. The need for other relevant permits and licences remains.

1.5.1.1 State Environmental Planning Policies

State Environmental Planning Policies (SEPPs) are environmental planning instruments that regulate land use and development. SEPPs are made by the Minister for Planning under Part 3 of the Environmental Planning and Assessment Act 1979, and administered by the Department of Planning and Infrastructure.

A number of SEPPs are relevant to entrance management and are briefly described below:

1.5.1.2 State Environmental Planning Policy (Infrastructure)

SEPP (Infrastructure) provides a consistent planning regime for infrastructure and the provision of services across NSW, along with providing for consultation with relevant public authorities during the assessment process. The intent of the SEPP is to support greater flexibility in the location of infrastructure and service facilities along with improved regulatory certainty and efficiency for the State.

The SEPP specifies a number of activities that may be permitted with or without consent when carried out by public authorities. These include for flood mitigation activities and activities related to maintaining or restoring tidal flows for ecological purposes. Where opening an ICOLL entrance, or maintaining an entrance berm at a certain level for the purposes of flood mitigation, a public authority may use the State Environmental Planning Policy (Infrastructure) to assess the activity in accordance with Part 5 of the Environmental Planning and Assessment Act 1979. This applies to undertaking works as set out in the Entrance Management Policies for Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, Lake Curalo and Wonboyn Lake as the works fall within the scope of provisions outlined in State Environmental Planning Policy (SEPP) Infrastructure (specifically works for flood mitigation).

Relevant approvals still need to be obtained from relevant authorities (see 1 below), and an assessment under Part 5 of the Act is required (including preparation of a Review of Environmental Factors, as contained within this document).

1.5.1.3 State Environmental Planning Policy 71 - Coastal Protection

SEPP 71 aims to ensure that development in the NSW coastal zone is appropriate and suitably located, to ensure that there is a consistent and strategic approach to coastal planning and management and to ensure there is a clear development assessment framework for the coastal zone.

SEPP 71 specifically aims to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast, protect and improve public access, protect and preserve Aboriginal heritage, visual amenity, beach environments and beach amenity, native coastal vegetation, the marine environment, rock platforms, and manage the coastal zone in accordance with the principles of ecologically sustainable development, ensure development is appropriate for the location, and encourage a strategic approach to coastal management.

The SEPP establishes which development is significant coastal development i.e. development within 100 m of the mean high water mark of the sea, a bay or an estuary; identifies the procedure for the determination of significant coastal development in terms of the referral process to the Director-General for comment, and identifies master plan requirements for certain development in the coastal zone.

SEPP-71 applies to the area declared as the NSW Coastal Zone under the Coastal Protection Act, 1979, which includes Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, Lake Curalo and Wonboyn Lake. As development consent is not required under SEPP (Infrastructure) on flood mitigation grounds for these ICOLLs, works associated with the implementation of the Entrance Management Policies do not apply to SEPP-71.

1.5.1.4 State Environmental Planning Policy 14 - Coastal Wetlands

SEPP 14 aims to ensure coastal wetlands are preserved and protected for environmental and economic reasons.

The policy applies to coastal local government areas outside the Sydney metropolitan area, and identifies over 1300 wetlands of high natural value. Land clearing, levee construction, drainage work or filling may only be carried out within these wetlands with the consent of the Local council and the agreement of the Department of Planning and Infrastructure Director General.

Whilst there are a number of SEPP-14 wetlands located across the Bega Valley, including on the fringes of Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, Lake Curalo and Wonboyn Lake, none of the gazetted wetlands cover the entrance channels where the entrance management works would be undertaken. As such, the provisions of SEPP 14 do not apply directly to these Entrance Management Policies.

1.5.2 Crown Lands Act 1989

The Crown Lands Act 1989 provides for the administration and management of Crown Land, which includes most beaches, coastal reserves, near-shore waters and estuaries. The Act contains a number of principles for administering and managing Crown Land, and these are:

a. that environmental protection principles be observed in relation to the management and administration of Crown Land;

b. that the natural resources of Crown Land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible;
c. that public use and enjoyment of appropriate Crown Land be encouraged;
d. that, where appropriate, multiple use of Crown Land be encouraged;
e. that, where appropriate, Crown Land should be used and managed in such a way that both the land and its resources are sustained in perpetuity; and
f. that Crown Land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles.

The estuary beds and entrance channels of Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, Lake Curalo and Wonboyn Lake are Crown Land. Landowner consent from the Department of Primary Industries (Lands) is therefore required before works on these Crown Land parcels can be undertaken. A single licence can be obtained from the Department of Primary Industries (Lands) under Part 4, Division 4 covering entrance management of all coastal lakes in the Shire, to be reviewed and renewed concurrently with the review of the individual Policies.

1.5.3 Fisheries Management Act 1994

The objectives of the Fisheries Management Act 1994 are to conserve, develop and share the fisheries resources of NSW for the benefits of present and future generations. The Act applies specifically to aquatic flora and fauna including fish, invertebrates and marine vegetation, such as mangroves, seagrass and saltmarsh. The Act also includes schedules of endangered aquatic species, populations and ecological communities, which must be considered in the same manner as species listed under the Threatened Species Conservation Act 1995.

Under the Act a public authority (other than a Local Government Authority) is required to consult with the relevant Minister prior to carrying out or authorising dredging or reclamation (s 199). Dredging works includes excavating and/or the removal of material. A Local Government Authority proposing to undertake dredging works is required to obtain a permit under Section 200. However, Section 200 does not apply if the dredging is authorised under the Crown Lands Act 1989 or by another relevant authority (other than a Local Government). This means that consent for the dredging works, if a licence is awarded under the Crown Lands Act 1989 or by another relevant authority, is not required for a second licence from the Department of Primary Industries (Fisheries) under the FM Act 1994. It is a condition of the FM Act 1994 however, that in issuing a licence for the works, other authorities (such as Department of Primary Industry - Lands) must consult with Department of Primary Industries (Fisheries) regarding the proposal. Section 205 (harm to marine vegetation) of the FM Act 1994 could apply if seagrasses or saltmarsh areas were to be damaged in managing the ICOLL entrances.

To support the Fisheries Management Act 1994, the Department of Primary Industries (DPI) also has Fish Habitat Management Policies and Guidelines (NSW Fisheries, 1999), these state:

- The Department supports minimal interference with ICOLL entrance barriers and advocates natural processes being allowed to operate to the greatest extent possible.
- The Department does not support the artificial opening of an ICOLL unless the proponent can demonstrate that the social, environmental and economic benefits greatly outweigh any potential adverse impacts.
- The Department supports using estuary management plans and environmental assessment processes to analyse the issues relating to opening a particular ICOLL, and to

develop an entrance management plan or entrance management policy. Proposals for artificial openings which are to be carried out according to a formulated entrance management plan or policy are more likely to be approved.

In implementing the above policies, DPI uses a number of guidelines relating to the development of entrance management policies, environmental assessment and criteria that should be met prior to artificial entrance opening occurring.

1.5.4 Commonwealth Environmental Protection and Biodiversity Conservation Act 1999

The Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) provides for the protection of matters of national environmental significance, including:

- World Heritage Properties;
- National Heritage Places;
- Wetlands of International Importance;
- Listed Threatened Species and Ecological Communities;
- Listed Migratory Species; and
- Commonwealth Marine Areas.

If an activity has the potential to impact on one or more matters of national environmental significance, an assessment process in accordance with the EPBC Act and Guidelines (Environment Australia 2000) is required. If the assessment concludes that a significant impact is likely, then the activity will be deemed a controlled action and approval for the activity is required from the Commonwealth Department of Environment and Heritage via a detailed referral process, including public exhibition.

The Wallaga and Wallagoot Lake Estuaries are listed in the Directory of Nationally Important Wetlands, though they are not classified as Ramsar wetlands. A number of Threatened and Migratory Species and Ecological Communities are found at many of the coastal lakes along the NSW South Coast, including those ICOLLs subject to this environmental assessment.

1.5.5 NSW Local Government Act 1993

Under the Local Government Act 1919, Councils had general authority to open coastal lakes and lagoons under Section 352A. Although this provision was not specifically carried through in the Local Government Act 1993, Councils have continued to assume such responsibility on behalf of the interests of the public.

1.5.6 NSW Coastal Protection Act 1979

The objects of the Coastal Protection Act 1979 are to provide for the protection of the coastal environment of NSW for the benefit of both present and future generations. The Act defines the coastal zone, contains provisions relating to the use and occupation of the coastal zone, the carrying out of coastal protection works, the preparation of CZMPs, and certain ancillary matters relating to the coastal zone.

Consideration needs to be given to Sections 38 and 39 of the Act, requiring concurrence by the Minister for undertaking development works within the coastal zone. The proposed entrance

works at the various coastal entrances are within the coastal zone as defined by the Act, however, no specific permit or approval is required for entrance openings under the Act.

1.5.7 NSW Threatened Species Conservation Act 1995

The Threatened Species Conservation Act 1995 aims to protect and encourage the recovery of threatened species, populations and communities listed under the Act. The Act provides for the identification, conservation and recovery of threatened species and their populations and communities. It also aims to reduce the threats faced by those species. Unless a licence has been obtained under the National Parks and Wildlife Act 1974 or the Threatened Species Conservation Act 1995, or approval under the EPA Act, it is an offence under the National Parks and Wildlife Act to harm any animal or plant that is a threatened species, population or ecological community (NPWA s.118(1)(b)). The Threatened Species Conservation Act 1995 does not apply to fish or marine vegetation, which are covered by the Fisheries Management Act 1994.

Threatened species, populations and communities are listed as endangered or vulnerable in Schedules 1 and 2 respectively. The integration of the Threatened Species Conservation Act 1995 with the Environmental Planning and Assessment Act 1979 requires consideration of whether a development or an activity is likely to significantly affect threatened species, populations and ecological communities or their habitat. Where a proposal is likely to have a significant impact on threatened species, a Species Impact Statement must be prepared. Under s 91 of the Act, a licence is required if a proposed activity is likely to significantly affect threatened species, populations or ecological communities or their habitats.

Consideration has been given to potential harm or damage to threatened species and listed migratory species, for each of the ICOLLs covered in this REF.

1.5.8 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* provides for the declaration of reserves (including national parks, nature reserves and state conservation areas) and the protection of flora, fauna and Aboriginal heritage. The Act is administered by the Minister for the Environment and the relevant State agency for the management of reserves is OEH (National Parks and Wildlife Service).

Consideration must be given to Section 86 of the *National Parks and Wildlife Act 1974*, as it is an offence to harm or desecrate an Aboriginal object or Aboriginal place without an exemption or defence (penalties apply). The transportation of heavy equipment to some of the ICOLL entrance sites (and to a lesser likelihood the entrance excavation) has the potential to harm Aboriginal objects and/or sites (Wallaga Lake in particular). As a precautionary measure, BVSC commissioned NSW Archaeology to undertake a specific Aboriginal Cultural Heritage Assessment Report (ACHAR) and have prepared an application for an Aboriginal Heritage Impact Permit (AHIP) associated with the entrance management works.

1.5.9 Native Vegetation Act 2003

This Act regulates the clearing of native vegetation on all land in NSW, except for excluded land listed in Schedule 1 of the Act. The Act outlines what landowners can and cannot do in clearing native vegetation.

Note: whilst works would involve disturbance to native vegetation in some instances, Council is exempt from requiring a controlled activity permit.

1.5.10 NSW Coastal Policy

The *NSW Coastal Policy 1997* sets the direction for coastal zone management and planning in NSW. It seeks to ensure the natural, cultural, spiritual and heritage values of the coastal environment are protected whilst acknowledging and planning for population growth and economic development. The management of the coastal zone is the responsibility of a range of government agencies, local councils and the community. The Policy provides a framework for the balanced and coordinated management of the coast and covers a range of themes including:

- population growth water quality along the coast, especially in estuaries
- disturbance of acid sulfate soils
- establishment of reserves
- integration of government agencies and community organisations involved in coastal planning and management
- respecting indigenous and European cultural heritage
- integrating Ecologically Sustainable Development principles into coastal zone management and decision making.

The Coastal Policy has two broad parts. Part A outlines the principles and theme guiding the Policy, while Part B details the goals, objectives and strategic actions.

1.5.11 Water Management Act 2000

The object of the *Water Management Act 2000* is the sustainable and integrated management of the state's water for the benefit of both present and future generations.
After an extensive period of public consultation, the *Water Management Act 2000* was passed by the NSW Parliament in December 2000, establishing a completely new statutory framework for managing water in NSW. For the first time, NSW had comprehensive water legislation to guide our water management activities.
The *Water Management Act 2000* is based on the concept of ecologically sustainable development – development today that will not threaten the ability of future generations to meet their needs. The Act recognises:

- the fundamental health of our rivers and groundwater systems and associated wetlands, floodplains, estuaries has to be protected
- the management of water must be integrated with other natural resources such as vegetation, soils and land
- to be properly effective, water management must be a shared responsibility between the government and the community
- water management decisions must involve consideration of environmental, social, economic, cultural and heritage aspects
- social and economic benefits to the state will result from the sustainable and efficient use of water.

Note: whilst works would involve disturbance to waterfront land, Council is exempt from requiring a controlled activity permit under section 38 of the Regulations.

1.6 Approvals Required for the Implementation of the Entrance Management Policies

The approvals potentially required for implementation of the Entrance Management Policies for Wallaga Lake, Cuttagee Lake, Bega River, Wallagoot Lake, Back Lake, and Curalo Lake are summarised in Table 1. These approvals are required prior to commencement of entrance management works.

As indicated in Section 1.5.3, a separate licence to dredge does not need to be obtained from the Department of Primary Industries (Fisheries), providing that a dredging licence is obtained under the Crown Lands Act, 1989, and that in issuing a licence for the works, Department of Primary Industries (Lands) have consulted with Department of Primary Industries (Fisheries) regarding the proposal.

Table 1: Potential Entrance Work Approvals/Concurrence Required

Relevant Act	Approvals Required	Approval Body
Crown Lands Act (refer Section 1.5.2)	Licence to carry out dredging activities on Crown Land	DPI (Lands)
NSW Fisheries Management Act (refer Section 1.5.3)	Permit for destruction of marine vegetation, if applicable	DPI (Fisheries)
NSW Threatened Species Conservation Act 1995 (refer Section 1.5.7)	Permit to carry out activities that could harm a threatened species, population or ecological community	OEH
National Parks and Wildlife Act (refer Section 1.5.8)	Permit to carry out activities on Aboriginal objects or places (Aboriginal Heritage Impact Permit)	OEH

1.7 Recommended Approval Conditions

It is recommended that approval be provided to enable Council to implement the various Entrance Management Policies for a fixed period of five (5) years, conditional to Council receiving relevant licences/permits from those outlined in 1. After this time, Council should be required to review the Policies and associated environmental impacts before approval and licence renewals are issued.

2 REF for the Artificial Entrance Opening of Wallaga Lake

2.1 Location

Wallaga Lake is situated on the far South Coast of New South Wales, between Tilba Tilba and Bermagui. It has a surface area of 7.8 km^2 and a catchment of 280 km^2. The two main creeks feeding the lake are Dignams and Narira Creeks. Wallaga Lake and the majority of its catchment fall within the Bega Valley Local Government Area (LGA), with the northern section of the catchment falling within the Eurobodalla LGA. The LGA boundary is along the northern shore of Wallaga Lake and Dignams Creek. National Park estate comprises 43% and State Forest 10% of the catchment (see Figure 2).

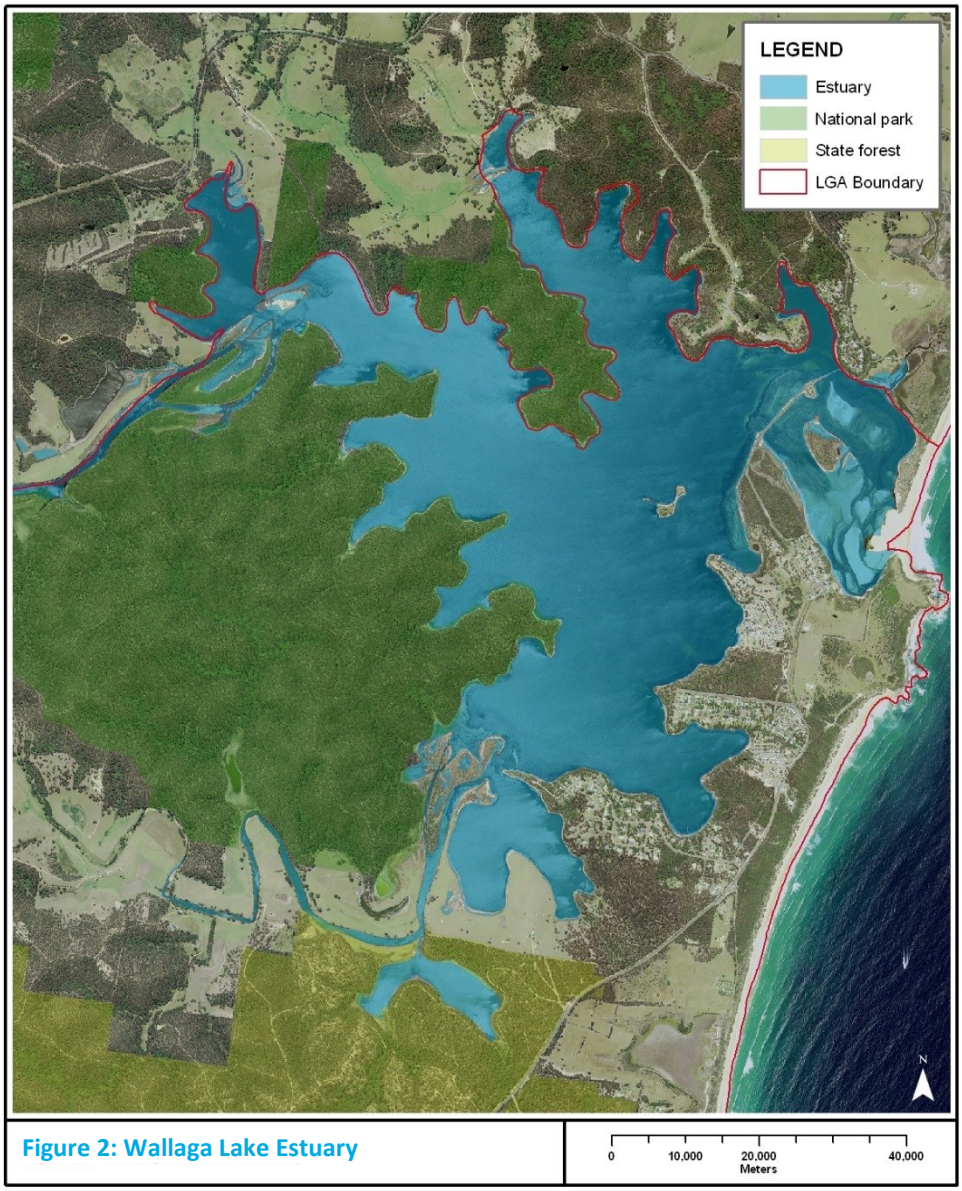

Figure 2: Wallaga Lake Estuary

2.2 Description of Proposed Activity

A channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals within 50 metres of the southern rocky foreshore of Wallaga Beach in the location shown in Figure 3 using mechanical equipment, most likely an excavator. The access route which the machine will use is also shown in Figure 3. This route has been selected to minimise disturbance to vegetation during machine access and egress, as it follows an existing cleared track. However, it is expected that minor damage to the track and grassed areas is inevitable. Particular care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes and shell middens and a permit (AHIP) from OEH has been sought for access over (that may harm) Aboriginal sites and objects, in particular the known Aboriginal burial site on the crest of Murunna Point.

Figure 3: Location of Entrance Opening Works

As outlined in the *Wallaga Lake Entrance Management Policy* (Appendix A) the excavation will only be undertaken if the following essential criteria are achieved:

a. lake water level between 1.10 and 1.25m AHD for longer than 3 months and NPWS support an opening; OR
b. lake water level exceeds 1.25 m AHD.

The excavated sand (estimated volume of around 500 m^3) will be pushed to the northern side of the excavated channel and will not be removed from site. The channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 4-6 hours duration. It would be rare for it to extend beyond 10 hours.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. The size and location of the channel will be constrained by the southern rocky headland of Murunna Point. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

While there is no intention to establish a permanent opening, a reasonably long lasting opening is preferred to maximise the possibility of full water exchange and obviate the need for repeated intervention after a short period of time (that is, a few weeks or months). To assist with the establishment of a large and deep channel, which will be slow to infill, completion of the excavated channel will generally be undertaken during the falling stage of

the tidal cycle. This should ensure that an adequate head difference between the water in the lake and the ocean is maintained for the first few hours of outflow. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

2.3 Purpose of the Activity

The purpose of the works is to re-establish a temporary tidal connection between the lake and the ocean to allow accumulated water to flush to the ocean and thereby lower water levels below that which causes flooding problems on the main road and other low lying lake assets.

The intention is not to establish a permanent opening. It is recognised that the entrance channel could well close again within a matter of weeks, although it would generally be hoped that the channel would remain open for a period of months to maximise the period available for tidal flushing and minimise the need for further openings in the short term.

2.4 Consideration of Alternatives

Ultimately there are no viable alternatives to the artificial opening of the lake. The "do-nothing" option is unacceptable because of the potential damage and disruption that could be caused if the lake was left closed and water inundated public and private assets, including the main road between Narooma and Bermagui. The high water levels may also remain for many months compounding the scale of damage done by floodwaters. Therefore not interfering and allowing nature to take its course so that water levels rise until a natural breakout takes place, could in most situations cause flood damage and associated problems for local residents.

Rather than adopting a fixed level, a variable level could be used. This would have more ecological benefits. However, the current intervention level of 1.25 m AHD represents a ceiling which is difficult to go above in the short-term as this is the level of the main road. Variation has been introduced somewhat for openings at lower levels, provided certain conditions are met.

In the longer term it is the intention to increase the intervention level above 1.25 m AHD by selectively flood proofing, raising, removing or relocating those items of infrastructure which are most prone to flooding. Currently, the main road at the southern end of the causeway becomes inundated at 1.26 m AHD and that along with foreshore pastures and caravan park land are the first main items of infrastructure to be affected by water level rise. The Interim Wallaga Lake Entrance Management Policy (Appendix A) proposes works that should be completed in desired timeframes in order to increase the intervention level. It should be noted that the Entrance Management Policy allows water to inundate the main road at the causeway for a period of 1 day to allow sufficient runoff to enter the lake before opening. This will disrupt traffic and vehicle access between Narooma and Bermagui but is considered acceptable for a short period given that an alternative road route exists (i.e. Princes Highway/Cobargo Road).

A two dimensional unsteady hydrodynamic model as part of a Flood Risk Management Study and Plan should be prepared to better investigate flood management options, with consideration of higher berm heights and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) for a full range of annual exceedance probabilities up to

the possible maximum flood consistent with the NSW Floodplain Development Manual 2005. It would be preferable if no intervention was required but it is not known whether this will ever be a practical alternative considering the current configuration of development.

2.5 Description of the Existing Environment

2.5.1 General Characteristics

The Wallaga Lake entrance is situated at the southern end of Wallaga Beach, and is constrained to the south by a rocky outcrop of Murunna Point. The entrance area itself is characterised by an expanse of unvegetated sand. The substrate in the entrance area is completely dominated by unconsolidated and unsorted sand with varying amounts of broken shell and drying algae, such as kelp, which has been washed ashore.

2.5.2 Sediments

2.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show the entire bed of Wallaga Lake as having a high risk of potential acid sulfate soils. Additional and more prolonged inundation of these soils as proposed by the policy, compared to historic lower water level break outs would reduce the oxidation potential of the soils, thus reducing their acid-generating potential.

In relation to the berm area where the excavation works are proposed, acid sulfate soils are highly unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

2.5.2.2 Bank Erosion and Sedimentation

Bank erosion and sedimentation in Wallaga Lake have been documented as a concern to the local community (BVSC, 2006). A comparison of air photos between 1957 and 1994 together with hydro survey data conducted by Patterson Britton and Partners in 1997 indicates that Narira Creek and Dignams Creek have infilled at rates of ≈ 5000 m^3/yr and ≈ 4000 m^3/yr respectively (Patterson, Britton & Partners 1997). It has been observed that sources of sediment are primarily a result of remanent land clearing for agriculture and urban development in the upper Wallaga Lake catchment creeks.

Sediment within the entrance of Wallaga Lake is comprised of marine (beach) sands, rather than terrigenous sediment. This material is deposited under the combined action of tides and waves. The non-cohesive sands are dynamic in nature and tend to be redistributed during times of flood. It is expected that during large floods, a large proportion of the marine sands in the entrance channel are actually scoured and transported into the nearshore coastal zone, only to be reworked back into the entrance, or transported alongshore, under the influence of ocean processes such as waves and tides.

2.5.3 Hydrology

2.5.3.1 Entrance Behaviour / Characteristics

The frequency and duration of entrance opening is an important determinant of the hydraulic character of the lake (that is, the frequency and magnitude of water level fluctuations and quality changes). OEH have undertaken an analysis of the entrance state for Wallaga Lake on the basis of available gauged data, which is included below.

OEH Analysis:

Manly Hydraulics Laboratory have maintained a water level gauge on behalf of OEH in Wallaga Lake at Regatta Point since 13/10/1993. In addition, a water level gauge was also deployed in the entrance channel of Wallaga Lake from 20/8/1993 to 2/7/2007 when it was decommissioned. The following analysis is based off the Regatta Point water level gauge only as it is the longest record. In total there exists around 23 years of water level data. At the time of installation at Regatta Point in 1993 the entrance was open.

Entrance closure and opening has been identified from observing the stop and start of a tidal signal from the graphed data (see Figure 4). There are several periods of time where data has not been collected and it is possible, but unlikely, that an opening and closing episode could have been missed in this period. For the opening that occurred on 28/01/1999, the regatta point gauge was not recording data and the date of opening and opening height has been obtained from the decommissioned Wallaga Lake gauge. In addition, for the opening that occurred on around the 5/2/2010, the data stops on this day at a rapidly increasing water level height of 0.75m, and the gauge doesn't start recording data again until 17/2/2010 when the entrance had become open and tidal. Hence, the opening height is likely to be greater and the day of opening could be out by a day/s.

Between 13/10/1993 and 1/8/2015, 12 separate periods of entrance closed conditions have been identified, with closed conditions ranging from 9 days up to 810 days, but typically in the order of several months (2). The total duration of closed entrance conditions compared to the full record equates to approximately being closed for 39% of the time. This illustrates that Wallaga Lake can remain closed for considerable periods of time. The duration that the entrance stays open for ranged from 35 days to 1146 days, but typically of the order of 6 months or greater. The total duration of open entrance conditions for the full record equates to approximately being open for 61% of the time. This illustrates that Wallaga Lake is more open than closed and can remain open and tidal for considerable periods of time.

The level of entrance opening ranges from 0.86 m to 1.78 m AHD, but typically over 1.1m AHD. Note that this does not provide a good surrogate for natural berm height range as most of the openings are likely to be artificial as result of Council opening to alleviate flooding hazards. Comparison of Wallaga Lake water levels to ocean water levels recorded from Twofold Bay in Eden show that the majority of the time when the entrance is open the tidal range is restricted to significantly less than the full open ocean tidal range, with a maximum tidal range of up to around 0.5m after a significant rainfall event and/or opening (Figure 5 and Figure 6). Wallaga Lake, like many other ICOLLs, does not experience tidal water levels that drop far below approximately mean sea level (0.0m AHD).

Table 2: Periods of Entrance Closures, Opening and Opening Levels for Wallaga Lake

Entrance Closure Date	Entrance Opening Date	WL Height at Opening	Closure Duration (days)	Open Duration (days)
NA	13/10/1993	NA	NA	NA
9/05/1995	29/09/1995	0.95	143	573
30/07/1998	8/08/1998	1.1	9	1035
19/01/1999	28/01/1999	1.62#	9	164
7/10/1999	25/10/1999	0.86	18	252
29/11/1999	29/09/2000	1.07	305	35
24/03/2001	20/08/2001	1.21	149	176
4/01/2002	27/02/2002	1.21	54	137
26/08/2002	17/04/2003	1.18	234	180
3/09/2003	12/07/2005	1.28	678	139
16/10/2005	12/02/2007	1.78	484	96
18/11/2007	5/02/2010	0.75*	810	279
27/03/2013	18/09/2013	1.501	175	1146
NA	1/08/2015	NA	NA	682
Total			3068	4894
Total			39%	61%

Notes:

Data for opening and opening height missing from Regatta gauge but available on Wallaga Lake gauge (now decommissioned)

* Data from gauge stops at this height and day for opening, definitely opens over this event but could have been day later and likely greater opening height

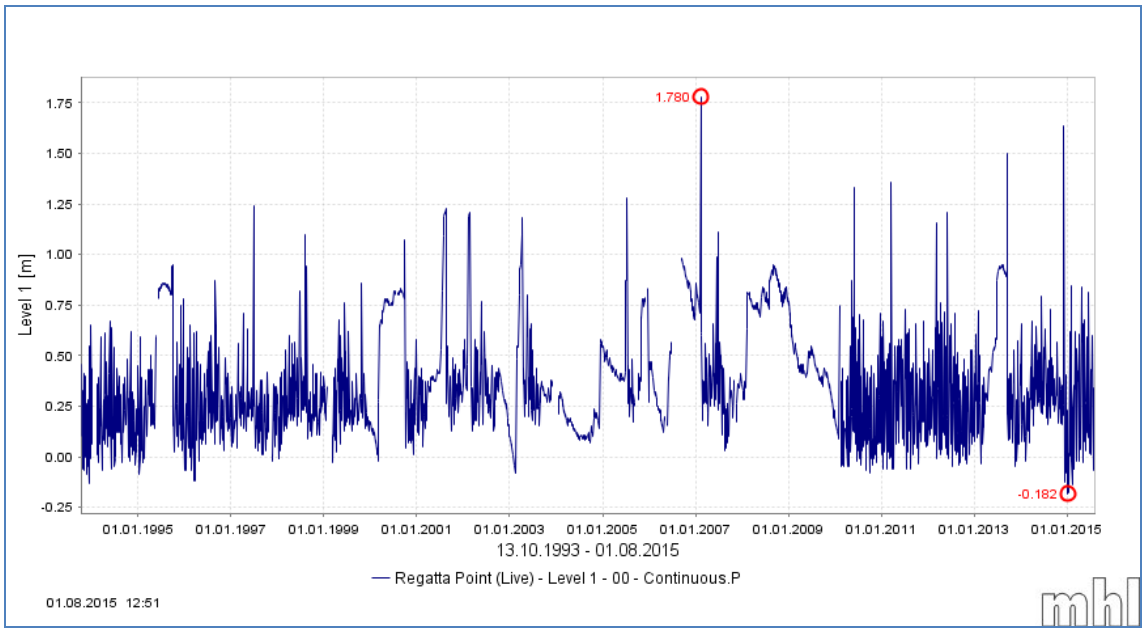

Figure 4: Complete Water Level Data set from Wallaga Lake Water Level Gauge Situated at Regatta Point from 13/10/1993 to Present Day

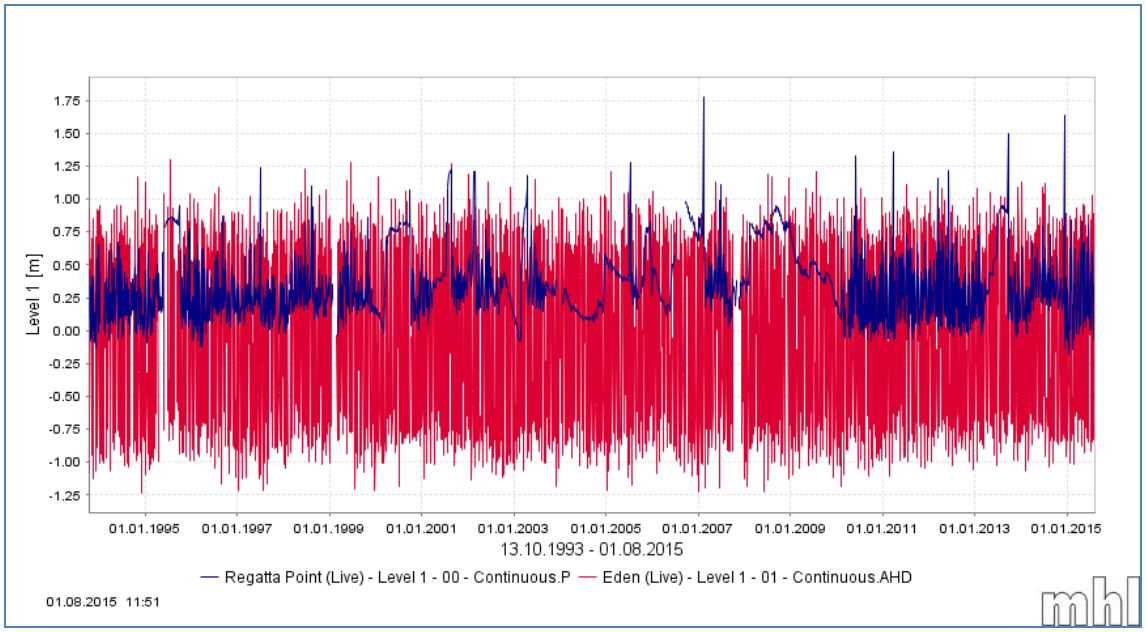

Figure 5: Complete Water Level Data set from Wallaga Lake Water Level Gauge Situated at Regatta Point, plotted against the Open Ocean Water Level Records from Twofold Bay

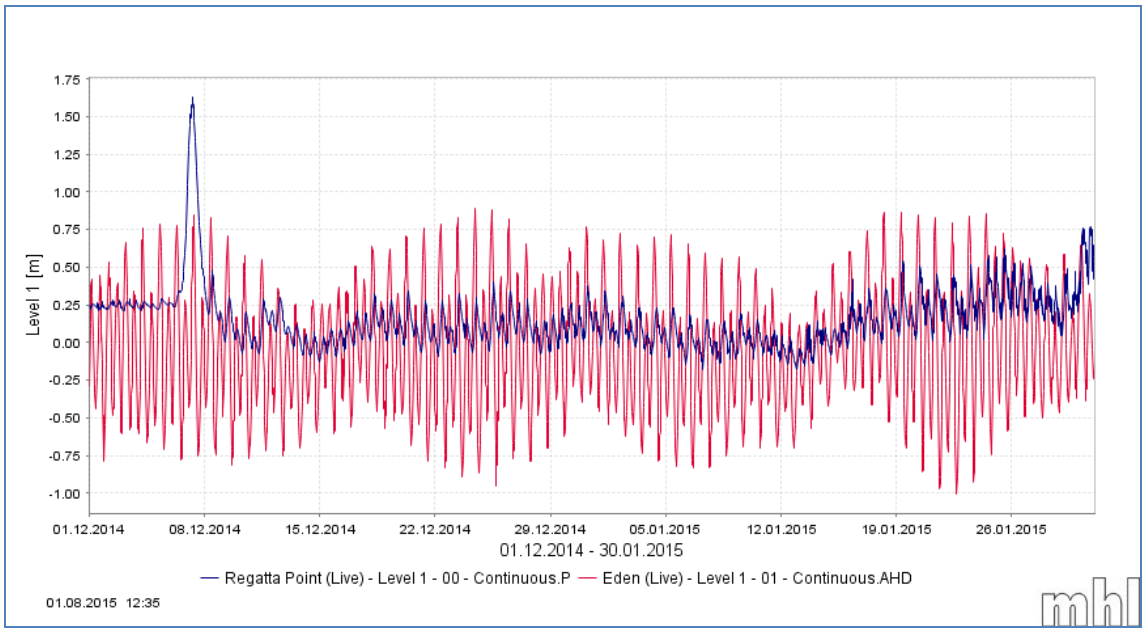

Figure 6: Snapshot of Wallaga Lake Water Level Record Plotted Against the Open Ocean Water Level Record from Twofold Bay

Entrance breakout location based on aerial photograph interpretation has shown that lake entrance opening has typically occurred adjacent to the Murunna Point rocky foreshore at the southern end of Wallaga Beach (Figure 7). For this reason the proposed artificial works are proposed to be conducted within 50 metres of the southern rocky foreshore of Wallaga Beach.

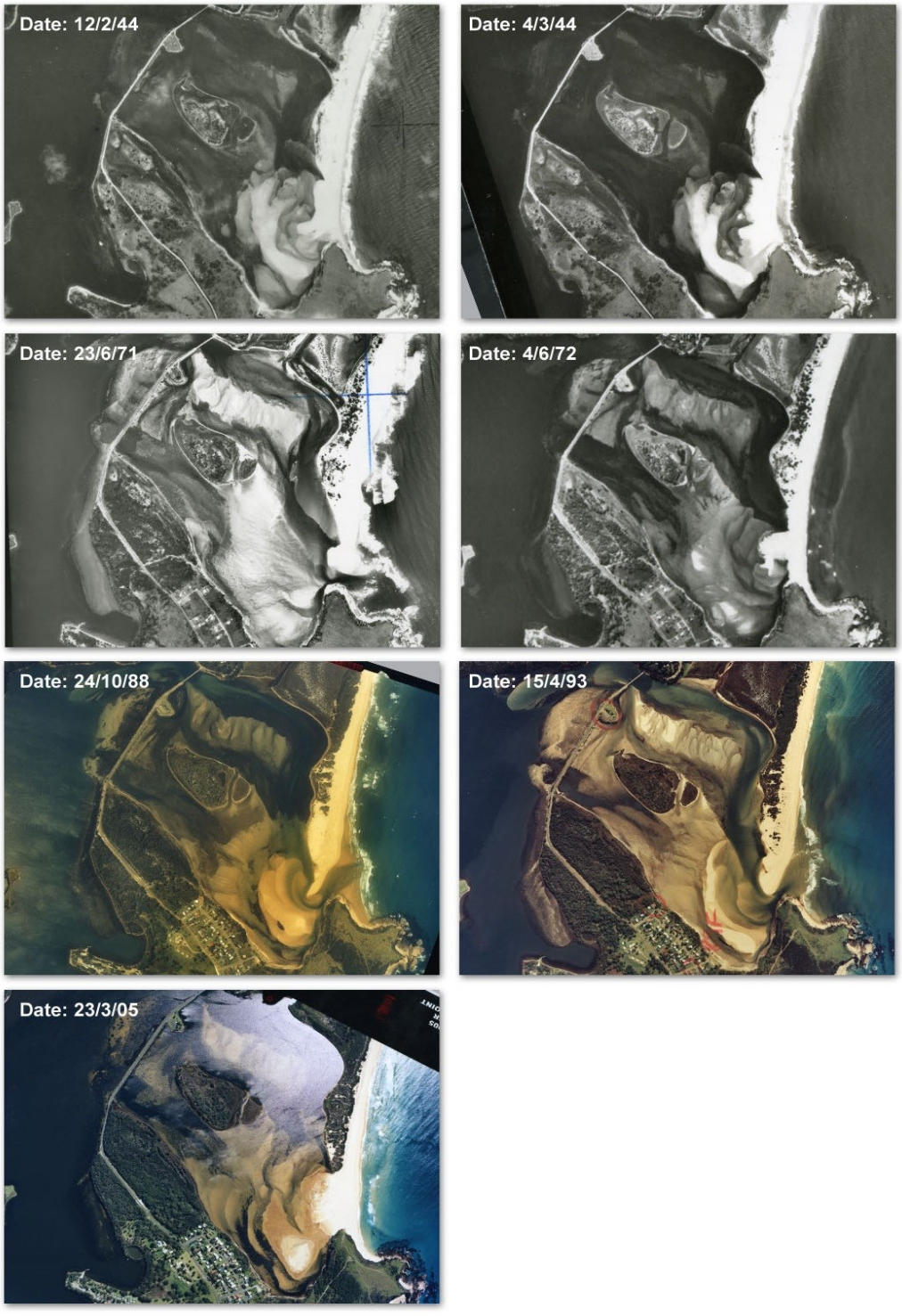

Figure 7: Aerial photographs of Wallaga Lake entrance 1944 to 2005

2.5.3.2 Water Quality

Water quality data collected by the NSW State Government between December 2008 and March 2009, indicate that micro-algae levels were consistently very high and turbidity was good (DECCW, 2010). Of the 18 samples, Chlorophyll a exceeded the MER lake guideline value

of 3.6 ug/L every time and turbidity exceeded the MER lake guideline value of 5.7 NTU twice (Roper et.al. 2011).

Spooner in 2003 showed that nutrient levels within the lake water column were dominated more by strong seasonal patterns (i.e. summer maximum and winter minimums) than by the state of the lake entrance. However, he also stated that entrance bar breaching can cause a significant and rapid reduction in gross nutrient levels in the water column, which is most likely to be noticeable within and close to the entrance channel area.

In early 2003, Wallaga Lake suffered from oxygen sags throughout much of the lake. Dissolved oxygen levels in the bottom layers below the surface few metres were severely depleted at <10% saturation. Death of bottom-dwelling fish and other organisms were reported although not on a large scale. Hence there have been periods when water quality issues have occurred in Wallaga Lake.

2.5.4 Ecology

Wallaga Lake and its surrounds provides habitat for a number of significant flora and fauna species and has been listed on the Commonwealth Directory of Important Wetlands in Australia as a result. For the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, the lake and its immediate surrounds where defined within the geographical domain:

GDA94

North: -36.29 South: -36.4

East: 150.1 West: 150

The Atlas of NSW Wildlife identified 51 species protected under the Threatened Species Conservation Act 1995, 21 species protected under the Environment Protection and Biodiversity Conservation Act 1999, and 13 species protected under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

2.5.4.1 Flora

Aquatic Vegetation

A seagrass community composed of Zostera capricorni, Halophila ovalis and Ruppia spp. covers ≈1,343,000 m^2 of Wallaga Lake. Zostera capricorni is the predominate species covering an area of ≈1,007,600 m^2 with large clusters around Honeysuckle Island, Narira Creek delta and Dignams Creek delta (DPI,2006). These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are import marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997.

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under either NSW (Threatened Species Conservation Act 1995) and/or Australian (Environment Protection and Biodiversity Conservation Act 1999) government legislation are known to occur within the

Wallaga Lake estuarine catchment. These EECs cover a total area of 3.9 km^2 and include Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest, Littoral Rainforest, River Flat Eucalypt Forest and Southern Floodplain Wetlands (Figure 8).

Coastal Saltmarsh occupies a total area ≈161,600 m^2 at seven localities around the Lake (DPI, 2006). The three largest areas of saltmarsh communities are located on and around Honeysuckle Island, Narira Creek delta and Dignams Creek delta. This endangered ecological community comprises a complex of succulent herbfields and sedgelands predominately characterised by Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha, Austrostipa stipoides along with Scirpus nodosa and Sporobolus virginicus (Tozer et al 2004). This community of species is very important to estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients. Saltmarsh has declined around the state and Wallaga Lake is no exception with a reduction of approximately 45% based on analysis conducted by the Department of Primary Industries (Fisheries) between 1985 and 2006. Due to this state wide declining trend Coastal Saltmarsh has been listed as an endangered ecological community under the Threatened Species Conservation Act 1995.

The Freshwater Wetlands on Coastal Floodplains endangered ecological community occupies an area ≈400,600 m^2 at two predominate locations within the Wallaga lake estuarine catchment. These locations are Bobundara Swamp and Narira Creek. Melaleuca ericifolla, Baumea articulata, Periscaia Praetermissa, Phragmites australis, Triglochin procerum, Typha orientallis and Cladium procerum typically characterise this endangered ecological community which provides important habitat, food and water source for freshwater fish, amphibian, native mammal and bird species (Tozer et al 2004).

Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions endangered ecological community occupies a total area of ≈146,800 m^2 at localities on Murunna Point and the landward side of the Wallaga Beach dunes. Bangalay Sand Forest typically has a dense to open tree canopy and occurs on dunes exposed to salt-bearing sea breezes. The most common vegetation species within this endangered ecological community are Eucalyptus botryoides, Banksia integrifolia subsp. Integrifolia, Eucalyptus pilularis, Acmena smithii, Dianella spp., Lepidosperma concavum, Lomandra longifolia, Pteridium esculentum (Bracken), and the grasses Imperata cylindrical, Microlaena stipoides var. stipoides, Themeda australis (Tozer et al 2004). This vegetation complex once would have occupied many coastal localities however clearing, habitat degradation and weeds have caused substantial losses across the NSW state. As a result this remanent vegetation community has been placed as endangered and likely to become extinct unless the circumstances and factors threatening its survival cease to operate (NSW Scientific Committee 2012).

Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest are comprised within the Swamp Oak Forest on Coastal Floodplains endangered ecological community. The Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest inhabits an area ≈220,700 m^2 and ≈111,200 m^2 respectively around Wallaga Lake. Estuarine Creekflat Scrub is characterised by Melaleuca ericifolia, Casuarina glauca, Parsonsia straminea, Baumea juncea, Lobelia alata, Baumea articulate, Leptinella longipes, Samolus repens, Selliera radicans. Swamp Oak Floodplain Forest is characterised by Casuarina glauca, with climbers and groundcover species Parsonsia straminea, Geitonoplesium cymosum, Centella asiatica (Tozer et al 2004). Typically these

forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and are vital refuges for many fauna species.

Southern Floodplain Wetlands are comprised within both the Freshwater Wetland on Coastal Floodplains EEC and the River Flat Eucalypt Forest on Coastal Floodplains EEC. This endangered ecological community occupies an area ≈341,300 m^2 with large areas around the tidal limit of Dignams Creek and Narira Creek. The Southern Floodplain Wetland is characterised by Hymenanthera dentate, Melaleuca ericifolia, Acaena novae-zelandiae, Carex appressa, Centella Asiatica, Lobella anceps, Persicaria decipiens, Persicaria praetemissa, Phragmites australis, Ranunculus inundatus, Ranunculus plebelus, and Senecio minimus (Tozer et al 2004). These wetlands are particularly important for reducing flow velocities, filtering nutrients, and providing habitat and food sources for a range of fauna.

The Lowland Grassy Woodland in the South East Corner Bioregion endangered ecological community occupies a total area ≈131,800 m^2 at a number of localities around the Lake. This community complex typically comprises of Acacia mearnsii, Angophora floribunda, Eucalyptus globoidea, Eucalyptus tereticornis, Bursaria spinosa, Ozothamnus diosmifolius, Clematis glycinoides var. glycinoides, Rubus parvifolius, Cheilanthes sieberi, Desmodium varians, Dichondra spp., Echinopogon ovatus, Eragrostis leptostachya, Glycine clandestine, Glycine tabacina, Hydrocotyle laxiflora, Hypericum gramineum, Lepidosperma laterale, Lomandra longifolia, Lomandra multiflora subsp. Multiflora, Microlaena stipoides, Oxalis perennans, Themeda australis, Wahlenbergia gracilis (Tozer et al 2004). Habitat fragmentation due to clearing and grazing has reduced the ecological function of this community since European settlement resulting in a substantial loss of mammal flora. After an examination of historical and contemporary survey data Lunney and Leary (1988) concluded that at least six native mammal species had become locally extinct, including the Wallaroo (Macropus robustus), the Parma Wallaby (Macropus parma), the red-necked Pademelon (Thylogale thetis), the Tasmanian Bettong (Bettongia gaimardi), the Eastern Quoll (Dasyurus viverrinus) and the Brush-tailed Phascogale (Phascogale tapoatafa).

The Dry Rainforest of the South East Forests in the South East Corner Bioregion endangered ecological community occupies a total area ≈311,700 m^2 at one location in the north-western region of the Wallaga Lake estuarine catchment. This community complex is typically characterised by Ficus rubiginosa, Pittosporum unudulatum, Brachychiton populneus, Eucalyptus bosistoana Plectranthus graveolans, Sigesbeckia orientalis, Pellaea falcata, and the grass, Oplismenus imbecillis (Tozer et al 2004).

Littoral Rainforest is an endangered ecological community in NSW and a critically endangered commonwealth community that occupies a total area of ≈19,600 m^2 at four locations on the Lake. Littoral rainforest is typically characterised by Angophora costata, Banksia integrifolia, Eucalyptus botryoides and Eucalyptus tereticornis, Leptospermum laevigatum, Acmena smithii, Breynia oblongifolia, Notelaea longifolia, Stephania japonica var. discolour, Lomandra longifolia, Oplismenus imbecillis and is home to many vulnerable micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and in-vertebrate (Tozer et al 2004).

The River-Flat Eucalypt Forest on Coastal Floodplains is an endangered ecological community that occupies an area ≈648,000 m^2 at numerous locations within the Wallaga Lake estuarine catchment. This community was typically comprised of Eucalyptus. Baueriana, Eucalyptus botryoides, Eucalyptus elata, Eucalyptus ovata, Rubus parvifolius, Breynia oblongifolia, Hymenanthera dentate, Glycine clandestine, Stephania japonica, Microlaena stipoides, Lomandra longifolia, Pteridium esculentum, Oplismenus aemulus, Pratia purpurascens, Echinopogon ovatus, Entolasia marginate, and Desmodium varians (Tozer et al 2004). This EEC

provides habitat for a broad range of flora, including many that are dependent on the vegetation for food, nesting or roosting such as the White-bellied Sea-eagle, Kingfishers, Owls, Yellow-bellied Glider etc. The clearing of native vegetation; alteration to the natural flow regimes; invasion of native plant communities by exotic perennial grasses; anthropogenic climate change; high frequency fire; and Removal of dead wood and dead trees are listed as threatening processes leading to the NSW Scientific Committee determining that River-Flat Eucalypt Forest is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2012).

In addition to the identified endangered ecological communities two NSW listed vulnerable plant species, occur within close vicinity of Wallaga Lake. These plant species are Square Raspwort (Haloragis exalata) and Bodalla Pomaderris (Pomaderris bodalla). Although these plants tend to grow in damp areas close to watercourses they are unlikely to be significantly affected either by lowering or raising the average lake level. A Section 5A assessment for these species is contained in Section 2.8.

It is possible that three threatened plant species which have yet to be comprehensively surveyed for, but which are known from similar estuarine areas in the region, may occur within the saltmarsh of the lake. Although this is the case, they have assessed as being unlikely to occur in the area of disturbance, therefore further survey work is not deemed necessary. These plants are Narrow-leaf Wilsonia (Wilsonia backhousei), Round-leaf Wilsonia (Wilsonia rotundifolia) and Australian Salt-grass (Distichlis distichophylla). These species could benefit or be adversely affected by less frequent lake openings. In general, if these species are present then less frequent opening is likely to be of benefit as it may result in an expansion of their saltmarsh habitat. On the other hand, prolonged inundation could be detrimental.

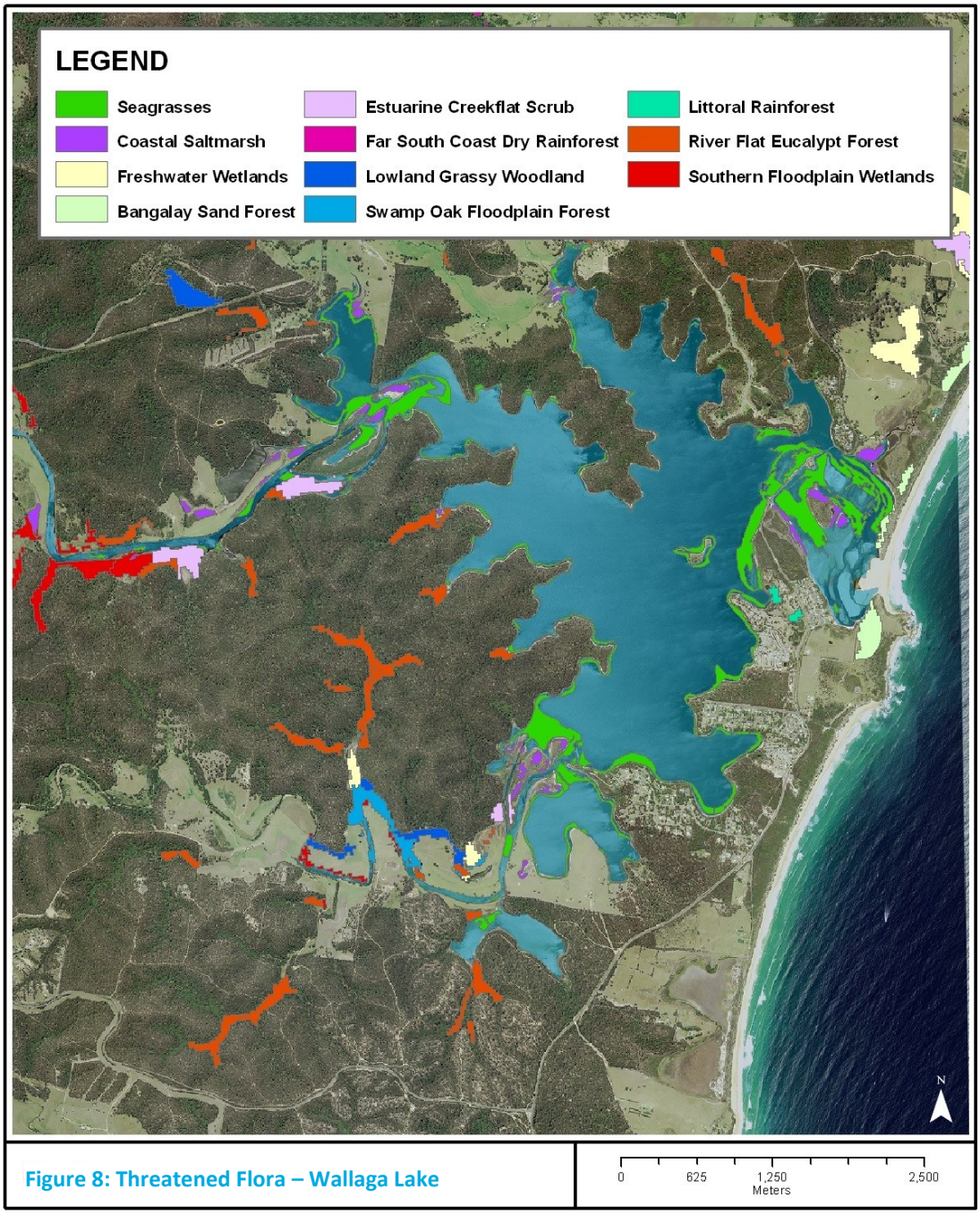

Figure 8: Threatened Flora – Wallaga Lake

2.5.4.2 Fauna

Mammals

The Atlas of NSW Wildlife has identified 9 species listed as vulnerable and the Eurobodalla Greater Glider Population as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 2 are listed as vulnerable and 1 listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in Table 3:

Table 3: Threatened Mammals in the Wallaga Lake Region			
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	
Eastern False Pipistrelle	Falsistrellus tasmaniensis	V	
Long-nosed Potoroo	Potorous tridactylus	V	V
Squirrel Glider	Petaurus norfolcensis	V	
Yellow-bellied Glider	Petaurus australis	V	
Eastern Pygmy-possum	Cercartetus nanus	V	
Koala	Phascolarctos cinereus	V	V
Brush-tailed Phascogale	Phascogale tapoatafa	V	
Spotted-tailed Quoll	Dasyurus maculatus	V	E
Greater Glider population in the Eurobodalla local government area	Petauroides Volans	E	

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

Birds

The Atlas of NSW Wildlife has identified 17 bird species listed as vulnerable and 9 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 2 are listed as vulnerable and 3 listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition12 species are protected under the Japan-Australia, Republic of Korea-Australia and China-Australia Migratory Birds Agreements. These species are shown in Table 4. OEH (2015) present maps of sites that are significant to shorebird nesting throughout the Bega Valley Shire, and identify the Wallaga Lake entrance as one of these sites. Figure 10 shows the identified locations and species from OEH (2015).

Table 4: Threatened Avifauna in the Wallaga Lake Region				
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**	**Migratory Bird Agreements**
White-throated Needletail	Hirundapus caudacutus			C,J,K
Short-tailed Shearwater	Ardenna tenuirostris			J,K
Australasian Bittern	Botaurus poiciloptilus	E	V	
Spotted Harrier	Circus assimilis	V		
White-bellied Sea-Eagle	Haliaeetus leucogaster			C

Little Eagle	Hieraaetus morphnoides	V		
Eastern Osprey	Pandion cristatus	V	V	
Bush Stone-curlew	Burhinus grallarius	E		
Beach Stone-curlew	Esacus magnirostris	E	E	
Sooty Oystercatcher	Haematopus fuliginosus	V		
Pied Oystercatcher	Haematopus longirostris	E		
Pacific Golden Plover	Pluvialis fulva			C,J,K
Hooded Plover	Thinornis rubricollis	CE		
Sharp-tailed Sandpiper	Calidris acuminate			C,J,K
Curlew Sandpiper	Calidris ferruginea	E		C,J,K
Red-necked Stint	Calidris ruficollis			C,J,K
Bar-tailed Godwit	Limosa lapponica			C,J,K
Eastern Curlew	Numenius madagascariensis			C,J,K
Whimbrel	Numenius phaeopus			C,J,K
Caspian Tern	Hydroprogne caspia			C,J
Common Tern	Sterna hirundo			C,J,K
Little Tern	Sternula albifrons	E		C,J,K
Gang-gang Cockatoo	Callocephalon fimbriatum	V		
Glossy Black-Cockatoo	Calyptorhynchus lathami	V		
Little Lorikeet	Glossopsitta pusilla	V		
Swift Parrot	Lathamus discolour	E	E	
Eastern Ground Parrot	Pezoporus wallicus wallicus	V		
Powerful Owl	Ninox strenua	V		
Masked Owl	Tyto novaehollandiae	V		
Sooty Owl	Tyto tenebricosa	V		
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae	V		
Regent Honeyeater	Anthochaera Phrygia	E	E	
White-fronted Chat	Epthianura albifrons	V		
Varied Sittella	Daphoenositta chrysoptera	V		
Olive Whistler	Pachycephala olivacea	V		
Scarlet Robin	Petroica boodang	V		
Flame Robin	Petroica phoenicea	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife has identified 2 amphibian species listed as vulnerable under the NSW Threatened Species Conservation Act 1995. These two amphibian species are also listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are shown in Table 5:

Table 5: Threatened Amphibians and Reptiles in the Wallaga Lake Region

Common Name	Scientific Name	NSW Status	Comm. Status
Giant Burrowing Frog	Heleioporus australiacus	V	V
Littlejohn's Tree Frog	Litoria littlejohni	V	V

V= Vulnerable; facing a high risk of extinction in the medium-term future

Aquatic Fauna

A total of 52 fish species have been recorded in Wallaga Lake during a 3 year research study, carried out by the Ocean and Coastal Research Centre, University of Wollongong (West and Jones 2001). During this study conducted between July 1997 and July 2000, Wallaga Lake was sampled seasonally at the entrance, middle and upper regions of the lake with a total of 61,492 fish caught. The most abundant species captured were the Glassed goby (Gobiopterus semivestitus, 25,997 individuals), glassy perchlet (Ambassis jacksoniensis, 18,081), large-mouth goby (Redigobius macrostoma, 5758) and southern blue eye (Pseudogobius signifer, 3427). Of the 52 species captured, twenty species were significant to commercial and recreational fisheries (West and Jones 2001).

Both School and Eastern King prawns have been recorded within Wallaga Lake. Other crustacean species such as the Blue swimmer, Mud and Sand crab have also been recorded. No aquatic animals that are classified as threatened are known or expected to occur in the Lake.

Prawn and fish recruitment has sometimes been given as a reason for artificially opening Wallaga Lake. However, Gibbs (1997) has concluded based on numerous studies, that without a detailed sampling and analysis of offshore and coastal larval populations, it is virtually impossible to artificially manipulate entrance opening with any certainty of enhancing fish or prawn recruitment and subsequent production. Further, the artificial opening of coastal lagoons to promote production of one species or a group of species may in fact disadvantage other species, with the final outcome being no net benefit i.e. a spring/summer opening favours tarwhine, snapper, sand whiting, luderick, leatherjackets and prawns, while an autumn or winter opening favours yellowfin bream, dusky flathead and flat tail mullet (NSW Fisheries, 1998).

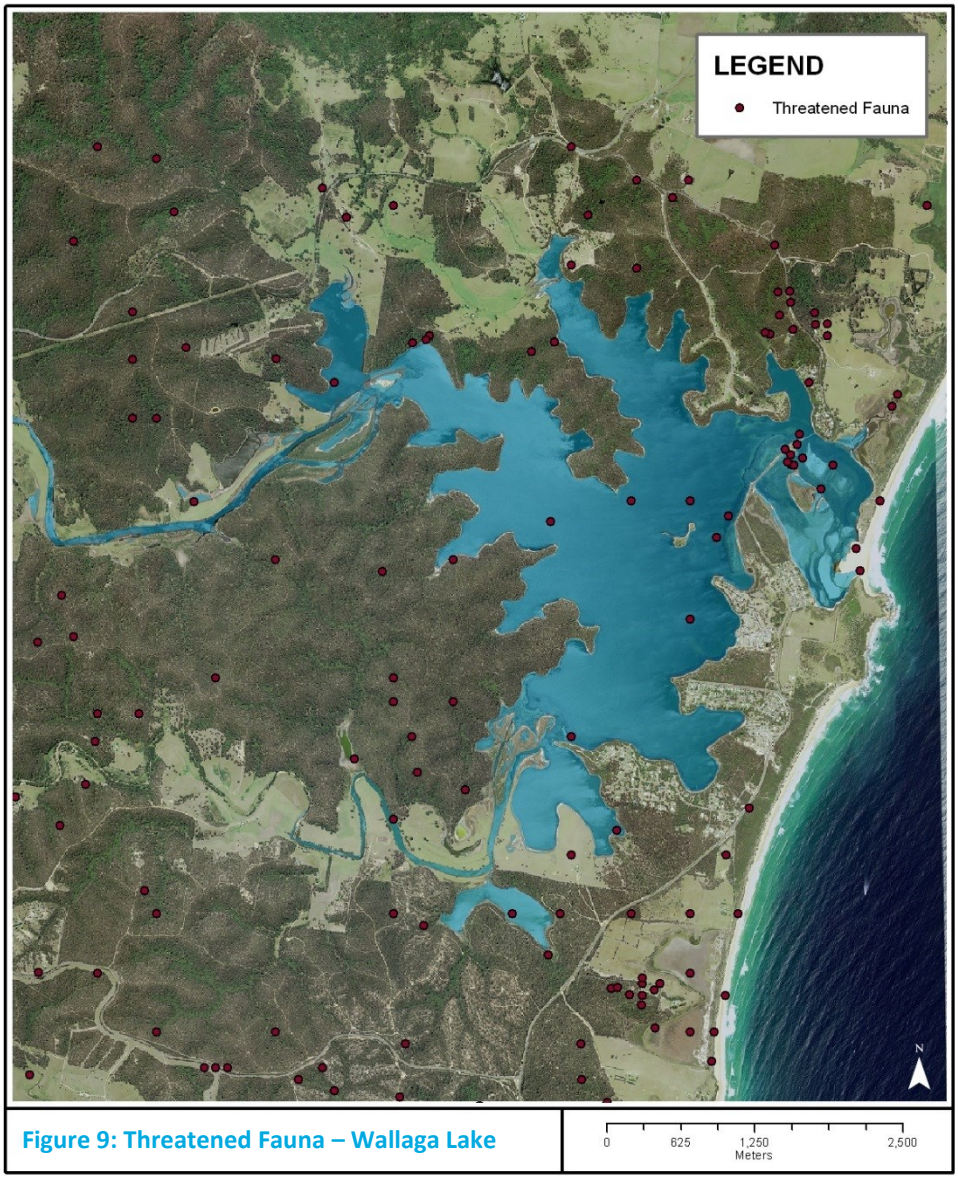

Figure 9: Threatened Fauna – Wallaga Lake

Figure 10: Significant Shorebird Sites at Wallaga Lake Entrance (OEH, 2015)

2.5.5 Cultural Heritage

2.5.5.1 Aboriginal Cultural Heritage

Sites of Aboriginal cultural significance such as middens, are extensive around Wallaga Lake, with previous investigations including (Feary, 1992) and (PBP, 1996) discussing the richness and nature of the sites. Midden deposits on all shores of the lake are reported to be up to one and a half metres thick and lie on gently sloping platforms five to six metres above the water level (PBP, 1996). Examination of these extensive midden sites around Wallaga Lake suggests that the local Aboriginal community have lived here for up to 6000 years. As well as middens, camping areas, artefact scatters, shelters and other sites are frequent around the lake's shorelines, beaches and islands. There are also many areas of spiritual and cultural significance, the details of which are not generally known and are unlikely to be made known to people other than the tribal custodians of the knowledge.

The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance. The investigation included searches of the NSW OEH Aboriginal Heritage Management Information System (AHIMS), the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access track and entrance opening area.

While the AHIMS search across the broader Wallaga Lake region identified a large number of objects, only eight of these were identified within the immediate area of works (including both the access track and lake entrance), and are summarised in Table 6 below. This table also provides a statement of significance for each object, which has considered the social or cultural value to contemporary Aboriginal people, historical value, scientific/archaeological value and aesthetic value. No new objects or sites were identified in the field inspection beyond those already identified in the AHIMS search, and a number of objects in the AHIMS search could not be located during the field inspection.

Table 6: Aboriginal Objects on AHIMS Relevant to Wallaga Lake Entrance Management (Dibden, 2016)							
Site ID	**Description**	**Identifier/Date**	**Statement of Significance**	**Datum**	**Easting (m)**	**Northing (m)**	**2016 Field Inspection Details**
62-7-0312 *Marunna Point*	Non-human bone and organic material	David Dixon, 2001	Low/moderate local significance	AGD	237900	5970750	Nil artefacts or shell found
62-7-0018 *Wallaga Lake 3*	Shell, Artefact	Marjorie Sullivan, 1978	Low/moderate local significance	AGD	237900	5970700	Nil artefacts or shell found
62-7-0253 *VW5*	Shell, Artefact	Veronica Webster	Low/moderate local significance	AGD	237870	5970850	Artefacts found
62-7-0257 *VW10*	Artefact, Shell, Burial	South East Archaeology	High local significance	AGD	237870	5970870	Shell found, burial location identified
62-7-0252 *VW6*	Shell, Artefact	Veronica Webster	Low/moderate local significance	AGD	237850	5970620	Nil artefacts or shell found
62-7-0258 *VW7*	Artefact	Veronica Webster	Low/moderate local significance	AGD	237820	5970600	Nil artefacts or shell found
62-7-0256 *VW8*	Artefact	Veronica Webster	Low/moderate local significance	AGD	237800	5970580	Nil artefacts or shell found
62-7-0251 *VW9*	Artefact	Veronica Webster	Low/moderate local significance	AGD	237750	5970550	Nil artefacts or shell found

2.5.5.2 Other Cultural Heritage

The Wallaga Lake Bridge is the only European heritage listed item in the catchment. The Wallaga Lake Bridge was constructed in 1894 to provide local loggers and farmers easy access from Tilba Tilba and its surrounds to the coastal steamer which travelled from Bermagui wharf to Sydney. In 2002 the bridge was heritage listed due to its historic, aesthetic and social significance.

2.5.6 Recreational and Commercial Uses

2.5.6.1 Recreation

Wallaga Lake supports a range of recreational uses including swimming, boating and fishing. The entrance area is not used for any specific purpose apart from swimming / surfing, walking, dog exercise and nature observation.

When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels also provide for improved recreational opportunities such as sailing. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times.

Recreational fishing also takes place but there is no data available regarding the extent of recreational fishing or the magnitude and nature of the catch

2.5.6.2 Commercial

Holiday Parks: There are three holiday parks located on the foreshore of Wallaga Lake, namely Regatta Point Holiday Park, Ocean Lake Caravan Park and Wallaga Lake Park. Some of these parks have foreshore assets, mainly jetties and boat ramps, which get inundated by rising lake levels well below 1.0 m AHD. Regatta Point Holiday Park also has 21 powered sites on the lake foreshore which are unusable when the lake water level reaches 1.0 m AHD. When the lake floods these sites during fully booked peak holiday periods (most Christmas school holidays only) the park owners suffer a direct loss of income from those sites. Unless the park is fully booked there are alternative sites for the campers to go.

Commercial fishing: Wallaga Lake is amongst the five major estuaries on the NSW South Coast for crustacean and finfish catches (Gibbs, 1997). For the six year period 1990 to 1996, the average annual catch of finfish from Wallaga Lake was 26,434 kg which ranked its productivity fourth in terms of south coast estuaries. Bream, sea mullet and luderick dominated the finfish catch. For the same period the average annual catch of crustaceans from Wallaga Lake was 787 kg, comprising predominantly eastern king prawns and school prawns. In terms of crustacean productivity on the NSW South Coast, Wallaga Lake ranks ninth behind the larger prawn producers such as the Shoalhaven River and St Georges Basin.

When the lake is closed to the sea the catches made by the commercial fishers are generally higher than those made when the lake entrance is open. Some fishers also catch live eels and keep them alive in nets around the lake edge until they have sufficient numbers to send to the market. Opening the lake can rapidly drop the water level below these holding nets killing the eels before they can be removed.

Agriculture: Freehold grazing land also exists around large parts of the lake foreshore. These areas are being utilised to graze cattle and are therefore important to the livelihood of a number of farming families. When the lake water level rises to 1.05 m AHD or higher, access to pasture areas becomes impassable making it difficult for farmers to tend to their stock. Alternative access to some pastures cut-off by rising lake levels is possible however, and could be considered acceptable for short periods of time (e.g. up to 3 months).

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

2.6 Description of the Activity Impacts

2.6.1 Acid Sulfate Soil Impacts

It is highly unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Wallaga Lake has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

2.6.2 Bank Erosion and Sedimentation Impacts

It is likely due to the consistent opening regime at low water levels below 1.25 m AHD for the last century, that entrance opening works would actually reduce the risk of bank collapse by limiting bank inundation and bank destabilisation potential, resulting from a rapid drop in water level post entrance opening. It must be highlighted however, that water levels in excess of 2 m AHD would be within the natural hydrological regime, and as a result it is considered that the potential for bank collapse would be slight. Overall, the influence of other factors such as the presence of riparian vegetation, soil type, and access to the banks would have a much greater influence on this issue.

Over the long term, the progradation of the marine sediments into the lake resulting from artificial entrance openings at lower than natural water levels, may cause moderate adverse sedimentation impacts to the lake due to less effective scour of the marine flood tide delta. It is advised that further study be undertaken when resources are available to examine the impacts of entrance opening on this process.

2.6.3 Hydrology Impacts

The works will have a moderate negative impact on the Lake as entrance opening is an important determinant of the hydraulic character. Natural breakout of Wallaga Lake would tend to occur during or soon after a significant rainfall event. Rainfall is a necessary precursor to raise water levels to a level significantly greater than mean sea level, and to 'liquefy' the sand barrier and reduce its cohesion. The ability of the lake water to erode a deep and wide

entrance channel is directly related to the head difference that exists between the lake and the ocean at the time of breakout. A large head difference will result in a larger and deeper channel.

Therefore, intervention in the breakout process at low lake water levels with an unsaturated entrance bar will reduce the capacity of the opening to erode sediments from the entrance area. Over the long term this may cause sedimentation impacts and changes to the hydrologic regime as a build up of sediment in the entrance area may progressively result in beach bar widening and lake infilling.

Both positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid increases in dissolved oxygen concentrations resulting from rapid decay of organic material.

2.6.4 Aquatic Vegetation Impacts

Entrance opening and the resulting drop in water levels is likely to have a slight negative impact on aquatic vegetation. The negative impacts include; the scouring of Zostera capricorni from the lakebed particularly around Honeysuckle Island (which is just as likely to occur during natural entrance openings), a relative shift in species composition from Ruppia spp. to Zostera capricorni due to more frequent entrance openings and potential die-back due to exposure caused by more frequent rapid decreases in water level.

2.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The works will indirectly have moderate negative impacts on several transitional and fringing endangered ecological communities (EECs). These impacts occur as the natural flow regimes and water levels of Wallaga Lake have and will be altered by the entrance opening works. Endangered ecological communities such as Coastal Saltmarsh, Freshwater Wetlands, Swamp sclerophyll forest on coastal floodplains and River-Flat Eucalypt Forest are impacted due to reduced inundation. This can result in significant species composition shifts such as reduced Saltmarsh, Grassy Woodlands, River-Flat Eucalypt Forest and Freshwater Wetland habitat, and can also result in encroachment of terrestrial vegetation. This is already evident as existing transitional and fringing wetland species have been constrained in their distribution to areas below 1.25 m AHD as a result of past opening levels.

It is identified that some dieback will occur following long periods of inundation particularly Casuarina glauca and entrance opening may relieve this pressure. However, it must be noted this is a natural reclamation process and many endangered ecological communities rely on this dieback and inundation for survival. Repeated artificial entrance opening at this lower range of natural break-out water levels will therefore continue to have moderate negative impacts on several transitional and fringing endangered ecological communities.

A Section 5A assessment for the endangered ecological communities and the two NSW listed vulnerable plant species Haloragis exalata and Pomaderris bodalla is located in Section 2.8.

2.6.6 Direct Impacts to Access Track Vegetation

The track which will be used to provide access and egress for the excavator is shown in Figure 3. This existing and predominantly cleared track has been selected for the access route, as it will minimise impacts to surrounding vegetation. In driving the excavator along this track, it is expected that minor disturbance of grass will occur, and there may also be small sections of the track where hand pruning of low hanging shrub branches (predominantly Coastal Wattle and Banksia) will be required. There will be no need to remove trees to provide access. Photographs of the access track are shown in Figure 11, where it can be seen that there will be minimal impacts to vegetation from machine access.

Figure 11: Photos of Wallaga Lake Access Track and Vegetation

2.6.7 Fauna Impacts

Mammals

It is unlikely the entrance works will have a direct impact on threatened mammal species or endangered populations. The longer-termindirect impacts of undertaking these works however, may result in habitat destruction placing pressure on vulnerable species such as the Long-nosed Potoroo. It must be recognised, that water levels will be within the natural range.

Birds

Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works, in particular channel excavation, could potentially have a significant negative impact on a number of resident and migratory threatened shorebird species. Shorebirds inclusive of the Little Turn, Hooded Plover and Pied Oystercatcher could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- A machine access route that minimises areas of dune impacted by the machine;
- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators, restrict pedestrian access and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform

additional adaptive management responses on an “opening-by-opening” basis, as opposed to a “one-off” survey for this REF. Section 5A assessments have been carried out for the potentially impacted shorebird species (Hooded Plover, Little Tern, and Pied Oystercatcher), and are included in Section 2.8. As the impacts to these species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement. Entrance opening works are unlikely to negatively impact other threatened bird species, rather the reduction in water levels may expose feeding grounds and food sources (decomposing vegetation and invertebrates) for many of the bird species.

Amphibians and Reptiles

Frog species identified are unlikely to occur in habitats directly connected to the lake due to excessive salinities and preference for different habitat types. The upper reaches of the tributaries may however provide habitat for both species (the Giant Burrowing Frog and Littlejohn's Tree Frog). As a result impacts on these species are negligible given that they would most likely occur some distance from the lake entrance.

Aquatic Fauna

The entrance works will have both positive and negative impacts on aquatic animal species. These positive and negative impacts could include assemblage changes, habitat shifts, and fish kills. As the entrance works rapidly change the surrounding environment, some species may benefit and others may perish due to stress from low dissolved oxygen and sudden salinity increases, however, it should be noted that such changes would also be expected to occur as a result of natural entrance openings. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and the opening works are within the lower range of the natural regime. Jones and West (2005) found that the artificial opening of Lake Conjola (situated south of Jervis Bay) resulted in the loss of a large seagrass bed. Consequently, there was a large decrease in the recruitment of economically important fish species to the Lake. While there are seagrass beds in the lower Wallaga Lake estuary that could be at risk of such scour, it should be recognised that the risk of this happening is no higher and potentially lower than during natural entrance openings.

2.6.8 Aboriginal Cultural Heritage Impacts

In broad terms the entrance management works may indirectly have both positive and negative impacts on Aboriginal cultural heritage sites located around the fringes of the greater lake area. Positive impacts include opening the entrance prior to naturally high lake water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts include an increased frequency of wetting and drying from rises and falls in Lake water level as a result of more frequent entrance openings.

Given that existing access tracks will be used, and excavation of the entrance channel will take place through marine sands that are historically transient and mobile in nature, direct impacts can generally be considered minimal in extent and area (Dibden, 2016). An impact assessment

for each identified Aboriginal object was undertaken in the ACHAR (see Appendix J), with a summary of impacts provided in 7.

Table 7: Impacts on Aboriginal Objects from Implementation of Wallaga Lake Entrance Management Policy (Dibden, 2016)

Site ID	Type of Harm	Degree of Harm	Consequence of Harm
62-7-0312 *Marunna Point*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0018 *Wallaga Lake 3*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0253 *VW5*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0257 *VW10*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0252 *VW6*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0258 *VW7*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0256 *VW8*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-7-0251 *VW9*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value

With regards to minimising and mitigating harm, Dibden (2016) reported "Except for 62-7-0257 VW10 in which a burial is known to be present, generally, the areas in which impacts would occur are of insufficient value and significance to warrant a serious consideration of Ecological Sustainable Development (ESD) and cumulative harm. The sites are generally disturbed as a result of previous impacts. The cultural and archaeological significance of these (*sites)* has not been assessed to be of sufficient significance to warrant the implementation of avoidance or mitigation strategies.". Nevertheless, to allow Council to proceed with works that will result in direct harm (though of low significance or extent), a Section 90 Aboriginal Heritage Impact Permit (AHIP) has been sought for the works.

Dibden (2016) made the following recommendations in the ACHAR with regards to mitigation of impacts from the entrance management works:

- For site 62-7-0253 VW5, salvage recording of artefacts form a part of the mitigation strategy;
- For site 62-7-0257 VW10, regular monitoring of site conditions with remediation if required to ensure ongoing stability of the area, particularly where the known burial is present; the use of a suitable protective barrier to put down in the area of the burial, with wheels (*or tracks*) lined up to straddle the burial area when beach is accessed; monitoring

when work occurs. Measures (physical barrier) should be put in place to stop pedestrian beach access via the informal track which has midden exposed.

2.6.9 Other Cultural Heritage Impacts

It is unlikely the entrance works will have a negative impact on the Historic Wallaga Lake Bridge. Increased water levels and inundation of the bridge for a period of 1 day may cause structural damage, however, it is the intention of this policy to raise the asset over the short term to accommodate higher water levels. A structural evaluation of the bridge should be undertaken to assess the appropriateness of inundation and increased scour resulting from higher water levels and break-out.

2.6.10 Recreational Impacts

The entrance management works may result in both positive and negative recreational impacts. When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels provide for improved recreational opportunities such as sailing and boating. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times. Impacts on recreational fishing may also occur however as detailed previously artificial opening regimes favour some species over others.

2.6.11 Commercial Impacts

The entrance works have significant commercial impacts. Artificial entrance opening is required to prevent flooding of both public and private assets. The predominant assets are jetties and boat ramps, holiday park camping sites, agricultural land, and the Wallaga Lake Bridge. Regatta Point Holiday Park has 21 powered sites on the lake foreshore which are unusable when the lake water level reaches 1.0 m. When the lake water level rises to 1.05 m AHD or higher, impacts to the agricultural sector are experienced as access to pasture areas becomes difficult and grass die-off occurs. However, when the lake is closed to the sea, catches made by the commercial fishers are generally higher than those made when the lake entrance is open. Therefore, entrance opening has both positive and negative commercial impacts, however, it is the intention of this policy to return to a more natural opening regime and work with landholders to relocate affected assets.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

2.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The community most likely to be affected will be the residents within close proximity to Wallaga Lake. There will be no significant adverse impact upon the general wider community. Malodorous conditions can sometimes occur for a few days after an entrance opening due to the rotting vegetation around the lake shoreline. To prevent this affecting holiday makers, where possible the lake will not be artificially opened during peak holiday periods. There are a small number of lakeside property owners who will be directly affected by elevated lake levels. In the past the Lake has been artificially opened at lower levels. The Wallaga Lake Entrance Management Policy however, has raised the opening level which will now allow minor flooding of some parts of the lake foreshore for a short period of time, compared to that previously allowed with ad-hoc opening of the Lake entrance. Caravan parks around the lake will have parts of their land inundated and unavailable for camping, some jetties will be underwater and pastures of some rural properties will be flooded causing access and productivity impacts. As the only purpose for conducting the entrance opening works is to protect private and public assets from flooding, the activity will have positive outcomes for the community beneficiaries.
b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The locality will not be transformed in any significant manner. The lake entrance will change temporarily, but these changes will be within natural bounds.
c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There are a range of environmental impacts on the ecosystems of Wallaga Lake as discussed in Section 2.6. The cumulative impacts of the entrance works may and most likely have caused medium adverse environmental impacts on the ecosystems of Wallaga Lake. These impacts predominately relate to hydrologic and ecological shifts from natural states, as a result of lower water level breakouts. Regular and repeated low water level (artificial) openings will likely further change many ecosystems particularly aquatic and wetland ecosystems over the long-term, as the works alter the ecosystems structure, composition and diversity. However, it should be recognised that BVSC has intentions (as documented in the Policy) to undertake planning and upgrade works to improve low lying assets affected by high lake water levels which will allow the trigger water level for mechanical opening to be raised in the future. As such, long term adverse impacts to fringing and aquatic ecosystems are expected to be low.

d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There is not likely to be any reduction in the aesthetic quality or value of the locality as a result of implementing the Policy. The impact upon fish and prawn populations may have a bearing upon the recreational value. If an artificial breakout allows a large population of prawns and fish to escape to sea there would be a significant loss of recreational opportunity, especially if this occurred just prior to the Christmas/New Year holiday period. However, an artificial opening could enhance recreational prawning and fishing opportunities the following year if the opening coincided with a high abundance of prawn larvae and fish spawning in nearshore coastal waters. Such conditions are impossible to predict. On balance and over the long term, the impacts are likely to be slightly negative. Impacts to other recreational activities such as sailing and walking are deemed negligible as fluctuating water levels will favour differing recreational activities at different times. While intervention in the natural breakout process conceptually diminishes the scientific value of the system since an element of 'naturalness' has been lost, in reality the vast majority of ecological processes will continue to operate. The locality could still be suitably used for a wide range of scientific purposes (this has been demonstrated at other ICOLLs on the Far South Coast such as Wallagoot Lake).
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The completed ACHAR identified that there is the potential for direct partial harm that will result in a partial loss of value for up to 8 recognised sites containing Aboriginal objects. With the exception of one object, potential impacts from the works were reported to be of too lower significance to warrant implementation of mitigation strategies. A range of mitigation measures have been proposed for an Aboriginal burial site located on the proposed access track on the apex of Murunna Point, with implementation of these mitigation measures minimising the potential for harm beyond that already realised through previous disturbances. BVSC have sought an AHIP from OEH as a precautionary measure and to proceed with works that have the potential to cause harm of low significance.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There is potential that moderate to significant adverse impacts may result to habitat of protected fauna. These impacts are documented in Section 2.6 and primarily result from hydrologic changes (increased frequency and lower water level opening) and

	habitat disturbance due to machinery and channel scour. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher, Hooded Plover, and Little Tern by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 2.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 2.8.
g.	Will there be any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The endangered ecological communities listed in Section 2.6 (i.e. Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest, Littoral Rainforest, River Flat Eucalypt Forest and Southern Floodplain Wetlands) in conjunction with the identified threatened mammal species may be indirectly impacted by the entrance management works. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher, Hooded Plover, and Little Tern by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 2.6.7 and the Policy, these impacts will be reduced to low adverse. For these communities and bird species a Section 5A assessment has been prepared and is contained in Section 2.8. Considerations of the activity impacts on the threatened vegetation species Square Raspwort (Haloragis exalata), Bodalla Pomaderris (Pomaderris bodalla) and Tall Knotweed (Persicaria elatior) although negligible have also been included in Section 2.8.
h.	Will there be any long-term effects on the environment? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The cumulative impacts of the entrance works may in the future and most likely have caused medium adverse environmental impacts on the ecosystems of Wallaga Lake. These impacts are documented in Section 2.6 and may primarily involve: a relative shift in the structure, composition, diversity, and location of the lake's fringing ecology; increased rates of lake infilling particularly at the entrance bar; and reduced frequency and duration of flooding at higher levels.
i.	Will there be any degradation of the quality of the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The quality of the lake environment will be degraded by virtue of the fact that a major natural process is being interfered with. In effect the lake is losing a major element of 'naturalness'. Naturalness is a significant environmental attribute. It is often

	a criteria used to determine environmental or conservation value. Although this activity has occurred for almost a century, the works continue to perpetuate the problem.
j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of undertaking the entrance opening works. The robustness or ability of the environment to withstand environmental fluctuations should not be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above. On the whole, there is more likely to be positive benefits to the use of the environment through improved access at high lake water levels.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not result in any pollution of the environment.
m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Although it is difficult to predict what other future activities might take place it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or on the foreshore.

p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. Over the long-term additional influx of marine sediment into the estuary and the widening of the beach berm may occur, as a result of entrance openings at lower water levels that likely result in less scour of entrance sediments. This may alter coastal processes. The Policy has been developed to incorporate a progressive increase in entrance opening levels to partially accommodate current best estimates of sea level rise and reduce the need to intervene in natural entrance behaviour in the longer term.

2.8 7-Part Test for Threatened Species, Populations and Ecological Communities

2.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Hooded Plover (Thinornis rubricollis) and Pied Oystercatcher (Haematopus longirostrus)

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSCA LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallaga Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wallaga Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

2.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Migratory Shorebirds - Little Tern (Sterna albifrons).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSCA LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the

composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallaga Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wallaga Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

2.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Flora – Square Raspwort (Haloragis exalata) and Bodalla Pomaderris (Pomaderris bodalla).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

It is unlikely the activity will impact upon the lifecycle of these species. Haloragis exalata tends to grow in damp areas at a variety of locations around Wallaga Lake inclusive of Narira and

Dignams Creeks. Pomaderris bodalla occurs in moist open forest along sheltered gullies and along stream banks and has been recorded along Dignams Creek. Although these species tend to grow close to watercourses it is unlikely these species will be significantly impacted.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSCA LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible that some habitat will be slightly modified through the cumulative impacts of the works resulting in a decrease in upper limit water levels, however, impacts of this process are unlikely to significantly impact these species.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Habitat modification through this activity is unlikely to affect the long-term survival of these species.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallaga Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is not inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wallaga Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

2.8.4 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest, Littoral Rainforest, River Flat Eucalypt Forest and Southern Floodplain Wetlands

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

The artificial opening works of the past, have possibly constrained the distribution of these endangered ecological communities (EECs) to areas below 1.25 m AHD in most locations. It is likely future entrance opening works will perpetuate this trend. If the Wallaga Lake Entrance Management Policy is adhered to and future works/planning are implemented to raise low lying assets, it is likely a “more natural” lake water level can be achieved before the lake is artificially breached in the future. This may reduce the future cumulative impacts of the proposed entrance works on these important EECs. It is unlikely any of the EECs are to be placed at risk of extinction as a result of activity, however, declines and shifts in extent, composition, and diversity are likely to continue as a result of the activities.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible that some habitat will be modified through the cumulative impacts of undertaking the works. This may result in impacts to the EECs as detailed in Section 2.6.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is possible that some EECs will become isolated from the water body, limiting inundation as a result of reduced upper limit water levels following artificial entrance opening.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Future habitat modification through this activity may compromise the long-term survival EECs around Wallagoot Lake through impacts listed in Section 2.6, if the Policy is implemented indefinitely into the future. However, it is Council’s intention to reduce the need for

intervention in entrance processes by raising the low lying assets around Wallaga Lake in the coming 5 to 10 years. As such the long-term survival of these EECs is unlikely to be at risk.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallaga Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is a threatening process and as a result would be inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wallaga Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

2.9 Conclusion

The proposed entrance management works are required for the sole purpose of reducing the impacts of flooding to private and public assets. This occurs as Lake water levels above 1.25 m AHD have the potential to cause undue hardship and disruption to members of the local community. In implementing the proposed Wallaga Lake Entrance Management Policy, there are three notable potential impacts. These are:

1. Potential direct impacts to threatened shorebird species;
2. Potential cumulative environmental impacts of altering the natural hydrologic regime, indirectly impacting endangered ecological communities;
3. Potential direct and cumulative impacts to an Aboriginal site at Morunna Point.

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes specific selection of excavator access routes that minimise impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

With regards to changes to the hydrologic processes of the Lake and resulting cumulative indirect impacts on EECs, the Wallaga Lake Entrance Management Policy has outlined planning and adaptation works for low lying assets that will allow mechanical entrance opening at higher lake water levels in the future, returning hydrologic behaviour to more natural regimes. As such, the potential for future significant adverse impacts to saltmarsh and other fringing EECs, beyond those already occurred, are expected to be minimised.

With regards to the potential impacts to the Aboriginal burial site on Morunna Point, there are proposed mitigation measures to be implemented as a part of the Policy so as to minimise the impacts beyond those already realised. These include covering the burial site with a protective barrier, and straddling the site with the excavator tracks where possible when traversing over

the site. Regular monitoring of the site will also be required into the future, with remediation works if required.

As there are no viable alternatives to the proposed entrance management in the short term, the proposed Wallaga Lake Entrance Management Policy should be approved, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- Bega Valley Shire Council plan and implement modifications to the low lying assets that are affected by inundation when lake water levels are high;
- A Flood Risk Management Study and Plan should be undertaken when resources become available to investigate future flood management options, with consideration of natural berm heights, sea level rise projections and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) and consistent with the NSW Floodplain Development Manual (DIPNR 2005). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions.

3 REF for the Artificial Entrance Opening of Cuttagee Lake

3.1 Location

Cuttagee Lake is situated on the far South Coast of New South Wales, approximately 5km south of Bermagui. The lake and saltmarsh have a combined area of 1.26km^2 (OEH, 2016), with an east west elongation, and a catchment area of 53.25km^2 (Elgin, 2016). The lake is shallow saline coastal lagoon that is formally classified as semi-mature wave dominated intermittent estuary (Roy, 2001). Only approximately 5% of the catchment has been cleared for agricultural and residential purposes (Elgin, 2016), with the remainder being a mix of forested private (3% of catchment area), State Forest (Murrah State Forest, 47% of catchment area) or National Park (Biamanga National Park, 45% of catchment area) lands (see Figure 12). Cuttagee Creek is the Lake's main tributary and drains what is a relatively short and steep catchment.

Figure 12: Cuttagee Lake Estuary

3.2 Description of Proposed Activity

A channel will be excavated through the unvegetated marine sand barrier within approximately 50 metres of the northern rocky foreshore of Cuttagee Point in the location

shown in Figure 13 using mechanical equipment, most likely an excavator. The access route which the machine will use is also shown in Figure 13. This route has been selected to minimise disturbance to dune vegetation during machine access and egress, as it follows an existing cleared track. However, it is expected that minor damage to the track and grassed areas is inevitable. Particular care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes and shell middens, and as a precautionary measure a permit (AHIP) from OEH has been sought to undertake the works (though there are no known Aboriginal objects or places within the access or work areas).

Figure 13: Location of Entrance Opening Works

As outlined in the Cuttagee Lake Entrance Management Policy (Appendix B) the excavation will only be undertaken if the following essential criteria are achieved:

a. lake water level between 1.6 and 1.8m AHD and significant rainfall forecast within the catchment (>100 mm); OR
b. lake water level exceeds 1.8m AHD.

The excavated sand will be pushed to the southern side of the excavated channel and will not be removed from site. The exact channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 4-6 hours duration. It would be rare for it to extend beyond 10 hours.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. The size and location of the channel will be

constrained by the northern rocky headland of Cuttagee Point. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

While there is no intention to establish a permanent opening, a reasonably long lasting opening is preferred to maximise the possibility of full water exchange and obviate the need for repeated intervention after a short period of time (that is, a few weeks or months). To assist with the establishment of a large and deep channel, which will be slow to infill, completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle. This should ensure that an adequate head difference between the water in the lake and the ocean is maintained for the first few hours of outflow. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

3.3 Purpose of the Activity

The purpose of the works is to re-establish a temporary tidal connection between the lake and the ocean to allow accumulated water to flush to the ocean and thereby lower water levels below that which causes flooding problems for roads and private property access on the lake foreshore.

The intention is not to establish a permanent opening. It is recognised that the entrance channel could well close again within a matter of weeks, although it would generally be hoped that the channel would remain open for a period of months to maximise the period available for tidal flushing and minimise the need for further openings in the short term.

3.4 Consideration of Alternatives

Ultimately in the short term there are no viable alternatives to the artificial opening of the lake during times of high water level. The “do-nothing” option is unacceptable because of the disruption that would be caused to local residents whose property access would be inundated. The high water levels may remain for many months, causing ongoing inconvenience. Due to the extent of the flooding and realistic public safety concerns, Council does not consider the do nothing option appropriate or feasible at this time.

Rather than adopting a fixed level, a variable opening level has been proposed in the Entrance Management Policy. No action will be taken to open the lake when water levels are lower than 1.6m AHD. Once this level is exceeded, the flooding situation and public risks will be assessed by Council officers, and if heavy rain is forecast the entrance may be opened. This provides the opportunity to delay intervention as long as practical in order to maximise ecological benefits. A lake water level of 1.8m AHD is considered a ceiling which is difficult to go above in the short-term due to excessive road inundation and safety risk. This level also represents the lower window of natural entrance breakouts and provides the opportunity for the lake entrance to open naturally depending on the level of sand built up at the entrance berm.

In the longer term it is the intention to remove the need for Council intervention in entrance opening by selectively raising the necessary sections of Council owned roads to eliminate flood risks.

3.5 Description of the Existing Environment

3.5.1 General Characteristics

The Lake entrance is situated at the eastern of the lake at the northern end of Cuttagee Beach and under the southern side of Cuttagee Point. The entrance area itself is characterised by an expanse of marine sand, which is generally scoured away during each opening event. To the south of the entrance are the relatively narrow Cuttagee Beach dunes, whilst the cliffed bedrock of Cuttagee Point lines the northern shore of the entrance.

There are 5 SEPP 14 wetlands within the Lake, with 4 of the 5 located adjacent to the Cuttagee Creek delta at the western end of the lake.

3.5.2 Sediments

3.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show the entire bed of Cuttagee Lake as having a high risk of potential acid sulfate soils. Additional and more prolonged inundation of these soils as proposed by the Policy, compared to lower water level break outs would reduce the oxidation potential of the soils, thus reducing their acid-generating potential.

In relation to the berm area where the excavation works are proposed, acid sulfate soils are highly unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

3.5.2.2 Bank Erosion and Sedimentation

Kidd (1978) found that the eastern half of the lake was dominated by marine sands, while the western sections of the lake and various inlets of the lake were comprised primarily of riverine muds, with a narrow spur of immature gravel being deposited at the Cuttagee creek delta and centre of the lake. Elgin (2016) reported that in general the foreshore banks of Cuttagee Lake are highly stable, with very few signs of unnatural erosion.

Sediment within the entrance of Cuttagee Lake is comprised of marine (beach) sands, rather than terrigenous sediment. This material is deposited under the combined action of tides and waves. The non-cohesive sands are dynamic in nature and tend to be redistributed during times of flood. It is expected that during large floods, a large proportion of the marine sands in the entrance channel are actually scoured and transported into the nearshore coastal zone, only to be reworked back into the entrance, or transported alongshore, under the influence of ocean processes such as waves and tides.

3.5.3 Hydrology

3.5.3.1 Entrance Behaviour / Characteristics

The frequency and duration of entrance opening is an important determinant of the hydraulic character of the lake (that is, the frequency and magnitude of water level fluctuations and quality changes). OEH have undertaken an analysis of the entrance state for Cuttagee Lake on the basis of available gauged data, which is included below. This is supplemented by additional information recorded by local resident S. Cameron and reported in Elgin (2016).

OEH and Local Resident Analysis:

Manly Hydraulics Laboratory maintained a temporary water level gauge on behalf of OEH in Cuttagee Lake from 20/6/2013 to 14/7/2015 when it was decommissioned. In total there exists around 2 years of water level data. While this is only a small period of time, it still provides a valuable assessment of the likely ranges in water level and entrance state. At the time of installation in 2013 the entrance was closed.

Entrance closure and opening based on the recorded water level data has been identified from observing the stop and start of a tidal signal from the graphed data (see Figure 14). This is generally easy to identify but there are small periods of time were the entrance is likely closed but still being overtopped on the top of the high tide that make picking the precise closure date difficult. Earlier records of entrance behaviour between 16/05/2003 and 20/06/2013 have also been documented based on the observations provided by a local resident, and have been used to supplement the period of gauged data.

Between 20/6/2013 and 14/7/2015, 5 separate periods of entrance closed conditions were identified from the gauged water level data, with closed conditions ranging from 12 days up to 158 days, but typically in the order of several months (8). The duration that the entrance stayed open for ranged from 14 days to 138 days, but typically in the order of weeks to several months. The record of gauged water levels indicates that the lake is approximately closed for 58% of the time and open for 42% of the time. When extended to the full 12 year period of observations, the longest continual period with a closed entrance was 544 days, while the longest period with an open entrance was 541 days. In total, the lake was open and closed an equal percentage of the time, however, on several occasions the lake was opened mechanically, and as such it is expected that naturally the lake would remain closed more so than open.

During the period of gauged water level data, the level of entrance opening ranges from 1.27 to 2.13 m AHD, and typically over 1.8 m AHD, noting that the opening at 1.27 m AHD was only a partial opening resulting in a slow draining of the lake over a period of days then rapid re-closure. An OEH survey of the berm height completed on 16 July 2015, three weeks after the entrance opened, showed the height of the berm immediately either side of the opened entrance were 2.16 and 2.45m AHD respectively. This indicates the berm was likely in the range of around 2.1 to 2.4m AHD at the time of opening.

Comparison of Cuttagee Lake water levels to ocean water levels recorded from Twofold Bay in Eden show that the majority of the time when the entrance is open the tidal range is restricted to significantly less than the full open ocean tidal range, with a maximum tidal range of up to around 0.9m after a significant rainfall event and/or opening (Figure 15 Figure 16). Cuttagee Lake, like many other ICOLLs, does not experience tidal water levels that drop far below approximately mean sea level (0.0m AHD).

Table 8: Periods of Entrance Closures, Opening and Opening Levels for Cuttagee Lake				
Entrance Closure Date	**Entrance Opening Date**	**WL Height at Opening**	**Closure Duration (days)**	**Open Duration (days)**
	16/05/2003	*Unknown*		*NA*
16/06/2004	*12/07/2005*	*Unknown*	*391*	*397*
5/08/2005	*19/08/2006 (#)*	*Unknown*	*379*	*24*
18/11/2006	*16/06/2007*	*Unknown*	*210*	*91*
10/08/2008	*5/02/2010*	*Unknown*	*544*	*421*
31/07/2011	*2/03/2012*	*Unknown*	*215*	*541*
21/04/2013	25/11/2013	1.895	218	415
13/04/2014	12/09/2014 (#)	1.8	152	139
1/10/2014	7/12/2014	2.126	67	19
14/04/2015	26/04/2015 (*)	1.27	12	128
10/05/2015	24/06/2015 (#)	2.02	45	14
NA	14/07/2015	NA	NA	20
Total			2233	2189
Total			50%	50%

Notes:

* Only a partial opening occurred on this occasion, # The lake entrance was mechanically opened on this occasion

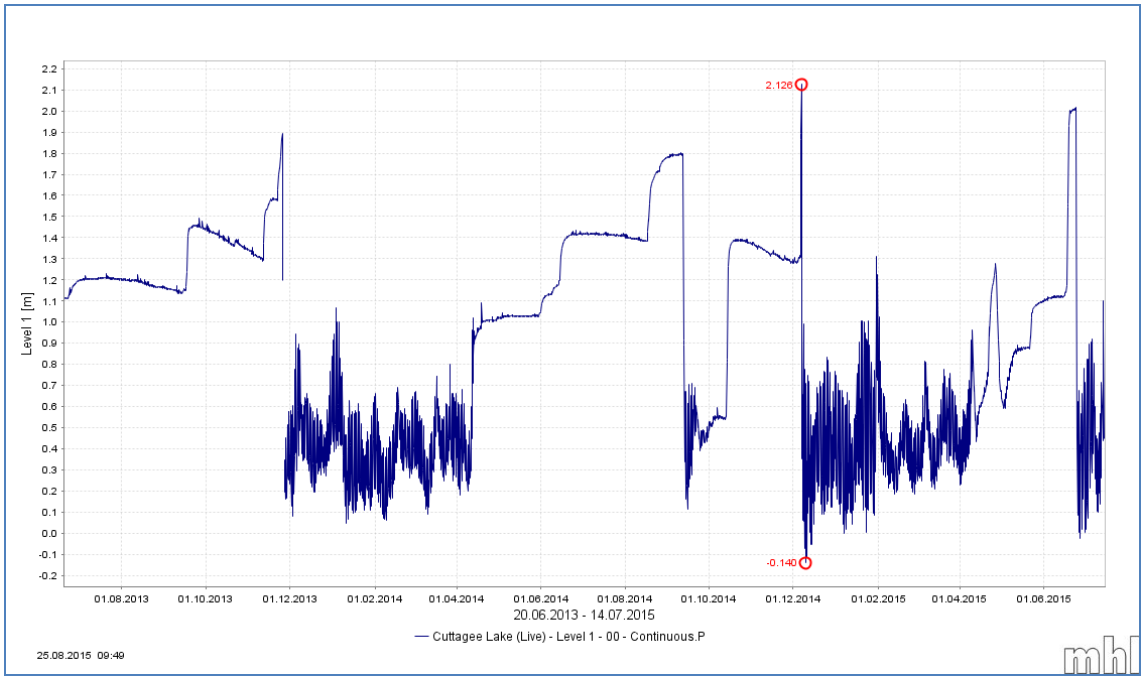

Figure 14: Complete Water Level Data set from Cuttagee Lake Water Level Gauge from 20/06/2013 to 14/07/2015

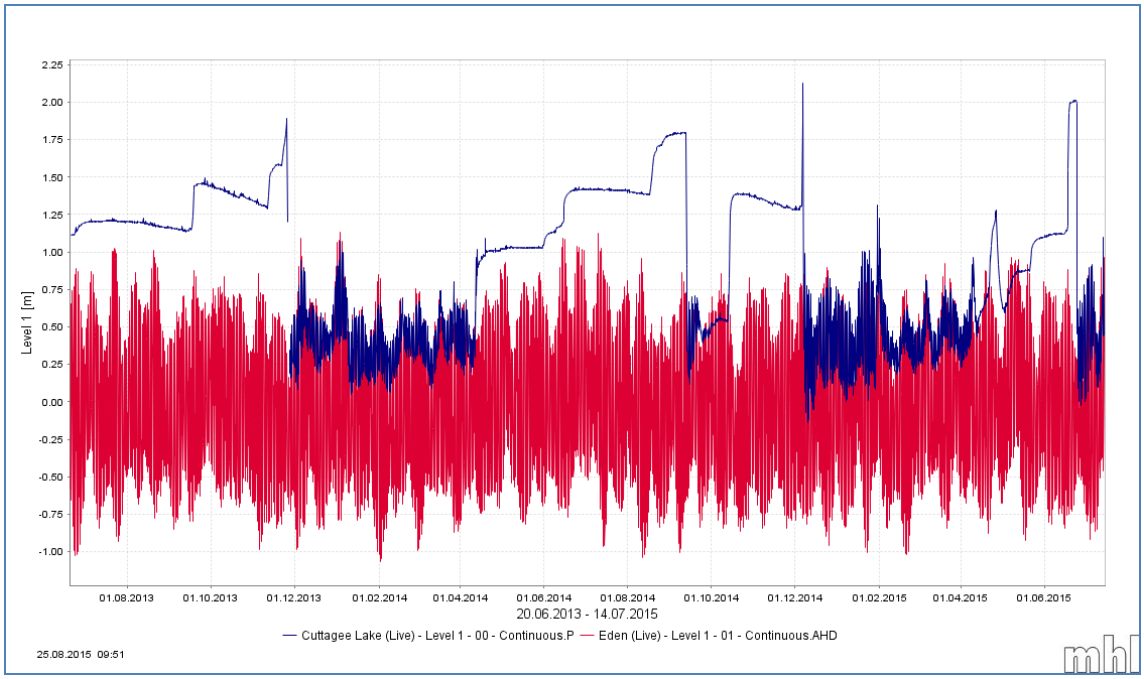

Figure 15: Complete Water Level Data set from Cuttagee Lake Water Level Gauge, plotted against the Open Ocean Water Level Records from Twofold Bay

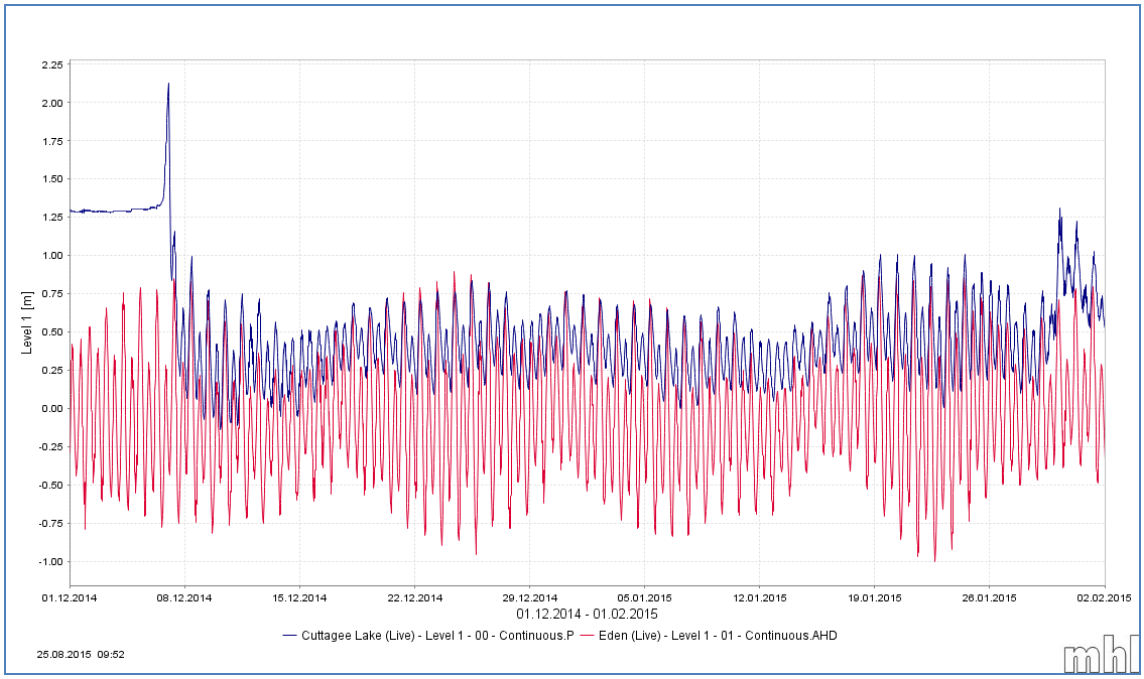

Figure 16: Snapshot of Cuttagee Lake Water Level Record Plotted Against the Open Ocean Water Level Record from Twofold Bay

Entrance breakout location based on aerial photograph interpretation has shown that Lake entrance opening has always occurred adjacent to the Cuttagee Point rocky foreshore at the northern end of Cuttagee Beach (Figure 17). For this reason the proposed artificial works are proposed to be conducted within 50 metres of the northern rocky foreshore of Cuttagee Beach in the natural breakout location.

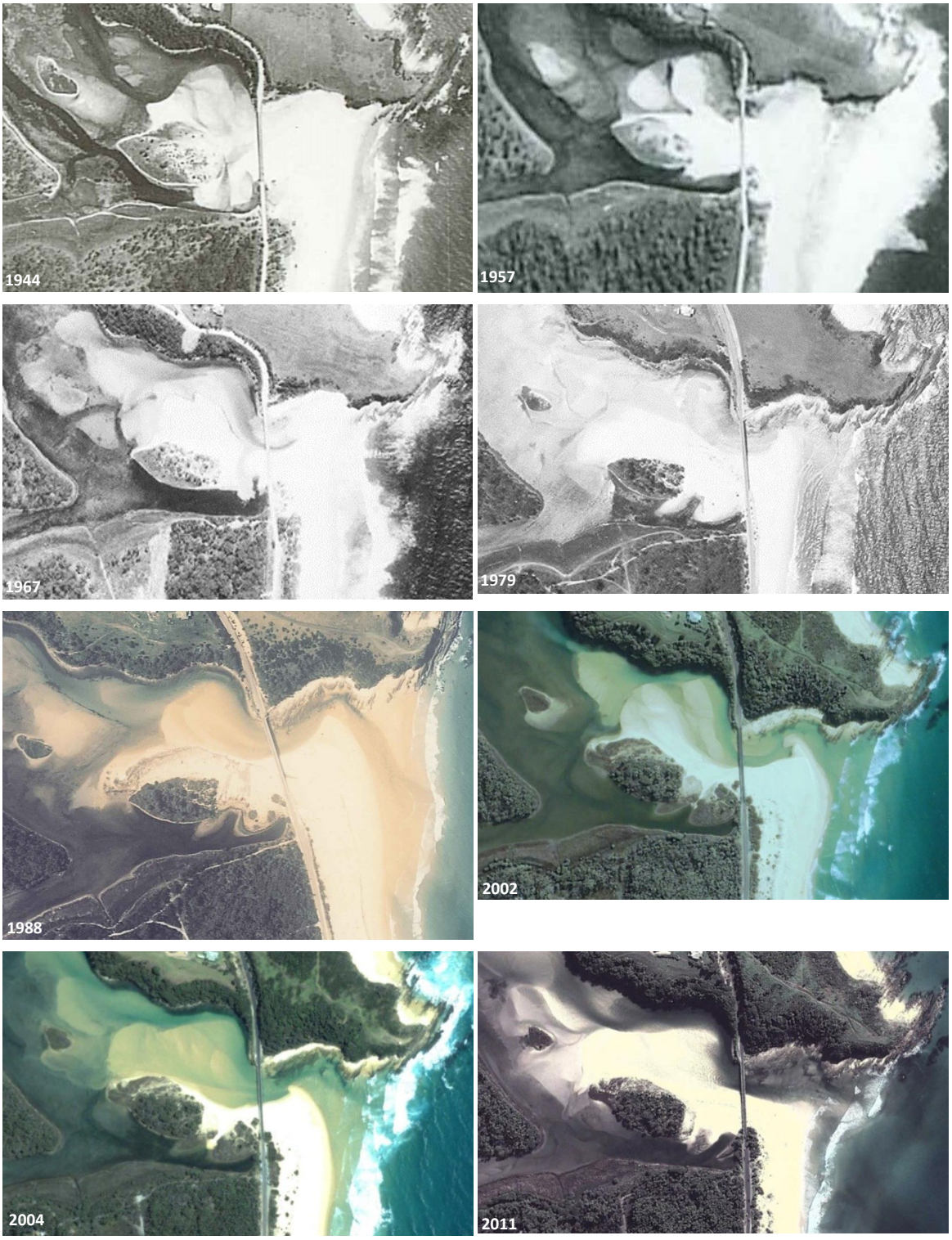

Figure 17: Aerial photographs of Cuttagee Lake entrance 1944 to 2015

3.5.3.2 Water Quality

Water quality in Cuttagee Lake was most recently assessed over a three year period (2010 to 2013) and reported in Elgin (2014). The effects of intermittent entrance opening and closing and of significant rainfall events was also analysed in this investigation. Water quality was assessed in terms of eutrophication indicators including microalgal abundance (as chlorophyll a), clarity (turbidity) and nutrients. Elgin (2016) summarised the water quality conditions of Cuttagee Lake as:

- Typically high levels of dissolved oxygen (DO);
- High to moderate water clarity (i.e. low turbidity);
- Generally low levels of nutrients with mean levels of Total Nitrogen (TN) and Total Phosphorous (TP) below recommended guideline limits for the protection of estuarine aquatic ecosystems; and
- Typically low abundance of algae, with occasional algal blooms not a series threat to ecosystem health.

It is reported that generally these water quality conditions are evident irrespective of the entrance state, though surface water salinity does tend to decline during periods with a closed entrance. Large rainfall events and subsequent freshwater inflows can result in salinity density gradients throughout the lake, during both entrance open and closed conditions. Depth profiling indicated that tidal flushing and wind driven advection were adequate to result in generally well mixed conditions throughout the water column, and as a result the salinity density gradients do not prevail (Elgin, 2016). Overall the water quality of Cuttagee Lake is reported to be very good based on data collected between 2010 and 2013 (Elgin, 2014).

3.5.4 Ecology

Cuttagee Lake and its surrounds provides habitat for a number of significant flora and fauna species and has been listed on the Commonwealth Directory of Important Wetlands in Australia as a result. For the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, the lake and its immediate surrounds where defined within the geographical domain:

GDA94

North: -36.29 South: -36.4

East: 150.1 West: 150

Within this domain The Atlas of NSW Wildlife identified 150 fauna and 9 flora species protected under the Threatened Species Conservation Act 1995, 6 species listed under the Environment Protection and Biodiversity Conservation Act 1999, and 9 species listed under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

3.5.4.1 Flora

Aquatic Vegetation

A range of aquatic macrophytes occur throughout the Cuttagee Lake estuary with seagrasses including Zostera muelleri, Halophila ovalis and Ruppia megacarpa covering approximately 30% of the estuary. The estimated special distribution of seagrasses mapped from aerial imagery and ground truthing surveys (DPI, 2006) is shown Figure 18 (Elgin, 2016). These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are import marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997.

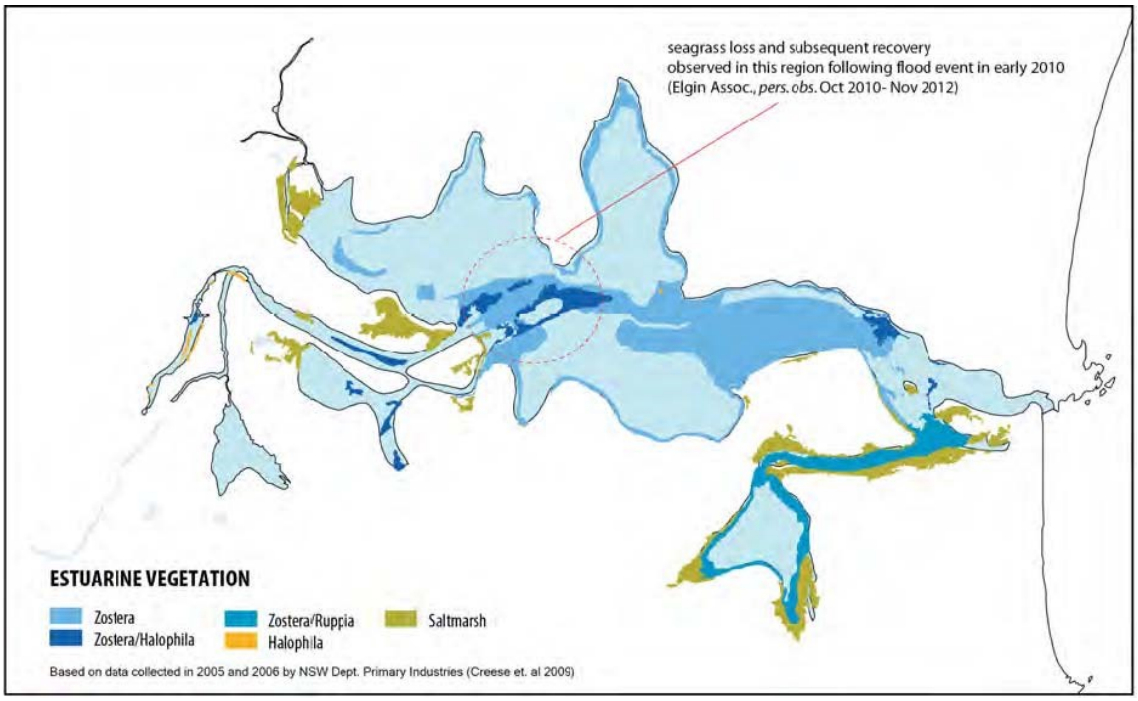

Figure 18: Map of Cuttagee Lake Estuarine Vegetation (Creese et. al, 2009)

The DPI (2006) mapping suggested estimated seagrass losses of 10-40% in Cuttagee Lake over the period 1985 to 2006. This appears to be an ongoing trend for the estuary, with observations from 2010-2012 indicating further seagrass losses (Elgin, 2014), with seagrass

appearing to be sparse to absent in basin areas, and absent in the central section of the lake where it had previously been mapped in DPI (2006). Several large flood events since 2010 are reported to have resulted in sediment covering much of the seagrass on the Cuttagee Creek delta (Elgin, 2016).

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under either NSW (Threatened Species Conservation Act 1995) and/or Australian (Environment Protection and Biodiversity Conservation Act 1999) government legislation are known to occur within the Cuttagee Lake estuarine catchment. These EECs cover a total area of approximately 0.52 km^2 and include Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Littoral Rainforest, Swamp Sclerophyll Forest on Coastal Floodplains and River Flat Eucalypt Forest on Coastal Floodplains (Figure 19).

Coastal Saltmarsh occupies a total area ≈109,400 m^2 and is present at the inland edges of both Cuttagee and Little Cuttagee Lake including the area where Cuttagee Creek and other tributaries enter the Lake. Elgin (2016) reports that the areas of Saltmarsh around Cuttagee Lake are generally in good condition and include a large population of the threatened species Wilsonia backhousiae. In general this endangered ecological community typically comprises a complex of succulent herbfields and sedgelands predominately characterised by Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha, Austrostipa stipoides along with Scirpus nodosa and Sporobolus virginicus (Tozer et al 2004). This community of species is very important to estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients. In general Saltmarsh has declined around the state, however, very little reliable information is available regarding long term trends in Saltmarsh areas around Cuttagee Lake. Due to this state wide declining trend Coastal Saltmarsh has been listed as an endangered ecological community under the Threatened Species Conservation Act 1995.

The Freshwater Wetlands on Coastal Floodplains endangered ecological community occupies an area of only approximately 3,100 m^2 on alluvial flats at the head of the lake. These areas are mostly subject to stock grazing (Elgin, 2016). Typically species such as Melaleuca ericifolla, Baumea articulata, Periscaia Praetermissa, Phragmites australis, Triglochin procerum, Typha orientallis and Cladium procerum typically characterise this endangered ecological community which provides important habitat, food and water source for freshwater fish, amphibian, native mammal and bird species (Tozer et al 2004).

While there is an extensive area of Bangalay Sand Forest located landward of the dunes between Cuttagee Point and Baragoot Lake to the North of Cuttagee, the extent of this EEC fringing Cuttagee Lake is much smaller, occupying an area of ≈109,300 m^2. As shown in Figure 19, this area of Bangalay Sand Forest is located in the area between Little Cuttagee and Cuttagee Lakes. Elgin (2016) reports that this small section of forest is in excellent condition and is dominated by Eucalyptus botryoides. Bangalay Sand Forest typically has a dense to open tree canopy and generally occurs on dunes exposed to salt-bearing sea breezes. The most common vegetation species within this endangered ecological community are Eucalyptus botryoides, Banksia integrifolia subsp. Integrifolia, Eucalyptus pilularis, Acmena smithii, Dianella spp., Lepidosperma concavum, Lomandra longifolia, Pteridium esculentum (Bracken), and the grasses Imperata cylindrical, Microlaena stipoides var. stipoides, Themeda australis

(Tozer et al 2004). This vegetation complex once would have occupied many coastal localities however clearing, habitat degradation and weeds have caused substantial losses across the NSW state. As a result this remanent vegetation community has been placed as endangered and likely to become extinct unless the circumstances and factors threatening its survival cease to operate (NSW Scientific Committee 2012).

Littoral Rainforest is an endangered ecological community in NSW and a critically endangered commonwealth community that occupies a total area of only ≈5,600 m^2 at two small locations on the Lake. The first patch is located on the south side of Cuttagee Point, while the second patch is located on the northern foreshore of the Lake, just west of the bridge. Both areas are dominated by Szygium smithii, and have become overgrown by blackberries though this is now being controlled (Elgin, 2016). Littoral rainforest is typically characterised by Angophora costata, Banksia integrifolia, Eucalyptus botryoides and Eucalyptus tereticornis, Leptospermum laevigatum, Acmena smithii, Breynia oblongifolia, Notelaea longifolia, Stephania japonica var. discolour, Lomandra longifolia, Oplismenus imbecillis and is home to many vulnerable micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and in-vertebrate (Tozer et al 2004).

The River-Flat Eucalypt Forest on Coastal Floodplains is an endangered ecological community that occupies an area ≈170,600 m^2, predominantly on the edges of Cuttagee Creek above the tidal and inundation limits of the Lake. The classification of this area is, however, reported in Elgin (2016) as questionable due to the lack of key species that would ordinarily be expected to be present. This community was typically comprised of Eucalyptus. Baueriana, Eucalyptus botryoides, Eucalyptus elata, Eucalyptus ovata, Rubus parvifolius, Breynia oblongifolia, Hymenanthera dentate, Glycine clandestine, Stephania japonica, Microlaena stipoides, Lomandra longifolia, Pteridium esculentum, Oplismenus aemulus, Pratia purpurascens, Echinopogon ovatus, Entolasia marginate, and Desmodium varians (Tozer et al 2004). This EEC provides habitat for a broad range of fauna, including many that are dependent on the vegetation for food, nesting or roosting such as the White-bellied Sea-eagle, Kingfishers, Owls, Yellow-bellied Glider etc. The clearing of native vegetation; alteration to the natural flow regimes; invasion of native plant communities by exotic perennial grasses; anthropogenic climate change; high frequency fire; and Removal of dead wood and dead trees are listed as threatening processes leading to the NSW Scientific Committee determining that River-Flat Eucalypt Forest is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2012).

The Swamp Sclerophyll Forest on Coastal Floodplains EEC is mapped as being present in the area adjacent to the channel connecting Little Cuttagee to Cuttagee Lake, as well as the areas where Cuttagee Creek enters the Lake. This EEC occupies an area of approximately 122,500 m^2, is dominated by Melaleuca armillarisand, and is reported in Elgin (2016) as being in good condition. Typical species often found in this EEC include Eucalyptus robusta, Melaleuca quinquenervia and, south from Sydney, Eucalyptus botryoides and Eucalyptus longifolia. Swamp Sclerophyll Forest on Coastal Floodplains EEC provides habitat for a broad range of animals, including many that are dependent on the vegetation for food, nesting or roosting such as Sugar Glider, Osprey, Yellow-bellied Glider etc.

In addition to the identified endangered ecological communities, Elgin (2016) reports that a number of other rare, threatened or regionally significant plant species occur within close vicinity of Cuttagee Lake. These include Wilsonia backhousiae (vulnerable, located at at least 4 sites, some with quite large populations), Haloragis exalata subsp. Exalata (square Raspwort, vulnerable, located at several sites around the lake shore exclusively within the high water

inundation area), Pomaderris Bodalla (vulnerable, located within a rainforest gully at the head of the Lake), Pultenaea pedunculata (endangered, may occur within the catchment of Cuttagee Lake, as it is found in adjacent areas such as beside the road at Cuttagee Beach and Baragoot), Acacia pedina (restricted distribution between Bermagui and Tathra, common around the shores of Cuttagee Lake, just above the lake high water inundation area).

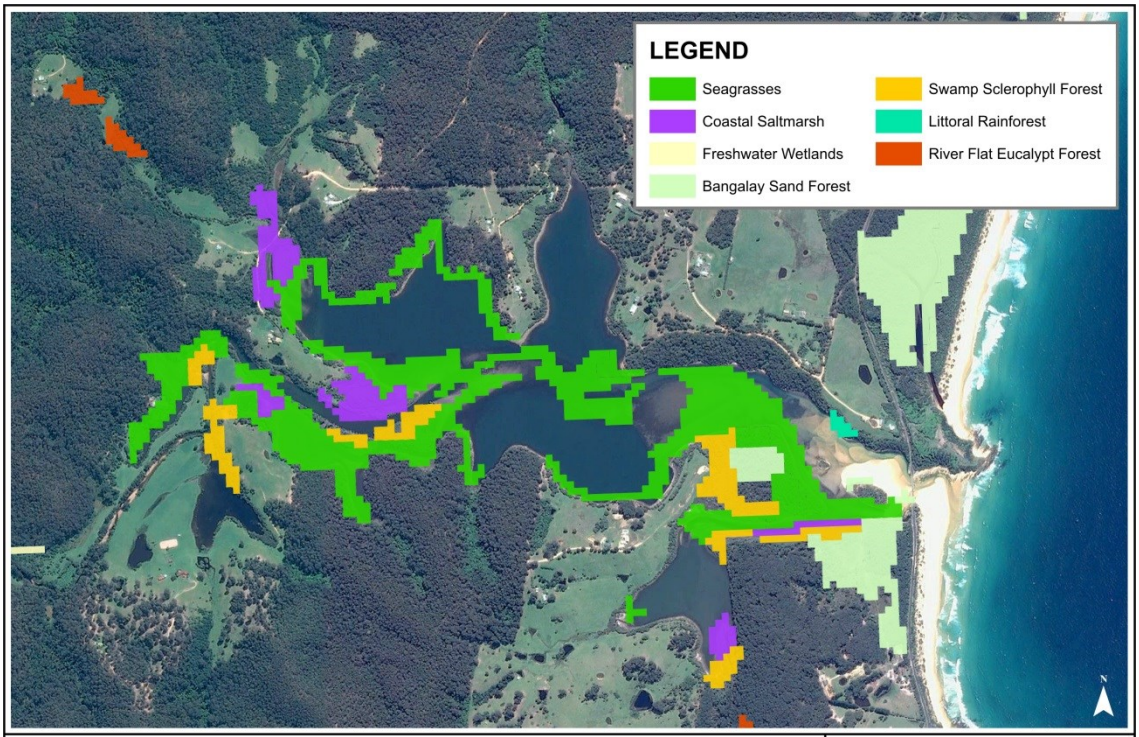

Figure 19: Threatened Flora – Cuttagee Lake

3.5.4.2 Fauna

Mammals

The Atlas of NSW Wildlife has identified 4 species listed as vulnerable under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 2 are listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in Table 9:

Table 9: Threatened Mammals in the Cuttagee Lake Region

Common Name	Scientific Name	NSW Status	Comm. Status
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	
Long-nosed Potoroo	Potorous tridactylus	V	V
Eastern Pygmy-possum	Cercartetus nanus	V	
Koala	Phascolarctos cinereus	V	V

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

Birds

The Atlas of NSW Wildlife has identified 9 bird species listed as vulnerable and 2 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 1 is listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition1 species is protected under the Japan-Australia Migratory Birds Agreements. These species are shown in Table 10. OEH (2015) present maps of sites that are significant to shorebird nesting throughout the Bega Valley Shire, and identify the Cuttagee Lake entrance as one of these sites. Figure 21 shows the identified locations and species from OEH (2015).

Table 10: Threatened Avifauna in the Cuttagee Lake Region

Common Name	Scientific Name	NSW Status	Comm. Status	Migratory Bird Agreements
Sooty Oystercatcher	Haematopus fuliginosus	V		
Pied Oystercatcher	Haematopus longirostris	E		
Gang-gang Cockatoo	Callocephalon fimbriatum	V		
Providence Petrel	Pterodroma solandri	V		J
Swift Parrot	Lathamus discolour	E	E	
Powerful Owl	Ninox strenua	V		
Barking Owl	Ninox connivens	V		
White-fronted Chat	Epthianura albifrons	V		
Varied Sittella	Daphoenositta chrysoptera	V		
Scarlet Robin	Petroica boodang	V		
Square Tailed Kite	Lophoictinia isura	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife has identified 1 amphibian species listed as endangered under the NSW Threatened Species Conservation Act 1995 and also listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. This species is shown in Table 11:

Table 11: Threatened Amphibians and Reptiles in the Cuttagee Lake Region			
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**
Green and Golden Bell Frog	Litoria aurea	E1	V

V= Vulnerable; facing a high risk of extinction in the medium-term future

Aquatic Fauna

More details regarding aquatic fauna are to be added to the REF once available.

Figure 20: Threatened Fauna – Cuttagee Lake

Figure 21: Significant Shorebird Sites at Cuttagee Lake Entrance (OEH, 2015)

3.5.5 Cultural Heritage

3.5.5.1 Aboriginal Cultural Heritage

The area around Cuttagee Lake is recognised is being significant to local Aboriginal people, and while Elgin (2016) reported two documented Aboriginal sites in the Aboriginal Heritage Information Management System that lie in the lake catchment, the ACHAR undertaken for this study (Dibden, 2016) reported no sites within the immediate area of the access track or lake entrance. The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance.

The ACHAR included searches of the NSW OEH AHIMS, the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access track and entrance opening area. Dibden (2016) reported that the impact areas from entrance opening are disturbed and generally of very low to negligible archaeological potential.

3.5.6 Recreational and Commercial Uses

3.5.6.1 Recreation

Cuttagee Lake supports a range of recreational uses including swimming, boating, kayaking, prawning and fishing. The entrance area is not used for any specific purpose apart from swimming / surfing, walking and nature observation.

When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels also provide for improved recreational opportunities such as fishing. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times. While it is known that recreational fishing and prawning take place, there is no data available regarding the extent of recreational fishing or the magnitude and nature of the catch.

3.5.6.2 Commercial

Commercial fishing: While Cuttagee Lake is open to commercial fishing, areas west of the Main Road 272 bridge are closed to fishing undertaken with any type of hauling net.

Agriculture: Freehold grazing land exists around small sections of the lake's catchment and foreshore, however, it is reported that these are not significant commercial operations (Elgin, 2016.

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

3.6 Description of the Activity Impacts

3.6.1 Acid Sulfate Soil Impacts

It is highly unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Cuttagee Lake has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

3.6.2 Bank Erosion and Sedimentation Impacts

The proposed trigger water level at which the entrance would be mechanically opened (1.8 m AHD) is within, but at the lower end of the range of natural entrance breakout water levels. As such, mechanically opining the lake at this level is expected to have minimal impacts on bank erosion. The chance of impacts are further reduced by healthy and stable existing shorelines, and the fact that Council only intend on mechanically opening the entrance for up to five years until relevant adaptation works can be undertaken to raise low lying sections of road/bridge.

If the entrance was regularly opened at the proposed trigger level on an ongoing basis, over the long term, there is a minor risk that the progradation of the marine sediments into the lake resulting from artificial entrance openings at the lower range of natural opening water levels, may cause moderate adverse sedimentation impacts to the lake. This could occur primarily due to less effective scour of the marine flood tide delta. However, with the proposed trigger water level at 1.8 m AHD and with mechanical entrance openings proposed for a finite and relatively short timeframe into the future, any impacts on sedimentation are thought to be negligible.

3.6.3 Hydrology Impacts

Entrance opening is an important determinant of the hydraulic character of an ICOLL. The ability of the lake water to erode a deep and wide entrance channel is directly related to the head difference that exists between the lake and the ocean at the time of breakout. A large head difference will result in a larger and deeper channel. As the proposed entrance opening trigger water level is within (albeit at the lower end) the range of natural entrance breakout levels, and is certainly higher than the trigger level adopted for other ICOLLs, implementation

of the Policy is expected to have only low adverse impacts on the Lake. This is reinforced by the finite duration that Council expect to implement mechanical opening of the entrance for.

Both positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid increases in dissolved oxygen concentrations resulting from rapid decay of organic material. However, it should be noted that good lake water quality was recorded during periods with both an open and closed entrance (Elgin, 2014), and the trigger water level for mechanical entrance opening is within the natural breakout range.

3.6.4 Aquatic Vegetation Impacts

Mechanical opening of the Cuttagee Lake entrance is unlikely to impact seagrasses through scouring effects, as there are no seagrass communities mapped in the vicinity of the lake entrance where high flow velocities will occur.

The intermittent opening/closing regime of Cuttagee Lake make the estuary suitable for Halophila and Zostera seagrasses, but not Posidonia australis which requires marine conditions more associated with permanently open entrances. In contrast, the variable salinity levels of the lake provide suitable conditions for Ruppia megacarpa (Elgin, 2016). While it is recognised that changes to the entrance opening regime could have adverse impacts such as changes to seagrass species composition, in the case of the proposed Cuttagee Lake Entrance Management Policy, changes are likely to be negligible. The relatively high entrance opening trigger level proposed is within the natural opening regime, and is therefore not expected to significantly increase the percentage of time that the lake spends with an open entrance. Impacts to seagrasses from naturally occurring events (such as burial from sedimentation during large floods) are expected to be much more significant than any minor impacts from implementing the proposed Entrance Management Policy.

3.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The works have the potential to indirectly have moderate adverse impacts on several transitional and fringing endangered ecological communities (EECs). These impacts occur as the natural flow regimes and upper range water levels of Cuttagee Lake have and will be altered by the entrance opening works. Endangered ecological communities such as Coastal Saltmarsh, Littoral Rainforest, Swamp Sclerophyll Forest on Coastal Floodplains and River-Flat Eucalypt Forest have the potential to be indirectly impacted due to reduced inundation (in terms of inundation depth, extent and duration).

There are a number of vegetation species that require a constant tidal regime, and are present in nearby permanently open estuaries such as Bermagui River and Murrah River estuaries, but absent from Cuttagee Lake. These include mangroves (Avicennia marina and Aegiceras corniculatum) and the saltmarsh species Limonium austral (sea lavender), Austrostipa stipoides and Gahnia filum. However, the rare and threatened saltmarsh species Wilsonia backhousiae that is found in Bermagui River estuary is also present in Cuttagee Lake and evidently is able to withstand months of inundation (Elgin, 2016). Should the lake entrance be mechanically opened on a regular basis, then the works would inevitably result in species composition and location shifts. However, as the proposed entrance opening trigger water level is within the natural opening range, and the artificial entrance management is not

expected to significantly change the natural balance of time that the lake spends with an open/closed entrance, any impacts to saltmarsh and other fringing EECs are expected to be minimal. This is further supported by the short term nature of Council's proposed intervention in entrance opening, with the lake expected to resume natural entrance behaviour within the next five years.

Elgin (2016) reports a number of other naturally occurring species composition and location changes that evolve when the lake maintains a high water level for a sustained period of time. These changes include subsequent dieback of species in the transiently inundated areas (including species typically tolerant of inundation such as Melaleuca spp), followed by relatively rapid recovery of certain species, including the threatened Haloragis exalata subs exalata.

A Section 5A assessment for the endangered ecological communities, the three NSW listed vulnerable plant species (Haloragis exalata, Pomaderris Bodalla, and Wilsonia backhousiae) and the one NSW listed endangered plant species (Pultenaea pedunculata) is located in Section 3.8.

3.6.6 Direct Impacts to Access Track Vegetation

The track which will be used to provide access and egress for the excavator is shown in Figure 13. This existing and predominantly cleared track has been selected for the access route, as it will minimise impacts to surrounding vegetation. In driving the excavator along this track, it is expected that minor disturbance of grass will occur. There may also be small sections of the track where hand pruning of low hanging shrub branches (Coastal Wattle and Banksia) will be required, however, in most cases it is expected that this will be avoided. There will be no need to remove trees to provide access. Once on the dune area of the beach, there may be minor and very localised damage to Spinifex that are growing on the edges of the track. Photographs of the access track are shown in Figure 22, where it can be seen that there will be minimal impacts to vegetation from machine access.

Figure 22: Photos of Cuttagee Lake Access Track and Vegetation

3.6.7 Fauna Impacts

Mammals

It is very unlikely the entrance works will have any direct impact on threatened mammal species or endangered populations, and also unlikely that the works would indirectly impact species due to habitat changes (as discussed in Section 3.6.5).

Birds

Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works including machine access and channel excavation could potentially have a significant negative impact on a number of resident threatened shorebird species. Shorebirds inclusive of the Red Capped Plover (not threatened) and Pied Oystercatcher could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- A machine access route that minimises areas of dune impacted by the machine;
- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators, restrict pedestrian access and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform

additional adaptive management responses on an "opening-by-opening" basis, as opposed to a "one-off" survey for this REF. A Section 5A assessment has been carried out for the potentially impacted shorebird species (Pied Oystercatcher), and is included in Section 3.8. As the impacts to this species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement. Entrance opening works are unlikely to negatively impact other threatened bird species, rather the reduction in water levels may expose feeding grounds and food sources (decomposing vegetation and invertebrates) for many of the bird species.

Amphibians and Reptiles

While the Green and Golden Bell Frog (endangered) was identified in the atlas search of nearby areas, they are unlikely to occur in habitats directly connected to the lake due to excessive salinities and preference for different habitat types. More likely they would be present in the upper reaches of the tributaries. As a result impacts on these species are negligible given that they would most likely occur some distance from the lake entrance.

Aquatic Fauna

The entrance works will have both positive and negative impacts on aquatic animal species. These positive and negative impacts could include assemblage changes, habitat shifts, and fish kills. As the entrance works rapidly change the surrounding environment, some species may benefit and others may perish due to stress from low dissolved oxygen and sudden salinity increases, however, it should be noted that such changes would also be expected to occur as a result of natural entrance openings. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and the opening works are within the lower range of the natural regime.

3.6.8 Aboriginal Cultural Heritage Impacts

Any unknown Aboriginal sites that may exist around the immediate foreshore of the lake will have been subject to cycles of flooding and drying over many years and thus may be fairly resilient to changes in lake level. It is possible however, that further flooding and drying combined with wave action may expose sensitive sites or lead to erosion of culturally important areas. While unlikely, entrance works may have both positive and negative impacts on currently un-reported Aboriginal cultural heritage sites. Positive impacts could include opening the entrance prior to naturally high lake water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts could include increased frequency of wetting and drying from rises and falls in Lake water level as a result of slightly more frequent entrance openings.

While no impacts to Aboriginal places or items in the areas of excavator access or entrance opening were identified in the ACHAR (Dibden, 2016), as a precautionary measure BVSC has sought an AHIP associated with the entrance management works. It is also recommended that monitoring take place during the access and entrance opening process, and that whenever possible access be restricted to the corridor within the intertidal and wave runup zone of the beach.

3.6.9 Other Cultural Heritage Impacts

Other cultural heritage impacts are unlikely to occur.

3.6.10 Recreational Impacts

The entrance management works may result in both positive and negative recreational impacts. When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels provide for improved recreational opportunities such as kayaking and boating. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times. Impacts on recreational fishing may also occur, however, these are expected to be the same as would be experienced with natural entrance openings.

3.6.11 Commercial Impacts

The proposed Cuttagee Lake Entrance Management Policy has been developed to reduce impacts of inundation on Council owned roads and a bridge that provide access to private properties. No commercial assets will be impacted by the implementation of the Policy, however, the Policy will have both positive and negative impacts on a range of aquatic fauna that are subject to commercial fishing. These impacts are expected to be relatively minor, and occur only slightly more frequently than would otherwise occur with natural entrance opening/closing behaviour.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

3.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The community most likely to be affected will be the residents living adjacent to Cuttagee Lake who will benefit from reduced periods of inundation of access roads to their properties. There will be no significant adverse impact upon the general wider community. Malodorous conditions can sometimes occur for a few days after an entrance opening due to the rotting vegetation around the lake shoreline, however, this is very transient in nature.
b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The locality will not be transformed in any significant manner. The lake entrance will change temporarily, but these changes will be within natural bounds.
c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There are a range of potential environmental impacts on the ecosystems of Cuttagee Lake as discussed in Section 3.6. The majority of these impacts will only occur to a negligible or minor extent, as the relatively high entrance opening trigger level that has been adopted in the Policy will not result in significant hydrological changes to the lake.
d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There is not likely to be any reduction in the aesthetic quality or value of the locality as a result of implementing the Policy. The impact upon fish and prawn populations may have a bearing upon the recreational value. If an artificial breakout allows a large population of prawns and fish to escape to sea there would be a significant loss of recreational opportunity, especially if this occurred just prior to the Christmas/New Year holiday period. However, an artificial opening could enhance recreational prawning and fishing opportunities the following year if the opening coincided with a high abundance of prawn larvae and fish spawning in nearshore coastal waters. Such conditions are impossible to predict. On balance and over the long term, the impacts are likely to be slightly negative. Impacts to other recreational activities such as boating and walking are deemed negligible as fluctuating water levels will favour differing recreational activities at different times. Intervention in the natural breakout process diminishes the scientific value of the system since an element of 'naturalness' has been lost. However the vast majority of ecological

	processes will continue to operate unimpacted and the locality could still be suitably used for a wide range of scientific purposes.
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no significant impacts. BVSC have sought an AHIP associated with the works as a precautionary measure.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? [1] ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: There are a range of potential environmental impacts on the ecosystems of Cuttagee Lake as discussed in Section 3.6. The majority of these impacts will only occur to a negligible or minor extent, as the relatively high entrance opening trigger level that has been adopted in the Policy will not result in significant hydrological changes to the lake. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 3.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 3.8.
g.	Will there be any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The endangered ecological communities listed in Section 3.6 (i.e. Coastal Saltmarsh, Swamp Sclerophyll Forest on Coastal Floodplains and River-Flat Eucalypt Forest) have the potential to be indirectly impacted due to reduced inundation (in terms of inundation depth, extent and duration). However, as the proposed entrance opening trigger water level is within the natural opening range, and the artificial entrance management is not expected to significantly change the natural balance of time that the lake spends with an open/closed entrance, any impacts to saltmarsh and other fringing EECs are expected to be minimal. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 3.6.7 and the Policy, these impacts will be

	reduced to low adverse. However, due to the potential impacts on these communities and bird species, a Section 5A assessment has been prepared and is contained in Section 3.8. Considerations of the activity impacts on the three NSW listed vulnerable plant species (Haloragis exalata, Pomaderris Bodalla, and Wilsonia backhousiae) and the one NSW listed endangered plant species (Pultenaea pedunculata) although negligible, have also been included in Section 3.8.
h.	Will there be any long-term effects on the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There are a range of potential environmental impacts on the ecosystems and environment of Cuttagee Lake as discussed in Section 3.6. The majority of these impacts will only occur to a negligible or minor extent, as the relatively high entrance opening trigger level that has been adopted in the Policy will not result in significant hydrological changes to the lake. Furthermore, Council propose a range of adaptation/management options to raise low lying sections of road which will eliminate the need for intervention in entrance opening in the long term.
i.	Will there be any degradation of the quality of the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: While it is recognised that implementation of the Policy will only result in negligible or low adverse long term impacts on the physical environment of Cuttagee Lake and surrounds, the quality of the lake environment will be degraded by virtue of the fact that a major natural process is being interfered with. In effect the lake is losing a major element of 'naturalness'. Naturalness is a significant environmental attribute that is often a criteria used to determine environmental or conservation value.
j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of undertaking the entrance opening works. The robustness or ability of the environment to withstand environmental fluctuations should not be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not result in any pollution of the environment.

m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Although it is difficult to predict what other future activities might take place it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or on the foreshore.
p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. The Policy has been developed with a plan to adapt low lying assets to alleviate the need to intervene in natural entrance behaviour in the longer term, including the impacts of sea level rise.

3.8 7-Part Test for Threatened Species, Populations and Ecological Communities

3.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Pied Oystercatcher (Haematopus longirostrus)

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations will be adversely impacted to any significant degree, and certainly not such that viable local populations are placed at risk of extinction, provided the Policy and associated mitigation measures are followed.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is unlikely that there will be any isolation of habitats.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Cuttagee Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Cuttagee Lake to the sea, this constitutes a moderate alteration to the natural flow regimes, however, it should be recognised that in the case of the proposed Cuttagee Lake Entrance Management Policy, alterations will be extremely similar to that which would occur with a natural entrance opening.

3.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Flora – Square Raspwort (Haloragis exalata), Bodalla Pomaderris (Pomaderris bodalla), Narrow-leafed Wilsonia (Wilsonia backhousiae) and Matted Bush Pea (Pultenaea pedunculata).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

It is unlikely the activity will impact upon the lifecycle of these species. Haloragis exalata tends to grow in damp areas at several locations around the shore of Cuttagee Lake, exclusively within the high water inundation zone. Wilsonia backhousiae exists occurs at at least 4 locations around the lake, with large populations at some sites. Pomaderris bodalla has a restricted distribution around Cuttagee Lake, and is found in a rainforested gully at the head of the lake. Although these species tend to grow close to watercourses it is unlikely these species will be significantly impacted, as the changes to the hydrology and hydrodynamics of the lake will be minimal. While Pultenaea pedunculata is known to occur on the roadside at Cuttagee Beach and Baragoot, it is unknown if it occurs in the catchment proper for the lake (Elgin, 2016).

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

While Pultenaea pedunculata (endangered in NSW) is known to occur on the roadside at Cuttagee Beach and Baragoot, it is unknown if it occurs in the catchment proper for the lake. Nevertheless, it is very unlikely that implementation of the Policy will result in any adverse effects on the lifecycle of this species, and certainly not to any degree that could result in the species being placed at risk of extinction.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for these species is to be removed. Due to the proposed entrance opening trigger level being relatively high and within the natural entrance opening range, any modifications to habitat for these species will be relatively minor and unlikely to significantly impact these species.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Habitat modification through this activity is unlikely to affect the long-term survival of these species.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Cuttagee Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is not inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Cuttagee Lake to the sea, this constitutes a moderate alteration to the natural flow regimes, however, it should be recognised that in the case of the proposed Cuttagee Lake Entrance Management Policy, alterations will be extremely similar to that which would occur with a natural entrance opening.

3.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Swamp Sclerophyll Forest, Littoral Rainforest and River Flat and Eucalypt Forest

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not populations.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

Should the lake entrance be mechanically opened on a regular basis, then the works would inevitably result in species composition and location shifts within some of these EECs. However, as the proposed entrance opening trigger water level is relatively high and within the natural opening range, and the artificial entrance management is not expected to significantly change the natural balance of time that the lake spends with an open/closed entrance, any impacts to saltmarsh and other fringing EECs are expected to be minimal. This is further supported by the short term nature of Council's proposed intervention in entrance opening, with the lake expected to resume natural entrance behaviour within the next five years.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible though unlikely that habitat will be modified to a minor degree through implementing this Policy, as discussed in Section 3.6

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is possible that some EECs will become isolated from the water body, limiting inundation as a result of reduced water levels following artificial entrance opening. This would, however, also occur to the same degree following a natural entrance opening.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Habitat modification through this activity is unlikely to compromise the long-term survival EECs at Cuttagee Lake as discussed in Section 3.6.

(2.e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Cuttagee Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Cuttagee Lake to the sea, this constitutes a moderate alteration to the natural flow regimes, however, it should be recognised that in the case of the proposed Cuttagee Lake Entrance Management Policy, alterations will be extremely similar to that which would occur with a natural entrance opening. While artificial entrance opening would likely be contrary to a threat abatement plan for these EECs, the proposed Policy is unlikely to compromise any such plan.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Cuttagee Lake to the sea, this constitutes a moderate alteration to the natural flow regimes, however, it should be recognised that in the case of the proposed Cuttagee Lake Entrance Management Policy, alterations will be extremely similar to that which would occur with a natural entrance opening.

3.9 Conclusion

The proposed entrance management works are required for the sole purpose of reducing the impacts of flooding to Council owned roads and a bridge which provide access to privately owned properties. When the Lake entrance is closed and water levels exceed 1.8 m AHD, inundation of localised sections of these roads limit safe access and cause disruption to these land owners. However, in implementing the proposed Entrance Management Policy, there are two notable potential impacts. These are

1. Potential direct impacts to threatened shorebird species;
2. Potential cumulative environmental impacts of altering the natural hydrologic regime, indirectly impacting endangered ecological communities.

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes specific selection of an excavator access route that minimises impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

With regards to changes to the hydrologic processes of the Lake and resulting cumulative indirect impacts on EECs, the proposed entrance opening trigger water level is within the natural opening range, and the artificial entrance management is not expected to significantly change the natural balance of time that the lake spends with an open/closed entrance. As such, any indirect impacts to Saltmarsh and other fringing EECs are expected to be minimal. This is further supported by the short term nature of Council's proposed intervention in entrance opening, with the lake expected to be allowed to resume natural entrance behaviour within the next five years. The accompanying Cuttagee Lake Entrance Management Policy has outlined progressive steps that will allow this to occur.

Therefore, the activities should be approved in the short term, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- Bega Valley Shire Council plan and implement modifications to the sections of road and bridge that are affected by inundation when water levels are high;
- A Flood Risk Management Study and Plan should be undertaken when resources become available to investigate future flood management options, with consideration of natural berm heights, sea level rise projections and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) and consistent with the NSW Floodplain Development Manual (DIPNR 2005). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions.

4 REF for the Artificial Entrance Opening of Bega River

4.1 Location

Bega River is situated on the far South Coast of New South Wales, east of Bega and north of Tathra. It has a surface area of 3.8 km^2 and a catchment of 1934.8 km^2. The main tributaries are Brogo River and Double Creek in the north, the Bemboka River, Tantawangalo Creek, Sandy Creek, Candelo Creek and Wolumla Creek in the south. The Estuary is a mature barrier estuary based upon its advanced stage of infilling with sediment (CMG 2000, Roy et al 2001). Tathra Beach is a prograded beach ridge barrier that forms the seaward boundary of the Estuary. National Park estate comprises 21% and State Forest 7% of the catchment (see Figure 23).

Figure 23: Bega River Estuary

4.2 Description of Proposed Activity

A channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals within 50 metres of the northern rocky foreshore of Mogareeka Inlet in the location shown in Figure 24 using mechanical equipment, most likely an excavator. The access route which the machine will use is also shown in Figure 24. This route has been selected to minimise disturbance to vegetation and nesting shorebirds during machine access and egress, as it follows an existing cleared track through vegetation and then tracks along Tathra Beach as close as possible to the high tide wave runup area. However, it is expected that minor damage to the track and grassed areas is inevitable. Particular care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes and shell middens and as a precautionary measure an Aboriginal Heritage Impact Permit (AHIP) from OEH has been sought for access over Aboriginal sites and objects (though there are no known sites on this path).

Figure 24: Location of Entrance Opening Works

As outlined in the Bega River Entrance Management Policy (Appendix C) the excavation will only be undertaken if the water level exceeds 1.36 m AHD as recorded by the Manly Hydraulics Laboratory Bega River gauge on Hancocks Bridge.

The excavated sand (estimated volume of around 200 m^3) will be pushed to the southern side of the excavated channel and will not be removed from site. The channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 2-6 hours duration. It would be rare for it to extend beyond 10 hours.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes and rivers has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. The size and location of the channel will be constrained by the northern rocky headland. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

While there is no intention to establish a permanent opening, a reasonably long lasting opening is preferred to maximise the possibility of full water exchange and obviate the need for repeated intervention after a short period of time (that is, a few weeks or months). To assist with the establishment of a large and deep channel, which will be slow to infill, completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle, just after the peak of the high tide. This should ensure that an adequate head

difference between the water in the river and the ocean is maintained for as long as possible. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

4.3 Purpose of the Activity

The purpose of the works is to re-establish a temporary tidal connection between the River and the ocean to allow accumulated water to flush to the ocean and thereby lower water levels below that which causes flooding problems to the Mogareeka coastal road and other low lying lake assets.

The intention is not to establish a permanent opening. It is recognised that the entrance channel could well close again within a matter of weeks, although it would generally be hoped that the channel would remain open for a period of months to maximise the period available for tidal flushing and minimise the need for further openings in the short term.

4.4 Consideration of Alternatives

Ultimately there are no viable alternatives to the artificial opening of the lake. The "do-nothing" option is unacceptable because of the potential damage and disruption that could be caused if the River was left closed and water inundated public and private assets, including the Tathra STP. The high water levels may also remain for many months compounding the scale of damage done by floodwaters. Therefore not interfering and allowing nature to take its course so that water levels rise until a natural breakout takes place, could in most situations cause flood damage and associated problems for local residents.

Rather than adopting a fixed level, a variable level could be used. This would have more ecological benefits. However, the current intervention level of 1.36 m AHD represents a ceiling which is difficult to go above in the short-term.

In the longer term it is the intention to increase the intervention level above 1.36 m AHD by selectively flood proofing, raising, removing or relocating those items of infrastructure which are most prone to flooding. Currently, the coastal road between Tathra and Mogareeka becomes inundated around 1.36 m AHD and that along with foreshore pastures, 3 holes on the Tathra Beach Country Club Golf Course, and a car park are the first main assets to be affected by water level rise. The Interim Bega River Entrance Management Policy (Appendix C) proposes works that should be completed in desired timeframes in order to increase the intervention level.

A two dimensional unsteady hydrodynamic model as part of the Bega River Flood Study is currently being prepared. This will investigate flood impacts in consideration of higher berm heights and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW, 2010b) for a full range of annual exceedance probabilities up to the possible maximum flood consistent with the NSW Floodplain Development Manual 2005. From this study a risk management study and plan will be prepared detailing proposed flood mitigation options inclusive of asset raising. It would be preferable if no intervention was required but it is not known whether this will ever be a practical alternative considering the current configuration of development.

4.5 Description of the Existing Environment

4.5.1 General Characteristics

The Bega River entrance, also known as Mogareeka Inlet is situated at the northern end of Tathra Beach, and is constrained to the north by a rocky outcrop. The entrance area itself is characterised by an expanse of unvegetated sand. The substrate in the entrance area is dominated by unconsolidated sand with varying amounts of broken shell and traces of terrigenous muddy sediment.

4.5.2 Sediments

4.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show Mogareeka Inlet having a low risk of potential acid sulfate soils. Additional and more prolonged inundation of these soils as proposed by the policy, compared to historic lower water level break outs would reduce the oxidation potential of the soils, thus reducing their acid-generating potential.

In relation to the berm area where the excavation works are proposed, acid sulfate soils are highly unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

4.5.2.2 Bank Erosion and Sedimentation

Bank erosion and sedimentation in the Bega River has been documented as a minor to moderate concern to the local community (BMT WBM, 2011). Geomorphological investigations (Brooks and Brierley, 1997; Fryirs and Brierly 1998) have found that widespread clearing for agriculture and urban development in the upper, mid and lower catchment creeks have transformed the lower reaches of the Bega River from a suspended mixed load river system (i.e. relatively deep channel with fine grained banks and floodplain) to a predominant bedload system (i.e. broad shallow sandy channel, mid channel bars and islands, sand floodplain) (CMG 1999). This geomorphic change has increased erosion at several locations within close proximity to the estuary entrance. Although erosion is a natural process, remanent and current anthropogenic influences are contributing (BMT WBM, 2011).

Sediment within the entrance of the Bega River is predominantly comprised of marine (beach) sands. This material is deposited under the combined action of tides and waves. The non-cohesive sands are dynamic in nature and tend to be redistributed during times of flood.

Entrance opening works during the late 1990's have been attributed to the accelerated foreshore erosion at Lions Park on the downstream side of Hancocks Bridge. This resulted as entrance works where undertaken in the centre of the entrance bar causing the channel to subsequently migrate to the south causing foreshore erosion (BMT WBM, 2011).

4.5.3 Hydrology

4.5.3.1 Entrance Behaviour / Characteristics

The frequency and duration of entrance opening is an important determinant of the hydraulic character of the lake (that is, the frequency and magnitude of water level fluctuations and quality changes). OEH have undertaken an analysis of the entrance state for Bega River on the basis of available gauged data, which is included below.

OEH Analysis:

Manly Hydraulics Laboratory have maintained a water level gauge on behalf of OEH in the Bega River since 7/11/2000, so approximately 15 years of water level data exists for the estuary. At the time of installation on Hancocks Bridge in 2000 the river entrance was open.

Entrance closure and opening has been identified from observing the stop and start of a tidal signal from the graphed data (see Figure 25). This is generally easy to identify but there is one small period of time (between 13/8/2003 and 16/9/2003) where the actual closure date cannot be specified to an absolute date due to equipment failure. In this instance a midway point has been chosen based on the strength of tidal signal prior to the data gap. There are other small periods of time where data has not been collected, however, it is considered unlikely to have resulted in missing other entrance opening/closures as there are not many of these periods, they are short, and wouldn't match up well with pre and post gap tidal signals.

Between 7/11/2000 and 18/6/2015, 13 separate periods of entrance closed conditions have been identified, with closed conditions ranging from 32 days up to 510 days, but typically in the order of 2-5 months (12). The total duration of closed entrance conditions compared to the full record equates to approximately being closed for 34% of the time. The duration that the entrance stays open for ranges from 32 days to over 767 days, but typically in the order of several months to over a year. The total duration of open entrance conditions for the full record equates to approximately being open for 66% of the time. This illustrates that Bega River is open more than closed. A significant portion of the water level data has been recorded during a period of exceptionally dry conditions (~2000 – 2009) where other ICOLLs on the South Coast experienced longer and more frequent periods of closed conditions. This may bias the degree of entrance closed to entrance open conditions for the Bega River, and hence this information may not be an accurate reflection of average entrance conditions over a longer time span for the Bega River entrance.

The level of entrance opening ranges from 1.19 to 2.09 m AHD, but typically over 1.3 m AHD. It should be noted that this does not provide a good surrogate for natural berm height range as most of the openings are likely to be artificial as result of Council opening to alleviate flooding hazards. An OEH survey of Bega River berm height on 11/6/13 found the berm height to be around 3.5 - 3.6 m AHD, noting that higher berm heights may be possible at this location. Comparison of Bega River water levels to ocean water levels recorded from Twofold Bay in Eden show that the majority of the time the tidal range is restricted to less than 50% of the full open ocean tidal range (Figure 26). However, after a significant rainfall event and opening, tidal range can be significantly greater (> 1m), with full open ocean high tides experienced and attenuation only of the bottom section of the full low tide (Figure 26 and Figure 27).

Table 12: Periods of Entrance Closures, Opening and Opening Levels for Bega River				
Entrance Closure Date	**Entrance Opening Date**	**WL Height at Opening**	**Closure Duration (days)**	**Open Duration (days)**
NA	7/11/2000	NA	NA	NA
16/05/2001	6/07/2001	1.19	51	190
12/12/2001	6/02/2002	1.73	56	159
29/06/2002	24/02/2003	1.61	240	143
27/08/2003*	23/12/2003	1.3	118	184
19/02/2004	22/11/2004	1.31	277	58
23/04/2005	3/07/2005	1.8	71	152
14/09/2005	2/11/2005	1.92	49	73
24/02/2006	19/06/2006	1.43	115	114
16/09/2006	12/02/2007	2.09	149	89
23/04/2008	9/08/2008	1.35	108	436
10/09/2008	6/02/2010	2.04	514	32
23/12/2011	13/02/2012	1.408	52	685
16/05/2013	17/06/2013	1.463	32	458
NA	24/07/2015	NA	NA	767
Total			1832	3540
Total			34%	66%

Notes:

* Entrance closes somewhere after 13/8/2003 and before 16/9/2003 but actual date not captured due to data loss, midway point between dates picked for closure date as still reasonable tidal signal on 13/8/2003

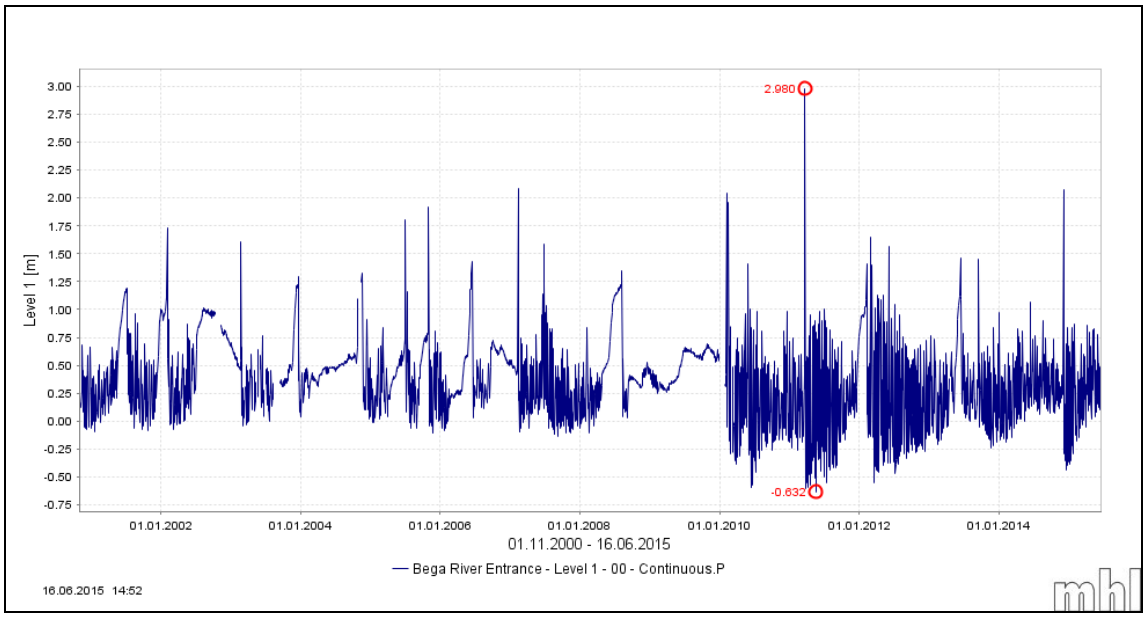

Figure 25: Complete Water Level Data set from Bega River Water Level Gauge Situated at Hancocks Bridge

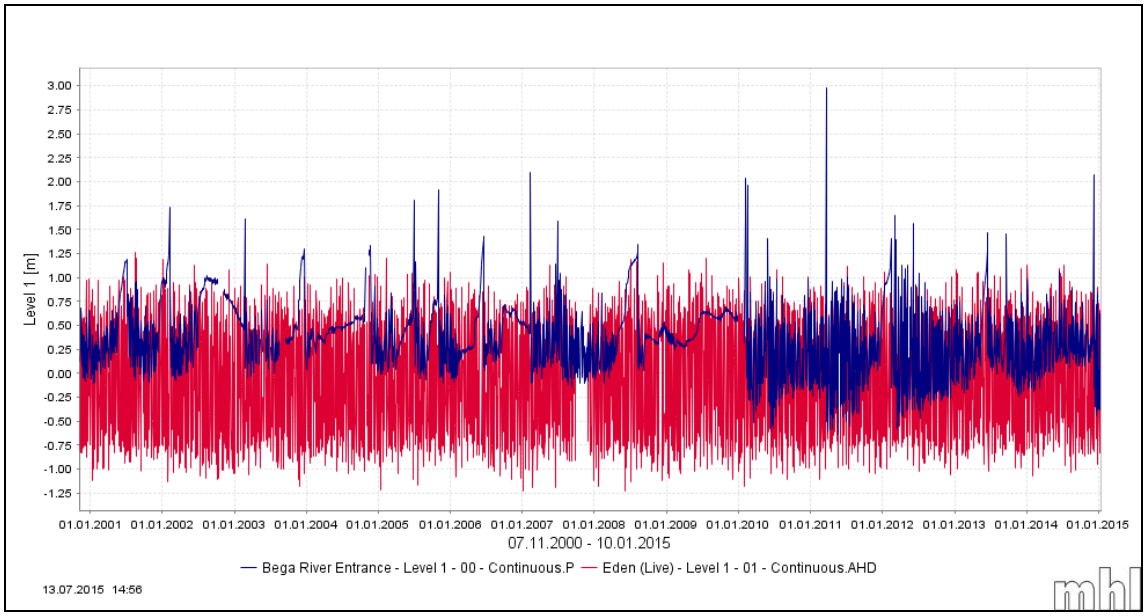

Figure 26: Complete Water Level Data set from Bega River Water Level Gauge Situated at Hancocks Bridge, plotted against the Open Ocean Water Level Records from Twofold Bay

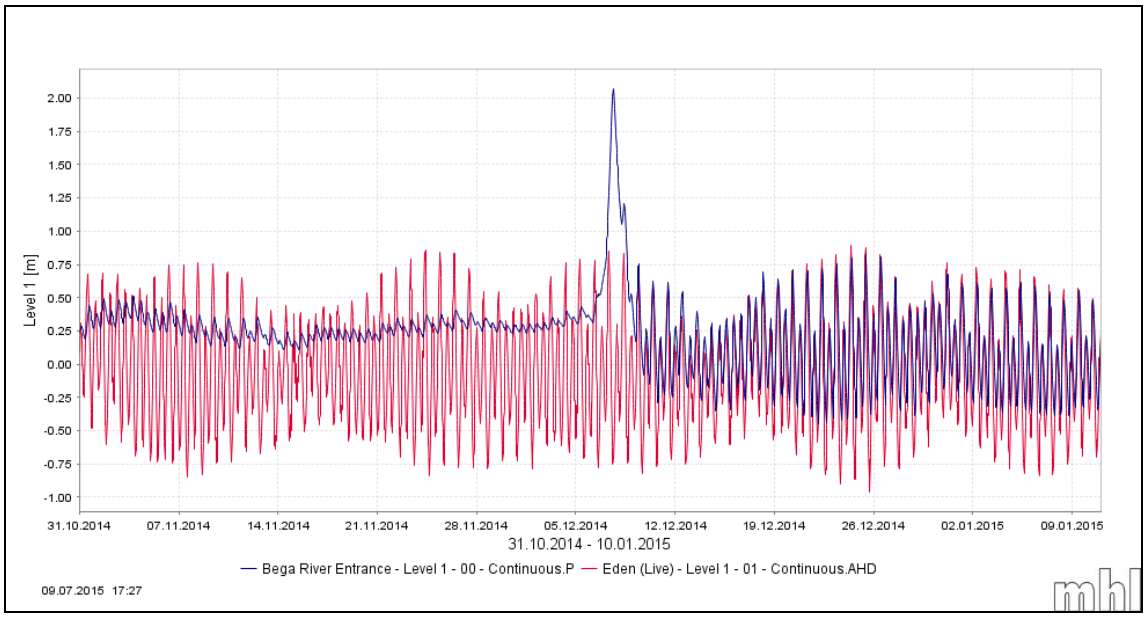

Figure 27: Snapshot of Bega River Water Level Record Plotted Against the Open Ocean Water Level Record from Twofold Bay

Entrance breakout location based on aerial photograph interpretation has shown that the River's entrance has predominantly opened in the northern region of the sand bar adjacent to the northern rocky foreshore (Figure 28, Figure 29). The recent 1990's and 2011 openings are the exceptions, with the River opening to south. As this southern position has been identified as causing erosion to the southern dunal region, it is proposed the artificial opening works be conducted within 50 metres of the northern rocky foreshore.

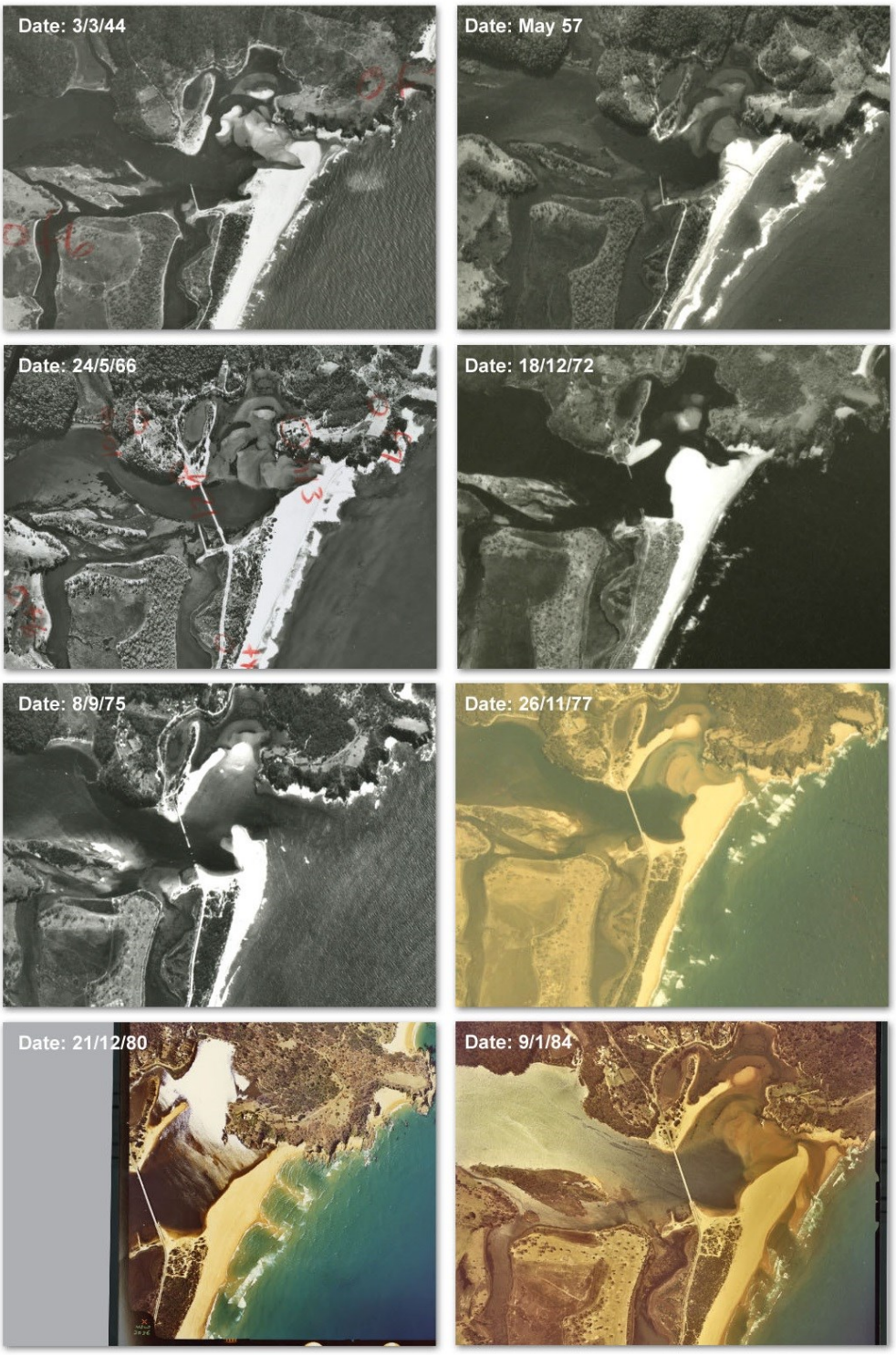

Figure 28: Aerial Photographs of Mogareeka Inlet 1944 to 1984

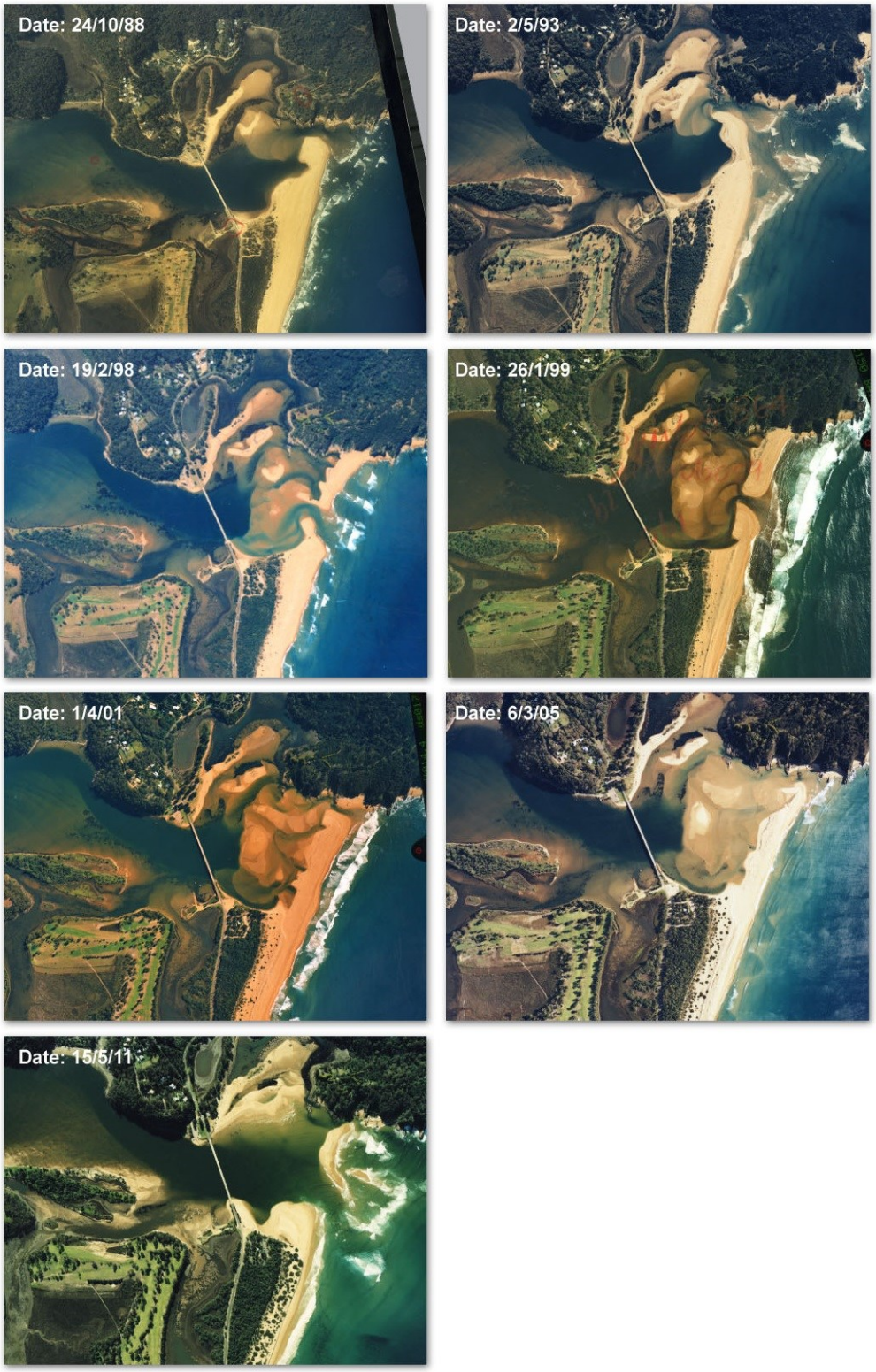

Figure 29: Aerial Photographs of Mogareeka Inlet 1988 to 2011

4.5.3.2 Water Quality

Water quality sampling undertaken by Elgin Associates in January and July 2012 indicate water quality was very good with both turbidity and chlorophyll a below MER guideline values. In comparison water quality data collected by the NSW State Government between December 2008 and March 2009, show turbidity was good but micro-algae levels were consistently very high (DECCW 2010). Of the 12 samples, Chlorophyll a exceeded the MER River guideline value every time and turbidity exceeded the MER River guideline value twice (Roper et.al. 2011).

Bega Valley Shire Council commissioned a water quality and algal assessment of the Racecourse Creek and Mogareeka Wetland in 2008 (undertaken by Elgin Associates). The results of this assessment indicate that macroalgae rafts covered approximately 50% of the waterways of Racecourse Creek and Mogareeka Wetland in April 2008, however, the algae was notably absent in July 2008 given the cooler temperatures and reduced sunlight. By December 2008, macroalgae had again established, covering 30% of Racecourse Creek and 25% of Mogareeka Wetland (BMT WBM, 2011).

A study in 1997 found turbidity results for streams adjacent to areas used for dairy farming were four times greater than those from streams within native forest, and streams within land used for grazing was shown to have twice the level of turbidity than those samples from streams in native forest (Turner et al 1998).

4.5.4 Ecology

Bega River and its surrounds provides habitat for a number of significant flora and fauna species. For the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, Mogareeka Inlet and its immediate surrounds where defined within the geographical domain:

GDA94

North: -36.65 South: -36.75

East: 149.91 West: 150.01

Within this domain The Atlas of NSW Wildlife identified 90 species protected under the Threatened Species Conservation Act 1995, 29 species protected under the Environment Protection and Biodiversity Conservation Act 1999, and 31 species protected under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

4.5.4.1 Flora

Figure 30 shows a map identifying threatened flora locations around the Bega River estuary.

Aquatic Vegetation

A seagrass community composed of Zostera capricorni covers ≈261,200 m^2 of the Bega River estuary predominantly around Black Ada Swamp and Mogareeka Inlet (DPI, 2006). These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are import marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997.

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under either NSW (Threatened Species Conservation Act 1995) and/or Australian (Environment Protection and Biodiversity Conservation Act 1999) government legislation are known to occur within the Bega River estuarine catchment. These EECs cover a total area of 6.5 km^2 and include Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Swamp Oak Floodplain Forest, Littoral Rainforest, River Flat Eucalypt Forest and Southern Floodplain Wetlands.

Coastal Saltmarsh occupies a total area ≈577,950 m^2 at seven localities around the River (DPI, 2006). The three largest areas of saltmarsh communities are located on and around the Tathra Beach Country Club Golf Course and Tathra River Estate. This endangered ecological community comprises a complex of succulent herbfields and sedgelands predominately characterised by Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha, Austrostipa stipoides along with Scirpus nodosa and Sporobolus virginicus (Tozer et al 2004). This community of species is very important to estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients.

The Freshwater Wetlands on Coastal Floodplains endangered ecological community occupies an area ≈228,800 m^2 at Zecks Lagoon within the Bega River estuarine catchment. Melaleuca ericifolla, Baumea articulata, Periscaia Praetermissa, Phragmites australis, Triglochin procerum, Typha orientallis and Cladium procerum typically characterise this endangered ecological community which provides important habitat, food and water source for freshwater fish, amphibian, native mammal and bird species (Tozer et al 2004).

Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions endangered ecological community occupies a total area of ≈146,800 m^2 at localities on the northern Tathra dunes and the landward side of Paspalum Point. Bangalay Sand Forest typically has a dense to open tree canopy and occurs on dunes exposed to salt-bearing sea breezes. The most common vegetation species within this endangered ecological community are Eucalyptus botryoides, Banksia integrifolia subsp. Integrifolia, Eucalyptus pilularis, Acmena smithii, Dianella spp., Lepidosperma concavum, Lomandra longifolia, Pteridium esculentum (Bracken), and the grasses Imperata cylindrical, Microlaena stipoides var. stipoides, Themeda australis (Tozer et al 2004). This vegetation complex once would have occupied many coastal localities however clearing, habitat degradation and weeds have caused substantial losses across the NSW state. As a result this remanent vegetation community has been placed as endangered and likely to become extinct unless the circumstances and factors threatening its survival cease to operate (NSW Scientific Committee 2012).

Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest are comprised within the Swamp Oak Forest on Coastal Floodplains endangered ecological community. The Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest inhabits an area ≈796,300 m^2 and ≈932,200 m^2 respectively within the Bega River estuarine catchment. Estuarine Creekflat Scrub is characterised by Melaleuca ericifolia, Casuarina glauca, Parsonsia straminea, Baumea juncea, Lobelia alata, Baumea articulate, Leptinella longipes, Samolus repens, Selliera radicans. Swamp Oak Floodplain Forest is characterised by Casuarina glauca, with climbers and groundcover species Parsonsia straminea, Geitonoplesium cymosum, Centella asiatica (Tozer et al 2004).

Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and are vital refuges for many fauna species.

Southern Floodplain Wetlands are comprised within both the Freshwater Wetland on Coastal Floodplains EEC and the River Flat Eucalypt Forest on Coastal Floodplains EEC. This endangered ecological community occupies an area ≈912,200 m^2 with large areas around Reedy Swamp, Chinnock and Duckhole Lagoon. The Southern Floodplain Wetland is characterised by Hymenanthera dentate, Melaleuca ericifolia, Acaena novae-zelandiae, Carex appressa, Centella Asiatica, Lobella anceps, Persicaria decipiens, Persicaria praetemissa, Phragmites australis, Ranunculus inundatus, Ranunculus plebelus, and Senecio minimus (Tozer et al 2004). These wetlands are particularly important for reducing flow velocities, filtering nutrients, and providing habitat and food sources for a range of fauna.

The Lowland Grassy Woodland in the South East Corner Bioregion endangered ecological community occupies a total area ≈2,357,200 m^2 at a number of localities around the River particularly at Reedy Swamp. This community complex typically comprises of Acacia mearnsii, Angophora floribunda, Eucalyptus globoidea, Eucalyptus tereticornis, Bursaria spinosa, Ozothamnus diosmifolius, Clematis glycinoides var. glycinoides, Rubus parvifolius, Cheilanthes sieberi, Desmodium varians, Dichondra spp., Echinopogon ovatus, Eragrostis leptostachya, Glycine clandestine, Glycine tabacina, Hydrocotyle laxiflora, Hypericum gramineum, Lepidosperma laterale, Lomandra longifolia, Lomandra multiflora subsp. Multiflora, Microlaena stipoides, Oxalis perennans, Themeda australis, Wahlenbergia gracilis (Tozer et al 2004). Habitat fragmentation due to clearing and grazing has reduced the ecological function of this community since European settlement resulting in a substantial loss of mammal flora. After an examination of historical and contemporary survey data Lunney and Leary (1988) concluded that at least six native mammal species had become locally extinct, including the Wallaroo (Macropus robustus), the Parma Wallaby (Macropus parma), the red-necked Pademelon (Thylogale thetis), the Tasmanian Bettong (Bettongia gaimardi), the Eastern Quoll (Dasyurus viverrinus) and the Brush-tailed Phascogale (Phascogale tapoatafa).

Littoral Rainforest is an endangered ecological community in NSW and a critically endangered commonwealth community that occupies a total area of ≈85,800 m^2 predominately around Mogareeka. Littoral rainforest is typically characterised by Angophora costata, Banksia integrifolia, Eucalyptus botryoides and Eucalyptus tereticornis, Leptospermum laevigatum, Acmena smithii, Breynia oblongifolia, Notelaea longifolia, Stephania japonica var. discolour, Lomandra longifolia, Oplismenus imbecillis and is home to many vulnerable micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and in-vertebrate (Tozer et al 2004).

The River-Flat Eucalypt Forest on Coastal Floodplains is an endangered ecological community that occupies an area ≈174,400 m^2 predominately in the north western region of Chinnock lagoon. This community is typically comprised of Eucalyptus. Baueriana, Eucalyptus botryoides, Eucalyptus elata, Eucalyptus ovata, Rubus parvifolius, Breynia oblongifolia, Hymenanthera dentate, Glycine clandestine, Stephania japonica, Microlaena stipoides, Lomandra longifolia, Pteridium esculentum, Oplismenus aemulus, Pratia purpurascens, Echinopogon ovatus, Entolasia marginate, and Desmodium varians (Tozer et al 2004). This EEC provides habitat for a broad range of flora, including many that are dependent on the vegetation for food, nesting or roosting such as the White-bellied Sea-eagle, Kingfishers, Owls, Yellow-bellied Glider etc. The clearing of native vegetation; alteration to the natural flow regimes; invasion of native plant communities by exotic perennial grasses; anthropogenic climate change; high frequency fire; and Removal of dead wood and dead trees are listed as threatening processes leading to the NSW Scientific Committee determining that River-Flat Eucalypt Forest is likely to become

extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2012).

In addition to the identified endangered ecological communities a NSW listed vulnerable plant species, occurs within close vicinity of Bega River entrance. This plant species is the Bega Wattle (Acacia georgensis). As this tree tends to grow in well-drained, shallow soils at sites with considerable exposed rock the entrance works and resulting drop in river level is unlikely to impact this species.

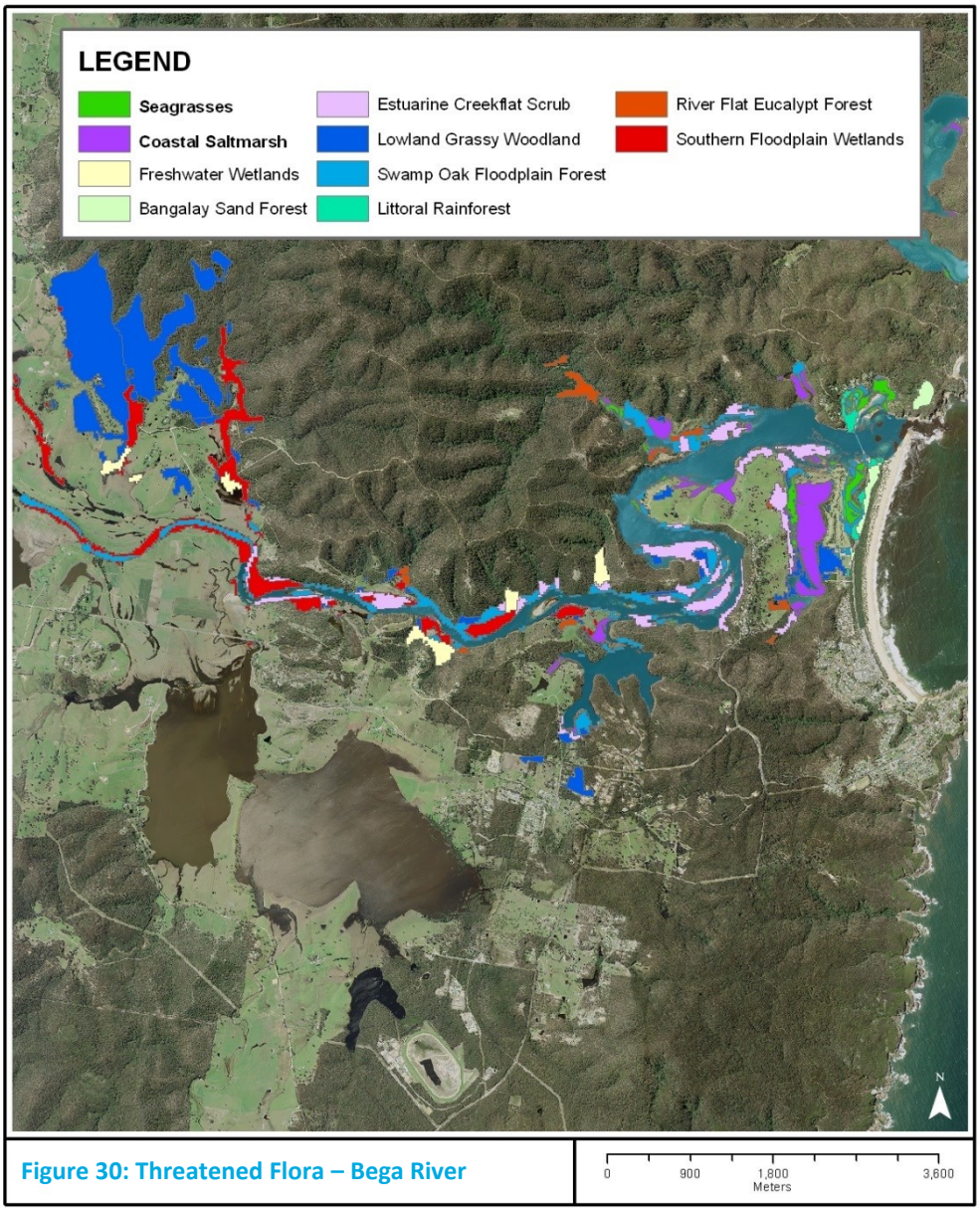

Figure 30: Threatened Flora – Bega River

4.5.4.2 Fauna

Figure 31 identifies the location of threatened fauna throughout the Bega River estuary area.

Mammals

The Atlas of NSW Wildlife has identified 17 species listed as vulnerable and 3 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 4 are listed as vulnerable and 4 listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in Table 13:

Table 13: Threatened Mammals in the Mogareeka Inlet Region

Common Name	Scientific Name	NSW Status	Comm. Status
Spotted-tailed Quoll	Dasyurus maculatus	V	E
Brush-tailed Phascogale	Phascogale tapoatafa	V	
White-footed Dunnart	Sminthopsis leucopus	V	
Southern Brown Bandicoot (eastern)	Isoodon obesulus obesulus	E	E
Koala	Phascolarctos cinereus	V	V
Eastern Pygmy-possum	Cercartetus nanus	V	
Yellow-bellied Glider	Petaurus australis	V	
Squirrel Glider	Petaurus norfolcensis	V	
Long-footed Potoroo	Potorous longipes	E	E
Long-nosed Potoroo	Potorous tridactylus	V	V
Grey-headed Flying-fox	Pteropus poliocephalus	V	V
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	V	
Eastern Freetail-bat	Mormopterus norfolkensis	V	
Large-eared Pied Bat	Chalinolobus dwyeri	V	V
Eastern False Pipistrelle	Falsistrellus tasmaniensis	V	
Golden-tipped Bat	Kerivoula papuensis	V	
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	
Southern Myotis	Myotis macropus	V	
Greater Broad-nosed Bat	Scoteanax rueppellii	V	
Smoky Mouse	Pseudomys fumeus	E	E

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

Birds

The Atlas of NSW Wildlife has identified 50 bird species listed as vulnerable and 13 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 7 are listed as vulnerable, 6 listed as endangered and 1 species listed as critically endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition 31 species are protected under the Japan-

Australia, Republic of Korea-Australia and China-Australia Migratory Birds Agreements. These species are shown in Table 14. OEH (2015) present maps of sites that are significant to shorebird nesting throughout the Bega Valley Shire, and identify the Bega River entrance as one of these sites. Figure 32 shows the identified locations and species from OEH (2015).

Table 14: Threatened Avifauna in the Mogareeka Inlet Region

Common Name	Scientific Name	NSW Status	Comm. Status	Migratory Bird Agreements
Superb Fruit-Dove	Ptilinopus superbus	V		
Fork-tailed Swift	Apus pacificus			C,J,K
White-throated Needletail	Hirundapus caudacutus			C,J,K
White-bellied Storm-Petrel	Fregetta grallaria	V	V	
Antipodean Albatross	Diomedea antipodensis	V	V	
Wandering Albatross	Diomedea exulans	E	E	J
Gibson's Albatross	Diomedea gibsoni	V	V	
Sooty Albatross	Phoebetria fusca	V	V	
Shy Albatross	Thalassarche cauta	V	V	
Flesh-footed Shearwater	Ardenna carneipes	V		J,K
Wedge-tailed Shearwater	Ardenna pacificus			J
Short-tailed Shearwater	Ardenna tenuirostris			J,K
Southern Giant Petrel	Macronectes giganteus	E	E	
Northern Giant-Petrel	Macronectes halli	V	V	
Gould's Petrel	Pterodroma leucoptera leucoptera	V	E	
Kermadec Petrel (west Pacific subspecies)	Pterodroma neglecta neglecta	V	V	
Black-winged Petrel	Pterodroma nigripennis	V		
Providence Petrel	Pterodroma solandri	V		J
Little Shearwater	Puffinus assimilis	V		
Masked Booby	Sula dactylatra	V		J,K
Australasian Bittern	Botaurus poiciloptilus	E	E	
Eastern Reef Egret	Egretta sacra			C
Black Bittern	Ixobrychus flavicollis	V		
Glossy Ibis	Plegadis falcinellus			C
Spotted Harrier	Circus assimilis	V		
White-bellied Sea-Eagle	Haliaeetus leucogaster			C
Little Eagle	Hieraaetus morphnoides	V		
Square-tailed Kite	^^Lophoictinia isura	V		

Eastern Osprey	Pandion cristatus	V		
Bush Stone-curlew	Burhinus grallarius	E		
Beach Stone-curlew	Esacus magnirostris	E		
Sooty Oystercatcher	Haematopus fuliginosus	V		
Pied Oystercatcher	Haematopus longirostris	E		
Greater Sand-plover	Charadrius leschenaultii	V		C,J,K
Lesser Sand-plover	Charadrius mongolus	V		C,J,K
Hooded Plover	Thinornis rubricollis	E		
Comb-crested Jacana	Irediparra gallinacea	V		
Common Sandpiper	Actitis hypoleucos			C,J,K
Sharp-tailed Sandpiper	Calidris acuminata			C,J,K
Sanderling	Calidris alba	V		C,J,K
Curlew Sandpiper	Calidris ferruginea	E		C,J,K
Red-necked Stint	Calidris ruficollis			C,J,K
Great Knot	Calidris tenuirostris	V		C,J,K
Latham's Snipe	Gallinago hardwickii			C,J,K
Broad-billed Sandpiper	Limicola falcinellus	V		C,J,K
Bar-tailed Godwit	Limosa lapponica			C,J,K
Black-tailed Godwit	Limosa limosa	V		C,J,K
Eastern Curlew	Numenius madagascariensis			C,J,K
Whimbrel	Numenius phaeopus			C,J,K
Common Greenshank	Tringa nebularia			C,J,K
Terek Sandpiper	Xenus cinereus	V		C,J,K
Arctic Jaeger	Stercorarius parasiticus			J,K
White Tern	Gygis alba	V		
Caspian Tern	Hydroprogne caspia			C,J
Sooty Tern	Onychoprion fuscata	V		
Common Tern	Sterna hirundo			C,J,K
Little Tern	Sternula albifrons	E		C,J,K
Gang-gang Cockatoo	^^Callocephalon fimbriatum	V		
Glossy Black-Cockatoo	^Calyptorhynchus lathami	V		
Purple-crowned Lorikeet	^^Glossopsitta porphyrocephala	V		
Little Lorikeet	Glossopsitta pusilla	V		
Swift Parrot	^^Lathamus discolor	E	E	
Orange-bellied Parrot	^^Neophema chrysogaster	E	CE	
Turquoise Parrot	^^Neophema pulchella	V		
Eastern Ground Parrot	^^Pezoporus wallicus wallicus	V		

Barking Owl	^^Ninox connivens	V		
Powerful Owl	^^Ninox strenua	V		
Masked Owl	^^Tyto novaehollandiae	V		
Sooty Owl	^^Tyto tenebricosa	V		
Brown Treecreeper (eastern subspecies)	Climacteris picumnus victoriae	V		
Striated Fieldwren	Calamanthus fuliginosus	E		
Speckled Warbler	Chthonicola sagittata	V		
Regent Honeyeater	Anthochaera phrygia	E	E	
White-fronted Chat	Epthianura albifrons	V		
Varied Sittella	Daphoenositta chrysoptera	V		
Olive Whistler	Pachycephala olivacea	V		
Hooded Robin (south-eastern form)	Melanodryas cucullata cucullata	V		
Scarlet Robin	Petroica boodang	V		
Flame Robin	Petroica phoenicea	V		
Pink Robin	Petroica rodinogaster	V		
Diamond Firetail	Stagonopleura guttata	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife has identified 4 amphibian and reptile species listed as vulnerable and 3 as endangered under the NSW Threatened Species Conservation Act 1995. These amphibian and reptile species are also listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 with exception of Varanus rosenbergi. These species are shown in Table 15:

Table 15: Threatened Amphibians and Reptiles in the Mogareeka Inlet Region

Common Name	Scientific Name	NSW Status	Comm. Status
Giant Burrowing Frog	Heleioporus australiacus	V	V
Stuttering Frog	^Mixophyes balbus	E	V
Green and Golden Bell Frog	Litoria aurea	E	V
Littlejohn's Tree Frog	Litoria littlejohni	V	V
Green Turtle	Chelonia mydas	V	V

Rosenberg's Goanna	Varanus rosenbergi	V	
Broad-headed Snake	^Hoplocephalus bungaroides	E	V

V= Vulnerable; facing a high risk of extinction in the medium-term future

E= Endangered; facing a very high risk of extinction in the near future.

Aquatic Fauna

Fish populations in the Bega River are relatively high considering the small size of the catchment and environmental stresses, however, the diversity of fish species varies throughout the river system (HRC, 2000). Predominant recreational fish species caught in the Bega River include Black and Yellow Fin Bream, Dusky Flathead, Jewfish, Whiting, Mullet, Tailor, Estuary Perch, Bass and Luderick (BMT WBM, 2011). The total estuarine production of the Bega River for the 1991-1992 fiscal year, as recorded by NSW Fisheries (1995), was 9246 tonnes. Commercial fishing is no longer permitted in the Bega River, since its declaration as a recreational fishing haven in 2002.

Both School and Greasyback prawns are often caught within the Bega River estuary. Other crustacean species such as the Eastern Rock Lobster, Mud and Sand crab have also been recorded. No aquatic animals that are classified as threatened are known or expected to occur around Mogareeka Inlet.

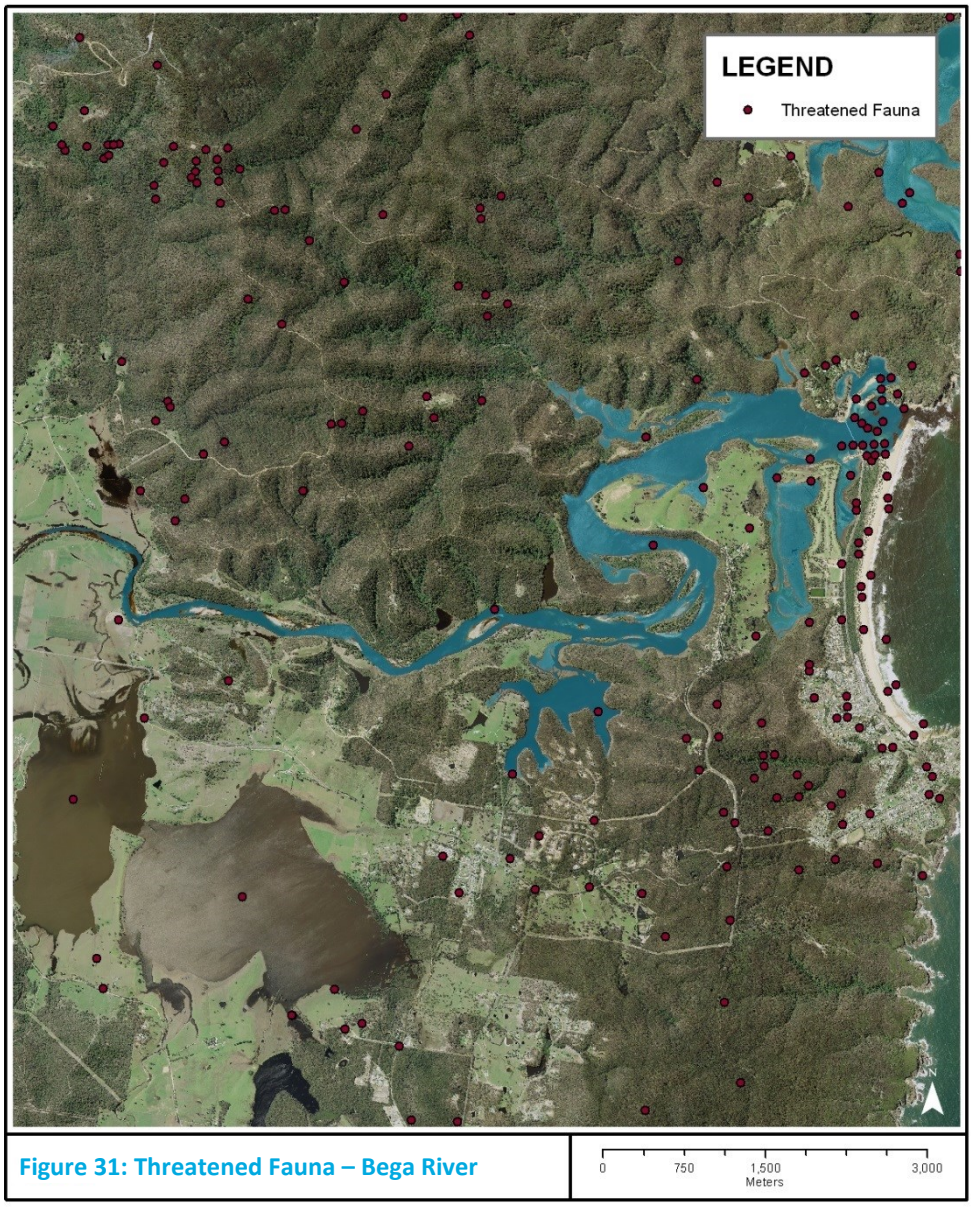

Figure 31: Threatened Fauna – Bega River

Figure 32: Significant Shorebird Sites at Bega River Entrance (OEH, 2015)

4.5.5 Cultural Heritage

4.5.5.1 Aboriginal Cultural Heritage

Sites of Aboriginal cultural significance, such as middens, camping areas, artefact scatters, shelters and other sites are frequent around Bega Valley Shire Council estuary shorelines, beaches and islands. There are also many areas of spiritual and cultural significance, the details of which are not generally known and are unlikely to be made known to people other than the tribal custodians of the knowledge.

The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance. The investigation included searches of the NSW OEH AHIMS, the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access track and entrance opening area. While 112 sites were identified in the database searches for the wider Bega River estuary search area, no sites in the direct access track or river entrance area were identified, and Dibden (2016) reported that the impact areas from entrance opening are disturbed and generally of very low to negligible archaeological potential.

4.5.6 Recreational and Commercial Uses

4.5.6.1 Recreation

Bega River supports a range of active and passive recreational uses including swimming, boating and fishing. The entrance area is not used for any specific purpose apart from swimming, canoeing, wind surfing, walking, nature observation, recreational fishing and boating.

When water levels are low the exposed edges of the lake provide areas for walking around the inlet. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels also provide for improved recreational

opportunities such as wind surfing and canoeing. Thus maintaining variable water levels in the river will favour differing recreational activities at different times.

4.5.6.2 Commercial

Golf Course: The major recreational facility within the Bega River Estuary is the Tathra Beach Country Club (TBCC). The TBCC incorporates an 18 hole golf course, tennis courts, sporting fields, clubhouse and restaurant. The golf course is located between the Black Ada Lagoon, Black Ada Swamp / Racecourse Creek and the Bega River. Low lying sections of the golf course are subject to inundation during periods of entrance closure and can result in access difficulties for one hole when the water level reaches 1.1 m AHD, and the closure of 3 holes when water levels exceed approximately 1.5 m AHD.

Tourism: Due to its coastal location, Tathra is the fishing, recreation and tourism centre of the Bega River Catchment (HRC, 2000). The population of the coastal Tathra village increases by 70% during peak tourist season (BVSC, 2005a). Other towns within the catchment experience smaller population increases during the holiday seasons. The economies of coastal towns in the Bega Valley such as Tathra have become increasingly dependent on tourism. The recent inclusion of the Bega Valley Shire Coastline in the "Wilderness Coast" by Tourism Australia, has reinforced the importance of the protection of areas such as the Bega River Estuary. The natural qualities of the local coastal zone have the potential to provide a distinct marketing advantage to the local tourism industry.

Agriculture: Freehold grazing land exists around large parts of the River foreshore. These areas are being utilised to graze cattle/produce fodder and are therefore important to the livelihood of a number of farming families. When the lake water level rises above 1.36 m AHD or higher, access to pasture areas becomes impassable making it difficult for farmers to tend to their stock.

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

4.6 Description of the Activity Impacts

4.6.1 Acid Sulfate Soil Impacts

It is highly unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Mogareeka Inlet has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

4.6.2 Erosion and Sedimentation Impacts

It is likely due to the consistent opening regime at low water levels below 1.36 m AHD, that entrance opening works would actually reduce the risk of bank collapse by limiting bank inundation and bank destabilisation potential, resulting from a rapid drop in water level post entrance opening. It must be highlighted however, that water levels in excess of 4 m AHD

would be within the natural hydrological regime, and as a result it is considered that the potential for bank collapse would be slight.

Over the long term, the progradation of the marine sediments into the river resulting from artificial entrance openings may cause minor adverse sedimentation impacts in the northern area of Mogareeka Inlet. It is advised that further study be undertaken when resources are available to examine the impacts of entrance opening on this process. Gordon (2013) presented a discussion that identified important differences between an ICOLL (Intermittently Closed and Open Lake or Lagoon) and an IORE (Intermittently Open River Entrance), of which the Bega River entrance was a key example presented of the latter. In particular, it was noted that a significant flood event at an IORE tends to result in a more energetic entrance breakout compared to an ICOLL which tends to have a larger water body at the lower section of the estuary to buffer hydraulic energy. The more energetic breakout at an IORE was seen to result in an entrance sand bar being shifted further offshore of the entrance, which in turn can result in erosion along adjacent beaches as the entrance bar re-develops over subsequent years. The 1971 flood in the Bega River was cited as an example case, from which the entrance breakout was postulated to have contributed to significant erosion of the Tathra Beach throughout the following decade, and the eventual need for protection of the Tathra Surf Life Saving Club building at the southern end of the beach.

While artificial opening of the entrance at lower water levels may result in increased ingression of marine sand to the lower part of the estuary during calm periods, it may also reduce the impacts of a severe entrance breakout during a flood, and subsequent beach erosion effects.

4.6.3 Hydrology Impacts

The works will have a moderate negative impact on the River as entrance opening is an important determinant of the hydraulic character. Natural breakout of the Bega River would tend to occur during or soon after a significant rainfall event. Rainfall is a necessary precursor to raise water levels to a level significantly greater than mean sea level, and to 'liquefy' the sand barrier and reduce its cohesion. The ability of the lake water to erode a deep and wide entrance channel once opened is directly related to the head difference that exists between the lake and the ocean at the time of breakout. A large head difference will result in a larger and deeper channel.

Therefore, intervention in the breakout process at low lake water levels with an unsaturated entrance bar will reduce the capacity of the opening to erode sediments from the River. Over the long term this may cause sedimentation impacts and changes to the hydrologic regime.

Positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid increases in dissolved oxygen concentrations resulting from rapid decay of organic material. Moreover water quality within the estuary would be better managed through reducing catchment inputs, for example, by minimising STP discharges, stormwater runoff, and the application of fertilisers, and by rehabilitating riparian buffers, rather than artificially breaching the entrance.

4.6.4 Aquatic Vegetation Impacts

Entrance opening and the resulting drop in water levels is likely to have a slight negative impact on aquatic vegetation. The predominant negative impact is the scouring of Zostera capricorni from the riverbed particularly around the entrance, however, it should be noted that this can also occur (and is likely more possible) during natural entrance openings.

4.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The works will have moderate negative impacts on several transitional and fringing endangered ecological communities (EECs), most notably coastal saltmarsh. These impacts occur as the natural flow regimes of the Bega River have and will be altered by the entrance opening works in conjunction with extraction. Endangered ecological communities such as Coastal Saltmarsh, Freshwater Wetlands, Swamp Oak Forest on Coastal Floodplains, Lowland Grassy Woodland and River-Flat Eucalypt Forest are impacted due to reduced inundation. This can result in significant species composition shifts such as reduced Saltmarsh, Grassy Woodlands, River-Flat Eucalypt Forest and Freshwater Wetland habitat, and also allow the encroachment of terrestrial vegetation.

It is identified that some dieback will occur following long periods of inundation particularly Casuarina glauca and entrance opening may relieve this pressure. However, it must be noted this is a natural reclamation process and many endangered ecological communities rely on this dieback and inundation for survival. Repeated artificial entrance opening at this low range of natural break-out water levels will therefore continue to have moderate negative impacts on several transitional and fringing endangered ecological communities.

A Section 5A assessment for the endangered ecological communities is located in Section 4.8.

4.6.6 Direct Impacts to Access Track Vegetation

The track which will be used to provide access and egress for the excavator is shown in Figure 24. This existing and predominantly cleared track has been selected for the access route, as it will minimise impacts to surrounding vegetation. In driving the excavator along this track, it is expected that minor disturbance of grass will occur, and there may also be small sections of the track where hand pruning of low hanging shrub branches (predominantly Coastal Wattle and Banksia) will be required. There will be no need to remove trees to provide access. Once on the dune area of the beach, there may be minor and very localised damage to Spinifex and Coastal Wattle that are growing on the edges of the track. Photographs of the access track are shown in Figure 33, where it can be seen that there will be minimal impacts to vegetation from machine access.

Figure 33: Photos of Bega River Access Track and Vegetation

4.6.7 Fauna Impacts

Mammals

It is unlikely the entrance works will have an impact on threatened mammal species or endangered populations. It must however, be recognised that water levels will be within the natural range.

Birds

Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works including machine access and channel excavation could potentially have a significant negative impact on a number of resident and migratory threatened shorebird species. Shorebirds inclusive of the Little Turn, Hooded Plover and Pied Oystercatcher could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- A machine access route that minimises areas of dune impacted by the machine;

- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators, restrict pedestrian access and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform additional adaptive management responses on an “opening-by-opening” basis, as opposed to a “one-off” survey for this REF. Section 5A assessments have been carried out for the potentially impacted shorebird species (Hooded Plover, Little Tern, and Pied Oystercatcher), and are included in Section 4.8. As the impacts to these species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement. Entrance opening works are unlikely to negatively impact other threatened bird species, rather the reduction in water levels may expose feeding grounds and food sources (decomposing vegetation and invertebrates) for many of the bird species.

Amphibians and Reptiles

The majority of frog and reptile species identified are unlikely to occur in habitats directly connected to the lake due to excessive salinities and preference for different habitat types. The Green and Golden Bell on the other hand may be significantly impacted by entrance opening and as a result a Section 5A assessment has been carried out for this species and included in Section 4.8.

Aquatic Fauna

The entrance works will have both positive and negative impacts on aquatic animal species. These positive and negative impacts include assemblage changes, habitat shifts, and fish kills. As the entrance works rapidly change the surrounding environment some species may benefit and others may perish due to stress from low dissolved oxygen and sudden salinity increases, which can also occur during natural entrance openings. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and the opening works are within the lower range of the natural regime.

4.6.8 Aboriginal Cultural Heritage Impacts

Any unknown Aboriginal sites that may exist around the immediate foreshore of the estuary will have been subject to cycles of flooding and drying over many years and thus may be fairly resilient to changes in lake level. It is possible however, that further flooding and drying combined with wave action may expose sensitive sites or lead to erosion of culturally important areas. While unlikely, entrance works may have both positive and negative impacts on currently un-reported Aboriginal cultural heritage sites. Positive impacts could include opening the entrance prior to naturally high estuary water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts could include increased frequency of wetting and drying from rises and falls in estuary water level as a result of slightly more frequent entrance openings.

While no impacts to Aboriginal places or items in the areas of excavator access or entrance opening were identified in the ACHAR (Dibden, 2016), as a precautionary measure BVSC has sought an AHIP associated with the entrance management works. It is also recommended that monitoring take place during the access and entrance opening process, and that whenever possible access be restricted to the corridor within the intertidal and wave runup zone of the beach.

4.6.9 Recreational Impacts

The entrance management works may result in both positive and negative recreational impacts. When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels provide for improved recreational opportunities such as canoeing and boating. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times. Impacts on recreational fishing may also occur however as detailed previously artificial opening regimes favour some species over others.

4.6.10 Commercial Impacts

The entrance works have minor to moderate positive commercial impacts. Artificial entrance opening is required to prevent flooding of both public and private assets. These main assets are Mogareeka Ave, Tathra STP, agricultural land, and several holes at the Tathra Golf Course. When river levels rises to 1.36 m AHD or higher, impacts to these assets are experienced. It is the intention of this policy to return to a more natural opening regime through alleviating asset damages by progressively removing, relocating or modifying these assets.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

4.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The community most likely to be affected will be the residents within close proximity to the Bega River. There will be no significant adverse impact upon the general wider community. Malodorous conditions can sometimes occur for a few days after an entrance opening due to the rotting vegetation around the river shoreline. To prevent this affecting holiday makers, whenever possible the lake will not be artificially opened during peak holiday periods. There are a small number of riverside property owners who will be directly affected by elevated lake levels. Mogareeka Ave residents that access Bermagui Road from the south may be affected, 3 holes of the golf course at Tathra Country Club will be underwater and pastures of some rural properties will be flooded causing access and productivity impacts. As the only purpose for conducting the entrance opening works is to protect private and public assets from flooding, the activity will have positive outcomes for the community beneficiaries.
b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The locality will not be transformed in any significant manner. The lake entrance will change temporarily, but these changes will be within natural bounds.
c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There are a range of environmental impacts on the ecosystems of Bega River as discussed in Section 4.6. The cumulative impacts of the entrance works may and most likely have caused low adverse environmental impacts on the ecosystems of Bega River's lower reaches. These impacts predominantly relate to hydrologic and ecological shifts from natural states, as a result of lower water level breakouts, and lake water levels no longer being allowed to reach the upper levels that would naturally occur. Regular and repeated low water level (artificial) openings would likely continue to further change many ecosystems over the long term, particularly aquatic and wetland ecosystems, as the works alter the ecosystems structure, composition and diversity. However, it should be recognised that BVSC has intentions (as documented in the Policy) to undertake planning and upgrade works to improve low lying assets affected by high river water

	levels which will allow the trigger water level for mechanical opening to be raised in the future. As such, long term adverse impacts to fringing and aquatic ecosystems are expected to be low.
d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There is not likely to be any reduction in the aesthetic quality or value of the locality as a result of implementing the Policy. The impact upon fish and prawn populations may have a bearing upon the recreational value. If an artificial breakout allows a large population of prawns and fish to escape to sea there would be a significant loss of recreational opportunity, especially if this occurred just prior to the Christmas/New Year holiday period. However, an artificial opening could enhance recreational prawning and fishing opportunities the following year if the opening coincided with a high abundance of prawn larvae and fish spawning in nearshore coastal waters. Such conditions are impossible to predict. On balance and over the long term, the impacts are likely to be slightly negative. Impacts to other recreational activities such as sailing and walking are deemed negligible as fluctuating water levels will favour differing recreational activities at different times. While intervention in the natural breakout process conceptually diminishes the scientific value of the system since an element of 'naturalness' has been lost, in reality the vast majority of ecological processes will continue to operate. The locality could still be suitably used for a wide range of scientific purposes (this has been demonstrated at other ICOLLs on the Far South Coast such as Wallagoot Lake). Certainly the scientific value would not be diminished by the proposed entrance management works to the same degree that other catchment modifications have.
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: As discussed in Section 4.6, there are no known sites within the entrance area that may be affected. Given that artificial lake openings are the early facilitation of a natural process it could be assumed that its effect on cultural artefacts around the river would be minimal. BVSC have sought an AHIP associated with the works as a precautionary measure.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? [2] ☐ **n/a or negligible** ☐ positive ☒ low adverse ☒ medium adverse ☐ high adverse Comment: There is potential that moderate to significant adverse impacts may result to habitat of protected fauna. These impacts are documented in Section 4.6 and primarily result from hydrologic changes (increased frequency and lower water level opening) and

.

	habitat disturbance due to machinery and channel scour. While it is recognised that there is the potential for significant direct adverse impacts on ground nesting species such as the Little Tern, Hooded Plover and Pied Oystercatcher by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 4.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 4.8. Similarly, in the long term the works have the potential to have moderate indirect impacts on other threatened mammals and amphibians such as the Green and Golden Bell Frog through habitat modification as a result of changes to the lake's hydrologic regime and upper range water levels. It should be recognised that many of these habitat changes will have already occurred over previous decades, and that the intentions to raise trigger water levels for entrance opening in the future will minimise future impacts. As such, long term adverse impacts to fringing and aquatic ecosystems which provide habitat for threatened species are expected to be low.
g.	Will there be any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The endangered ecological communities listed in Section 4.6 (i.e. Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest, River Flat Eucalypt Forest and Southern Floodplain Wetlands) in conjunction with the identified fauna species may be indirectly impacted by the entrance management works. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher, Hooded Plover, and Little Tern by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 4.6.7 and the Policy, these impacts will be reduced to low adverse. For these communities and bird species a Section 5A assessment has been prepared and is contained in Section 4.8.
h.	Will there be any long-term effects on the environment? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The cumulative impacts of the entrance works may in the future cause low to medium adverse environmental impacts on the ecosystems of the Bega River estuary. These impacts are documented in Section 4.6 and primarily involve: a relative shift in the structure, composition, diversity, and location of the lake's fringing ecology; increased rates of marine delta progradation particularly at Mogareeka Inlet; reduced frequency and duration of flooding at higher levels; and an increase in salinity resulting in River marinisation.

i.	Will there be any degradation of the quality of the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The quality of the River environment will be degraded by virtue of the fact that a major natural process is being interfered with. In effect the River is losing a major element of 'naturalness'. Naturalness is a significant environmental attribute. It is often a criteria used to determine environmental or conservation value. Although this activity has occurred in the past, the works continue to perpetuate the problem.
j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of undertaking the entrance opening works. The robustness or ability of the environment to withstand environmental fluctuations should not be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above. On the whole, there is more likely to be positive benefits to the use of the environment through improved access at high lake water levels.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not result in any pollution of the environment.
m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse

	Comment: Although it is difficult to predict what other future activities might take place it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or on the foreshore.
p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. Over the long-term, additional influx of marine sediment into the estuary and the widening of the beach berm may occur as a result of entrance openings at lower water levels that likely result in less scour of entrance sediments. This may alter coastal processes. The Policy has been developed to incorporate a progressive increase in entrance opening levels to partially accommodate current best estimates of sea level rise and reduce the need to intervene in natural entrance behaviour in the longer term.

4.8 7-Part Test for Threatened Species, Populations and Ecological Communities

4.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Hooded Plover (Thinornis rubricollis) and Pied Oystercatcher (Haematopus longirostrus).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSCA LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Mogareeka Inlet.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Bega River to the sea, this constitutes a moderate alteration to the natural flow regimes.

4.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Migratory Shorebirds - Little Tern (Sterna albifrons).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSCA LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Mogareeka Inlet.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of the Bega River to the sea, this constitutes a moderate alteration to the natural flow regimes.

4.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to the Endangered Green and Golden Bell Frog (Litoria aurea).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of this species may be disrupted by the entrance works if breeding colonies are present. Salinity increases and isolation can affect breading success, particularly if entrance works are conducted between August and March. It should be noted that these same affects could occur as a result of natural flooding and breakout of the river entrance.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for this species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. Some habitat will be modified during the activity as a result of reduced water levels. This may isolate tadpoles and or eggs particularly if the works are undertaken between August and March.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The habitat is of critical importance to this species particularly between August and March for breeding activity.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Mogareeka Inlet.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statement and Recovery Plan for this species. However, it should be noted that even without intervention in entrance opening processes, similar impacts to the habitat of this endangered species may still occur as a result of estuarine flooding and natural entrance breakout.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of the Bega River to the sea, this constitutes a moderate alteration to the natural flow regimes.

4.8.4 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest, River Flat Eucalypt Forest and Southern Floodplain Wetlands

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

The artificial opening works of the past, have possibly constrained the distribution of these endangered ecological communities (EECs) to low lying areas. It is likely that future entrance opening works will perpetuate this trend. If the Bega River Entrance Management Policy is adhered, it is likely a “more natural” river water level can be achieved before the river is artificially breached in the future. This may reduce the future cumulative impacts of the proposed entrance works on these important EECs. It is unlikely any of the EECs are to be placed at risk of extinction as a result of activity, however, declines and shifts in extent, composition, and diversity are likely to continue as a result of the activities.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible that some habitat will be modified through the cumulative impacts of undertaking the works. This may result in impacts to the EECs as detailed in Section 4.6.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is possible that some EECs will become isolated from the water body, limiting inundation as a result of reduced upper limit water levels following artificial entrance opening.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Future habitat modification through this activity may compromise the long-term survival EECs around Bega River through impacts listed in Section 4.6, if the Policy is implemented indefinitely into the future. However, it is Council’s intention to reduce the need for intervention in entrance processes by raising the low lying assets and developing relevant

management plans around Bega River in the coming 10 years. As such the long-term survival of these EECs is unlikely to be at risk.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Bega River.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is a threatening process and as a result would be inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of the River to the sea, this constitutes a moderate alteration to the natural flow regimes.

4.9 Conclusion

The proposed entrance management works are required for the sole purpose of reducing the impacts of flooding to private and public assets. This occurs as River water levels above 1.36 m AHD have the potential to cause undue hardship and disruption to members of the local community. In implementing the proposed Bega River Entrance Management Policy, there are two notable potential impacts. These are:

1. Potential direct impacts to threatened shorebird species;
2. Potential cumulative environmental impacts of altering the natural hydrologic regime, indirectly impacting endangered ecological communities and threatened fauna species.

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes specific selection of excavator access routes that minimise impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

With regards to changes to the hydrologic processes of the River and resulting cumulative indirect impacts on EECs and threatened species, the Bega River Entrance Management Policy has outlined planning and adaptation works for low lying assets that will allow mechanical entrance opening at higher lake water levels in the future, returning hydrologic behaviour to more natural regimes. As such, the potential for future significant adverse impacts to saltmarsh, other fringing EECs, and threatened species beyond those already occurred, are expected to be minimised.

As there are no viable alternatives to the proposed entrance management in the short term, the proposed Bega River Entrance Management Policy should be approved, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- Bega Valley Shire Council plan and implement modifications to the low lying assets that are affected by inundation when lake water levels are high;
- A Flood Risk Management Study and Plan should be undertaken when resources become available to investigate future flood management options, with consideration of natural berm heights, sea level rise projections and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) and consistent with the NSW Floodplain Development Manual (DIPNR 2005). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions.

5 REF for the Artificial Entrance Opening of Wallagoot Lake

5.1 Location

Wallagoot Lake is situated on the far South Coast of New South Wales, approximately 7 km south of Tathra and 12 km North of Merimbula. With a surface area estimated at 4.0 km^2 (OEH, 2016) the lake is one of the largest waterways in the Bega Valley Shire. The catchment area is reported as approximately 26.5 km^2. The main tributary of the lake is Moncks Creek, which enters the lake on the western foreshore (Elgin, 2014). The estuary is classified as an intermediate saline coastal lagoon (CMG 2000, Roy et al 2001). Bournda Beach is a prograded beach ridge barrier that forms the seaward boundary of the Estuary. There is very low density rural type development throughout the catchment, along with light agriculture. However, predominantly the catchment is contained within Bournda National Park, which comprises approximately 68% of the catchment area (Elgin, 2014; Sulisit, 2012) and is managed through the Bournda National Park and Bournda Nature Reserve Plan of Management (NPWS, 2014). See Figure 34 for a catchment map.

Figure 34: Wallagoot Lake Estuary

5.2 Description of Proposed Activity

A channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals within 50 metres of the northern rocky foreshore of Bournda Beach in the location shown in Figure 35 using mechanical equipment, most likely an excavator. The preferred access route which the machine will follow is also shown in Figure 35. This route traverses an existing track from the carpark at the eastern end of Wallagoot Lake Road, through Bournda National Park, to the lake entrance. If this preferred access route is not feasible at the time when the entrance is to be opened (due to excessive inundation of Wallagoot Lake Road for example), an alternative access route exists as also shown in Figure 35. This alternative access route starts at the Bournda Lagoon carpark at the southern end of Bournda Beach, and traverses through an existing track before crossing the dune area of Bournda Beach and tracking north along the beach some 3.8 km to the Wallagoot Lake Entrance. While tracking along the beach, the machine would crawl as close as possible to the high tide wave runup area.

Both access routes have been selected to minimise disturbance to vegetation and nesting shorebirds during machine access and egress, as they follow existing cleared tracks through vegetation. However, it is expected that minor damage to the track is inevitable and potentially some hand pruning of overhanging vegetation may be required on both tracks. Particular care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes and shell middens, and as a precautionary measure a permit (AHIP) from OEH has been sought to undertake the works (though there are no known Aboriginal objects or places within the access or work areas).

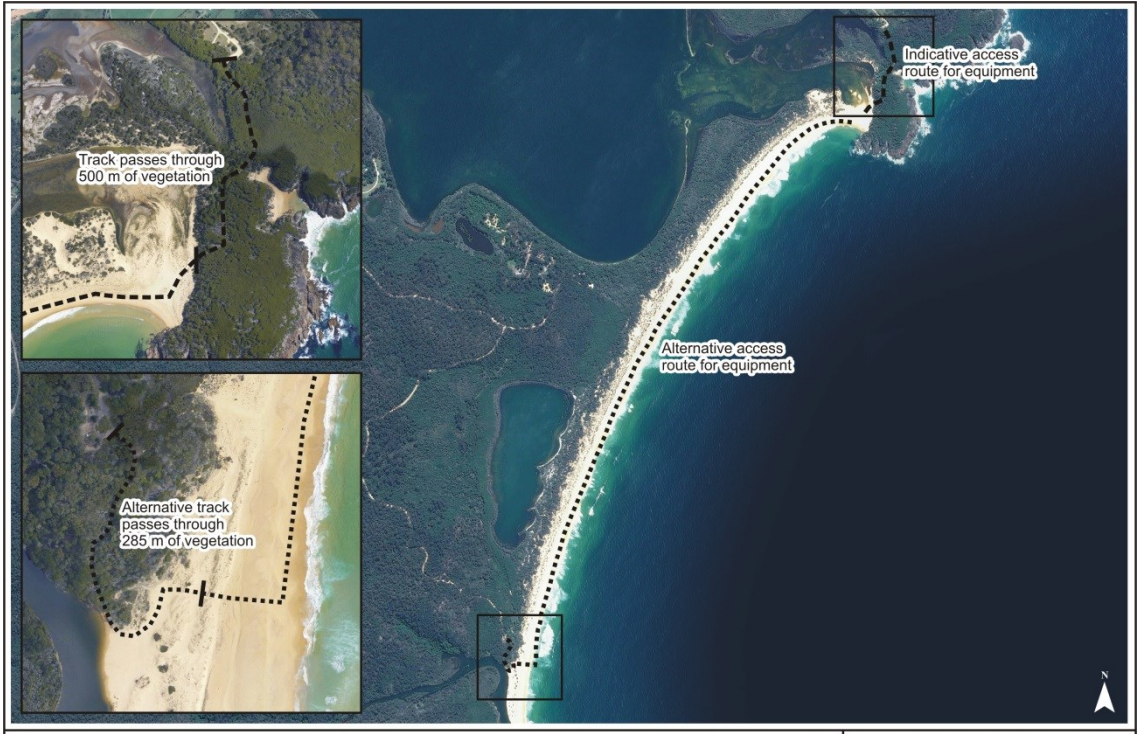

Figure 35: Location of Entrance Opening Works

As outlined in the Wallagoot Lake Entrance Management Policy (Appendix D) the excavation will only be undertaken if the water level exceeds 1.2 m AHD (and preferably 1.4 m AHD) as indicated on the water level gauge pole (installation location to be confirmed).

The excavated sand will be pushed to the side of the excavated channel and will not be removed from site. The channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 2-6 hours duration. It would be rare for it to extend beyond 10 hours.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes and rivers has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. The size and location of the channel will be constrained by the northern rocky headland. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

While there is no intention to establish a permanent opening, a reasonably long lasting opening is preferred to maximise the possibility of full water exchange and obviate the need for repeated intervention after a short period of time (that is, a few weeks or months). To assist with the establishment of a large and deep channel, which will be slow to infill, completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle, just after the peak of the high tide. This should ensure that an adequate head difference between the water in the lake and the ocean is maintained for as long as possible. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

5.3 Purpose of the Activity

The purpose of the works is to re-establish a temporary tidal connection between the lake and the ocean to allow accumulated water to flush to the ocean and thereby lower water levels below that which causes flooding problems to the Wallagoot Lake Road.

The intention is not to establish a permanent opening. It is recognised that the entrance channel could well close again within a matter of weeks, although it would generally be hoped that the channel would remain open for a period of months to maximise the period available for tidal flushing and minimise the need for further openings in the short term.

5.4 Consideration of Alternatives

Ultimately there are no viable alternatives to the artificial opening of the lake in the short term. The “do-nothing” option is unacceptable because of the potential safety risk and disruption that could be caused if the lake was left closed and water inundated Wallagoot Lake Road. The high water levels may also remain for many months compounding the scale of disruption through lack of access to private properties, National Park and other recreational facilities by floodwaters. Therefore not interfering and allowing nature to take its course so that water levels rise until a natural breakout takes place, could in most situations cause undue disturbance.

Rather than adopting a fixed trigger water level for mechanically opening the lake, the Policy has been developed such that once the water level reaches the point that Wallagoot Lake Road begins to inundate (1.2 m AHD), the safety risks, impacts and weather conditions can be monitored by Council officers on a case-by-case basis, and the lake opened only if necessary. A lake water level of 1.4 m AHD is considered to be an upper limit at which point access to private properties becomes unsafe, and the lake will then be opened. This approach provides the opportunity to allow lake water levels to reach as high as practical, and the ecological benefits associated with increased inundation of fringe areas.

In the longer term it is the intention to increase the intervention level above 1.4 m AHD by selectively raising or relocating sections of Wallagoot Lake Road which are most prone to flooding. The Wallagoot Lake Entrance Management Policy (Appendix D) proposes works that should be completed in desired timeframes in order to increase the intervention level.

5.5 Description of the Existing Environment

5.5.1 General Characteristics

The Wallagoot Lake entrance is situated at the northern end of Bournda Beach, and is constrained to the north by a rocky point and rock outcrops along the northern foreshore of the entrance (see Figure 36). The entrance area itself is characterised by an expanse of unvegetated sand. The substrate in the entrance area is dominated by unconsolidated marine sand with varying amounts of broken shell and traces of terrigenous muddy sediment.

Figure 36: Wallagoot Lake Entrance

5.5.2 Sediments

5.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show the entire bed of Wallagoot Lake as well as some fringing areas as having a high risk of potential acid sulfate soils. Ensuring lake water levels are as high as practical prior to entrance opening (and planning to increase entrance opening trigger levels in the future), compared to lower water level break outs would reduce the oxidation potential of the soils, thus reducing their acid-generating potential. It should be noted that low lake water levels that would occur following a mechanical entrance opening could occur to the same degree following a natural breakout. Likewise, the extended periods of lake closure and low freshwater inflows that Wallagoot Lake is subjected to, have also been reported to result in low lake water levels (through evaporation) and hyper saline conditions (Claydon, 2010).

In relation to the berm area where the excavation works are proposed, acid sulfate soils are highly unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

5.5.2.2 Bank Erosion and Sedimentation

Some of the surrounding catchment is used for agriculture (including cattle, horses and goats), and in places there is direct access for grazing animals to the shoreline of the lake and tributaries. In places this has resulted in detrimental impacts to riparian zones, however, the vast majority of the catchment and lake is in good condition in terms of bank erosion (Sulisit, 2012).

Transient freshwater inflows from Monchs Creek bring the main source of fluvial sediment to the lake, with a fluvial delta present where the creek enters on the western side. Sediment within the entrance of Wallagoot Lake is predominantly comprised of marine (beach) sands. This material is deposited under the combined action of tides and waves. The non-cohesive sands are dynamic in nature and tend to be redistributed during times of flood.

5.5.3 Hydrology

5.5.3.1 Entrance Behaviour / Characteristics

The frequency and duration of entrance opening is an important determinant of the hydraulic character of the lake (that is, the frequency and magnitude of water level fluctuations and quality changes). In general, due to the large size of Wallagoot Lake's waterway area but relatively small catchment and freshwater inflows, the lake can go many years and even decades without naturally opening to the ocean. This results in rather unique water quality characteristics compared to many of the other ICOLLs on the NSW South Coast. Based on modelling of entrance behaviour, DLWC (2000) estimated that between 1944 and 1999, the entrance would have opened on approximately 8 occasions, a long term average of being open to the ocean only 4% of the time.

OEH have undertaken an analysis of the entrance state for Wallagoot Lake on the basis of available gauged data, which is included below.

OEH Analysis:

MHL have maintained a temporary water level gauge on behalf of OEH in Wallagoot Lake from 21/6/2013 (still operational as of April 2006). There currently exists approximately 2.5 years of available water level data (Figure 37). While this is only a small period of time for an estuary that has historically stayed closed for periods believed to be over 15 years, it has captured a period when the entrance was mechanically opened and provides an indication of the likely ranges in water level when open and tidal, as well as water level fluctuations when closed. At the time of installation in 2013 the entrance was closed.

Between 21/6/2013 and 04/02/2016 (current data availability), one period of entrance closed conditions occurred, with closed conditions lasting from prior to the gauge being installed to the 12/11/2015, a period of over 2.5 years. Data provided by Council also indicates that a second closure occurred on the 24/3/2016, but data from the water level recorder has not yet been obtained. Information provided by Council also indicates that the entrance was previously opened on the 1/3/2012 after being closed for a period of greater than 15 years. Elgin (2014) reports that the entrance closed again at some point in June 2014, prior to the water level recorder being installed on the 21/6/2013, indicating that the entrance was open for roughly 3 months. Based on the two recorded periods of entrance openings in 2012 and 2015, open conditions last for approximately 3-4 months. Entrance closure periods have ranged from roughly 2.5 years to reportedly as long as 15 years (16).

The level of the one captured entrance opening (from the water level recorder) on the 12/11/2015 was 1.48 m AHD and the duration that the lake then stayed open for was 133 days. Note that the level of the entrance opening does not provide a good surrogate for natural berm height, as the entrance was artificially opened by Council to alleviate flooding pressure. An OEH survey of the entrance berm height (considered to be a better proxy for the natural breakout level) completed on 29 September 2015 while the entrance was closed found the level of the berm crest low point to be 1.9m AHD.

Comparison of Wallagoot Lake water levels to ocean water levels recorded from Twofold Bay in Eden show that when the entrance is open the tidal range is significantly restricted compared to the ocean tidal range, with a maximum tidal range of up to around 0.18 m during a large spring tide (Figure 38). During neap tides, the tidal range drops to around 1-3 cm and can become undetectable. Two periods of water level drops of around 0.3-0.4 m over a period of 3-4 months during the summers of 2013-14 and 2014-15 are evident during the period when the entrance was closed (Figure 37). These drops in water level would largely be attributable to evaporation losses being greater than rainfall gains during the hot summer months of below average rainfall that was experienced over both these periods.

Table 16: Periods of Entrance Closures, Opening and Opening Levels for Wallagoot Lake					
Entrance Closure Date	**Entrance Opening Date**	**WL Height at Opening**	**Closure Duration (days)**	**Open Duration (days)**	**Notes**
Late 1990's	1/03/2012	unknown	~ 15 years	93-113	data provided by Council
1-20 June 2012*	12/11/2015	1.48	~ 2.5 years	133	
24/03/2016	NA	NA	NA	NA	data provided by Council

Notes:

* Entrance closed at some point in June, prior to water level gauge installation on 21/06/2012, but actual date not captured (Elgin, 2014)

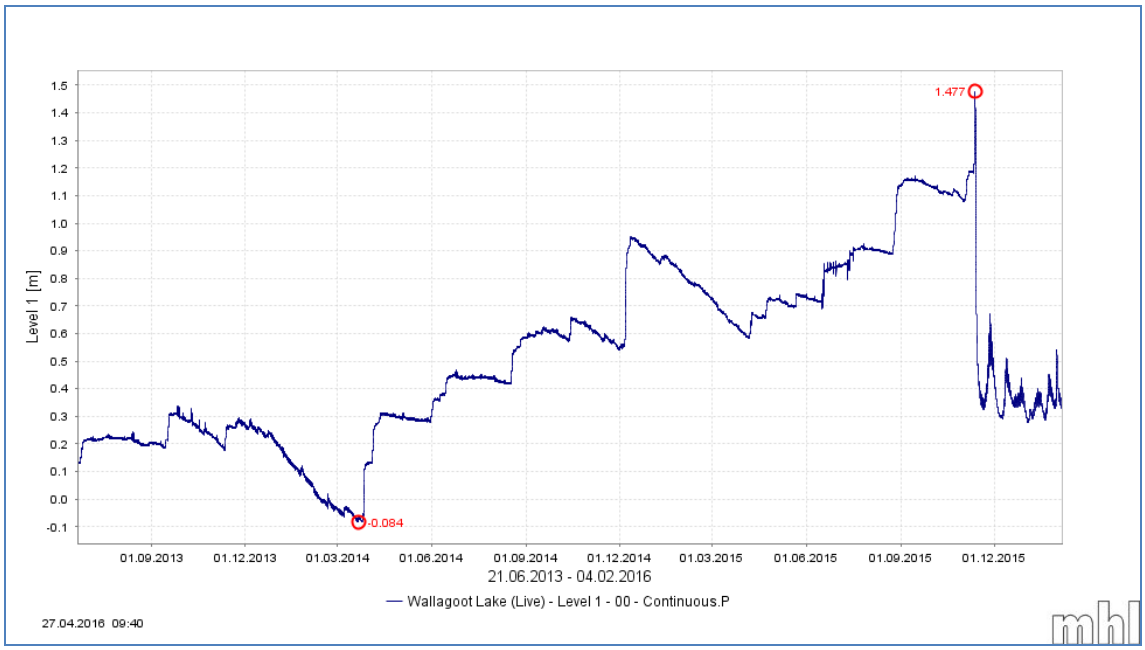

Figure 37: Complete Water Level Data set from Wallagoot Lake Water Level Gauge

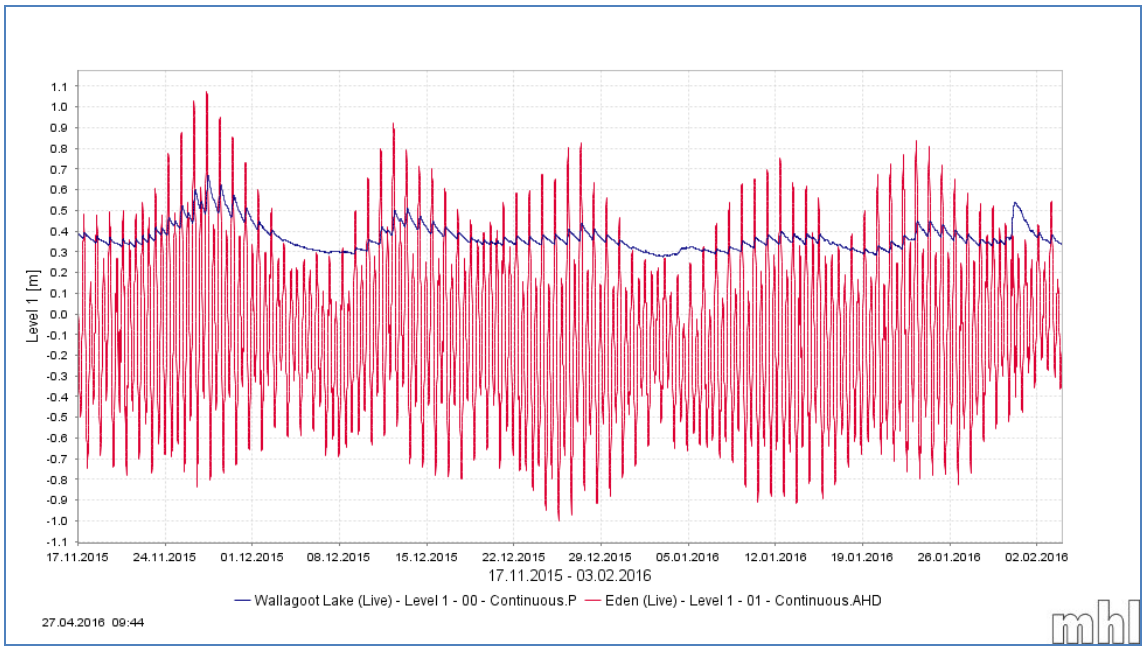

Figure 38: Snapshot of Wallagoot Lake water level record plotted against the open ocean water level record from Twofold Bay in Eden

Due to the infrequent nature of Wallagoot Lake entrance openings, it is difficult to assess the variation in location of the lake entrance from aerial photos (Figure 39). Based predominantly on available photos, recent mechanical entrance openings (2012 and 2015) have been initiated adjacent to the northern rocky foreshore, and have not wandered from this location. It is proposed that future artificial opening works be conducted within 50 metres of the northern rocky foreshore, as outlined in the Wallagoot Lake Entrance Management Policy.

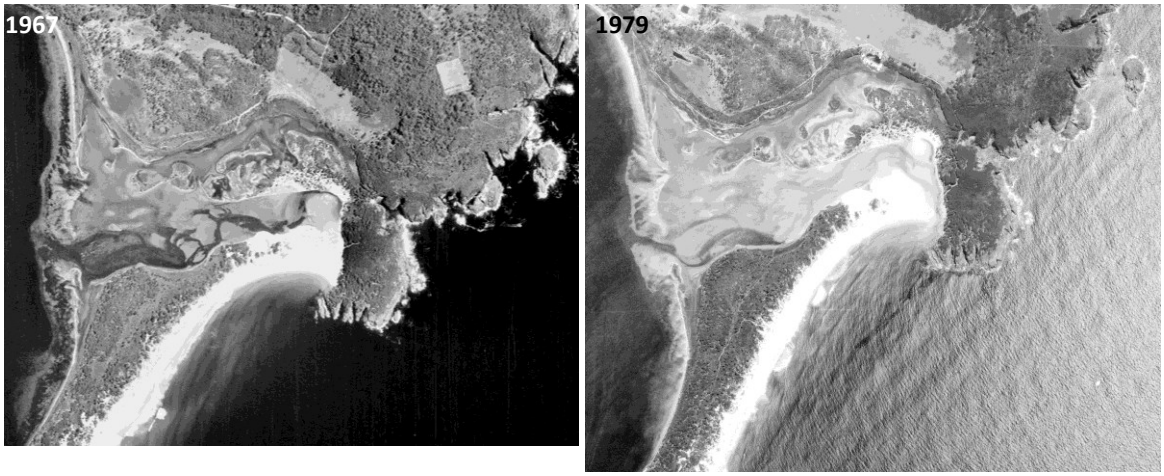

Figure 39: Aerial Photographs of Wallagoot Lake Entrance 1967 to 2015

5.5.3.2 Water Quality

Elgin Associates undertook an environmental monitoring program at Wallagoot Lake on behalf of BVSC between 2010 and 2013 (Elgin, 2014). The program (undertaken using protocols consistent with the Monitoring Evaluation and Reporting program for NSW estuaries), included both surface water quality sampling and depth profiling across the lake. Results indicated that water clarity was typically very high, with turbidity levels significantly lower than the MER guideline. While turbidity was noted to increase following the heavy catchment rainfall/runoff and mechanical entrance opening in March 2012, analysis showed that it remained lower than the MER guideline. Seasonal micro-algae was assessed on the basis of Chlorophyll a sampling throughout the monitoring period. Mean levels of Chlorophyll a ranged between 0.8 and 18.6 µg/L, with levels exceeding the MER guideline (3.6 µg/L) on 5 of the 9 monitoring events including spring 2010, summer and autumn 2011, and autumn and winter 2012. The highest levels of micro-algae were recorded following the entrance opening in March 2012, with Chlorophyll a recorded at 18.6 µg/L. Dissolved Oxygen levels for surface waters were observed to be high (>90% saturation) throughout the 2010 to 2012 monitoring period. In contrast, DO levels were very low at depths greater than 5 m. High levels of Total Nitrogen (primarily organic) were recorded throughout the monitoring period, and typically exceeded ANZECC guideline values, however, nutrients were not measured following the 2012 flood event and entrance opening, so no conclusion was drawn with regards to nutrient levels from catchment runoff.

An important observation from noted in Elgin (2014) was the strong vertical stratification that is often present. Depth profiling of water quality parameters showed that from spring 2010 to autumn 2011, there was a moderate to strong stratification, with the lake “turning over” at some point prior to winter 2011 when minimal stratification was recorded. When stratified, water quality at depths greater than 5 to 6 m typically had low DO and significantly more saline water which was also several degrees cooler. The depth profiling also showed that during periods of heavier rainfall and more significant freshwater inflows, the lake also tended toward a stratified profile with oxygenated freshwaters remaining nearer the surface. During the four month period with the lake entrance open in 2012, depth profiling showed that the lake was well mixed. It is clear from this monitoring campaign that stratified conditions can persist for many months when the entrance is closed, and that the lake relies primarily on wind driven mixing.

With the relatively large depth (5-11 m in central basin), large waterway to catchment ratio, and predominantly forested catchment, pressures on Wallagoot Lake in terms of catchment disturbance and nutrient loads are considerably low (DECCW, 2011) and the lake has a good ability to buffer nutrient loads. In general, monitoring (both the Elgin 2010-2013 and previous programs) have shown that the lake typically has good surface water quality and generally meets the objectives for ecosystem protection.

5.5.4 Ecology

Wallagoot Lake is a listed wetland of National Importance on the grounds of it being a habitat for endangered and/or vulnerable species and due to the historical and cultural significance. There are also a number of SEPP(14) wetlands on the fringes of the lake. Wallagoot Lake and its surrounds provides habitat for a number of significant flora and fauna species, and for the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, the lake entrance and its immediate surrounds where defined within the geographical domain:

GDA94

North: -36.77 South: -36.80 East: 149.91 West: 149.91

Within this domain, The Atlas of NSW Wildlife identified 159 fauna and 10 flora species protected under the Threatened Species Conservation Act 1995, 9 species listed under the Environment Protection and Biodiversity Conservation Act 1999, and 20 species listed under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

5.5.4.1 Flora

Figure 41 shows a map identifying threatened flora locations around the Wallagoot Lake estuary.

Aquatic Vegetation

Mapping of aquatic vegetation has shown that Wallagoot Lake has an extensive seagrass community, estimated to cover 744,000 m^2 (19%) of the estuary area (Creese et al, 2009). Seagrass species include Zostera muelleri (eelgrass), Halophila ovalis (paddleweed) and Ruppia spp. (sea tassel), which are primarily restricted to shallower sections of the lake (see Figure 40). These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are import marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997. While the invasive Caulerpa taxifolia was found in Wallagoot Lake almost a decade ago (in particular around Scotts Bay), intervention has eradicated this species and prevented its takeover of native seagrasses (Elgin, 2014)

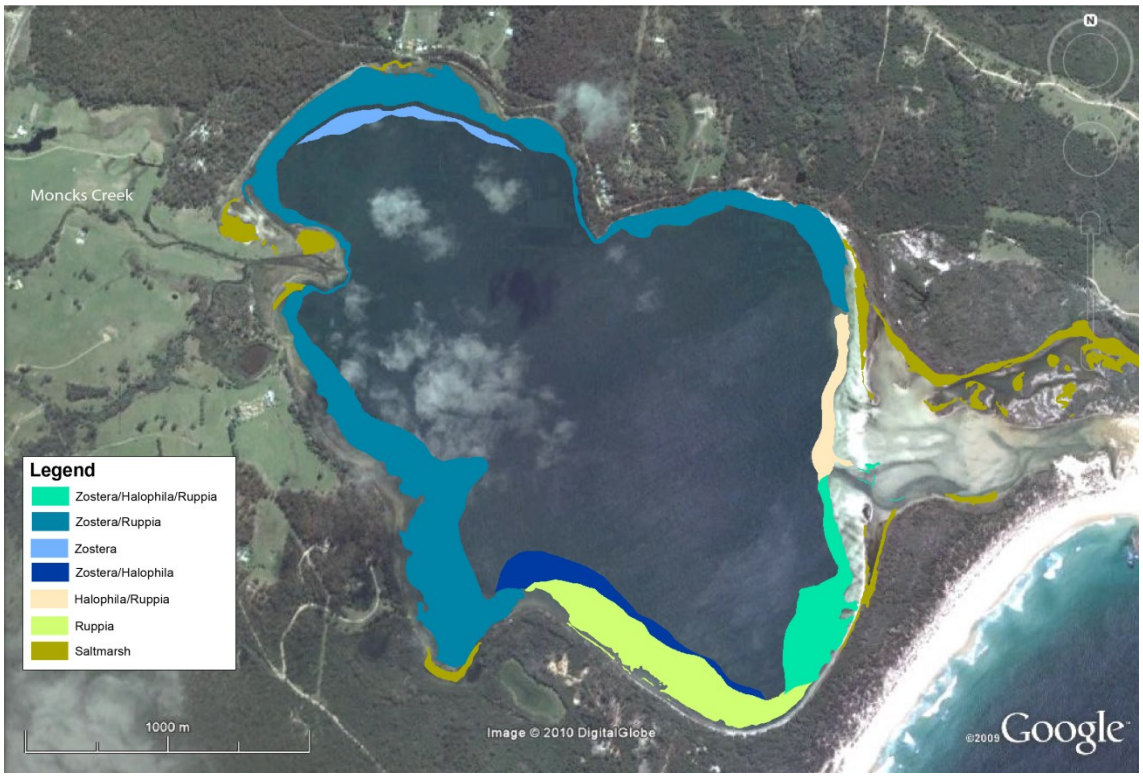

Figure 40: Aquatic Vegetation Species and Distribution in Wallagoot Lake (Creese, et al, 2009; Elgin, 2014)

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under either NSW (Threatened Species Conservation Act 1995) and/or Australian (Environment Protection and Biodiversity Conservation Act 1999) government legislation are known to occur within the Wallagoot Lake estuarine catchment. These EECs cover a total area of 5.8 km^2 and include Coastal Saltmarsh, Freshwater Wetlands on Coastal Floodplains, Bangalay Sand Forest, Lowland Grassy Woodland, Littoral Rainforest, River Flat Eucalypt Forest and Swamp Sclerophyll Forest on Coastal Floodplains.

Small and localised areas of saltmarsh occur on the fringes of the estuary and are mapped as covering 118,000 m^2 (3%) of the estuary area (Creese et al, 2009). The largest and most notable of these areas occurs along the northern fringes of the flood tide delta in the eastern corner of the lake. This endangered ecological community comprises a complex of succulent herbfields and sedgelands predominately characterised by Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha, Austrostipa stipoides along with Scirpus nodosa and Sporobolus virginicus (Tozer et al 2004). This community of species is very important to estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients.

The Freshwater Wetlands on Coastal Floodplains endangered ecological community occupies an area ≈206,300 m^2, and is predominantly located on the fringes of the creeks that feed into the western side of the lake. Melaleuca ericifolla, Baumea articulata, Periscaia Praetermissa, Phragmites australis, Triglochin procerum, Typha orientallis and Cladium procerum typically characterise this endangered ecological community which provides important habitat, food and water source for freshwater fish, amphibian, native mammal and bird species (Tozer et al 2004).

Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions endangered ecological community occupies a total area of ≈284,000 m^2 at various locations around the Wallagoot Lake catchment, however, very little (≈12,000 m^2) of these areas are directly linked to the lake foreshore. Predominantly the areas of Bangalay Sand Forest are located on the dunes behind Bournda Beach to the south of the lake entrance, and also within the area of coast behind the rocky foreshore to the north of the lake entrance. Bangalay Sand Forest typically has a dense to open tree canopy and occurs on dunes exposed to salt-bearing sea breezes. The most common vegetation species within this endangered ecological community are Eucalyptus botryoides, Banksia integrifolia subsp. Integrifolia, Eucalyptus pilularis, Acmena smithii, Dianella spp., Lepidosperma concavum, Lomandra longifolia, Pteridium esculentum (Bracken), and the grasses Imperata cylindrical, Microlaena stipoides var. stipoides, Themeda australis (Tozer et al 2004). This vegetation complex once would have occupied many coastal localities however clearing, habitat degradation and weeds have caused substantial losses across the NSW state. As a result this remanent vegetation community has been placed as endangered and likely to become extinct unless the circumstances and factors threatening its survival cease to operate (NSW Scientific Committee 2012).

A single stand of the Swamp Sclerophyll Forest on Coastal Floodplains EEC is mapped as being present on the southwestern foreshore of the lake, adjacent to private property. This EEC occupies an area of approximately 28,750 m^2. Typical species often found in this EEC include Eucalyptus robusta Melaleuca quinquenervia and, south from Sydney, Eucalyptus botryoides and Eucalyptus longifolia. Swamp Sclerophyll Forest on Coastal Floodplains EEC provides

habitat for a broad range of animals, including many that are dependent on the vegetation for food, nesting or roosting such as Sugar Glider, Osprey, Yellow-bellied Glider etc.

The Lowland Grassy Woodland in the South East Corner Bioregion endangered ecological community occupies a total area ≈5,012,550 m^2 at a number of localities around the lake. The most significant areas are located on the fringes to the creeks to the west and north-west of the lake, though other notable areas occur around Wallagoot Lake Road to the north of the marine flood tide delta on the northern foreshore of the lake. This community complex typically comprises of Acacia mearnsii, Angophora floribunda, Eucalyptus globoidea, Eucalyptus tereticornis, Bursaria spinosa, Ozothamnus diosmifolius, Clematis glycinoides var. glycinoides, Rubus parvifolius, Cheilanthes sieberi, Desmodium varians, Dichondra spp., Echinopogon ovatus, Eragrostis leptostachya, Glycine clandestine, Glycine tabacina, Hydrocotyle laxiflora, Hypericum gramineum, Lepidosperma laterale, Lomandra longifolia, Lomandra multiflora subsp. Multiflora, Microlaena stipoides, Oxalis perennans, Themeda australis, Wahlenbergia gracilis (Tozer et al 2004). Habitat fragmentation due to clearing and grazing has reduced the ecological function of this community since European settlement resulting in a substantial loss of mammal flora. After an examination of historical and contemporary survey data Lunney and Leary (1988) concluded that at least six native mammal species had become locally extinct, including the Wallaroo (Macropus robustus), the Parma Wallaby (Macropus parma), the red-necked Pademelon (Thylogale thetis), the Tasmanian Bettong (Bettongia gaimardi), the Eastern Quoll (Dasyurus viverrinus) and the Brush-tailed Phascogale (Phascogale tapoatafa).

Littoral Rainforest is an endangered ecological community in NSW and a critically endangered commonwealth community that occupies a total area of ≈110,000 m^2 predominately around Wallagoot Lake Road, just north of the marine flood tide delta. Littoral rainforest is typically characterised by Angophora costata, Banksia integrifolia, Eucalyptus botryoides and Eucalyptus tereticornis, Leptospermum laevigatum, Acmena smithii, Breynia oblongifolia, Notelaea longifolia, Stephania japonica var. discolour, Lomandra longifolia, Oplismenus imbecillis and is home to many vulnerable micro-organisms, fungi, cryptogamic plants and a diverse fauna, both vertebrate and in-vertebrate (Tozer et al 2004).

The River-Flat Eucalypt Forest on Coastal Floodplains is an endangered ecological community that occupies several small localised stands with a total area of only ≈22,500 m^2. No areas of this EEC in the Wallagoot Lake catchment are directly connected to the lake, with mapping showing most areas dotted around the catchment of Monchs Creek to the west of the lake. This community is typically comprised of Eucalyptus. Baueriana, Eucalyptus botryoides, Eucalyptus elata, Eucalyptus ovata, Rubus parvifolius, Breynia oblongifolia, Hymenanthera dentate, Glycine clandestine, Stephania japonica, Microlaena stipoides, Lomandra longifolia, Pteridium esculentum, Oplismenus aemulus, Pratia purpurascens, Echinopogon ovatus, Entolasia marginate, and Desmodium varians (Tozer et al 2004). This EEC provides habitat for a broad range of flora, including many that are dependent on the vegetation for food, nesting or roosting such as the White-bellied Sea-eagle, Kingfishers, Owls, Yellow-bellied Glider etc. The clearing of native vegetation; alteration to the natural flow regimes; invasion of native plant communities by exotic perennial grasses; anthropogenic climate change; high frequency fire; and Removal of dead wood and dead trees are listed as threatening processes leading to the NSW Scientific Committee determining that River-Flat Eucalypt Forest is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2012).

In addition to the identified endangered ecological communities a NSW listed vulnerable plant species, occurs within the catchment of Wallagoot Lake. This plant species is the Bodalla

Pomaderris (Pomaderris bodalla). The mapped occurrences of this species within the catchment have been well set back from the lake, and are therefore unlikely to be impacted by lake processes.

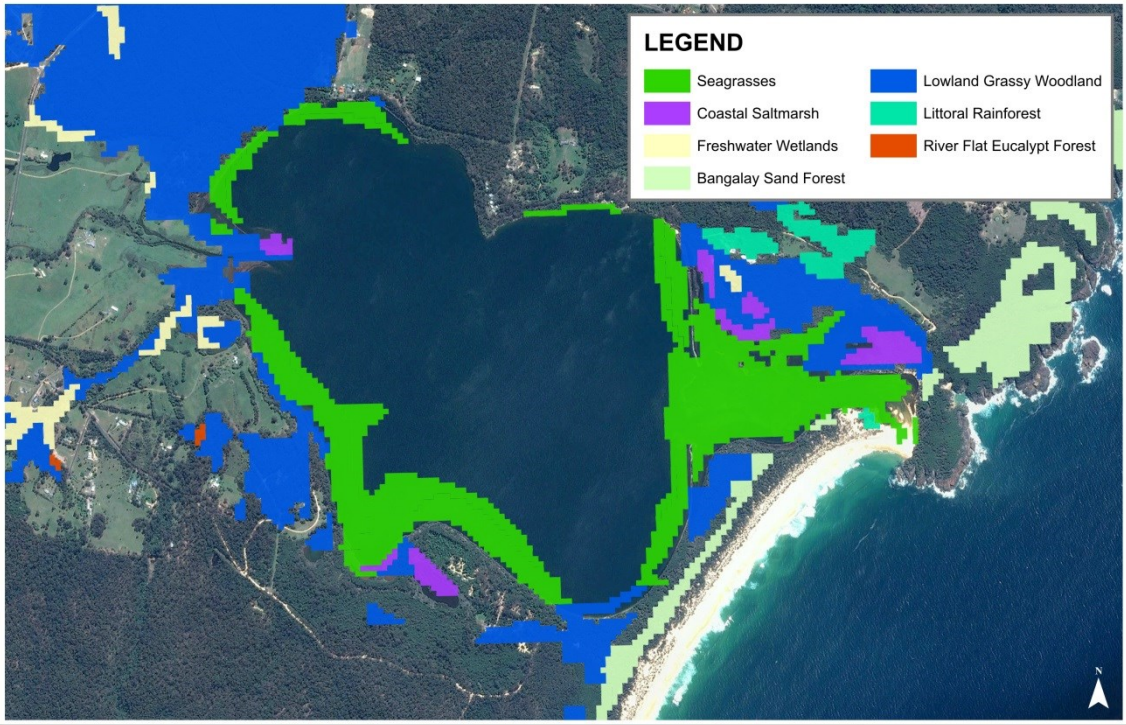

Figure 41: Threatened Flora – Wallagoot Lake

5.5.4.2 Fauna

Figure 42 identifies the location of threatened fauna throughout the Wallagoot Lake estuary area based on the Atlas search.

Mammals

The Atlas of NSW Wildlife has identified 3 species listed as vulnerable under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 1 is listed as vulnerable and 1 listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in 17:

Table 17: Threatened Mammals in the Wallagoot Lake Region			
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**
Spotted-tailed Quoll	Dasyurus maculatus	V	E
Koala	Phascolarctos cinereus	V	V
Yellow-bellied Glider	Petaurus australis	V	

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

Birds

The Atlas of NSW Wildlife has identified 9 bird species listed as vulnerable and 5 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 1 is listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition 3 species are protected under the Japan-Australia, Republic of Korea-Australia and China-Australia Migratory Birds Agreements. These species are shown in Table 18:

Table 18: Threatened Avifauna in the Wallagoot Lake Region				
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**	**Migratory Bird Agreements**
Australasian Bittern	Botaurus poiciloptilus	E	E	
Little Eagle	Hieraaetus morphnoides	V		
Sooty Oystercatcher	Haematopus fuliginosus	V		
Pied Oystercatcher	Haematopus longirostris	E		
Hooded Plover	Thinornis rubricollis	E		
Sanderling	Calidris alba	V		C,J,K
Curlew Sandpiper	Calidris ferruginea	E		C,J,K
Little Tern	Sternula albifrons	E		C,J,K
Gang-gang Cockatoo	^^Callocephalon fimbriatum	V		
Little Lorikeet	Glossopsitta pusilla	V		
Eastern Ground Parrot	^^Pezoporus wallicus wallicus	V		
Powerful Owl	^^Ninox strenua	V		
White-fronted Chat	Epthianura albifrons	V		
Varied Sittella	Daphoenositta chrysoptera	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife didn't identify any threatened reptile or amphibian species within the study area.

Aquatic Fauna

A list of aquatic fauna found in Wallagoot Lake was published in Sulisit (2012), and has been reproduced in Table 19.

Table 19: Aquatic Fauna in the Wallagoot Lake Region

Species	Scientific Name	Common Name	Abundance/Location
Fish	Girella tricuspidata	Luderick/Blackfish	Upper estuary & fresh
	Acanthopagrus australis	Yellowfin Bream	Lower estuary
	Acanthopagrus butcheri	Black Bream	Upper estuary
	Rhombosolea tapirina	Flounder	Lower estuary
	Atherinidae	Hardy Heads	Lower estuary
	Platycephalus fuscus	Dusky Flathead	Lower/Upper estuary
	Arenigobius bifrenatus	Bridled Goby	Lower estuary
	Pagarus auratus	Snapper	Lower estuary
	Arenigobius sp.	Goby sp.	Lower estuary
	Pomatomus saltrix	Tailor	Lower estuary
	Hyporhamphus regularis	River Garfish	Upper estuary & fresh
	Syngnathidae	Pipe Fish	Lower estuary
	Mugliadae cephulus	Sea Mullet	Upper estuary & fresh
	Anguilla australis	Short finned Eel	Upper estuary & fresh
	Anguilla reinhardtii	Long finned Eel	Upper estuary & fresh
Crustaceans	Paridotea ungulata	Sea Centipede	Lower estuary
	Amphipoda Sp	Beach Hopper	Lower estuary
	Palaemon intermedius	Red spotted Shrimp	Lower estuary
	Penaeus plebejus	King Prawns	Lower estuary
Jellyfish/ Cnidaria	Catostylus mosaicus	Mosaic Jelly	Lower estuary
	Aurelia aurita	Moon jelly	Lower estuary
Molluscs	Anadara trapezia	Sydney cockle	Lower estuary
	Austrocochlea porcata	Zebra winkle	Lower estuary
	Soletellina Sp	Sunset Shell	Lower estuary
	Buccinidae Sp	Little Whelk	Lower estuary
	Batillaria australis	Southern mudwhelk	Lower estuary
	Trochidae Sp	Top Shell	Lower estuary
	Tellinidae Sp	Tellin Shell	Lower estuary

	Idiosepius notoides	Pygmy Squid	Lower estuary
	Euprymna tasmanica	Dumpling Squid	Lower estuary
	Anadara trapezia	Bimbula	Lower estuary
	Laternula marilina	Fragile Bivalve	Lower estuary
	Polinices sordidus	Leaden moon snail	Lower estuary
	Pyrazus ebeninus	Hercules club whelk	Lower estuary

Figure 42: Threatened Fauna – Wallagoot Lake

5.5.5 Cultural Heritage

5.5.5.1 Aboriginal Cultural Heritage

Sites of Aboriginal cultural significance, such as middens, camping areas, artefact scatters, shelters and other sites are frequent around Bega Valley Shire Council estuary shorelines, beaches and islands. There are also many areas of spiritual and cultural significance, the details of which are not generally known and are unlikely to be made known to people other than the tribal custodians of the knowledge.

The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance. The investigation included searches of the NSW OEH AHIMS, the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access tracks and entrance opening area.

While the AHIMS search across the broader Wallagoot Lake region identified a large number of objects, only three of these were identified within the immediate northern access track area and four within the immediate southern access track area. The relevant objects for both southern and northern access tracks are summarised in 20. This table also provides a statement of significance for each object, which has considered the social or cultural value to contemporary Aboriginal people, historical value, scientific/archaeological value and aesthetic value. During the field inspection undertaken for this project, one new site was identified over a 10 m length of eroded track on the north side of Bournda Lagoon, and has been identified as "*Bournda Lagoon 3 – BL3*".

Table 20: Identified Aboriginal Objects Relevant to Wallagoot Lake Entrance Management (Dibden, 2016)							
Site ID	**Description**	**Identifier/Date**	**Statement of Significance**	**Datum**	**Easting (m)**	**Northing (m)**	**2016 Field Inspection Details**
62-6-0144 *Wallagoot Lake No 2*	Artefact	Unknown	Low/moderate local significance	AGD	764100	5924300	Stone artefacts found
62-6-0217 *BNPJT2*	Artefact	Ben Evans	Low/moderate local significance	AGD	764080	5924250	Stone artefacts found
62-6-0285 *BNPJT2*	Artefact	Ben Evans	Low/moderate local significance	AGD	764080	5924250	Stone artefacts found
62-6-771 *BL1*	Artefact	Sue Feary	Low local significance	GDA	762022	5921426	Stone artefacts not found
62-6-771 *BL2*	Artefact	Sue Feary	Low local significance	GDA	762022	5921424	Stone artefacts not found
62-6-57 *Bondi Lake*	Shell, Artefact	ASRSYS	Moderate local significance	AGD	762700	5921800	Not inspected
62-6-58 *Bondi Lake*	Burial	ASRSYS	High local significance	AGD	762800	5922500	Not inspected
Bournda Lagoon 3 BL3	Artefact	Julie Dibden	Low local significance	GDA	762058	5921526	New site

5.5.6 Recreational and Commercial Uses

5.5.6.1 Recreation

Wallagoot Lake is used extensively for a range of recreational activities including sailing, kayaking, water skiing, swimming, fishing, prawning, bushwalking, camping, bike riding and bird watching. Bournda National Park provides a range of popular facilities around the lake that support these activities including the Wallagoot Lake boat Ramp, Wallagoot Lake Sailing Club, designated walking tracks, environmental education activities, car parking and toilets.

5.5.6.2 Commercial

Fisheries: Wallagoot Lake is closed to commercial fishing for part of the year, with restrictions on the types of nets that are allowed to be used (DPI, 2016). Sulisit (2012) reported that at that time there was only one commercial operator using the lake.

Tourism: The economies of coastal towns in the Bega Valley such as Tathra and Merimbula have become increasingly dependent on tourism. The recent inclusion of the Bega Valley Shire Coastline in the "Wilderness Coast" by Tourism Australia has reinforced the importance of the protection of areas with high natural and recreational value to tourism, such as the Wallagoot Lake. The natural qualities of the local coastal zone have the potential to provide a distinct marketing advantage to the local tourism industry.

Agriculture: Freehold grazing land exists around large parts of the lake foreshore. These areas are being utilised to graze cattle and other agricultural purposes and are therefore important to the livelihood of a number of local families.

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

5.6 Description of the Activity Impacts

5.6.1 Acid Sulfate Soil Impacts

It is highly unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Wallagoot Lake has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

5.6.2 Erosion and Sedimentation Impacts

While artificial opening of the entrance at lower water levels in theory has the potential to result in increased ingression of marine sand to the lower part of the lake, due to the very infrequent nature that mechanical opening of the entrance is expected to be required (based on previous occurrences), and the comparatively short duration that the entrance tends to stay open for, it is very unlikely that noticeable sedimentation will actually occur. This is

further supported by Council's intention to undertake management works for Wallagoot Lake Road within the next 5 years to allow raising of the opening trigger level to 1.4 m AHD, and higher into the future beyond that.

With regards to bank erosion, if anything, limiting lake water levels to 1.4 m AHD would actually reduce the risk of bank collapse by limiting bank inundation and bank destabilisation potential resulting from a rapid drop in water level post entrance opening.

5.6.3 Hydrology Impacts

The works will have a moderate negative impact on the lake as entrance opening is an important determinant of the hydraulic character. Natural breakout of Wallagoot Lake would tend to occur during or soon after a significant rainfall event. Rainfall is a necessary precursor to raise water levels to a level significantly greater than mean sea level, and to 'liquefy' the sand barrier and reduce its cohesion. The ability of the lake water to erode a deep and wide entrance channel once opened is directly related to the head difference that exists between the lake and the ocean at the time of breakout. A large head difference will result in a larger and deeper channel.

Therefore, intervention in the breakout process at low lake water levels with an unsaturated entrance bar will reduce the capacity of the opening to erode sediments from the lake, and potentially result in reduced scour of the entrance channel. This in-turn has the potential to result in less tidal exchange to the lake while the entrance is open and a reduced amount of time until the entrance closes again (altering the extent of flushing and chemistry of the lake that would occur naturally).

Positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid increases in dissolved oxygen concentrations resulting from rapid decay of organic material. Moreover water quality within the estuary would be better managed through reducing catchment inputs, for example, by minimising nutrients from agricultural activities, and by rehabilitating riparian buffers, rather than artificially breaching the entrance.

5.6.4 Aquatic Vegetation Impacts

Entrance opening and the resulting drop in water levels has the potential to have a slight negative impact on aquatic vegetation. The predominant potential negative impacts include:

- the scouring of Zostera/Halophila/Ruppia, particular in the lower section of the lake's central basin in the area adjacent to the marine flood tide delta
- the exposure of seagrasses in shallow sections of the lake to lower water depths.

However, it should be noted that scour of aquatic vegetation can also occur (and is likely more possible) during natural entrance openings, and exposure of aquatic vegetation to low water levels is more likely to occur through evaporation when the lake is entrance is closed.

5.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The works have the potential to indirectly have moderate adverse impacts on several transitional and fringing endangered ecological communities (EECs), most notably Coastal Saltmarsh. These impacts occur as the natural flow regimes and upper range water levels of Wallagoot Lake have and will be altered by the entrance opening works. Endangered ecological communities such as Coastal Saltmarsh, Lowland Grassy Woodlands, Littoral Rainforest and Swamp Sclerophyll Forest on Coastal Floodplains have the potential to be indirectly impacted due to reduced inundation (in terms of inundation depth, extent and duration). This can result in significant species composition shifts and also allow the encroachment of terrestrial vegetation.

It is identified that some species dieback will occur following long periods of inundation and entrance opening may relieve this pressure. However, it must be noted this is a natural reclamation process and many endangered ecological communities rely on this dieback and inundation for survival. Ongoing artificial entrance opening at the lower range of natural break-out water levels will therefore continue to have moderate negative impacts on several transitional and fringing endangered ecological communities, though not to the same degree as other managed ICOLLs due to the very infrequent nature of intervention.

A Section 5A assessment for the endangered ecological communities is located in Section 5.8.

5.6.6 Direct Impacts to Access Track Vegetation

As discussed in Section 5.2, there are two potential tracks that will be will be used to provide access and egress for the excavator as shown in Figure 35. Both are existing and predominantly cleared tracks that have been selected for the access route, so as to minimise impacts to surrounding vegetation. In driving the excavator along either of these tracks, it is expected that minor disturbance of the gravel track base and previously fallen (naturally or through track maintenance) vegetation on the access track may occur. There may also be small sections of the track where hand pruning of low hanging shrub branches (predominantly Coastal Tea Tree) will be required. There will be no need to remove trees to provide access, and there will be no damage to hollow bearing trees. Once on the dune area of the beach, there may be minor and very localised damage to Spinifex grasses that are growing on the edges of the track. Photographs of both the northern (Wallagoot Lake Road) and southern (Bournda Lagoon) access tracks are shown in Figure 43 and Figure 44 respectively, where it can be seen that there will be minimal impacts to vegetation from machine access.

Figure 43: Photos of Wallagoot Lake Preferred Access Track and Vegetation (Northern Access Track from Wallagoot Lake Road and Turingal Head Carpark)

Figure 44: Photos of Wallagoot Lake Alternative Access Track and Vegetation (Southern Access Track from Bournda Lagoon Carpark)

5.6.7 Fauna Impacts

Mammals

It is very unlikely the entrance works will have any direct impact on threatened mammal species or endangered populations, however, it is possible that the works would indirectly impact species due to habitat changes (as discussed in Section 5.6.5). It must however, be recognised that water levels will be within the natural range, even with mechanical entrance opening as outlined in the Wallagoot Lake Entrance Management Policy.

Birds

Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works including machine access and channel excavation could potentially have a significant negative impact on a number of resident and migratory threatened shorebird

species. Shorebirds inclusive of the Pied Oystercatcher, Sooty Oystercatcher, Hooded Plover, Sanderling, Little Tern and Curlew Sandpiper could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- Machine access routes that minimises areas of dune impacted by the machine;
- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators, restrict pedestrian access and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform additional adaptive management responses on an “opening-by-opening” basis, as opposed to a “one-off” survey for this REF. A Section 5A assessment has been carried out for the potentially impacted shorebird species (Pied Oystercatcher, Sooty Oystercatcher, Hooded Plover, Sanderling, Little Tern and Curlew Sandpiper), and is included in Section 5.8. As the impacts to this species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement. Entrance opening works are unlikely to negatively impact other threatened bird species, rather the reduction in water levels may expose feeding grounds and food sources (decomposing vegetation and invertebrates) for many of the bird species.

Amphibians and Reptiles

No threatened amphibian or reptile species were identified from the Atlas search within the areas impacted by the Entrance Management Policy.

Aquatic Fauna

The entrance works will have both positive and negative impacts on aquatic animal species. These positive and negative impacts could include assemblage changes, habitat shifts, and fish kills. As the entrance works rapidly change the surrounding environment, some species may benefit and others may perish due to stress from low dissolved oxygen and sudden salinity increases, however, it should be noted that such changes would also be expected to occur as a result of natural entrance openings. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and lake water levels will remain within the natural range.

5.6.8 Aboriginal Cultural Heritage Impacts

In broad terms the entrance management works may indirectly have both positive and negative impacts on Aboriginal cultural heritage sites located around the fringes of the greater lake area. Positive impacts include opening the entrance prior to naturally high lake water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts include an increased frequency of wetting and drying from rises and falls in Lake water level as a result of more frequent entrance openings.

Given that existing access tracks will be used, and excavation of the entrance channel will take place through marine sands that are historically transient and mobile in nature, direct impacts to undisturbed deposits can generally be considered minimal in extent and area. (Dibden, 2016). An impact assessment for each identified Aboriginal object was undertaken in the ACHAR (see Appendix J), with a summary of impacts provided in Table 21.

Table 21: Impacts on Aboriginal Objects from Implementation of Wallagoot Lake Entrance Management Policy (Dibden, 2016)

Site ID	Type of Harm	Degree of Harm	Consequence of Harm
62-6-0144 *Wallagoot Lake No 2*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-6-0217 *BNPJT2*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-6-0285 *BNPJT2*	Direct	Partial (site is likely to	Partial loss of value

		extend outside of the impact area)	
62-6-771 *BL1*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-6-771 *BL2*	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
BL3	Direct	Partial (site is likely to extend outside of the impact area)	Partial loss of value
62-6-57 *Bondi Lake*	nil	n/a	n/a
62-6-58 *Bondi Lake*	nil	n/a	n/a

With regards to minimising and mitigating harm, Dibden (2016) reported "generally, the areas in which impacts would occur are of insufficient value and significance to warrant a serious consideration of Ecological Sustainable Development (ESD) and cumulative harm. The sites are generally disturbed as a result of previous impacts. The cultural and archaeological significance of these (*sites)* has not been assessed to be of sufficient significance to warrant the implementation of avoidance or mitigation strategies.". Nevertheless, to allow Council to proceed with works that will result in direct harm (though of low significance or extent), a Section 90 AHIP has been sought for the works.

Dibden (2016) made the following recommendations in the ACHAR with regards to mitigation of impacts from the entrance management works:

- For sites potentially impacted along the northern access track (62-6-0144 *Wallagoot Lake No 2*, 62-6-0217 *BNPJT2* and 62-6-0285 *BNPJT2)*, salvage recording of artefacts form a part of the mitigation strategy;
- For sites potentially impacted along the southern access track (62-6-771 *BL1*, 62-6-771 *BL2*, *BL3*, 62-6-57 *Bondi Lake* and 62-6-58 VW10 *Bondi Lake*), monitoring of sites when excavator access occurs, and all machinery access should take place within the corridor identified (within the intertidal and wave runup areas of the beach).

5.6.9 Recreational Impacts

Lake water levels vary significantly with natural processes, and previous monitoring has shown that the lake entrance is typically only open to the sea on rare occasions (average time between openings of more than a decade). Once open, the lake entrance normally closes again within a few months. It is therefore relevant to note that on the whole, recreational activities are more likely impacted by natural variations in water level when the entrance is closed, than water level fluctuations induced by a mechanical entrance opening. In particular, when the lake entrance is closed, high water levels during wet periods can inundate Wallagoot Lake road and boat ramp, limiting access for many recreational activities. Negative impacts on recreational activities will mostly be associated with fishing and prawning, with an open lake entrance providing an opportunity for species to migrate to the sea (as a part of their natural movements). However, largely it is expected that implementation of the Wallagoot Lake Entrance Management Policy will result in positive impacts to recreational activities.

5.6.10 Commercial Impacts

Impacts to commercial activities will mostly be associated with commercial fisheries, through species and abundance changes when the lake is opened to the sea. As discussed in Section 5.5, it is understood that at present there is only 1 licenced commercial fishing operator working in Wallagoot Lake, and fishing activities are restricted to certain times of year. As such it is considered that the positive impacts to private and public assets and to recreational activities, outweigh any potential negative impacts to commercial fishing.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

5.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The community most likely to be affected will be the residents within close proximity to Wallagoot Lake. There will be no significant adverse impact upon the general wider community. Malodorous conditions can sometimes occur for a few days after an entrance opening due to the rotting vegetation around the lake shoreline; however, this can also occur naturally during dry periods when lake water levels drop. There are a small number of lakeside property owners who will be directly affected by elevated lake levels. Access to a number of private properties off Wallagoot Lake Road, launching of vessels at the boat ramp, access to the Wallagoot Lake Sailing Club, and access to National Park facilities are hindered by flooding during periods of high lake water level. As the only purpose for conducting the entrance opening works is to eliminate these impacts, the activity will have positive outcomes for the community beneficiaries.
b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The locality will not be transformed in any significant manner. The lake entrance will change temporarily, but these changes will be within natural bounds.
c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There are a range of environmental impacts on the ecosystems of Wallagoot Lake as discussed in Section 5.6. The cumulative impacts of the entrance works may and most likely have caused low adverse environmental impacts on the ecosystems of the fringes of Wallagoot Lake. These impacts predominantly relate to hydrologic and ecological shifts from natural states, as a result of lower water level breakouts, and lake water levels no longer being allowed to reach the upper levels that would naturally occur. As Wallagoot Lake is predominantly closed to the sea, mechanical openings will only be required on rare occurrences. Furthermore, BVSC has intentions to undertake improvements to Wallagoot Lake Road that will allow the trigger water level for mechanical opening to be raised in the future. As such, long term adverse impacts to fringing and aquatic ecosystems are expected to be low.
d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There is not likely to be any reduction in the aesthetic quality or value of the locality as a result of implementing the Policy.

	The impact upon fish and prawn populations may have a bearing upon the recreational value. If an artificial breakout allows a large population of prawns and fish to escape to sea there would be a significant loss of recreational opportunity, especially if this occurred just prior to the Christmas/New Year holiday period. However, an artificial opening could enhance recreational prawning and fishing opportunities the following year if the opening coincided with a high abundance of prawn larvae and fish spawning in nearshore coastal waters. Such conditions are impossible to predict. On balance and over the long term, these impacts are likely to be slightly negative. Impacts to other recreational activities such as sailing, kayaking, and walking are deemed positive, as implementation of the Policy removes the limitations on access to the lake at high water levels. Overall it is considered that these positive impacts dominate the consequences for recreational activities that will result from implementation of the Policy. While intervention in the natural breakout process conceptually diminishes the scientific value of the system since an element of 'naturalness' has been lost, in reality the vast majority of ecological processes will continue to operate. As demonstrated over the past 15-20 years during which time mechanical intervention in the lake entrance opening has been occurring, Wallagoot Lake has remained a highly valued location for environmental science and education to the broader south coast region. As such, implementation of the Policy is expected to have negligible impact on the scientific value of the Lake.
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Impacts on the scientific value of the Wallagoot Lake beyond those already occurred are expected to be minimal. The completed ACHAR identified that there is the potential for direct partial harm that will result in a partial loss of value for up to 4 recognised sites containing Aboriginal objects. In general, the suggested mitigation is limited to monitoring when access occurs along the southern access track, and salvage recording of artefacts when access occurs along the northern access track. Council have sought an AHIP from OEH as a precautionary measure and to proceed with works that have the potential to cause harm of low significance.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? [3] ☐ **n/a or negligible** ☐ positive ☒ low adverse ☒ medium adverse ☐ high adverse Comment: There is potential that moderate adverse impacts may result to habitat of protected fauna. These impacts are documented in Section 5.6 and primarily result from hydrologic changes (increased frequency and lower water level opening) and habitat disturbance due to machinery and channel scour.

.

	While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher, Sooty Oystercatcher, Hooded Plover, Sanderling, Little Tern and Curlew Sandpiper, by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 5.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 5.8.
g.	Will there be any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The endangered ecological communities listed in Section 5.6 (i.e. Coastal Saltmarsh, Lowland Grassy Woodlands, Littoral Rainforest and Swamp Sclerophyll Forest on Coastal Floodplains) in conjunction with identified threatened mammal species (such as Spotted Tail Quoll, Koala and Yellow-Bellied Glider) may be moderately impacted by the entrance management works. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher, Sooty Oystercatcher, Hooded Plover, Sanderling, Little Tern and Curlew Sandpiper, by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 5.6.7 and the Policy, these impacts will be reduced to low adverse. For these communities and fauna species a Section 5A assessment has been prepared and is contained in Section 5.8.
h.	Will there be any long-term effects on the environment? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The cumulative impacts of the entrance works may in the future indirectly cause low to medium adverse environmental impacts on the ecosystems of the Wallagoot Lake estuary. These impacts are documented in Section 5.6 and primarily involve: a relative shift in the structure, composition, diversity, and location of the lakes fringing ecology; and reduced frequency and duration of flooding at higher levels.
i.	Will there be any degradation of the quality of the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The quality of the Lake environment will be degraded by virtue of the fact that a major natural process is being interfered with. In effect the lake is losing a major element of 'naturalness'. Naturalness is a significant environmental attribute. It is often a criteria used to determine environmental or conservation value. Although this activity has occurred in the past, the works continue to perpetuate the problem.
j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of

	undertaking the entrance opening works. The robustness or ability of the environment to withstand environmental fluctuations should not be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above. On the whole, there will be positive benefits to the use of the environment through improved access at high lake water levels.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not result in any pollution of the environment.
m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Although it is difficult to predict what other future activities might take place it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or on the foreshore.
p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse

	Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. The Policy has been developed with a plan to adapt low lying assets to alleviate the need to intervene in natural entrance behaviour in the longer term, including the impacts of sea level rise.

5.8 7-Part Test for Threatened Species, Populations and Ecological Communities

5.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Pied Oystercatcher (Haematopus longirostrus), Sooty Oystercatcher (Haematopus fuliginosus) and Hooded Plover (Thinornis rubricollis)

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations will be adversely impacted to any significant degree, and certainly not such that viable local populations are placed at risk of extinction, provided the Policy and associated mitigation measures are followed.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result,

habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallagoot Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of Lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wallagoot Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

5.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Migratory Shorebirds - Sanderling (Calidris alba), Little Tern (Sternula albifrons) and Curlew Sandpiper (Calidris ferruginea)

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations will be adversely impacted to any significant degree, and certainly not such that viable local populations are placed at risk of extinction, provided the Policy and associated mitigation measures are followed.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallagoot Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of Lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wallagoot Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

5.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Lowland Grassy Woodlands, Littoral Rainforest and Swamp Sclerophyll Forest on Coastal Floodplains

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not endangered populations.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

The artificial opening works of the past, have possibly constrained the distribution of these endangered ecological communities (EECs) to low lying fringing areas. It is likely future entrance opening works will perpetuate this trend. As the artificial entrance management is not expected to significantly change the natural balance of time that the lake spends with an open/closed entrance, and Council's intention is for entrance intervention to be minimised into the future through modifications to the elevation of Wallagoot Lake Road, future impacts to saltmarsh and other fringing EECs beyond those already occurred are expected to be minimal, and it is unlikely any of the EECs are to be placed at risk of extinction as a result of implementation of the Policy in the future.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible that some habitat will be modified through the cumulative impacts of undertaking the works. This may result in impacts to the EECs as detailed in Section 5.6.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is possible that some EECs will become isolated from the water body, limiting inundation as a result of reduced upper limit water levels associated with artificial entrance opening.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Future habitat modification through this activity may compromise the long-term survival EECs around Wallagoot Lake through impacts listed in Section 5.6, if the Policy is implemented

indefinitely into the future. However, it is Council's intention to reduce the need for intervention in entrance processes by raising the low lying Sections of Wallagoot Lake Road in the coming 5 to 10 years. As such the long-term survival of these EECs is unlikely to be at risk.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wallagoot Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is a threatening process and as a result would be inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of the lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

5.9 Conclusion

The proposed entrance management works are required for the sole purpose of reducing the impacts of flooding to the Council managed Wallagoot Lake Road, which provide access to privately owned properties and the section of Bournda National Park on the north side of Wallagoot Lake. When the Lake entrance is closed and water levels exceed 1.2 m AHD, inundation of localised sections of the road limits safe access and causes disruption to these land owners, NPWS staff and visitors wishing to use a range of recreational facilities. However, in implementing the proposed Entrance Management Policy, there are three notable potential impacts. These are

1. Potential direct impacts to threatened shorebird species;
2. Potential cumulative environmental impacts of altering the natural hydrologic regime, indirectly impacting endangered ecological communities;
3. Potential direct partial impacts to Aboriginal objects (of low significance).

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes specific selection of excavator access routes that minimise impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

With regards to changes to the hydrologic processes of the Lake and resulting cumulative indirect impacts on EECs, the artificial entrance management is not expected to significantly change the natural balance of time that the lake spends with an open/closed entrance, and Council's intention is for entrance intervention to be minimised into the future through modifications to the elevation of Wallagoot Lake Road. The accompanying Wallagoot Lake Entrance Management Policy has outlined progressive steps that will allow this to occur. As such, future impacts to saltmarsh and other fringing EECs beyond those already occurred are expected to be minimal.

With regards to impacts on Aboriginal heritage objects, due to the low significance nature of the objects that could be potentially impacted, the suggested mitigation measures are centred around monitoring and salvage recording of artefacts, with an AHIP sought as a precautionary measure.

Therefore, the activities should be approved in the short term, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- Bega Valley Shire Council plan and implement modifications to the sections of road that are affected by inundation when water levels are high;
- A Flood Risk Management Study and Plan should be undertaken when resources become available to investigate future flood management options, with consideration of natural berm heights, sea level rise projections and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) and consistent with the NSW Floodplain Development Manual (DIPNR 2005). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions.

6 REF for the Artificial Entrance Opening of Back Lake

6.1 Location

Back Lake is situated on the far South Coast of New South Wales, northeast of the Merimbula Township. It has a surface area of 0.4 km^2 and a catchment of 31.4 km^2. The "Lake" is actually classified as a semi-mature, saline coastal lagoon (Roy et al 2001). Merimbula Creek is the primary drainage inflow into the lagoon. Merimbula Lake and its catchment are located directly south of the lagoon. No National Park estate or State Forest is located in the catchment however, 80% of the catchment remains currently vegetated (see Figure 45).

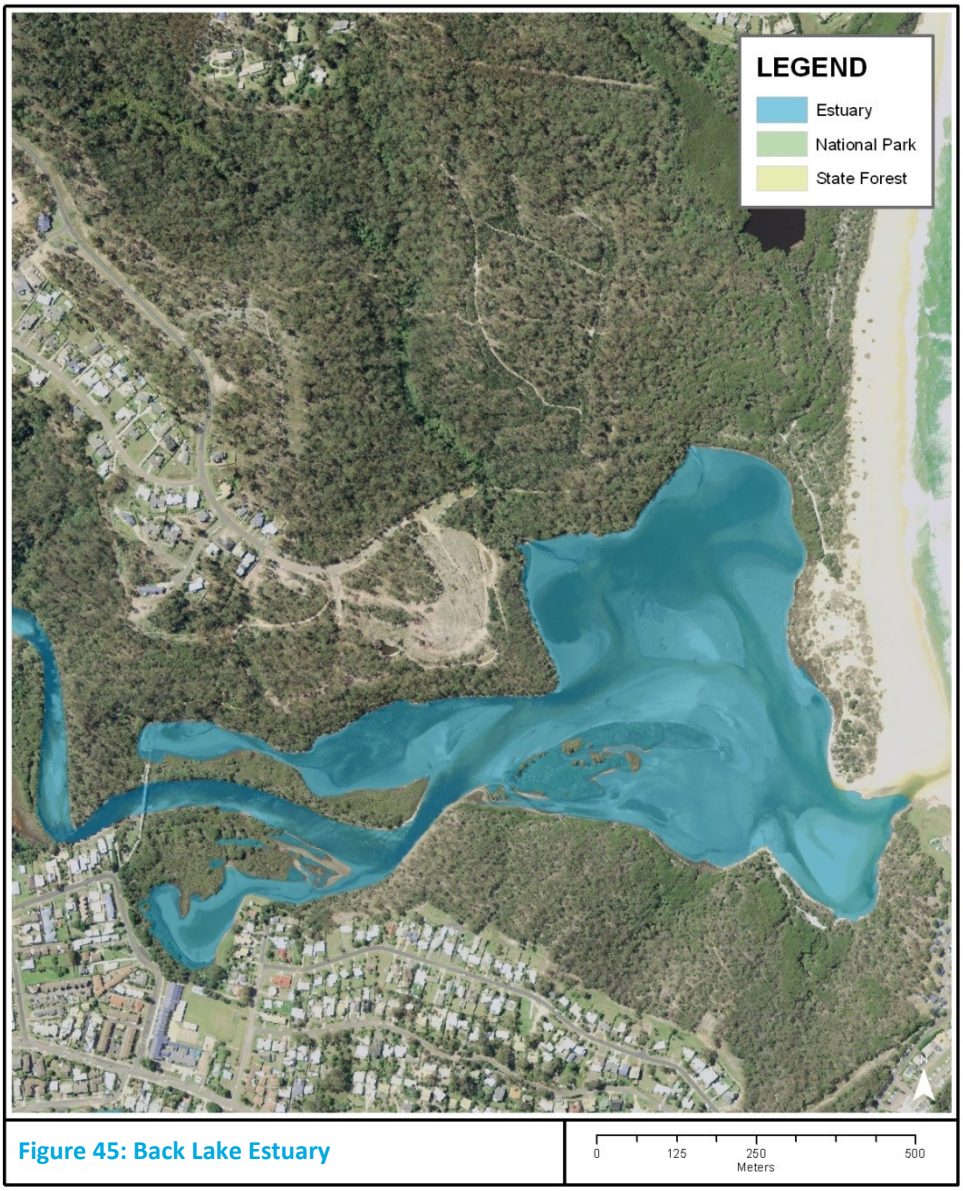

Figure 45: Back Lake Estuary

6.2 Description of Proposed Activity

A channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals within 50 metres of the southern rocky foreshore of Short Point in the location shown in Figure 46 using mechanical equipment, most likely an excavator. The machine will access the site from the Short Point carpark, following the access route also shown in Figure 46. This route has been selected to minimise disturbance to vegetation during machine access and egress, as it follows an existing access path. However, it is expected that minor damage to the grassed areas is inevitable. Particular care will be taken to minimise damage to, or disturbance of the grass vegetated hillside at Short Point

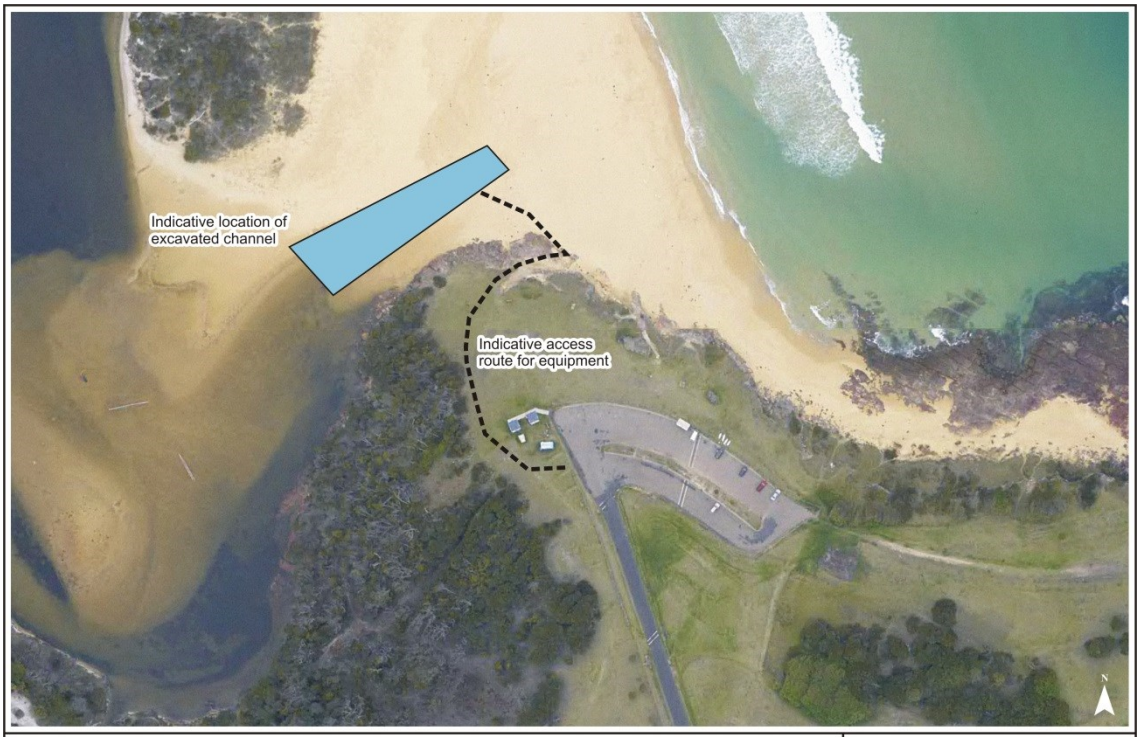

Figure 46: Location of Entrance Opening Works

As outlined in the Back Lake Entrance Management Policy (Appendix E) the excavation will only be undertaken if the water level exceeds 1.4 m AHD, or if the water level is above 1.2 m AHD and there is significant rain forecast in the catchment.

The excavated sand (estimated volume of around 200 m^3) will be pushed to the northern side of the excavated channel and will not be removed from site. The channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 2-4 hours duration. It would be rare for it to extend beyond 10 hours.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. The size and location of the channel will be constrained by the Short Point southern rocky headland. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

While there is no intention to establish a permanent opening, a reasonably long lasting opening is preferred to maximise the possibility of full water exchange and obviate the need for repeated intervention after a short period of time (that is, a few weeks or months). To assist with the establishment of a large and deep channel, which will be slow to infill, completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle. This should ensure that an adequate head difference between the water in the lake and the ocean is maintained for the first few hours of outflow. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days

every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

6.3 Purpose of the Activity

The purpose of the works is to re-establish a temporary tidal connection between the lake and the ocean to allow accumulated water to flush to the ocean and thereby lower water levels below that which causes flooding problems to the Berrambool Sporting Complex and other low lying lake assets.

The intention is not to establish a permanent opening. It is recognised that the entrance channel could well close again within a matter of days to weeks, although it would generally be hoped that the channel would remain open for as long as possible to maximise the period available for tidal flushing and minimise the need for further openings in the short term.

6.4 Consideration of Alternatives

Ultimately there are no viable alternatives to the artificial opening of the lake. The "do-nothing" option is unacceptable because of the potential damage and disruption that could be caused if the lake was left closed and water inundated public and private assets, including the Berrambool Sporting Complex. The high water levels may also remain for many months compounding the scale of damage done by floodwaters. Therefore not interfering and allowing nature to take its course so that water levels rise until a natural breakout takes place, could in most situations cause flood damage and associated problems for local residents.

Rather than adopting a fixed level, a variable level could be used. This would have more ecological benefits. However, the current intervention level of 1.4 m AHD represents a ceiling which is difficult to go above in the short-term as this is the level of the Council approved private development on lots at Munn and Henwood Streets. Variation has been introduced somewhat for openings at lower levels, provided certain conditions are met.

In the longer term it is the intention to increase the intervention level above 1.4 m AHD by selectively flood proofing, raising, removing or relocating assets which are most prone to flooding. Currently, the Berrambool Sporting Complex grounds is the primary Council owned asset that becomes inundated when lake water levels are high (~1.4 m AHD) and there has been heavy rainfall, and that along with some foreshore land on Munn and Henwood Street are the first items to be affected by water level rise. The Back Lake Entrance Management Policy (Appendix F) proposes works that should be completed in desired timeframes in order to increase the intervention level.

A two dimensional unsteady hydrodynamic model as part of a Flood Risk Management Study and Plan should be prepared to better investigate flood management options, with consideration of higher berm heights and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) for a full range of annual exceedance probabilities up to the possible maximum flood consistent with the NSW Floodplain Development Manual (DIPNR 2005). It would be preferable if no intervention was required.

6.5 Description of the Existing Environment

6.5.1 General Characteristics

The Back Lake entrance is situated at the southern end of Short Point Beach, and is constrained to the south by a rocky outcrop. The entrance area itself is characterised by an expanse of unvegetated sand. The substrate in the entrance area is dominated by unconsolidated, well sorted mainly medium grain well rounded quartzose sand. The fines and lithic content is low but there are some shell particles.

6.5.2 Sediments

6.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show the entire bed of Back Lake as having a high risk of potential acid sulfate soils. Additional and more prolonged inundation of these soils as proposed by the policy, compared to historic lower water level break outs would reduce the oxidation potential of the soils, thus reducing their acid-generating potential.

In relation to the berm area where the excavation works are proposed, acid sulfate soils are unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

6.5.2.2 Bank Erosion and Sedimentation

Bank erosion and sedimentation in Back Lake have been documented as a concern to the local community (WMA, 1997). There has been significant stream bank and gully erosion within the catchment, particularly in relation to new urban development. Specific developments (such as the Mirador subdivision at Berrambool, Yellow Pinch Dam and various upgrades to the Princes Highway) have resulted in sheet and gully erosion. Sediment controls at these locations have generally been insufficient to mitigate this erosion and significant sediment load to adjacent waterways (WMA, 1997).

Sediment within the entrance of Back Lake is predominantly comprised of marine (beach) sands, rather than terrigenous sediment. This material is deposited under the combined action of tides and waves. The non-cohesive sands are dynamic in nature and tend to be redistributed during times of flood. It is expected that during large floods, a large proportion of the marine sands in the entrance channel are actually scoured and transported into the nearshore coastal zone, only to be reworked back into the entrance, or transported alongshore, under the influence of ocean processes such as waves and tides.

In the lake area and further upstream, the percentage of silt and clay particles increases and in some locations the surface sediments are unconsolidated muds. In these areas the organic content is also high (WMA, 1997).

6.5.3 Hydrology

6.5.3.1 Entrance Behaviour / Characteristics

The frequency and duration of entrance opening is an important determinant of the hydraulic character of the lake (that is, the frequency and magnitude of water level fluctuations and quality changes). OEH have undertaken an analysis of the entrance state for Back Lake on the basis of available gauged data, which is included below.

OEH Analysis:

Manly Hydraulics Laboratory have maintained a water level gauge on behalf of OEH in Back Lake since 27/02/2009, so approximately 6 years of water level data exists for the estuary. At the time of installation the entrance was closed.

Entrance closure and opening has been identified from observing the stop and start of a tidal signal from the graphed data (see Figure 47). This is generally easy to identify but there are small periods of time were the entrance is likely closed but still being overtopped at the peak of the high tide that make picking the precise closure date difficult. There is one small period of time where data has not been collected (between 11/3/2014 and 2/6/2014), and it is possible that an opening and closing episode could have been missed within this period.

Between 27/02/2009 and 24/7/2015, 15 separate periods of entrance closed conditions have been identified, with closed conditions ranging from 34 days up to 376 days, but typically in the order of 1.5 - 4 months (22). The total duration of closed entrance conditions compared to the full record equates to approximately being closed for 83% of the time. The duration that the entrance stays open for ranges from 1 day to 104 days, but typically in the order of a week to month. The total duration of open entrance conditions for the full record equates to approximately being open for 17% of the time. This illustrates that Back Lake is predominantly closed.

The level of entrance opening ranges from 1.22 m to 2.44 m AHD, but typically over 1.35 m AHD. It should be noted that this does not provide a good surrogate for natural berm height range as most of the openings are likely to be artificial as result of Council opening to alleviate flooding hazards. An OEH survey of Back Lake berm height on 18/6/13 found the berm height to be approximately 3.0-3.1 m AHD. The potential for slightly higher berm heights may also be possible at this location. Comparison of Back Lake water levels to ocean water levels recorded from Twofold Bay in Eden show that the majority of the time when the entrance is open the tidal range is restricted to significantly less than 50% of the full open ocean tidal range (Figure 48). However, after a significant rainfall event and opening, tidal range can be up to approximately 0.75 m with full open ocean high tides experienced and attenuation only of the full low tide below 0.0 m AHD (Figure 48 and Figure 49).

Table 22: Periods of Entrance Closures, Opening and Opening Levels for Back Lake				
Entrance Closure Date	**Entrance Opening Date**	**WL Height at Opening**	**Closure Duration (days)**	**Open Duration (days)**
27/02/2009	15/02/2010	2.44	353	NA
8/04/2010	31/05/2010	1.95	53	52
7/08/2010	3/12/2010	1.33	118	68
18/12/2010	22/03/2011	2.44	94	15
15/04/2011	19/08/2011	1.479	126	24
20/08/2011	1/03/2012	1.734	194	1
13/06/2012	24/06/2013	1.345	376	104
6/07/2013	18/09/2013	1.467	74	12
22/11/2013	10/06/2014	1.369	200	65
20/07/2014	23/08/2014	1.378	34	40
26/08/2014	14/10/2014	1.217	49	3
21/10/2014	7/12/2014	1.955	47	7
15/12/2014	29/04/2015	1.417	135	8
5/05/2015	14/07/2015	1.396	70	6
20/07/2015*	NA	NA	32	6
21/08/2015*	NA	NA	NA	NA
Total			1923	405
Total			83%	17%

Notes:

* Entrance closed for 32 days to date

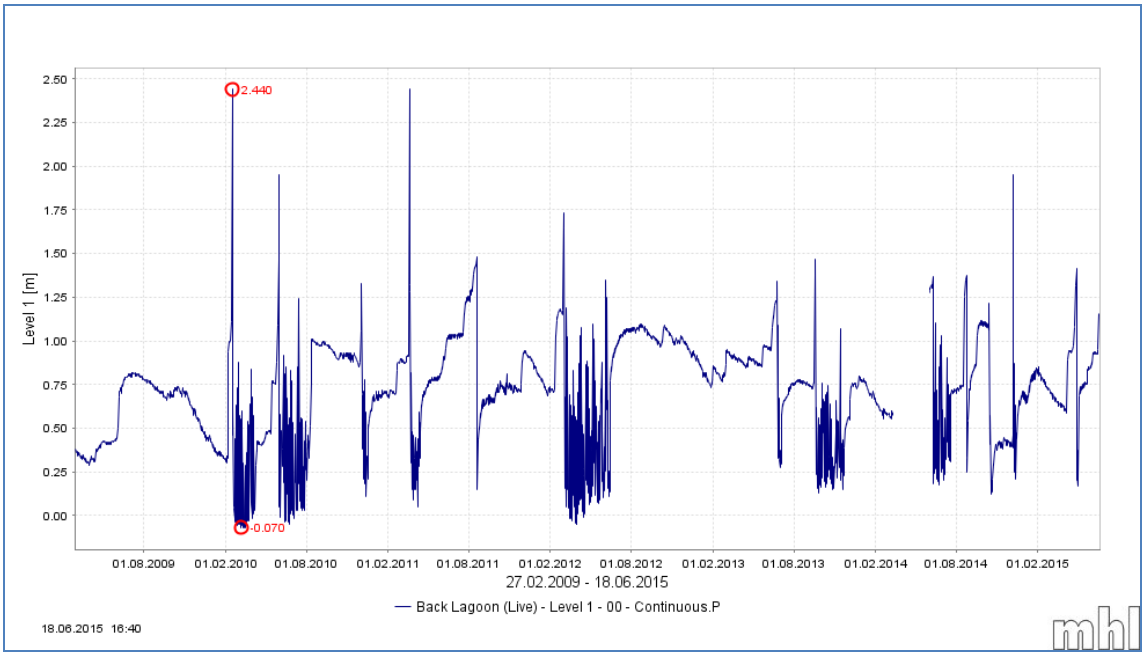

Figure 47: Complete Water Level Data set from Back Lake Water Level Gauge

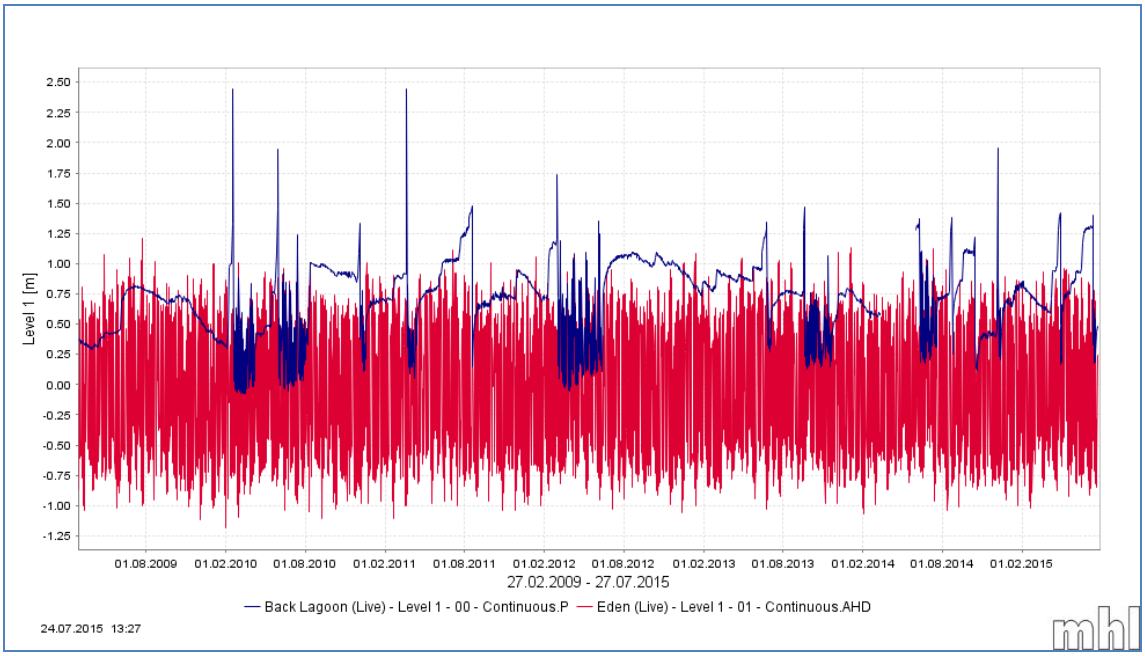

Figure 48: Complete Water Level Data set from Back Lake Water Level Gauge, plotted against the Open Ocean Water Level Records from Twofold Bay

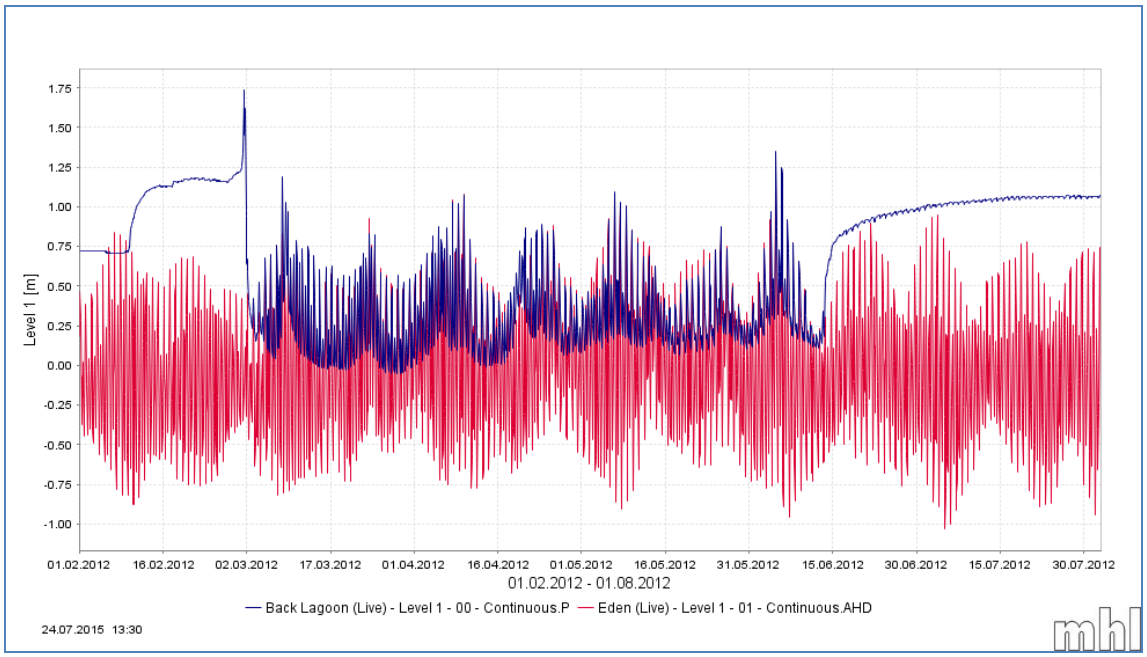

Figure 49: Snapshot of Back Lake Water Level Record Plotted Against the Open Ocean Water Level Record from Twofold Bay

Entrance breakout location based on aerial photograph interpretation has shown that lake entrance opening has typically occurred adjacent to Short Point (Figure 50). For this reason the proposed artificial works are proposed to be conducted within 50 metres of the southern rocky foreshore of Short Point.

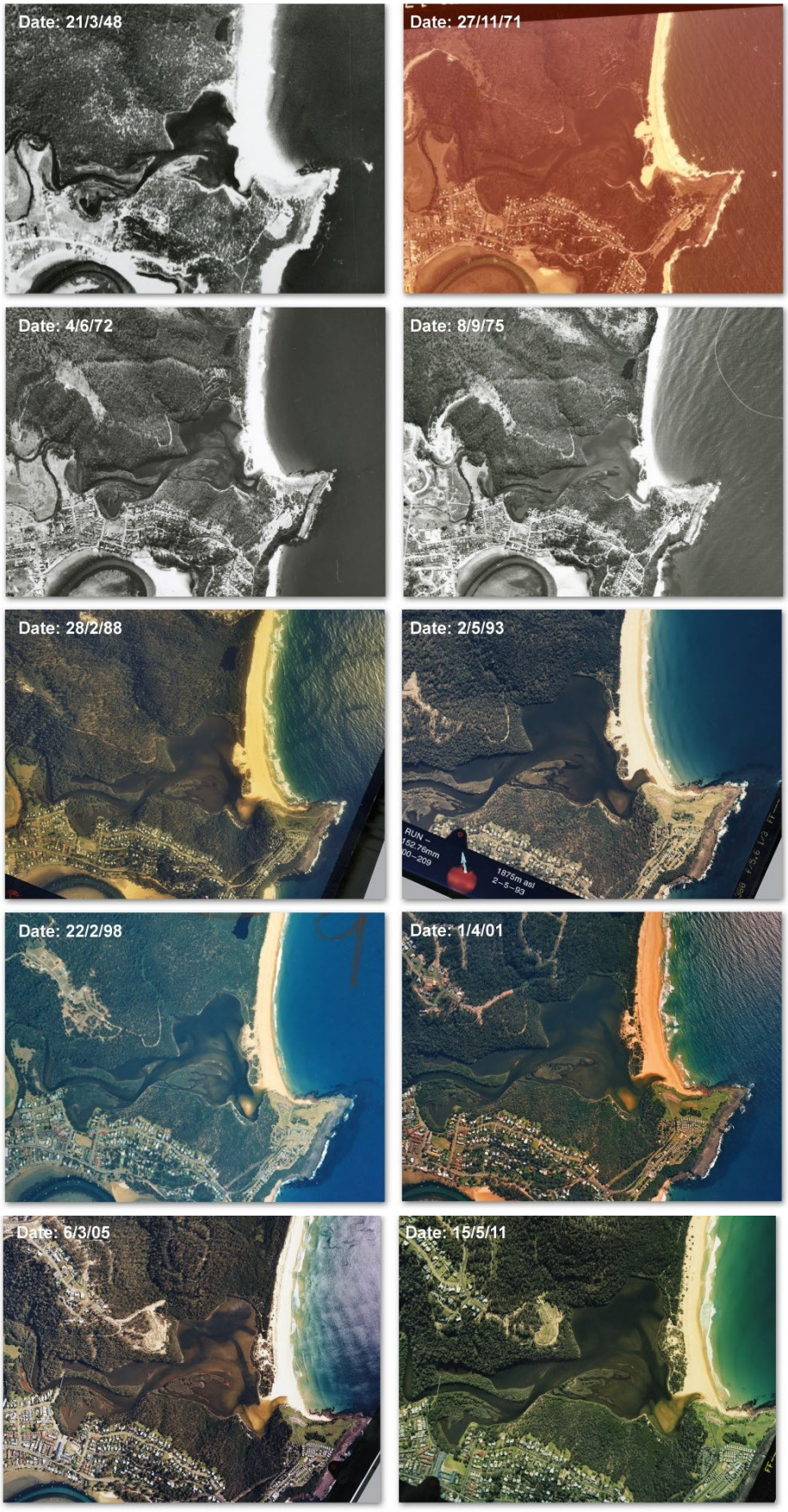

Figure 50: Aerial Photographs of Back Lake 1948 to 2011

6.5.3.2 Water Quality

There is no recent water quality data available for Back Lake however a previous study in January 1994, found that Back Lake water quality met ANZECC guidelines for estuarine waters with respect to temperature, salinity, dissolved oxygen and pH. Turbidity was a little high and mean nutrients were very high. The median faecal coliform value was higher than the ANZECC swimming guideline value but lower than the secondary contact value indicating water quality was suitable for boating etc. It was noted the high-medium faecal coliform count could be the result of a bias towards wet weather sampling (WMA 1997).

A study in 2004 showed that the total nitrogen load per unit of waterway area is 6.6 $t/km^2/year$, compared with a denitrification rate of 0.73 $t/km^2/year$ (Robson et.al. 2004). Denitrification therefore cannot balance incoming nutrient loads and as a result algal blooms may result. This is to be expected given the large catchment size relative to the waterway area (a ratio of 1:101) (Robson et.al. 2004)

6.5.4 Ecology

Back Lake and its surrounds provides habitat for a number of significant flora and fauna species. For the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, the lake and its immediate surrounds where defined within the geographical domain:

GDA94

North: -36.82 South: -36.92

East: 149.859 West: 149.959

Within this domain The Atlas of NSW Wildlife identified 36 species protected under the Threatened Species Conservation Act 1995, 10 species protected under the Environment Protection and Biodiversity Conservation Act 1999, and 15 species protected under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

6.5.4.1 Flora

Aquatic Vegetation

A seagrass community composed of Halophila ovalis covers a significant proportion of the Back Lake estuary bed (≈215,400 m^2) (DPI, 2006). These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are important marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997.

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under either NSW (Threatened Species Conservation Act 1995) and/or Australian (Environment Protection and Biodiversity Conservation Act 1999) government legislation are known to occur within the Back Lake estuarine catchment. These EECs cover a total area of ≈560,000 m^2 and include Coastal Saltmarsh, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Swamp Oak Floodplain Forest and River Flat Eucalypt Forest.

Coastal Saltmarsh occupies a total area ≈21,250 m^2 around the Lake (DPI, 2006). This endangered ecological community comprises a complex of succulent herbfields and sedgelands predominately characterised by Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha, Austrostipa stipoides along with Scirpus nodosa and Sporobolus virginicus (Tozer et al 2004). This community of species is very important to estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients.

Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions endangered ecological community occupies a total area of ≈63,500 m^2 at localities on the landward side of the Short Point Beach dunes. Bangalay Sand Forest typically has a dense to open tree canopy and occurs on dunes exposed to salt-bearing sea breezes. The most common vegetation species within this endangered ecological community are Eucalyptus botryoides, Banksia integrifolia subsp. Integrifolia, Eucalyptus pilularis, Acmena smithii, Dianella spp., Lepidosperma concavum, Lomandra longifolia, Pteridium esculentum (Bracken), and the grasses Imperata cylindrical, Microlaena stipoides var. stipoides, Themeda australis (Tozer et al 2004). This vegetation complex once would have occupied many coastal localities however clearing, habitat degradation and weeds have caused substantial losses across the NSW state. As a result this remanent vegetation community has been placed as endangered and likely to become extinct unless the circumstances and factors threatening its survival cease to operate (NSW Scientific Committee 2012).

Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest are comprised within the Swamp Oak Forest on Coastal Floodplains endangered ecological community. The Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest inhabits an area ≈11,900 m^2 and ≈29,900 m^2 respectively around Merimbula Creek. Estuarine Creekflat Scrub is characterised by Melaleuca ericifolia, Casuarina glauca, Parsonsia straminea, Baumea juncea, Lobelia alata, Baumea articulate, Leptinella longipes, Samolus repens, Selliera radicans. Swamp Oak Floodplain Forest is characterised by Casuarina glauca, with climbers and groundcover species Parsonsia straminea, Geitonoplesium cymosum, Centella asiatica (Tozer et al 2004). Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and are vital refuges for many fauna species.

The Lowland Grassy Woodland in the South East Corner Bioregion endangered ecological community occupies a total area ≈34,300 m^2 at two predominate localities around the Lake. This community complex typically comprises of Acacia mearnsii, Angophora floribunda, Eucalyptus globoidea, Eucalyptus tereticornis, Bursaria spinosa, Ozothamnus diosmifolius, Clematis glycinoides var. glycinoides, Rubus parvifolius, Cheilanthes sieberi, Desmodium varians, Dichondra spp., Echinopogon ovatus, Eragrostis leptostachya, Glycine clandestine, Glycine tabacina, Hydrocotyle laxiflora, Hypericum gramineum, Lepidosperma laterale, Lomandra longifolia, Lomandra multiflora subsp. Multiflora, Microlaena stipoides, Oxalis perennans, Themeda australis, Wahlenbergia gracilis (Tozer et al 2004). Habitat fragmentation due to clearing and grazing has reduced the ecological function of this community since European settlement resulting in a substantial loss of mammal flora. After an examination of historical and contemporary survey data Lunney and Leary (1988) concluded that at least six native mammal species had become locally extinct, including the Wallaroo (Macropus robustus), the Parma Wallaby (Macropus parma), the red-necked Pademelon (Thylogale thetis), the Tasmanian Bettong (Bettongia gaimardi), the Eastern Quoll (Dasyurus viverrinus) and the Brush-tailed Phascogale (Phascogale tapoatafa).

The River-Flat Eucalypt Forest on Coastal Floodplains is an endangered ecological community that occupies an area ≈120,700 m^2 at numerous locations within the Back Lake estuarine catchment particularly around Merimbula Creek. This community was typically comprised of Eucalyptus. Baueriana, Eucalyptus botryoides, Eucalyptus elata, Eucalyptus ovata, Rubus parvifolius, Breynia oblongifolia, Hymenanthera dentate, Glycine clandestine, Stephania japonica, Microlaena stipoides, Lomandra longifolia, Pteridium esculentum, Oplismenus aemulus, Pratia purpurascens, Echinopogon ovatus, Entolasia marginate, and Desmodium varians (Tozer et al 2004). This EEC provides habitat for a broad range of flora, including many that are dependent on the vegetation for food, nesting or roosting such as the White-bellied Sea-eagle, Kingfishers, Owls, Yellow-bellied Glider etc. The clearing of native vegetation; alteration to the natural flow regimes; invasion of native plant communities by exotic perennial grasses; anthropogenic climate change; high frequency fire; and Removal of dead wood and dead trees are listed as threatening processes leading to the NSW Scientific Committee determining that River-Flat Eucalypt Forest is likely to become extinct in nature in New South Wales unless the circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2012).

In addition to the identified endangered ecological communities one NSW listed vulnerable plant species, occurs within close vicinity of the Back Lake entrance. This vulnerable species is Bodalla Pomaderris (Pomaderris bodalla). Although these shrubs tend to grow in moist open forest along sheltered gullies and along stream banks they are unlikely to be significantly affected either by lowering or raising the average lake level. A Section 5A assessment for this species is contained in Section 6.8.

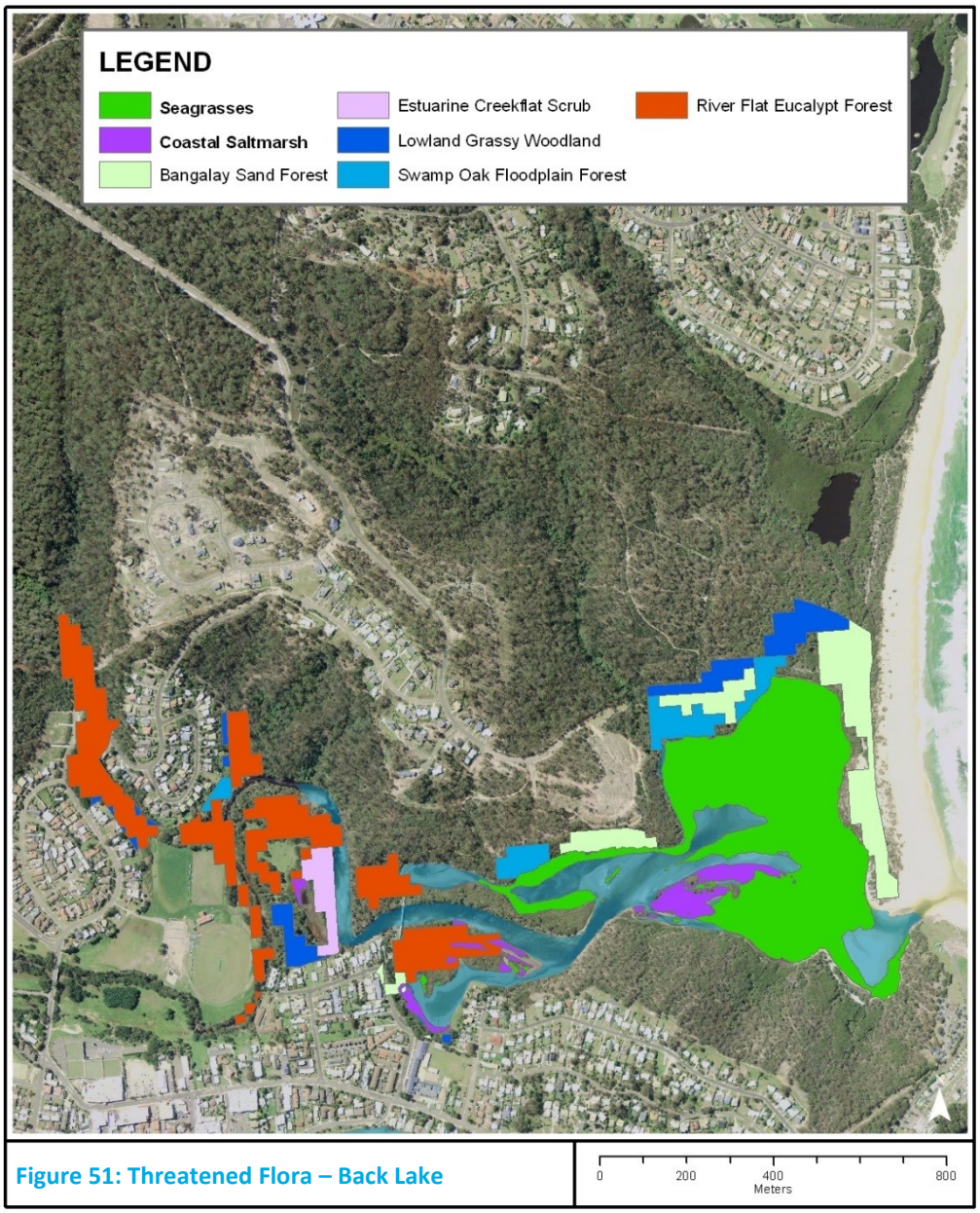

Figure 51: Threatened Flora – Back Lake

6.5.4.2 Fauna

Locations of threatened fauna species throughout the Back Lake area are shown in Figure 52.

Mammals

The Atlas of NSW Wildlife has identified 11 species listed as vulnerable under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 4 are listed as vulnerable and 1 listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in Table 23:

Table 23: Threatened Mammals in the Back Lake Region			
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**
Spotted-tailed Quoll	Dasyurus maculatus	V	E
Brush-tailed Phascogale	Phascogale tapoatafa	V	
Koala	Phascolarctos cinereus	V	V
Yellow-bellied Glider	Petaurus australis	V	
Long-nosed Potoroo	Potorous tridactylus	V	V
Grey-headed Flying-fox	Pteropus poliocephalus	V	V
Eastern Freetail-bat	Mormopterus norfolkensis	V	
Large-eared Pied Bat	Chalinolobus dwyeri	V	V
Eastern False Pipistrelle	Falsistrellus tasmaniensis	V	
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	
Greater Broad-nosed Bat	Scoteanax rueppellii	V	

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

Birds

The Atlas of NSW Wildlife has identified 19 bird species listed as vulnerable and 4 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, 1 is listed as vulnerable and 2 listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition15 species are protected under the Japan-Australia, Republic of Korea-Australia and China-Australia Migratory Birds Agreements. These species are shown in Table 24. OEH (2015) present maps of sites that are significant to shorebird nesting throughout the Bega Valley Shire, and identify the Back Lake entrance as one of these sites. Figure 53 shows the identified locations and species from OEH (2015).

Table 24: Threatened Avifauna in the Back Lake Region				
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**	**Migratory Bird Agreements**
White-throated Needletail	Hirundapus caudacutus			C,J,K
Gibson's Albatross	Ardenna tenuirostris	V	V	
Sooty Shearwater	Botaurus poiciloptilus			C,J
Wedge-tailed Shearwater	Circus assimilis			J
Short-tailed Shearwater	Haliaeetus leucogaster			J,K
Cattle Egret	Hieraaetus morphnoides			C,J
Australasian Bittern	Pandion cristatus	E	E	

Eastern Reef Egret	Burhinus grallarius			C
White-bellied Sea-Eagle	Esacus magnirostris			C
Little Eagle	Haematopus fuliginosus	V		
Square-tailed Kite	Haematopus longirostris	V		
Sooty Oystercatcher	Pluvialis fulva	V		
Pied Oystercatcher	Thinornis rubricollis	E		
Hooded Plover	Calidris acuminata	E		
Sanderling	Calidris ferruginea	V		C,J,K
Latham's Snipe	Calidris ruficollis			C,J,K
Bar-tailed Godwit	Limosa lapponica			C,J,K
Eastern Curlew	Numenius madagascariensis			C,J,K
Whimbrel	Numenius phaeopus			C,J,K
Grey-tailed Tattler	Hydroprogne caspia			C,J,K
Arctic Jaeger	Sterna hirundo			J,K
Caspian Tern	Sternula albifrons			C,J
Gang-gang Cockatoo	Callocephalon fimbriatum	V		
Glossy Black-Cockatoo	Calyptorhynchus lathami	V		
Little Lorikeet	Glossopsitta pusilla	V		
Swift Parrot	Lathamus discolor	E	E	
Barking Owl	Pezoporus wallicus wallicus	V		
Powerful Owl	Ninox strenua	V		
Masked Owl	Tyto novaehollandiae	V		
Sooty Owl	Tyto tenebricosa	V		
White-fronted Chat	Climacteris picumnus victoriae	V		
Varied Sittella	Anthochaera phrygia	V		
Olive Whistler	Epthianura albifrons	V		
Hooded Robin (south-eastern form)	Daphoenositta chrysoptera	V		
Scarlet Robin	Pachycephala olivacea	V		
Flame Robin	Petroica boodang	V		
Diamond Firetail	Petroica phoenicea	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife has identified 1 amphibian species listed as vulnerable and1 species listed endangered under the NSW Threatened Species Conservation Act 1995. These amphibian species are also listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are shown in Table 25:

Table 25: Threatened Amphibians and Reptiles in the Back Lake Region

Common Name	Scientific Name	NSW Status	Comm. Status
Giant Burrowing Frog	Heleioporus australiacus	V	V
Green and Golden Bell Frog	Litoria aurea	E	V

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

Aquatic Fauna

Reliable fish data is unavailable for this Lake. It is expected that predominant commercial fish species caught include Black and Yellow fin Bream, Dusky Flathead, Whiting, Mullet, Tailor, Estuary Perch, Bass and Luderick. Both School and Greasyback prawns are also assumed to be commercially viable species in this estuary.

Figure 52: Threatened Fauna – Back Lake

Figure 53: Significant Shorebird Sites at Back Lake Entrance (OEH, 2015)

6.5.5 Cultural Heritage

6.5.5.1 Aboriginal Cultural Heritage

Sites of Aboriginal cultural significance, such as middens, camping areas, artefact scatters, shelters and other sites are frequent around Bega Valley Shire Council estuary shorelines, beaches and islands. There are also many areas of spiritual and cultural significance, the details of which are not generally known and are unlikely to be made known to people other than the tribal custodians of the knowledge.

The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance. The investigation included searches of the NSW OEH AHIMS, the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access track and entrance opening area. While 29 sites were identified in the database searches for the wider Back Lake estuary search area, no sites in the direct access track or lake entrance area were identified, and Dibden (2016) reported that the impact areas from entrance opening are disturbed and generally of very low to negligible archaeological potential.

6.5.6 Recreational and Commercial Uses

6.5.6.1 Recreation

Back Lake supports a range of recreational uses including swimming, boating, canoeing and fishing. The entrance area is not used for any specific purpose apart from swimming / surfing, walking, and nature observation.

When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels also provide for improved recreational opportunities such

as kayaking. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times.

Recreational fishing also takes place but there is no data available regarding the extent of recreational fishing or the magnitude and nature of the catch.

6.5.6.2 Commercial

Commercial activity within Back Lake is less extensive than other south coast lakes. Economic activities include some recreation, tourism and fishing (ANU, 2006). Commercial fishing: Net fishing is permitted in Back Lake however, catch data is unavailable.

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

6.6 Description of the Activity Impacts

6.6.1 Acid Sulfate Soil Impacts

It is unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Back Lake has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings

6.6.2 Bank Erosion and Sedimentation Impacts

It is likely the entrance opening works would actually reduce the risk of bank collapse by limiting bank inundation and bank destabilisation potential, resulting from a rapid drop in water level post entrance opening. It must be highlighted however, that water levels of approximately 3 m AHD would be within the natural hydrological regime, and as a result it is considered that the potential for bank collapse would be slight.

Over the long term, the progradation of the marine sediments into the lake resulting from artificial entrance openings at lower than natural water levels, may cause moderate adverse sedimentation impacts to the lake due to less effective scour of the marine flood tide delta. It is advised that further study be undertaken when resources are available to examine the impacts of entrance opening on this process.

6.6.3 Hydrology Impacts

The works will have a moderate negative impact on the Lake as entrance opening is an important determinant of the hydraulic character. Natural breakout of Back Lake would tend to occur during or soon after a significant rainfall event. Rainfall is a necessary precursor to raise water levels to a level significantly greater than mean sea level, and to 'liquefy' the sand barrier and reduce its cohesion. The ability of the lake water to erode a deep and wide entrance channel is directly related to the head difference that exists between the lake and

the ocean at the time of breakout. A large head difference will result in a larger and deeper channel.

Therefore, intervention in the breakout process at low lake water levels with an unsaturated entrance bar will reduce the capacity of the opening to erode sediments from the entrance area. Over the long term this may cause sedimentation impacts and changes to the hydrologic regime as a build up of sediment in the entrance area may progressively result in beach bar widening and lake infilling.

Positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid increases in dissolved oxygen concentrations resulting from rapid decay of organic material.

6.6.4 Aquatic Vegetation Impacts

Entrance opening and the resulting drop in water levels is likely to have a slight negative impact on aquatic vegetation. The negative impacts may include; the scouring of Halophila ovalis from the lakebed and, a potential relative shift in species composition from Halophila ovalis to Zostera capricorni and potential die-back due to exposure caused by the rapid decrease in water level.

6.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The works will have moderate negative impacts on several transitional and fringing endangered ecological communities (EECs). These impacts occur as the natural flow regimes of Back Lake have and will be altered by the entrance opening works. Endangered ecological communities such as Coastal Saltmarsh, Swamp Oak Forest on Coastal Floodplains, Lowland Grassy Woodland and River-Flat Eucalypt Forest are impacted due to reduced inundation. This can result in significant species composition shifts such as reduced Saltmarsh, Grassy Woodlands, and River-Flat Eucalypt Forest habitat and encroachment of terrestrial vegetation.

It is identified that some dieback will occur following long periods of inundation particularly Casuarina glauca and entrance opening may relieve this pressure. However, it must be noted this is a natural reclamation process and many endangered ecological communities rely on this dieback and inundation for survival. Repeated artificial entrance opening at this lower range of natural break-out water levels will therefore continue to have moderate negative impacts on several transitional and fringing endangered ecological communities.

A Section 5A assessment for the endangered ecological communities and Pomaderris bodalla a NSW listed vulnerable plant species located in Section 6.8.

6.6.6 Direct Impacts to Access Track Vegetation

The path which will be used to provide access and egress for the excavator is shown in Figure 46. This existing grassed access path has been selected for the access route to the lake entrance, as it will minimise impacts to surrounding grassed areas that are used for recreational activities. In driving the excavator along this path, it is expected that minor disturbance of the grass will occur. Once on the dune area of the beach, there may be minor and very localised damage to dune vegetation if present, though the beach berm area at the

entrance of Back Lake is typically devoid of dune vegetation. Photographs of the access path are shown in Figure 54, where it can be seen that there will be minimal impacts to vegetation from machine access.

Figure 54: Photos of Back Lake Access Track

6.6.7 Fauna Impacts

Mammals

It is unlikely the entrance works will have an impact on threatened mammal species or endangered populations. The longer-term impacts of undertaking these works however, may result in habitat change, placing pressure on vulnerable species such as the Long-nosed Potoroo. It must be recognised, that water levels will be within the natural range.

Birds

Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works including channel excavation and entrance scouring, could potentially have a significant negative impact on a number of resident and migratory threatened shorebird species. Shorebirds inclusive of the Hooded Plover and Pied Oystercatcher could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- A machine access route that minimises areas of dune impacted by the machine;
- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators, restrict pedestrian access and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast

Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform additional adaptive management responses on an "opening-by-opening" basis, as opposed to a "one-off" survey for this REF. Section 5A assessments have been carried out for the potentially impacted shorebird species (Hooded Plover and Pied Oystercatcher), and are included in Section 6.8. As the impacts to these species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement. Entrance opening works are unlikely to negatively impact other threatened bird species, rather the reduction in water levels may expose feeding grounds and food sources (decomposing vegetation and invertebrates) for many of the bird species.

Amphibians and Reptiles

The majority of frog and reptile species identified are unlikely to occur in habitats directly connected to the lake due to excessive salinities and preference for different habitat types. The Green and Golden Bell Frog on the other hand may be significantly impacted by entrance opening and as a result a Section 5A assessment has been carried out for this species and included in Section 6.8.

Aquatic Fauna

The entrance works will have both positive and negative impacts on aquatic animal species. These positive and negative impacts could include assemblage changes and habitat shifts, and in theory fish kills, however there is no know evidence of this occurring previously for Back Lake. As the entrance works rapidly change the surrounding environment, some species may benefit and others may perish due to stress from low dissolved oxygen under certain conditions, and sudden salinity increases. It should however be noted, that these impacts would also occur as a result of natural lake entrance openings. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and the opening works are within the lower range of the natural regime.

6.6.8 Aboriginal Cultural Heritage Impacts

Any unknown Aboriginal sites that may exist around the immediate foreshore of the estuary will have been subject to cycles of flooding and drying over many years and thus may be fairly resilient to changes in lake level. It is possible however, that further flooding and drying combined with wave action may expose sensitive sites or lead to erosion of culturally important areas. While unlikely, entrance works may have both positive and negative impacts on currently un-reported Aboriginal cultural heritage sites. Positive impacts could include opening the entrance prior to naturally high estuary water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts could include increased frequency of wetting and drying from rises and falls in estuary water level as a result of slightly more frequent entrance openings.

While no impacts to Aboriginal places or items in the areas of excavator access or entrance opening were identified in the ACHAR (Dibden, 2016), as a precautionary measure BVSC has sought an AHIP associated with the entrance management works.

6.6.9 Recreational Impacts

The entrance management works may result in both positive and negative recreational impacts. When water levels are low the exposed edges of the lake and the Short Point recreation reserve provide areas for walking. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Moreover, as Berrambool Sporting Complex is the primary asset that becomes inundated at lake water levels of around 1.4 m AHD, recreational sporting activities that take place on the grounds would be adversely affected if works were not undertaken. Conversely, high water levels provide for improved recreational opportunities such as canoeing and kayaking. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times. Impacts on recreational fishing may also occur however as detailed previously artificial opening regimes favour some species over others.

6.6.10 Commercial Impacts

The entrance works may have minor positive and negative commercial impacts on commercial fishing and tourism sectors. Positive impacts include increased walking access around the Lake. However, negative impacts may include reducing fish and prawn catch for commercial fishers and malodorous conditions due to rotting vegetation around the lake shoreline. To prevent this affecting holiday makers, whenever possible Council will avoid artificially opening the lake during peak holiday periods. Therefore, entrance opening has both positive and negative commercial impacts, however, it is the intention of this policy to return to a more natural opening regime through alleviating asset damages.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

6.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The community most likely to be affected will be the residents within close proximity to Back Lake. There will be no significant adverse impact upon the general wider community. Malodorous conditions can sometimes occur for a few days after an entrance opening due to the rotting vegetation around the lake shoreline. To prevent this affecting holiday makers where possible the lake will not be artificially opened during peak holiday periods. The wider community on the other hand would be negatively impacted if the works were not undertaken as the Berrambool Sporting Complex grounds are the primary asset that becomes inundated at 1.4 m AHD. In addition a few local residents may also experience inundation of foreshore land on Munn and Henwood Streets. As the only purpose for conducting the entrance opening works is to protect private and public assets from flooding, the activity will have positive outcomes for the community beneficiaries.

b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The locality will not be transformed in any significant manner. The lake entrance will change temporarily, but these changes will be within natural bounds.
c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: There are a range of environmental impacts on the ecosystems of Back Lake as discussed in Section 6.6. The cumulative impacts of the entrance works may and most likely have caused medium adverse environmental impacts on the ecosystems of Back Lake. These impacts predominately relate to hydrologic and ecological shifts from natural states, as a result of lower water level breakouts. Regular and repeated low water level (artificial) openings will likely further change many ecosystems particularly aquatic and wetland ecosystems over the long-term, as the works alter the ecosystems structure, composition and diversity. However, it should be recognised that BVSC has intentions (as documented in the Policy) to undertake planning and upgrade works to improve low lying assets affected by high lake water levels which will allow the trigger water level for mechanical opening to be raised in the future. Nevertheless, in the case of Back Lake, this will be a lengthy process that will likely take decades to implement. As such, long term medium adverse impacts to fringing and aquatic ecosystems are still expected to occur into the future.
d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There is not likely to be any reduction in the aesthetic quality or value of the locality as a result of implementing the Policy. The impact upon fish and prawn populations may have a bearing upon the recreational value. If an artificial breakout allows a large population of prawns and fish to escape to sea there would be a significant loss of recreational opportunity, especially if this occurred just prior to the Christmas/New Year holiday period. However, an artificial opening could enhance recreational prawning and fishing opportunities the following year if the opening coincided with a high abundance of prawn larvae and fish spawning in nearshore coastal waters. Such conditions are impossible to predict. On balance and over the long term, the impacts are likely to be slightly negative. Impacts to other recreational activities such as kayaking and walking are deemed negligible as fluctuating water levels will favour differing recreational activities at different times. While intervention in the natural breakout process conceptually diminishes the scientific value of the system since an element of 'naturalness' has been lost, in reality the vast majority of ecological processes will continue to operate. The locality could still be suitably used for a wide range of scientific purposes (this has been demonstrated at other ICOLLs on the Far South Coast such as Wallagoot Lake). Certainly the scientific value would not be diminished by the proposed entrance management works to the same degree that other catchment modifications (such as significant clearing and

	development of fringing areas) have.
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: As discussed in Section 6.6, there are no known significant sites within the entrance area. Given that artificial lake openings are the early facilitation of a natural process it could be assumed that its effect on cultural artefacts would be minimal. BVSC have sought an AHIP associated with the works as a precautionary measure.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? [4] ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: There is potential that moderate to significant adverse impacts may result to habitat of protected fauna. These impacts are documented in Section 6.6 and primarily result from hydrologic changes (increased frequency and lower water level opening) and habitat disturbance due to machinery and channel scour. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher and Hooded Plover by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 6.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 6.8. Similarly, in the long term the works have the potential to have moderate indirect impacts on other threatened mammals and amphibians such as the Green and Golden Bell Frog through habitat modification as a result of changes to the lake's hydrologic regime and upper range water levels. It should be recognised that many of these habitat changes will have already occurred over previous decades, and that the intentions to raise trigger water levels for entrance opening in the future will minimise future impacts. As such, future long term adverse impacts to fringing and aquatic ecosystems which provide habitat for threatened species are expected to be low.
g.	Will there be any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The endangered ecological communities listed in Section 6.8 (i.e. Coastal Saltmarsh, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Swamp Oak Floodplain Forest, and River Flat Eucalypt Forest in conjunction with the threatened Hooded Plover, Pied Oystercatcher and Green and Gold Bell Frog may be indirectly impacted by the entrance management works. While it is recognised that there is the potential for significant adverse impacts on

.

	ground nesting species such as the Pied Oystercatcher and Hooded Plover by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 6.6.7 and the Policy, these impacts will be reduced to low adverse. For these communities and fauna species a Section 5A assessment has been prepared and is contained in Section 6.8. Considerations of the activity impacts on the threatened vegetation species Bodalla Pomaderris (Pomaderris bodalla) although negligible has also been included in Section 6.8.
h.	Will there be any long-term effects on the environment? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The cumulative impacts of previous entrance management works most likely have cause medium adverse environmental impacts on the ecosystems of Back Lake. Future impacts, while expected to be no worse than those already experienced, are documented in Section 6.6 and may involve: continued shift in the structure, composition, diversity, and location of the lakes ecology; increased rates of Lake infilling particularly at the entrance bar; reduced frequency and duration of flooding at higher levels.
i.	Will there be any degradation of the quality of the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The quality of the lake environment will be degraded by virtue of the fact that a major natural process is being interfered with. In effect the lake is losing a major element of 'naturalness'. Naturalness is a significant environmental attribute. It is often a criteria used to determine environmental or conservation value. Although this activity has occurred in the past, the works continue to perpetuate the problem.
j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of undertaking the entrance opening works. The robustness or ability of the environment to withstand environmental fluctuations should not be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse

	Comment: The proposed works will not result in any pollution of the environment.
m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Although it is difficult to predict what other future activities might take place it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or on the foreshore.
p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. Over the long-term, additional influx of marine sediment into the estuary and the widening of the beach berm may occur as a result of entrance openings at lower water levels that likely result in less scour of entrance sediments. This may alter coastal processes. The Policy has been developed to incorporate a progressive increase in entrance opening levels to partially accommodate current best estimates of sea level rise and reduce the need to intervene in natural entrance behaviour in the longer term.

6.8 7-Part test for Threatened Species, Populations and Ecological Communities

6.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Hooded Plover (Thinornis rubricollis) and Pied Oystercatcher (Haematopus longirostrus).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Back Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Back Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

6.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to the Endangered Green and Golden Bell Frog (Litoria aurea).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of this species may be disrupted by the entrance works if breeding colonies are present. Salinity increases and isolation can affect breading success, particularly if entrance works are conducted between August and March. It should be noted that these same affects could occur as a result of natural flooding and breakout of the river entrance.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for this species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(2.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. Some habitat will be modified during the activity as a result of reduced water levels. This may isolate tadpoles and or eggs particularly if the works are undertaken between August and March.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The habitat is of critical importance to this species particularly between August and March for breeding activity.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Back Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is inconsistent with the Priority Action Statement and Recovery Plan for this species. However, it should be noted that even without intervention in entrance opening processes, similar impacts to the habitat of this endangered species may still occur as a result of estuarine flooding and natural entrance breakout.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of the Back Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

6.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Flora – Bodalla Pomaderris (Pomaderris bodalla).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

It is unlikely the activity will impact upon the lifecycle of these species. Pomaderris bodalla occurs in moist open forest along sheltered gullies and along stream banks and has been recorded on the northern side of the estuary. Although these species tend to grow close to watercourses it is unlikely these species will be significantly impacted.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

There are no endangered populations recognised in the BVSC LGA for this species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. Some habitat will be slightly modified via the activity resulting in a decrease in upper limit water levels, however, impacts of this process are unlikely to significantly impact this species.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Habitat modification through this activity is unlikely to affect the long-term survival of this species.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Back Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is not inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Back Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

6.8.4 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Freshwater, Bangalay Sand Forest, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest and River Flat Eucalypt Forest.

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

The artificial opening works of the past, have likely constrained the distribution of these endangered ecological communities (EECs) to low lying areas. It is likely that future entrance opening works will perpetuate this trend. If the Back Lake Entrance Management Policy is adhered, it is likely a “more natural” Lake water level can be achieved before the lake is artificially breached in the future. This may reduce the future cumulative impacts of the proposed entrance works on these important EECs. It is unlikely any of the EECs are to be placed at risk of extinction as a result of activity, however, declines and shifts in extent, composition, and diversity are likely to continue as a result of the activities.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible that no habitat will be modified through the cumulative impacts of undertaking the works. This may result in impacts to the EECs as detailed in Section 6.6.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is possible that some EECs will become isolated from the water body, limiting inundation as a result of reduced upper limit water levels following artificial entrance opening.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Future habitat modification through this activity may compromise the long-term survival EECs around Back Lake through impacts listed in Section 6.6, if the Policy is implemented indefinitely into the future. However, it is Council's intention to reduce the need for intervention in entrance processes by raising the low lying assets and developing relevant management plans around Back Lake. Nevertheless, this process will be slow and may take decades to implement. As such the long-term survival of these EECs is unlikely to be at risk, but the will continue to be significantly modified and restricted for some time into the future.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Back Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan

The activity is a threatening process and as a result would be inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Back Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

6.9 Conclusion

The proposed entrance management works are required for the sole purpose of reducing the impacts of flooding to private and public assets. This occurs as lake water levels above 1.4 m AHD have the potential to cause undue hardship and disruption to members of the local community. In implementing the proposed Back Lake Entrance Management Policy, there are two notable potential impacts. These are:

1. Potential direct impacts to threatened shorebird species;

2. Potential cumulative environmental impacts of altering the natural hydrologic regime, indirectly impacting endangered ecological communities and threatened fauna species.

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes specific selection of an excavator access route that minimise impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

With regards to changes to the hydrologic processes of the lake and resulting cumulative indirect impacts on EECs and threatened species, the Back Lake Entrance Management Policy has outlined planning and adaptation works for low lying assets that will allow mechanical entrance opening at higher lake water levels in the future, returning hydrologic behaviour to more natural regimes. Nevertheless, this process will be slow and may take decades to implement. While the potential for future significant adverse impacts to saltmarsh, other fringing EECs, and threatened species beyond those already occurred are expected to be minimal, they will continue to occur for many years.

As there are no viable alternatives to the proposed entrance management in the short term, the proposed Back Lake Entrance Management Policy should be approved, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- Bega Valley Shire Council plan and implement modifications to the low lying assets that are affected by inundation when lake water levels are high;
- A Flood Risk Management Study and Plan should be undertaken when resources become available to investigate future flood management options, with consideration of natural berm heights, sea level rise projections and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) and consistent with the NSW Floodplain Development Manual (DIPNR 2005). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions.

7 REF for the Artificial Entrance Opening of Lake Curalo

7.1 Location

Lake Curalo is situated on the far South Coast of New South Wales, between Eden and Nullica State Forest. It has a surface area of 0.8 km^2 and a catchment of 28.2 km^2. The "Lake" is actually classified as a semi-mature, saline coastal lagoon (Roy et al 2001). Palestine Creek is the primary drainage inflow into the Lake. The Lake bed is relatively shallow with an average depth of approximately 0.4 m AHD, with a maximum depth of 2 m AHD (ESE 2002). National Park estate comprises 7% and State Forest 86% of the catchment (see Figure 55).

Figure 55: Lake Curalo Estuary

7.2 Description of Proposed Activity

A channel will be excavated through the unvegetated sand barrier and adjacent shallow shoals as shown in Figure 56 using mechanical equipment, most likely an excavator. The access route which the machine will use is also shown in Figure 56. This route has been selected to minimise disturbance to vegetation and any nesting shorebirds during machine access and egress, as it follows an existing cleared track through vegetation and then progresses along Aslings Beach as close as possible to the high tide wave runup area. However, it is expected that minor damage to the track and grassed areas is inevitable. Particular care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes and shell middens and a permit from NPWS has been sought for access over Aboriginal sites and objects (though there are no known sites on this path).

The machine will access the site via the northern Aslings Beach Road car park where minor damage to the track and dunal system is inevitable. Particular care should be taken to avoid damage to, or disturbance of vegetated sand dune areas.

Figure 56: Location of Entrance Opening Works

As outlined in the Lake Curalo Entrance Management Policy (Appendix E) the excavation will only be undertaken if the water level exceeds 1.2 m AHD.

The excavated sand (the volume of sand is likely to vary depending on a range of environmental conditions including the time since the lake entrance was last open) will be pushed to the northern side of the excavated channel and will not be removed from site. The channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 4-6 hours duration. It would be rare for it to extend beyond 10 hours.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

While there is no intention to establish a permanent opening, a reasonably long lasting opening is preferred to maximise the possibility of full water exchange and obviate the need for repeated intervention after a short period of time (that is, a few weeks or months). To assist with the establishment of a large and deep channel, which will be slow to infill, completion of the excavated channel will generally be undertaken during the falling stage of

the tidal cycle. This should ensure that an adequate head difference between the water in the lagoon and the ocean is maintained for the first few hours of outflow. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

7.3 Purpose of the Activity

The purpose of the works is to re-establish a temporary tidal connection between the lake and the ocean to allow accumulated water to flush to the ocean and thereby lower water levels below that which causes flooding problems on the main road and other low lying lake assets.

The intention is not to establish a permanent opening. It is recognised that the entrance channel could well close again within a matter of weeks, although it would generally be hoped that the channel would remain open for a period of months to maximise the period available for tidal flushing and minimise the need for further openings in the short term.

7.4 Consideration of Alternatives

Ultimately there are no viable alternatives to the artificial opening of the lake. The "do-nothing" option is unacceptable because of the potential damage and disruption that could be caused if the lake was left closed and water inundated public and private assets. The high water levels may also remain for many months compounding the scale of damage done by floodwaters. Therefore not interfering and allowing nature to take its course so that water levels rise until a natural breakout takes place, could in most situations cause flood damage and associated problems for local residents.

Rather than adopting a fixed level, a variable level could be used. This would have more ecological benefits. However, the current intervention level of 1.2 m AHD represents a ceiling which is difficult to go above in the short-term. The netball courts begin to inundate at water levels of approximately 0.95 m AHD, while the soccer and AFL fields begin to inundate at a water level of approximately 1.5 m AHD. The Eden Cove walking track begins to inundate at water levels of 1.0 m to 1.2 m AHD (but was created in the knowledge that this inundation would occur during times of lake closure and high water levels) and the boardwalk inundates at approximately 1.4 m AHD. The foreshore land at Eden Tourist Park begins to inundate at a water level of 0.9 m AHD, however, the lowest significant constructed asset in the caravan park is the sewer pumping station which has a floor level of 1.6 m AHD.

In the longer term it is the intention to increase the intervention level above 1.5 m AHD by selectively flood proofing, raising, removing or relocating those items of infrastructure which are most prone to flooding. The Lake Curalo Entrance Management Policy (Appendix E) proposes works that should be completed in desired timeframes in order to increase the intervention level.

A two dimensional unsteady hydrodynamic model as part of a Flood Risk Management Study and Plan should be prepared to better investigate flood management options, with consideration of higher berm heights and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW, 2010b) for a full range of annual exceedance probabilities up to the possible maximum flood consistent with the NSW Floodplain Development Manual 2005. It

would be preferable if no intervention was required but it is not known whether this will ever be a practical alternative considering the current configuration of development.

7.5 Description of the Existing Environment

7.5.1 General Characteristics

The Lake Curalo entrance is situated at the northern end of Aslings Beach. The entrance area itself is characterised by an expanse of unvegetated sand. The substrate in the entrance area is completely dominated by unconsolidated and well sorted marine sand.

7.5.2 Sediments

7.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show the entire bed of Lake Curalo as having a high risk of potential acid sulfate soils. Additional and more prolonged inundation of these soils as proposed by the policy, compared to historic lower water level break outs would reduce the oxidation potential of the soils, thus reducing their acid-generating potential.

In relation to the berm area where the excavation works are proposed, acid sulfate soils are highly unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

7.5.2.2 Bank Erosion and Sedimentation

Sedimentation in Lake Curalo has been documented as a concern to the local community (ESE 2002). Sediments within and around Lake Curalo comprise clean quartzose marine sands along the seaward margin; fine-grained, organic-rich sandy muds from the catchment in the main basin of the lake, with coarser grained sediments along the western shore in the vicinity of Palestine Creek.

Vibrocoring of the lake basin (sediment samples obtained by vibrating a pipe into the lake bed, then splitting the pipe to view sediment layers) showed a relatively thin layer (about 2 m deep) of organic-rich sandy muds which have been deposited within the last 10,000 years.

Long-term estimates of sediment delivery from the catchment to Lake Curalo were made using the plan area of deposited material, thickness of sediments estimated from the vibrocores and a start date of 6,500 before today (when the lake formed as the sea level rose to present day levels). The results indicate a sediment delivery rate within, but at the upper end of, estimates for other undisturbed South Coast estuaries (ESE, 2002).

7.5.3 Hydrology

7.5.3.1 Entrance Behaviour / Characteristics

The frequency and duration of entrance opening is an important determinant of the hydraulic character of the lake (that is, the frequency and magnitude of water level fluctuations and quality changes). OEH have undertaken an analysis of the entrance state for Lake Curalo on the basis of available gauged data, which is included below.

OEH Analysis:

Manly Hydraulics Laboratory have maintained a water level gauge on behalf of OEH in Lake Curalo since 28/06/2007. In addition, a water level gauge was also deployed in Curalo Lake from 9/3/1996 to 11/3/1998. In total approximately 10 years of water level data exists for the estuary. At the time of installation in 2007 the entrance was closed, while in 1998 the entrance was open.

Entrance closure and opening has been identified from observing the stop and start of a tidal signal from the graphed data (see Figure 57). This is generally easy to identify but there are small periods of time where the entrance is likely closed but still being overtopped on the top of the high tide that make picking the precise closure date difficult. There is one small period of time where data has not been collected (between 12/3/2010 and 13/4/2010), and it is possible, but unlikely, that an opening and closing episode could have been missed in this period.

Between 9/3/1996 and 11/3/1998, and between 26/06/2007 and 24/7/2015, 8 separate periods of entrance closed conditions have been identified, with closed conditions ranging from 32 days up to 523 days, but typically in the order of several months (26). The total duration of closed entrance conditions compared to the full record equates to approximately being closed for 43% of the time. The duration that the entrance stays open for ranges from 68 days to 555 days, but typically in the order of 6 months or greater. The total duration of open entrance conditions for the full record equates to approximately being open for 57% of the time. This illustrates that Lake Curalo is almost equally open and closed and can remain open and tidal for considerable periods of time.

The level of entrance opening ranges from 1.03 to 1.45 m AHD, but typically over 1.2 m AHD. It should be noted that this does not provide a good surrogate for natural berm height range as most of the openings are likely to be artificial as result of Council opening to alleviate flooding hazards. An OEH survey of Lake Curalo berm height on 19/6/13 found the berm height to be approximately 2.4 m AHD. The potential for slightly higher berm heights may also be possible at this location. Comparison of Lake Curalo water levels to ocean water levels recorded from Twofold Bay in Eden show that the majority of the time when the entrance is open the tidal range is restricted to significantly less than 50% of the full open ocean tidal range (Figure 59). However, after a significant rainfall event and opening, tidal range can be up to approximately 0.6 m with attenuation of the top of the full open ocean high tides experienced and attenuation of the full low tide below 0.0 m AHD (Figure 59 and Figure 60).

Table 26: Periods of Entrance Closures, Opening and Opening Levels for Lake Curalo				
Entrance Closure Date	**Entrance Opening Date**	**WL Height at Opening**	**Closure Duration (days)**	**Open Duration (days)**
NA	28/06/2007	NA	NA	NA
16/12/2007	5/02/2008	1.44	51	171
10/09/2008	15/02/2010	1.45	523	218
24/08/2011	1/03/2012	1.349	190	555
14/09/2012	19/09/2013	1.031	370	197
9/05/2014	27/06/2014	1.152	49	232
3/09/2014	8/12/2014	1.204	96	68
NA	24/07/2015	NA	NA	228
Total			1279	1669
Total			43%	57%
NA	9/03/1996	NA	NA	NA
30/01/1997	3/03/1997	1.42	32	327
10/07/1997	NA	NA	244	NA
11/03/1998				
Total			276	327
Total			46%	54%

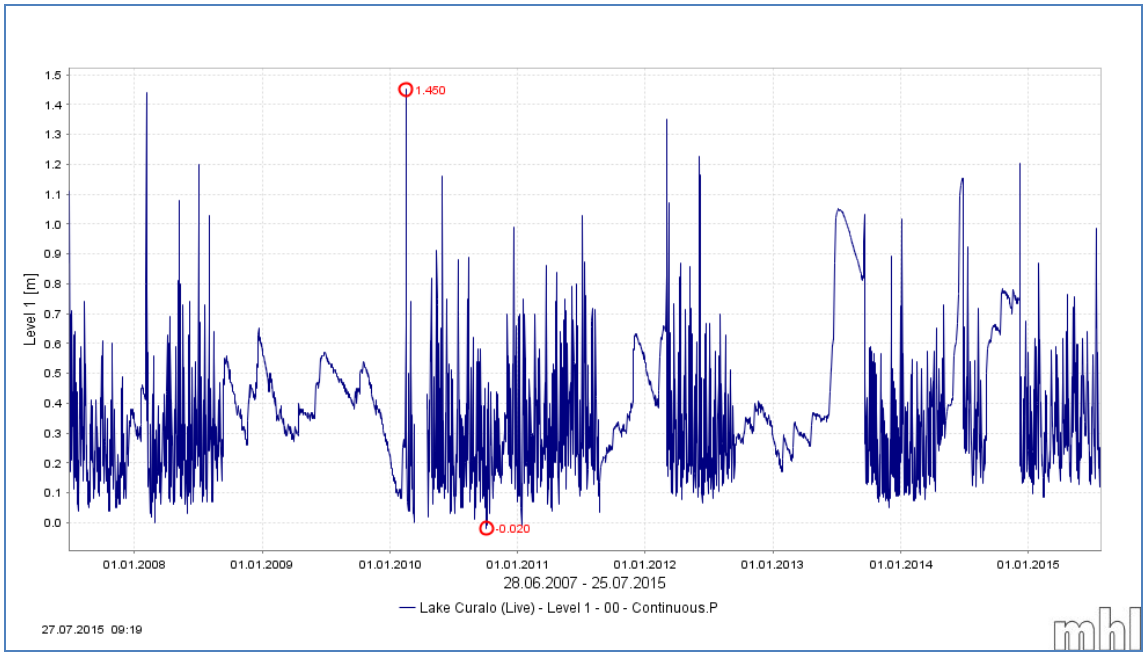

Figure 57: Complete Water Level Data Set from Lake Curalo Water Level Gauge Situated in the Entrance from 28/06/2007 to Present Day

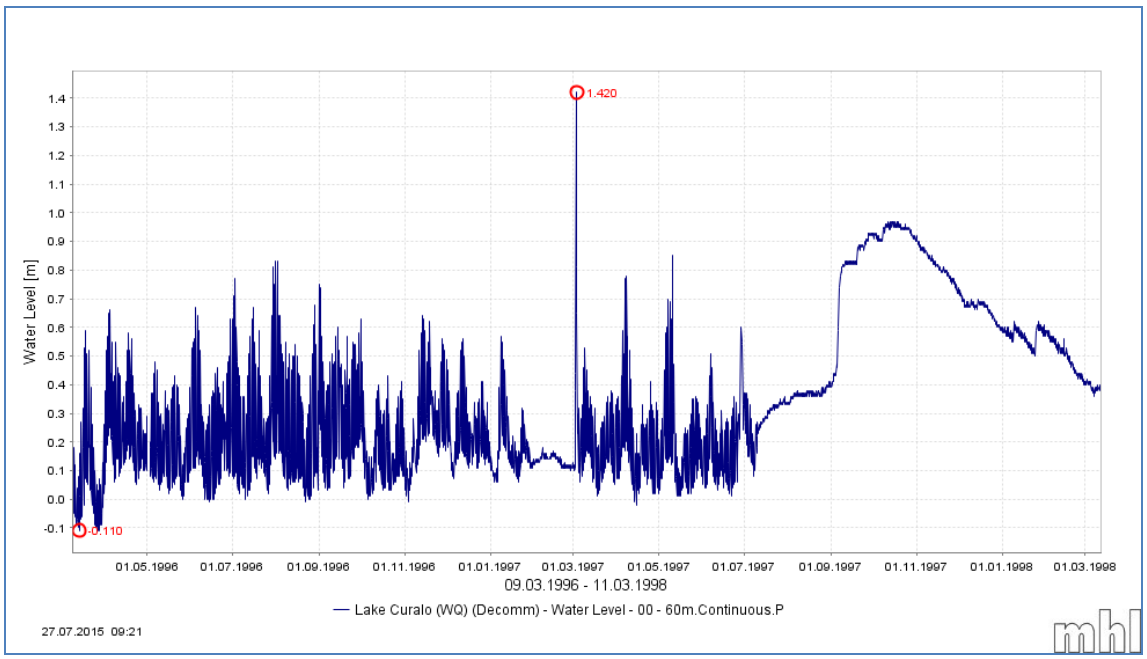

Figure 58: Complete Water Level Data Set from Lake Curalo Water Level Gauge Situated in the Entrance from 09/03/1996 to 11/03/1998

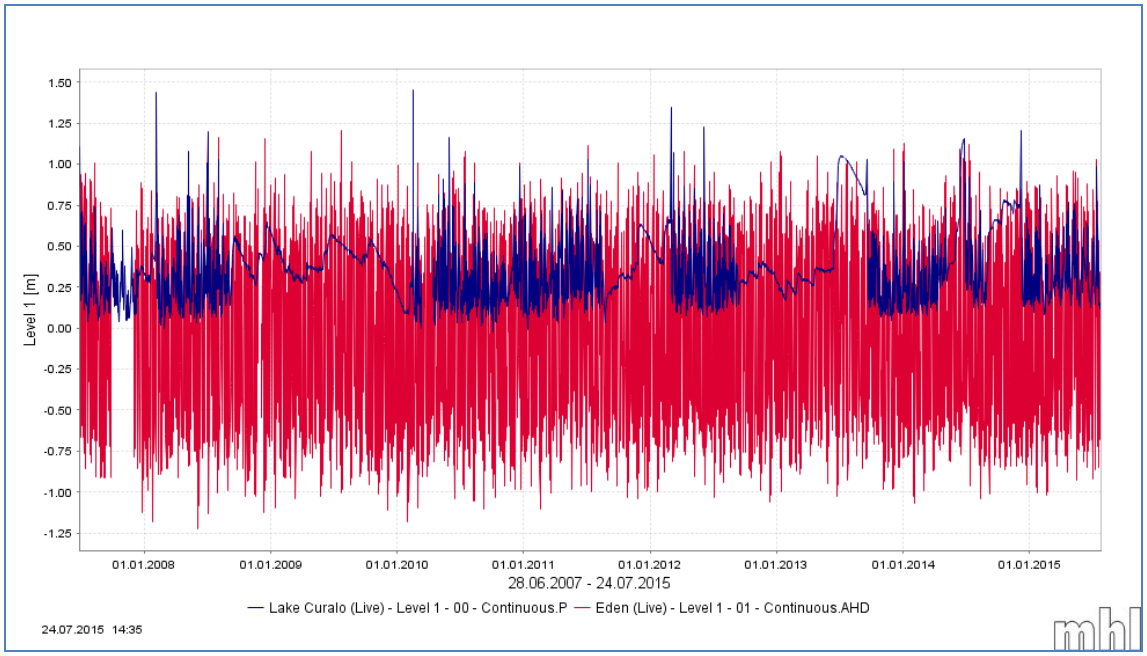

Figure 59: Complete Water Level Data set from Lake Curalo Water Level Gauge, plotted against the Open Ocean Water Level Records from Twofold Bay

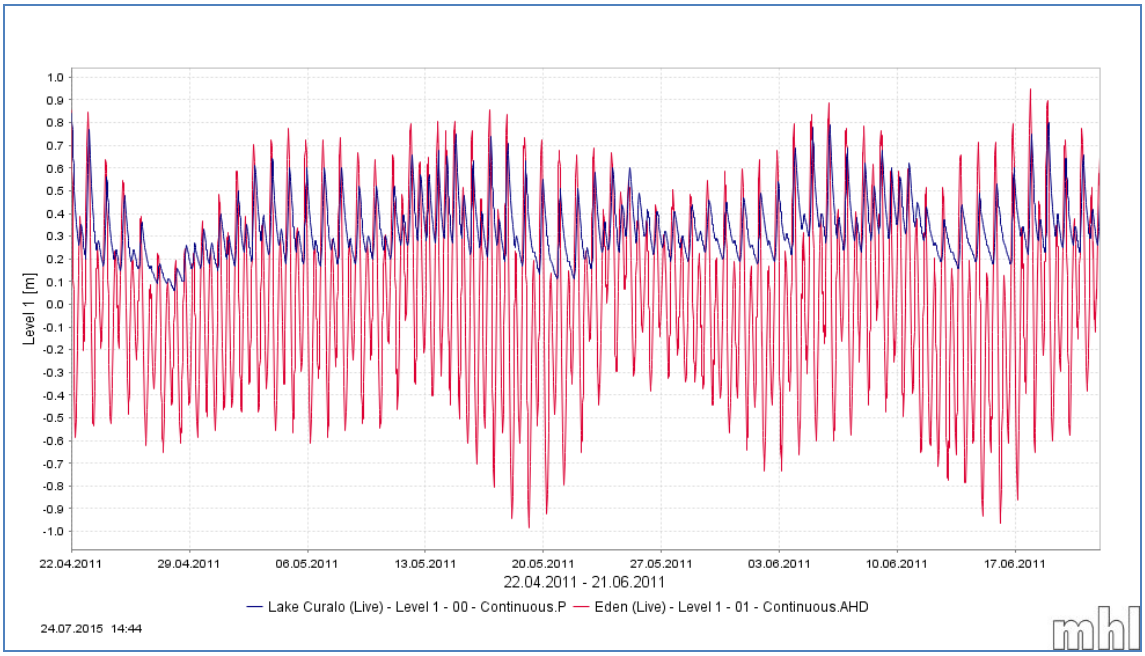

Figure 60: Snapshot of Lake Curalo Water Level Record Plotted Against the Open Ocean Water Level Record from Twofold Bay

ESE identified that "artificial opening has probably been the most significant change to the lake system. Prior to development of flood liable land and the need for opening to reduce flooding, the lake probably remained closed for periods of years until a significant wet period raised the level to around 3 m AHD and the barrier dune was breached"(ESE, 2002).

Entrance breakout location based on aerial photograph interpretation has shown that lake entrance opening has typically occurred in the northern region of the Lake Curalo entrance spit (Figure 61).

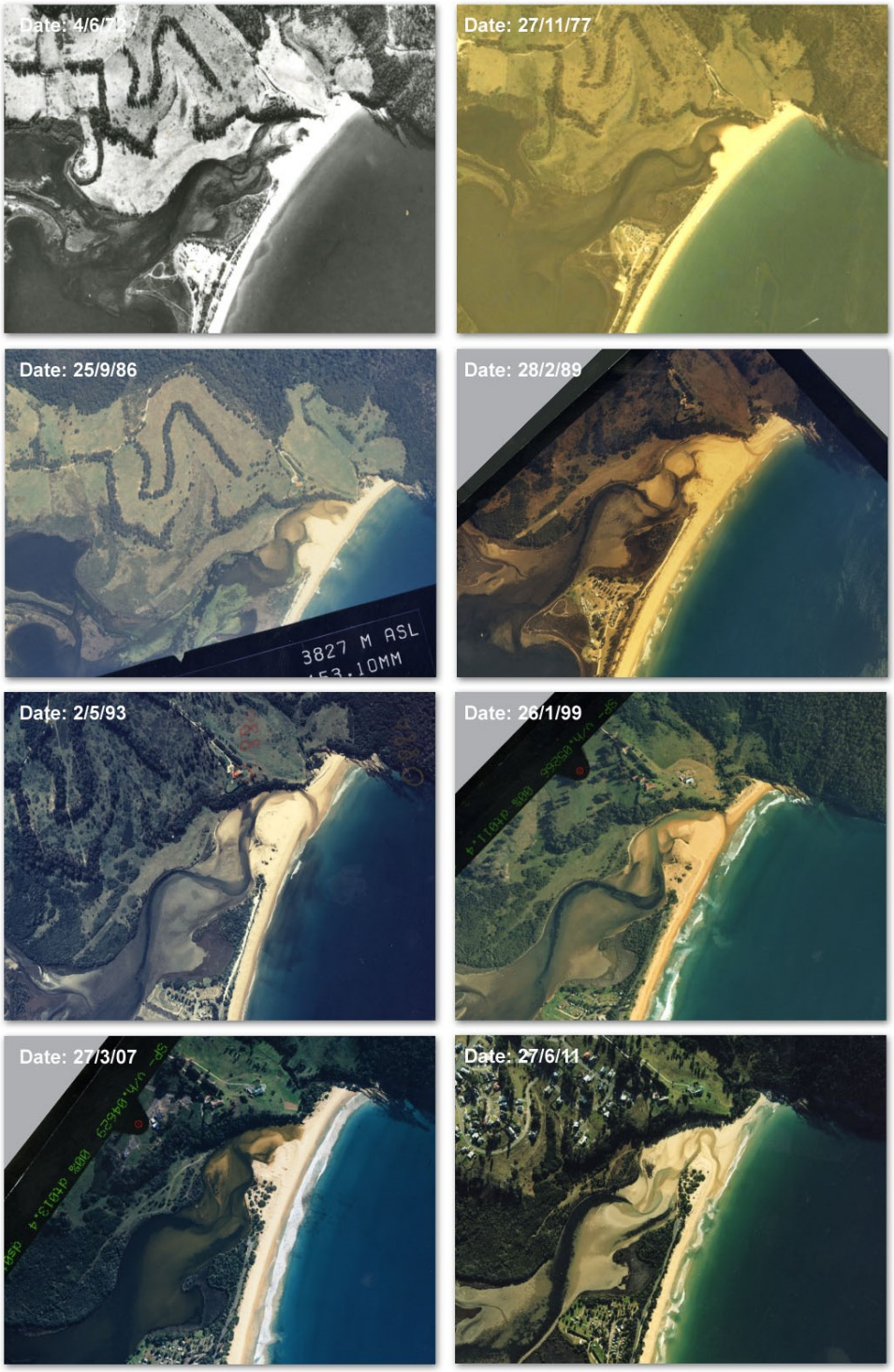

Figure 61: Aerial Photographs of the Lake Curalo Entrance 1972 to 2011

7.5.3.2 Water Quality

Water quality data collected by NSW State Agencies between 1969 and 1995 indicate micro algae is low, with Chlorophyll a samples exceeding MER guideline values 3 out of 17 samples (Roper et.al. 2011). Turbidity data collected between June 1997 and March 1998 by the EPA were generally high. Data logger monitoring of bottom waters in the main basin of Lake Curalo

(1996-98) indicated that turbidity generally decreases within a few days after rainfall/runoff from the catchment. Strong winds also affect turbidity through the re-suspension of fine bed material (organic material and fine silt particles) (ESE 2002).

7.5.4 Ecology

Lake Curalo and its surrounds provides habitat for a number of significant flora and fauna species. For the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, the lake and its immediate surrounds where defined within the geographical domain:

GDA94

North: -36.99 South: -37.09

East: 149.86 West: 149.96

Within this domain The Atlas of NSW Wildlife identified 23 species protected under the Threatened Species Conservation Act 1995, 4 species protected under the Environment Protection and Biodiversity Conservation Act 1999, and 7 species protected under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

7.5.4.1 Flora

Figure 62 shows the various areas EECs located around the Lake Curalo estuary catchment.

Aquatic Vegetation

A seagrass community composed of Zostera capricorni and Halophila ovalis and covers ≈81,500 m^2 of Lake Curalo (DPI, 2006). Zostera capricorni is the predominate species covering an area of ≈65,500 m^2 with large clusters in shallow areas of the Lake proper and northern bay. These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are import marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997.

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under the NSW Threatened Species Conservation Act 1995 are known to occur within the Lake Curalo estuarine catchment (Figure 20). These EECs cover a total area of 247,000 m^2 and include Coastal Saltmarsh, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Far South Coast Dry Rainforest, Swamp Oak Floodplain Forest and River Flat Eucalypt Forest.

Coastal Saltmarsh occupies a total area ≈22,000 m^2 at seven localities around the Lake. The three largest areas of saltmarsh communities are located on the island at the mouth of Palestine Creek and to the north and south of Eden Tourist Park. This endangered ecological community comprises a complex of succulent herbfields and sedgelands predominately characterised by Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis, Zoysia macrantha, Austrostipa stipoides along with Scirpus nodosa and Sporobolus virginicus (Tozer et al 2004). This community of species is very important to estuarine food

webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients. Saltmarsh has declined around the state and Lake Curalo is no exception with a reduction of approximately 22% based on analysis conducted by the Department of Primary Industries (Fisheries) between 1985 and 2006 (DPI 2006). Due to this state wide declining trend Coastal Saltmarsh has been listed as an endangered ecological community under the Threatened Species Conservation Act 1995.

Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest are comprised within the Swamp Oak Forest on Coastal Floodplains endangered ecological community. The Estuarine Creekflat Scrub and Swamp Oak Floodplain Forest inhabits an area ≈13,800 m^2 and ≈500 m^2 respectively around Lake Curalo. Estuarine Creekflat Scrub is characterised by Melaleuca ericifolia, Casuarina glauca, Parsonsia straminea, Baumea juncea, Lobelia alata, Baumea articulate, Leptinella longipes, Samolus repens, Selliera radicans. Swamp Oak Floodplain Forest is characterised by Casuarina glauca, with climbers and groundcover species Parsonsia straminea, Geitonoplesium cymosum, Centella asiatica (Tozer et al 2004). Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and are vital refuges for many fauna species.

The Lowland Grassy Woodland in the South East Corner Bioregion endangered ecological community occupies a total area ≈9,500 m^2 at a number of localities in the northern region of the Lake. This community complex typically comprises of Acacia mearnsii, Angophora floribunda, Eucalyptus globoidea, Eucalyptus tereticornis, Bursaria spinosa, Ozothamnus diosmifolius, Clematis glycinoides var. glycinoides, Rubus parvifolius, Cheilanthes sieberi, Desmodium varians, Dichondra spp., Echinopogon ovatus, Eragrostis leptostachya, Glycine clandestine, Glycine tabacina, Hydrocotyle laxiflora, Hypericum gramineum, Lepidosperma laterale, Lomandra longifolia, Lomandra multiflora subsp. Multiflora, Microlaena stipoides, Oxalis perennans, Themeda australis, Wahlenbergia gracilis (Tozer et al 2004). Habitat fragmentation due to clearing and grazing has reduced the ecological function of this community since European settlement resulting in a substantial loss of mammal flora. After an examination of historical and contemporary survey data Lunney and Leary (1988) concluded that at least six native mammal species had become locally extinct, including the Wallaroo (Macropus robustus), the Parma Wallaby (Macropus parma), the red-necked Pademelon (Thylogale thetis), the Tasmanian Bettong (Bettongia gaimardi), the Eastern Quoll (Dasyurus viverrinus) and the Brush-tailed Phascogale (Phascogale tapoatafa).

The River-Flat Eucalypt Forest on Coastal Floodplains is an endangered ecological community that occupies an area ≈131,000 m^2 at two locations within the Lake Curalo estuarine catchment. This community was typically comprised of Eucalyptus. Baueriana, Eucalyptus botryoides, Eucalyptus elata, Eucalyptus ovata, Rubus parvifolius, Breynia oblongifolia, Hymenanthera dentate, Glycine clandestine, Stephania japonica, Microlaena stipoides, Lomandra longifolia, Pteridium esculentum, Oplismenus aemulus, Pratia purpurascens, Echinopogon ovatus, Entolasia marginate, and Desmodium varians (Tozer et al 2004). This EEC provides habitat for a broad range of flora, including many that are dependent on the vegetation for food, nesting or roosting such as the White-bellied Sea-eagle, Kingfishers, Owls, Yellow-bellied Glider etc. The clearing of native vegetation; alteration to the natural flow regimes; invasion of native plant communities by exotic perennial grasses; anthropogenic climate change; high frequency fire; and Removal of dead wood and dead trees are listed as threatening processes leading to the NSW Scientific Committee determining that River-Flat Eucalypt Forest is likely to become extinct in nature in New South Wales unless the

circumstances and factors threatening its survival or evolutionary development cease to operate (NSW Scientific Committee 2012).

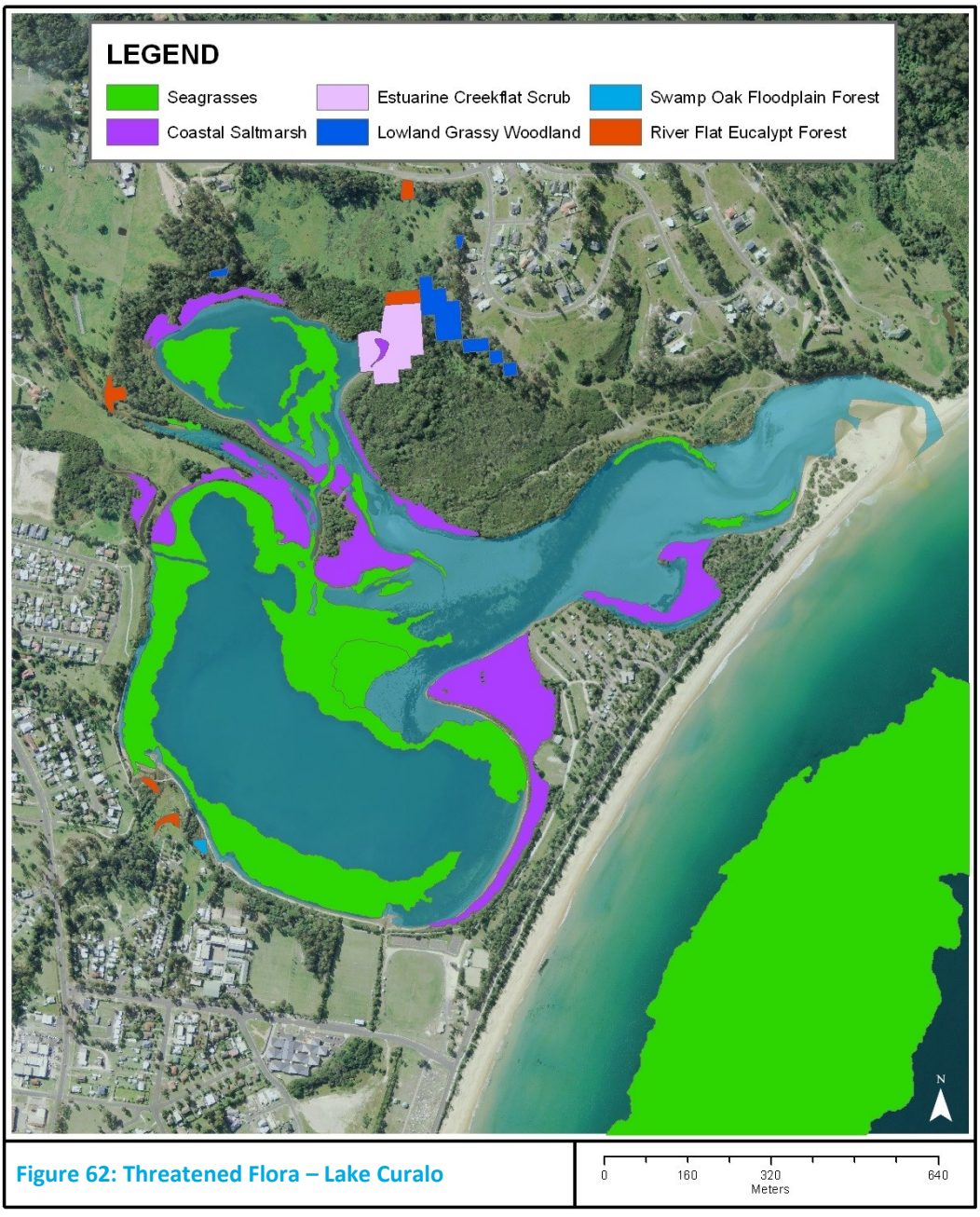

Figure 62: Threatened Flora – Lake Curalo

7.5.4.2 Fauna

Mammals

The Atlas of NSW Wildlife has identified 7 species listed as vulnerable under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, the Koala is listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in Table 27:

Table 27: Threatened Mammals in the Lake Curalo Region			
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**
White-footed Dunnart	Sminthopsis leucopus	V	
Koala	Phascolarctos cinereus	V	V
Yellow-bellied Glider	Petaurus australis	V	
Eastern Freetail-bat	Mormopterus norfolkensis	V	
Eastern False Pipistrelle	Falsistrellus tasmaniensis	V	
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	
Southern Myotis	Myotis macropus	V	

V= Vulnerable; facing a high risk of extinction in the medium-term future.

Birds

The Atlas of NSW Wildlife has identified 12 bird species listed as vulnerable and 2 species listed as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, the Swift Parrot is listed as endangered under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition 7 species are protected under the Japan-Australia, Republic of Korea-Australia and China-Australia Migratory Birds Agreements. These species are shown in Table 28. OEH (2015) present maps of sites that are significant to shorebird nesting throughout the Bega Valley Shire, and identify the Lake Curalo entrance as one of these sites. Figure 64 shows the identified locations and species from OEH (2015).

Table 28: Threatened Avifauna in the Lake Curalo Region				
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**	**Migratory Bird Agreements**
White-throated Needletail	Hirundapus caudacutus			C,J,K
Black-browed Albatross	Thalassarche melanophris	V		V
Short-tailed Shearwater	Ardenna tenuirostris			J,K
Eastern Reef Egret	Egretta sacra			C
White-bellied Sea-Eagle	Haliaeetus leucogaster			C
Little Eagle	Hieraaetus morphnoides	V		
Eastern Osprey	Pandion cristatus	V		
Sooty Oystercatcher	Haematopus fuliginosus	V		
Pied Oystercatcher	Haematopus longirostris	E		
Grey Plover	Pluvialis squatarola			C,J,K
Arctic Jaeger	Stercorarius parasiticus			J,K

Gang-gang Cockatoo	^^Callocephalon fimbriatum	V		
Glossy Black-Cockatoo	^Calyptorhynchus lathami	V		
Little Lorikeet	Glossopsitta pusilla	V		
Swift Parrot	^^Lathamus discolor	E	E	
Powerful Owl	^^Ninox strenua	V		
Masked Owl	^^Tyto novaehollandiae	V		
Sooty Owl	^^Tyto tenebricosa	V		
Varied Sittella	Daphoenositta chrysoptera	V		
Scarlet Robin	Petroica boodang	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife has identified 1 amphibian species listed as vulnerable and 1 species listed as endangered under the NSW Threatened Species Conservation Act 1995. These two amphibian species are also listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are shown in Table 29:

Table 29: Threatened Amphibians in the Lake Curalo Region

Common Name	Scientific Name	NSW Status	Comm. Status
Giant Burrowing Frog	Heleioporus australiacus	V	V
Green and Golden Bell Frog	Litoria aurea	E	V

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

Aquatic Fauna

Recent fish data is unavailable for this Lake. The most abundant fish caught by commercial fishermen have been mullet, bream, flathead, trevally and luderick with a maximum catch 4091 kgs between 1995 and 1996. Catches of molluscs and crustaceans have also been recorded with prawns being the dominant crustacean (ESE, 2002).

Figure 63: Threatened Fauna – Lake Curalo

Figure 64: Significant Shorebird Sites at Lake Curalo Entrance (OEH, 2015)

7.5.5 Cultural Heritage

7.5.5.1 Aboriginal Cultural Heritage

Sites of Aboriginal cultural significance, such as middens, camping areas, artefact scatters, shelters and other sites are frequent around Bega Valley Shire Council estuary shorelines, beaches and islands. There are also many areas of spiritual and cultural significance, the details of which are not generally known and are unlikely to be made known to people other than the tribal custodians of the knowledge.

The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance. The investigation included searches of the NSW OEH AHIMS, the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access track and entrance opening area. While 31 sites were identified in the database searches for the wider Lake Curalo estuary search area, no sites in the direct access track or lake entrance area were identified, and Dibden (2016) reported that the impact areas from entrance opening are disturbed and generally of very low to negligible archaeological potential.

7.5.6 Recreational and Commercial Uses

7.5.6.1 Recreation

Lake Curalo supports a range of recreational uses including swimming, boating and fishing. The entrance area is not used for any specific purpose apart from swimming / surfing, walking and nature observation.

When water levels are low the exposed edges of the lake provide areas for walking around the lake. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Conversely, high water levels also provide for improved recreational opportunities such

as kayaking. Thus maintaining variable water levels in the lake will favour differing recreational activities at different times.

Recreational fishing also takes place but there is no data available regarding the extent of recreational fishing or the magnitude and nature of the catch

7.5.6.2 Commercial

Holiday Parks: There are two holiday parks located on the foreshore of Lake Curalo, namely Eden Tourist Park and Garden of Eden Caravan Park. Some of these parks have foreshore land and sites which get inundated by rising lake levels above approximately 0.9 m AHD.

Commercial fishing: Commercial fishing is undertaken however, catch data is unknown.

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

7.6 Description of the Activity Impacts

7.6.1 Acid Sulfate Soil Impacts

It is highly unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Lake Curalo has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings.

7.6.2 Bank Erosion and Sedimentation Impacts

It is unlikely bank erosion would result from this activity.

Over the long term, the progradation of the marine sediments into the lake resulting from artificial entrance openings at lower than natural water levels, may cause moderate adverse sedimentation impacts to the lake due to less effective scour of the marine flood tide delta. It is advised that further study be undertaken when resources are available to examine the impacts of entrance opening on this process.

7.6.3 Hydrology Impacts

The works will have a moderate negative impact on the Lake as entrance opening is an important determinant of the hydraulic character. Natural breakout of Lake Curalo would tend to occur during or soon after a significant rainfall event. Rainfall is a necessary precursor to raise water levels to a level significantly greater than mean sea level, and to 'liquefy' the sand barrier and reduce its cohesion. The ability of the lake water to erode a deep and wide entrance channel is directly related to the head difference that exists between the lake and the ocean at the time of breakout. A large head difference will result in a larger and deeper channel.

Therefore, intervention in the breakout process at low lake water levels with an unsaturated entrance bar will reduce the capacity of the opening to erode sediments from the entrance area. Over the long term this will cause sedimentation impacts and changes to the hydrologic regime as a build up of sediment in the entrance area will result in lower breakout levels and may progressively result in beach bar widening and lake infilling.

Positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening could include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid decreases in dissolved oxygen concentrations resulting from rapid decay of organic material.

7.6.4 Aquatic Vegetation Impacts

Entrance opening and the resulting drop in water levels is likely to have a slight negative impact on aquatic vegetation. The negative impacts include; the scouring of Zostera capricorni from the lakebed and potential die-back due to exposure caused by more frequent rapid decreases in water level.

7.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The works will have moderate negative impacts on several transitional and fringing endangered ecological communities (EECs). These impacts occur as the natural flow regimes of Lake Curalo have and will be altered by the entrance opening works. Endangered ecological communities such as Coastal Saltmarsh, Swamp Oak Forest on Coastal Floodplains, Lowland Grassy Woodland and River-Flat Eucalypt Forest are impacted due to reduced inundation and marinisation. This can result in significant species composition shifts such as reduced Saltmarsh, Grassy Woodlands and River-Flat Eucalypt Forest habitat as well as encroachment of terrestrial vegetation.

It is identified that some dieback will occur following long periods of inundation particularly Casuarina glauca and entrance opening may relieve this pressure. However, it must be noted this is a natural reclamation process and many endangered ecological communities rely on this dieback and inundation for survival. Repeated artificial entrance opening at this lower range of natural break-out water levels will therefore continue to have moderate negative impacts on several transitional and fringing endangered ecological communities.

A Section 5A assessment for the endangered ecological communities and is located in Section 7.8.

7.6.6 Direct Impacts to Access Track Vegetation

The track which will be used to provide access and egress for the excavator is shown in Figure 56. This existing and predominantly cleared track has been selected for the access route, as it will minimise impacts to surrounding vegetation. In driving the excavator along this track, it is expected that only very minor and localised disturbance of dune grasses and shrubs growing on the edges of the track (predominantly Coastal Wattle) will occur, specifically when passing through the short stretch of dunes. There will be no need to remove trees to provide access. While traversing the northern section of Aslings Beach to the lake entrance, the excavator will travel as low as possible to the wave runup zone, minimising the chance of any further

disturbance to dune vegetation. Photographs of the access track are shown in Figure 65, where it can be seen that there will be minimal impacts to vegetation from machine access.

Figure 65: Photos of Lake Curalo Access Track and Vegetation

7.6.7 Fauna impacts

Mammals

It is unlikely the entrance works will have an impact on threatened mammal species or endangered populations.

Birds

Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works including machine access and channel excavation could potentially have a significant negative impact on a number of resident and migratory threatened shorebird species. Shorebirds inclusive of the Grey Plover and Pied Oystercatcher could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- A machine access route that minimises areas of dune impacted by the machine;
- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators, restrict pedestrian access and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform additional adaptive management responses on an “opening-by-opening” basis, as opposed to a “one-off” survey for this REF. Section 5A assessments have been carried out for the potentially impacted shorebird species (Grey Plover and Pied Oystercatcher), and are included in Section 7.8. As the impacts to these species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement. Entrance opening works are unlikely to negatively impact other threatened bird species, rather the reduction in water levels may expose feeding grounds and food sources (decomposing vegetation and invertebrates) for many of the bird species.

Amphibians and Reptiles

The Giant Burrowing Frog is unlikely to occur in habitats directly connected to the lake due to excessive salinities and preference for different habitat types. The Green and Golden Bell on the other hand may be significantly impacted by entrance opening and as a result a Section 5A assessment has been carried out for this species and included in Section 7.8.

Aquatic Fauna

The entrance works will have both positive and negative impacts on aquatic animal species. These positive and negative impacts include assemblage changes, habitat shifts, and fish kills under certain conditions. As the entrance works rapidly change the surrounding environment some species may benefit and others may perish due to stress from low dissolved oxygen and sudden salinity increases. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and the opening works are within the lower range of the natural regime.

7.6.8 Aboriginal Cultural Heritage Impacts

Any unknown Aboriginal sites that may exist around the immediate foreshore of the estuary will have been subject to cycles of flooding and drying over many years and thus may be fairly resilient to changes in lake level. It is possible however, that further flooding and drying combined with wave action may expose sensitive sites or lead to erosion of culturally important areas. While unlikely, entrance works may have both positive and negative impacts on currently un-reported Aboriginal cultural heritage sites. Positive impacts could include opening the entrance prior to naturally high estuary water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts could include increased frequency of wetting and drying from rises and falls in estuary water level as a result of slightly more frequent entrance openings.

While no impacts to Aboriginal places or items in the areas of excavator access or entrance opening were identified in the ACHAR (Dibden, 2016), as a precautionary measure BVSC has sought an AHIP associated with the entrance management works. It is also recommended that monitoring take place during the access and entrance opening process, and that whenever possible access be restricted to the corridor within the intertidal and wave runup zone of the beach.

7.6.9 Recreational Impacts

The entrance management works may result in both positive and negative recreational impacts. When water levels are low the exposed edges of the lake provide areas for walking. This activity becomes more difficult as water levels rise and inundate vegetated foreshore areas. Moreover, as the netball courts and AFL grounds are the primary assets that become inundated at 1.2 m AHD, recreational sporting activities that take place on the grounds would be adversely affected if works were not undertaken. Conversely, high water levels provide for improved recreational opportunities such as canoeing and kayaking. Thus maintaining variable

water levels in the lake will favour differing recreational activities at different times. Impacts on recreational fishing may also occur however as detailed previously artificial opening regimes favour some species over others.

7.6.10 Commercial Impacts

The entrance works may have minor positive and negative commercial impacts on commercial fishing and tourism sectors. Positive impacts may include relieving inundation of foreshore areas providing increased walking access around the Lake. However, negative impacts may include reducing fish and prawn catch for commercial fishers and trigger Malodorous conditions due to rotting vegetation around the lake shoreline. To prevent this affecting holiday makers it is not advisable to artificially open the lake during peak holiday periods. Therefore, entrance opening has both positive and negative commercial impacts, however, it is the intention of this policy to return to a more natural opening regime through alleviating asset damages.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

7.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The community most likely to be affected will be the residents within close proximity to Lake Curalo. There will be no significant adverse impact upon the general wider community. Malodorous conditions can sometimes occur for a few days after an entrance opening due to the rotting vegetation around the lake shoreline. To prevent this affecting holiday makers, where possible the lake will not be artificially opened during peak holiday periods. The wider community on the other hand would be negatively impacted if the works were not undertaken as the netball courts, AFL grounds and boardwalk are the primary recreational assets that become inundated to varying extents as lake levels exceed 0.9 m AHD. In addition a few local residents may also experience inundation of foreshore land on Emblem Street, and grounds of two caravan parks are also impacted. As the only purpose for conducting the entrance opening works is to protect private and public assets from flooding, the activity will have positive outcomes for the community beneficiaries.
b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The locality will not be transformed in any significant manner. The lake entrance will change temporarily, but these changes will be within natural bounds.

c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: There are a range of environmental impacts on the ecosystems of Lake Curalo as discussed in Section 7.6. The cumulative impacts of the entrance works may and most likely have caused medium adverse environmental impacts on the ecosystems of Lake Curalo. These impacts predominately relate to hydrologic and ecological shifts from natural states, as a result of lower water level breakouts. Regular and repeated low water level (artificial) openings will likely further change many ecosystems particularly aquatic and wetland ecosystems over the long-term, as the works alter the ecosystems structure, composition and diversity. However, it should be recognised that BVSC has intentions (as documented in the Policy) to undertake planning and upgrade works to improve low lying assets affected by high lake water levels which will allow the trigger water level for mechanical opening to be raised in the future. Nevertheless, in the case of Lake Curalo, this will be a lengthy process that will likely take decades to implement. As such, long term medium adverse impacts to fringing and aquatic ecosystems are still expected to occur into the future.
d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: There is not likely to be any reduction in the aesthetic quality or value of the locality as a result of implementing the Policy. The impact upon fish and prawn populations may have a bearing upon the recreational value. If an artificial breakout allows a large population of prawns and fish to escape to sea there would be a significant loss of recreational opportunity, especially if this occurred just prior to the Christmas/New Year holiday period. However, an artificial opening could enhance recreational prawning and fishing opportunities the following year if the opening coincided with a high abundance of prawn larvae and fish spawning in nearshore coastal waters. Such conditions are impossible to predict. On balance and over the long term, the impacts are likely to be slightly negative. Impacts to other recreational activities such as kayaking and walking are deemed negligible as fluctuating water levels will favour differing recreational activities at different times. While intervention in the natural breakout process conceptually diminishes the scientific value of the system since an element of 'naturalness' has been lost, in reality the vast majority of ecological processes will continue to operate. The locality could still be suitably used for a wide range of scientific purposes (this has been demonstrated at other ICOLLs on the Far South Coast such as Wallagoot Lake). Certainly the scientific value would not be diminished by the proposed entrance management works to the same degree that other catchment modifications (such as significant development of fringing areas) have.
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other

	special value for present or future generations? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: As discussed in Section 7.6, there are no known sites within the entrance area. Given that artificial lake openings are the early facilitation of a natural process it could be assumed that its effect on cultural artefacts would be minimal. BVSC have sought an AHIP associated with the works as a precautionary measure.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? [5] ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: There is potential that moderate to significant adverse impacts may result to habitat of protected fauna. These impacts are documented in Section 7.6 and primarily result from hydrologic changes (increased frequency and lower water level opening) and habitat disturbance due to machinery and channel scour. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher and Grey Plover by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 7.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 7.8. Similarly, in the long term the works have the potential to have moderate indirect impacts on other threatened mammals and amphibians such as the Green and Golden Bell Frog through habitat modification as a result of changes to the lake's hydrologic regime and upper range water levels. It should be recognised that many of these habitat changes will have already occurred over previous decades, and that the intentions to raise trigger water levels for entrance opening in the future will minimise future impacts. As such, future long term adverse impacts to fringing and aquatic ecosystems which provide habitat for threatened species are expected to be low.
g.	Will there be any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The endangered ecological communities listed in Section 7.8 (i.e. Coastal Saltmarsh, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Swamp Oak Floodplain Forest, and River Flat Eucalypt Forest in conjunction with the threatened Grey Plover, Pied Oystercatcher and Green and Gold Bell Frog may be indirectly impacted by the entrance management works. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher and Grey Plover by disrupting

.

	breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 7.6.7 and the Policy, these impacts will be reduced to low adverse. For these communities and species a Section 5A assessment has been prepared and is contained in Section 7.8.
h.	Will there be any long-term effects on the environment? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment: The cumulative impacts of previous entrance management works most likely have cause medium adverse environmental impacts on the ecosystems of Lake Curalo. Future impacts, while expected to be no worse than those already experienced, are documented in Section 7.6 and may involve: continued shift in the structure, composition, diversity, and location of the lakes ecology; increased rates of Lake infilling particularly at the entrance bar; reduced frequency and duration of flooding at higher levels.
i.	Will there be any degradation of the quality of the environment? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The quality of the lake environment will be degraded by virtue of the fact that a major natural process is being interfered with. In effect the lake is losing a major element of 'naturalness'. Naturalness is a significant environmental attribute. It is often a criteria used to determine environmental or conservation value. Although this activity has occurred in the past, the works continue to perpetuate the problem.
j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of undertaking the entrance opening works. The robustness or ability of the environment to withstand environmental fluctuations should not be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not result in any pollution of the environment.

m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Although it is difficult to predict what other future activities might take place it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or on the foreshore.
p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. Over the long-term the influx of marine sediment into the estuary and the widening of the beach berm may alter sediment processes in the coastal zone, impacting future coastal processes. The Policy has been developed to incorporate a progressive increase in entrance opening levels to partially accommodate current best estimates of sea level rise and reduce the need to intervene in natural entrance behaviour in the longer term.

7.8 7-Part Test for Threatened Species, Populations and Ecological Communities

7.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Grey Plover (Thinornis rubricollis) and Pied Oystercatcher (Haematopus longirostrus).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Lake Curalo.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Lake Curalo to the sea, this constitutes a moderate alteration to the natural flow regimes.

7.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to the Endangered Green and Golden Bell Frog (Litoria aurea).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of this species may be disrupted by the entrance works if breeding colonies are present. Salinity increases and isolation can affect breading success, particularly if entrance works are conducted between August and March. However, it should be noted that the lake entrance could open naturally at any point in time, which would result in the same potential impacts.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for this species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. Some habitat will be modified during the activity as a result of reduced water levels. This may isolate tadpoles and or eggs particularly if the works are undertaken between August and March.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The habitat is of critical importance to this species particularly between August and March for breeding activity.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Lake Curalo.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is inconsistent with the Priority Action Statement and Recovery Plan for this species. However, it should be noted that even without intervention in entrance opening processes, similar impacts to the habitat of this endangered species may still occur as a result of estuarine flooding and natural entrance breakout.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Curalo Lake to the sea, this constitutes a moderate alteration to the natural flow regimes.

7.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Estuarine Creekflat Scrub, Lowland Grassy Woodland, Swamp Oak Floodplain Forest, and River Flat Eucalypt Forest.

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

The artificial opening works of the past have likely constrained the distribution of these endangered ecological communities (EECs) to low lying areas. It is likely that future entrance opening works will perpetuate this trend. If the Lake Curalo Entrance Management Policy is adhered, it is likely a “more natural” Lake water level can be achieved before the lake is artificially breached in the future. This may reduce the future cumulative impacts of the proposed entrance works on these important EECs. It is unlikely any of the EECs are to be placed at risk of extinction as a result of activity, however, declines and shifts in extent, composition, and diversity are likely to continue as a result of the activities.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. It is possible that some habitat will be modified through the cumulative impacts of undertaking the works. This may result in impacts to the EECs as detailed in Section 7.6.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

It is possible that some EECs will become isolated from the water body, limiting inundation as a result of reduced upper limit water levels following artificial entrance opening.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

Future habitat modification through this activity may compromise the long-term survival EECs around Lake Curalo through impacts listed in Section 7.6, if the Policy is implemented indefinitely into the future. However, it is Council's intention to reduce the need for intervention in entrance processes by raising the low lying assets and developing relevant management plans around the Lake. Nevertheless, this process will be slow and may take decades to implement. As such the long-term survival of these EECs is unlikely to be at risk, but the will continue to be significantly modified and restricted for some time into the future.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Lake Curalo.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is a threatening process and as a result would be inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Lake Curalo to the sea, this constitutes a moderate alteration to the natural flow regimes.

7.9 Conclusion

The proposed entrance management works are required for the sole purpose of reducing the impacts of flooding to private and public assets. This occurs as lake water levels above 0.9 m AHD have the potential to cause undue hardship and disruption to members of the local community. In implementing the proposed Lake Curalo Entrance Management Policy, there are two notable potential impacts. These are:

1. Potential direct impacts to threatened shorebird species;
2. Potential cumulative environmental impacts of altering the natural hydrologic regime, indirectly impacting endangered ecological communities and threatened fauna species.

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes

specific selection of an excavator access route that minimises impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

With regards to changes to the hydrologic processes of the lake and resulting cumulative indirect impacts on EECs and threatened species, the Lake Curalo Entrance Management Policy has outlined planning and adaptation works for low lying assets that will allow mechanical entrance opening at higher lake water levels in the future, returning hydrologic behaviour to more natural regimes. Nevertheless, this process will be slow and may take decades to implement. While the potential for future significant adverse impacts to saltmarsh, other fringing EECs, and threatened species beyond those already occurred are expected to be minimal, they will continue to occur for many years.

As there are no viable alternatives to the proposed entrance management in the short term, the proposed Lake Curalo Entrance Management Policy should be approved, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- Bega Valley Shire Council plan and implement modifications to the low lying assets that are affected by inundation when lake water levels are high;
- A Flood Risk Management Study and Plan should be undertaken when resources become available to investigate future flood management options, with consideration of natural berm heights, sea level rise projections and coincidence events as outlined in the NSW Flood Risk Management Guide (DECCW 2010b) and consistent with the NSW Floodplain Development Manual (DIPNR 2005). In adopting this philosophy affected communities will benefit by reducing their risk exposure under both existing and changed climate conditions.

8 REF for the Artificial Entrance Opening of Wonboyn Lake

8.1 Location

Wonboyn Lake is situated on the far south coast of New South Wales, approximately 30 km south of Eden. The lake has a surface area of 4.2 km^2, a catchment of 335.4 km^2 and is classified as a youthful, wave dominate barrier estuary (Roy et al 2001). The lake bed is deeper than most other ICOLLs in the area, with an average bed depth of approximately 2.7 m (Roper et al., 2011) and a maximum depth of approximately 6 m (WBM, 2004). The Wonboyn River and Stevens Creek provide the significant freshwater inflows to the lake. Ninety percent of the lake's catchment lies within the East Boyd, Nadgee and Timbillica State Forests, with a further 4% of the catchment in the Nadgee Nature Reserve and Mount Imlay National Park (see Figure 66).

Figure 66: Wonboyn Lake Estuary

8.2 Description of Proposed Activity

As discussed previously in the REF, it is proposed that Council artificially open the entrances of certain ICOLLs throughout the shire, but only when there is a need to alleviate nuisance

flooding of foreshore assets which can occur when the ICOLL entrances are closed. This intervention is carried out in accordance with a defined water level as outlined in the relevant formal Entrance Management Policies and summarised in 30 below. In the past Wonboyn Lake has remained open to the ocean more than 95% of the time, and only once in recent decades has Council had to intervene to mechanically open the lake entrance. This intervention was primarily to alleviate the impact of lack of estuary flushing on the local oyster industry when the entrance closed in 2004. The Wonboyn Lake Entrance Management Policy (Appendix G) stipulates that in the future, Council will only fund mechanical opening of the entrance to the lake when Council assets or Council approved private assets become at risk of inundation due to elevated lake water levels. The lake water level adopted in the Policy to trigger mechanical opening of the lake by Council is 1.4 m AHD, and has been adopted so as to avoid inundation of Wonboyn Road at Myrtle Cove.

The success of ICOLL entrance openings generally depends on a large volume of water being released from the lake to scour built up marine sands from the entrance channel and any near shore marine deposits. Generally, the higher the lake water level prior to mechanical opening, the more successful the opening is. The proposed entrance opening trigger water level of 1.4 m AHD is considered to be at the low end of the range for achieving a successful opening.

It is recognised that the lake entrance may require artificial opening at lower water levels in order to maintain estuarine conditions that are suitable for oyster survival. However, funding for such openings would be the responsibility of the local oyster farming industry, and entrance opening works would still have to be undertaken as specified within the Wonboyn Lake Entrance Management Policy. To maintain suitable conditions for oyster health, mechanical entrance openings may be required to take place at relatively low lake water levels, as such, achieving a meaningful entrance scour could be quite difficult. The Policy stipulates a minimum trigger water level for mechanical entrance opening on the grounds of oyster health, at 1.1 m AHD. Mechanical entrance openings at lower water levels would be unlikely to produce an effective opening, and would be lower than the trigger level adopted in the Entrance Management Policies for other ICOLLs within the shire (30). If the entrance is opened at lower water levels, the lake may close again in a short space of time, potentially compounding water quality problems in terms of oyster health.

Table 30: Summary of Entrance Opening Levels for other BVSC ICOLLs

Estuary	Lake Opening Trigger Level
Wallaga Lake	1.1-1.25 m AHD
Cuttagee Lake	1.6-1.8 m AHD
Bega River	1.36 m AHD
Wallagoot Lake	1.2-1.4 m AHD
Back Lake	1.2-1.4 m AHD
Lake Curalo	1.2 m AHD

The proposed entrance opening works have two distinct components:

1. Site access; and
2. Entrance excavation.

Both components need to be considered in this REF independently due to their particular potential environmental impacts.

8.2.1 Equipment Access

The earthmoving equipment (most likely an excavator or backhoe) required to carry out the opening would need to be unloaded on the intersection of Greencape Lighthouse Road and Archers Road due to the unsuitable condition of Archers Road for a semi-trailer to travel. It is approximately 2.1 km from this point to the powerline easement on the northern boundary of the houses that line the northern shoreline of Wonboyn Lake (See Figure 67). The final 500 m of the route is through a dense, vine forest type vegetation community (including Lilly Pilli Acmena smithi, Sweet Pittosporum, Water Vine, Pomaderris sp.) that forms a tight canopy over the track, giving a tunnel appearance. The canopy is only high enough for a conventional vehicle to pass and would be damaged by heavy machinery moving along this route. While the vegetation here is visually appealing, it does not constitute part of any threatened ecological community, nor were there threatened vegetation types identified. There is no alternative option in accessing the powerline easement due to the topography of the area. It was hoped that Council would be able to travel down to the powerlines to the rear of the properties and avoid the canopy covered section of the track. However, a near vertical cliff along the easement makes this option impossible.

From the eastern end of the powerline easement the machine would be required to follow an existing track for some 660 m around the northeastern side of the lake to reach the beach. This track was previously used by BVSC on a previous lake entrance opening approximately 12 years ago, and traverses a significant section of native vegetation. At the advice of OEH, BVSC engaged specialist consultant Envirokey to undertake a Flora and Vegetation Community Impact Assessment (FVCIA) for this section of the machine access route. The purpose of the FVCIA was to assess the potential impacts of the proposed access to threatened flora species, flora populations and threatened ecological communities (TEC) and their habitats as listed under the schedules of the NSW Threatened Species Conservation Act 1995 (TSC Act) and the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The findings of the Envirokey investigation are provided in Envirokey (2016) and attached as Appendix I.

Once on the beach the excavator would travel 400 m along the high tide wave runup line to reach the entrance excavation site.

This route has been selected to minimise future disturbance to vegetation during machine access and egress, as it follows an existing cleared track. The route also minimises the extent to which the machine would pass through dune areas that are potential habitat for threatened shorebirds. However, it is expected that minor damage to vegetation along the edges of the track and dune grasses is inevitable. Particular care will be taken to avoid damage to, or disturbance of vegetated areas of sand dunes and shell middens, and as a precautionary measure a permit (AHIP) from OEH has been sought to undertake the works (though there are no known Aboriginal objects or places within the access or work areas).

The earthmoving equipment will be escorted by a supervisor to ensure that the correct access route is followed and opening procedures are correctly adhered to. As part of Council's Memorandum of Understanding the Eden Aboriginal Lands Council would be invited to have a sites officer present during the site access and entrance opening works. As per the Wonboyn Lake Entrance Management Policy, if the lake is required to be opened between August and April, BVSC staff will also liaise with NPWS and the local Shorebird Coordinator.

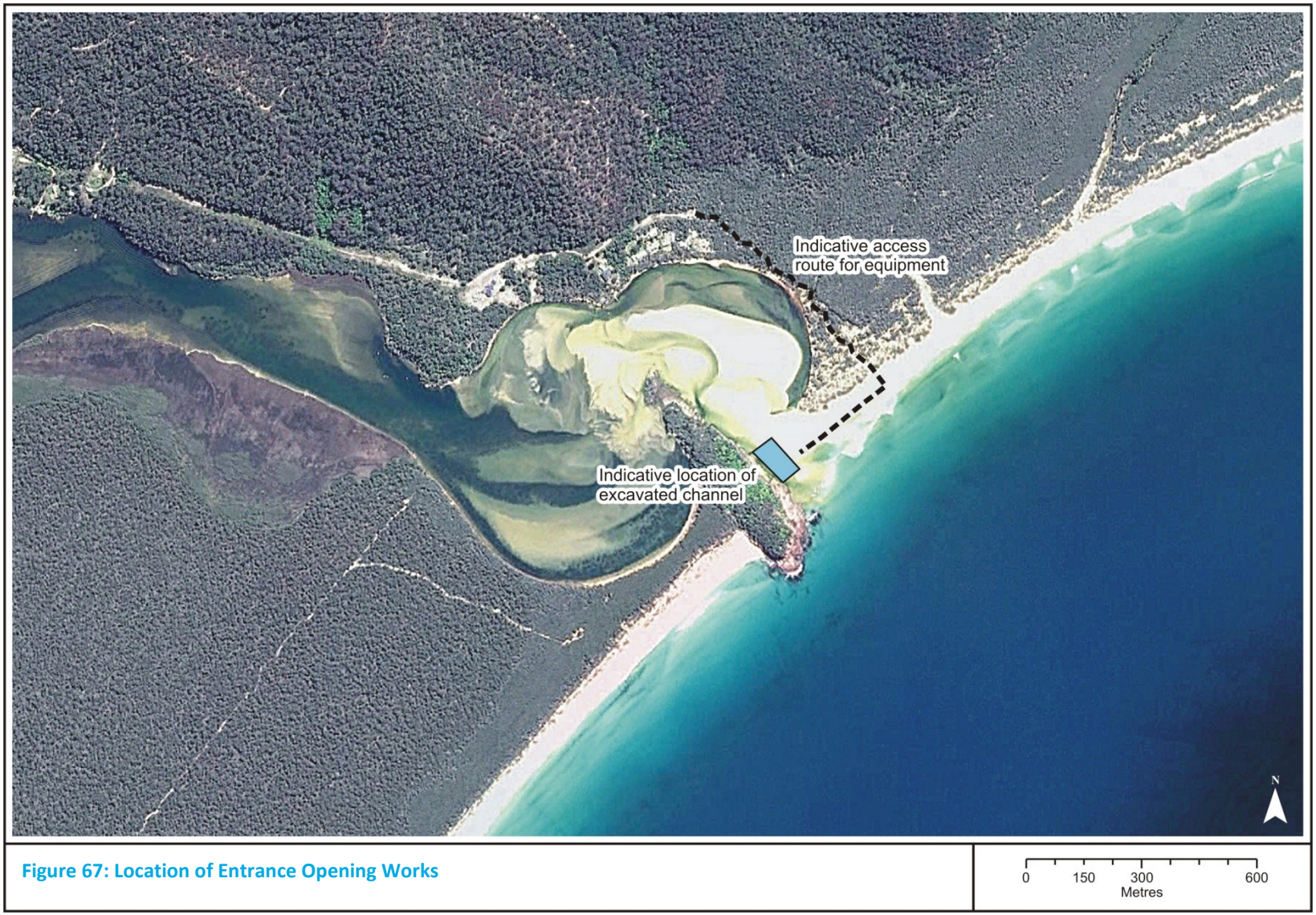

Figure 67: Location of Entrance Opening Works

8.2.2 Channel Excavation

The work will involve excavating a small channel across Disaster Bay Beach immediately to the north of 'Baycliff' using mechanical equipment, most likely an excavator. Sand excavated from the beach berm will be deposited on the beach adjacent to the excavated channel, away from any dunal vegetation or identified threatened shorebird habitat, and will not be removed from the site (though during other estuary opening events the excavated material is usually naturally dispersed within the first couple of tidal cycles). The exact disposal area will depend on the extent of the entrance bar at the time of opening.

The channel dimensions cannot be specified, but the preferred size as outlined in the Policy is 2-5 m wide with the bed graded to the ocean. Excavation will cease once a strong outward flow of water has been established. The total excavation time will typically be of 4-6 hours duration, but could be 10+ hours if a significant entrance berm is present or during particularly adverse working conditions.

The flowing water will scour sand from the excavated channel causing the channel to enlarge and/or migrate. The degree of enlargement/migration cannot be predicted but experience at this site and at other lakes has shown that if excavation is in the area of the natural entrance channel the artificial channel will rarely exceed the dimensions, or move from the locations, that are attained by natural breakouts. Monitoring of the rate of enlargement or migration of the channel over time will be undertaken as outlined in the Policy.

To maximise the effectiveness of the established entrance channel, completion of the excavated channel will generally be undertaken during the falling stage of the tidal cycle, just after the peak of the high tide. This should ensure that an adequate head difference between the water in the lake and the ocean is maintained for as long as possible. Preference will also be given to undertaking the works during a spring tide but since these only occur for a few days every fortnight this is not always possible. However, the commencement of the excavation will be dependent upon the amount of sand to be removed and the capacity of the machinery being used.

8.3 Purpose of the Activity

The purpose of the works is to lower lake water levels below that which causes flooding problems for low-lying assets, and to re-establish a tidal connection between the lake and the ocean. As outlined in the Policy, the lake may also be opened on the grounds of maintaining suitable water quality conditions for oyster survival, however, in this case the entrance opening campaign would be funded by the local oyster farming industry.

8.4 Consideration of Alternatives

Ultimately there are no viable alternatives to the artificial opening of the lake in the short term to reduce inundation if high lake water levels occur. The "do-nothing" option is unacceptable because of the potential safety risk and disruption that could be caused if the lake was left closed and water inundated Wonboyn Road. The high water levels may also remain for many months compounding the scale of disruption through lack of access to private properties, National Park and other recreational facilities by floodwaters. Therefore not interfering and allowing nature to take its course so that water levels rise until a natural breakout takes place, could in most situations cause undue disturbance.

Due to the relative economic importance of the local oyster farming industry to the small community of Wonboyn, Council has elected to continue to support the requirements of the industry in the short term, by allowing (though not funding) the lake to be opened for water quality purposes. While it is difficult to quantify the value of these economic and social drivers, Council is concerned about the impacts on the Wonboyn Village as a whole, if there was to be a major downturn in the oyster industry and a possible long term reduction in fish stocks and changes in the Lake's ecology. As such, there is no short term viable alternative to artificially opening the entrance to the lake on water quality grounds when required for oyster survival.

However, the ongoing mechanical opening of Wonboyn Lake is logistically difficult, expensive and unsustainable during long periods of drought, predicted to potentially worsen with ongoing climate change. The difficulty lies in:

- the distance the machinery is required to travel from the nearest trafficable road;
- no well-established/maintained access route to the beach; and
- the potentially low water levels in the lake at the time of opening (for water quality purposes), which will likely result in only a shallow entrance channel being scoured.

Due to these limitations, the Wonboyn Lake Entrance Management Policy (Appendix G) advocates a minimal entrance intervention in the long term, with preference for returning to a "natural as possible" breakout regime. In order to achieve this, a number of measures will need to be considered. These are likely to include:

- Investigating alternative methods to retain oyster survival when the lake is closed, e.g. transporting to another lake, raising oyster bags etc.;
- Raising the level of Wonboyn Road at Myrtle Cove;
- Progressive and opportunistic raising of assets to levels above 3.0 m AHD;
- Maintaining a buffer of no new development within close proximity to and below an elevation of 3.0 m AHD around Wonboyn Lake.

8.5 Description of the Existing Environment

8.5.1 General Characteristics

The Wonboyn River enters Disaster Bay approximately 20km due south of Eden. The river winds downstream from its waterfall tidal limit through steeply sided, wooded terrain. Wonboyn Lake forms a 1 km^2 lobe attached to the river along its southern bank some 3.5 km upstream of the entrance. The village of Wonboyn is situated on the southern shore of the lake. The river is freely navigable to about 1 km downstream of the tidal limit, except over the difficult entrance bar which is often shallow but rarely closed.

8.5.2 Sediments

In general, sediment qualities in the Wonboyn Estuary are typical of an undisturbed estuary with low rates of tidal flushing and low tidal velocities. Fine sediments from the catchment have accumulated in the estuary, especially in Wonboyn Lake, where the low tidal velocities and similarly low flood velocities allow such deposition and accumulation (WBM Oceanics, 2004).The entrance bar and adjoining shoals are composed predominantly of marine sands that have been deposited in the entrance, largely by the forcing of waves and wind.

8.5.2.1 Acid Sulfate Soils

In NSW, potential acid sulfate soils have been mapped in estuaries and embayments along the coastline. The impacts of acid drainage can be substantial and may include fish kills, oyster damage and mortality, release of heavy metals from contaminated sediment, human and animal health impacts, adverse impacts on soil structure and damage to built structures such as bridges.

Acid sulfate soils are those that have been formed in low energy, depositional environments over the last 6000 years. Published risk maps show the entire bed of Wonboyn Lake as having a high risk of potential acid sulfate soils. By maintaining an open entrance to the lake, water levels in the lake will be similar to those experienced following a natural entrance breakout or when the entrance is open to tidal exchange (as has been typical for Wonboyn Lake for several decades). It is therefore unlikely that artificially opening the entrance to the ocean will have any effect on potential acid sulfate soils. In relation to the berm area where the excavation works are proposed, acid sulfate soils are highly unlikely to occur as the area is highly dynamic and consists predominantly of marine sands deposited from wave action.

8.5.2.2 Bank Erosion and Sedimentation

Coastal and Marine Geosciences (1999) undertook a sedimentation study of the Wonboyn Estuary for DLWC. This study examined the major depositional environments within the estuary and provides background data on the nature and origin of sediments in the estuary. Key findings of this study (as summarised in WBM Oceanics, 2002) were as follows:

- The estuary comprises three geomorphic divisions, as follows:
    - Tidal Delta – This lower section of the estuary is comprised of emergent sand shoals and bifurcating tidal channels. Sediments are typically clean, moderately well to well sorted, medium grained, rounded, shelly quartz sand of marine origin.
    - Central Basin – The central basin or lake is relatively deep, and marks the inland limit of the deposition of marine sands. The basin is partially filled with organic rich shelly muds typical of an estuarine central mud basin environment.
    - Fluvial Delta – Upstream of Wonboyn Lake, moderately sorted muddy sands and sandy muds of fluvial origin occur within the incised bedrock valley. Fluvial sediments from the local catchment merge with marine sands of the tidal delta in the north of the lake basin. Poorly sorted, lithic rich, gravelly, angular sands characterise fluvial delta deposits in the area.
- Material deposited in the Central Basin essentially comprised organic rich sandy muds with shell, gravel and plant fragments;
- Nitrogen levels in Wonboyn Lake sediments were high, possibly due to naturally higher levels of organic material in the mud basin sediments.

WBM Oceanics (2002) undertook an analysis of sedimentation (both catchment and marine based) of the Wonboyn estuary, and concluded:

- Historical rates of fluvial sedimentation will undoubtedly have been affected by catchment forestry, but are unlikely to be affected in the foreseeable future;

- There would appear to be no significant likelihood that the existing (and historic) rates of fluvial sedimentation (which are comparatively slight) are affecting estuarine health; and
- Catchment forestry does not appear to be a major problem for the estuary.
- Marine sedimentation rates are dominated by the condition of the estuary entrance; and
- Oyster leases present within the estuary appear to be having a minimal to negligible effect on marine sedimentation processes.

In recent years the foreshore along North Wonboyn has eroded, which has resulted in private residents constructing a range of ad-hoc and/or temporary protection works in attempt to slow the erosion. During heavy coastal storms with elevated water levels in the lower estuary, ocean swells were seen to cross the lower part of the estuary, and cause significant overtopping of the eroded foreshore. WRL (2015) provided an analysis of processes in the lower estuary and concluded that no definite or obvious cause of the foreshore recession at North Wonboyn could be identified, but it is likely that the recession is a natural adjustment of the shoreline position, within a dynamic section of the estuary. These adjustments in the foreshore are more than likely linked to adjustments in the surrounding estuary shoals and channels, and are driven by a number of processes including:

- Time periods between large freshwater flooding events that scour the lower estuary sand shoals;
- Wave climate on the open coast which drives the infilling of sand within the lower estuary shoals;
- The extent to which the estuary entrance is open to the sea, which dictates the tidal exchange; and
- Ongoing evolution of the estuary due to a shift of the entrance from the southern side of the headland to the present northern side.

8.5.3 Hydrology

8.5.3.1 Entrance Behaviour / Characteristics

The typical tidal range within Wonboyn Lake is somewhat less than the open ocean due to the attenuation caused by the constrained nature of the shallow entrance shoals (WBM Oceanics, 2002). During a short water level data collection campaign in 2000, WBM Oceanics (2002) determined that with a significantly shoaled entrance, there is only minimal tidal fluctuation within the lake for all but the largest ocean tides. From the assessment, the following conclusions were drawn with respect to tidal flushing of the estuary:

- The lower estuary (below Wonboyn Lake) is extremely well flushed, even with the constrained (2000) entrance conditions. Flushing times are of the order of 1-15 days for most areas;
- Wonboyn Lake tends to act as a ‘dampener’ on tidal flushing due to its significant volume. This effect is particularly noticeable for the 2000 assessment and associated constrained entrance channel; and
- The upper estuary is poorly flushed by tidal processes, and as such is sensitive to increased pollutants loadings.

OEH have undertaken an analysis of the entrance state for Wonboyn on the basis of available gauged data, which is included below.

OEH Analysis:

Manly Hydraulics Laboratory have maintained a water level gauge on behalf of OEH in Wonboyn Lake since 20/8/1997, so approximately 18 years of water level data exists for the estuary. At the time of installation the entrance was open. Entrance closure and opening has been identified from observing the stop and start of a tidal signal from the graphed data (see Figure 68). There are other small periods of time where no data has not been collected, but considered unlikely to have resulted in missing other entrance opening/closures as periods of closure are uncharacteristic and have been well documented.

Between 20/8/1997 and 25/7/2015, only 2 separate periods of entrance closed conditions have been identified, with closed conditions lasting 98 days and 131 days respectively (31). The total duration of closed entrance conditions compared to the full record equates to being closed for only approximately 3% of the time. The duration of open entrance conditions from the water level records highlights that the estuary typically is open to tidal flow for periods of several years and rarely closes. The total duration of open entrance conditions for the full record equates to approximately being open for 97% of the time, outlining the predominantly open nature of the estuary. The two periods of time where the entrance did close were during exceptionally dry conditions (~2000 – 2009) where other ICOLLs on the South Coast experienced similar uncharacteristic closed periods and/or longer and more frequent periods of closed conditions.

The level of the two recorded entrance openings were 1.55 and 1.34 m AHD. It should be noted that this may not provide a good surrogate for natural berm height. An OEH survey of Wonboyn Lake berm on 11/9/14 directly adjacent to the open entrance channel found the berm height to be approximately 1.87 m AHD. Comparison of Wonboyn water levels to ocean water levels recorded from Twofold Bay in Eden show that the tidal range is heavily restricted compared to the full open ocean tidal range (Figure 69). Tidal range is generally in the order of about 0.1 to 0.3 m and rarely exceeds this range (Figure 69 and Figure 70).

Table 31: Periods of Entrance Closures, Opening and Opening Levels for Wonboyn Lake

Entrance Closure Date	Entrance Opening Date	WL Height at Opening	Closure Duration (days)	Open Duration (days)
NA	20/08/1997	NA	NA	NA
2/09/2004	9/12/2004	1.55	98	2570
7/10/2009	15/02/2010	1.34	131	1763
NA	25/07/2015	NA	NA	1986
Total			229	6319
Total			3%	97%

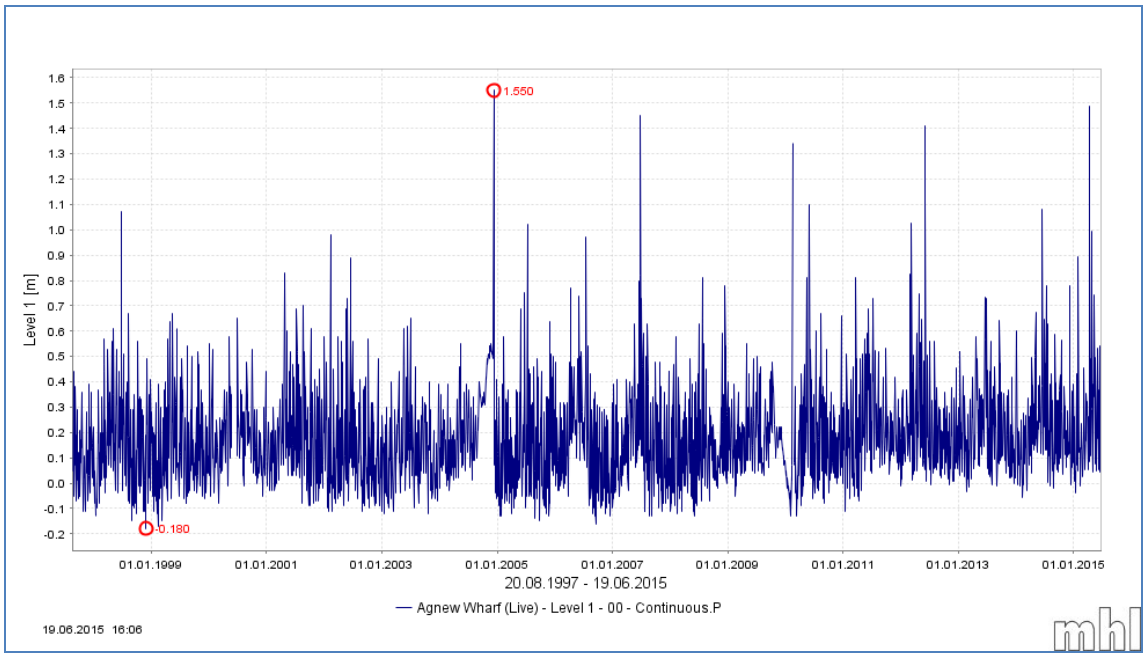

Figure 68: Complete Water Level Data Set from the Wonboyn Lake Water Level Gauge Situated off Agnew Wharf

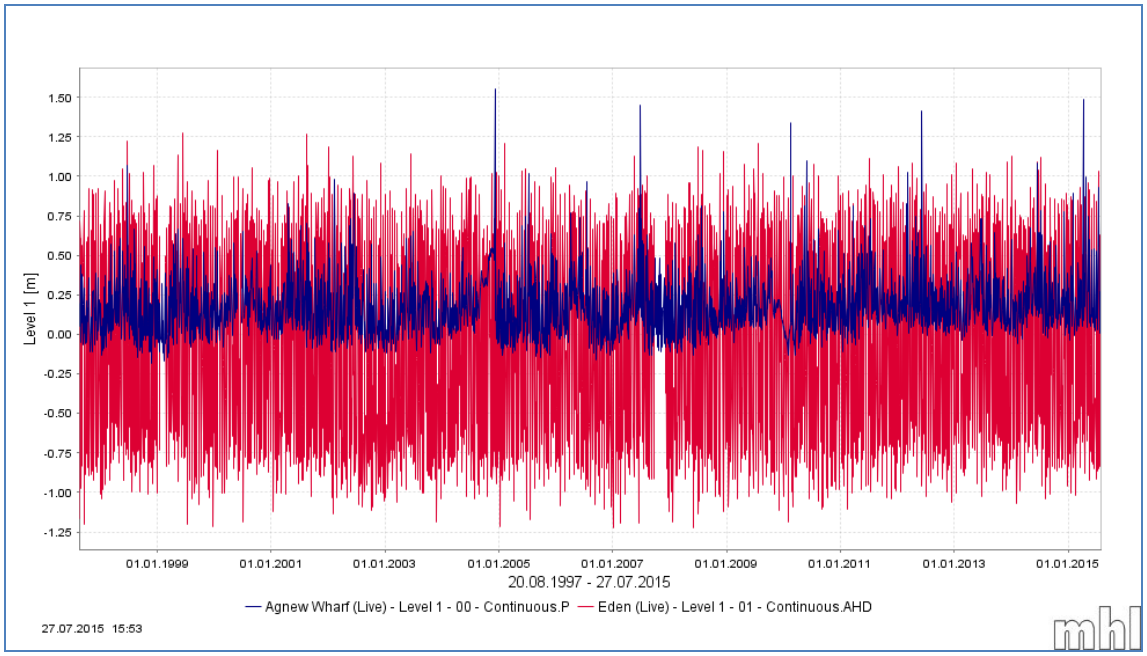

Figure 69: Complete Water Level Data set from Wonboyn Lake Water Level Gauge, plotted against the Open Ocean Water Level Records from Twofold Bay

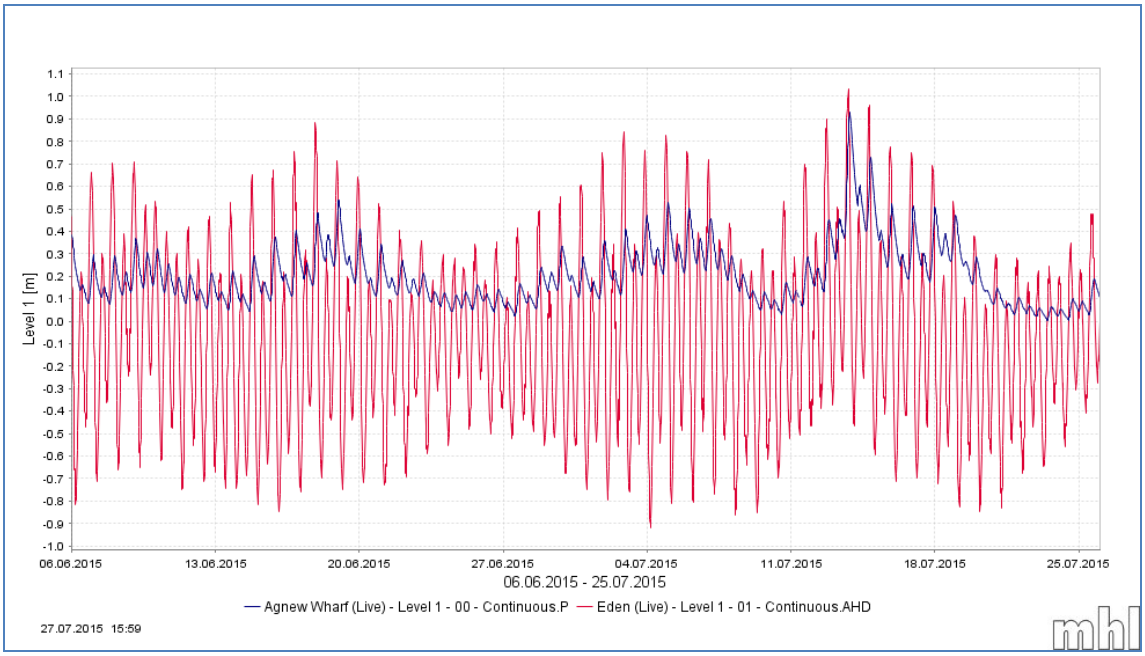

Figure 70: Snapshot of Wonboyn Lake Water Level Record Plotted Against the Open Ocean Water Level Record from Twofold Bay

Prior to approximately 2000, Wonboyn Lake entrance was in general considered to be permanently open. This was confirmed by a review of aerial photography available for the area (WBM Oceanics, 2002). However, the nature of the entrance and lower estuary shoals varies considerably with time, and the relative incidence of floods (which tend to scour the entrance and re-align channels) and large wave events (which will tend to mobilise nearshore sand deposits and encourage the entrance to close). Interpretation of available aerial photographs since 1962 (Figure 71) shows that the entrance of the lake is typically on the immediate north side of 'Baycliff', though WRL (2015) reports that it is possible that at some stage in the past (pre 1962) that the entrance would have been located further to the south.

8.5.3.2 Water Quality

The waters of the Wonboyn estuary exhibit excellent chemical water quality attributes, indicative of the near pristine nature of the catchment, and minimal sources of pollutant input (WBM Oceanics, 2002). It can be expected that the water quality adjacent to the entrance will be of similarly good condition, although any prolonged closure will obviously have an impact on the chemical composition of the waters in the lower estuary, due to the absence of any tidal flushing.

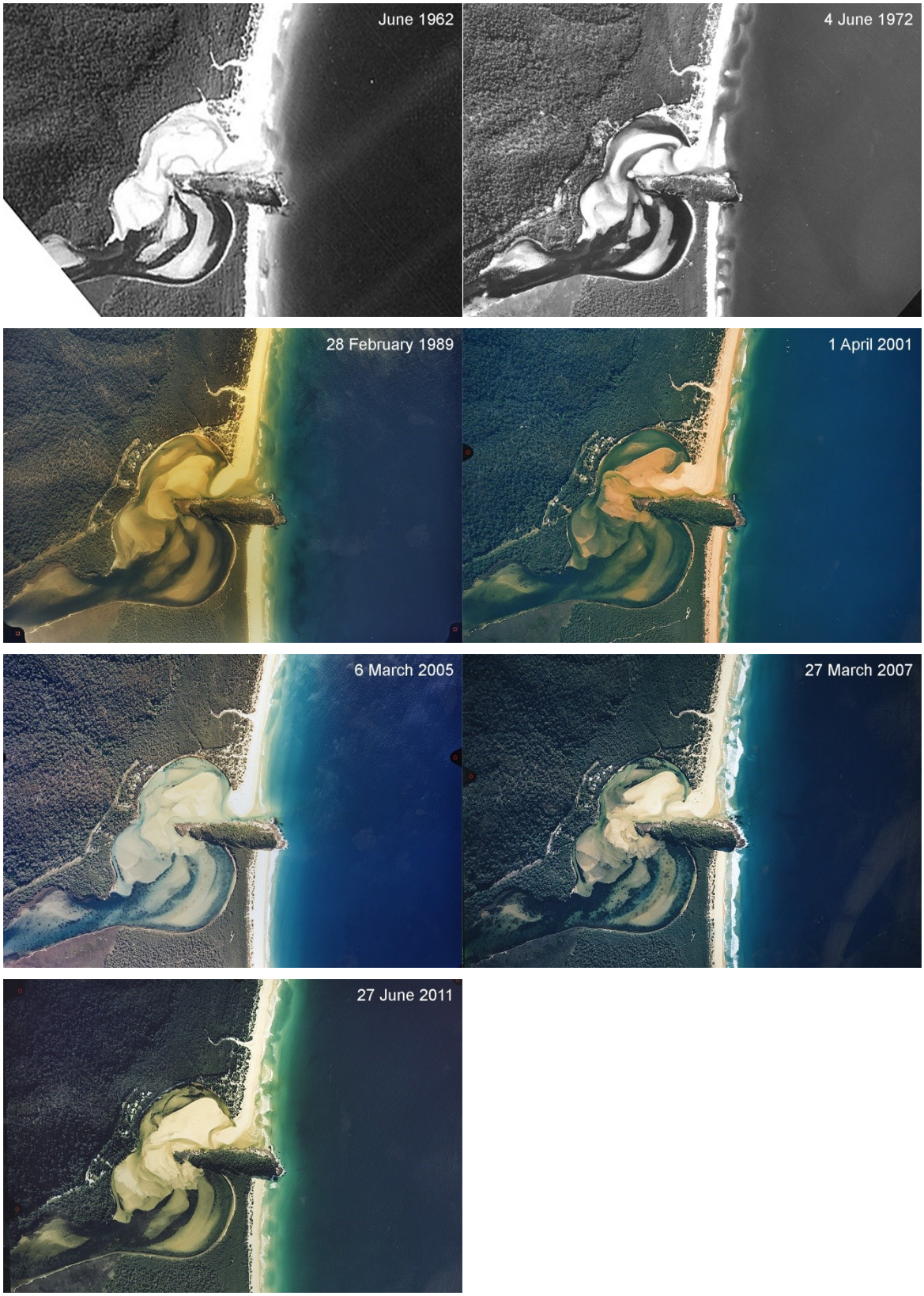

Figure 71: Aerial Photographs of the Wonboyn Lake Entrance 1962 to 2011

8.5.4 Ecology

Wonboyn Lake and its surrounds provides habitat for a number of significant flora and fauna species. The estuary itself contains several significant saltmarsh species and regionally significant wetland areas (listed under SEPP-14), as well as a diverse range of habitats such as rocky shores, sand shoals, deep lake sediments and estuarine wetlands. WBM Oceanics (2002) presented a detailed review of the ecological processes for both the Wonboyn estuary and its surrounding catchment, the information of which has contributed largely to this summary of lake ecology. As well as a detailed field work program, WBM Oceanics (2002) also completed a desktop review of existing information using a range of sources including:

- collation of existing database records for the estuary (eg. NSW NPWS Wildlife Atlas);
- review of previous published and unpublished studies for the estuary (eg. DLWC zooplankton sampling);
- airphoto interpretation to investigate patterns of vegetation cover and vegetation types;
- review of vegetation mapping prepared by NSW National Parks & Wildlife Service and NSW Fisheries.

For the purpose of assessing threatened and endangered species via the Atlas of NSW Wildlife, the lake and its immediate surrounds where defined within the geographical domain:

GDA94

North: -31.18 South: -37.28

East: 149.99 West: 149.89

Within this domain The Atlas of NSW Wildlife identified 28 species protected under the Threatened Species Conservation Act 1995, 7 species protected under the Environment Protection and Biodiversity Conservation Act 1999, and 7 species protected under the Japan Australia, Korea Australia and China Australia Migratory Birds Agreements.

8.5.4.1 Flora

Aquatic Vegetation

Two seagrass species were recorded during field inspections in July – August 2000: Zostera capricorni, which was the most conspicuous seagrass species; and the paddle weed Halophila australis, which had relatively sparse coverage throughout the lower estuary reaches. These seagrasses are highly productive, provide nursery and foraging habitat (for fish, crustaceans and molluscs), bind sediments against erosion and help regulate nutrient cycling. These seagrasses are import marine vegetation and as a result are protected under the NSW Fisheries Management Act 1997. However, there are no seagrasses or saltmarsh communities in the immediate entrance area for which entrance opening works are proposed.

Marine dominated macroalgae assemblages (multicellular plants which can be seen with the naked eye including seaweeds and filamentous algae) were reported by WBM Oceanics (2002) as being present around Bay Cliff, the rocky headland at the mouth of the Wonboyn River. The brown algae Hormosira banksii and Sargassum spp. were reported to be abundant along

sheltered parts of the lower intertidal zone and among rock-pools throughout the lower estuary and around Bay Cliff. Colpomenia sinuosa, a cosmopolitan species of brown algae, was also common in sheltered areas around Bay Cliff. At the time of initial field surveys (July-August 2000), the brown alga Ectocarpus constituted the dominant macroalgae species in the lower estuary. This species was reported to blanket the rocky shores, as well as seagrass beds (restricted mainly to Zostera capricorni) and oyster racks, throughout the lower estuary and Wonboyn Lake, but was comparatively uncommon in the upper estuary.

Transitional and Fringing Wetland Vegetation

Several transitional and fringing endangered ecological communities (EECs) listed under the NSW Threatened Species Conservation Act 1995 are known to occur within the Wonboyn Lake estuarine catchment (Figure 72). These EECs include Coastal Saltmarsh, Bangalay Sand Forest and Freshwater Wetlands.

Saltmarsh areas occur throughout the lower reaches of Wonboyn estuary. It was noted in WBM Oceanics (2002) that Wonboyn estuary had the fifth largest area of saltmarsh in southern NSW estuaries (ie. south of Clyde River), totalling 0.483 km^2. This community of species is very important to estuarine food webs, providing a site for invertebrate breeding and a feeding area for economically important fish and shorebirds. In conjunction Coastal Saltmarsh also provides an ecological buffer and filter mechanism for sediment and nutrients. Saltmarsh has declined around the state, and due to this state wide declining trend Coastal Saltmarsh has been listed as an endangered ecological community under the Threatened Species Conservation Act 1995.

There are four SEPP14 Wetlands within the Wonboyn Estuary, with SEPP14 Wetland #11 having the closest proximity to the entrance area, some 300 + metres to the west of the entrance at the western end of Baycliff. These wetlands are located at the following areas (see Figure 72):

- the southern banks of the river mouth (SEPP-14 #11) = 1.11 ha;
- southern bank of the entrance channel (SEPP-14 #9) = 34.20 ha;
- south-eastern shoreline of Wonboyn Lake (SEPP-14 #10) = 80.47 ha;
- western shoreline of Wonboyn Lake (SEPP-14 #12) = 5.35 ha; and
- the mouth of Bull Creek in the upper estuary (SEPP-14 #15) = 4.35 ha.

The NPWS Threatened Species Unit undertook site inspections of three areas in the lower reaches of Wonboyn estuary during November 1999. A number of significant plant species were recorded during the site inspection, as follows:

- Distichlis distichophylla (Australian Saltgrass): this species is listed as endangered under Schedule 1, Part 1 of the Threatened Species Conservation Act 1995. Australian saltgrass is a perennial, salt-tolerant grass growing up to 30cm tall, with creeping rhizomes up to more than 1m long. It grows in saline soils, and is known from the South Western Plains region of NSW and areas in Victoria, Tasmania and South Australia, but is also known to occur in the south-eastern margin of Wonboyn Lake (SEPP14 #10).
- Myoprum insulare: this species is thought be at its northern distribution limit at the study area (recorded in SEPP14# 9, 10), and may therefore represent a significant record.

The Freshwater Wetlands on Coastal Floodplains endangered ecological community occupies an area ≈220,000 m^2 north east of the Wonboyn entrance (see Figure 72). Melaleuca ericifolla, Baumea articulata, Periscaia Praetermissa, Phragmites australis, Triglochin procerum, Typha orientallis and Cladium procerum typically characterise this endangered ecological community which provides important habitat, food and water source for freshwater fish, amphibian, native mammal and bird species (Tozer et al 2004).

Extensive areas of the catchment for the lower Wonboyn estuary are dominated by the Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions endangered ecological community, which occupies a total area of ≈500 ha across two significant areas (see Figure 72). Firstly, stretching from the private properties at North Wonboyn in a north easterly direction just inland from the sand dunes of Disaster Bay beach, and secondly stretching south from the lower part of the Wonboyn estuary, again just inland from the sand dunes of the ocean beach. Bangalay Sand Forest typically has a dense to open tree canopy and occurs on dunes exposed to salt-bearing sea breezes. The most common vegetation species within this endangered ecological community are Eucalyptus botryoides, Banksia integrifolia subsp. Integrifolia, Eucalyptus pilularis, Acmena smithii, Dianella spp., Lepidosperma concavum, Lomandra longifolia, Pteridium esculentum (Bracken), and the grasses Imperata cylindrical, Microlaena stipoides var. stipoides, Themeda australis (Tozer et al 2004). This vegetation complex once would have occupied many coastal localities however clearing, habitat degradation and weeds have caused substantial losses across the NSW state. As a result this remanent vegetation community has been placed as endangered and likely to become extinct unless the circumstances and factors threatening its survival cease to operate (NSW Scientific Committee 2012).

Access Track Vegetation

The FVCIA undertaken by Envirokey (2016) provided a botanical survey of vegetation 5 m either side of the proposed 660 m long access track from the power line easement at North Wonboyn to the beach. The report from this investigation is presented in Appendix I, and a summary of the identified vegetation presented here. The botanical survey identified a total of 54 native and 7 introduced plant species, while no threatened flora were identified. The survey identified 3 native vegetation communities that would be impacted along the access route:

- 0.15 hectares of impacted “Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin and South East Corner” (Threatened Ecological Community, with identified species indicating the community can be classified as the EEC Bangalay Sand Forest);
- 0.12 hectares of impacted “Coast Banksia – Coast Wattle Dune Scrub, Sydney Basin and South East Corner” (not listed as a Threatened Ecological Community);
- 0.0048 hectares of impacted “Spinifex beach strand grassland, Sydney Basin and South East Corner” (not listed as a Threatened Ecological Community).

No threatened flora species as listed under the schedules of the TSC Act or EPBC were recorded within the vicinity of the proposed works, though there is potential for the following species to occur within the area:

- Australian Saltgrass (Distichlis distichophylla);
- Hidden Violet (Viola cleistagamoides).

A total of 15 hollow-bearing trees were identified in the area within 5 m of the access track. These comprised 17 hollows of which 12 were small, two medium and three large.

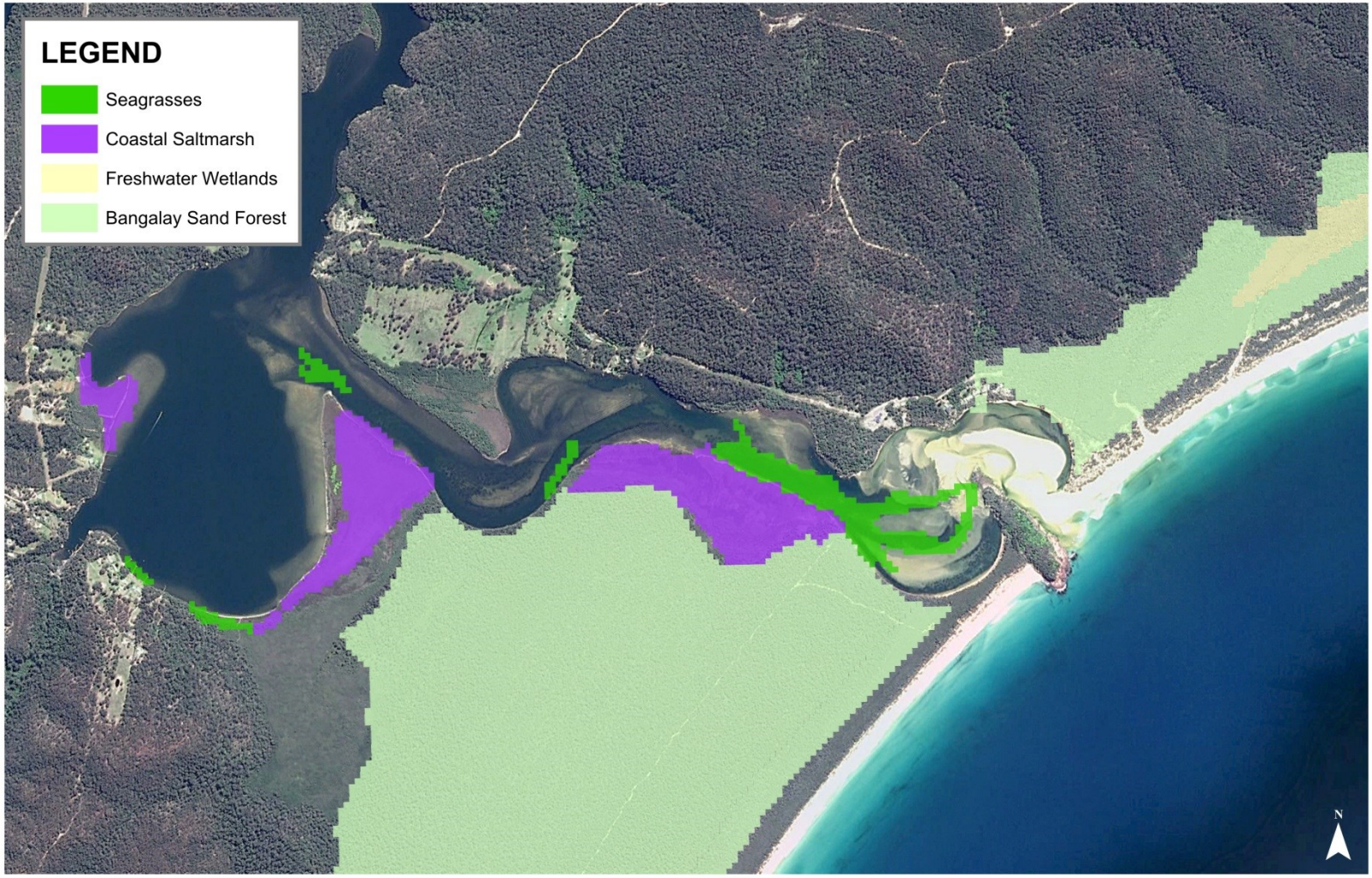

Figure 72: Threatened Flora – Wonboyn Lake

8.5.4.2 Fauna

Mammals

The Atlas of NSW Wildlife has identified 9 species listed as vulnerable and one species as endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, the Southern Brown Bandicoot is listed as endangered, and the Koala, Long-nosed Potoroo and the Grey-headed Flying-Fox are listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. These species are listed in Table 32:

Table 32: Threatened Mammals in the Wonboyn Lake Region

Common Name	Scientific Name	NSW Status	Comm. Status
Southern Brown Bandicoot (eastern)	Isoodon obesulus obesulus	E	E
White-footed Dunnart	Sminthopsis leucopus	V	
Koala	Phascolarctos cinereus	V	V
Long-nosed Potoroo	Potorous tridactylus	V	V
Eastern Pygmy-Possum	Cercartetus nanus	V	
Yellow-bellied Glider	Petaurus australis	V	
Eastern Freetail-bat	Mormopterus norfolkensis	V	
Eastern Bentwing-bat	Miniopterus schreibersii oceanensis	V	
Greater Broad-nosed Bat	Scoteanax rueppellii	V	
Grey-headed Flying-fox	Pteropus poliocephalus	V	V

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

Birds

The Atlas of NSW Wildlife has identified 15 bird species listed as vulnerable, 1 species listed as endangered and 1 species listed as critically endangered under the NSW Threatened Species Conservation Act 1995 within the study area. Of these species, the Eastern Curlew is listed as critically endangered and the Hooded Plover as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999. In addition 7 species are protected under the Japan-Australia, Republic of Korea-Australia and China-Australia Migratory Birds Agreements. These species are shown in Table 33. OEH (2015) present maps of sites that are significant to shorebird nesting throughout the Bega Valley Shire, and identify the Wonboyn Lake entrance as one of these sites. Figure 74 shows the identified locations and species from OEH (2015).

Table 33: Threatened Avifauna in the Wonboyn Lake Region				
Common Name	**Scientific Name**	**NSW Status**	**Comm. Status**	**Migratory Bird Agreements**
White-throated Needletail	Hirundapus caudacutus			C,J,K
Short-tailed Shearwater	Ardenna tenuirostris			J,K
Eastern Curlew	Numenius madagascariensis		CE	C, J, K
Caspian Tern	Hydroprogne caspia			C, J
Eastern Reef Egret	Egretta sacra			C
White-bellied Sea-Eagle	Haliaeetus leucogaster			C
Fork-tailed Swift	Apus pacificus			C, J, K
Little Eagle	Hieraaetus morphnoides	V		
Eastern Osprey	Pandion cristatus	V		
Sooty Oystercatcher	Haematopus fuliginosus	V		
Pied Oystercatcher	Haematopus longirostris	E		
Hooded Plover	Thinornis rubricollis	CE	V	
Brown Treecreeper	Climacteris picumnus victoriae	V		
Gang-gang Cockatoo	^^Callocephalon fimbriatum	V		
Glossy Black-Cockatoo	^Calyptorhynchus lathami	V		
Olive Whistler	Pachycephala olivacea	V		
Little Lorikeet	Glossopsitta pusilla	V		
Eastern Ground Parrot	Pezoporus wallicus wallicus	V		
Powerful Owl	^^Ninox strenua	V		
Masked Owl	^^Tyto novaehollandiae	V		
Sooty Owl	^^Tyto tenebricosa	V		
Barking Owl	Ninox connivens	V		
Scarlet Robin	Petroica boodang	V		
Flame Robin	Petroica phoenicea	V		

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

CE= Critically Endangered; facing a very high risk of extinction in the immediate future.

J= JAMBA listed; Japan-Australia Migratory Bird Agreement.

C= CAMBA listed; China-Australia Migratory Bird Agreement.

K= ROKAMBA listed; Republic of Korea-Australia Migratory Bird Agreement.

Amphibians and Reptiles

The Atlas of NSW Wildlife has identified 1 amphibian species listed as endangered under the NSW Threatened Species Conservation Act 1995, which is also listed as vulnerable under the

Commonwealth Environment Protection and Biodiversity Conservation Act 1999. This species is shown in Table 34:

Table 34: Threatened Amphibians in the Wonboyn Lake Region

Common Name	Scientific Name	NSW Status	Comm. Status
Green and Golden Bell Frog	Litoria aurea	E	V

V= Vulnerable; facing a high risk of extinction in the medium-term future.

E= Endangered; facing a very high risk of extinction in the near future.

Aquatic Fauna

Discussions with local residents indicate that the major species caught by recreational anglers include jewfish (Argyrosomus japonicus), flathead (Platycephalus spp.), bream (Acanthopagrus spp.), tarwhine (Rhabdosargus sarba), luderick (Girella tricuspidata), whiting (Sillago spp.) and tailor (Pomatomus saltatrix). No data are available to assess the relative catch of these species, nor the amount of angling effort in the estuary. Given the general lack of any significant tourist infrastructure on the estuary (one caravan/cabin park, and one resort), fishing pressures would not be expected to be as high as more popular tourist centres of the NSW south coast (eg. Eden, Merimbula). As there is restricted shoreline access around the estuary, almost all fishing is conducted from boats.

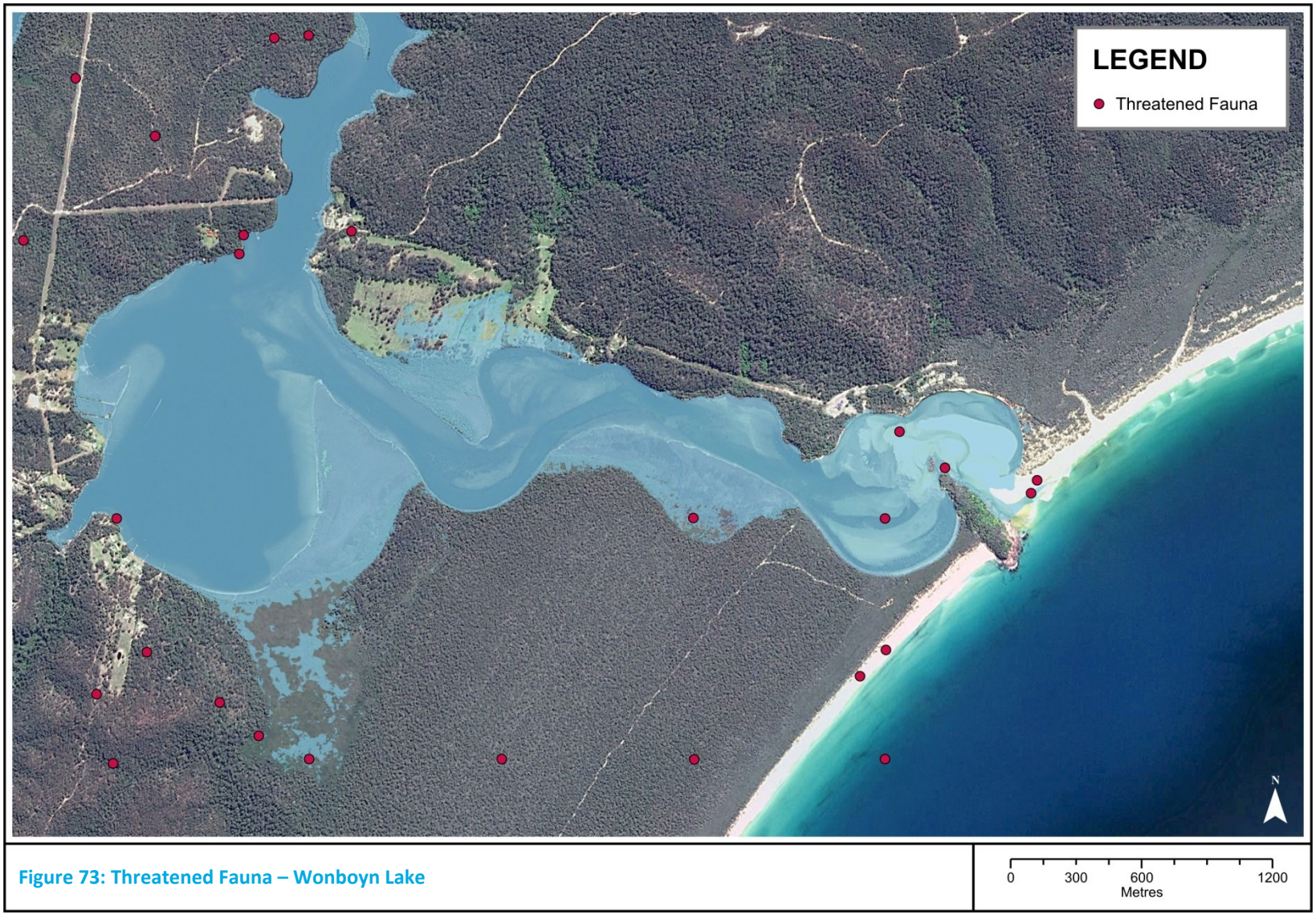

Figure 73: Threatened Fauna – Wonboyn Lake

Figure 74: Significant Shorebird Sites at Wonboyn Lake Entrance (OEH, 2015)

8.5.5 Cultural Heritage

8.5.5.1 Aboriginal Cultural Heritage

Sites of Aboriginal cultural significance, such as middens, camping areas, artefact scatters, shelters and other sites are frequent around Bega Valley Shire Council estuary shorelines, beaches and islands. There are also many areas of spiritual and cultural significance, the details of which are not generally known and are unlikely to be made known to people other than the tribal custodians of the knowledge.

The ACHAR undertaken by Archaeology NSW for this project (Dibden, 2016), is included as Appendix J of this REF, and should be referred to for a detailed description of the relevant Aboriginal cultural significance. The investigation included searches of the NSW OEH AHIMS, the NSW State Heritage Inventory and the Australian Heritage Database, as well as a detailed field inspection of the access track and entrance opening area. Six sites were identified in the database searches for the wider Wonboyn Lake estuary search area, and the field inspection identified artefacts and fragmented shell along most of the access track. While the access track area is disturbed, it was identified in the ACHAR to be of archaeological potential and to contain subsurface deposits with the possibility of burials. The cluster of objects identified at location (762855mE, 5873988mN) was logged as site “Wonboyn Lake 1”, and was assessed to be of moderate local significance.

8.5.6 Socio-Economic Discussion, Recreational and Commercial Uses

Socio-economic issues were the primary driver for Council moving to support a Policy that includes an option to mechanically open the lake on the grounds of water quality and oyster health. The Lake is seen as being central to Wonboyn economic and social wellbeing as the village’s main industry, and recreational activities are centred around the Lake.

8.5.6.1 Recreation

The Wonboyn Lake estuary and its foreshore provide a number of recreational opportunities for both residents and holiday makers alike. Fishing, boating, swimming, hiking, picnics/bbqs, sight seeing and nature observation are just a few of the many recreational activities available in, on and around the lake. Mechanically opening the entrance to the lake will allow the lake to continue to be used for recreational purposes in much the same manner as has happened in the past, as prior to the last decade, the lake has typically remained open to the sea.

8.5.6.2 Commercial

As previously discussed, there is a significant oyster farming industry that is established on Wonboyn Lake. While historically there was a larger number of leases present on the lake, a range of environmental factors (flooding, low tidal flushing, toxigenic bloom of Prorocentrum minimum) saw the industry somewhat devastated around 2002. The lake's oyster farmers invested a great deal of resources in re-establishing their leases and are significant stakeholders in the management of the lake and its entrance. It has been reported that Wonboyn Lake is the most southerly oyster-producing estuary in NSW, with an estimated 45.7 hectares of oyster lease, comprising 47 leases held by 13 aquaculture permit holders (BVSC, 2004). The oyster industry is the only primary industry in Wonboyn and is an important part of the Village's economy.

Wonboyn is a popular coastal holiday destination, with Wonboyn Village and North Wonboyn resort providing various forms of holiday accommodation. Holiday makers are an important source of income for the people of Wonboyn, with the areas natural values, outdoor recreational opportunities (including recreational fishing) and relative isolation being integral to the areas tourism appeal.

The Wonboyn community have previously expressed their concern at the potential impact on both the village's economy and the residents own recreational opportunities if the lake was allowed to remain closed for any significant amount of time. These concerns are centred on perceived threats to the lakes water quality and impact on fish stocks and the lake ecology.

For Use in Determination Only

☐ The existing environment adequately described.

Comments or conditions:

8.6 Description of the Activity Impacts

8.6.1 Acid Sulfate Soil Impacts

It is highly unlikely the entrance opening works will directly expose acid-generating sediment. Although the bed of Wonboyn has been identified as potential acid sulfate soils (PASS), it is unlikely that actual acid sulfate soils (AASS) are likely to occur where the works are proposed as the berm area is highly dynamic and consists predominantly of marine sands deposited from wave action following previous entrance openings. Furthermore, as the entrance channel has been well scoured by previous floods and was typically in a naturally open state for long periods of time, it is unlikely that artificially maintaining an open entrance will result in the development of actual ASS.

8.6.2 Bank Erosion and Sedimentation Impacts

Maintaining an open lake entrance will have an impact on the sand shoals and entrance bar in the vicinity of the entrance. However, due to the localised nature of these fluctuations, it is likely that natural background processes will dominate the evolution of sand shoals within the lower estuary which, and in-turn dominate any impacts on foreshore erosion processes.

It should be recognised that mechanical opening of the entrance will result in scouring and blowout of the entrance bar, that may in turn allow a greater amount of wave energy into the lower section of the lake than occurred prior to lake closure when the entrance was shoaled. This may aggravate existing erosion problems at North Wonboyn, and while this would also occur (likely to a greater extent) with a natural entrance breakout, in the case of a mechanical entrance opening it may be attributed to Council's intervention.

8.6.3 Hydrology Impacts

Artificially opening the lake entrance may have a moderate negative impact on the lake as entrance opening is an important determinant of the hydraulic character. Following periods of extended drought when the lake entrance would naturally close, natural breakout of Wonboyn Lake would tend to occur during or soon after a significant rainfall event. Rainfall is a necessary precursor to raise water levels to a level significantly greater than mean sea level, and to 'liquefy' the sand barrier and reduce its cohesion. The ability of the lake water to erode a deep and wide entrance channel is directly related to the head difference that exists between the lake and the ocean at the time of breakout. A large head difference will result in a larger and deeper channel.

Therefore, intervention in the entrance process during extended periods of dry weather may reduce the capacity of the opening to erode sediments from the entrance area and lower shoals during subsequent flood events. Over the long term this may conceptually cause sedimentation impacts and changes to the hydrologic regime as a build up of sediment in the entrance area will result in lower breakout levels and may progressively result in beach bar widening and lake infilling. However, it should be recognised that the extent to which this adverse effect can occur is limited due to the very infrequent natre of entrance closure.

Positive and negative water quality impacts may also result from entrance opening. Positive impacts include flushing nutrients and pollutants from the system in some locations. Negative impacts of entrance opening include: potential increases in nutrient concentrations in areas that aren't flushed as a result of entrance opening; and potential rapid increases in dissolved oxygen concentrations resulting from rapid decay of organic material.

8.6.4 Aquatic Vegetation Impacts

There are no seagrasses or saltmarsh communities in the immediate entrance area for which works are proposed. The endangered Australian Saltgrass Distichlis distichophylla has been identified in SEPP14 Wetland #10 which is located in the south-east margins of the lake, well away from the intended works area. The opening of the lake and potential restoration of pre-closing tidal cycle will impact on the frequency and degree of inundation experienced by these vegetation communities. As the proposed opening of the lake is aimed at restoring the tidal cycles that the Lake's aquatic vegetation communities have experienced for the last 60 years, it is unlikely that this would have serious negative impacts on these vegetation communities.

8.6.5 Indirect Impacts to Transitional and Fringing Wetland Vegetation

The entrance excavation works themselves are unlikely to have any direct impact on any endangered ecological communities (EECs). As the 'typical' hydraulic regime of Wonboyn Lake is for the entrance to be open to the ocean, it is also unlikely that indirect impacts associated with changing water levels from opening the entrance would have an impact on any EECs. As a precautionary measure, a Section 5A assessment for the endangered ecological communities has been completed and is located in Section 8.8.

8.6.6 Direct Impacts to Access Track Vegetation

Envirokey (2016, Appendix I) provided an analysis of the likely direct impacts associated with excavator access to the site, with their analysis reproduce below. Photographs of the access track vegetation are shown in Figure 75.

Envirokey Vegetation Impacts Report:

"The proposed 660 metre excavator track would occur mostly within an existing track that was evidently being used frequently by four-wheeled motorcycles resulting in an existing area of disturbance up to two metres wide. Additionally, there was also evidence of the previous excavator movement which was about 15 years ago. This consisted of small piles of Coast Tea-tree which had been pushed over in a more open area through the existing vegetation. The vegetation present in the previously disturbed track was mostly low regrowth shrubs and native groundcovers. Despite this, the movement of an excavator through this vegetation would result in some damage mostly by crushing of groundcovers and low growing shrubs under the weight of the machine. Some larger Coast Tea-tree and Tree Broom-heath would most likely need removal which could be facilitated by the excavator arm, however this would result in extensive damage to the groundcover as the root system would also be extracted using this method. It is recommended that if larger shrubs need to be removed, that they are cut off at ground level using a chainsaw as this would minimise the ground disturbance. Some minor lopping of overhead vegetation would also be required to facilitate the movement of the excavator however this is expected to be minimal.

The damage to the vegetation communities present would result in damage to the TSC Act listed Bangalay Sand Forest TEC of up to about 0.15 hectares. This is expected to be temporary and would not result in permanent removal of vegetation. As it is not expected that any canopy species would be removed, low growing shrubs and groundcovers would recover reasonably quickly from this disturbance."

Section 5A assessments for the 2 potentially impacted threatened vegetation species (Australian Saltgrass and Hidden Violet) and 1 threatened ecological community (Bangalay Sand Forest) were presented in Envirokey (2016). The results of the assessment concluded that the proposed machine access would be unlikely to have a significant effect on these threatened species and community, and on this basis, a Species Impact Statement is not required.

Figure 75: Photos of Wonboyn Lake Access Track and Vegetation

8.6.7 Fauna impacts

Mammals

It is unlikely that the entrance excavation works will have an impact on threatened mammal species or endangered populations, as these populations would typically be located some distance from the lake entrance.

Localised areas of damage to vegetation communities during access of the excavator may result in damage or very minor loss of habitat for threatened mammal species. These impacts would be minimised through careful route selection when moving through habitat areas, with an attempt to utilise already disturbed areas. However, it is inevitable that some vegetation will be damaged or removed during the process.

Any impacts to threatened mammals are expected to be very minimal due the extensive availability of alternative habitat throughout the surrounding localised woodland community.

Birds

The small sand dunes to the north/north west of the entrance are a known nesting area of the Hooded Plover. During previous site inspections, several Hooded Plovers were identified in this

area, as well as Pied Oyster catchers that were noted on the lake foreshore. Depending on the time of the year, if undertaken without appropriate mitigation measures, entrance works including machine access and channel excavation could potentially have a significant negative impact on these and other resident and migratory threatened shorebird species. Shorebirds could be adversely impacted if entrance works were to be undertaken between August and April and critically if the works were to occur between September and March, as the works could disrupt breeding colonies and/or disturb and destroy nests.

To ensure that the entrance opening works result in no or only relatively minor impacts to shorebirds, a number of mitigation measures to reduce the likelihood and extent of impacts on shorebirds have been written into the Entrance Management Policy. These mitigation measures include:

- A machine access route that minimises areas of dune impacted by the machine;
- Stipulated communication with NPWS staff, including the Shorebird Recovery Coordinator, if entrance management works are to be implemented between August and April inclusive;
- Awareness of the presence and location of nesting shorebirds in access and entrance areas through the monitoring undertaken by the South Coast Shorebird Recovery Program; and
- Assistance on site from NPWS Officer/Shorebird Recovery Coordinator to provide a lower impact access and entrance opening if nesting shorebirds are present.

If a mechanical entrance opening is planned within the shorebird breeding season (August to April inclusive), Council officers will liaise with the local National Parks and Wildlife Service/Shorebird Recovery Coordinator to determine appropriate responses. This may include altering the location of the channel opening works and/or as a last resort translocating nests to a site nearby that is safe. If required, assistance from NPWS officers and/or the Shorebird Recovery Coordinator will ensure that the entrance opening process does not adversely impact nesting shorebirds.

Entrance opening may also be beneficial to shorebird populations in other circumstances as it may hamper access to nest sites by predators and expose aquatic food sources. It should also be noted that any impacts to shorebirds from scour of the entrance berm could also occur with a natural entrance opening, and in fact managing the entrance opening possibly reduces the chance of impacts by allowing for translocation of nests that are located on the entrance berm/channel area. If the entrance was to break out naturally and rapidly, these nests may be destroyed.

As the location and number of nesting shorebirds at the site is variable from season to season, it is preferable to rely on up-to-date knowledge regarding shorebirds from the South Coast Shorebird Recovery Program and advice from the Shorebird Recovery Coordinator, to inform additional adaptive management responses on an “opening-by-opening” basis, as opposed to a “one-off” survey for this REF. Section 5A assessments have been carried out for the potentially impacted shorebird species (Grey Plover and Pied Oystercatcher), and are included in Section 8.8. As the impacts to these species are likely to be minimal due to the mitigation measures stipulated within the Policy, at this stage it is not necessary to undertake a Species Impact Statement.

The sand shoals that dominate the lower estuary are important for wader and water birds. The diversity of species and numbers depend on the extent of the sand shoals and food sources. During the rare times of lake closure, higher lake water levels can result in inundation of these sand shoals, with the impact of a prolonged inundation of entrance shoals on wading species unknown. However, this is a naturally occurring process.

Amphibians and Reptiles

The process of clearing vegetation for the required access of the excavator may have an impact on the endangered Green and Golden Bell frog. As a result, a Section 5A assessment has been carried out for this species and included in Section 8.8.

Aquatic Fauna

The lake entrance area allows passage for a variety of fish species and prawns. A closed entrance obviously impacts on fish and prawn recruitment and the ability of fish and prawns to pass to sea to spawn. The impact on the fish stocks within Wonboyn Lake following a prolonged entrance closure is unknown. For the purposes of this REF it is recognised that no threatened species or populations of fish will be impacted and the opening works are within the lower range of the natural opening regime.

8.6.8 Aboriginal Cultural Heritage Impacts

Any unknown Aboriginal sites that may exist around the immediate foreshore of the estuary will have been subject to cycles of flooding and drying over many years and thus may be fairly resilient to changes in lake level. It is possible however, that further flooding and drying combined with wave action may expose sensitive sites or lead to erosion of culturally important areas. While unlikely, entrance works may have both positive and negative impacts on currently un-reported Aboriginal cultural heritage sites. Positive impacts could include opening the entrance prior to naturally high estuary water levels. This will reduce the risk of inundation and erosion from hydrologic forces. During high water levels it has also been recognised that boats may travel close to and over sites, drop anchors and create wake that may lead to site degradation. On the contrary negative impacts could include increased frequency of wetting and drying from rises and falls in estuary water level as a result of slightly more frequent entrance openings.

While no impacts to Aboriginal places or items in the area of entrance opening were identified in the ACHAR (Dibden, 2016), the potential for further impacts to disturbed and subsurface deposits along the access track was identified. BVSC has sought an AHIP associated with the entrance management works. It is recommended that monitoring take place during the access and entrance opening process, that impacts to the ground surface along the access track be minimised, and that whenever possible access along the beach section be restricted to the corridor within the intertidal and wave runup zone of the beach.

8.6.9 Recreational Impacts

The Wonboyn Lake estuary and its foreshore provide a number of recreational opportunities for both residents and holiday makers alike. Fishing, boating, swimming, hiking, picnics/bbqs, sight seeing and nature observation are just a few of the many recreational activities available

in, on and around the lake. As the lake has functioned with a near permanent entrance to the sea for many years, the recreational activities that are established on the lake have evolved with an open estuary entrance arrangement. As such, it is expected that recreational activities would benefit from maintaining an open entrance, at least in the short term.

8.6.10 Commercial Impacts

Socio-economic and primarily commercial issues are the primary driver for Council to support a Policy that specifies artificial opening of Wonboyn Lake during periods of prolonged lake closure. The lake is seen as being central to the economic and social wellbeing of Wonboyn, as the village's main industry (oyster farming) is centred around the lake. The oyster industry is the only primary industry in Wonboyn and is an important part of the Villages economy. Council has expressed its support for the Wonboyn oyster industry and through the *Wonboyn Lake Entrance Management Policy*, has resolved to maintain a tidal exchange by artificially opening the lake entrance during infrequent periods of prolonged closure.

Wonboyn is a popular coastal holiday destination, with Wonboyn Village and North Wonboyn Resort providing various forms of holiday accommodation. Holiday makers are an important source of income for the people of Wonboyn, with the area's natural values, outdoor recreational opportunities (including recreational fishing) and relative isolation being integral to the areas tourism appeal. These characteristics have been developed and are supported by a lake that is open to the sea on a near permanent basis.

For Use in Determination Only

☐ The REF adequately describes the impacts of the activity.

Comments or conditions:

8.7 EP&A Act 1979, Clause 82: Impact Consideration Checklist

a.	Will there be any environmental impact on a community? ☐ **n/a or negligible** ☒ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no impact on the community during the carrying out of the work. The community will be restricted from using the entrance area whilst works are in progress. Suitable precautionary measures will be taken to lessen such impacts. A range of community members would be negatively impacted if the Policy was not implemented, as access to properties and infrastructure would be inundated. The local oyster farming industry could also be significantly impacted if the Policy was not implemented, and there was no structured mechanism for opening the lake entrance to maintain suitable water quality for oyster survival.
b.	Will there be any transformation of a locality? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Access The minimal removal of vegetation as required to provide access for earthmoving equipment will result in temporary impact on a section of EEC on the northern side of the lake. This impact would be temporary, in that there is no proposal to create or allow any form of formalised vehicular access. Expert investigation into the vegetation impacts reported "The damage to the vegetation communities present would result in damage to the TSC Act listed Bangalay Sand Forest TEC of up to about 0.15 hectares. This is expected to be temporary and would not result in permanent removal of vegetation. As it is not expected that any canopy species would be removed, low growing shrubs and groundcovers would recover reasonably quickly from this disturbance". Excavation The work will result in the lake entrance being opened to the ocean to restore tidal exchange between the lake and the ocean. The size of the entrance after opening will be dependent the degree of scouring that occurs during the first outgoing tide. If a successful opening is achieved, there is expected to be little lateral migration of the entrance and as such the entrance would retain the same physical characteristics as it had prior to closure.
c.	Will there be any environmental impact on the ecosystems of the locality? ☐ **n/a or negligible** ☐ positive ☐ low adverse ☒ medium adverse ☐ high adverse Comment:

	Access As described in Section 8.6.6 (and Envirokey, 2016), there may be a temporary impact on the vegetation community along the end of Archers Road and short-term physical impacts on a small section of Bangalay Sand Forest EEC on the northern section of the lake. Excavation There will be no adverse environmental impact on the ecosystems of the locality through the restoration of a regular tidal cycle. Historical records indicated that the lake has been open and therefore subject to tidal cycles for some 60 years. The lake's ecosystem has adapted to this tidal regime and should not suffer any negative impacts from the proposed opening and restoration of tidal cycles. If following opening, water leaves the lake on the outgoing tide and the lake closes prior to the high tide there is potential for the exposure of foreshore/nearshore ecosystems due to the reduced water levels in the lake. Shallow sections of the lake could experience rapid increases in biological oxygen demand which will have an impact on aquatic fauna. This eventuality is difficult to predict due to the complex natural factors that will combine to determine the success or otherwise of the works. None the less it is important that this possible outcome is identified.
d.	Will there be any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: Access There will be a temporary aesthetic impact due to the required removal of vegetation along parts of the proposed access route. There will be no broad or permanent reduction in aesthetic, recreational, scientific or other environmental quality or value of a locality Excavation Following the works there may be small piles of excavated sand present, until channel migration results in their removal. This normally happens on the first outgoing tide following the opening. There will be heavy machinery onsite during the works which will have a temporary impact on the aesthetics of the entrance area. An exclusion area would be enforced during works around the entrance area, resulting in a temporary loss of access and recreational opportunity to the occasional person who visits the area. While intervention in the natural breakout process conceptually diminishes the scientific value of the system since an element of 'naturalness' has been lost, in reality the vast majority of ecological processes will continue to operate. The locality could still be suitably used for a wide range of scientific purposes (this has been demonstrated at

	other ICOLLs on the Far South Coast such as Wallagoot Lake).
e.	Will there be any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Stone artefacts and fragmented shell were identified along the excavator access track during the site investigation. The ACHAR also identified the potential for subsurface deposit and burials along the access track. Impacts beyond those already occurred to disturbed surface deposits are unlikely, nevertheless BVSC have sought an AHIP associated with the works.
f.	Will there be any impact on the habitat of any protected fauna (within the meaning of the *National Parks and Wildlife Act, 1974*)? [6] ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: Localised and transient areas of damage to woodland vegetation communities during access of the excavator may result in short term damage for threatened mammal species. These impacts will be minimised by the careful selection of the access route so as to use existing cleared/disturbed areas. While it is inevitable that some ground cover and small shrubs will be damaged or removed during the process, any impacts to threatened mammals are expected to be very minimal due the extensive availability of alternative habitat throughout the surrounding localised woodland community. The temporary and low adverse impacts that would be generated are supported by the conclusions of the expert assessment undertaken by Envirokey (2016) and presented in Appendix I. While it is recognised that access across the dune creates the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher and Hooded Plover by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 8.6.7 and the Policy, these impacts will be reduced to low adverse. Nevertheless, any loss of a breeding colony would be considered significant and as a result Section 5A assessments are contained in Section 8.8. It is very unlikely that mechanical opening of the entrance would have any significant impacts on the Green and Golden Bell Frog, as there will be no significant changes to the lake's typical hydrologic regime (the lake is typically open to the sea). In reality, closure of the lake entrance and lake water levels that are significantly higher than normally experienced with an open entrance would present potential impacts. As a precautionary measure, a Section 5A assessment for the Green and Golden Bell Frog is contained in Section 8.8.
g.	Will there be any endangering of any species of animal, plant or other form of life,

.

	whether living on land, in water or in the air? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: It is very unlikely that mechanical opening of the entrance would have any significant impacts on the endangered ecological communities listed in Section 8.8 (i.e. Coastal Saltmarsh and Bangalow Sand Forest) or the Green and Golden Bell Frog, as there will be no significant changes to the lake's typical hydrologic regime (the lake is typically open to the sea). In reality, closure of the lake entrance and lake water levels that are significantly higher than normally experienced with an open entrance would present potential impacts. As a precautionary measure, Section 5A assessments for these communities and species are contained in Section 8.8. While it is recognised that there is the potential for significant adverse impacts on ground nesting species such as the Pied Oystercatcher and Hooded Plover by disrupting breeding activity including pair formation, nesting and fledging, with the mitigation and adaptive management measures stipulated in Section 8.6.7 and the Policy, these impacts will be reduced to low adverse.
h.	Will there be any long-term effects on the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Access Areas of Bangalay Sand Forest EEC disturbed by machinery accessing the beach would be expected to recover rapidly and there should be no long-term impacts through this part of the proposal. Excavation The works should not result in any long term negative impacts on the lake or beach/entrance berm area. If the entrance opening is successful, the regular tidal cycle to which the ecosystem has adapted will be restored.
i.	Will there be any degradation of the quality of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Access There will be no future reduction in the environmental quality, as the proposed access route is an existing and already disturbed track. Excavation There will be no degradation of the environment resulting from excavation works. Natural coastal processes will rapidly re-position excavated marine sand and stabilise the position of the entrance channel adjacent to Baycliff.

j.	Will there be any risk to the safety of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: It is unlikely that the environment will be any less 'safe' as a result of undertaking the entrance opening works. Council's established lake opening procedures will be put in place, and experienced or well briefed machinery operators will be used. These procedures address environmental protection, public and operator safety. Site fencing and signage will also be erected. The robustness or ability of the environment to withstand environmental fluctuations is unlikely to be compromised.
k.	Will there be any reduction in the range of beneficial uses of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no reduction in the range of beneficial uses of the environment apart from those discussed under point d) above. More likely implementation of the Policy will result in improved use of the environment for both recreational and commercial purposes.
l.	Will there be any pollution of the environment? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Machinery will be inspected prior, during and following works to ensure there are no fuel/oil leakages that may be a minor point source pollutant. Noise emitted from the works will only affect the localised area of the access path and the entrance area. As the excavated material is clean and moist marine sand there will be no dust created from the excavation.
m.	Will there be any environmental problems associated with the disposal of waste? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: There will be no problems associated with waste as a result of this project.
n.	Will there be any increased demands on resources (natural or otherwise) that are, or are likely to become in short supply? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: The proposed works will not increase the demands of any resources such that they become in short supply.
o.	Will there be any cumulative environmental effect with other existing or likely future activities? ☒ **n/a or negligible** ☐ positive ☐ low adverse ☐ medium adverse ☐ high adverse Comment: Although it is difficult to predict what other future activities might take place,

	it is unlikely that this activity (that is, implementation of the Policy) would have a cumulative effect with these other activities. Other activities are likely to be based in the catchment or upper areas of the estuary.
p.	Will there be any impact on coastal processes and coastal hazards, including those under projected climate change conditions? ☐ **n/a or negligible** ☐ positive ☒ low adverse ☐ medium adverse ☐ high adverse Comment: The works may have a slight impact on natural coastal processes. This impact may occur as the opening process if successful will scour a channel in the beach bar, redepositing the sediment in the near shore active zone. As these works pre-empt a natural opening the impact should be minimal. Over the long-term the influx of marine sediment into the estuary and the widening of the beach berm may alter sediment processes in the coastal zone, impacting future coastal processes. Though unlikely, altering the entrance behaviour of the estuary may indirectly impact foreshore erosion processes at North Wonboyn, and an additional study would be required to investigate this. The policy encourages the development of alternative techniques to maintain the oyster industry during periods of extended lake closure in the longer term.

8.8 7-Part Test for Threatened Species, Populations and Ecological Communities

8.8.1 Section 5A Assessment under the EP&A Act 1979 with Respect to Threatened Resident Shorebirds - Hooded Plover (Thinornis rubricollis) and Pied Oystercatcher (Haematopus longirostrus).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of these species is not likely to be disrupted to any significant extent provided the Policy and associated mitigation measures are followed.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for these species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. These species do not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. A localised section of potential habitat will be modified during the activity, in that the activity will involve the excavation of a pilot channel with heavy machinery to allow a lake entrance opening to be initiated. As a result, habitat in the form of sediment will be redistributed in the nearshore active coastal zone through channel scouring.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The localised habitat that will be modified is a part of a larger habitat area that is essential to these species particularly between August and April for breeding activity such as pair formation, nesting and fledging.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wonboyn Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is inconsistent with the Priority Action Statements for these species if works were to be undertaken during breading periods between August and April and appropriate mitigation and adaptive management measures were not adhered to.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wonboyn Lake to the sea, this constitutes a moderate alteration to the natural flow regimes. However, the typical hydraulic regime for the Wonboyn Lake entrance is for the lake to be open to the sea.

8.8.2 Section 5A Assessment under the EP&A Act 1979 with Respect to the Endangered Green and Golden Bell Frog (Litoria aurea).

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

The life cycle of this species is unlikely to be disrupted by implementing the Policy, as the proposed entrance management works return the lake's hydrologic regime to its typcical form (entrance open to tidal exchange). Not implementing the Policy would allow lake water levels to significantly exceed typical values, which may potentially result in adverse effects on the life cycle.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

No endangered populations have been recognised in the BVSC LGA for this species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

N/A. This species does not constitute an EEC.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

No area of habitat for this species is to be removed. Implementation of the Policy will be beneficial by maintaining habitat that would otherwise have been significantly impacted by elevated lake water levels.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

There will be no isolation of habitats created.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

The habitat that will be maintained by implementing the policy is of critical importance to this species, particularly between August and March for breeding activity.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wonboyn Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is not inconsistent with the Priority Action Statement and Recovery Plan for this species if works were to be undertaken.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wonboyn Lake to the sea, this constitutes a moderate alteration to the natural flow regimes. However, the typical hydraulic regime for the Wonboyn Lake entrance is for the lake to be open to the sea.

8.8.3 Section 5A Assessment under the EP&A Act 1979 with Respect to Endangered Ecological Communities – Coastal Saltmarsh, Bangalow Sand Forest

(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

N/A. These are Endangered Ecological Communities, not threatened species.

(c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

These EECs have developed and evolved around Wonboyn Lake during a period when the lake has been open to the sea and tidal exchange on a near permanent basis. The proposed entrance opening works will maintain the lake in its 'typical' hydraulic regime, and therefore help to maintain the existing state of the EECs.

(d.i) In relation to the habitat of a threatened species, population or ecological community, detail the extent to which habitat is likely to be removed or modified as a result of the action proposed;

Localised areas of damage to Bangalow Sand Forest vegetation communities during access of the excavator may result in damage of habitat for threatened mammal species. These impacts have been minimised through careful selection of an existing and already disturbed access track. However, it is inevitable that some ground cover and small shrubs will be damaged or removed during the process. Any impacts are not expected to be long term due the extensive localised area of this EEC. The temporary and low adverse impacts that would be generated are supported by the conclusions of the expert assessment undertaken by Envirokey (2016) and presented in Appendix I.

Given that the proposal seeks to make the restore the 'typical' tidal cycle, it is assumed that this will only benefit the fringing vegetation communities of the lake including saltmarsh.

(d.ii) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community;

No EECs are likely to become isolated as a result of the works.

(d.iii) The importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

There is expected to be very minimal short term impact to the Bangalow Sand Forest over a very localised area. As this EEC is extensive and extends over a much larger area, it is expected that the works will have an insignificant long term impact on this EEC.

As discussed in (d.i), the proposed works will assist in minimising damage to Coastal Saltmarsh through prolonged periods of lake entrance closure, by maintaining lake water level fluctuations within a more “typical’ range.

(e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

No areas of critical habitat have been identified at Wonboyn Lake.

(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan;

The activity is a threatening process and as a result would be inconsistent with these plans.

(g). Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process;

Alteration to the natural flow regimes of lakes, rivers and streams and their floodplains and wetlands is recognised as a threatening process. As these works involve the artificial opening of Wonboyn Lake to the sea, they are considered to be an interference with natural processes. However, the works will maintain the lake processes within the ‘typical’ regime for tidal flows exchange and water levels.

8.9 Conclusion

The proposed entrance management works are primarily required for the sole purpose of reducing the impacts of flooding on the Council managed Wonboyn Road at Myrtle Cove, which provides access to a range of private, commercial and recreational properties. This occurs when lake water levels exceed approximately 1.4 m AHD. The Wonboyn Lake Entrance Management Policy also provides a structured and approved mechanism for the local oyster farming industry to fund opening of the entrance on the grounds of lake water quality putting oyster health at risk. In implementing the proposed Wonboyn Lake Entrance Management Policy, there are two notable potential impacts. These are:

1. Potential direct impacts to a localised section of Bangalay Sand Forest EEC on the northeastern side of the lake, associated with access of the excavation plant;
2. Potential direct impacts to threatened shorebird species.

With regards to damage to the Bangalay Sand Forest EEC, a Flora and Vegetation Community Impact Assessment was undertaken by Envirokey (2016) to further investigate. The assessment found that while there will be minor transitory environmental impacts to a very localised section of the Bangalay Sand Forest EEC on the northeastern side of the lake, machine access was unlikely to have a significant effect on threatened species, populations and communities.

With regards to potential impacts to threatened shorebirds, the Policy has been developed in such a way so as to both minimise risk and consequence of any such impacts. This includes specific selection of an excavator access route that minimises impacted areas that are potentially significant to shorebirds, as well as an entrance opening process that includes a range of mitigation and adaptive management measures. If the Policy and proposed mitigation measures are adhered to, then potential impacts to shorebirds will be minimal.

While the current Policy advocates artificial opening of the Wonboyn Lake entrance upon realisation of certain triggers, it needs to be recognised that the ongoing mechanical opening of the lake is logistically difficult, expensive and unsustainable during long periods of drought which are predicted to potentially worsen with ongoing climate change. The difficulty lies in:

- the distance the machinery is required to travel from the nearest trafficable road;
- no well-established access route to the beach;
- determining a route to the beach which avoids cultural sites and threatened shorebird nesting sites; and
- the relatively low water levels in the lake at the time of opening (if opening on water quality grounds), which will likely result in only a shallow entrance channel being scoured.

Due to these limitations, the formal Entrance Management Policy (Appendix G) advocates a minimal entrance intervention in the long term, with preference for returning to a "natural as possible" breakout regime. However, as there are no viable alternatives to the proposed entrance management in the short term, the proposed Wonboyn Lake Entrance Management Policy should be approved, conditional upon:

- The works being implemented in accordance with the proposed Policy and the mitigation measures it contains;
- The local oyster farming industry investigate alternative methods to retain oyster survival when the lake is closed, e.g. transporting to another lake, raising oyster bags etc.;
- Bega Valley Shire Council plan and implement modifications to the low lying assets that are affected by inundation when lake water levels are high;
- Maintaining a buffer of no new development within close proximity to and below an elevation of 3.0 m AHD around Wonboyn Lake.

9 References

ANU (2006) Coastal Lake Assessment and Management (CLAM) tool for Back Lake, developed by the Integrated Catchment Assessment and Management Centre (iCAM) of the ANU in association with NSW Department of Natural Resources (DNR) and Department of Environment and Conservation (DEC), 2006.

BMT WBM (2011). Bega River Estuary Management Study and Plan. Prepared for Bega Valley Shire Council, January 20011.

Brooks, A. and Brierley, G. (1997) Geomorphic response of lower Bega River to catchment disturbance, 1851-1926, Geomorphology, 18, p. 291-304

BVSC (2000). Wallaga Lake Estuary Management Study and Plan.

BVSC (2004) A Review of Environmental Factors (REF) for Wonboyn Lake.

BVSC (2005) Review of environmental factors for the artificial opening of Wallaga Lake.

BVSC (2006) An Interim Review of Environmental Factors (REF) for Back Lake.

Claydon (2010) The Hydrodynamic Properties Associated with the Recovery of an ICOLL After Flood Conditions, Honours Thesis, ANU

Coastal & Marine Geosciences [CMG] (2000) Bega River Estuary Sediment Study, Prepared for the Bega Valley Shire Council, January 2000.

Creese, R.G., Glasby, T.M., West, G. and Gallen, C. (2009) Mapping the habitats of NSW estuaries, Report to the Hunter Central Rivers Catchment Management Authority, September 2009,

DECCW (2010). State of the Catchments 2010, Estuaries and Coastal Lakes - Southern Rivers region. Department of Environment, Climate Change and Water, November, 2010. Downloaded 15th August 2011 from: http://www.environment.nsw.gov.au/resources/soc/southernrivers/10603SRestuarine.pdf

DECCW (2010b) Flood Risk Management Guide - Incorporating sea level rise benchmarks in flood risk assessments. Department of Environment, Climate Change and Water NSW, Sydney South.

DIPNR (2005) Floodplain Development Manual. NSW Department of Infrastructure, Planning and Natural Resources, Sydney

DLWC (2000) Vulnerability Assessment of Estuaries in the Eurobodalla and Bega Valley Shires

DPI (2006) Final Report CCA-24 Preparation of Sustainability Assessments for Coastal Lakes, Comprehensive Coastal Assessment DVD, Volume 1. Report prepared by Department of Natural Resources for Department of Planning, Sydney.

DPI (2016), Schedule 1 of the Fisheries Management (Estuary General Share Management Plan) Regulation 2006 for Wallagoot Lake, www.dpi.nsw.gov.au, Accessed 30/04/2016

Elgin (2014) Wallagoot Lake – Environmental Monitoring in Coastal Lakes and Lagoons of Bega Valley Shire Council Region, 2010-2013, Estuary Health Monitoring Report Series Number 6, Prepared for Bega Valley Shire Council

Elgin (2014) Cuttagee Lake – Environmental Monitoring in Coastal Lakes and Lagoons of Bega Valley Shire Council Region, 2010-2013, Estuary Health Monitoring Report Series Number 3, Prepared for Bega Valley Shire Council

Elgin (2016) Cuttagee Lake Rapid Catchment Assessment, Catchment Management Plan Report, Prepared for Bega Valle Shire Council

Envirokey (2016) Flora and Vegetation Community Impact Assessment, Proposed Excavator Track, Wonboyn Lake, Wonboyn NSW, Prepared for Bega Valley Shire Council, Report No. 16.EcIA-032

ESE (2002) Lake Curalo Estuary Management Study and Plan, prepared for Bega Valley Shire Council, January 2002.

Fryirs, K. & Brierley, G. (1998) The use of River Styles and Their Associated Sediment Storage in the Development of a Catchment-Based River Rehabilitation Strategy for Bega/Brogo Catchment, School of Earth Sciences, Macquarie University

Gibbs P. (1997) A Review of Information on NSW South Coast Estuarine Fisheries. NSW Fisheries Research Institute, Cronulla

Keith DA (2004) 'Ocean shores to desert dunes: the native vegetation of New South Wales and the ACT.' (NSW Department of Environment and Conservation, Sydney.)

Lunney D, Leary T (1988) The impact on native mammals of land-use changes and exotic species in the Bega district, New South Wales, since settlement. Australian Journal of Ecology 13, 67-92.

NSW Fisheries (1998) Policy and Guidelines - Aquatic Habitat Management and Fish Conservation. NSW Fisheries, Sydney.

NSW Scientific Committee (2012) Scientific committee determinations. Office of Environment and Heritage. Accessed on 18/9/2012 at: http://www.environment.nsw.gov.au/determinations/index.htm

OEH (2015) Significant Shorebird Sites on Bega Valley Shire Council Estate – Map Series

OEH(2016) Estuaries of NSW: Physical characteristics, tidal surveys and hydrographic surveys, URL: http://www.environment.nsw.gov.au/estuaries/list.htm

Pollard D. (1994) A comparison of fish assemblages and fisheries in intermittently opening and permanently open coastal lagoons of the South Coast of New South Wales. Wetlands (Australia) 13, pp.16-35.

Roper T. Creese B. Scanes P. Stephens K. Williams R. Dela-Cruz J. Coade G. and Coates B. (2011). Assessing the condition of estuaries and coastal lake ecosystems in NSW Technical Report - NSW State of the Catchments 2010. NSW Office of Environment and Heritage, Sydney.

Roy PS. William, RJ. Jones, AR. Yassini, I. Gibbs, PJ. Coates, B. West, RJ. Scanes, PR. Hudson, JP. and Nichol S. (2001) Structure and Function of South-east Australian Estuaries, Estuarine, Coastal and Shelf Science, 53, 351-384, Academic Press.

Sanderson, B.G., Coade, G., Robson, B., Davies, P. and Baginska, B. (2006) Response of estuaries and coastal lakes to total nitrogen loading, prepared for the Comprehensive Coastal Assessment (DoP) by NSW Department of Environment and Conservation.

Spooner, D. (2003) Wallaga Lake Nutrient Exports & Water Quality Synthesis. Prepared in conjunction with Peter Spurway & Associates, Bingi.

Sulisit (2012) Draft Estuary Management Plan for Wallagoot Lake and Bournda Lagoon, Bournda EEC and Sulisit Consulting

Tozer MG, Turner K, Keith DA, Simpson C, Beukers P, Mackenzie B, Tindall D, Pennay C, (2004) Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands. Version 1.0. NSW Department of Environment and Conservation and NSW Department of Natural Resources, Sydney.

WBM Oceanics Australia (2004). Wonboyn Lake and Estuary Management Plan. Prepared for Bega Valley Shire Council, January 2004.

Webb McKeown & Associates (1997), Merimbula Lake and Back Lake Estuary Management Plan and Management Study Summary, prepared for Bega Valley Shire Council, January 1997.

Webb McKeown & Associates (1995), Merimbula Lake and Back Lake Estuary Processes Study, prepared for Bega Valley Shire Council, March 1995.

West, R.J., Thorogood, C., Walford, T. and Williams, R.J. (1985). An estuarine inventory for New South Wales, Australia, dept. of Agriculture NSW.

WRL (2015). North Wonboyn NSW Foreshore Protection Study, Water Research Laboratory Technical Report 2013/29, Manly Vale

Appendix A. Wallaga Lake Entrance Management Policy

Appendix B. Cuttagee Lake Entrance Management Policy

Appendix C. Bega River Entrance Management Policy

Appendix D. Wallagoot Lake Entrance Management Policy

Appendix E. Back Lake Entrance Management Policy

Appendix F. Lake Curalo Entrance Management Policy

Appendix G. Wonboyn Lake Entrance Management Policy

Appendix H. Recommended Site Works Report

Appendix I. Wonboyn Lake Access Track FVCIA

Appendix J. Aboriginal Cultural Heritage Assessment Report