Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall

Appendix F
Flood Assessment

Appendix F

Flood Assessment

Client: Bega Valley Shire Council

ABN: 26 987 935 332

Prepared by

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Executive Summary

Bega Valley Shire Council (BVSC) is proposing an upgrade to the Merimbula Sewage Treatment Plant (STP) including a new ocean outfall in Merimbula Bay (the Project). The Project would be located between Merimbula and Pambula on Arthur Kaine Drive, within the Bega Valley Shire local government area (LGA). The Merimbula STP is bounded by the Pambula Merimbula Golf Club (PMGC) to the south, Merimbula Lake to the west, Merimbula Airport to the north and Arthur Kaine Drive to the east. The Merimbula STP is accessed via Arthur Kaine Drive, which links to Princes Highway to the west and providing direct access to Merimbula Airport in the north.

The Project would involve an upgrade of sewage treatment at the Merimbula STP and replacement of the existing beach face outfall and dunal exfiltration ponds with an ocean outfall in Merimbula Bay. Specifically, the Project would involve:

- upgrade of the STP to improve the quality of treated wastewater (including for beneficial re-use);
- decommissioning of the beach-face outfall, as well as an STP effluent pond;
- discontinuing the use of the dunal exfiltration ponds;
- installation of a secondary disposal mechanism - an ocean outfall pipeline about 3.5 km in length to convey treated wastewater to a submerged diffuser;
- installation of upgraded pumps; and
- continuation of the beneficial re-use irrigation scheme at the PMGC grounds and the Oaklands agricultural area, with treated wastewater of improved quality.

The Project area comprises the existing Merimbula STP site and ocean outfall alignment, as well as areas required for construction, including laydown areas within the adjacent PMGC grounds and on Merimbula Beach (with access via Pambula Beach).

The Project is aimed at reducing the environmental and health impacts of current operations, by providing a higher level of treatment and a superior mode of discharge/ dispersion of the treated wastewater via an ocean outfall in Merimbula Bay. The upgraded STP would be operated with the additional treatment processes which would improve the quality of the treated wastewater.

This flood assessment has been undertaken to satisfy the Secretary's Environmental Assessment Requirements (SEARs) issued for the Project, and support the Environmental Impact Statement (EIS) for the Project by:

- evaluating the existing flood risk across the Project area;
- determining the potential flood risk and impacts associated with the Project; and
- developing mitigation measures for the Project where necessary.

A flooding assessment for the Project was undertaken based on the results of the previously completed *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017). It was determined that the Project is not expected to impact existing flooding conditions. Increases in flood level due to climate change are also not expected to impact the upgraded STP site.

It is recommended that construction activities should ensure that any required temporary site compounds, stockpiles and storage areas are located outside of the 1% Annual Exceedance Probability (AEP) flood extent shown in **Figure 4-8** of this report. No other mitigation measures have been identified as being required.

1.0 Introduction

Bega Valley Shire Council (BVSC) is proposing an upgrade to the Merimbula Sewage Treatment Plant (STP) including a new ocean outfall in Merimbula Bay (the Project). The Project would be located between Merimbula and Pambula, within the Bega Valley Shire local government area (LGA). The Project area includes both the operational footprint and the construction footprint, and is shown in **Figure 2-1**.

This Flood Assessment has been prepared to assess the potential flood-related impacts during construction and operation of the Project.

1.1 Project overview

The Project would involve an upgrade of sewage treatment processes at the Merimbula STP, decommissioning of an existing effluent storage pond, and replacement of the existing beach-face outfall and dunal exfiltration ponds with an ocean outfall pipeline in Merimbula Bay.

When operational, the Project would involve continuation of the beneficial re-use irrigation scheme at the PMGC grounds and the nearby Oaklands agricultural area, with improved treated wastewater quality from the upgraded STP.

The Project would reduce the environmental and health impacts of the current operations, by providing a higher level of treatment and a superior mode of discharge/dispersion of the treated wastewater via the ocean outfall offshore in Merimbula Bay.

The Project is described in further detail in **Section 2.0**, and an overview of the Project area is provided in **Figure 2-1**. A full Project description is provided in the EIS (refer **Chapter 2 Project description**).

1.2 Purpose of this technical report

This qualitative flood assessment is one of a number of technical documents that forms part of the EIS. The aim of this technical report is to address the relevant Secretary's Environmental Assessment Requirements (SEARs) issued for the Project by the NSW Department of Planning Industry and Environment (DPIE) (Application number SS1 7614). The assessment assesses the flood risk across the Project area and identifies relevant mitigation where necessary.

1.3 Secretary's environmental assessment requirements

The SEARs relevant to this flooding assessment are presented in **Table 1-1**.

Table 1-1 Secretary's Environment Assessment Requirements – Flooding

Secretary's Environmental Assessment Requirements	Where addressed in report
12. Flooding	
1. The Proponent must assess and (model where required) the impacts of flood behaviour during construction and operation for a full range of flood events up to the probable maximum flood (taking into account, sea level rise due to climate change) including: (a) consistency (or inconsistency) with applicable Council floodplain risk management plans (b) compatibility with the flood hazard of the land	**Section 4.0** and **Section 5.0**
(c) compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land (d) impacts the development may have upon existing community emergency management arrangements for flooding. These matters must be discussed with the State Emergency Services; and (e) any impacts the development may have on the social and economic costs to the community as consequence of flooding.	**Section 5.0**

2.0 Project description

This chapter outlines the existing operations at the Merimbula STP and provides a summary of the Project description. A full Project description is provided in **Chapter 2 Project description** of the EIS.

The Project would be located between Merimbula and Pambula on Arthur Kaine Drive, within the Bega Valley LGA approximately 3.5 kilometres (km) south of the Merimbula town centre and 2.5 km north of Pambula village, as shown on **Figure 2-1**. The Merimbula STP is bounded by the PMGC to the south, Merimbula Lake to the west, Merimbula Airport to the north and Arthur Kaine Drive to the east. The Merimbula STP is accessed via Arthur Kaine Drive, which links to Princes Highway to the west and provides direct access to Merimbula Airport in the north.

2.1 Existing operations

The existing operations at the Merimbula STP consist of:

- sewage treatment at the Merimbula STP; and
- disposal of treated wastewater via:
  - a beach-face outfall;
  - dunal exfiltration ponds; and
  - a beneficial re-use scheme at the adjacent Pambula Merimbula Golf Club (PMGC) grounds, and at Oaklands agricultural area.

The STP is an intermittently decanted extended aeration (IDEA) activated sludge plant designed to serve an equivalent population of 15,500. The STP has a capacity to accommodate an average dry weather flow of up to 3.72 megalitres per day (ML/day) and a peak wet weather flow of seven times the average dry weather flow, or 26 ML/day. It handles an average of 790 megalitres (ML) of treated wastewater per year .

The current strategy for managing treated wastewater from the Merimbula STP comprises a combination of:

- beneficial re-use (the preferred disposal option): use of treated wastewater to irrigate the adjacent PMGC grounds and ‘Oaklands’ agricultural area (approximately 25% of annual treated wastewater), located on the Pambula River flats at South Pambula; and
- disposal: discharge of excess treated wastewater to the environment, via dunal exfiltration ponds located within the sand dunes east of the STP between the ocean and Merimbula Lake (approximately 25% of annual treated wastewater), or via the existing beach-face outfall east of the STP at Merimbula Beach (approximately 50% of annual treated wastewater).

2.2 The Project

The Project would involve:

- upgrade of the STP to improve the quality of treated wastewater (including for beneficial re-use);
- decommissioning of the beach-face outfall, as well as an STP effluent storage pond;
- discontinuing the use of the dunal exfiltration ponds;
- installation of a secondary disposal mechanism - an ocean outfall pipeline about 3.5 km in length to convey treated wastewater to a submerged diffuser;
- installation of upgraded pumps; and
- continuation of the beneficial re-use irrigation scheme at the PMGC grounds and nearby Oaklands agricultural area with treated wastewater of improved quality.

Upgrades to the STP and the ocean outfall would reduce the environmental and health risks and impacts of the current operations, by providing a higher level of treatment and a superior mode of discharge/ dispersion of the treated wastewater via an ocean outfall offshore in Merimbula Bay.

A summary of the proposed Project elements is provided in **Table 2-1**.

The Project area comprises the existing Merimbula STP site and the proposed outfall pipeline alignment. The Project construction areas would include areas within the Merimbula STP, temporary laydown areas on the adjacent PMGC grounds and on Merimbula Beach (with associated access from Pambula), as shown in **Figure 2-1**.

This EIS is based on a concept design for the Project. It is noted that during subsequent design stages, and subsequent to a design and construction contractor(s) being engaged, details of the Project may change or be refined (e.g. specific locations of some elements or infrastructure within the existing STP site; materials to be used in plant construction and technology).

Table 2-1 Project elements

Project element	Summary
STP upgrade	The STP upgrade would involve additional treatment processes incorporated into the existing STP site, including two stage poly aluminium chloride (PAC) dosing, ultraviolet (UV) disinfection, chlorine dosing and tertiary filtration (if required). The indicative physical layout of the proposed STP upgrade is shown in **Figure 2-2**. The new treatment processes would be incorporated into the following existing STP phases (refer **Chapter 2 Project description** for further information): *Phase two: secondary treatment* Addition of: • two stage PAC dosing for phosphorous removal. *Phase three: disinfection* A change to the existing disinfection (chlorine dosing) treatment, involving: • addition of ultraviolet (UV) treatment; • chlorine dosing, using chlorine gas, would continue to be applied to treated wastewater, however wastewater would be divided into two separate streams: - wastewater to be beneficially re-used would be dosed with chlorine; and - wastewater to be discharged via the ocean outfall would no longer be subject to chlorine dosing. • the chlorine dosing proposed would involve installation of a new chlorine dosing unit (including two 920 kg drum storage of chlorine, and a new pump system). The chlorine dosing unit would be stored at a dedicated storage facility within the STP (either the existing chlorine storage shed would be upgraded to house the increased volume of chlorine required for the Project, or a new shed would be built on or near to the site of the existing shed); and • tertiary filtration could also be installed (if required).

Project element	Summary
	The Project would also require the following within the existing STP site: • a new storage tank and new chlorine contact tank; • installation of up to four additional pump stations: - ocean outfall pump station – to pump treated wastewater through the outfall pipeline; - storage tank pump station – to pump treated wastewater to the new storage tank; - chemical sludge pump station (if tertiary filters required) – to pump sludge and treated wastewater; and - pump station – to pump from wet weather overflow back into the STP treatment train. • installation of ancillary infrastructure (including new sheds/structures to house new treatment processes, above-ground storage tanks, pipes, pits, power supply and additional low voltage (LV) connection (including transformer, cabling and distribution board), control kiosks, a retaining wall and internal access roads); and • relocation and upgrade of utilities to accommodate the additional features proposed.
Existing STP effluent storage pond	The existing 17 ML effluent storage pond within the STP site would be decommissioned, including dewatering and sediment/sludge removal.
New ocean outfall pipeline and effluent diffuser, and associated pump station	*Phase four: Disposal and beneficial re-use* New additions would involve: • installation of a 3.5 km outfall pipeline – the pipeline would travel from the STP in an east-south-easterly direction to a location approximately 2.7 km offshore in Merimbula Bay; • the pipeline would involve two construction methods for different sections of the pipeline as follows: - 'Section one' – STP to a location beyond surf zone: underground trenchless drilling method (refer **Figure 2-3**); and - 'Section two' – Location beyond surf zone to offshore pipeline termination point: laying of pipeline on sea floor and covering with rock or concrete mattresses (refer **Figure 2-4**). • Section one of the pipeline (the onshore component) would be about 0.8 km and below ground. installation of the underground section would be via a trenchless method (e.g. horizontal direction drilling or direct drive tunnelling), followed by pipeline insertion via pulling or pushing; • Section two (the above ground section of the pipeline) would be installed via direct placement on the sea floor in 600 m to 800 m pipe lengths. This would also involve progressive protection and stabilisation works for the pipeline (e.g. potentially using concrete or rock mattresses) held together with ropes/ slings/ cables; • the terrestrial component of the outfall pipeline would be laid between about -9.3 m and -19.5 m AHD, with greater depth largely depending on the nature of the overlying sand dunes; • a multi-port pipeline diffuser would be located at the end of the pipeline at a depth of approximately 30 m; the diffuser would be approximately 80 m in length; • the pipeline would have an outer diameter of up to 450 mm (366 mm internal diameter) and consist of pipeline lengths welded together; • a transition riser may be required to connect the underground pipeline with the above ground section of pipeline on the sea floor (if required, the riser would be located beyond the surf zone); and • the pipeline would contain valves along its length for mitigating against air entrapment.

Project element	Summary
Existing exfiltration ponds	The existing exfiltration ponds within the adjacent sand dunes (east of the STP site) would cease to be used under the Project.
Existing beach-face outfall	The existing public beach-face outfall pipeline would be decommissioned. The exposed end of the outfall pipeline would be removed, and the remainder of the pipeline would remain in-situ (i.e. would remain buried underground).
Water use	The STP would continue to use potable town water for kitchen and amenities on site. Apart from these water inputs, the Project would not require any other ongoing water source during operation.
Construction	
Construction footprint	The construction footprint includes temporary compound and laydown areas as shown in **Figure 2-5**. The location of laydown areas would be confirmed during detailed design and would depend on the method and location/s proposed to be used for directional drilling by the construction contractor. Temporary construction laydown areas would be located: • within the STP site; • within a portion of the adjacent PMGC grounds; and • on Merimbula Beach (if required, for pipe stringing and potentially an intermediate drill rig site for directional drilling). A total of approximately 2,800 square metres (m^2) (or 0.28 hectares) of vegetation removal / trimming would be required in the following locations: • approximately 217 m^2 at the Pambula Beach access track; • approximately 2,464 m^2 of regrowth scrub within the existing STP site and for construction access from the construction laydown area within the PMGC grounds; and • approximately 47 m^2 at the existing beach face outfall pipeline (to be decommissioned). Note that 0.28ha is a rounded up figure in accordance with the calculation of biodiversity offset credits contained in **Appendix H** (Biodiversity Assessment Report)).
Construction timing, hours and workforce	Pending Project approval, it is proposed to commence construction in 2022, with construction anticipated to be undertaken over a period of 24 months. Construction would be staged and there would be times when some construction stages overlap. Works would typically be limited to standard daytime hours, which include: • 7:00 am to 6:00 pm Monday to Friday; • 8:00 am to 1:00 pm Saturday; and • no work on Sundays, public holidays. Certain works may need to occur outside standard construction hours for the safety of workers, in accordance with transport licence requirements, or for constructability reasons. Activities to be carried out during out of hours periods may include oversized load deliveries and pipeline pulling as part of the directional drilling (which would need to be undertaken continuously until completed, which may take up to 48 hours). Construction works in Merimbula Bay could occur seven days a week to maximise works during favourable offshore weather conditions. Approval from BVSC would be required for any out of hours work and the affected community would be notified. Construction of the Project would require a workforce of around 20 workers, with peak construction periods requiring up to 30 workers.

Project element	Summary
Traffic, construction vehicle types and workforce	Construction traffic would indicatively comprise: • 5-10 heavy vehicles per day (e.g. truck and dogs); and • 10-20 light vehicles per day. Vehicles transporting machinery or oversized materials such as prefabricated units may be required from time to time, and oversized vehicles would require escort to and from site. The largest truck expected as part of construction is the directional drilling rig truck (the exact size would be confirmed by the construction contractor). The construction phase of the Project would require construction vehicles to transport materials and equipment along the existing road network to the construction compound/laydown areas at the Merimbula STP and PMGC grounds and, if required, at the Merimbula Beach laydown area via Pambula Beach. In facilitating these construction activities, various plant and equipment would be required, including: • small, medium and large excavators (3 tonne to 25 tonne) (tracked and wheeled); • compaction plant (e.g. roller/s, plate compactor); • grader; • bulldozer; • directional drilling rig truck and associated infrastructure (i.e. drilling fluid recovery and recovery unit); • pumps for dewatering (if required); • vacuum truck; • bobcat; • concrete trucks and pumps; • mobile cranes (e.g. franna crane, scissor lift, forklift); • semi-trailers and tipper truck; • telehandlers; • micro-piling rig (on barge); • water carts; • hand tools and welding equipment; • barges (e.g. 55 m and 73 m barges, jack-up barge) and tugs; • small, self-propelled vessel; • demolition saw, jackhammer, grinder; • generator/s, lighting tower; • forklift; • light vehicles and light trucks; and • heavy vehicles. The size of vehicles used for haulage would be consistent with the access route constraints, safety and any worksite constraints. Some construction activities (such as the delivery of precast sections) may require truck and trailer combinations or semi-trailers.

Project element	Summary
Access	Construction vehicles would access/egress the STP site via the following accesses: • Arthur Kane Drive, via either the northern end of the STP site, and/or the existing main STP entrance. Construction of the outfall pipeline would also utilise the following accesses: • Coraki Drive, Pambula (construction vehicles would enter the temporary beach access track from the end of Coraki Drive, before traversing the beach access track to the laydown area on Merimbula Beach); and • Port of Eden, Twofold Bay (barge/s would transport materials and equipment northward to the location of the proposed outfall pipeline alignment). Construction site accesses at Arthur Kaine Drive and Pambula Beach are shown in **Figure 2-5**. Construction materials and equipment could also be delivered to the Port of Eden using shipping containers, with construction vehicles expected to haul these containers to the construction sites via the Princes Highway.

2.3 Operational stage

The Project would be operated with the additional treatment processes which would improve the quality of the treated wastewater. Levels of total phosphorus, total suspended solids, biological oxygen demand, virus, bacteria and other pathogens would be managed to be within discharge limits. Treated wastewater would be tested for quality prior to discharge via the ocean outfall pipeline or via beneficial re-use offsite (to existing land application areas at the Oaklands agricultural area or the adjacent PMGC grounds). Maintenance activities for the STP and ocean outfall would also be undertaken and would continue until the STP is decommissioned or further upgraded in the future..

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FIGURE 2-1: PROJECT AREA

Legend

- Project area
- Project area (temporary construction area)

N

0 500 1,000 m

AECOM

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 2-2: PROPOSED STP LAYOUT (INDICATIVE)

N 0 50 100 m

AECOM

Legend

- Project area
- Project area (temporary construction area)

Proposed Project Upgrades

- PAC dosing, UV disinfection, tertiary treatment
- Pump stations, storage, chlorine disinfection
- PAC dosing (second unit)
- Effluent storage pond to be decommissioned

Source: Nearmap, 2019

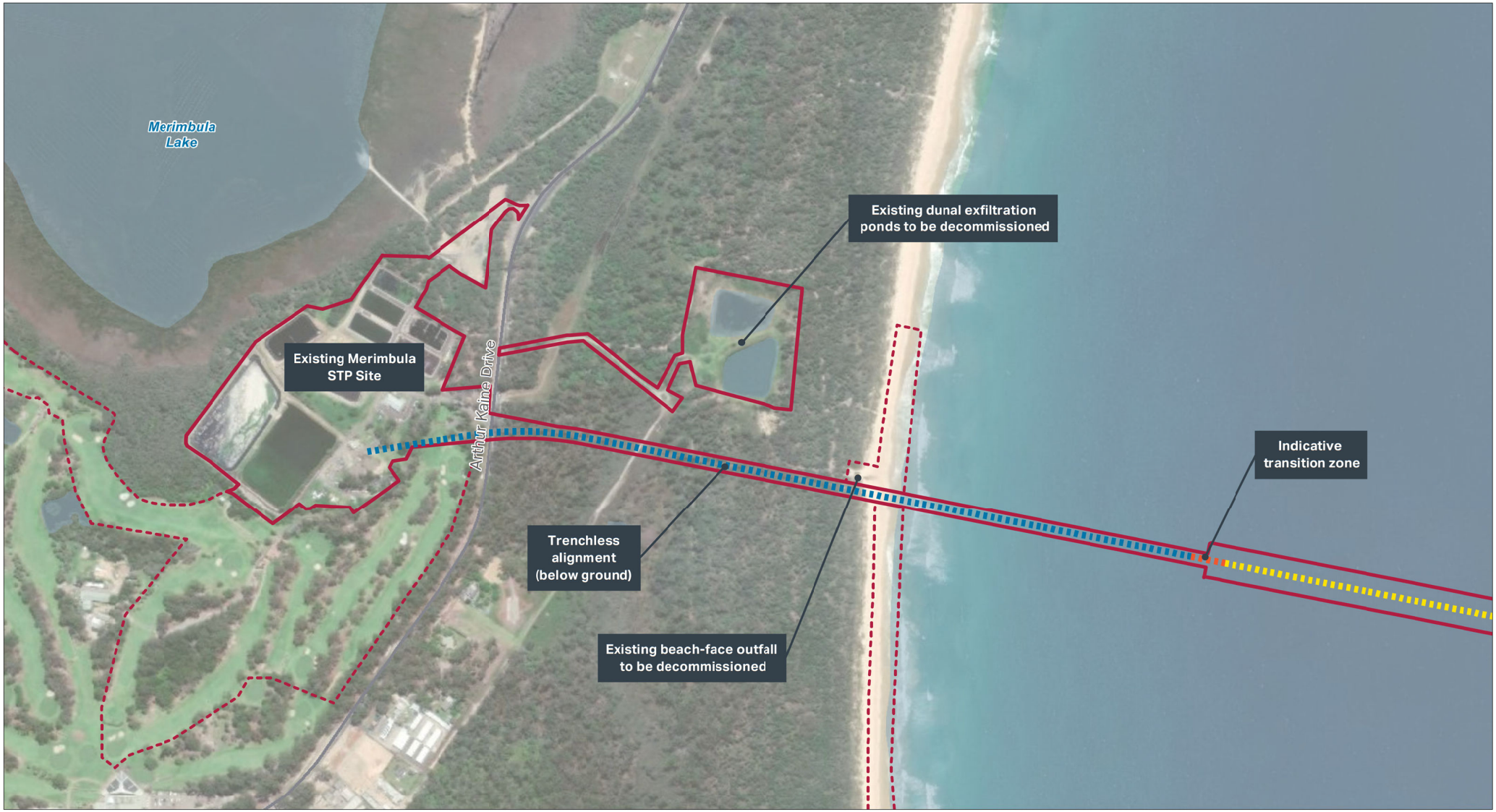

FIGURE 2-3: OCEAN OUTFALL PIPELINE - SECTION 1 (BELOW GROUND)

N

0 100 200 m

AECOM

Legend

- Project area
- Project area (temporary construction area)
- Outfall pipeline – Section 1 (below ground)
- Transition Zone
- Outfall pipeline – Section 2 (above seafloor)

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 2-4 : OCEAN OUTFALL PIPELINE – SECTION 2 (ABOVE SEAFLOOR)

Legend

- Project area
- Project area (temporary construction area)
- Outfall pipeline – Section 1 (below ground)
- Transition Zone
- Outfall pipeline – Section 2 (above seafloor)
- Diffuser (above seafloor)

N

0 200 400 m

AECOM

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 2-5: CONSTRUCTION COMPOUND/LAYDOWN AREAS

N

0 300 600 m

AECOM

Legend

- Project area
- Temporary project area for construction
- Construction access
- Construction compound/laydown area
- Construction laydown area and potential intermediate drilling site
- Construction laydown area at Pambula-Merimbula Golf Club grounds

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

3.0 Methodology

This section outlines the methods used to complete the flooding, hydrology and water quality impact assessment for the Project.

A detailed description of the Project and its associated works are provided in **Chapter 2 Project Description** of the EIS.

3.1 Overview

This assessment includes consideration of readily available data, with the key study relied on being *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017).

As detailed modelling has been undertaken previously, a qualitative desktop assessment of flooding impacts associated with the Project has been undertaken, which included:

- a desktop review and analysis of existing information to characterise the existing environment, identify surface water receptors, existing flood behaviours and identify potential issues;
- consideration of the location of the Project area in the context of surrounding catchment areas and potential sensitivity of downstream waterways;
- identification of key topographical features which may influence overland flow paths;
- assessment of potential construction and operational impacts relating to flooding; and
- identification of appropriate measures to mitigate and/or manage potential impacts on the environment.

3.2 Relevant guidelines and policies

Bega Valley Local Environmental Plan 2013

Section 6.3 of the *Bega Valley Local Environmental Plan 2013* (Bega Valley LEP 2013) defines flood planning as follows:

6.3 Flood planning

(1) The objectives of this clause are as follows—

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to land at or below the flood planning level.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development—

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0) published by the NSW Government in April 2005, unless it is otherwise defined in this clause.

(5) In this clause, flood planning level means the level of a 1:100 ARI (Average Recurrent Interval) flood event plus 0.5 metre freeboard.

The Project has been declared State Significant Infrastructure (SSI) under Division 5.2, section 5.12 (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act) by reason of clause 3 of Schedule 4 of the *State Environmental Planning Policy (State and Regional Development) 2011*.

Section 5.22(2) of the EP&A Act excludes the application of environmental planning instruments to SSI Projects, and therefore the Bega Valley LEP 2013 does not apply; however it has been considered in this assessment.

Bega Valley Development Control Plan 2013

The objectives of the *Bega Valley Development Control Plan 2013* (Bega Valley DCP 2013) are to:

- minimise the impacts of flooding on development within flood prone land or potentially flood prone land;
- ensure that development on flood prone land is consistent within the objectives of the *NSW Flood Prone Land Policy* 1984 and *NSW Floodplain Development Manual 2005*; and
- ensure the impact of climate change is considered when assessing development of flood prone land.

As described above, as the Project is SSI the Bega Valley DCP 2013 does not apply; however has been considered in this assessment.

Merimbula Lake and Back Lake Floodplain Risk Management Study

The *Merimbula Lake and Back Lake Floodplain Risk Management Study* (FRPMS) (Rhelm, 2020) has been undertaken by Rhelm. The study reviewed and adopted the modelling undertaken by Cardno (2017) (i.e. the key study relied upon for this assessment) as a basis for floodplain risk management within the Bega Valley Shire. Several Flood Planning Recommendations were made as part of this study. Note that the FRPMS was on public exhibition recently (in 2020) and has just recently Adopted by BVSC in February 2021.

NSW Floodplain Development Manual

The *NSW Floodplain Development Manual* (DIPNR, 2005) sets out the methodology in which floodplain management is undertaken in NSW. It provides guidance on how to enact the principles of the policy and is built on a risk management approach. The manual promotes management measures to reduce the risk, either by decreasing the probability, the consequence or both.

Australian Rainfall and Runoff Guidelines

Australian Rainfall and Runoff (ARR) – *A Guide to Flood Estimation* (Commonwealth of Australia, 2019) is the primary technical publication guiding hydrological design in Australia. The latest issue was finalised in 2019 and was the result of several years' of updates to the previous version of *Australian Rainfall and Runoff* (Engineers Australia, 1987).

The technical analysis and development of the hydrologic and hydraulic models for the *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017) commenced prior to finalisation of the 2019 version and this study is therefore largely based on the Engineers Australia 1987 guidelines.

A sensitivity analysis was undertaken on the Flood Study in 2020 and the results showed that the impact of applying ARR 2019 compared with ARR 1987 are negligible in the Merimbula Lake. On that basis, the *Merimbula Floodplain Risk Management Study* (Rhelm, 2020) adopted the Flood Study (Cardno, 2017) results based on ARR 1987. The results discussed herein are also based on the outcomes of the Cardno (2017) Flood Study.

3.3 Study area

The study area for this assessment is the catchment in which the Project area is located, and specifically focussed on the Project area and immediate surrounds. The components of the Project relevant to this flood assessment are those proposed within the boundary of the STP, and the potential construction laydown areas of the adjacent PMGC grounds. The remaining works associated with the Project would occur underground, along the beach sections, or along the seabed within the ocean (for the ocean outfall alignment). Note that potential impacts from inundation of the Merimbula Beach area from significant storm events and/or high tides is addressed in the EIS in **Chapter 10 Marine and coastal processes**.

The Project area sits within the Merimbula Lake catchment which extends approximately 7 km to the west. Merimbula Lake has a catchment area of approximately 4,300 hectares (ha) with a mixed land use, predominantly consisting of forested and rural lands with some urban development along the lake foreshore and entrance. The STP is located near the southern foreshore of the lake and is situated between the PMGC and the Merimbula Airport.

4.0 Existing environment

4.1 Existing flood conditions

The *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017) presents the estimated flood behaviour in the lake and surrounds for a range of local catchment and coastal flooding events. Key findings with regards to flooding behaviour were that the flooding at Merimbula Lake and Back Lake is driven more by entrance conditions and ocean behaviour rather than catchment flows at peak levels due to the catchment size in relation to the storage volume available at the lake. The STP site is located just south of Merimbula Lake (Back Lake is located on the northern side of the Merimbula estuary).

The existing ground elevation of the STP site is between approximately 3.6 m AHD and 10 m AHD, as shown in **Figure 4-1.** Maximum water extent maps for catchment flood events from the *Merimbula Lake and Back Lake Flood Study* for the 20% Annual Exceedance Probability (AEP), 10% AEP, 5% AEP, 2% AEP and Probable Maximum Flood (PMF) are presented in **Figure 4-2** to **Figure 4-7** respectively. The extent of the flood planning level (FPL) within the vicinity of the STP site is shown in **Figure 4-8**, and it is approximately 2.5 m AHD. The mapped flood depths for each flood event are provided in the *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017).

Given that the STP site is located outside of both the 1% AEP and the PMF extents, it is located above the FPL and is thus not affected by flooding; and therefore the clauses in the Bega Valley LEP 2013 do not apply (applicability of the Bega Valley LEP 2013 is further explained in **Section 3.2**).

A temporary construction laydown area (primary for pipeline stringing) is proposed within a portion of the PMGC grounds. A small part of the temporary laydown area is subject to the 1% AEP flood extent and PMF extent (refer **Figure 4-6** and **Figure 4-7** respectively).. Note that the extent of flood mapping produced by Cardno (2017) ends at the southern boundary of the flood extents shown in **Figure 4-2** to **Figure 4-9**; therefore areas south of this extent, including a larger portion of the temporary laydown area on the PMGC grounds, may be subject to flooding.

In the PMF event, the STP is not accessible from the north via Arthur Kaine Drive but access remains flood-free to the south, towards Pambula. Flood hazard for the PMF is shown on **Figure 4-9** and shows areas of low and high hazard outside the Project area boundary.

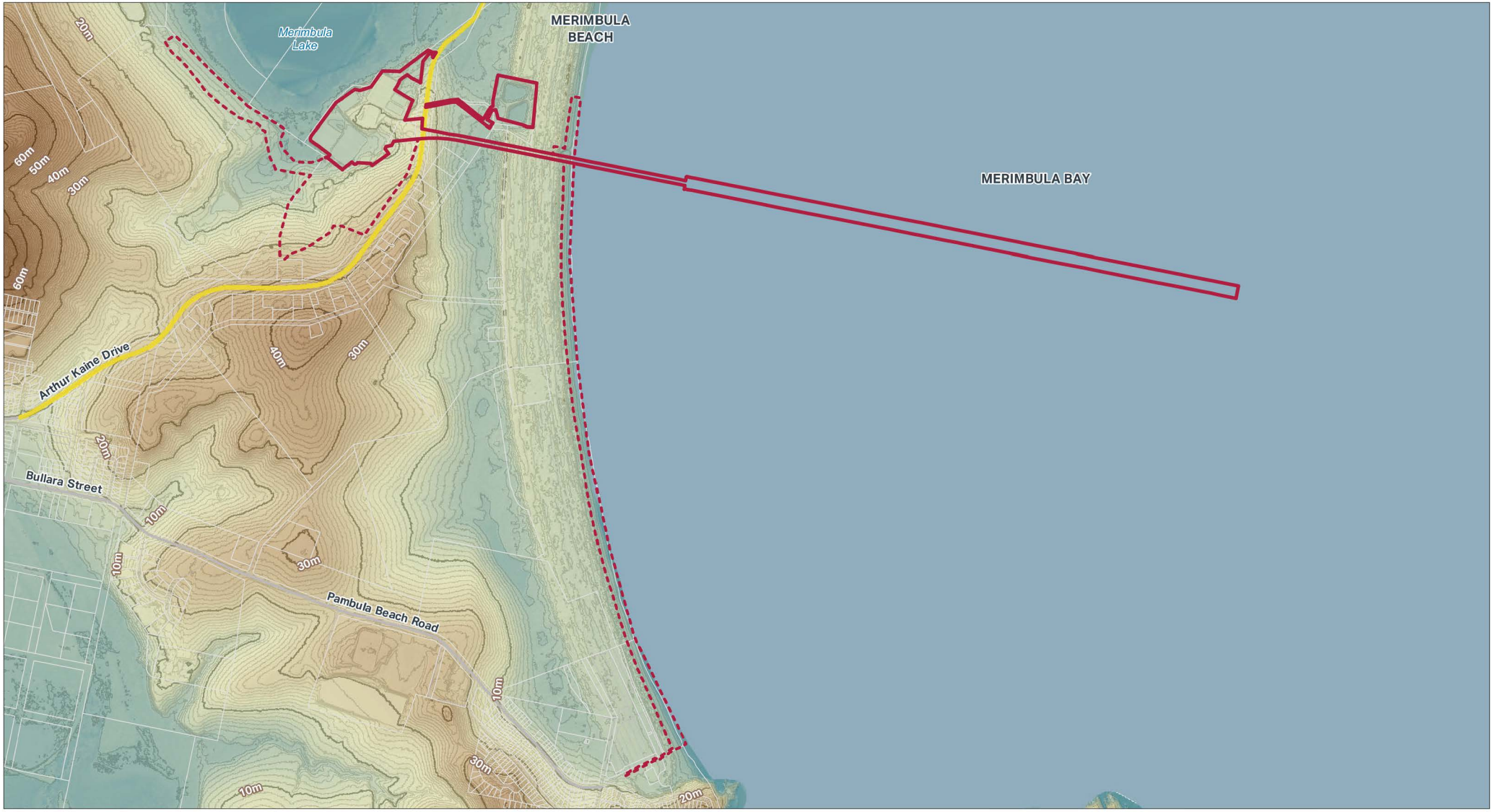

FIGURE 4-1: TOPOGRAPHY

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- 10m contour
- 1m contour

Lidar 1m AHD (m)

High : 160.989

Low : -1.817

N

0 250 500 m

AECOM

Source: Department of Customer Services, 2020

FIGURE 4-2: 20% AEP FLOOD EXTENT

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- 20% AEP flood extent

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-3: 10% AEP FLOOD EXTENT

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- 10% AEP flood extent

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-4: 5% AEP FLOOD EXTENT

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- 5% AEP flood extent

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-4: 5% AEP FLOOD EXTENT

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- 5% AEP flood extent

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-6: 1% AEP FLOOD EXTENT

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- 1% AEP flood extent

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-7: PROBABLE MAXIMUM FLOOD EXTENT

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- Probable Maximum Flood (PMF) extent

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-8: FLOOD PLANNING AREA

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- Flood Planning Area (FPA)

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

FIGURE 4-9: FLOOD HAZARD - PROBABLE MAXIMUM FLOOD

Legend

- Project area
- Temporary project area for construction
- Cadastre
- Arthur Kaine Drive
- High Hazard
- Low Hazard

N

0 200 400 m

AECOM

Source: Merimbula Lake and Back Lake Flood Study (Cardno, 2017); Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

4.2 Climate change

The *Merimbula Lake and Back Lake Flood Study* considered climate change scenarios for the 1% AEP flood event by considering increased rainfall intensity combined with a tidal boundary increase of 0.4 m and 0.9 m sea level rise, representing year 2050 and 2100 time horizons respectively (Cardno, 2017).

The study showed that that changes due to climate change are unlikely to impact the Project area due to its existing elevation and vegetative buffers providing protection from tidal inundation. Erosional and depositional changes are more likely to be located at the Merimbula Lake entrance as a result of regular tidal flow and along the western side of Merimbula Lake where the topography is lower and has greater exposure to higher tides.

The Cardno (2017) study recommended that Council allow for the uncertainty of climate change impacts within their adopted freeboard placed upon the current FPL, and the flood extent shown in **Figure 4-8** includes this freeboard allowance. The FRPMS (Rhelm, 2020) also recommended that Council adopted the FPLs proposed by Cardno (2017).

5.0 Impact assessment

5.1 Construction impacts

As described in **Section 4.1**, the majority of the Project area is located outside of the 1% AEP and PMF extents, meaning that there would be no impact to flow conveyance in floodways and/or flood storage areas. The only exception is that a small portion of the temporary construction laydown area (primary for pipeline stringing) within the PMGC grounds is affected by the 1% AEP flood extent.

To address the risk of the temporary laydown area being affected by flooding, it is recommended that materials and equipment (e.g. pipeline lengths) within the laydown area are located outside of the 1% AEP flood extent (refer **Figure 4-6**) and the extent shown in **Figure 4-7**, and above approximately 2.5 m AHD. Lower elevations of the PMGC grounds should also be avoided to account for the limitation of the extent of the flood mapping available.

No flooding impacts to adjacent property and land are anticipated if adequate mitigation is put in place for the small portion of construction laydown area affected by relevant flood levels. The Project is not expected to impact upon existing community emergency management arrangements for flooding, and therefore the NSW State Emergency Services (SES) has not been consulted regarding the Project. Note however that **Chapter 18 Traffic and transport** (and **Appendix K** (Traffic and transport assessment)) provides that emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes. Access from the north along Arthur Kaine Drive may not be possible under extreme flood events (1% AEP and PMF), however this is not a proposed haulage route for the Project (refer **Chapter 18 Traffic and transport** of the EIS). Regardless, any construction access requirements to and from the STP site during potential flood conditions should be confirmed to be from the south along Arthur Kaine Drive.

5.2 Operational impacts

The operational footprint of the Project area is located outside of the mapped 1% AEP and PMF extents. Therefore there would be no impact to flow conveyance in floodways and/or flood storage areas.

Operation of the Project is therefore also not expected to affect existing community emergency management arrangements for flooding; or impact social and economic costs to the community as consequence of flooding.

As mentioned in **Section 5.1**, any access requirements to and from the STP site during potential flood conditions should be confirmed to be from the south along Arthur Kaine Drive.

6.0 Mitigation and management measures

6.1 Overview

This chapter describes the performance outcome for the Project in relation to flooding, and also describes the mitigation and management measure recommended to address identified impacts during construction and operation of the Project.

The measure described would be included in the Construction Environmental Management Plan (CEMP) for the Project.

6.2 Performance outcome

The performance outcome related to flooding for the Project is as follows:

- construction of the Project is outside the 1% AEP flood extent and therefore not affected by flood waters in this event.

6.3 Mitigation and management measures

Table 6-1 outlines the mitigation and management measure that would be implemented to minimise flooding related impacts during construction of the Project.

The Project would not be affected during operation, and as such, no mitigation and management measures have been identified.

Note that mitigation measures for water, soil and erosion control are provided in the EIS in **Chapter 13 Landform, geology and soils**.

Table 6-1 Mitigation and management measures

ID	Mitigation and management measure	Applicable location
Construction		
F1	Temporary construction compounds, stockpiles and storage areas are to be located outside the 1% AEP flood extent, and away from lower elevations of the PMGC grounds.	Construction laydown area in the PMGC grounds
F2	Any construction access requirements to and from the STP site during potential flood conditions should be confirmed to be from the south along Arthur Kaine, in order to avoid potential flood waters across the road north of the STP site.	Arthur Kaine Drive access to Project area

7.0 Conclusion

This Flood Assessment has been prepared to support the EIS and to address the relevant SEARs issued for the Project. Specifically this report has been prepared to identify potential flooding related impacts of construction and operation of the Project and to identify appropriate mitigation and management measures to address the impacts identified.

The qualitative flooding assessment undertaken for the Project has found that the proposed works are not expected to impact existing flooding conditions. Increases in flood level due to climate change are not expected to impact the STP site. Construction activities should be planned so that temporary site compounds, stockpiles and storage areas are located outside of the 1% AEP flood extent, and lower elevations of the PMGC grounds that may also be subject to flooding. No mitigation measures have been identified as being required for operation of the Project.

8.0 References

Cardno, 2017. *Merimbula Lake and Back Lake Flood Study*, prepared for Bega Valley Shire Council.

Commonwealth of Australia, 2019. *Australian Rainfall and Runoff – A Guide to Flood Estimation*.

Department of Infrastructure, Planning and Natural Resources (DIPNR), 2005. *NSW Floodplain Development Manual.*

Engineers Australia, 1987. *Australian Rainfall and Runoff*.

Rhelm, 2020, *Merimbula Lake and Back Lake Floodplain Risk Management Study*, prepared for Bega Valley Shire Council.

9.0 Glossary and abbreviations

Term	Description
AEP	Annual Exceedance Probability - The probability or likelihood of an event occurring or being exceeded within any given year.
AHD	Australian Height Datum
ARI	Average Recurrence Interval - The likelihood of occurrence, expressed in terms of the long-term average number of years, between flood events as large as, or larger, than the design flood event. For example, floods with a discharge as large as or larger than the 100-year ARI flood will occur on average once every 100 years.
ARR	Australian Rainfall and Runoff
BVSC	Bega Valley Shire Council
DCP	Development Control Plan
PMF	Probable Maximum Flood - The largest flood likely to ever occur. The PMF defines the extent of flood prone land or flood liable land, that is, the floodplain.
The Project	The Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall project, which comprises the upgrade of existing facilities, the installation of a 3.5 km outfall pipeline and the decommissioning of the existing beach-face outfall pipeline and other works as described in **Section 2.0**
SEARs	Secretary's Environmental Assessment Requirements
STP	Sewage Treatment Plant