Appendix M – Coastal Processes Assessment

Hunter Water Corporation

Belmont Drought Response Desalination Plant
Coastal Processes Assessment

November 2019

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Terms and definitions

Term/acronym	Definition
ADCP	Acoustic Doppler Current Profiler
Aeolian	Wind-driven
Almost Certain Line	There is a high possibility the event will occur as there is a history of frequent occurrence.
ARI	Average Recurrence Interval – the average number of years between the occurrence of an event (e.g. coastal flooding, storm waves) as big as or larger than the selected occurrence
CM Act	*Coastal Management Act 2016*
CMP	Coastal Management Program
CZMP	Coastal Zone Management Plan
EIS	Environmental Impact Statement
H_s	Significant wave height – the mean wave height of the highest one-third of waves
km	Kilometre
NSW	New South Wales
PSD	Particle Size Distribution
Rare Line	It is highly unlikely that the event will occur, except in extreme /exceptional circumstances, which have not been recorded historically.
SEARS	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
Storm surge	Increase in water level from a reduction in barometric pressure
Unlikely Line	There is a low possibility that the event will occur, however, there is a history of infrequent or isolated occurrence.
Wave runup	Uprush of water from a breaking wave
Wave setup	Raised water levels as a result of broken waves, approximately 15% of offshore wave height
Wind setup	Increase in water level on the leeward side of a body of water caused by wind stresses on the surface of the water.
WWTW	Wastewater treatment works

1. Introduction

1.1 Overview

The Lower Hunter has sufficient water to meet its needs in average climate conditions in the medium term. However, the region's reliance on rain-fed dams and groundwater supplies makes it vulnerable to severe drought.

The Lower Hunter Water Plan (LHWP) was developed in 2014 with the aim to ensure that the Lower Hunter is able to withstand a severe drought as well as meeting community needs in the medium term. Within the plan, desalination is proposed in conjunction with other staged drought response measures in the event of extreme drought. A drought response desalination plant would help make the water supply system more resilient to climate variability, with the primary benefit being that it would provide a drought contingency measure that is not dependent on rainfall.

Following a number of options assessments, a drought response desalination plant (also referred to as the temporary desalination plant), to be located within the existing wastewater treatment works site at Belmont, was selected as the preferred option. Hunter Water submitted a State Significant Infrastructure (SSI) application for the project to the Department of Planning and Environment in November 2017 and received the Secretary's Environmental Assessment Requirements (SEARs) in December 2017 (SSI 8896). These SEARs outline the requirements for the preparation of an EIS to assess the future construction and operation of the project, with particular requirements for the assessment of coastal processes.

1.2 Purpose and scope of this report

This report is part of a broader EIS assessing the impact of the temporary desalination plant proposed at Belmont. A requirement of the overall project is to complete a coastal processes and hazards assessment. The specific requirements of the SEARs for the coastal processes assessment is provided in Table 1-1, along with where each requirement has been addressed in this report. The methodology employed to address the requirements of the SEARs is provided in Section 3.

Table 1-1 SEARs requirements

SEARs requirement	Where addressed
Detailed assessment and consideration of coastal hazards including the preparation of a site specific coastal hazards assessment (which includes assessment of recession, wave overtopping and coastal inundation) prepared in accordance with the *draft NSW Coastal Management Manual*	Sections 5.3 and 6.
Detailed design of all coastal protection works required to protect the proposed development from coastal hazards. These design works must be undertaken in a manner consistent with the principles of the *Coastal Management Act 2016*, *NSW Coastal Management Manual* and the *Lake Macquarie Coastal Zone Management Plan*.	Coastal protection works are not required provided that mitigation measures in Section 7 are adhered to.

This report draws upon the information and outcomes, and should be read in conjunction with, a number of other specialist studies have been undertaken as part of the broader EIS, including:

- Geotechnical investigation report
- Brine discharge modelling report
- Biodiversity development assessment report (and the marine environment chapter within the EIS)

All specialist reports are provided as separate attachments to the EIS.

1.3 Limitations and assumptions

This report is based on the concept design for the project and the level of information available at the time of preparation. The concept design purpose is to provide a basis for environmental assessment and future design and construct stages.

This report: has been prepared by GHD for Hunter Water Corporation and may only be used and relied on by Hunter Water Corporation for the purpose agreed between GHD and the Hunter Water Corporation as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Hunter Water Corporation arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

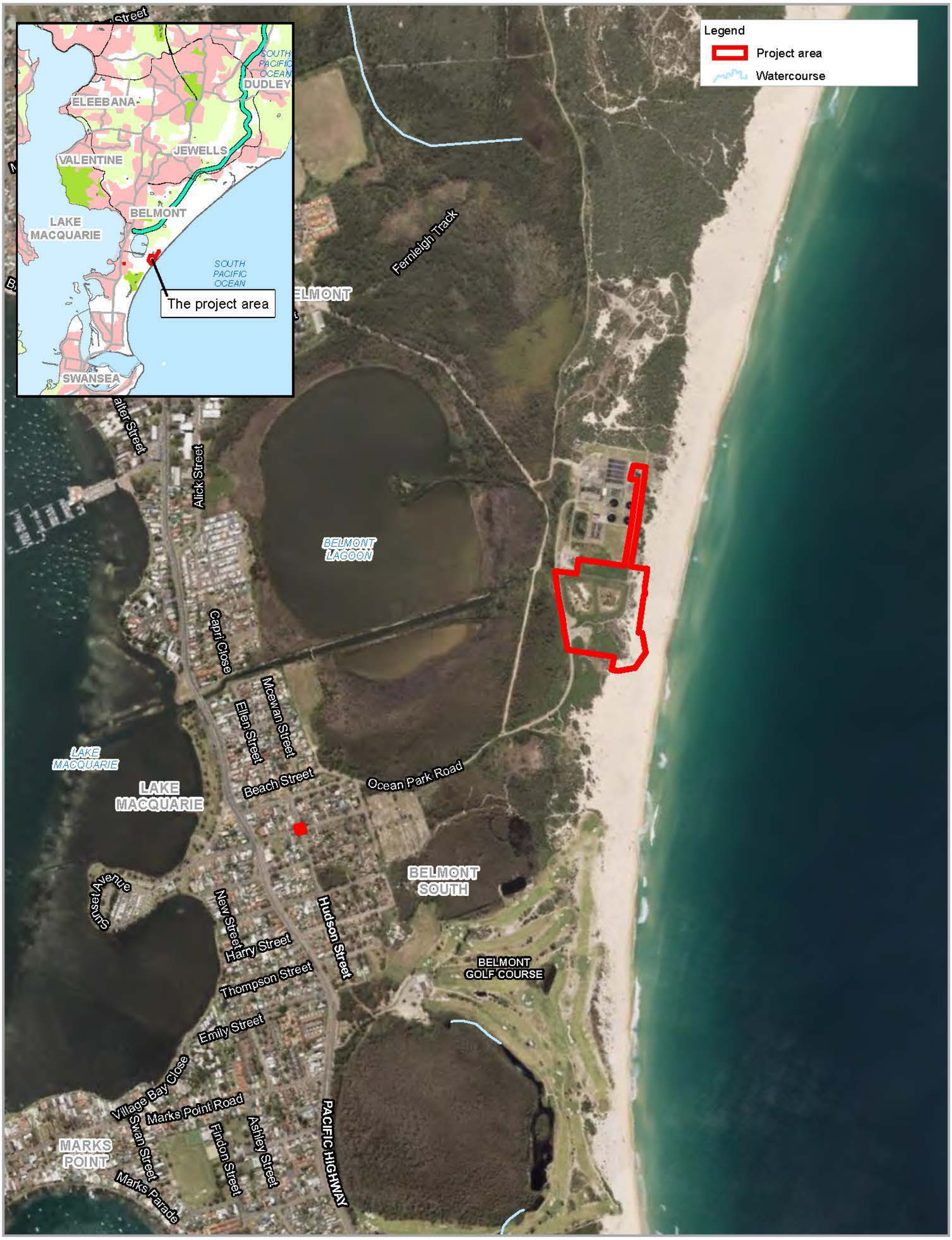
GHD has prepared this report on the basis of information provided by Hunter Water Corporation and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. The project

A brief overview of the proposed drought response desalination plant and associated infrastructure is presented in this Chapter to provide context for the Coastal Processes Assessment. A more detailed description of the project is provided in the EIS report.

2.1 Project location

The Belmont drought response desalination plant is proposed to be located on the southern portion of the current Wastewater Treatment Works (WWTW) site, on the boundary of Belmont and Belmont South, off Ocean Park Road. The proposed plant is just east of the Belmont Lagoon and west of the coastal dunes along Nine Mile Beach (Figure 2-1, Figure 2-2).



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GHD

Hunter Water Corporation
Belmont Temporary Desalination Plant
Coastal Processes Assessment Report

Project No. 22-19573
Revision No. 0
Date 10/10/2019

Project location

FIGURE 2-1

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Project No. 22-19573
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The Project

FIGURE 2-2

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2.2 Description of the project

2.2.1 Objectives

The key objectives of the Project are to:

- Provide a rainfall independent water source in the event of an extreme drought
- Slow the depletion of existing water storages in the event of an extreme drought

The Project would address these objectives while considering the environmental, social and economic impacts, with the options assessment process considering these factors.

2.2.2 Key features

The Project is for the construction and operation of a drought response desalination plant, designed to produce up to 15 ML/day of potable water, with key components including:

- **Seawater intakes** – The central intake structures would be a concrete structure (referred to as a caisson) of approximately nine to 11 metres diameter, installed to a depth up to 20 m below existing surface levels. The intake structures will be finished above the existing surface (0.5 m to 1 m) to prevent being covered by dune sands over time. The raw feed water (seawater) input is proposed to be extracted from a sub-surface saline aquifer. This would be extracted by intake pipes located approximately eight to 15 m below ground level radiating out from the central structure. Pipelines and pumps are required to transfer the seawater to the desalination plant.
- **Water treatment process plant** – The temporary desalination plant would comprise a range of equipment potentially in containerised form. Services to and from the process equipment (e.g. power, communications, and raw feed water (seawater)) would comprise a mix of buried and overhead methods. The general components of the water treatment process would comprise:
  - *Pre-treatment:* a pre-treatment system is required to remove micro-organisms, sediment, and organic material from the seawater.
  - *Desalination:* a reverse osmosis (RO) desalination system made up of pressurising pumps and membranes. These would be comprised of modular components. In addition, a number of tanks and internal pipework would be required.
  - *Post treatment:* desalinated water would be treated to drinking water standards and stored prior to pumping to the potable water supply network.
- **Brine disposal system** – The desalination process would produce around 28 ML/day of wastewater, comprising predominantly brine, as well as a small amount of pre-treatment and RO membrane cleaning waste. The waste brine from the desalination process would be transferred via a pipeline to the existing nearby Belmont WWTW for disposal via the existing ocean outfall pipe.
- **Power supply** – Power requirements of the plant would be met by a minor upgrade to the existing power supply network in the vicinity of Hudson and Marriot Streets. A power line extension from the existing line along Ocean Park Road into a new substation within the proposed drought response desalination plant would also be required.
- **Ancillary facilities** – including a tank farm, chemical storage and dosing, hardstand areas, stormwater and cross drainage, access roads, and fencing, signage and lighting.

Key features of the Project are shown on Figure 2-2, while a description of each of the key components of the Project is provided in Section 4 of the EIS.

The potable water pipelines connecting the Project to the potable water network do not form part of the Project and would be constructed separately. The construction and operation of the potable water pipeline would be part of a separate design and approvals process.

3. Methodology

3.1 Baseline conditions and legislative framework

A review of available literature and legislation related to the project was conducted to assess the existing conditions of the project site and surrounds, specifically in relation to the general setting and the coastal processes and hazards. Some of the key resources reviewed to inform the baseline conditions include:

- Survey data from the project site:
  - Acoustic Doppler Current Profiler (ADCP) data from 14 February to 24 March 2018 provided by Hunter Water, in particular current velocities (magnitude and direction), measured offshore of Belmont Beach.
  - Site geotechnical and geophysical survey data by GHD in August 2018.
  - Nearshore water depths from satellite derived bathymetry provider EOMAP, and offshore water depths from the MIKE global bathymetric database.
  - Site topographic data undertaken by RPS in April and July, 2019.
- Literature review:
  - NSW legislation identified in Section 4.
  - Lake Macquarie Coastal Zone Management Plan 2015-2023 (CZMP) (Umwelt, 2015) and associated studies, including a Coastal Zone Hazard and Risk Assessment and Coastal Hazard Study report (BMT WBM, 2015a, 2015b), both commissioned by LMCC as part of the Lake Macquarie CZMP.
  - NSW Sea Level Rise Policy Statement.

3.2 Impact assessment

An assessment of potential impacts of the project was undertaken via a qualitative assessment against previously endorsed plans. Previous plans include a Coastal Zone Hazard and Risk Assessment and Coastal Hazard Study report, both commissioned by Lake Macquarie City Council as part of the Lake Macquarie CZMP (BMT WBM, 2015a, b). These assessments included numerical modelling to assess the risk of present day and future coastal hazards including coastal erosion and coastal inundation. Given that modelling has been conducted for the project site relatively recently, there was no requirement to conduct additional modelling.

The impact assessment therefore builds upon available information and incorporates:

- Potential impacts during the construction of the project including undertaking construction activities on sandy soils and sand dunes
- Potential impacts during the operation of the project, including potential impacts to infrastructure from storm surges and erosion events
- An assessment of the potential impacts of coastal hazards on the project factoring in the potential amplification of impacts as a result of sea level rise associated with climate change

Coastal hazards are defined within the Lake Macquarie CZMP as rare, unlikely and almost certain. The definitions for these hazards for coastal erosion and coastal inundation are provided in Table 3-1 and Table 3-2, respectively.

For critical utilities, including water infrastructure, the recommended hazard line to use is the 2100 line, with the following hazard areas defined:

- High hazard area – Seaward of Unlikely line
- Medium hazard area – Unlikely to Rare line
- Low hazard area – Landward of Rare line

Table 3-1 Likelihood definitions for erosion recession hazards

Likelihood	Immediate timeframe (2010)	Future (2050 and 2100)
Almost certain	Average beach erosion, as measured over the last four decades	Immediate average beach erosion for both periods, plus structural impacts (such as Swansea breakwaters) for 2100.
Likely	N/A	Immediate average beach erosion, plus recession due to sea level rise (0.4 m above 1990 by 2050 and 0.9 m above 1990 by 2100, as set by the NSW Government Policy Statement), plus structural impacts.
Unlikely	Maximum beach erosion (as measured over the last four decades, and approximately equivalent to a 1 in 100 year event)	Immediate maximum beach erosion, plus recession due to sea level rise (0.4 m above 1990 by 2050 and 0.9 m above 1990 by 2100, as set by the NSW Government Policy Statement) and allowing for structural controls such as breakwaters and headlands.
Rare	Extreme beach erosion calculated as maximum beach erosion plus average beach erosion, with sea walls removed	Immediate maximum beach erosion, plus an allowance for higher than projected recession due to sea level rise, (using 0.7 m above 1990 level by 2050 and 1.4 m above 1990 levels by 2100) or Immediate extreme beach erosion plus recession associated with sea level rise (0.4 m above 1990 levels by 2050 and 0.9 m above 1990 levels by 2100), or Immediate maximum beach erosion, plus changes to the angle of wave approach and/or structural impacts.

Table 3-2 Likelihood definitions for coastal inundation hazard

Likelihood	Storm surge and wave set up	Sea level rise		
		2010	2050	2100
Almost certain	1 in 20 year	0 m	0.4 m	0.9 m
Unlikely	1 in 100 year			
Rare	1 in 100 year with an extreme climatic event (such as a tropical cyclone or extreme east coast low)			

The impact assessment has been undertaken for the both intake structures and plant pipelines, and the desalination plant itself.

The impact assessment relies upon inputs from the GHD concept design (July 2019) including:

- Concept design of buildings and associated services, intakes and outfalls configuration
- Proposed construction methodology including plant, equipment, duration and project footprint
- Geotechnical information including particle size distribution of dune sands

3.3 Development of mitigation measures

Mitigation measures were developed based on the outcome of the baseline conditions and impact assessment process. Mitigation measures were designed to address any potential impacts to coastal processes or to manage potential impacts of coastal hazards on the project.

4. Legislative setting

4.1 Introduction

The NSW Government has established a coastal management framework to manage the open coast and estuaries. The key components of the coastal management framework comprise:

- *Coastal Management Act 2016*
- *State Environmental Planning Policy (Coastal Management) 2018*
- NSW Coastal Management Manual

Under the new framework, local Councils will prepare Coastal Management Programs (CMPs) that set the long-term strategy for the coordinated management of the coast, consistent with the objectives of the *Coastal Management Act 2016* (CM Act). These CMPs will replace the current CZMPs, which will remain in force until 31 December 2021.

4.2 Coastal Management Act 2016 and State Environmental Planning Policy (Coastal Management) 2018

The objective of the CM Act is to manage the coastal environment of NSW in a manner consistent with the principals of ecologically sustainable development for the social, cultural and economic well-being of the people of the State. It aims to protect and enhance natural coastal process and values, support the social and cultural values of the coastal zone and mitigate current and future risks from coastal hazards. In the CM Act, the coastal zone means the area of land comprised of the following coastal management areas:

a. **Coastal wetlands and littoral rainforests area** – defined as areas with particular hydrologic and ecological characteristics.

b. **Coastal vulnerability area** –the area subject to any of the seven coastal hazards as defined in section 4 of the Act, as follows:

   – Beach erosion
   – Shoreline recession
   – Coastal lake or watercourse entrance instability
   – Coastal inundation
   – Tidal inundation
   – Coastal cliff or slope instability
   – Erosion and inundation of foreshores caused by tidal water and waves, including the interaction of those waters with catchment floodwaters

c. **Coastal environment area** – coastal waters, estuaries, coastal lakes and lagoons, and surrounding land including beaches, dunes, headlands and rock platforms.

d. **Coastal use area** – land adjacent to the coast where development is or may be carried out.

Each coastal management area has specific management objectives specified under the Act which reflect their different values to coastal communities and the priorities for those areas. A single parcel of land may be identified by a State Environmental Planning Policy (SEPP) as being within multiple coastal management areas. In the event management objectives of multiple areas are inconsistent, the management area hierarchy from highest to lowest is in accordance with the order listed above.

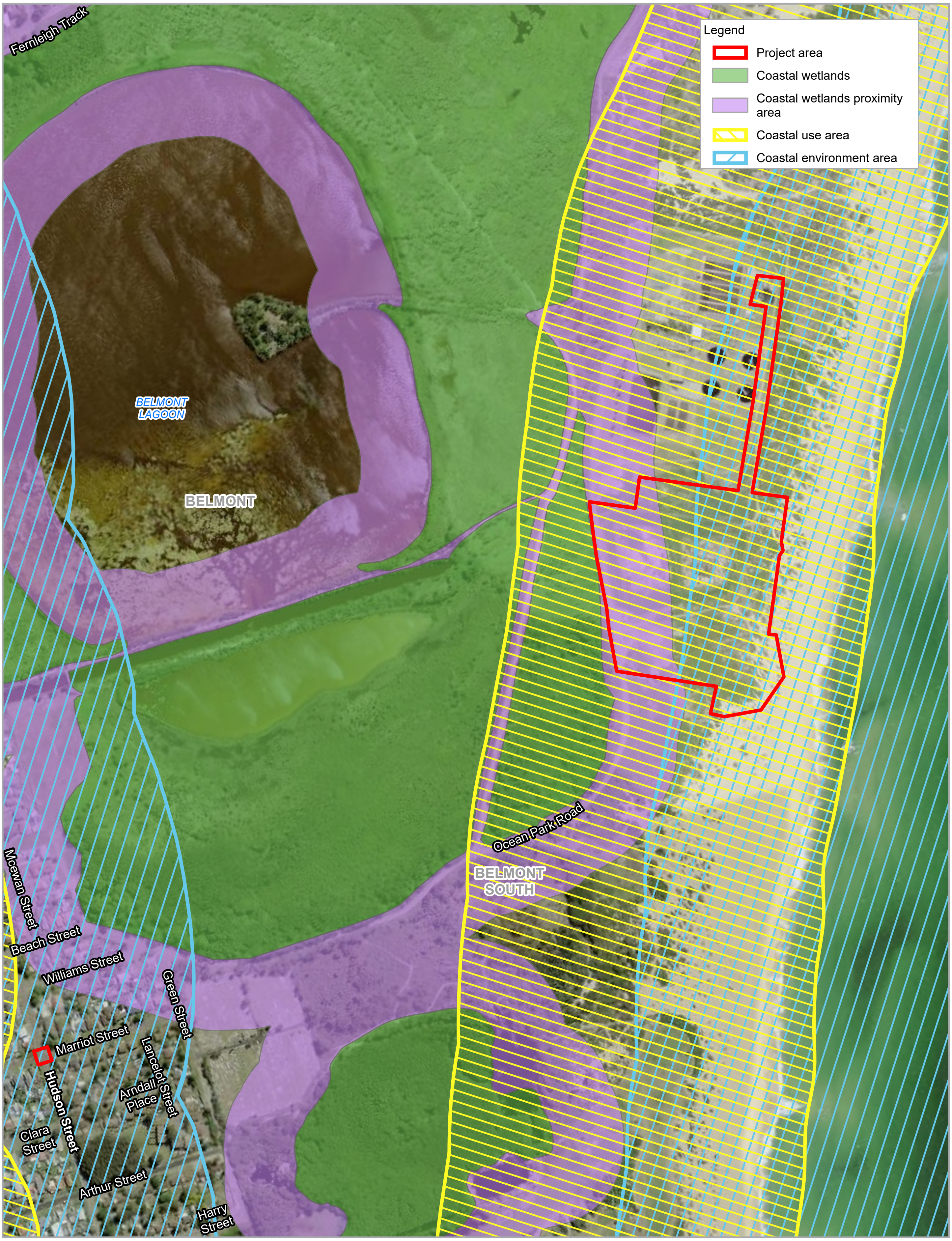
The *State Environmental Planning Policy (Coastal Management) 2018* provides detail on what management areas apply to a specific location. The temporary desalination plant at Belmont is to be located within the mapped coastal environment and coastal use areas and within the mapped proximity area of coastal wetlands (Figure 4-1). Mapping for coastal vulnerability areas is not yet available, however the proposed temporary desalination plant is considered to be subject to the seven coastal hazards listed above and therefore is considered to be a coastal vulnerability area for the purpose of this assessment. Therefore, based on the hierarchy specified in the CM Act, the priority management objectives are those for the coastal vulnerability area.

Management objectives for the coastal vulnerability area are described in section 7(2) of the CM Act. The items that are considered relevant to the proposed desalination plant include:

- (b) Mitigate current and future risk from coastal hazards by taking into account the effects of coastal processes and climate change.
- (c) Maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place.
- (d) Maintain public access, amenity and use of beaches and foreshores.
- (e) Encourage land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operational decisions.
- (h) Prioritise actions that support the continued functionality of essential infrastructure during and immediately after a coastal hazard emergency.

How the project addresses these management objectives is provided in Section 8.

Essential infrastructure as mentioned under section 7(2)(h) is defined under section 4 of the Act and includes, amongst others, *sewerage systems, water supply systems and stormwater management systems*. Therefore, the works required for the proposed temporary desalination plant, as well as the adjacent WWTW, can be classified as essential infrastructure.



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Coastal Management Areas

FIGURE 4-1

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4.3 NSW Coastal Management Manual

The NSW Coastal Management Manual (the manual) provides guidance to assist local councils when preparing and implementing CMPs under the new coastal management framework. The manual also provides technical information and guidance to assist councils in addressing the requirements of the CM Act and a risk management process for councils to follow when preparing their CMPs.

Many councils have previously prepared and implemented CZMPs to address management issues for coastal lakes, estuaries or beaches, dunes and headlands. If a CZMP was certified under the *Coastal Protection Act 1979*, it will continue to have effect until 31 December 2021 unless replaced by a CMP prepared and adopted under the CM Act prior to that date.

4.4 Lake Macquarie Coastal Zone Management Plan (CZMP)

A CZMP was prepared and certified for the Lake Macquarie Local Government Area (LGA) in 2015, prior to endorsement of the CM Act. While all local councils will be required to prepare a CMP under the CM Act, the Act does allow for transitional provisions such that councils have until 2021 to be fully compliant with the new Act and Manual. As such, the Lake Macquarie CZMP will remain in effect until 31 December 2021.

The existing CZMP is considered to be an appropriate tool for the determination of coastal processes and associated risks for the coastline of relevance to this project. A qualitative assessment of the proposed project against the previously endorsed CZMP is considered appropriate to meet the requirements of this assessment.

Part A of the Lake Macquarie CZMP (2015a) outlines the coastal processes and hazards affecting the Lake Macquarie coastline, including Belmont Beach, and defines the level of risk (likelihood and consequence) from coastal hazards. The report details the likelihood of coastal hazards, particularly beach erosion, recession and coastal inundation for the immediate (2010), and future (2050 and 2100) timeframes. The report also defines the consequence to land and assets in the coastal zone from these hazards.

A number of management options are presented in Part D of the Lake Macquarie CZMP (2015b), which address the coastal process hazards and risks identified in Part A of the CZMP. Options to manage these hazards and risk are summarised below:

- Belmont WWTW is the main piece of critical infrastructure on the Lake Macquarie coast. The plant is on land owned and managed by Hunter Water. However, it is in close proximity to land managed by the Trade and Investment – Crown Lands Division (Nine Mile Beach), Council and Belmont Golf Club. Any measures to protect the WWTW need to be developed in consultation with these land owners and managers.
- Coastal zone impacts associated with storm conditions, elevated water levels and erosion are not expected to be of concern until after 2050 or even 2100. In the interim, monitoring should be used to record progress of recession.
- Opportunities to relocate infrastructure outside of hazard zones at time of asset maintenance should be considered.
- Conduct beach management works such as beach scraping to reshape dunes and increase dune volume/recovery after storms if necessary.
- Stabilise the frontal dune system, remove invasive species and replace with locally indigenous dune vegetation and control off road vehicle access.

- The agency consultation undertaken as part of the CZMP determined a preference to not recommend a seawall in front of the WWTW as a medium to long term protective solution (beyond 2050).
- The dune area between the Belmont Golf Course and WWTW is the barrier between open coast marine processes and the lake (weakness via Cold Tea Creek). Investigate opportunities to place sand here to strengthen dune as a priority.

5. Existing and future conditions

5.1 Setting

The temporary desalination plant site would be located in the coastal dunes behind Nine Mile Beach, located within 170 metres of the shoreline (Figure 2-1). The immediate surrounds of the site consists of coastal bushland and wetland environments to the west, including Belmont Lagoon to the north-west, and Belmont Wetlands State Park to the north. Land to the east includes the coastal environment of Nine Mile Beach. Immediately north is the Belmont WWTW while to the south, the coastal dune drops significantly in elevation. Excluding the Belmont Golf Course (600 m south) and the WWTW, the central portion of Nine Mile Beach is relatively undeveloped, forming part of Belmont State Park.

Within the CM Act, the NSW coastline is separated into coastal sediment compartments, defined by sediment flows and landforms. The project site is located within Newcastle Coast sediment compartment, which extends from Nobbys Head to Norah Head and is made up of sandstone, siltstone and conglomerate headlands, embayed beaches, pocket beaches, transgressive dunes, backbarrier swamps and a large coastal lake (Lake Macquarie).

5.2 Coastal processes

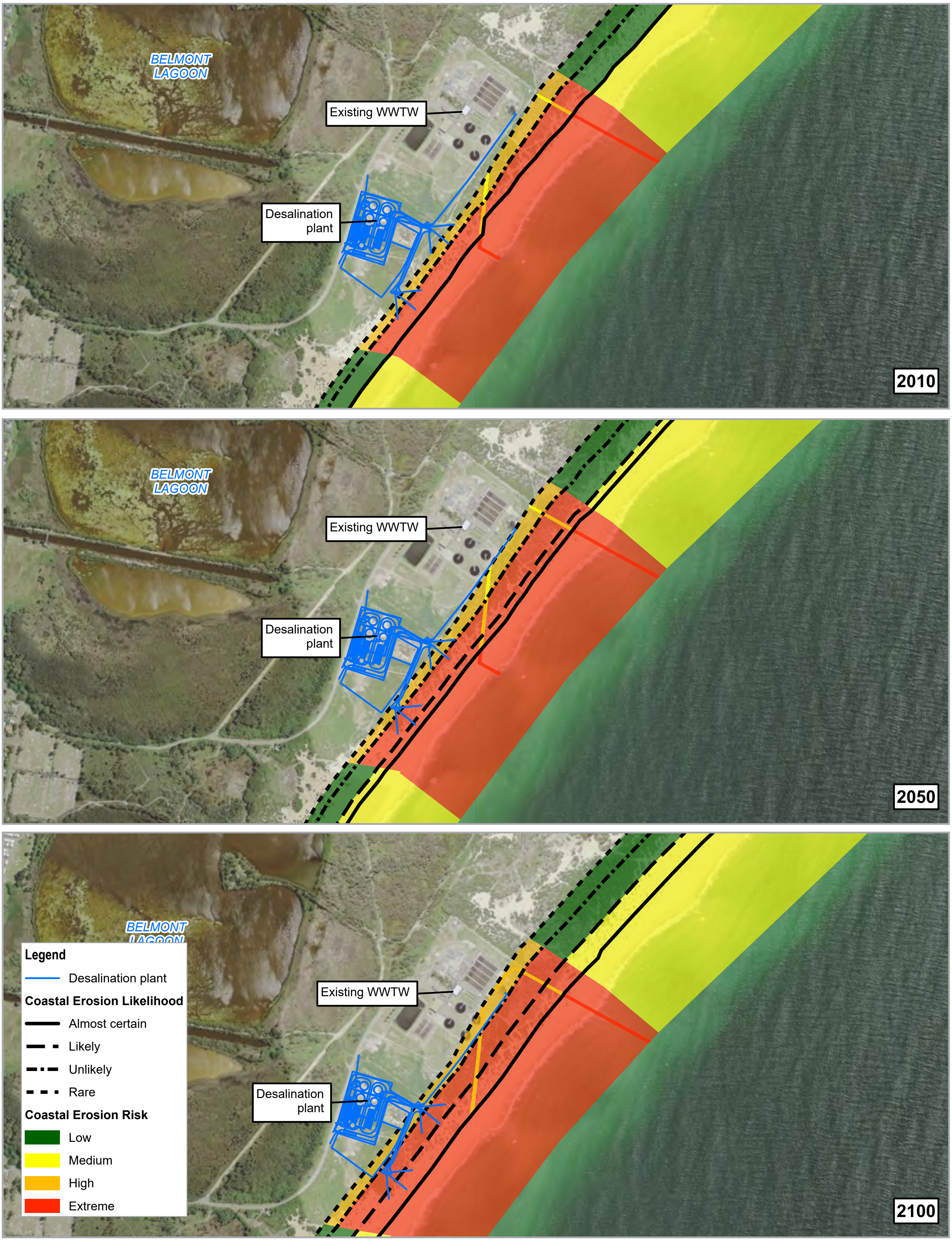
Coastal processes that influence the project site include:

- **Bathymetry and coastal morphology** – Nine Mile Beach is characterised by a low sandy beach ridge in the south near Swansea Channel, extending to wide dunes of heights up to 15 m to the north at Redhead. At the temporary desalination plant site, the beach is oriented to the south-east. The narrow and steep nature of the nearshore zone and continental shelf offshore of Nine Mile Beach means there is less energy dissipation of deep water waves as they travel into the nearshore zone and onto the shoreline, accentuating the potential for wave-induced coastal erosion relative to surrounding coastal compartments.
- **Geotechnical** – a number of boreholes and test pits revealed the sites subsurface typically comprises a thin layer of fill, followed by two sand layers increasing in density to 31 m depth and clay below to 41 m depth. The results of the Particle Size Distribution (PSD) testing indicate that the soils at the site are predominantly medium grained sand with small proportions of fine and coarse grained sand.
- **Wave climate** – The NSW coast is subject to a moderate wave climate predominantly from the south to southeast with an average offshore significant wave height (H_s) in the order of 1.6 m (Shand et al., 2011). Large waves can be generated year round by tropical cyclones, mid latitude cyclones and east coast lows. Given the orientation of the beach at the project site, waves from the south-east will have the most potential for cross-shore erosion.
- **Water levels** – fluctuate as they are influenced by tidal variation (semi diurnal), storm surge (from significant reduction in barometric pressure), wind setup (from onshore winds), wave setup (raised water levels as a result of broken waves, approximately 15% of offshore wave height), wave runup (uprush of water from a breaking wave).

- **Currents** – An Acoustic Doppler Current Profiler (ADCP) measured current velocities offshore of Belmont Beach from 14 February to 24 March 2018. It was noted that velocity components were greater along the north-south axis (longshore) than the east-west axis (cross shore). Also, the north-south velocity components at the surface and mid-depth were greater than at the seabed, whereas the east-west velocity components were similar amongst for all three depths.
- **Longshore sediment transport** – there is a prevailing northerly drift of sediment due to the dominant south-south-east wave direction on the NSW east coast. The annual gross transport rates for Nine Mile Beach have been estimated up to 600,000 m^3 although net littoral drift outside of the embayment is thought to be significantly lower.
- **Cross-shore sediment transport** – typical patterns are erosion during significant wave events (increased wave heights and elevated water levels cause sand to be eroded from the upper beach/dune system and transported in an offshore direction) and accretion when wave conditions are mild (in calmer weather, sand slowly moves onshore from the nearshore bars to the beach). Typically, the cross-shore exchange of sand from the upper beach/dune area to the nearshore profile represent a net balance in the overall active beach system.
- **Aeolian sediment transport** – transport of sediment from the dry upper beach face and berm into unvegetated incipient dunes and foredunes by wind.
- **Climate change and sea level rise** – it is predicted that there would be elevated water levels associated with climate change (increase in mean sea level above 1990 levels of 0.4 m by 2050 and 0.9 m by 2100 (DECCW, 2009)) and potential for variation to storm intensity and frequency. It should be noted that the NSW Government policy on sea level rise is in the process of transition. Following a review by the NSW Chief Scientist and Engineer (April 2012) and stage one coastal management reforms, the NSW Government announced that councils would have the flexibility to determine their own sea level rise projections to suit their local conditions. The Government would no longer prescribe statewide sea level rise projections for use by councils and the 2009 NSW Sea Level Rise Policy Statement would no longer be NSW Government policy. In the 2015 Lake Macquarie CZMP, the allowances for sea level rise at 2050 and 2100 were 0.4 and 0.9 m respectively as advised by the 2009 NSW Sea Level Rise Policy Statement. The values adopted in the CZMP are considered to be appropriate until an updated CMP is prepared which complies with the CM Act and considers the latest available guidance on future climate projections.

5.3 Coastal hazards

Maps defining the present day (2010) and future (2050 and 2100) hazard lines and risk areas associated with coastal inundation, erosion and recession in the vicinity of the proposed temporary desalination plant are presented in Figure 5-1 and Figure 5-2 and have been sourced from BMT WBM (2015a) (original figures in Appendix A). Coastal hazards under existing conditions in vicinity of the temporary desalination plant are described in the following sub-sections. It should be noted that while they have been separated for explanation, they are intrinsically linked to one another.



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Coastal Erosion and Recession Risk for 2010, 2050 and 2100

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FIGURE 5-1

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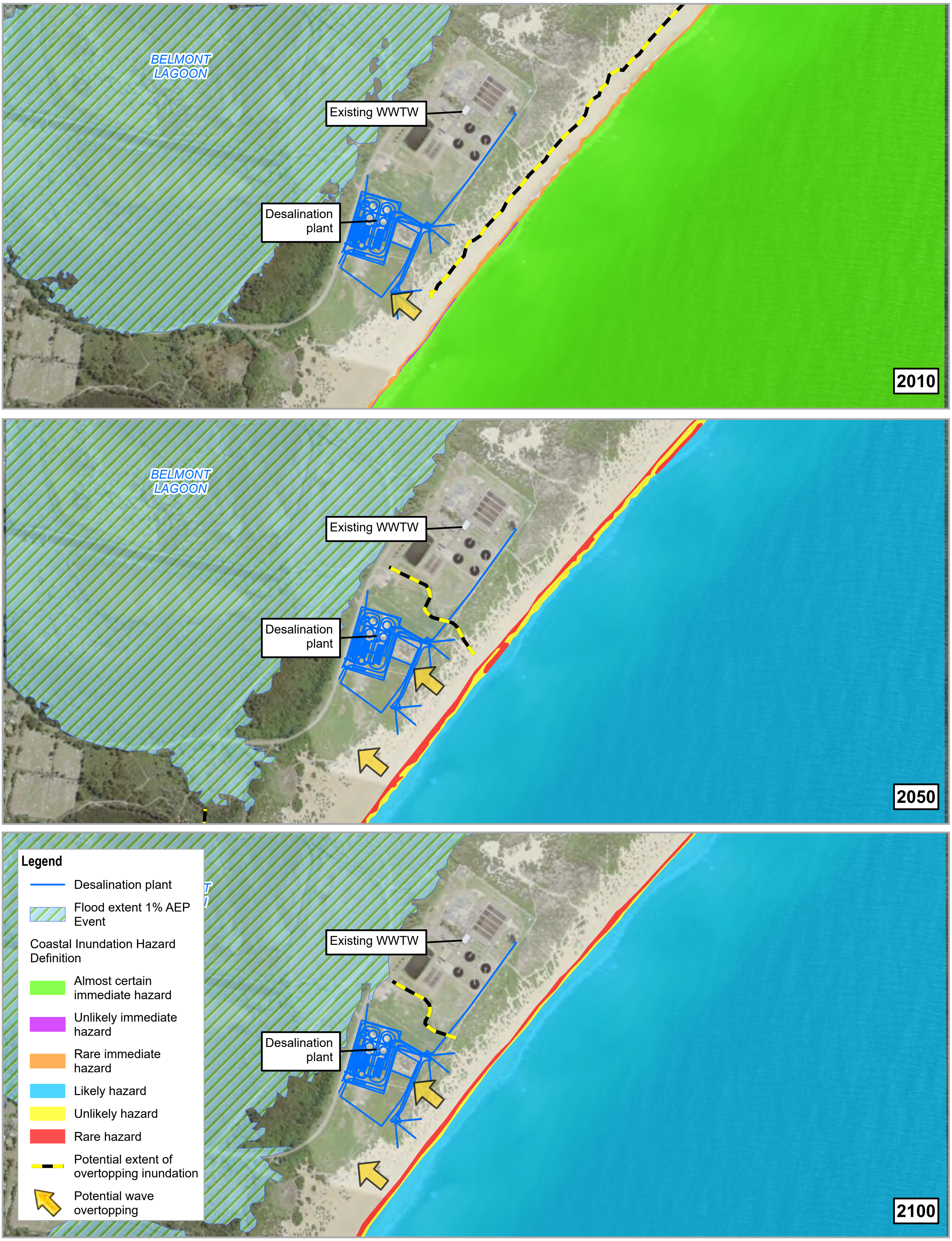

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Coastal Inundation Hazard for 2010, 2050 and 2100

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FIGURE 5-2

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Data source: LMCC: Coastal Inundation hazards, 2018; LPI: DTDB / DCDB, 2017; public_NSW_Imagery: . Created by: TMorton

5.3.1 Coastal erosion

Erosion occurs during storms (storm bite) or very high tides. Shoreline recession can occur under a number of situations, including:

- Sediment deficit or accretion when there is more sand migrating on to the beach
- Medium term changes to storm patterns
- Long term sea level rise

Slope instability is a by-product of coastal erosion whereby dune slopes become steeper until reaching an angle, known as the angle of repose, that the bearing capacity of the sand can no longer support itself (or any infrastructure it may be supporting) and subsequently slumps downwards. An extended erosion event can see multiple cycles of a dune being cut into by elevated waves and water levels until mass slumping occurs. This process will repeat itself provided erosive forces are able to reach the critical interface.

Erosion and recession risk maps for the project location (BMT WBM, 2015a) show that the beach and dunes adjacent to the WWTW and proposed site are subject to an extreme coastal erosion risk under all three timeframes assessed (2010, 2050, 2100). For the 2100 scenario, part of the existing WWTW infrastructure adjacent to the proposed site is assessed as having a high coastal erosion risk.

To the north and south of the WWTW and project site, the coastal erosion risk is mapped as medium for the beach area and low for the dunes under all three timeframes assessed. The erosion risk is lower to the north and south because risk is determined by assessing both likelihood and consequence. An asset such as the WWTW and the temporary desalination plant is subject to higher risk than an undeveloped coastal dune even if the likelihood is equal given that the consequence of the hazard occurring would be greater.

5.3.2 Coastal inundation

Inundation occurs when coastal barriers, such as dunes and seawalls, are overtopped by oceanic waters and waves, allowing for estuary, lake or lagoon foreshores and low lying back beach areas to be inundated. Coastal inundation is characterised by two processes:

- A “quasi-static” component, which includes the effects of elevated water levels due to astronomical tide, wind setup, storm surge, wave setup and sea level rise.
- A “dynamic” component, which includes the effects of wave runup and wave overtopping.

During an unlikely storm event (defined as a 100 year Average Recurrence Interval (ARI) storm surge and 100 year ARI design wave in combination), wave runup is expected to breach the low dune barrier along the northern boundary of Belmont Golf Course to a point near the southern property boundary of the Belmont WWTW and proposed site. At the Project area, the volumes of water that do overtop the dune may be dispersed by draining toward Belmont Lagoon via Cold Tea Canal or infiltrating directly through the dune sands, depending upon the rate of overtopping. The consequences of the wave runup will likely be enhanced by storm erosion. The occurrence of wave overtopping at the Project area will be enhanced by sea level rise.

6. Impact assessment

6.1 Coastal erosion

6.1.1 Potential impact of the project on coastal erosion

The potential impacts on coastal erosion from the Project are provided in Table 6-1 below. Mitigation measures provided in Section 7 would minimise these impacts. As advised in Section 3.2, the assessment has considered both the intake structures and pipelines, and the temporary desalination plant itself.

Table 6-1 Potential impacts of the Project on coastal erosion

Impact	Infrastructure	Existing conditions	Process
Exposing sands to aeolian processes, which may increase the mobility of dunal sands leading to increased rates of erosion	Intake structures, pipelines and desalination plant	The geotechnical investigation revealed near surface sediments are of loose to medium density and are thus susceptible to erosion.	Disruption to dune vegetation systems, aeolian processes and associated dune stability during: - Construction as a result of heavy vehicle movement and earthworks - Operation: due to hardstand runoff and other plant activities
Consolidating or ‘locking up’ of coastal dunes, removing the buffer for coastal erosion and increasing the risk of inland erosion	Intake structures, pipelines and desalination plant	Coastal processes are typically in equilibrium and rely on the availability of dunal sands during periods of erosion.	Establishment of built infrastructure is likely to lock up these sands such that they are no longer available to the natural system of coastal processes. - The temporary desalination plant would be constructed behind the front layer of dunes, which are proposed to be restored as part of a separate project by Hunter Water, which reduces the likelihood of this impact. This project is described in detail in Section 3.1.3 of the parent EIS document. - The horizontal intake pipes extend into the extreme hazard area for erosion and recession risk. However, with the exception of the isolated above ground portion of the caissons, the remainder of the wells will be at varying depths between eight and 15 metres below existing surface levels, which is considered to be deep enough such that the risk of sand lock-up is considered negligible.

6.1.2 Potential impact of erosion on the Project infrastructure

Present day (2010) and future (2050) scenarios

The mapping prepared under the 2015 CZMP designates that the temporary desalination plant is located landward of the designated risk areas under the 2010 and 2050 scenarios and is thus deemed not to be at risk (Figure 5-1). However, part of the subsurface infrastructure would extend into the mapped hazard areas of the coastal zone under these scenarios (Figure 5-1), including the horizontal intake wells and the pipeline connection between the temporary desalination plant and the WWTW for brine disposal.

Under the current concept design, the horizontal intake pipes extend into the extreme hazard area for erosion and recession risk. However, these wells will be at varying depths between eight and 15 metres below existing surface levels, which is considered to be deep enough such that the risk of exposure and reduced sand filtration capacity is negated. With regards to the brine pipeline connection between the temporary desalination plant and the WWTW, it is outside of the hazard area for 2010, but is within the mapped high hazard area for 2050. While it is unlikely that the temporary desalination plant would still be operational in 2050, potential beach erosion could expose and directly damage this infrastructure, which is critical to the operation of the temporary desalination plant. Further, beach erosion could expose sands to aeolian processes, with the potential to cause sand ingress into the plant leading to operational maintenance issues.

Should a storm occur during construction of the Project, coastal erosion could be exacerbated due to the exposure of the sub-surface. The aspect of the Project most at risk is the intake structures and pipelines that lie closest to the coastline. The construction timeframe and method would define the extent of the impact, such as open trenching compared with directional drilling and the duration of earthworks.

Long term future scenario (2100)

The temporary desalination plant itself is predicted to be subject to low erosion risk in 2100 given it is landward of the rare hazard line. However, the intake caissons and pipeline structures, including the brine pipeline connection to the WWTW is predicted to be subject to extreme erosion risk (Figure 5-1). Given that the temporary desalination plant would comprise a temporary project with a requested 10 year approval timeframe, the 2100 scenario is not likely to be of relevance to the project. However, should a rare 2100-equivalent event occur while the plant is in place, then beach erosion could occur resulting in shoreline recession, beach level fluctuation and storm bite leading to slope instability and disruption of dunes exposing sands to aeolian processes. These processes could have a range of impacts on the temporary desalination plant infrastructure including equipment, materials and personnel. However, as described above, the 2100 rare scenario is unlikely to affect the Project given the 10 year approval timeframe and temporary nature of operation.

6.2 Coastal inundation

6.2.1 Potential impact of the project on coastal inundation

There are no perceivable impacts on coastal inundation that could be caused by the Project. This is because the footprint and methodology for construction and operation would have zero influence on the processes that effect coastal inundation.

6.2.2 Risks of coastal inundation on the proposed project infrastructure

The mapping prepared under the 2015 CZMP specifies that all infrastructure within the temporary desalination plant location will be landward of the designated risk areas (Figure 5-2) and thus deemed not to be at risk of coastal inundation. However, indicative locations of wave overtopping during a storm event for the future 2050 and 2100 scenarios indicates that this could increase near the proposed location of the intake structures and pipelines (Figure 5-2). While this would likely be dispersed by draining, there could be a temporary impact to the above-surface portion of the intake structures as a result of the ocean water passing over the site.

7. Mitigation measures

Mitigation measures to address coastal hazards have been considered and documented in Table 7-1. It is recommended these mitigation measures be used to inform detailed design and adhered to during construction and operational phases of the temporary desalination plant.

Table 7-1 Proposed mitigation measures – coastal processes

Impact	Mitigation measure	Timing
Disruption to dune vegetation systems, aeolian processes and associated dune stability leading to a potential increased rate of erosion	Implement a coordinated erosion monitoring and mitigation program in conjunction with the strategies implemented for the WWTW, including: • Site profiling and revegetation following completion of civil works in accordance with the final design which is to comply with the Lake Macquarie CZMP (2015) and DLWC (2001). • Monitoring of recession and implementation of mitigation measures below as needed: - Beach management works such as beach scraping to reshape dunes and increase dune volume/recovery after storms if necessary. - Stabilisation of the frontal dune system by removing invasive species and replacing with locally indigenous dune vegetation. - Installation of sediment fences to minimise the movement of sands during construction. - Control offroad vehicle access and surface runoff. - Potential positive cumulative impact to align these works with Hunter Water's proposed dune protection and restoration project between the Belmont Golf Course and WWTW as described in Section 3.1.3 of the parent EIS document.	Construction and Operation
Consolidating or 'locking up' of coastal dunes by built infrastructure, removing the buffer for coastal erosion and increasing the risk of inland erosion	The current concept design situates the temporary desalination plant behind the foredunes. Avoid locating the plant and intake structures more seaward than is currently proposed in the concept design and minimise hardstand areas or structures that would consolidate the coastal dunes.	Detailed Design
Exposure of the subsurface network by coastal processes including beach level fluctuation and storm bite	Ensure that infrastructure installed within the active portion of the beach profile is of sufficient depth such that it is below the limit of scour. Alternatively, modify the infrastructure design such that it can be exposed to wave action during extreme events, or ensure plant is decommissioned prior to risk levels increasing under future scenarios.	Detailed Design
	Preferentially construct subsurface structures (particularly the deep intake wells) by directional drilling (or alternative), to avoid the need for an open trench. Monitor weather forecasts when working on the horizontal intake wells and the connection pipeline and halt works when extreme coastal warnings are issued by the Bureau of Meteorology.	Construction

Impact	Mitigation measure	Timing
Risk of coastal erosion impacting the plant and associated subsurface infrastructure under long term future or rare events	Any proposed changes to the current concept design need to consider the existing coastal hazard and risk maps in Figure 5-1 and Figure 5-2, as well as any future updates that may be available that would supersede the existing guidance. Ensure that plant boundaries do not extend into areas of present day erosion and recession risk and that the future risk level applied allows for the most conservative operational and decommissioning timeframes.	Detailed Design, Construction and Operation
	Conduct consistency reviews at major design milestones against the EIS, approval conditions and latest available literature including the Lake Macquarie CMP. It is understood that the EIS will have a 10 year validity period if approved, and as such it is likely that updated sea level rise guidance and coastal risk maps will be available in the interval between concept design and project implementation. The review is required to ensure that the project footprint remains acceptable from a coastal erosion risk perspective.	Operation
Aeolian sand ingress into the plant leading to operational maintenance issues	Implement a coordinated erosion monitoring and mitigation program and update if required.	Operation
Wave overtopping impacting the desalination plant	Design infrastructure and landscaping to minimise the likelihood and extent of wave overtopping. Minimise the impact on the plant should wave overtopping occur by maintaining appropriate drainage and designing the plant to withstand an overtopping event.	Detailed Design

8. Summary

With mitigation measures implemented, it is considered that the project adequately addresses the management objectives for the coastal vulnerability area as described in section 7(2) of the CM Act (Table 8-1). As such, the Project (according to the current concept design and CZMP) is not considered to pose a significant impact to or be at significant risk of impact from coastal hazards.

Table 8-1 Coastal vulnerability area management objectives

Item	Management objective	Project relevance
a	Ensure public safety and prevent risks to human life.	With mitigation measures incorporated, the project would not increase coastal hazards and therefore would not affect public safety.
b	Mitigate current and future risk from coastal hazards by taking into account the effects of coastal processes and climate change.	The effects of coastal processes and climate change (relating to coastal inundation) have been taken into account as part of this assessment and mitigation measures proposed.
c	Maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place.	All infrastructure required under the proposed project would be located behind the beach and dunes, therefore not impacting the presence of these natural features.
d	Maintain public access, amenity and use of beaches and foreshores.	The Project would not affect the amenity of use of the beach or foreshore.
e	Encourage land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operational decisions.	The Project has been designed with consideration to coastal hazards through siting and concept design. Mitigation measures to maintain this consideration through detailed design, construction and operation have been proposed.
f	Adopt coastal management strategies that reduce exposure to coastal hazards: (i) in the first instance and wherever possible, by restoring or enhancing natural defences including coastal dunes, vegetation and wetlands, and (ii) if that is not sufficient, by taking other action to reduce exposure to those coastal hazards.	There are potential positive cumulative impacts by aligning the project works with Hunter Water's proposed dune protection and restoration project between the Belmont Golf Course and WWTW as described in the parent EIS document. The Project has been designed and sited to reduce exposure to coastal hazards.

Item	Management objective	Project relevance
g	If taking that other action to reduce exposure to coastal hazards: (i) to avoid significant degradation of biological diversity and ecosystem integrity, and (ii) to avoid significant degradation of or disruption to ecological, biophysical, geological and geomorphological coastal processes, and (iii) to avoid significant degradation of or disruption to beach and foreshore amenity and social and cultural values, and (iv) to avoid adverse impacts on adjoining land, resources or assets, and (v) to provide for the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by actions to reduce exposure to coastal hazards,	The Project would not significantly degrade biological diversity or ecosystem integrity, or disrupt ecological, biophysical, geological or geomorphological coastal processes. Degradation of or disruption to the beach and foreshore amenity is avoided due to siting of the plant close to existing infrastructure and within previously disturbed areas behind the beach and dunes. With mitigation measures employed, increased erosion of the beach or adjacent land is not anticipated.
h	Prioritise actions that support the continued functionality of essential infrastructure during and immediately after a coastal hazard emergency.	The Project fits the definition of essential infrastructure and therefore meets this objective.
i	Improve the resilience of coastal development and communities by improving adaptive capacity and reducing reliance on emergency responses.	The Project is part of a broader program to provide long term water resilience and security.

9. References

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Appendices

Appendix A – Coastal hazard and risk maps

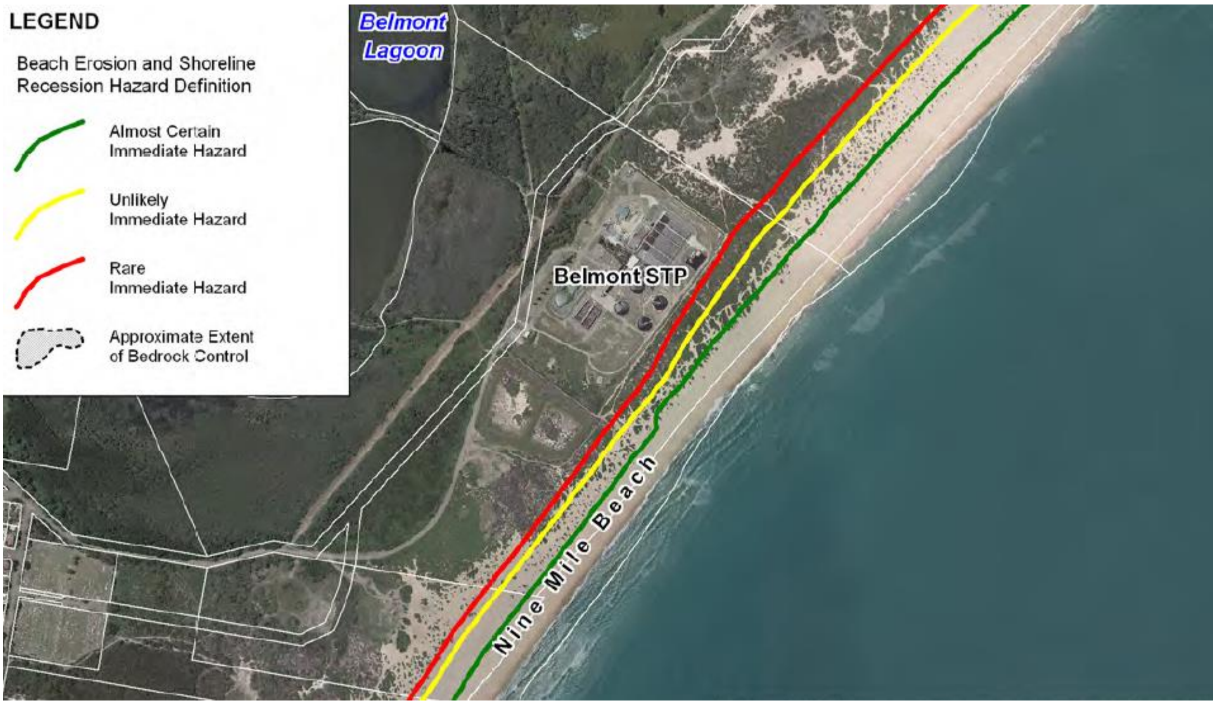

Figure A-1 Present day erosion and recession hazard definition

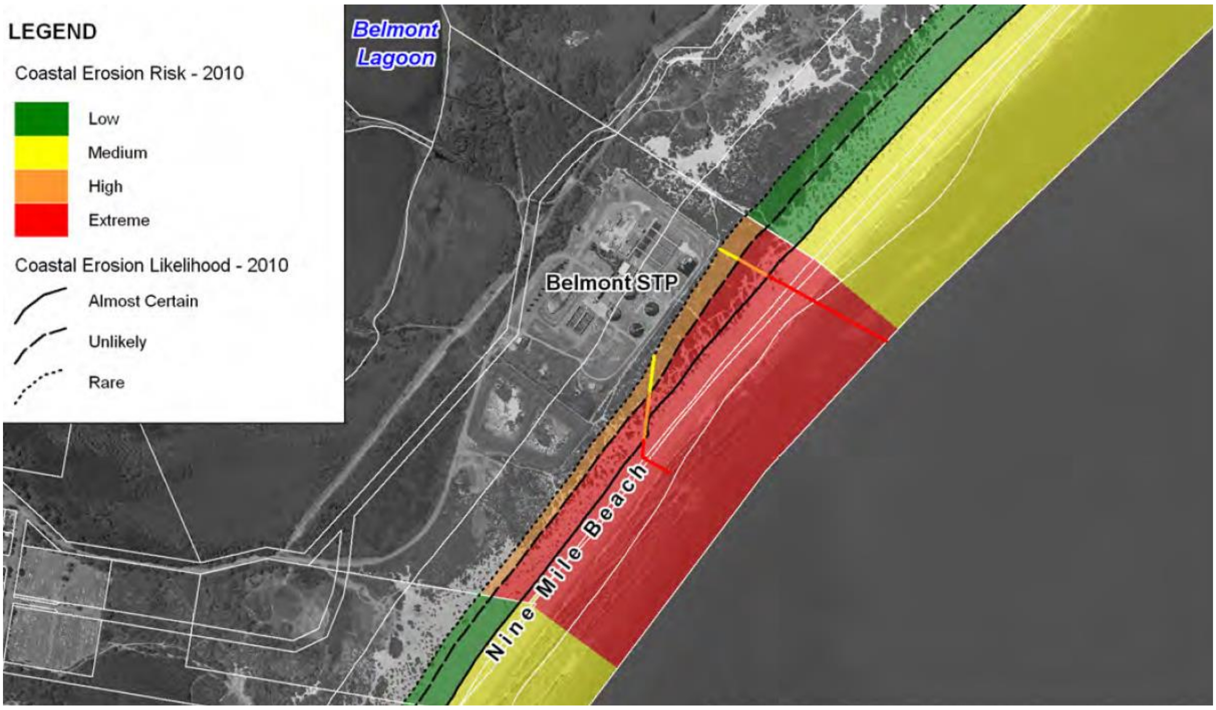

Figure A-2 Present day erosion and recession risk

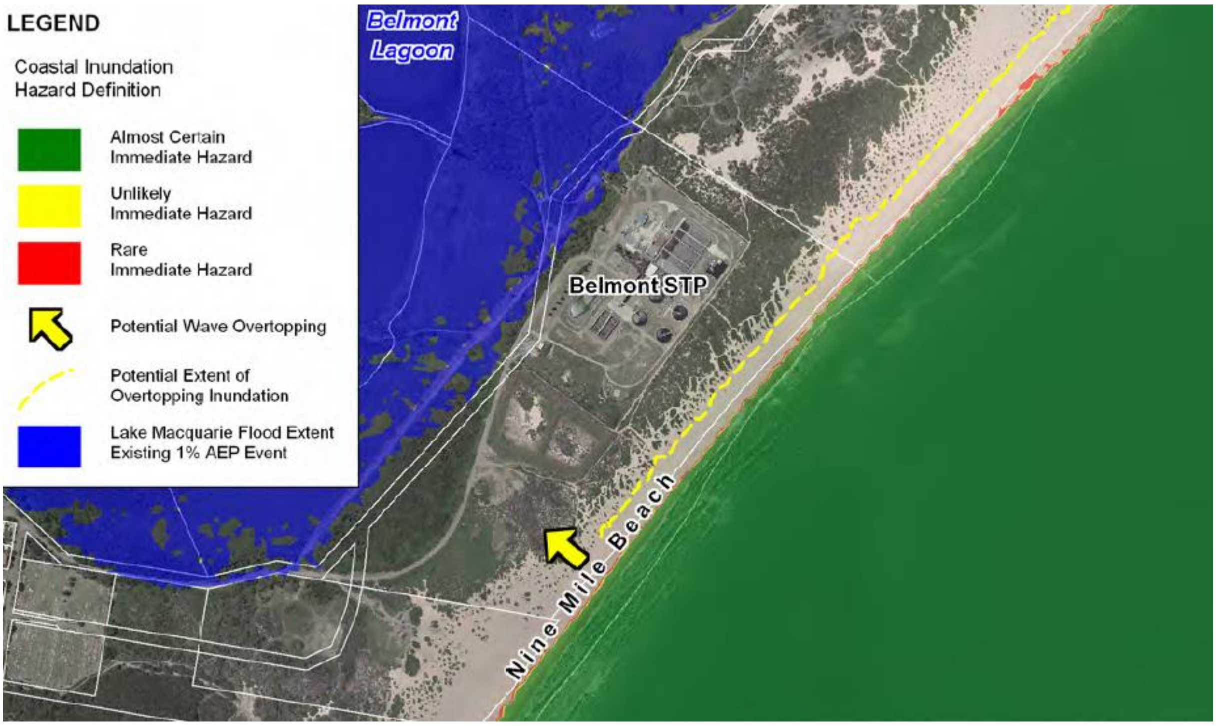

Figure A-3 Present day coastal inundation hazard definition

Figure A-4 Present day coastal inundation risk

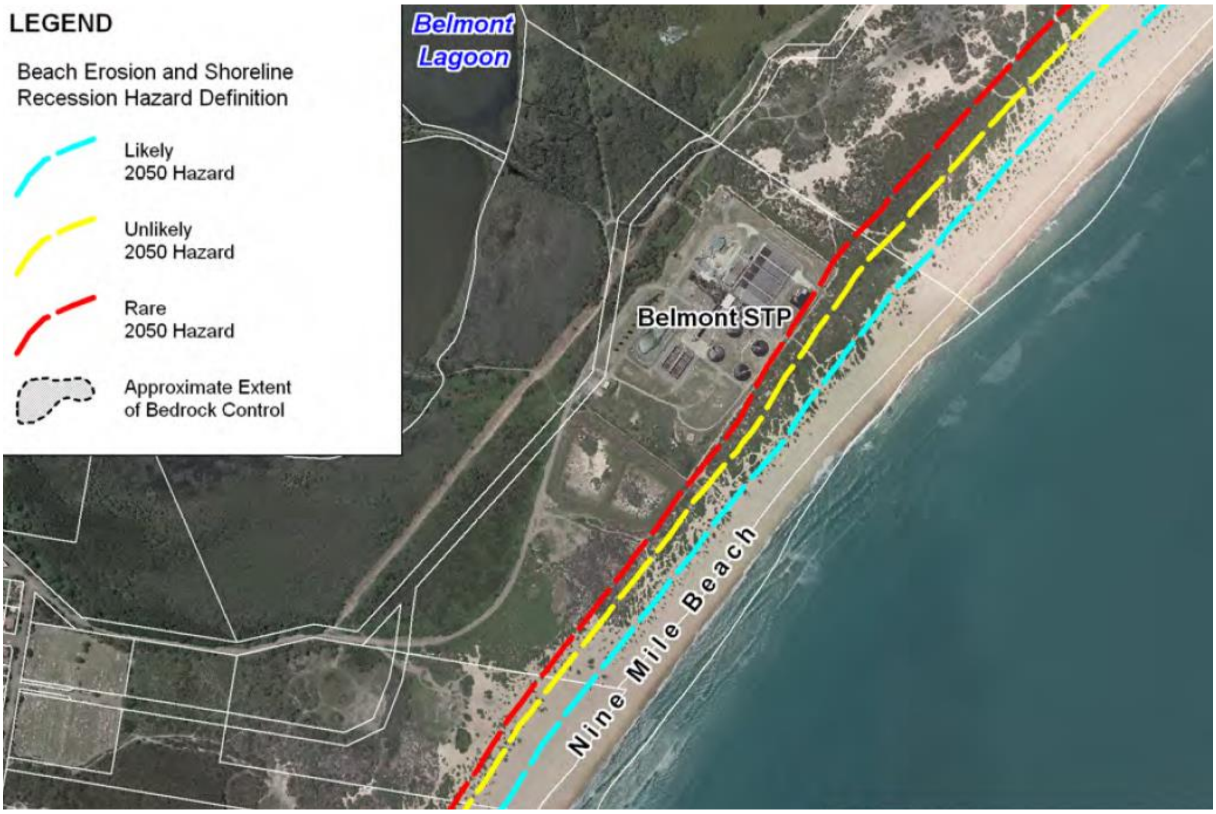

Figure A-5 2050 erosion and recession hazard definition

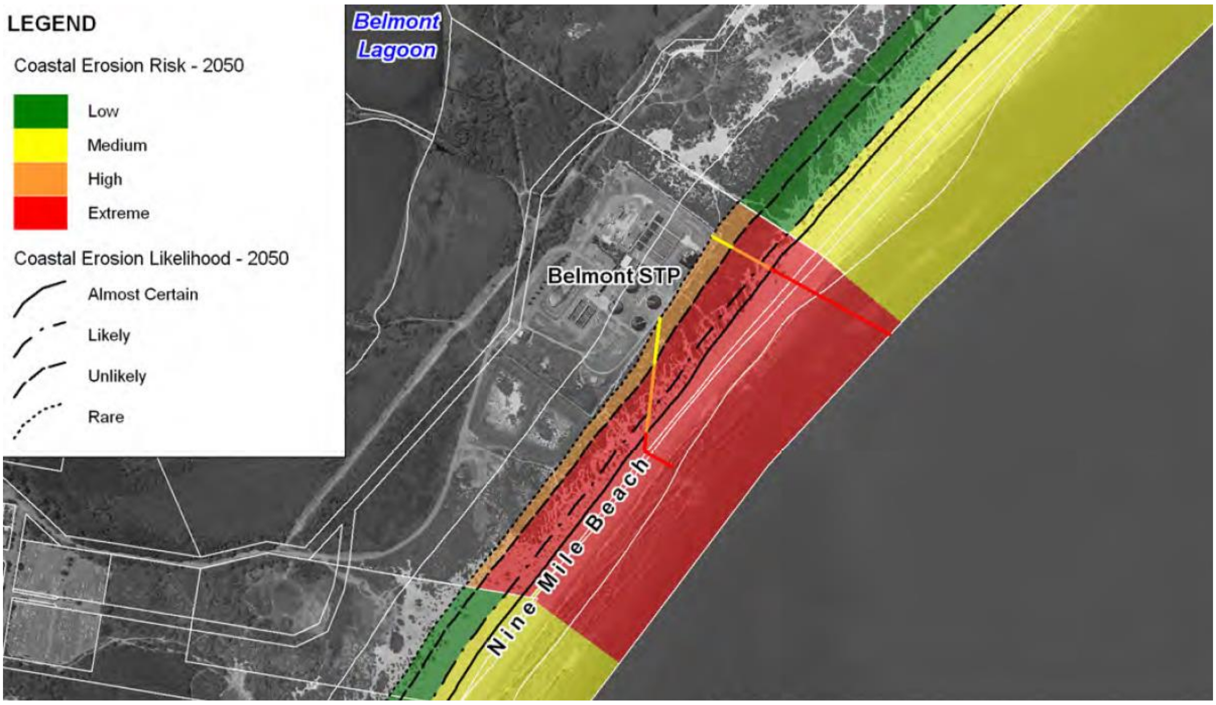

Figure A-6 2050 erosion and recession risk

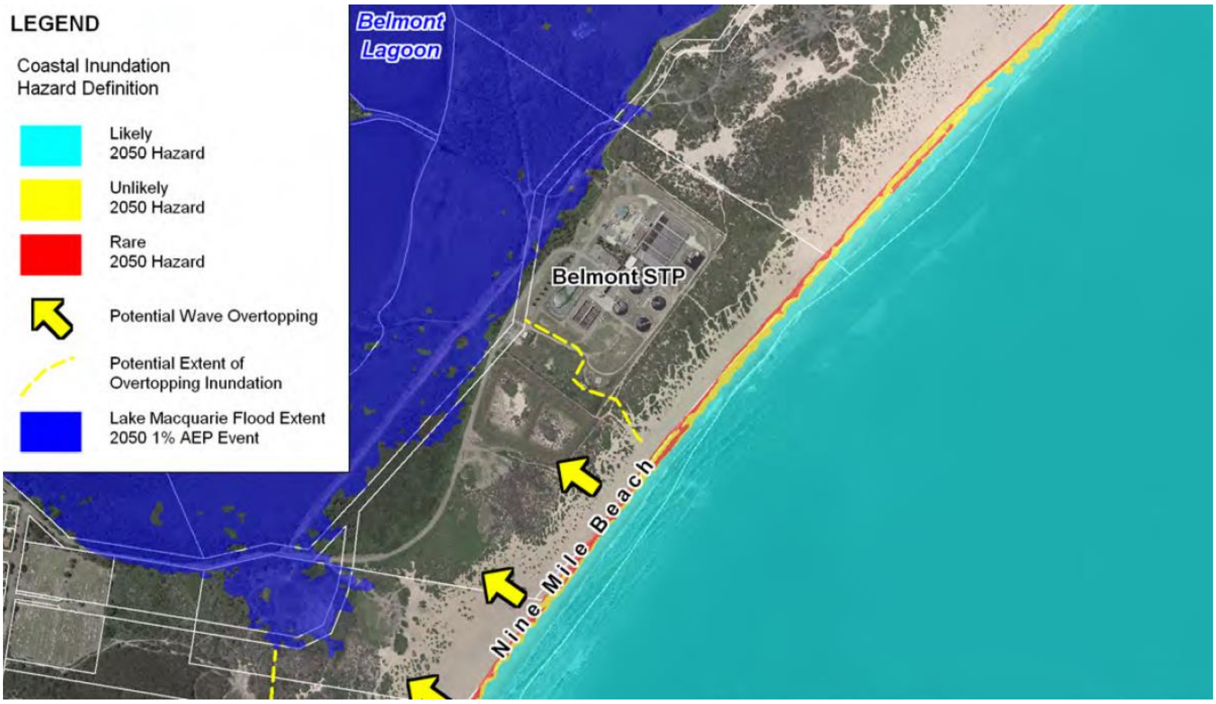

Figure A-7 2050 coastal inundation hazard definition

Figure A-8 2050 coastal inundation risk

Figure A-9 2100 erosion and recession hazard definition

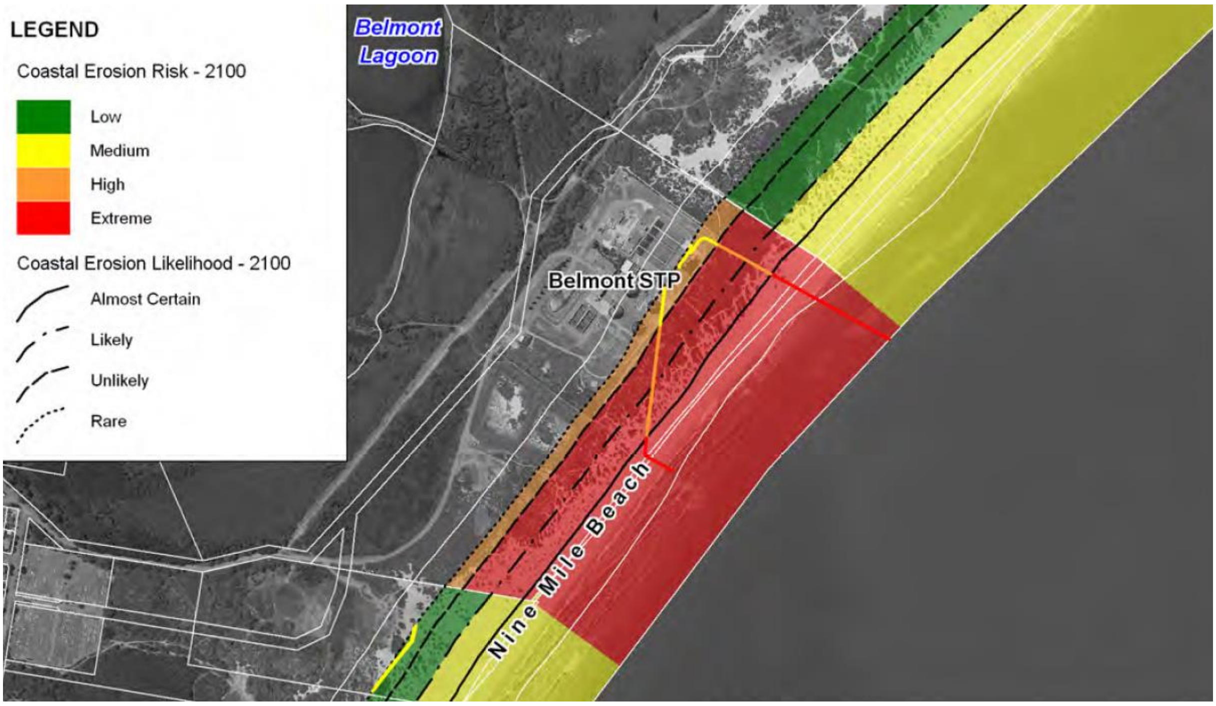

Figure A-10 2100 erosion and recession risk

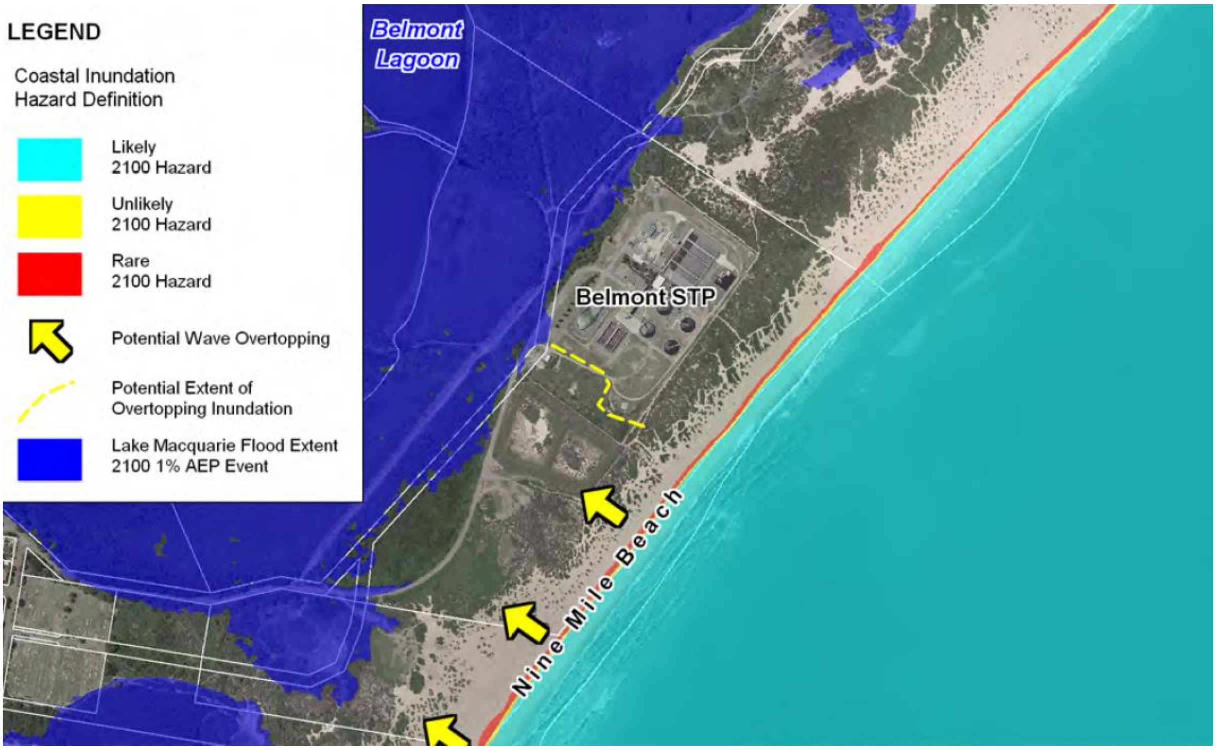

Figure A-11 2100 coastal inundation hazard definition

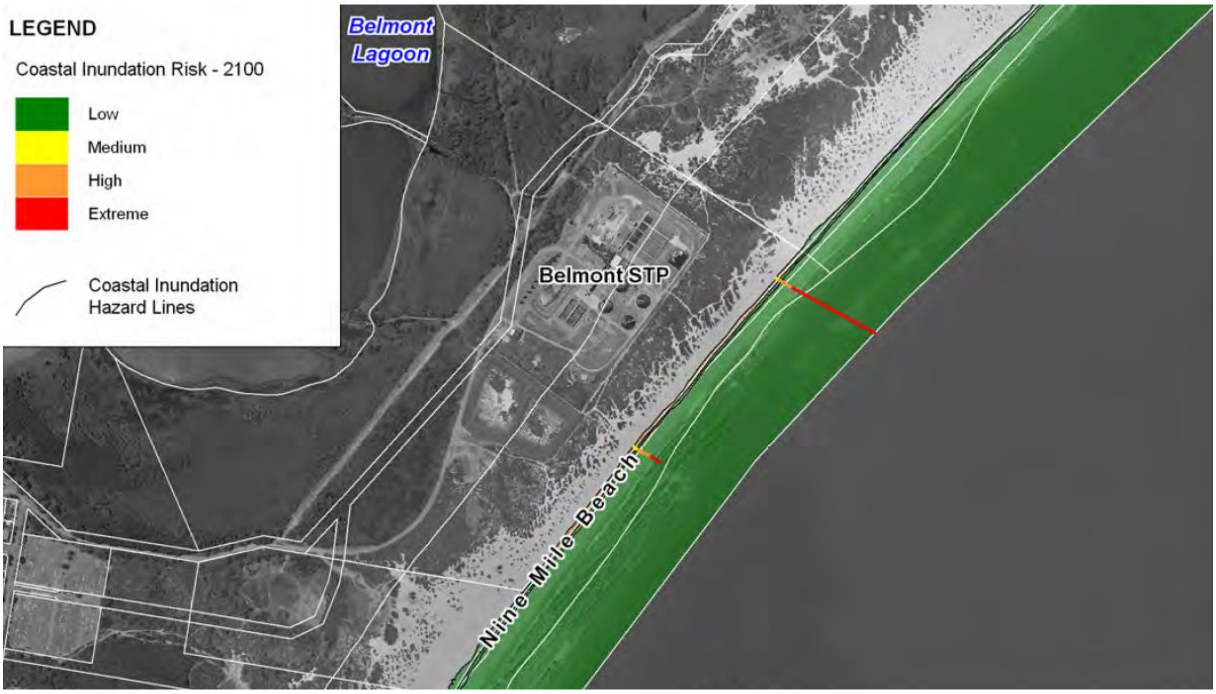

Figure A-12 2100 coastal inundation risk

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