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Our ref: P.A12264.003.01_TupiaStreetCoastalHazardRiskAssessment_PEH

9 February 2023

1 Newcastle Street
Rose Bay NSW 2029

Attention: Peter Zaverdinos

Dear Peter

RE: 26 TUPIA STREET, BOTANY COASTAL HAZARD AND RISK ASSESSMENT

BMT has been engaged to provide a coastal hazard and risk assessment regarding a Planning Proposal to facilitate residential development at 26 Tupia Street, Botany. This letter provides an update to the coastal hazard and risk assessment provide to support a planning proposal for 26 Tupia Street in August 2019. Based on the revised planning proposal drawings provided (dated 1 February 2023), the proposed development comprises the construction of three residential flat buildings within the site boundary. This letter outlines herein:

- A description of the site and elements of the proposed development that are relevant to the assessment of coastal hazards;
- An overview of coastal management legislation (State and Local) relevant to the proposed development;
- An overview of coastal processes at the site as relevant to the assessment of coastal hazards and risks;
- An overview of potential risks to the proposed development from coastal hazards, where relevant, in accordance with current legislation; and
- Concluding recommendations to mitigate coastal risks to the proposed development in accordance with current legislation, as relevant.

Yours Sincerely,

BMT

Kieran Smith
Senior Engineer

Description of the Site Proposed Development

The proposed development site is located at 26 Tupia Street, Botany (the Site), as shown in Figure 1.1. The Site is currently developed and is occupied by several industrial buildings and hardstand car parking areas. Sir Joseph Banks Park surrounds most of the Site, with Botany Bay located approximately 300m to the south-west.

Title:
Site Locality

Figure: **1.1**

Rev: **A**

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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Proposed Development

The proposed development comprises the construction of three residential flat buildings (RFB) that will be 3-4 storeys high and contain approximately 109 apartments. A plan view of the revised planning proposal design as provided to BMT (01/02/2023) is shown in Figure 1.2

The coastal hazards and risk assessment will consider the external development configuration as shown in Figure 1.2, which is taken to include underground access to car parking. The internal building design details are not considered relevant in this case.

Figure 1.2 Proposed Development at the Site

Coastal Risk Management Legislation and Development Controls Applying to the Proposed Development

A new NSW Coastal Management Framework (the Framework) was finalised in April 2018 that includes a new Coastal Management Act 2016 (the CM Act) to replace the former Coastal Protection Act 1979.The *State Environmental Planning Policy* (*Coastal Management*) *2018* (the CM SEPP) is now repealed and replaced with Resilience and Hazards SEPP (Chapter 2 – Coastal Management).

The Framework considers more than just coastal hazards with respect to management of the NSW coastal zone.

The Site is not currently in the mapped coastal zone (refer Figure 1.3). However, the Site has been identified within an area affected by coastal inundation hazards (as classified under the CM Act; refer to the Coastal Hazards and Risk Assessment below). As the Site is within an area of potential coastal vulnerability, a coastal hazard and risk assessment has been undertaken, outlined herein.

State and local legislation and development controls for coastal management that are relevant to the proposed development are summarised in Table 1.2, which also details the assessment of the proposed development against these legislative requirements and development controls.

It is noted that there are no specific coastal management requirements in Federal legislation.

Table 1.2 Coastal Management Legislation Pertaining to the Proposed Development

Legislative requirement / Development control	Assessment of the Proposed Development against the requirements
Coastal Management Act 2016	
S3 a) to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience,	The proposed development is set back approximately 300 m from the Botany Bay foreshore. The re-development of the Site also proposes to keep the existing buffer of mature trees and includes a deep soil setback to ensure their longevity in the future thus maintaining the scenic character and ecosystem values that are currently observed. Noting the above, the proposed development is considered highly unlikely to adversely impact upon natural coastal processes or coastal environmental values.
S3 (b) to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety,	The proposed development is not anticipated to impact on coastal zone social and cultural values and will not inhibit public access, amenity, use or safety. The region in which the development is proposed is already well developed and has existing public access and amenity features, and the development is not expected to impact upon these existing features.
S3 (e) to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making,	As above for S3 (b), the region in which the development is proposed is already well developed and is not considered likely to impede ecologically sustainable development and land use planning in the coastal zone.
S3 (f) to mitigate current and future risks from coastal hazards, taking into account the effects of climate change,	Coastal hazards relevant to the Site relate to coastal and tidal inundation only (see Table 1.3). Inundation risks to the Site, including the proposed development, will increase over time due to the increase in inundation levels with sea level rise. The risks from these coastal hazards and possible risk mitigation actions are outlined in the following section of this document. Based on the location of the Site and a technical understanding of the applicability of such hazards, none of the remaining coastal hazards as listed under the CM Act are expected to pose a threat to the site (i.e. beach erosion, shoreline recession, coastal lake or watercourse entrance instability, coastal cliff or slope instability and erosion and inundation of foreshores caused by tidal waters and the action of waves, refer Table 1.3).
Resilience and Hazards SEPP (Chapter 2 – Coastal Management)	
2.7 Development on certain land within coastal wetlands and littoral rainforests area	The Site is not located within or in a proximity area to the Coastal Wetlands and Littoral Rainforests Area, Coastal Vulnerability Area, Coastal Environment Area or Coastal Use Area, therefore these sections are not applicable.
2.8 Development on land in proximity to coastal wetlands or littoral rainforest	

Legislative requirement / Development control	Assessment of the Proposed Development against the requirements
2.9 Development on land within the coastal vulnerability area	
2.10 Development on land within the coastal environment area	
2.11 Development on land within the coastal use area	
2.12 Development in coastal zone generally—development not to increase risk of coastal hazards	Coastal hazards relevant to the Site relate to coastal inundation (storm events) and tidal inundation only. Coastal and tidal inundation present a risk to the Site because it is hydraulically connected to the ocean via the stormwater network. The Site is some 300 m from the Botany Bay shoreline, with parkland, a major road and wetland waterbody between the Site and shoreline. Therefore, the Site shall not be directly impacted by wave runup or overtopping from waves in Botany Bay. The proposed development is not considered likely to increase the risk of coastal inundation or tidal inundation, as the Site already has buildings and development on it, and so there is not expected to be a change (loss) of volume in the inundation area. Based on the location of the Site and a technical understanding of the applicability of such hazards, none of the remaining coastal hazards as listed under the CM Act are expected to pose a threat to the Site (i.e. beach erosion, shoreline recession, coastal lake or watercourse entrance instability, coastal cliff or slope instability and erosion and inundation of foreshores caused by tidal waters and the action of waves, refer Table 1.3).
Bayside LEP 2021 *(replacing Botany Bay Local Environmental Plan (LEP) 2013*	
Details	The site is zoned R3.
Botany Bay Development Control Plan (DCP) 2013	
No specific coastal requirements	
Draft Bayside Development Control Plan (DCP) 2022	
Objective 5. To avoid increasing the community's exposure to coastal hazards. Control 7: Subdivision and amalgamation is not permitted in areas identified to be affected by projected 2100 sea level rise by NSW State Government unless it can be demonstrated that potential impacts can be mitigated (refer to Sydney Coastal Council and CSIRO – Mapping and Responding to Coastal Inundation, February 2012).	BMT has utilised these data sets for the Coastal hazard assessment. Please refer to Figure 1.4.

Title:
Mapped Coastal Management Areas

Figure: **1.3**

Rev: **A**

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Coastal Hazard and Risk Assessment

Coastal Hazards Applicable to the Proposed Development

The CM Act defines “coastal hazard” to include seven different processes that potentially cause vulnerability in the coastal zone. A review of the Site has determined that only coastal inundation and tidal inundation is relevant to the proposed development, as explained in Table 1.3

Table 1.3 Coastal Hazards Applicable to the Site

Coastal Hazard as defined in CM Act	Applicability to the Proposed Development
Beach Erosion: The landward movement of the shoreline and/or a reduction in beach volume, usually associated with storm events or a series of events, which occurs within the beach fluctuation zone. Beach erosion occurs due to one or more process drivers; wind, waves, tides, currents, ocean water level, and downslope movement of material due to gravity.	***N/A to the Site.*** The Site is located some 300 m landward of the Botany Bay foreshore. Storm demand values typically applied in NSW range from 140 m^3/m for a low energy beach to 225 m^3/m for high energy beach (refer Gordon, 1987). The Botany Bay shoreline would not be expected to experience high energy waves typical of a fully open coastal site. However even if the high energy storm demand value were applied, beach erosion would not be expected to threaten the Site.
Shoreline Recession: The continuing landward movement of the shoreline, that is, a net landward movement of the shoreline, generally assessed over a period of several years. As shoreline recession occurs the beach fluctuation zone is translated landward.	***N/A to the Site.*** As above, the site is located some 300 m landward of the Botany Bay foreshore. The Bruun Rule (1962) is a commonly applied measure for expected shoreline recession distances in response to sea level rise, whereby the recession distance is relative to the shoreline slope and the amount of sea level rise such that shallower slopes produce greater recession. Continental shelf slopes in NSW average ~ 1:50, which would result in some 40 m of recession for a projected sea level rise of 0.8 m by 2100 (being the upper limit projection under the worst case emission scenario of SSP5-8.5 within the IPCC AR6) . Given the depth of Botany Bay to allow its use as a major port facility, shoreline slopes should be expected to be far steeper than 1:50, with recession distances commensurately smaller. For example, slopes used in a shoreline recession assessment for a nearby development application applied a 1:12 slope, which equates to ~ 10 m of recession. For the purpose of defining future coastline hazards, beach erosion and shoreline recession are combined. Even when using conservative upper limit values for NSW in calculations, it is incredibly unlikely that the site will be affected by shoreline recession and beach erosion over the next 100 years time.
Coastal lake or watercourse entrance instability: The variety of potential hazards and risks associated with the dynamic nature of both natural and trained entrances. Coastal lake and watercourse entrances are highly active environments with their shape constantly changing in response to processes such as alongshore sediment transport, tidal flows, storms and catchment flooding.	***N/A to the Site*** The Site it is not located on or near to the entrance of a coastal lake / watercourse.

Coastal Hazard as defined in CM Act	Applicability to the Proposed Development
Coastal Inundation: Occurs when a combination of storm (wind, waves, atmospheric pressure) and marine processes raises the water level at the coast above normal tidal levels, resulting in the inundation of low-lying areas adjacent or connected to the coast; and waves running up and overtopping natural or built shoreline structures (e.g. dunes, seawalls, promenades, groynes etc). Sea level rise will increase the elevated ocean water levels during such events and increase the extent of coastal inundation.	**Coastal inundation risks are projected at the Site in the future (2050, 2100)** based on inundation mapping produced by the CSIRO and Sydney Coastal Councils Group (SCCG) (2012), refer Figure 1.4 Coastal inundation risks may arise in the future with sea level rise, due to the Site being hydraulically connected to the ocean (e.g. via a stormwater pipe/channel, waterway, groundwater etc.) Risks related to wave run up and overtopping are not applicable to the Site, based on its location some 300 m from the Botany Bay shoreline, with parkland, a major road and wetland waterbody between the site and shoreline. The proposed development is not considered likely to increase the risk of coastal inundation or tidal inundation, as the Site already is developed and the proposed buildings will likely have a similar footprint, and so there is not expected to be a change (loss) of volume in the inundation area. Coastal inundation risks are assessed in detail in the following section.
Coastal cliff or slope instability: The variety of potential hazards and risks associated with the dynamic nature of both natural and trained cliffs (steep face of rock), which may be affected by coastal processes; or dune slope instability associated with the area landward of a beach erosion escarpment in the dunes, which may slump or collapse back to the natural angle of repose of sand sometime after the storm event).	***N/A to the Site***. The Site is not located in or on a coastal cliff or dune crest.
Tidal inundation: The inundation of land by sea water due to tidal action under average meteorological conditions, such as a king high tide. Tidal inundation is expected to increase commensurately with sea level rise, resulting in the incursion of sea water onto low lying land that is not normally inundated by tides.	**Tidal inundation risks are projected at the Site in the future (2050, 2100)** based on inundation mapping produced by the CSIRO and Sydney Coastal Councils Group (SCCG) (2012), refer Figure 1.4 As the site is hydraulically connected to the ocean, any increase in the height of tidal waters with sea level rise may consequently inundate the Site. While coastal inundation that occurs during storm events will periodically increase water levels along the coastline, there may also be regular or permanent inundation impacts due to the sustained increase in the Botany Bay mean water level with sea level rise, and above which the astronomical tide occurs. This risk is assessed in detail in the following section.

Coastal Hazard as defined in CM Act	Applicability to the Proposed Development
Erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters: The erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.	***N/A to the Site.*** The Site is not located on the foreshore of a coastal lake / watercourse.

Coastal Inundation Risk Assessment

Coastal Inundation Levels (McInnes et al., 2012)
CSIRO and SCCG (McInnes et al., 2012) undertook a study that evaluated sea level inundation along the Sydney coastal and estuarine regions, under current and future sea level rise conditions. The focus of this study was to map inundation that arises from the contribution of storm surges and astronomical tides to extreme sea levels (referred to as storm tides). Wave setup was also considered through 2D hydrodynamic modelling. The study adopted the design still water levels from Fort Denison for a 1 in 1-year event (which is roughly equivalent to the highest astronomical tide, HAT) and a 1 in 100-year event, plus sea level rise at 2050 and 2100 (using sea level benchmarks of 0.4 and 0.9 metres above 1990 levels, respectively).

Using the CSIRO and SCCG study outcomes, Bayside Council has produced broadscale maps showing the following scenarios across the Bayside Council Local Government Area (LGA):

- 1 in 1-year storm event, with a 40 cm sea level rise (estimated to be encountered in year 2050) and a 90 cm sea level rise (estimated to be encountered in year 2100); and
- 1 in 100-year storm event with a 40 cm sea level rise (estimated to be encountered in year 2050) and a 90 cm sea level rise (estimated to be encountered in year 2100).

These maps are available on the Bayside Council website and are reproduced showing the area surrounding the Site in Figure 1.4 This mapping has been adopted to assess coastal inundation risks at the Site for this assessment. Actual inundation levels are not provided with this mapping data. As such, inundation levels were inferred using the mapped extents of inundation and reviewing ground elevation data at these extents from LiDAR elevation data. With this approach, the derived levels for the 1 in 1-year storm event were determined to be 1.7 and 2.2 m AHD, respectively for the 2050 and 2100 scenarios. The derived levels for the 1 in 100-year storm event are 2.0 and 2.5 m AHD, respectively for the 2050 and 2100 scenarios (see Table 1.3 for summary, with estimated water levels compared against design levels provided for Sydney Harbour in Watson and Lord, 2008).

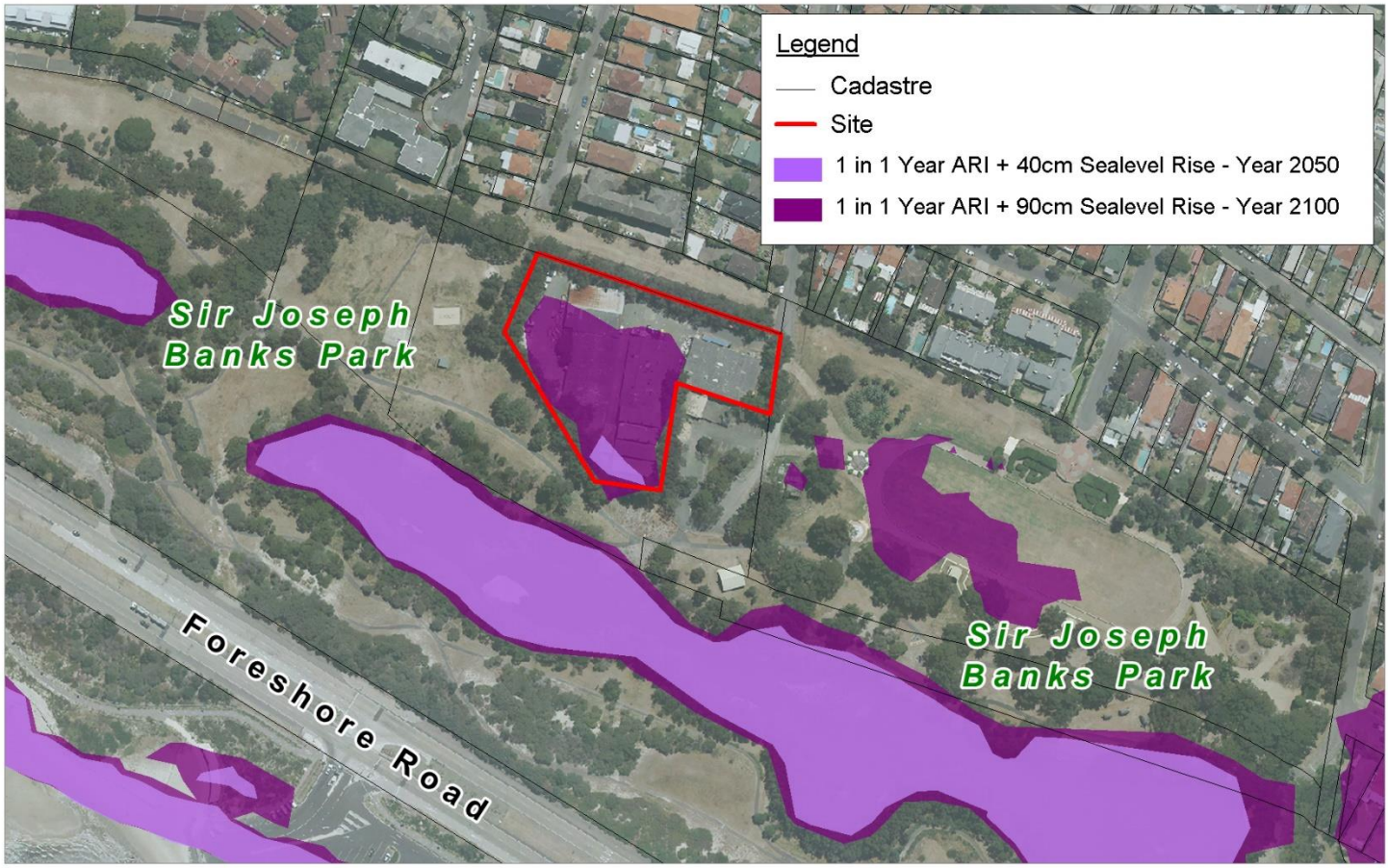
It is important to note that the inundation mapping is dependent on the ground levels of the Site. Should ground levels change in the future (e.g. through filling), then the inundation extents will likely change.

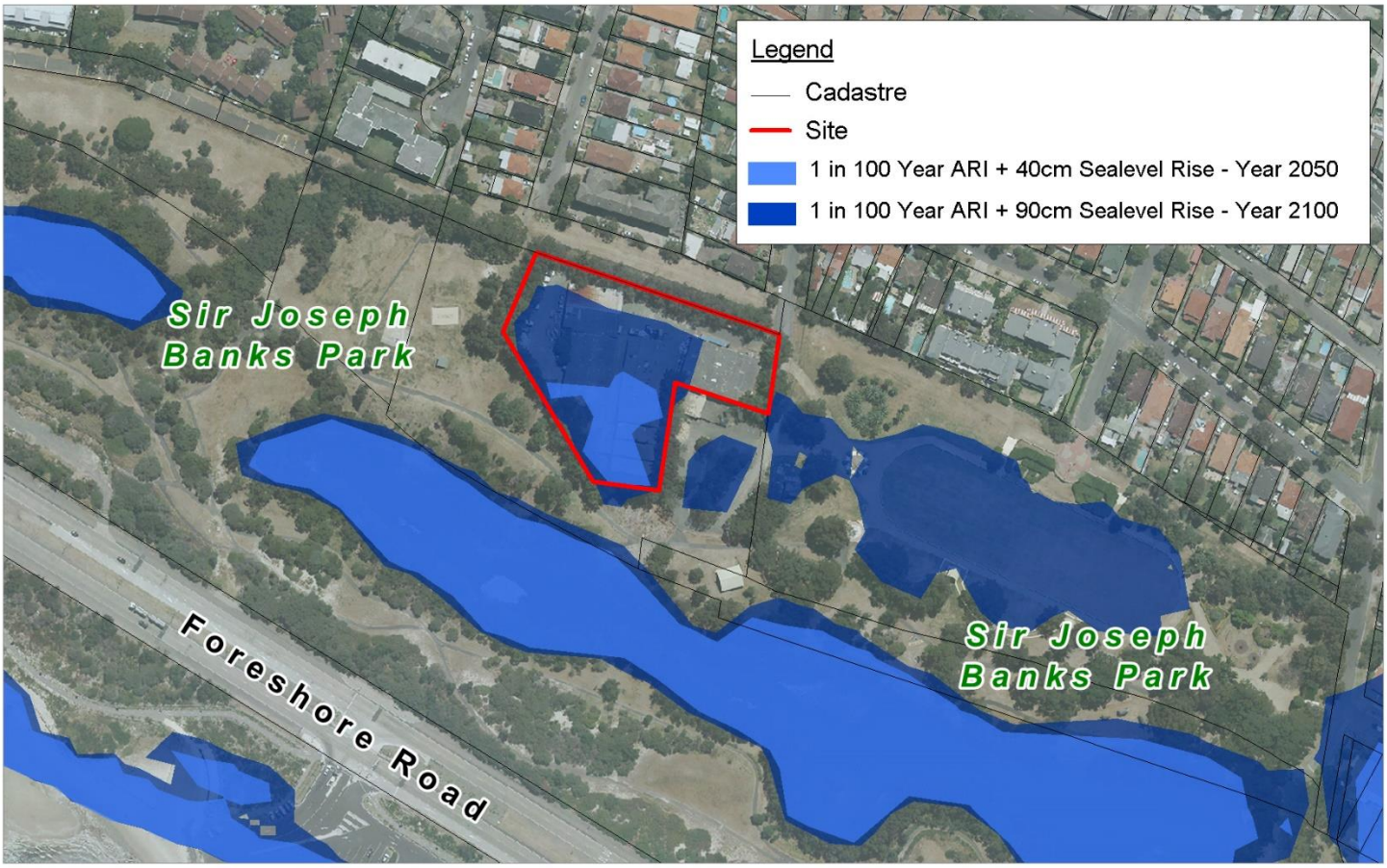
Table 1.4 Water Level Summary Table

Sea level rise condition	1 in 1 year water level (mAHD)		1 in 100 year water level (mAHD)	
Source	*Watson and Lord (2008)**	*McInnes et al (2012)***	*Watson and Lord (2008)**	*McInnes et al (2012)***
Present day (~1990) conditions	1.2	1.3	1.4	1.6
2050 (0.4 metre SLR) conditions	1.6	1.7	1.8	2.0
2100 (0.9 metre SLR) conditions	2.1	2.2	2.3	2.5

*** Design still water levels for Sydney Harbour for present day conditions (based on available water level; outlined in Watson and Lord (2008)), plus future sea level rise benchmarks (rounded to one decimal place).**

**** Approximate sea level rise inundation levels from 'storm tides' (including wave setup), based on LiDAR topography elevation (LPI survey in 2014) and mapped inundation extents in McInnes et al (2012) (rounded to one decimal place).**





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Coastal Inundation Mapping
Source: Reproduced from CSIRO and SCCG, 2012

Figure: **1.4**

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Combined Catchment and Coastal Levels (BMT WBM, 2015)

Additionally, the Botany Bay Foreshore Beach Flood Study (BMT WBM, 2015) has been used to assess potential inundation levels for the Site. The Botany Bay Foreshore Beach Flood Study (BMT WBM, 2015) assessed climate change impacts on flooding and adopted sea level rise planning benchmarks as provided in the repealed NSW Sea Level Rise Policy Statement (DECCW, 2009). Based on these former State Government guidelines, the design ocean boundary conditions were raised by 0.4 m and 0.9 m to assess the potential impact of sea level rise on flood behaviour in the catchment for the year 2050 and 2100 respectively.

Results from this study indicate that the 1% AEP (Annual Exceedance Probability) [equivalent to the 1 in 100 year ARI] design event flood level for the Site is approximately 2.4 m AHD. Climate change impact assessment mapping from this study showed that the 1% AEP flood levels for the 2050 and 2100 sea level rise scenarios are not impacted by the increase in mean sea level conditions. Flood conditions at the Site have been assessed as part of the Flood Impact Assessment prepared for this development (REF: R.A12264.01.00_Tupia Street FIA).

Flood Planning Levels

Whilst the Botany Bay DCP 2013 and associated flood planning requirements do not specifically apply to the Site, it is assumed that Bayside Council will enforce a Flood Planning Level (FPL) for development at the Site. As outlined on the Bayside Council website and widely adopted across NSW, the FPL is a height used to set floor levels for property development in flood prone areas. It is typically defined as the 1% AEP flood level plus an appropriate freeboard which is usually 0.5 m above the flood level.

Based on the Flood Impact Assessment prepared for the Site, the FPL is 4.2 mAHD and thus all habitable floor levels will need to be set above this level. These flood control requirements will also effectively manage coastal storm inundation risks under current and future timeframes, as the coastal inundation level for the Site is lower than the determined FPL level.

Underground carparking is proposed as part of the development. Underground carpark levels would likely be no higher than 0.5 – 1.0m AHD. Drainage from the carpark and backflow prevention in the stormwater system should be included into the hydraulic design of the development to manage risks of coastal inundation impacting assets and services within the underground carpark.

Tidal Inundation Risk Assessment

While coastal inundation that occurs during storm events will periodically increase water levels within Botany Bay and thus the Site, there may also be more frequent or permanent impacts upon the area's water levels and foreshores due to the sustained increase in Botany Bay's tidal range due to sea level rise. This hazard is defined in the CM Act as "tidal inundation" and poses a potentially greater risk than coastal inundation where impacts may occur, due to the permanent nature of the inundation.

The coastal inundation mapping shown in Figure 1.4 can be used to investigate tidal inundation as the 1 in 1-year storm is approximately equivalent to the HAT. The derived levels for the 1 in 1-year storm event are 1.7 and 2.2 m AHD, respectively for the 2050 and 2100 scenarios (see Table 1.3).

In order to prevent tidal inundation from becoming a nuisance issue (and permanent risk) for future residents, it is important that access to the Site via local roads can be maintained. Based on current LiDAR elevation data, the Site access road and the proposed driveway (as per Table 1.2) is currently located at or above 2.5 m AHD. This level will ensure the driveway and carpark access ramp entrance is maintained at or above the inundation level for the 2100 1 in 1-year storm event (i.e. 2.2 m AHD). As it is proposed to construct driveway access close to the Probable Maximum Flood Level (of 4.2 mAHD),

access to and from the Site would be maintained under future tidal inundation conditions estimated for the 2100 timeframe.

Conclusions

This letter report documents BMT's assessment of coastal hazards and management advice pertaining to a Planning Proposal to facilitate the development of a new residential complex at 26 Tupia Street, Botany.

The proposed development Site is currently outside of the coastal zone as defined by the CM Act and mapped in the Resilience and Hazards SEPP. Regardless, and until such time as coastal management area maps (particularly the coastal vulnerability area) are updated, existing modelling studies have identified that the development site may be subject to risks from both:

- Coastal inundation during storms when high open water levels propagated upstream, including via influences of groundwater and the stormwater network and inundate land; and

- Tidal inundation due to the regular high tide being expected to occur at greater depth / coverage as mean water levels and high tide increase in response to sea level rise in the open ocean.

Inundation risks to the Site, including the proposed development, will increase over time due to the increases in inundation levels with projected future sea level rise.

Coastal inundation and tidal inundation risks were investigated further, whereby it was determined that the storm (e.g. 1 in 100-year) event and the tidal inundation (e.g. high high-water solstice springs or highest astronomical tide, approximately equivalent to 1 in 1-year event) water levels are lower than the flood planning level of 4.2 mAHD applied to the Site. However, design of the underground carpark, which is likely to have levels of 0.5 – 1.0m AHD, should prevent backwater inundation from the stormwater system and groundwater ingress.

With regards to maintaining access to and from the Site under tidal inundation conditions that may occur on a regular basis, the assessment identified that the current egress road is at or above 2.5 m AHD. It is recommended that this level be maintained for the access road driveway and carpark access ramp, to mitigate the potential effects of tidal inundation by 2100.

References

Bayside Council (2019), *Climate Change*, Bayside Council, Sydney, viewed 26 September 2022, <https://www.bayside.nsw.gov.au/area/environment/climate-change>

McInnes, K., Lipkin, F., O'Grady, J., and Inman, M. (2012), *Mapping and Responding to Coastal Inundation: 1 Modelling and Mapping of Coastal Inundation Under Future Sea Level Rise*, CSIRO and SCCG, viewed 24 June 2019 https://www.sydneycoastalcouncils.com.au/projects/mapping-and-responding-to-coastal-inundation/

IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [https://report.ipcc.ch/ar6/wg1/IPCC_AR6_WGI_FullReport.pdf

Gordon, A.D., (1987). Beach Fluctuations and Shoreline Change - NSW, reprints of Papers, *8th Australasian Conference on Coastal and Ocean Engineering*, 30 November to 4 Dec, Institution of Engineers Australian National Conference Publication No 87/17 pp 103-167.