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STORMWATER MANAGEMENT REPORT

REQUEST FOR PLANNING PROPOSAL 251, 260R, 278 AND 280-282 CAPTAIN COOK DRIVE, KURNELL

Document information

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EXECUTIVE SUMMARY

This Stormwater Management report has been prepared by Egis Group to accompany a proponent initiated Planning Proposal (Planning Proposal) in support of the proposed amendment to *State Environmental Planning Policy (Precincts—Central River City) 2021* (SEPP Precincts) and *Sutherland Shire Local Environmental Plan 2015* (SSLEP 2015).

The Planning Proposal aims to translate and amend current land uses zones under the applicable controls to be consistent with the standard instrument local environmental plan zones and enable additional uses to accommodate a diverse range of land uses at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell (the site). The Planning Proposal will establish a new mixed-use community encompassing residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

This report has been prepared for Besmaw Pty Ltd to present the strategy for the management of flooding, stormwater drainage and water quality associated with the proposed development.

In March 2023, the proponent submitted a Scoping Proposal to Sutherland Shire Council to commence the formal Planning Proposal process, in accordance with the LEP Making Guidelines. The Scoping Proposal provided a comprehensive 'status update,' outlining the concept master plan, the intended development outcome, the proposed planning controls and the environmental considerations which were to be further resolved.

As part of the Scoping Proposal process, Council referred the Scoping Proposal package to the DPE, State agencies, and several internal Council teams for review and comment. The advice received from these stakeholders has provided clear directives on the necessary updates and key focus areas within the technical documentation.

Separate to the Scoping Proposal package, extensive and ongoing engagement with relevant State Agencies has occurred since November 2022, with the objective of clarifying and resolving any of the outstanding considerations.

Besmaw has engaged Egis Group to prepare a Stormwater Management Report to address the feedback received from the DPE and state agencies and reflects the engagement undertaken to date.

Within this report requirements for the proposed development that were identified through the Scoping Proposal process have been identified and summarised. The proposed methodology and measures proposed to be implemented to address them has been identified and discussed. The key elements of concern within the areas of Coastal Management, Environmental Impacts and Flooding have each been reviewed and addressed within the proposed design to ensure that the development will have a Neutral or Beneficial Effect on the receiving waters outside of the proposed site boundaries. Both parts of the development have an appropriate Stormwater Management and Treatment train including Onsite Detention, Onsite Retention and Reuse, Gross-Pollutant Traps, Stormwater Filters Bio-Retention Swales/Basins, Grassed Swales and Wetlands to ensure that both the Water Quantity and Quality discharging from the site do not exceed the identified baseline levels or Authority Guidelines.

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1. INTRODUCTION

The Stormwater Management Report has been prepared in support of planning proposal for the redevelopment of the site at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell. The existing site has currently been occupied for commercial/industrial purposes and a substantial portion of the site (280-282 Captain Cook Drive) has been occupied for sand extraction and replacement of the removed sand with clean fill.

The proposal is to replace the existing landform and developments with a new mixed-use community, which encompasses residential, employment, tourism, education, cultural facilities, ecological regenerative zones, and public open space areas.

Management of the stormwater drainage (both piped and overland), as well as flooding impacts are critical design elements for this project. The development site is constrained by both environmentally and culturally important elements and as such requires an approach which is both sympathetic to the site (both proposed and existing) but robust enough to meet the requirements of the various relevant authorities.

2. SITE DESCRIPTION

The land to which this planning proposal relates is 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell and is located within the Sutherland Shire Local Government Area (LGA). The site has an area of approximately 210.5 hectares and is located 4.5 kilometres northeast of Cronulla Station and commercial district.

The site is bordered by Cronulla State Park and Lindum Road to the West, Dicker Data and Council's conservation areas to the East, Green Hills Beach and Bate Bay to the South and Captain Cook Drive and Quibray Bay to the North see **Figure 1** below.

Source: Group GSA

Figure 1 Site Aerial and Map

The key features of the site are summarised below in **Table 1**.

Table 1 Site Description

Feature	**Lot 2 North**	**Lot 2 South**	**Lot 8**	**Lot 9**
Street Address	251 Captain Cook Drive	280-282 Captain Cook Drive	278 Captain Cook Drive	260R Captain Cook Drive Kurnell
Legal Description	Lot 2 in DP1030269	Lot 2 in DP559922	Lot 8 in DP586986	Lot 9 DP 586986
Site Area	16ha	160ha	34.5ha	82m^2
	Total Area: Approximately 210.5 hectares			
Local Government Area	Sutherland Shire			

Whilst the development consists of 4 lots it forms two distinct areas that are divided by Captain Cook Drive. Lot 2 North is located on the northern side of Captain Cook Drive and is surrounded on 3 sides by the Towra Point Nature Reserve and Quibray Bay. This area is currently being used for commercial purposes and is largely undeveloped and pervious in nature.

The southern area consists of Lot 2 South, Lot 8 and Lot 9 and is bounded by Captain Cook Drive to the north, Cronulla State Park and Lindum Road to the West, Dicker Data and Sutherland Council's conservation areas to the East, Green Hills Beach and Bate Bay to the South and has been used for predominantly industrial activities including the existing Allsands sand mining operations. Of the 3 lots that make up the southern area, Lot 8 and Lot 9 are largely undeveloped whereas Lot 2 South is entirely covered by the sand quarry. The rehabilitation of the existing quarry is underway and parts of the site have been reinstated for the development already. The remining areas of the quarry will continue to be progressively rehabilitated and will be completed prior to the commencement of the development in the area.

3. LEGISLATIVE AND PLANNING REQUIREMENTS

This section outlines the relevant state and Council legislations and requirements that are applicable to the planning, design and construction of the flooding and stormwater management infrastructure. Chapter 4 and Appendix C of the report provide the stormwater design strategy and comments to address these requirements.

3.1 DEPARTMENT OF PLANNING AND ENVIRONMENT

The Department of Planning and Environment has identified numerous comments and requirements for the flooding and stormwater management strategy, as part of the proposal for mixed-use residential development at the site.

3.1.1 COASTAL MANAGEMENT

- The future management and maintenance requirements of ongoing sea level rise and climate change and the impacts to flooding and ground water levels to be considered.

3.1.2 ENVIRONMENTAL IMPACTS

- Water pollution to the marine estate, and physical disturbance from clearing of the riparian vegetation and foreshore development to be addressed.
- Impact of Sea level rise (SLR) to be considered for ground water infiltration for the life of the project.
- Additional maintenance and management requirements due to increased groundwater levels to be addressed.
- Impact of sea level rise, shallow ground water levels and increase infiltration to the size of the onsite detention system to be considered.
- Additional considerations to be paid to how stormwater treatment will be managed on the site. Proposal to go beyond the Council's standard DCP requirements and requirements of Botany Bay Catchment Water Quality Improvement Plan.
- Integrated on-site treatment through Water Sensitive Urban Design (WSUD) measures to be provided during staged release of subdivisions, rather than relying of individual development site provisions.
- Management and maintenance of bioswale and bio-retention basins to be considered and costed for the life of the project. Early discussions to occur if these areas are dedicated to Council.
- WSUD provisions are sufficient to address water quantity and quality from the development within the site for the life of the development, mitigating any potential off-site impacts on sensitive environments.
- Management of water quality during construction to be considered, with compliance with Landcom's Managing Urban Stormwater.
- Consideration to be given to updated NSW Water Quality Objectives.
- The C1 National Parks and Nature Reserves zone to the immediate north of the site not to be relied on as a stormwater mitigation measure. Vegetation buffer to be provided to mitigate impacts.
- Water quality and quantity design to consider impacts of Climate Change beyond the (2120) 100yr planning ensure water quantity and quality from the site does not impact on surrounding sensitive receiving environments.

3.1.3 FLOODING

- Proposal to assess the full range of flood events up to the probable maximum flood (PMF). Considerations to be given up to and including 1 in 2000 & 1 in 5000-year flood events.

- Guidelines from the new Flood Risk Management Manual 2023 and its associated Flood Risk Management Guidelines to be addressed.
- Evacuation routes to be considered for both within site as well as to and from site. Road servicing the site to demonstrate ability for safe evacuation of residents from the site and from further on the Peninsula.
- Internal road sections have shown to be inundated. Alternate routes for evacuation to be considered.
- On-Site Detention (OSD) discharge appears to be on the adjacent property, which will need to be addressed.
- Due to filling of quarry and the time between fill and development, land stability is a concern. Compaction to be considered for long term viability.
- All buildings to be able to resist forces of floodwater up to probable maximum flood (PMF) levels and have habitable floor levels above the PMF.
- Updated flood model to extend as far as Greenhills to the West and Kurnell to the East. Provision of Captain Cook Drive as the only evacuation route for the peninsula and evacuation from new development to be evaluated.
- Updated flood model to include times of inundation to enable a decision on whether shelter in place or evacuation off site is the appropriate evacuation method.

3.2 NSW DEPARTMENT OF PRIMARY INDUSTRIES

NSW Department of Primary Industries have provided feedback in response to the scoping proposal, which include comments for the conservation and improvement of the aquatic biodiversity and foreshore communities.

- Protection or improvement of water quality through water sensitive urban design, adequate stormwater treatment and best practice erosion and sediment control measures during construction.
- Keeping stormwater treatment structures, pathways, cycle paths and other infrastructure etc outside the buffer zones mentioned above to maximise biodiversity values and therefore set back more than 100m from the aquatic reserves.
- Potential impacts to sensitive protected habitats from the discharge of the site to Quibray Bay and the two adjacent aquatic reserves to be considered.

3.3 SUTHERLAND SHIRE COUNCIL

Sutherland Shire Council has provided a set of comments and requirements for the design and development of the stormwater management plan for the site. These comments include requirements for the flood study and the proposed stormwater strategy:

3.3.1 FLOOD STUDY REQUIREMENTS

- The flood study to include figures showing adopted model parameters and locations.
- The extent of the flood model to ensure that all contributing catchment areas are modelled such that all runoff to the area is considered.
- Soil infiltration test confirm infiltration rates (loss rates) for the pre- and post-development scenarios as the proposed flood management and modelling is highly dependent on these factors.
- Modelled roughness values to represent the pre and post development land-uses.
- Sea-level rise advised in Council's Sea Level Rise Policy for 2070 and 2100 to be considered.

- Flood modelling and assessment to consider progressive and ultimate development scenarios.
- The proposed development to mitigate existing flood inundation of the heritage dune access track at southern end of Lindum Street.

3.3.2 PROPOSED STORMWATER STRATEGY REQUIREMENTS

- The proposed strategy incorporates infiltration and aquifer recharge, which is to be demonstrated, to achieve the required flood management outcomes for potential storm events of consecutive events with saturated soil/groundwater profiles.
- Drainage outlets to wetland/mangrove areas of Quibray Bay to consider potential future natural variations in ground levels of the area which may affect performance.

3.3.3 FLOOD MANAGEMENT OUTCOMES

- Potential changes in flood behaviour and consequential impacts to be assessed/mitigated for neighbouring properties, Captain Cook Drive and the downstream receiving environment. Changed flow behaviour includes peak flowrates, peak flood levels, flow velocity, flow volumes, flow duration and frequency for a range of storm events.
- Future parcels to be designed such that they are not inundated in a 1% AEP event as they would be subject to flood controls. Future roads and pathways should to be designed to mitigate potential flood hazards.

4. DESIGN STRATEGY

The design strategy for the site analyses both the stormwater and flooding requirements based on the available legislations and feedback from Council and relevant departments, as noted previously in Chapter 3, and provides an approach to ensure that the development complies with these requirements. Additionally, the authority requirements have been addressed individually in Appendix C of the report.

4.1 STORMWATER MANAGEMENT PLAN

This section outlines the strategy and measures that are proposed as part of planning proposal that will meet the water management targets. These requirements are set in the Sutherland Shire Council DCP 2015, and the comments and feedback received from the Council and relevant state authorities, as noted in Chapter 3 of the report. It should be noted that there are two components of the Stormwater Management system proposed for this development. The first being the Stormwater Drainage and the second the Water Quality system. The stormwater drainage component deals with collecting and managing the runoff from the site from the building roofs, down through the street drainage and out to the outlets into Quibray Bay. The water quality system sits within the stormwater drainage, managing and capturing pollutants to ensure that there is a Neutral or Beneficial Effect on the quality of the water being discharged into the natural ecosystem.

The approach taken towards developing the drainage strategy for the site was to try and limit the hard engineering solutions and adopt a more natural overland drainage approach where possible. As such for the roadways and around the individual development precincts a conventional pit and pipe approach has been adopted but this then discharges out into a pond and swale system that runs through the landscaped areas of the site. It is within this swale and pond network that much of the water quality measures are incorporated. The water quality approach mirrors that outlined above with hard engineering at source solutions such as tanks, filters and GPTs being used within the development precincts and then softer, more natural, measures, such as bioretention and wetlands, being implemented further downstream. This approach to drainage and water quality is discussed in more detail below.

4.1.1 STORMWATER DRAINAGE

In accordance with guidelines from Sutherland Shire Council 2015 Chapter 38, the stormwater drainage of the site would be designed to convey all stormwater up to and including the 1% AEP storm event.

The internal stormwater drainage network for individual precincts would be designed to the major/minor principle. The so-called "minor" flows would be conveyed by an in-ground pipe network. Storm runoff, in excess of the capacity of these pipes, up to the peak 100-year ARI design storm, would be conveyed by overland flow along the internal road network. For the individual precincts within the site, the stormwater drainage requirements to ensure:

- All roof areas are to drain through reuse, retention and detention systems. The sizing, operation, and maintenance requirements for these systems to be in compliance with the guidelines from Sutherland Shire Council DCP 2015 Chapter 38, Sutherland Shire Environmental Specification – Stormwater Management (2009) and relevant Australian Standards. More detail on the detention system approach is included in 4.1.2 below.
- All hardstand areas to be directed to water quality measures before discharging from the block. These would include roof areas, roads, and pavements.
- A sediment trap is to be provided at the property boundary prior to the drainage system connection into the wider development drainage network.
- A maintenance methodology and engagement/contract with a maintenance supplier to be provided at the Occupancy Certificate stage for each individual development site.
- Infiltration testing to be undertaken on each of the individual blocks during their respective Development Application (DA) phases.

The drainage outlet from each precinct would then be drained, using swales and surface drainage measures rather than the use of conventional pit and pipe system, towards the northern side of the site, to be ultimately discharged towards Quibray Bay. All stormwater channels and basins are to be lined to prevent infiltration occurring before the runoff has passed through the required treatment train.

The stormwater outlet(s) will be designed to ensure adequate erosion and scour protection and ensure that there are no long-term impacts as a result of the flows from the site. Potential concepts for the stormwater outlet controls have been provided in **Appendix A**. The outlets would need to be provided with a vegetation buffer to mitigate any impacts further downstream.

The provision of concrete blocks at the outlet not only help to reduce flow velocities, but also enable continuous cleaning and maintenance programs to be accommodated. The design also ensures that the outlet control is more tolerant of growing vegetations and future natural variations in the ground levels adjacent to the system.

Similar designs have previously been provided and accepted in other sites and projects within the Sutherland Shire Council area. Most recently at the Woolooware Bay Town Centre project that is currently under construction with the outlets being installed at the northern boundary of the site and discharges into the existing mangroves lining Woolooware Bay.

4.1.2 ON-SITE DETENTION SYSTEM

Sutherland Shire Council DCP 2015 Chapter 38 states requirements for the design of onsite detention systems within the proposed site. Based on the guidelines, the development shall make provision for on-site stormwater detention system(s) to ensure that the developed peak flows (including both pipe and overland flows) are limited by the permissible site discharge based on pre-developed (remediated site) flows for all storm events up to and including the major storm (1% AEP).

For any storm events greater than the major storm, all detention system will be provided with emergency overflow systems, which will be able to discharge excess flows safely towards the downstream network. The OSD systems will be designed to ensure that stormwater flows and volumes exiting the site will not exceed the existing (remediated) site values to safeguard the receiving environments and biodiversity from any adverse effects from higher flows and volumes from the redeveloped site.

The design strategy will be to investigate the requirements for each individual blocks and precincts and ensure that on-site detention (OSD) systems are provided for all individual precincts. This will require that the detention systems in each precinct will be sized only for the combined runoff from the precinct itself but would not include the greater site area, external to the site. The approach would be to provide detention systems for all buildings within the precincts, with additional detention facilities provided for paved and public domain spaces, as required.

This will ensure that each development precinct will have a stormwater management strategy governed by their own Site Storage Requirement (SSR) and Permissible Site Discharge (PSD) requirements. To maximise the use of land within each developed site, the detention storage can be to be provided in permanent concrete tanks with discharge control devices at the outlet of each tank.

The stormwater runoff on the external area and the flows captured from the outlet of individual precincts will pass through additional detention systems provided on the greater site area. These basins would typically be designed and constructed in the form of detention basins and be provided along with bioretention systems. The OSD basins would generally be lined, which would reduce the impacts of shallow groundwater and varying infiltration rates.

4.1.3 WATER QUALITY REQUIREMENTS

The approach to the water quality management strategy for the site is to be provided in 2 parts. The initial part would consist of the water quality treatment on the individual development precincts within the site, while the

subsequent part will cater for the additional treatment of public areas and drainage system outlets in the broader site-wide systems, before releasing into the receiving waters.

4.1.3.1 WATER QUALITY APPROACH FOR INDIVIDUAL PRECINCTS

The individual precincts within the larger development will include arrangements for water-sensitive urban design (WSUD) systems that conform to the water quality targets specified in Sutherland Shire Environmental Specification – Stormwater Management (2009) and the Stormwater Quality Targets Policy (2021) by Sydney Water.

The water quality objectives for the internal development will prioritise on the reduction of the pollutants, sediments and nutrients from the stormwater being discharged from the site. The water quality targets set out by Sutherland Shire Council is as per **Table 2**. These water quality targets are also in compliance with the pollutant load reduction targets set out in Botany Bay Catchment Water Quality Improvement Plan (April 2011) to protect the condition of Botany Bay, its estuaries, and waterways.

Table 2 Water Quality Targets

Pollutant	% Reduction
Gross Pollutants (>5mm)	90
Total Suspended Solids (TSS)	85
Total Phosphorous (TP)	60
Total Nitrogen (TN)	45

Additionally, the design will also seek to obtain retention organic matter (greater than 50mm) as well as oil and grease for storm events up to the 1 in 3-month ARI storm.

The primary water sensitive urban design (WSUD) devices that will be implemented for the first phase of treatment within the precincts would include underground rainwater tanks and Gross Pollutant Traps (GPTs). These devices would be advantageous to cater for runoffs from buildings and roads and become the primary and secondary forms of treatment, before being discharged to bioretention systems and wetlands.

1. Rainwater and Retention Tanks

A rainwater and reuse system is primarily used for storing rainwater and is specifically designed and sized to be installed in residential and commercial developments. The primary objective of the retention and reuse tank is to utilise the capture water for domestic use, including toilet flushing, irrigation, and laundry. In addition to the reuse of rainwater, the system will assist in diminishing the volume of stormwater existing the site, which will in turn reduce the detention and treatment load from the downstream network.

It is proposed that the runoff from the roof areas of the residential and commercial buildings within the development precincts will be captured by underground rainwater tanks. The collection of paved and public domain areas for reuse is not recommended due to the added requirement of treatment of the rainwater prior to storage.

2. Gross Pollutant Traps (GPTs)

Gross Pollutant Traps (GPTs) are generally provided to ensure that debris, litter, and contaminants can be captured and removed prior to being discharged to downstream stormwater network. GPTs are available in the form of stormwater filter chambers, filter baskets, trash racks and in-ground GPTs and are provided for all the buildings and at precinct outlets to ensure the capture and removal of large solid pollutants, oils, greases, and nutrients.

Proprietary products, as manufactured by Humes, Ocean Protect and SPEL can be designed and determined based on the site condition and requirement. These would be designed to ensure minimum water quality targets as specified in **Table 2**.

4.1.3.2 WATER QUALITY APPROACH FOR GREATER SITE

In addition to the WSUD systems implemented to cater for the independent blocks and precincts, the subdivision works will provide regional water quality measures ensuring that the discharge from the overall site complies with the water quality objectives specified in the ANZECC guidelines and updated NSW Water Quality Objectives. These measures aim to provide water quality controls above the general guidelines of Sutherland Shire Council and will have higher targets and requirements.

The water quality management approach for the greater site would be based on the baseline conditions and be designed to match or improve upon the existing values. The development will implement a testing and monitoring program to enable a baseline to be determined (rehabilitated stage) at the relevant points of discharge. The key indicators for these base line values will be established based on requirements of the ANZECC guidelines and the updated NSW Water Quality Objectives. These would include key indicators including and not limited to:

- Total Phosphorus
- Total Nitrogen
- Chlorophyll-a
- Turbidity
- Salinity
- Dissolved Oxygen
- pH

The ANZECC 2000 Guidelines establish trigger values that have been set conservatively to be used as a benchmark for assessing water quality. Testing and monitoring programs at key locations will assist consultants and authorities to identify and record the existing health of the waterways and establish comparison of these base lines to the trigger values. In cases where the base line values exceed the established trigger values, additional investigations maybe required to refine the trigger values to reflect the natural variation in the water way.

An ongoing testing and monitoring procedure will be implemented during and post-construction stage to ensure no discharges from the site exceed the applicable discharge limits or the baseline determined in the predevelopment testing. The post construction monitoring will be kept in place for the life of the development.

Infiltration is also anticipated to occur across all pervious areas. However, the infiltration rates in the rehabilitated zones with imported fill will be notably lower as a result of the lower permeability of the fill material in comparison to the naturally occurring sand layers. Geotechnical consultants will be engaged to allow for proper testing of areas with fill and naturally occurring sands to establish the infiltration rates of the site at different points of infiltration. Upon the completion of the stormwater treatment train, the stormwater will be discharged to unlined swales and basins, where infiltration will occur.

Establishment of ground water monitoring will also be required to ensure base line conditions can be identified. The monitoring systems will be required at points where basins and swales are expected to provide an infiltration outlet. The monitoring system will identify and monitor key indicators, including total dissolved solids, pH, alkalinity, turbidity, dissolved oxygen, heavy metals, oil and grease, nutrients, and hydrocarbons.

The water sensitive urban design (WSUD) controls that will be designed for this stage would include bioretention systems and wetlands. These would be employed primarily to ensure that either neutral or

beneficial impacts can be provided on the existing waterway. A stormwater concept plan with indicative location of bioswales, bioretention basin and wetlands has been provided in Appendix A.

1. Bioretention Systems

Bioretention systems, also knowns as biofiltration systems, are a low energy WSUD measure that provide water quality benefits with minor quantity benefits. The primary function of this system is to enable the removal of sediments and nutrients including finer sediment particles, phosphorus, metals, nitrogen and hydrocarbons, through the use of filter media.

The targeted pollutants are generally captured by a range of physical, chemical, and biological processes associated with the filter media, plants and soil microbial community. Stormwater, in a bioretention system, are treated in a vertical flow direction, which follows the temporary ponding of water in the extended detention zone.

2. Wetlands

Wetlands are shallow, artificial and densely planted ponds that function to treat stormwater through a range of physical and biological processes. These usually provide a more natural method to remove pollutants and treat stormwater before discharging to water bodies and creeks. Generally, wetlands have three parts that act together in the stormwater treatment process: the inlet zone that enables the removal of coarser sediment particles, the macrophyte zone that allows the removal of finer particles and dissolved pollutants and the high-flow bypass channel that allows the excess stormwater from larger storm events to flow around the wetland without damaging the system.

The three zones in the wetlands work on three different levels, physical, biological and chemical uptake as well as pollutant transformation. Plants form the physical component, and capture the finer particles and the pollutants attached with the sediments. Microorganisms assists in absorbing the pollutants by amplifying the processes of sedimentation and adhesion to fine suspended particles. Additionally, wetlands also ensure the transformation of the pollutants through microbial processes as well as ultraviolet UV treatment in open water areas.

Wetlands are fundamentally different from bioretention systems in how these systems treat stormwater. Biofiltration systems primarily have temporary ponding of water occurring only after a storm event and are intentionally designed to undergo drying periods between inflows. Whereas wetlands function as aquatic systems, exhibiting distinctions in their treatment processes and featuring permanent water pools. In a biofiltration system, water undergoes processing in a vertical flow direction. In contrast, constructed stormwater. The water in these wetlands is processed horizontally and retained for extended periods.

Preliminary analysis indicates that bioretention systems covering approximately 3% of the total site area or wetlands encompassing approximately 7% of the total site area would be required across the site. This would, however, be dictated by the base lines that have been identified in the preliminary testing and monitoring. The WSUD strategy would be to provide a combination of bioretention swales, basins and wetlands along the treatment train to ensure that the system enables a Neutral or Beneficial Effect (NorBE) on the receiving environments.

4.1.3.3 WATER QUALITY APPROACH DURING CONSTRUCTION STAGE

Considering the total site area of approximately 210.5 hectares and the scale of the redevelopment, including 6 independent precincts, roads and landscape areas, the construction stage for the project will be a vital part of the stormwater management strategy. This would encompass how the water quality and runoff is managed during all stages of construction, without having impacts on the receiving environments.

All fill material for the site is to be classified as Virgin Excavated Natural Material (VENM) so that the stormwater runoff and underground infiltration are not subject to contamination. Adequate compaction techniques will be utilised, in coordination with geotechnical consultants, to ensure acceptable compaction standards and land stability can be achieved. Prior to any construction activity, sediment and erosion control measures will be

provided throughout the site in accordance with Landcom's Managing Urban Stormwater: Soils and Construction Volume 1 and 2.

4.2 FLOOD STUDY

The flood model for the proposed redevelopment assesses the range of flood events, including 1 in 10, 1 in 20, 1 in 50, 1 in 100, 1 in 500, 1 in 2000, 1 in 5000 and Probable Maximum Flood (PMF). The extents of the flood model encompass Greenhills to the West and Kurnell to the East. As per the requirement of the DPE, the flood analysis determines that the habitable floor levels of the buildings are above the probable maximum flood levels. Refer to **Appendix B** for flood model details and flood maps.

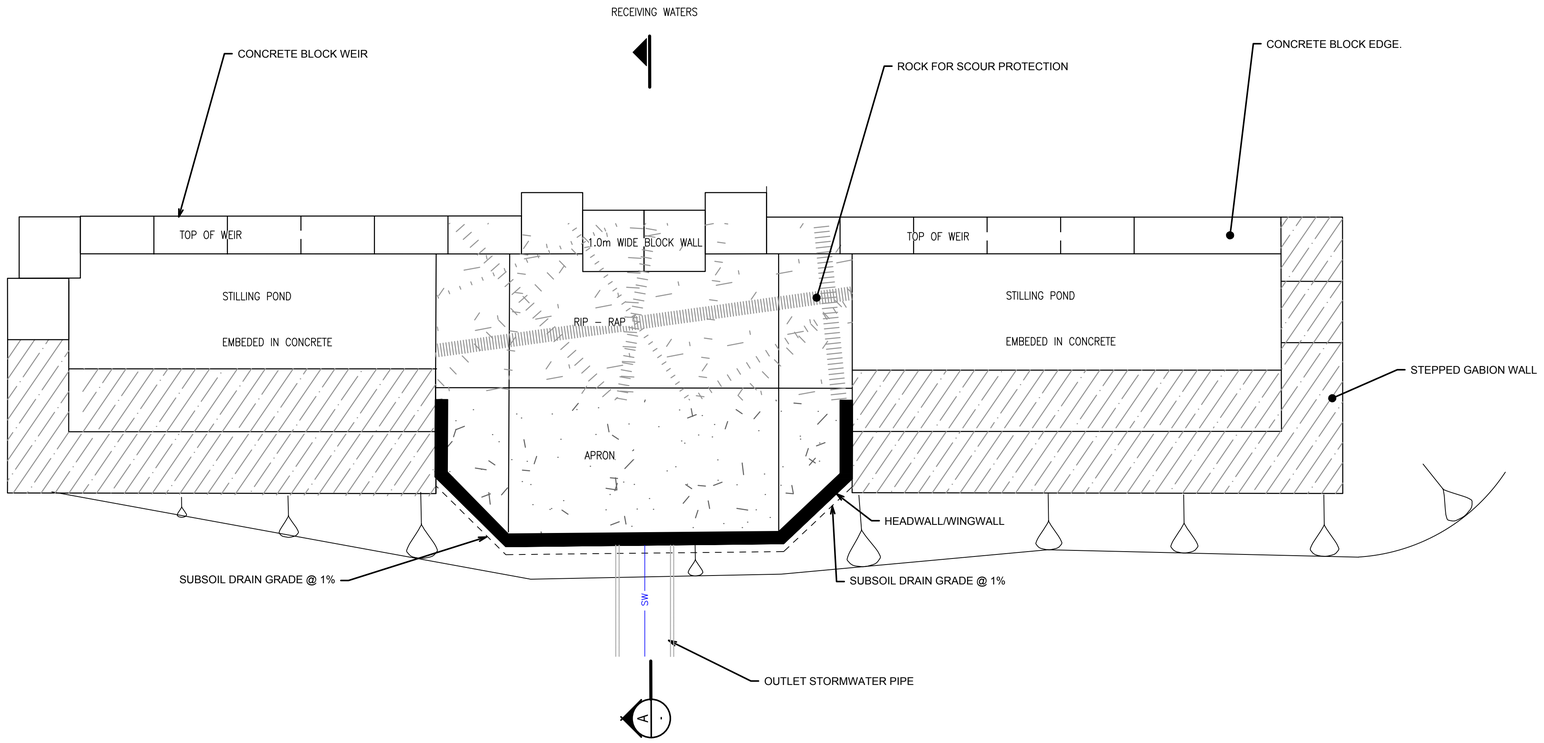
5 CONCLUSION

The development site at 251, 260R, 278 and 280-282 Captain Cook Drive, Kurnell, with its areas of significant ecological and cultural value, has proven to be a challenging environment in which to develop a stormwater management system that is sympathetic to these features whilst still achieving the levels of performance required by the authorities.

Despite these constraints, by developing a system that considers a combination of both built infrastructure as well as natural environmental processes, along with the provisions of initial and continuing monitoring measures, we have proposed a system that will enable the site to be developed whilst having a Neutral or Beneficial Effect (NorBE) on the water discharging from the site and thus the environment that forms part of the receiving waters for this site. By adopting different approaches across the site depending on the proposed future, use we have been able to incorporate stormwater management measures into the fabric of the development thus enabling them to be present without compromising the utility and aesthetic value of the development proposed for this site.

The report evaluates all the requirements that have been provided from the relevant authorities (Department of Planning and Environment, NSW Department of Primary Industries and Sutherland Shire Council) and provides comments and a design strategy which aims to address these key requirements.

APPENDIX A:
PLANS AND SKETCHES



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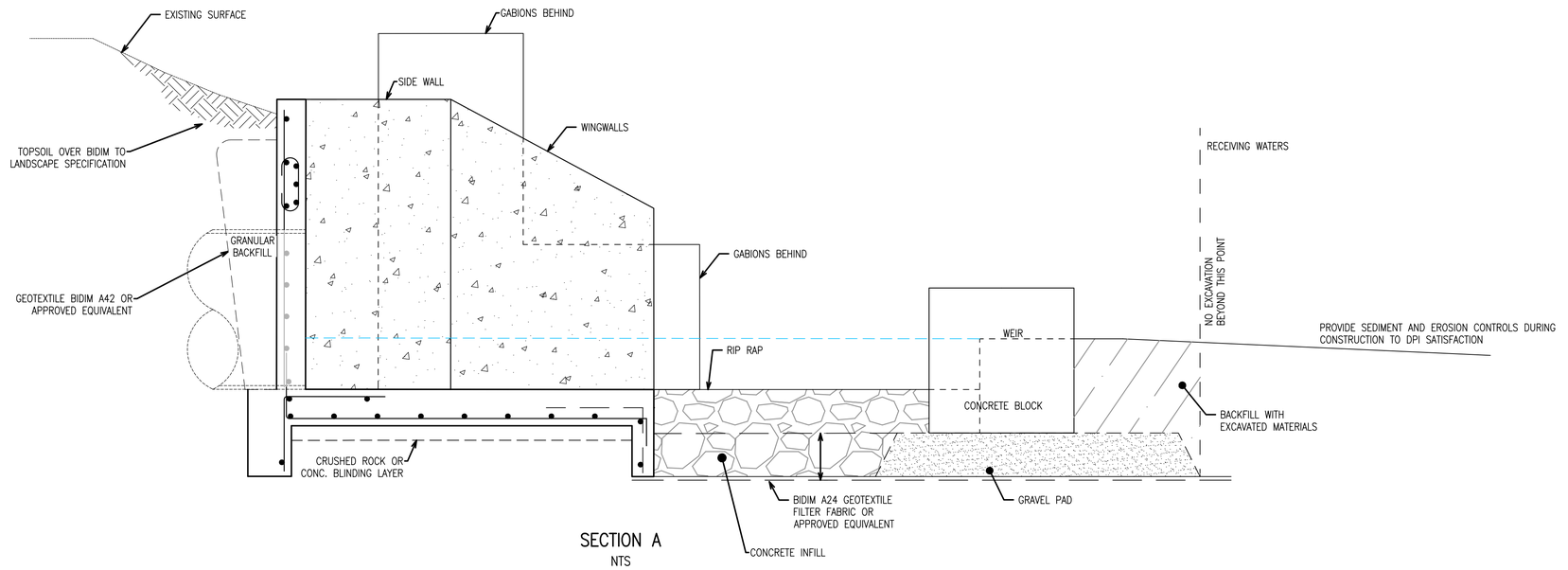

SECTION A
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SCALE:

DRAWING TITLE:
251, 260R, 278 AND 280-282
CAPTAIN COOK DRIVE, KURNELL
STORMWATER OUTLET CONCEPT (TYPE 1)

DRAWING No.	DATE	REVISION
SKC-01A	01/12/2023	1

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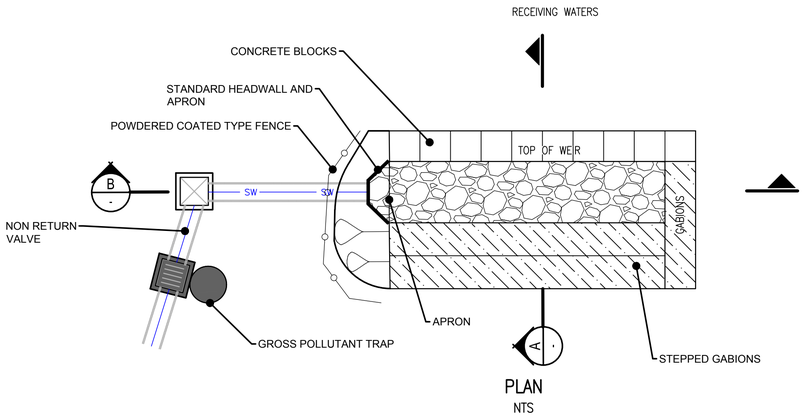

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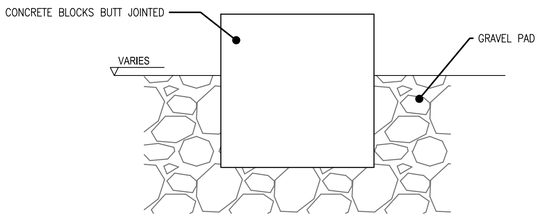

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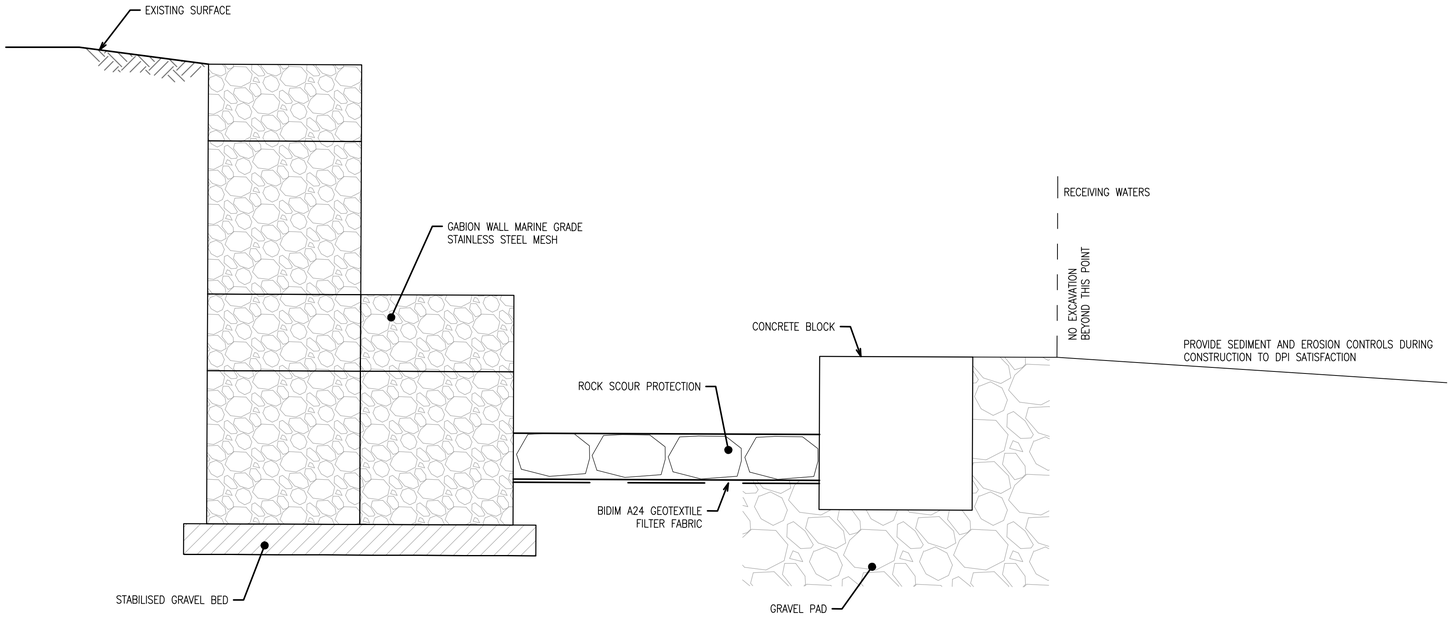

SECTION A
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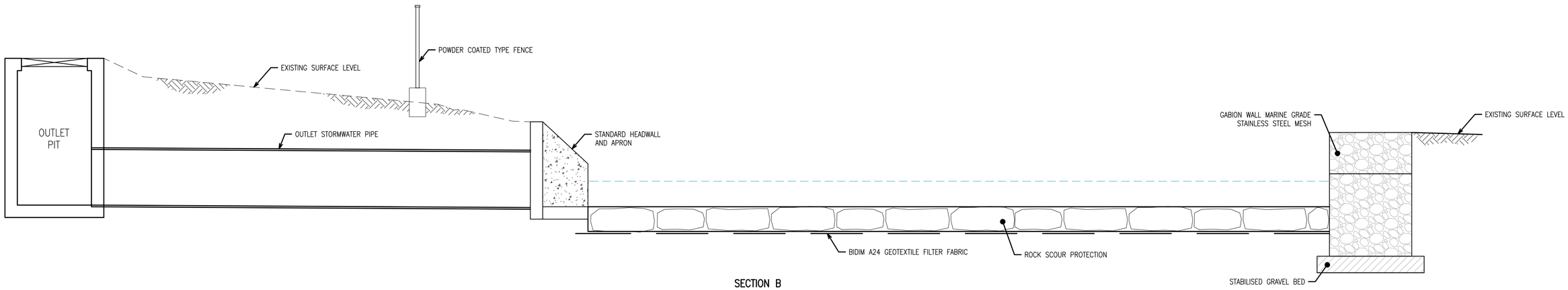

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2. ALL DIMENSIONS SUBJECT TO DETAILED DESIGN BASED ON SITE LEVELS, FLOWS AND GROUND CONDITIONS

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SCALE:

DRAWING TITLE:
251, 260R, 278 AND 280-282 CAPTAIN COOK DRIVE, KURNELL
STORMWATER OUTLET CONTROL (TYPE 2)

DRAWING No.	DATE	REVISION
SKC-01B	01/12/2023	1

CAPTAIN COOK DRIVE

CAPTAIN COOK DRIVE

BATE BAY

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NOTE:
- INDIVIDUAL PRECINCTS TO BE PROVIDED WITH ON-SITE STORMWATER STORMWATER DETENTION AND WATER QUALITY MEASURES BEFORE DISCHARGING TO EXTERNAL STORMWATER SYSTEM.
1. ON-SITE STORMWATER DETENTION SYSTEM TO ENSURE PEAK FLOWS AND VOLUMES ARE CONTROLLED TO PRE-DEVELOPMENT (REMEDIATED) VALUES FOR EACH PRECINCT.
2. WATER QUALITY MEASURES TO ENSURE COMPLIANCE WITH QUALITY TARGETS SET OUT BY SUTHERLAND SHIRE COUNCIL, SYDNEY WATER AND BOTANY BAY CATCHMENT WATER QUALITY PLAN.

- EXTERNAL AREAS TO BE PROVIDED WITH A COMBINATION OF ON-SITE STORMWATER DETENTION BASIN, BIORETENTION SYSTEMS (SWALES AND BASINS) AND WETLANDS.
1. STORMWATER FLOWS AND VOLUMES TO BE CONTROLLED TO PRE-DEVELOPMENT (REMEDIATED) LEVELS FOR THE ENTIRE SITE.
2. WATER SENSITIVE URBAN DESIGN (WSUD) MEASURES TO BE PROVIDED IN THE FORM OF BIORETENTION BASINS, SWALES AND WETLANDS. FINAL DESIGN AND SIZING TO BE BASED ON EXISING BASE VALUES AT THE OUTLETS AND UPDATED NSW WATER QUALITY OBJECTIVES.

STATUS	SCALE	DRAWING TITLE
FOR INFORMATION		251, 260R, 278 AND 280-282 CAPTAIN COOK DRIVE, KURNELL STORMWATER MANAGEMENT CONCEPT PLAN
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APPENDIX B:
FLOOD REPORT

egis

17-002832

KURNELL HYDROLOGY AND HYDRAULIC ANALYSIS

KURNELL HYDROLOGY AND HYDRAULIC ANALYSIS

Prepared for Besmaw

Document information

GENERAL INFORMATION

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1	29-Nov-2023	Troy Eyles

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1 INTRODUCTION

Egis have been engaged by Besmaw Pty Ltd to undertake a revised Hydrology and Hydraulic Analysis to support of planning proposal for the redevelopment of the site at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell. The existing site has currently been occupied for commercial/industrial purposes and a large portion of the site (280-282 Captain Cook Drive) has been occupied for sand extraction and replacement of the removed sand with clean fill.

Besmaw Pty Ltd, the landowner of 251 and 280-232 Captain Cook Drive, Kurnell aims to translate and amend current land uses zones under the applicable controls to be consistent with the standard instrument local environmental plan zones and enable additional uses to accommodate a diverse range of land uses at 251, 260R, 278, and 280-282 Captain Cook Drive, Kurnell (the site). The Planning Proposal will establish a new mixed-use community encompassing residential, employment, tourism, education, cultural facilities, ecological regenerative zones and public open space areas.

This report has been prepared for Besmaw Pty Ltd to present the strategy for the management of flooding associated with the proposed development.

In March 2023, the proponent submitted a Scoping Proposal to Sutherland Shire Council to commence the formal Planning Proposal process, in accordance with the LEP Making Guidelines. The Scoping Proposal provided a comprehensive 'status update,' outlining the concept master plan, the intended development outcome, the proposed planning controls and the environmental considerations which were to be further resolved.

As part of the Scoping Proposal process, Council referred the Scoping Proposal package to the DPE, State agencies, and several internal Council teams for review and comment. The advice received from these stakeholders has provided clear directives on the necessary updates and key focus areas within the technical documentation.

Separate to the Scoping Proposal package, extensive and ongoing engagement with relevant State Agencies has occurred since November 2022, with the objective of clarifying and resolving any of the outstanding considerations.

Besmaw has engaged Egis Group to prepare a Flooding Report to address the feedback received from the DPE and state agencies and reflects the engagement undertaken to date.

The primary objective of this report is to provide both hydrology and hydraulics information to inform the design of the proposed future development.

The Strategy has been based on the requirements of Australian Rainfall and Runoff 2019. The methodology has been provided in the revised documentation.

1.1 Site Location and Project Area

The site is located on the Kurnell Peninsula within the Sutherland Shire Council LGA in the southwest region of Sydney NSW. A map of the peninsula and the extent of the TUFLOW model is provided below in Figure 1.1.

The model extents is denoted by the purple line, the model will be set up with a 10 metre grid resolution for most parts of the peninsula with the areas in red, modelled with a 1.25 metre grid resolution (all road corridors and the site and adjoining lots)

The development site is bound by Quibray Bay to the north, Lindum Road to the west, a dirt road from Captain Cook drive leading to the Boat Harbour on the east and lot 8 (lot 8 on DP 586986) to the north east.

Additionally Figure 1.1 shows the development site locality plan with the following two (2) divisions:

- Lot 2 North - currently used as a private recreation facility (horse stables).
- Lot 2 South - currently operates under two separate Environmental Protection Licences issued by the NSW Environmental Protection Authority (EPA) for sand extraction (EPL 3629) and land rehabilitation (EPL 5658). Sand extraction has occurred at the site since 1968 and Rehabilitation of the void is undertaken using imported Virgin Excavated Natural Material (VENM) which is controlled through an Environmental Management Plan and associated Standard Operating Procedures.
- Lot 8 and 9 is considered part of the revised development site. This parcel of land is low lying and regularly ponds during rainfall events. The soil conditions within Lot 8 and 9 are sand which has a high infiltration rate and enables ponding to dissipate. In larger events, flows have the ability to drain towards Captain Cook Drive via the swale running alongside the dirt road. Lot 8 includes an area of ecological significance on the eastern end and aboriginal heritage at the northern end.

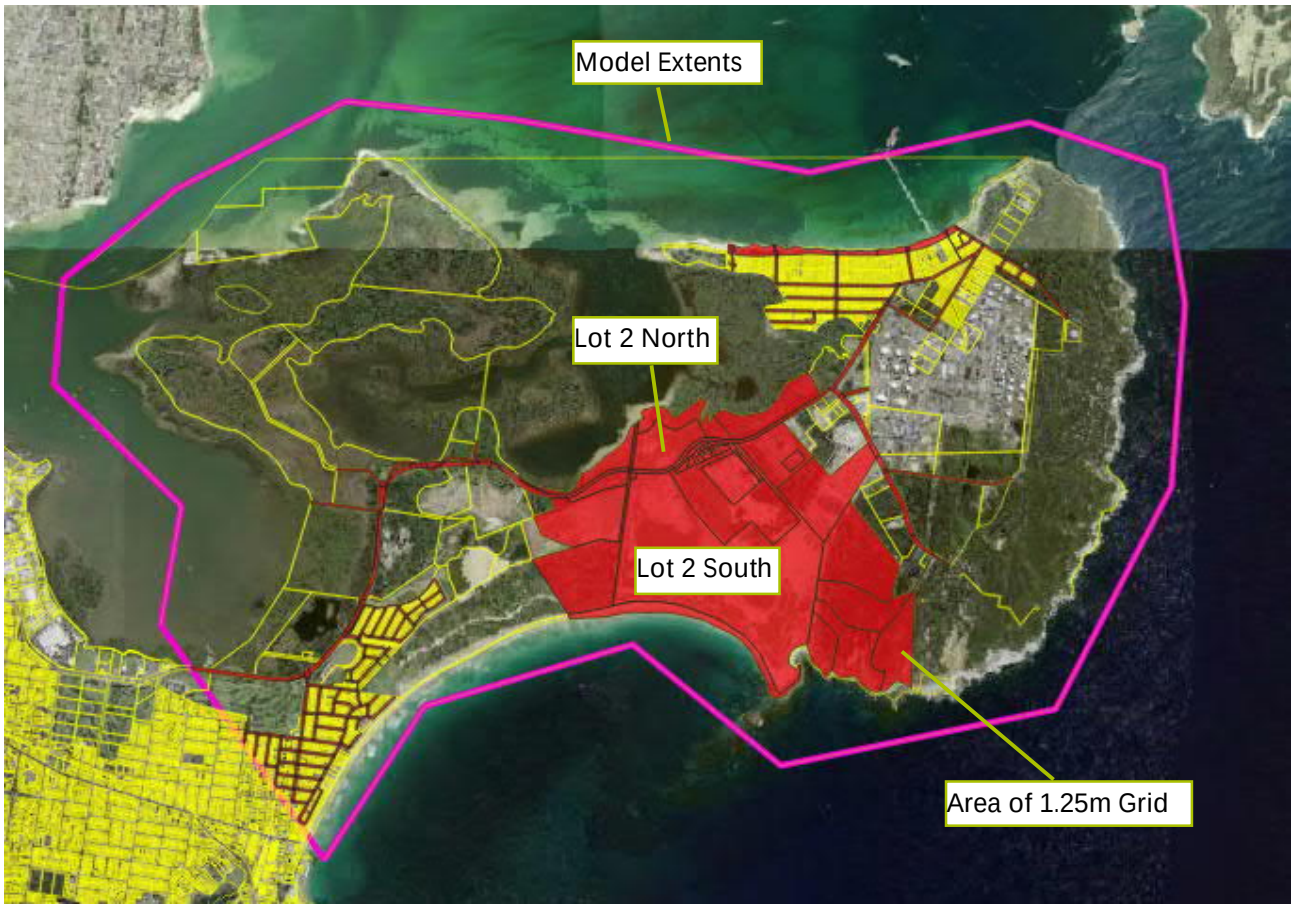

FIGURE 1.1: EXTENT OF TUFLOW MODEL

2 PROJECT BACKGROUND AND OBJECTIVES

Amendments to the SEPP are proposed to modify the land use zones and permissible uses (including residential accommodation) which currently apply to the site, into Standard Instrument zones. This will enable the site, which is presently identified as a "deferred matter" under Sutherland Local Environmental Plan 2015 (the LEP), to be zoned under that LEP and SEPP Kurnell Peninsula 1989 as it relates to the Besmaw site to be repealed.

In September 2017, the DPIE issued a 'scope of works' which identified the need for a range of technical studies to undertaken in order to support the proposed amendments to the SEPP. Refer to Section 3.1.

Besmaw have subsequently engaged Egis to prepare a *Hydrology and Hydraulic Analysis Report* to address the DPIE 'scope of works' items which relate to site flood management. The findings of this report have then informed the masterplanning process for the site. The primary objective is to provide enough information to enable both Council and DPIE to grant approval of the proposed amendments to the SEPP.

3 LEGISLATION AND PLANNING REQUIREMENTS

The legislative and planning requirements for this development have been referenced and addressed in the Stormwater Management Report prepared by egis. For details of the legislation and planning requirements as they pertain to this development, refer to Section 3 for all guidelines, for the purpose of this report and the associated flooding only those requirements as they relate to flooding and flooding impacts will be utilised and addressed in this report.

4 DATA SOURCES

The following sections provided details of the modelling parameters and assumptions used to perform the *Hydrology and Hydraulic Analysis* of the site.

4.1 Topographic Data

Initial topographic data for the base model was obtained from the ELVIS (Elevation and Depth – Foundation Spatial Data) web portal as operated by the Intergovernmental Committee on Surveying and Mapping (ICSM). The ELVIS web portal provides access to data from contributing state government bodies including NSW Spatial Services and ACT Government.

From the ELVIS web portal, Digital Elevation model (DEM) tiled data with a 1 metre horizontal resolution was downloaded for the site and surrounding area. The DEM tiles were created by NSW Spatial Services and are based on the latest Light Detection and Ranging Systems Technology (LiDAR).

The imagery used in this study is on the following tiles:

TABLE 4-1: LIDAR TILES USED

TILES	
PortHacking202004-LID1-AHD_3286230_56_0002_0002_1m.tif	PortHacking202004-LID1-AHD_3346232_56_0002_0002_1m.tif
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PortHacking202004-LID1-AHD_3286234_56_0002_0002_1m.tif	PortHacking202004-LID1-AHD_3366232_56_0002_0002_1m.tif
PortHacking202004-LID1-AHD_3306230_56_0002_0002_1m.tif	PortHacking202004-LID1-AHD_3366234_56_0002_0002_1m.tif
PortHacking202004-LID1-AHD_3306232_56_0002_0002_1m.tif	Sydney202004-LID1-AHD_3286236_56_0002_0002_1m.tif
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PortHacking202004-LID1-AHD_3326232_56_0002_0002_1m.tif	Sydney202004-LID1-AHD_3366236_56_0002_0002_1m.tif
PortHacking202004-LID1-AHD_3326234_56_0002_0002_1m.tif	
PortHacking202004-LID1-AHD_3346230_56_0002_0002_1m.tif	

The DEM data obtained from the ELVIS web portal was downloaded and read directly into the TUFLOW models without any conversion. The imported data sets were sampled by the TUFLOW engine using a grid to create detailed hydraulics models to allow hydraulic analysis of the site for the critical event.

TUFLOW is a one dimensional/ two dimensional flood and tidal modelling software package that has a range of applications and solutions to problems involving surface flows to simulate flooding and tidal flows. The modelling package is ideally suited to the modelling of rivers and creeks with complex flow patterns and unusual terrain. The TUFLOW package is based on a grid system where the terrain is broken in to discrete squares of equal size with levels extracted from each cell using the supplied data. The calculated flow within each square cell is determined from the combination of supplied model inflows and the natural overland flow from one cell to the next.

4.2 Design Surface

The development of the design surface was informed by an initial site contour design provided by Group GSA. These design contours generally undulating from east to west to allow for some topography and presentation of the development.

The supplied design contours were imported into the 3d design package 12D and were used to create a 3d surface. The surface was then was exported as a 12da TIN and applied within the TUFLOW model.

4.3 Hydrologic Modelling Data

Flood modelling of the entire Kurnell peninsula has not previously been undertaken, though as part of a previous study Egis has undertaken modelling of the site and immediately adjacent areas. Therefore, Egis had to determine the flows for the entire peninsula based on the rainfall patterns for the required events, using the ARR 2019 methodology.

4.3.1 XP-RAFTS Catchment Modelling

There is no existing hydrology models available for the peninsula. A simplified XP-RAFTS model was therefore created to represent the 'existing' site conditions based on Australian Rainfall and Runoff (ARR) 2019 Data Hub website. A number of durations and temporal patterns were then tested to calculate the critical duration and median temporal pattern for the site.

The southern limit of the site includes large frontal dunes which are well maintained and established. As a result, there is effectively no upstream catchments and the critical storms are determined solely by the run-off which falls upon the site.

In accordance with ARR, the 100 year ARI (1% AEP) storm is defined as the 'design event' and it is generally taken as the 'critical duration' for all high level assessments. This report has therefore adopted the critical duration for the 100 year ARI (or 1% AEP) flooding analysis to inform the development. This critical duration for the design event is important, since it informs the size of trunk stormwater infrastructure, overland flowpaths and is used to determine flood planning levels. Given this report is considered preliminary in nature, the critical duration is considered appropriate and it is expected that the full range of additional recurrence intervals (i.e 1 in 10) can be modelled and tested as part of future investigation works (i.e at the DA stage).

No changes have been made to the XP-RAFTS modelling to assess the impacts between the 'existing' and 'developed' models. The 'existing' model was created to determine the discharge flowrate from the site and to determine which is the critical duration. The 'developed' model was then run with the same critical duration. By doing so, this ensures that any potential impacts are associated with development changes rather than comparing durations.

Since this study is only being used to inform a planning proposal and is not as part of a DA application, the pit and pipe network has yet to be designed and subsequently have not been incorporated. Therefore, those smaller storms (such as the 10 and 20 year ARI events) have not been modelled since these are critical for the design of pit and pipe networks, not for the analysis of regional flood impacts.

The 500 year ARI have been modelled in line with the requirements of the DPE 'scope of works' as a requirement for emergency access and evacuation. These flood extents demonstrate the additional flooded areas which occur in events larger events than the 100 year ARI event. It is expected that more detailed flood modelling for climate change would be undertaken a later stage.

The overland flooding presented in this report is considered suitable to inform the planning proposal. These results show where overland flow is being directed as a result of the surface modelling and Section 5.5 provides discussion on how these flows will be managed. Any further detailed analysis of these events would need to be undertaken as part of the Development Application (DA) or Construction Certificate (CC) stage once the detailed design is undertaken and the site layout is finalised. Any sensitivity analysis for climate change would also need to be undertaken as part of the future stage.

XP-RAFTS modelling has solely been undertaken to determine the critical duration and to produce the rainfall patterns for use in TUFLOW modelling.

The catchment model was set up and run for the 30 and 45 minute events and the 1, 1.5, 2, 3, 4.5, 6, and 9 hour durations for the ten temporal patterns as specified in the revised method in ARR (2019).

The box and whisker plot output for the different storm durations and temporal patterns is shown in Error! Reference source not found. below.

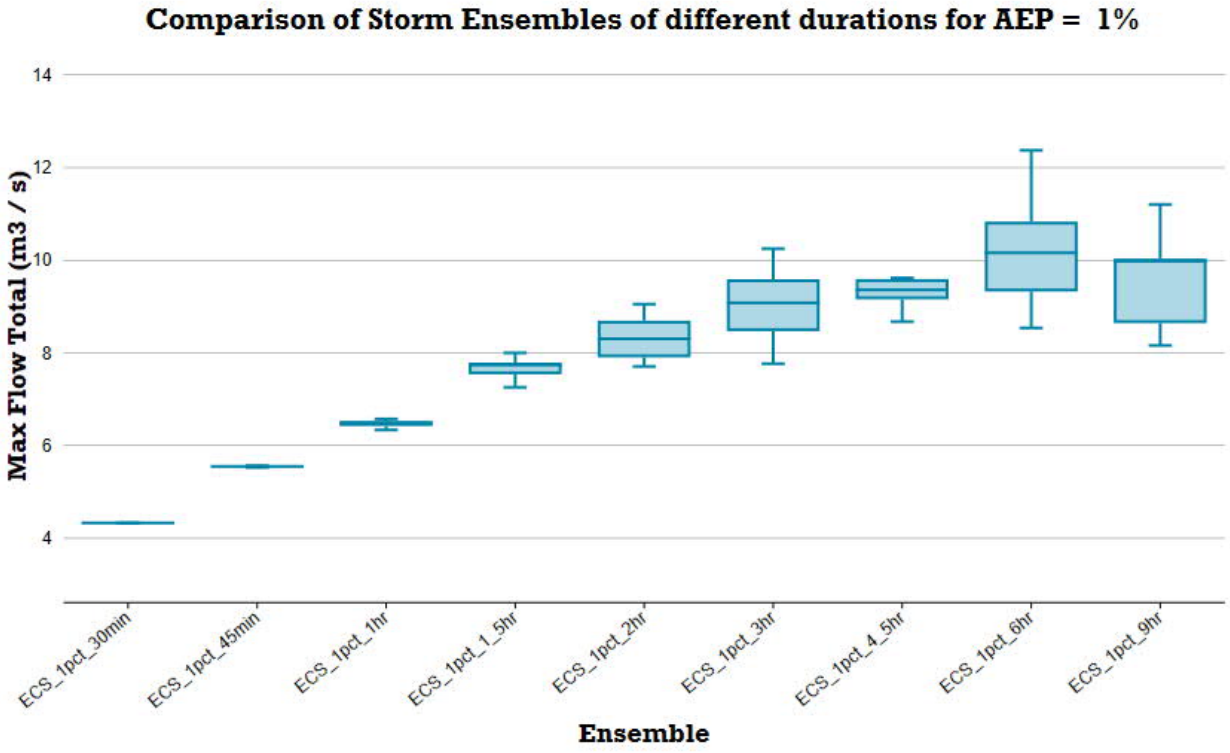

FIGURE 4.1: XP-RAFTS RESULTS

Under ARR2019, the critical event for a given duration is to be taken as the median (or next highest result) based on the ten rainfall temporal patterns as specified in ARR2019. In XP-RAFTS, the results are shown using a box and whisker plot, where the top and bottom 25 percentile results are shown with the lines (or whiskers) and the middle 50th percentile values are symbolised by a box. In the box and whisker plot extracted from the XP-RAFTS results, the highest median storm as designated by the line within the box was during the 6 hour (360 minute) storm. The table output from XP-RAFTS gives the median storm as the one generated from the fifth temporal pattern. Therefore, in all further TUFLOW modelling the 100 year 360 minute 5th Temporal pattern rain event (as specified in ARR2019) was used for the modelling of runoff from the site.

4.3.2 Effects of Sea Level Rise

The potential impact of sea level rise has not been considered as part of this assessment since the TUFLOW model does not include any pit and pipe networks and only considers overland flow. Considering this site has been built up by at least 1m or more, and will continue to drain overland to the bay, increases in sea level are expected to have no impact.

The impact of climate change and sea level rise has however been discussed in *Section 3.7 of the associated Draft Water Cycle Management Assessment for 251 and 280-282 Captain Cook Drive, Kurnell, NSW* as prepared by Coffey and Eco-Logical. The Coffey Report identified that the planning benchmarks for sea level rise developed by Sutherland Shire Council compared to the 2015 mean sea levels are a maximum size of 26 cm and 98 cm respectively by the years 2050 and 2100.

Reference was also made to a study by Royal Haskoning DHV in 2019 which considered the impact of coastal processes on the site and adjacent environmental protection areas, including the impact of sea level rise and climate change. The outcomes from this study identified the following impacts on the site:

Lot 2 North

- A wind wave height of 1.3 m and peak wave period of 3.3 seconds is predicted during a 100-year ARI storm event. Based on this, a 2120 storm nearshore still water level of approximately 2.6 m AHD is predicted at Quibray Bay.
- The current dune and wetland vegetation buffer adjacent to the Lot 2 North boundary is effective in inducing breaking of wind waves during extreme conditions and dissipating energy before wave runup reaches the Lot 2 North boundary. Therefore, wave run up associated with wind waves is not anticipated to significantly affect the development.

Lot 2 South

- No coastal inundation impacts are expected due to the existing dune crest levels along the open beach section which are at 8 m AHD elevation, i.e above the predicted design still water and wave runup levels in year 2120.
- The existing dune crest level at Boat Harbour is generally higher that the predicted wave runup design level for 2120, except for the eastern area, which is approximately 1.9 m AHD below the predicted wave runup level. The dune crest is expected to reduce wave velocities hence significant impacts are not expected. The proposed land dedication boundary at Boat Harbour is also considered a suitable setback distance for the proposed development.
  (Draft Water Cycle Management Assessment, 251 and 280-282 Captain Cook Drive, Kurnell, NSW, Coffey 2020)

Based on the findings of these reports, the sea level rises are not expected to have an effect on the development.

4.3.3 Catchment Mapping/ Rain-on-Grid

The site and the breakdown of sub-catchments draining the Kurnell peninsula were not mapped. Instead, the rainfall patterns as obtained from ARR2019 were used directly in the model. This methodology used in this modelling and analysis is known as the 'rain-on-grid' method.

In undertaking a 'rain-on-grid' model, the rainfall pattern for each storm is created using data obtained from ARR2019. This rainfall pattern is then applied to the entire model for each time step. This allows the material roughness and terrain geometry to determine the direction and velocity of any overland flow path.

To reduce the time required to run each model, the 'rain-on-grid' area was contained to the extent of the site and the immediately surrounding area. This reduces model processing time by reducing the amount of calculations required for each model, such that only the site and the immediate surrounding area experiences the storm to produce flows.

Since the 'rain-on-grid' model applied the storm event to the entire catchment and the physical terrain controlled the timing of the flow paths, breakdown of the area into sub-catchments is not required.

4.4 Hydraulic Modelling Data

The hydraulic modelling for this investigation used the requirements specified by Sutherland Shire Council's Development Control Plan and technical guidelines. These include that development will be sized up to and including the 1% AEP, all future water quality control devices will be designed, constructed, and maintained in accordance with the provisions of *Sutherland Shire's Environmental Specification – Stormwater management*. All stormwater will be maintained to flow to their natural catchments and that water discharges will be treated appropriately to avoid adverse impacts on receiving waters.

4.4.1 Boundary Conditions

No upstream boundary conditions were modelled in TUFLOW since flows were applied to the model using the 'rain-on-grid' method.

Separate downstream boundary conditions were provided in the model to represent the ocean water located around the Kurnell Peninsula. These were located to ensure any potential impacts from these boundary conditions on localised water levels occur far downstream and far enough to limit or remove the impact these may have on the site.

4.4.2 Land Use Categorisation (Roughness and Loss Factors)

The catchment land use regions and the initial regional characteristics have been identified during analysis of aerial photography sourced from the Nearmap website.

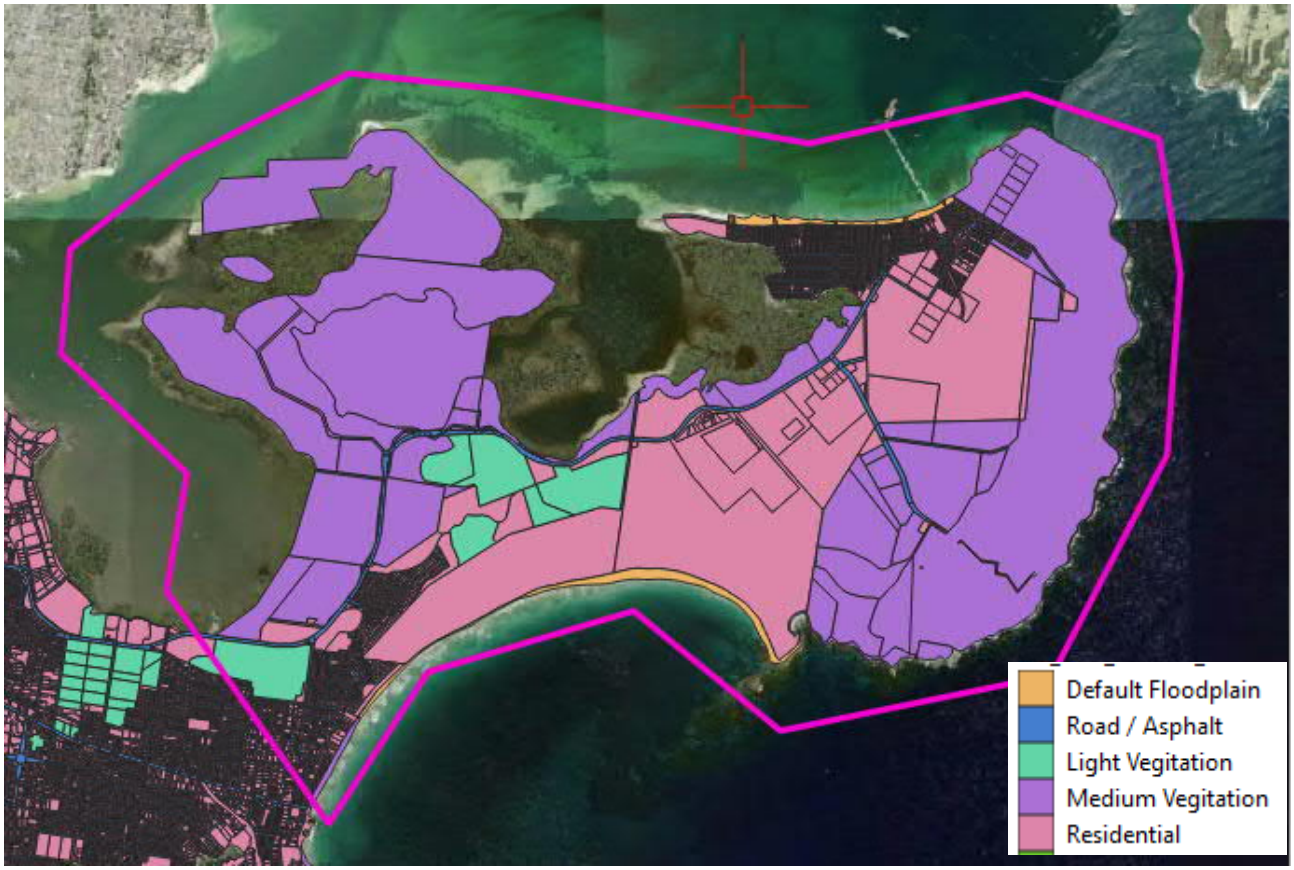

FIGURE 4.2: MATERIAL MAPPING

As part of this preliminary investigation, TUFLOW modelling has adopted a uniform floodplain roughness of n = 0.03 for the entire existing catchment since it is undeveloped. Roadways and other hardstand areas were also included in the model, with area present in the vicinity of the site being identified from the Nearmap Aerial image and digitised into GIS polygons for inclusion in the flood model.

Initial and Continuing Losses were also applied to the different land uses consistent with the advice from Council. This includes sand for the natural areas (which has high infiltration) whilst the areas of filling included typical soil conditions (with much less infiltration).

The materials used in the model are included in Table 4-2 below.

TABLE 4-2: MATERIAL MAPPING

MATERIAL	MANNING 'N'
Default Floodplain	0.03
Road	0.013
Light Vegetation	0.05
Medium Vegetation	0.08
Residential	0.1

Note: Fill in the rehabilitated site was assumed to have the same values as a standard urban area containing standard loamy soil.

4.4.3 Additional Ground Survey

As mentioned in Section 4.1, LiDAR data was used to inform the ground surface in TUFLOW. No additional ground survey was carried out by Egis for this investigation.

5 HYDRAULIC (TUFLOW) MODELLING RESULTS

Hydraulic modelling was undertaken using the TUFLOW (Build: 2020-10-AA-iSP-w64) software flood modelling software package. The methodology adopted used a 'rain-on-grid' method which applied the rainfall pattern to the site and surrounds, allowing the digital terrain model to determine the slope and location of flow paths within the site and thereby the timing for and magnitude of flows leaving the site.

As required by the DPIE Scope of Works, the TUFLOW Modelling has considered the following three (3) Scenarios:

- Scenario 1 – Curent Case ('Pre Rehabilitated Site')
- Scenario 2 – Base Case ('The Rehabilitated Site')
- Scenario 3 – Developed Case

These models were then run for the 100 year, 200 year, 500 year ARI and PMF storms for the critical duration and temporal pattern as determined during the XP-RAFTS modelling (see section 4.3.1).

Results are presented in the following Sections 5.1 to 5.8. These show the flood depths and velocities across the site and surrounding areas. The Proposed Stormwater Strategy to manage these flows are then shown in Section 5.9 to inform the masterplanning for the SEPP amendment.

5.1 Current Case (Pre Rehabilitated Site)

The flood depth mapping for Scenario 1 – 'Current Case' conditions has been prepared for the 10 year, 20 year, 50 year, 100 year, 500 year, 2000 year, 5000 year ARI and PMF events. As they are the major design events, the 100yr and PMF results are presented in the figures below, for the full range of results refer to the attached flood maps in appendix B2.

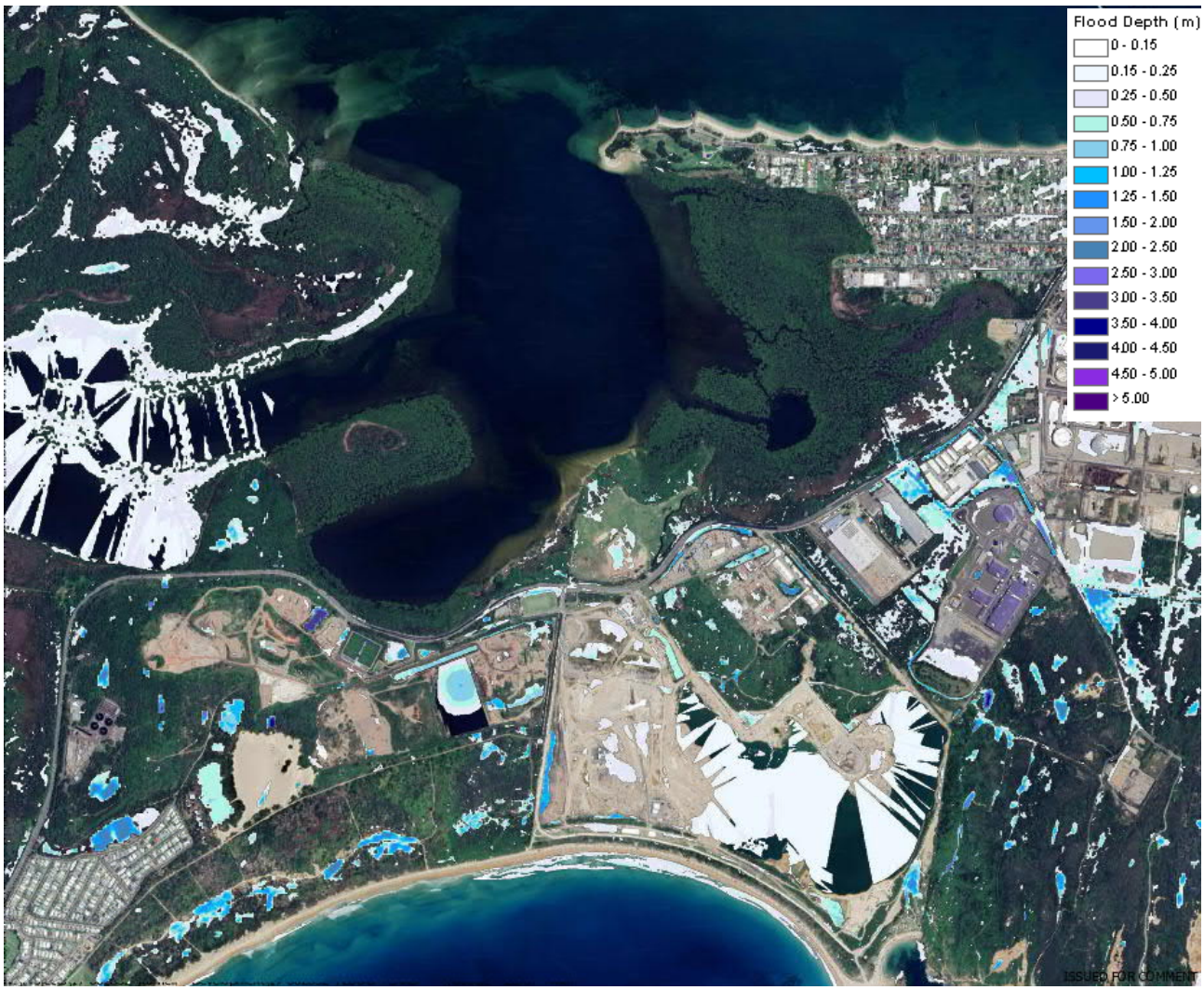

FIGURE 5.1: SCENARIO 1 –CURRENT CASE 100 YEAR ARI FLOOD DEPTH

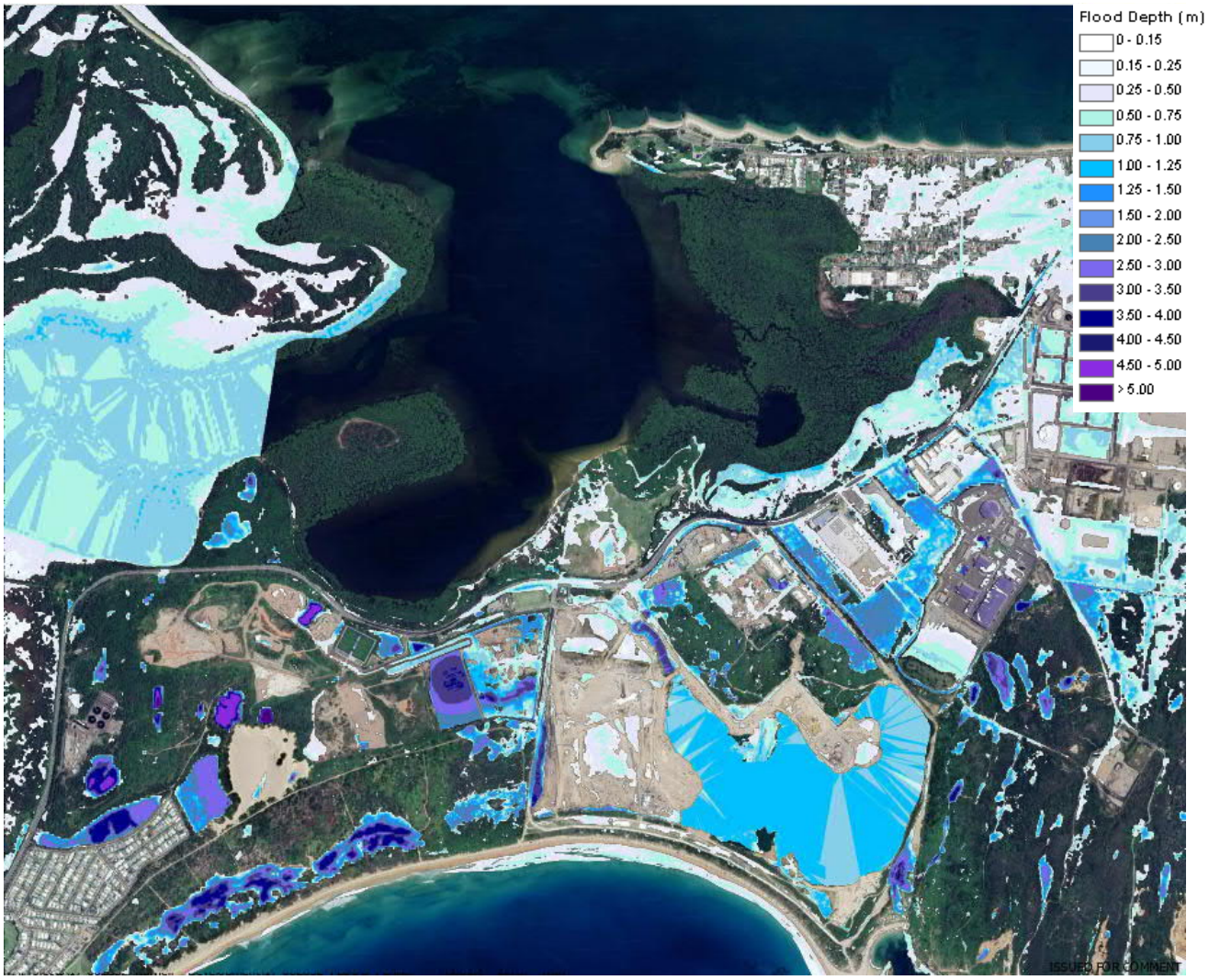

FIGURE 5.2: SCENARIO 1 – CURRENT CASE PMF FLOOD DEPTH

The mapping shown on Figures 5.1 and 5.2 has not shown flood depths below 150mm for clarity. During a 'rain on grid' model, rainfall is applied to every cell within the model boundary. As a result, flood depths are shown across the entire model, even though the flood depth may be as low as 1mm and could be attributed to either low sheet flow and shallow ponding. Therefore, to provide clarity, it is standard practice is to remove all areas with depths below 150mm. This limit is associated with both the level of accuracy of the LIDAR data and is also standard depth for gutter flows.

The results presented on Figures 5.1 and 5.2, demonstrate that since the site has yet to be rehabilitated, surface flows from the 'current case' are directed to the large depression in the middle of the site.

As the final rehabilitated landform has yet to be designed, the site as it is found in-situ today has been used as the basis for flood afflux mapping.

5.2 Scenario 2 – 'Base Case' Flood Depth Mapping

The existing site contains a large depression from the sand mining operations that is still being undertaken on the site under prior approvals and conditions. Rehabilitation of the site is operating concurrently on areas where operations have completed.

At the conclusion of the sand extraction and land rehabilitation, 'Lot 2 South' will be a brownfield site with finished levels consistent with the development consent that applies to the land. The landform will be engineered exclusively from VENM (such as sandstone, clay and sand) and will exhibit the characteristics which were envisaged by DPE when the consent was issued to undertake these activities including native grasses to stabilise the land surface.

The engineered fill within 'Lot 2 South' has generally been progressively occurring from the north-west corner, in an eastern direction, as evident by aerial images. Rehabilitation and reinstating the landform will continue to progress as sand extraction becomes depleted.

As a final rehabilitated landform was not part of the original consent and is and ongoing process, the final surface cannot be determined, therefore, the site as it is found in-situ today has been modelled.

In addition, topography for the site prior to the start of the mining operation to guide this landform is not available as this site has been in operation for over 50+ years and no record of the site topography exist from before this time.

5.3 Scenario 3 – 'Developed' Model

For the planning proposal, an initial bulk earthworks and layout plan for the site was prepared by Egis. A 3d terrain was created within 12D software by Egis and then adopted as the landform in TUFLOW.

The Scenario 3 'developed' site is based on the final landform following development of the site after the sand extraction and rehabilitation of the site has concluded. It also includes all proposed building footprints and associated mapping.

5.4 Scenario 3 – 'Developed' Flood Depth Mapping

The flood depth mapping has been prepared for the 10 year, 20 year, 50 year, 100 year, 500 year, 2000 year, 5000 year ARI and PMF events. The 100yr and PMF results are presented in the figures below , as these storms are the basis for design, for the full range of results refer to the attached flood maps in appendix B2.

The TUFLOW modelling has assessed the impact of the site regrading flow paths and flooding both within and surrounding the site.

FIGURE 5.3: SCENARIO 3 – DEVELOPED 100 YEAR FLOOD DEPTH

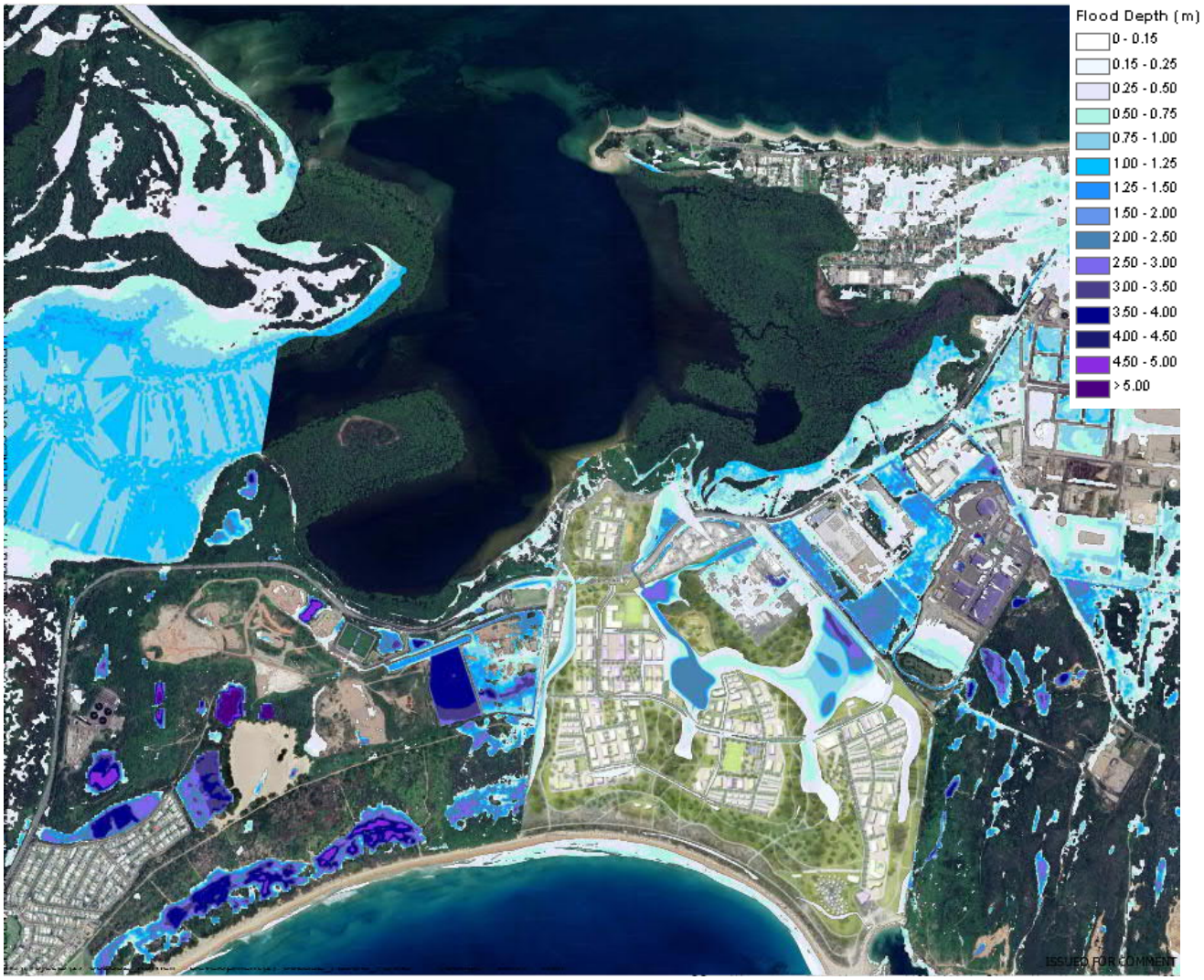

FIGURE 5.4: SCENARIO 3 – 'DEVELOPED' PMF FLOOD DEPTH

Similar to the Scenario 1 mapping, flood depths have also not been shown where flood depths below 150mm for clarity. This is required due to the model being created using a 'rain on grid' model.

The results presented in Figure 5.3 to Figure 5.4 demonstrate that under 'developed' conditions, surface flows are directed from the western portion of the site towards Lindum Road. An area of ponding then occurs within the southern end of Lindum Road.

The eastern portion of the site discharges into Lot 8 (which is under the ownership of *Besmaw Pty Ltd*) with ponding occurring in three (3) main locations. It is noted that ponding occurs naturally in this locations due the existing topography, however is increased as part of the development.

The modelling of the 200 year and 500 year ARI has provided a proxy to assess the sensitivity impact of climate change. Results show that ponding occurs in the same locations as the 100 year ARI event at Lindum Road and within Lot 8. Whilst the ponding extents increase, the general flood behaviour is similar and has no additional impacts on adjoining properties. It is therefore expected that the impact of climate change would be managed by the Stormwater Strategy.

The Proposed Stormwater Strategy to address these flows as part of the masterplan is discussed in Section 5.7.

5.5 Scenario 3 - 'Developed' Flow Velocities

The flood velocity mapping has been prepared for the 10 year, 20 year, 50 year, 100 year, 500 year, 2000 year, 5000 year ARI and PMF events. The 100yr and PMF results are presented in the figures below , as these storms are the basis for design, for the full range of results refer to the attached flood maps in appendix B2.

These categories are based on the Table 5-2 below.

TABLE 5-1: PEAK FLOOD VELOCITY CATEGORIES

VELOCITY (M/S)	CATEGORY
0 - 0.5	OK for most areas
0.5 - 1.0	Threshold for silt, fine sands and fine gravels
1.0 - 1.5	Threshold for clays and gravels up to 25mm
1.5 - 2.0	Threshold for gravels up to 50mm
2.0 - 2.5	Threshold for gravels up to 150mm
2.5 - 3.0	
3.0 - 3.5	Threshold for riprap with d50 = 150-225mm
3.5 - 4.0	Threshold for gravels and riprap with d50 = 300mm
4.0 - 4.5	
4.5 - 5.0	Threshold for gravels and riprap with d50 = 450mm
5.0 - 5.5	
5.5 - 6.0	Threshold for riprap with d50 = 600mm, gabions and concrete
> 6.0	High velocity for most areas

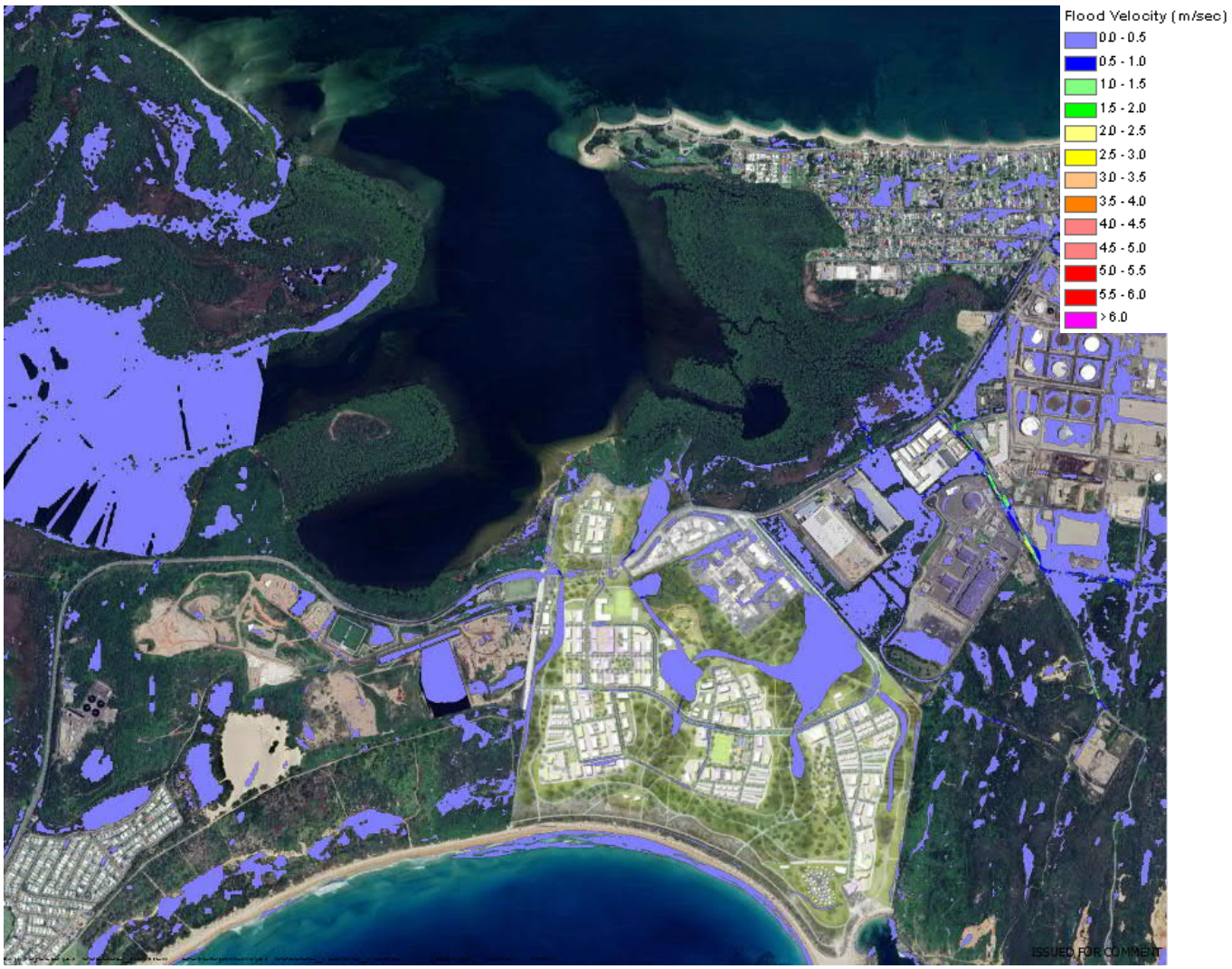

FIGURE 5.5: SCENARIO 3 – 'DEVELOPED' 100YR FLOOD VELOCITY

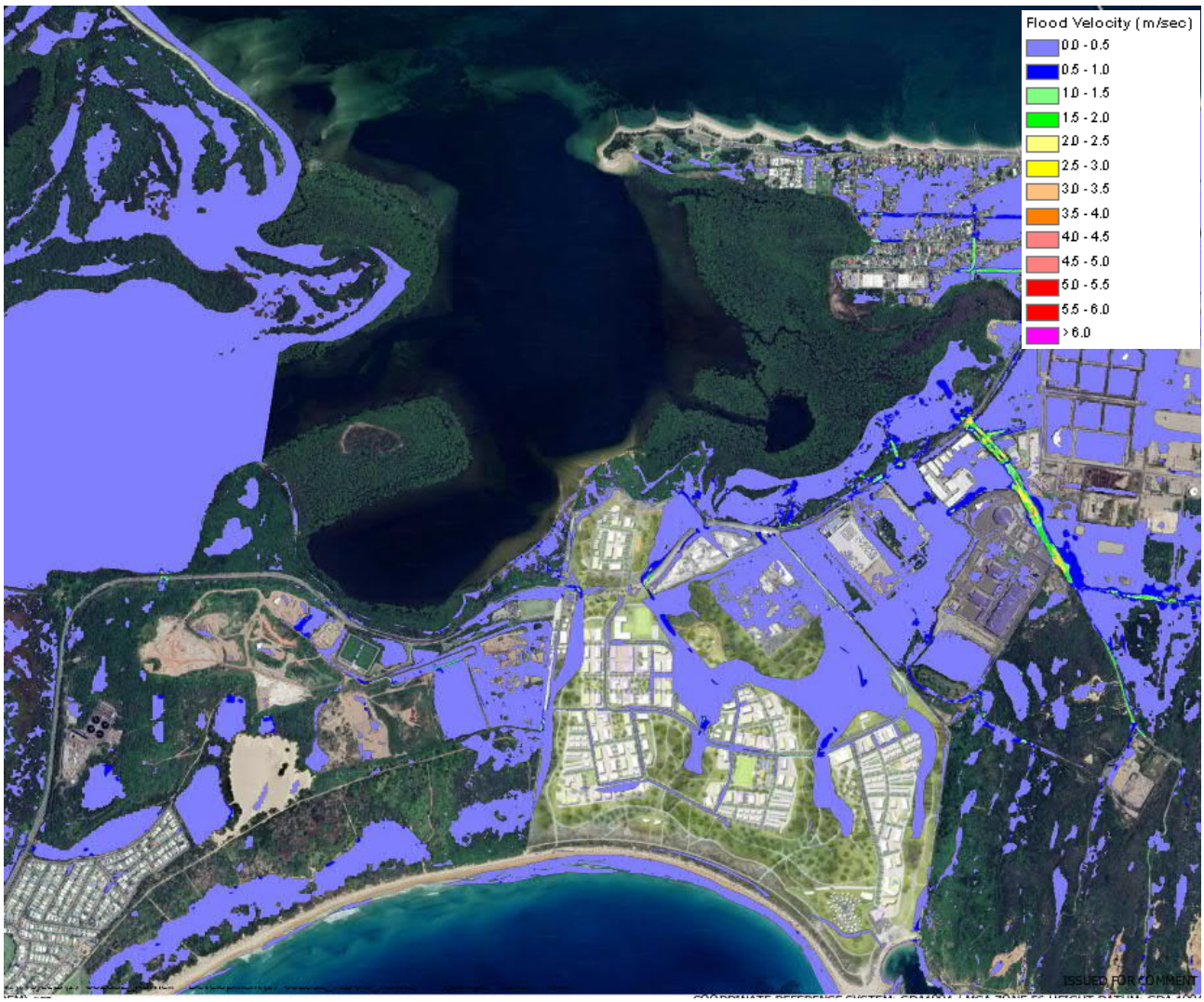

FIGURE 5.6: SCENARIO 3 – 'DEVELOPED' PMF FLOOD VELOCITY

The flood velocities shown on Figure 5.5 and Figure 5.6 have also not been shown where flood depths below 150mm for clarity. This is required due to the model being created using a 'rain on grid' model.

The results shown on Figure 5.5 to Figure 5.6 demonstrates that flows within the site and on the adjacent streets and lots are below 1.0 metre per second with most flows being below 0.5 metres per second. These velocities are suitable for most areas or at most approach the threshold for silts and fine sand. Since this is the underlying geology for the surrounding area, this means that flows discharging from the site should not pose a risk of causing major erosion.

Flows from this location were extracted for the 100, 200, and 500 year storm events, and are presented in chart the chart below.

5.6 Scenario 3 - Flood Difference Maps

The flood difference mapping has been prepared for the 10 year, 20 year, 50 year, 100 year, 500 year, 2000 year, 5000 year ARI and PMF events. The 100yr and PMF results are presented in the figures below , as these storms are the basis for design, for the full range of results refer to the attached flood maps in appendix B2.

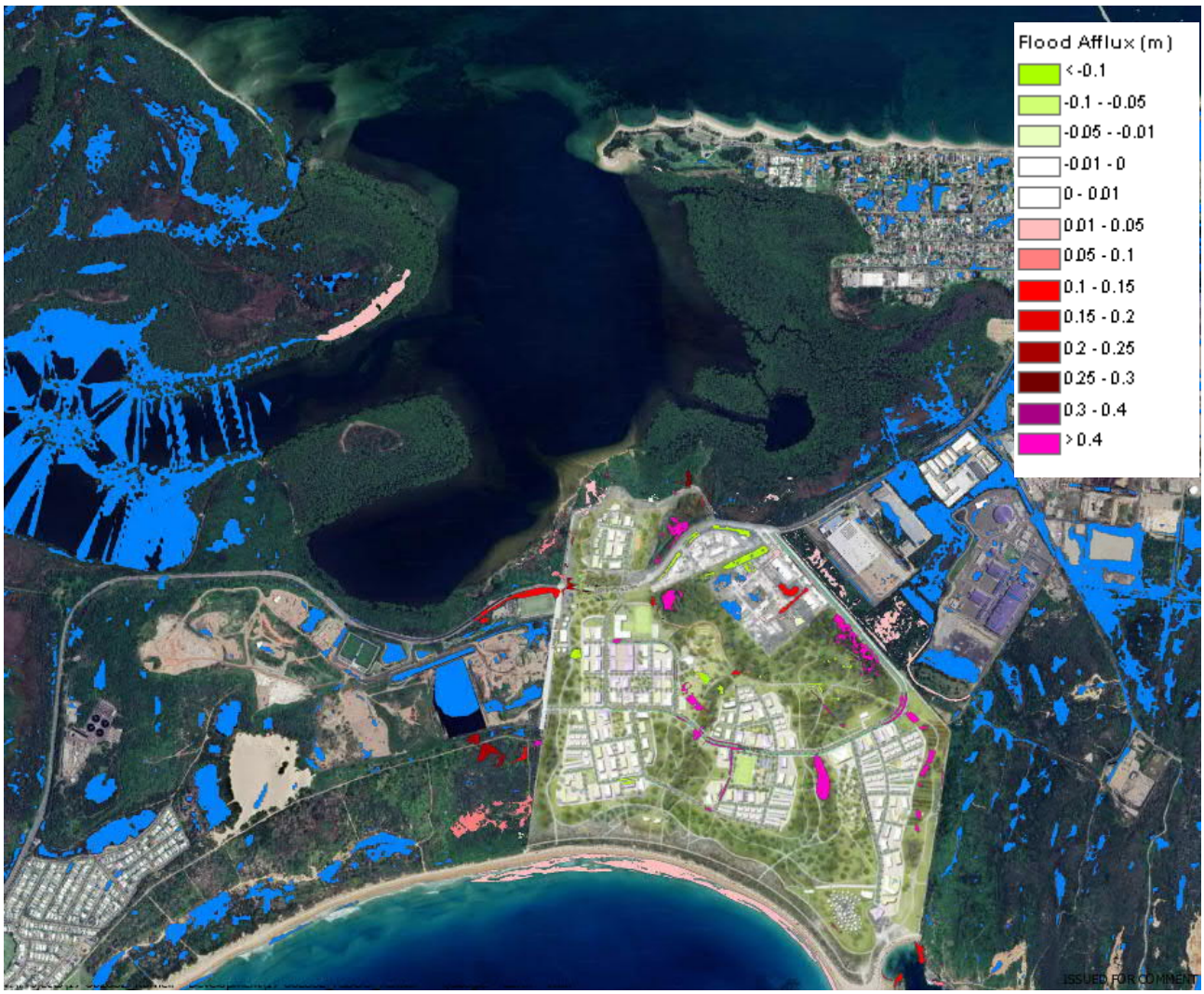

FIGURE 5.7: 100 YEAR ARI FLOOD DIFFERENCE

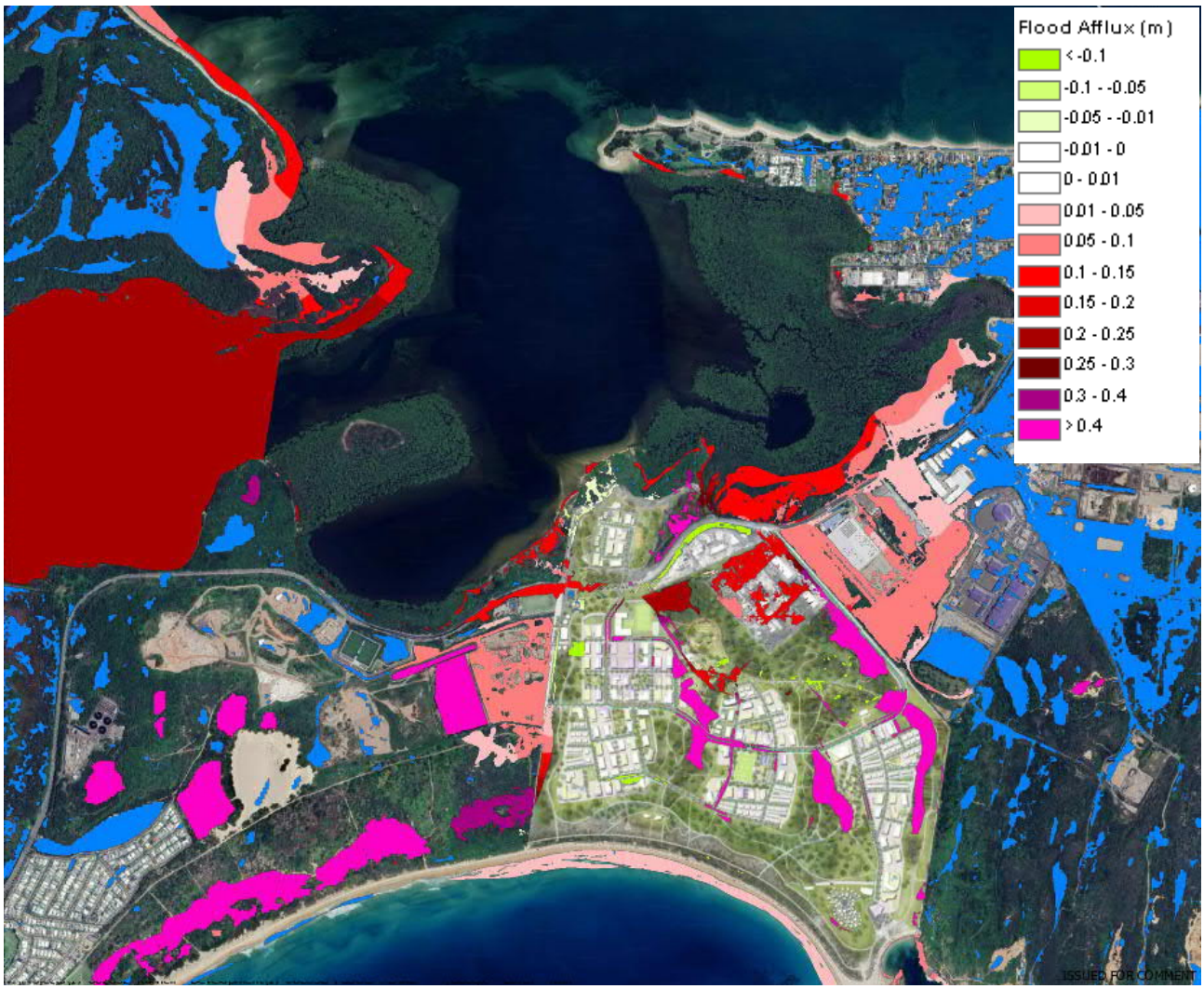

FIGURE 5.8: PMF YEAR ARI FLOOD DIFFERENCE

The flood difference mapping shows that as a result of the 'developed conditions', there are increases in flood depths:

- Within Lindum Road and properties to the West,
- Within Lot 8 including the road swale running to Captain Cook Drive.

These flood difference results are used to understand where surface flows are being directed and to inform the Proposed Stormwater Strategy. Refer to Section 5.9 below.

Importantly, further TUFLOW modelling and flood difference mapping will be provided as part of the future DA application once detailed design has been undertaken. This package will provide details of the design and demonstrate that there is no impact on surrounding properties.

5.7 Proposed Stormwater Strategy

TUFLOW results demonstrate that surface modelling across the Lot 2 South site will direct overland flows both to the west (to Lindum Road) and into Lot 8 (which is owned by *Besmaw Pty Ltd*). Whilst Lot 2 North will direct flows from the platform to surrounding areas.

Refer to the main section of the report for the Proposed Stormwater Strategy proposed for the site to manage these overland flows. The Strategy includes each of the following:

West (to Lindum Road)

- Water quality will be provided within the site using a combination of road swales and bio-retention raingardens.
- On site detention will also be provided within the site via detention basins
- Attenuated flows will be discharged via a pipe system into Lindum Road. These flows will then be conveyed in a minor / major system northward along Lindum Road, across Captain Cook Drive and discharged into Quibray Bay.
- The discharge of flows to Quibray Bay is proposed to include a headwall with scour protection. Energy dissipators and the position will also need to be carefully considered to ensure there is no detrimental impacts on the local environment.

East (to Lot 8 and Captain Cook Drive)

- Water quality will be provided within the site using a combination of road swales and bio-retention raingardens
- Since Lot 8 is within the ownership of Besmaw Pty Ltd, no attenuation is proposed within the site. Flows will instead be discharged to the natural low points within Lot 8 where they can infiltrate into the natural sandy soil conditions. It is expected that this area will provide pseudo detention and in larger events, flows can drain towards Captain Cook Drive within the existing swale – similar to what already occurs under existing conditions.

North (Lot 2 North above Captain Cook Drive)

- Water quality will be provided within the site using a combination of road swales and bio-retention raingardens

The detailed design of these Water Sensitive Urban Design (WSUD) measures will be designed at the DA and CC stage.

6 POST DEVELOPMENT ASSESSMENT

6.1 Flood Evacuation

Results of the TUFLOW modelling demonstrate that there is significant ponding on Captain Cook Drive in both the base (scenario 1) and the developed case (scenario 3). Demonstrate that this site will be isolated during major flood events, as Captain Cook Dive is the sole access into the Kurnell Peninsula. It is noted that a ridgeline to the west of the site could be used for an evacuation route, but this area is under private ownership by a third party. Therefore, agreements with the land owner(s) to the west would be required with easements generated burdening the titles to these properties. This would also require the construction of a road as this area is currently dunes and only traversable by foot. This is not suitable as an emergency access, given the need to potentially allow for the traversing of any proposed access by emergency vehicles and transport for those unable to walk the required route.

Therefore, Egis advise that any future detailed flood evacuation plan utilise a 'shelter-in-place' approach.

6.2 Attenuation of peak runoff

Results from the TUFLOW model demonstrates that the post-rehabilitated or in other words the Scenario 2 - 'Base Case' for Lot 2 South will only generate uniform sheet flows across the surface.

Given the preliminary nature of the TUFLOW model, it is noted that the land use has been applied as fill material across the 'developed' site with a Manning's of 0.04. It is recognised that once the site is full developed, roads and hard stand areas will however also be included which will likely increase the runoff being generated. The proposed OSD basins within the site will be designed to attenuate to pre-developed conditions prior to discharge.

As required by the Scope of Works, the Scenario 3 'Developed Case' has been created in TUFLOW to identify flows leaving the site and to determine potential flood impacts. Results have been provided to clearly show where these flows discharge to and what ponding occurs. A Proposed Stormwater Management Strategy will subsequently be designed as part of development application to manage these flows to ensure there are no downstream impacts. For details of the stormwater management refer to the report prepared by Egis.

It is noted that a comparison against Scenario 1 'Existing' is not considered appropriate given the non-rehabilitated site includes a large lake and water body at the centre which would capture a large portion of the runoff. Almost all discharge from site would therefore be shown to be increased – which is not what would have occurred naturally.

Importantly however, these mitigation measures cannot be replicated in TUFLOW via the 'rain on grid' method without detailed design works being undertaken. This will not be provided until further design at the DA stage.

Any other items mentioned within the 'Scope of Works' which have not been addressed as part of the Report (such as flood hazards, flood risk, detailed flood emergency response plan and evacuations) will also be provided at the DA stage.

7 CONCLUSION AND RECOMMENDATIONS

This *Hydrology and Hydraulic Analysis Report* provides flood modelling results in accordance with the 'scope of works' issued by the Department and the technical methodologies. The objective is to provide information to inform the 'Development Application' design and to support further development of the site.

The assessment and recommendations shown in this report are also in accordance with Australian Rainfall and Runoff Guidelines 2019 (ARR19), NSW Governments 2005 Floodplain Development Manual (FDM) and Flood Prone Land Policy and Sutherland Shire Council technical guidelines.

As required by the Scope of Works, the TUFLOW Modelling has represented both of the following two (2) Scenarios:

- Scenario 1 – Current Case ('The Pre-Rehabilitated Site')
- Scenario 3 – Developed Case

Flood depth and velocity mapping have been presented for the range of storms up to and including the PMF event. Flood difference mapping has also been provided to compare Scenario 1 and 3. These results demonstrate that surface flows will generally discharge with low velocities overland towards Lindum Road to the west and into Lot 8 to the east (which is owned by *Besmaw Pty Ltd*).

The ground level of Lot 2 North is taken to be roughly 5m, 2.4m above the combination of the 100 year ARI still water level, sea level rise to 2120 and 100 year ARI local wave setup according to the Kurnell Coastal Engineering Study Revision 2.0 report prepared by Royal Haskoning DHV. Thus no flood study in this area will be required.

The Proposed Stormwater Strategy to be adopted in the masterplan is shown in Section 5.9.

Any additional flood modelling required under the planning proposal items and associated Council regulations will be addressed as part of future analysis of the site as part of any DA or CC documentation.

APPENDIX B2:
FLOOD MAPPING

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

PMF

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
PMF STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-E-PMF-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH	-	7.12.23	FOR COMMENT
B				
C				
D				
E				

egis

LEGEND

PMF

EXIST

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

1% AEP

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
PMF STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-E-PMF-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
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D				
E				

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

ISSUED FOR COMMENT

WHILE EVERY CARE IS TAKEN TO ENSURE THE ACCURACY OF DATA SOURCED THROUGH THIRD PARTIES, CALIBRE PROFESSIONAL SERVICES PTY LTD MAKES NO REPRESENTATIONS OR WARRANTIES ABOUT ITS ACCURACY, RELIABILITY, COMPLETENESS OR SUITABILITY FOR ANY PARTICULAR PURPOSE AND DISCLAIMS ALL

egis

LEGEND

0.2% AEP

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
0.2% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-E-500-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
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B				
C				
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E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

0.2% AEP

EXIST

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
0.2% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-E-500-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

egis

LEGEND

1% AEP

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
1% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-E-100-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

1% AEP

EXIST

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
1% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-E-100-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

2% AEP

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-E-050-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

ISSUED FOR COMMENT

egis

LEGEND

2% AEP

EXIST

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-E-050-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

5% AEP

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-E-020-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

LEGEND

5% AEP

EXIST

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-E-020-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

LEGEND

10% AEP

EXIST

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-E-010-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH	-	?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

10% AEP

EXIST

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
EXISTING SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-E-010-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

DEM).qgz

ISSUED FOR COMMENT

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

PMF

DEV

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
PMF STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-D-PMF-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

egis

LEGEND

PMF

DEV

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
PMF STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-D-PMF-B

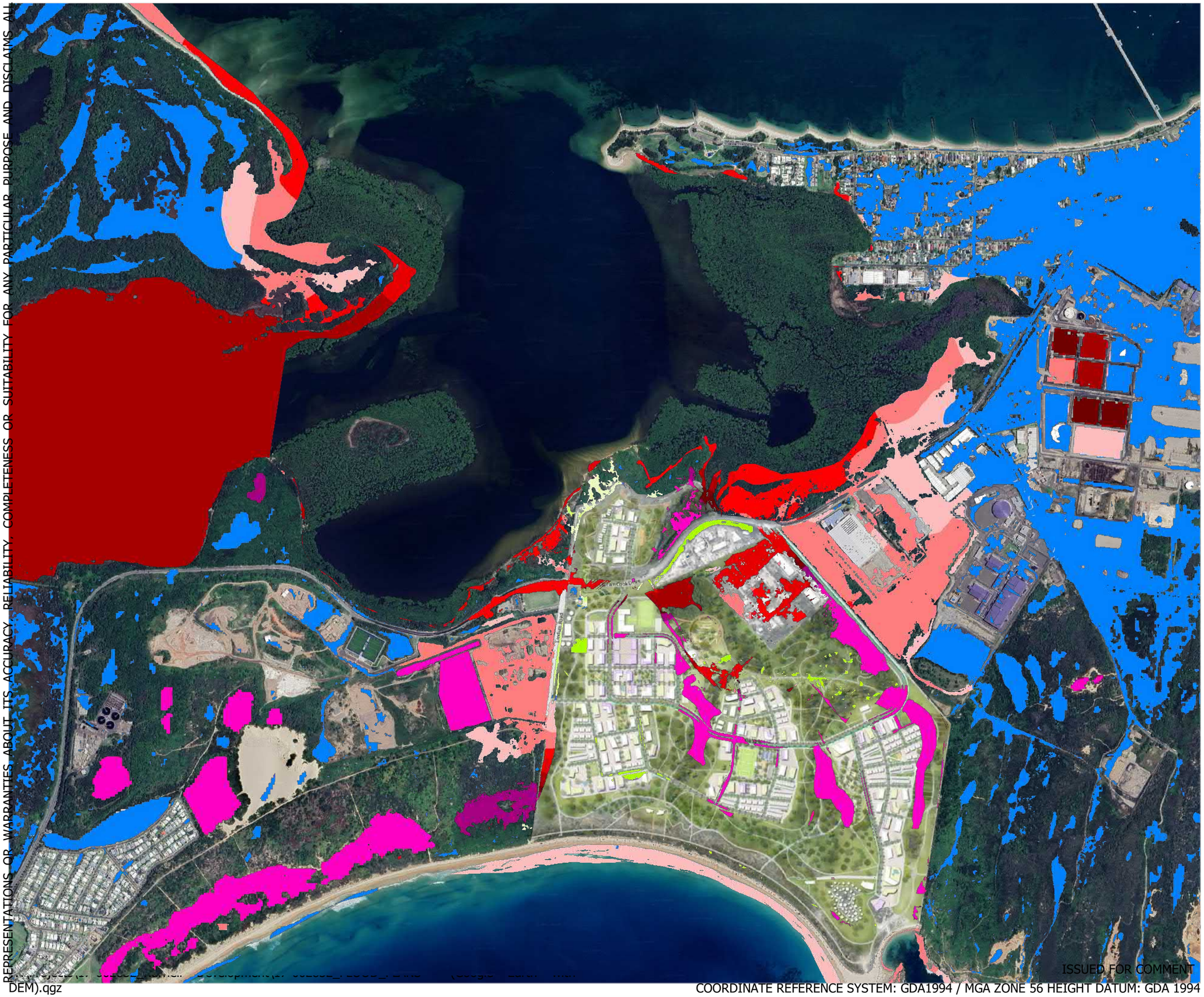
ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994



egis

LEGEND

PMF

DEV

WSL DIFFERENCE (m)

Band 1 (Gray)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.01
- -0.01 - 0.00
- 0.00 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
PMF STORM EVENT
MAXIMUM FLOOD LEVEL
DIFFERENCE

DRAWING NO: 17-002832-D-PMF-E

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

0.2% AEP

DEV

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
0.2% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-D-500-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
B				
C				
D				
E				

DEM).qgz

ISSUED FOR COMMENT

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

0.2% AEP

DEV

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
0.2% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-D-500-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

0.2% AEP

DEV

WSL DIFFERENCE (m)

Band 1 (Gray)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.01
- -0.01 - 0.00
- 0.00 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
0.2% AEP STORM EVENT
MAXIMUM FLOOD LEVEL
DIFFERENCE

DRAWING NO: 17-002832-D-500-E

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

1% AEP

DEV

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
1% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-D-100-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH	-	7.12.23	FOR COMMENT
B				
C				
D				
E				

egis

LEGEND

1% AEP

DEV

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
1% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-D-100-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

1% AEP

DEV

WSL DIFFERENCE (m)

Band 1 (Gray)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.01
- -0.01 - 0.00
- 0.00 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
1% AEP STORM EVENT
MAXIMUM FLOOD LEVEL
DIFFERENCE

DRAWING NO: 17-002832-D-100-E

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

DEM).qgz

ISSUED FOR COMMENT

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

2% AEP

DEV

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-D-050-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH	-	7.12.23	FOR COMMENT
B				
C				
D				
E				

egis

LEGEND

2% AEP

DEV

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-D-050-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		-	12.23 FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

2% AEP

DEV

WSL DIFFERENCE (m)

Band 1 (Gray)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.01
- -0.01 - 0.00
- 0.00 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
2% AEP STORM EVENT
MAXIMUM FLOOD LEVEL
DIFFERENCE

DRAWING NO: 17-002832-D-050-E

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

5% AEP

DEV

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-D-020-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

5% AEP

DEV

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-D-020-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

5% AEP

DEV

WSL DIFFERENCE (m)

Band 1 (Gray)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.01
- -0.01 - 0.00
- 0.00 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
5% AEP STORM EVENT
MAXIMUM FLOOD LEVEL
DIFFERENCE

DRAWING NO: 17-002832-D-020-E

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

10% AEP

DEV

FLOOD DEPTH (m)

Band 1 (Gray)

- 0.00 - 0.15
- 0.15 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.25
- 1.25 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- 3.00 - 4.00
- 4.00 - 5.00
- > 5.00

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD DEPTH

DRAWING NO: 17-002832-D-010-A

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

10% AEP

DEV

FLOOD VELOCITY (m/s)

Band 1 (Gray)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- 2.5 - 3.0
- 3.0 - 3.5
- 3.5 - 4.0
- 4.0 - 4.5
- 4.5 - 5.0
- 5.0 - 5.5
- 5.5 - 6.0
- > 6.0

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY

DRAWING NO: 17-002832-D-010-B

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		7.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

egis

LEGEND

10% AEP

DEV

WSL DIFFERENCE (m)

Band 1 (Gray)

- < -0.1
- -0.1 - -0.05
- -0.05 - 0.01
- -0.01 - 0.00
- 0.00 - 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.15
- 0.15 - 0.2
- 0.2 - 0.25
- 0.25 - 0.3
- 0.3 - 0.4
- > 0.4

NOTES:
1. REFER TO CALIBRE REPORT.

2. ALL LEVELS PRESENTED ARE IN METRES FROM AUSTRALIAN HEIGHT

150 0 150 300 450 m

1:15,000 (A3)

N

PROJECT:
Kurnell

CLIENT:
-

DRAWING TITLE:
DEVELOPED SCENARIO
10% AEP STORM EVENT
MAXIMUM FLOOD LEVEL
DIFFERENCE

DRAWING NO: 17-002832-D-010-E

ISSUE: A

ISS	BY	CHK	DATE	DETAILS
A	DKH		- ?.12.23	FOR COMMENT
B				
C				
D				
E				

ISSUED FOR COMMENT

DEM).qgz

COORDINATE REFERENCE SYSTEM: GDA1994 / MGA ZONE 56 HEIGHT DATUM: GDA 1994

APPENDIX C:
LEGISLATIVE REQUIREMENTS AND COMMENTS

LEGISLATIVE REQUIREMENTS AND FEEDBACK	EGIS COMMENTS
DEPARTMENT OF PLANNING AND ENVIRONMENT	
• The future management and maintenance requirements of ongoing sea level rise and climate change and the impacts to flooding and ground water levels to be considered.	• This comment has been addressed in the Coastal Management Plan prepared by RHDHV and other studies.
• Water pollution to the marine estate, and physical disturbance from clearing of the riparian vegetation and foreshore development to be addressed.	• Noted. Reflect the work undertaken to address the potential water pollution, including the Stormwater Strategy.
• Impact of Sea level rise (SLR) to be considered for ground water infiltration for the life of the project.	• Noted. Reflect the work undertaken to address the potential water pollution, including the Stormwater Strategy.
• Additional maintenance and management requirements due to increased groundwater levels to be addressed.	• Most of the WSUD controls, where infiltration is not desired, will be lined, which will ensure that the system is not impacted by increase groundwater level. Where the system is unlined and affected by groundwater level, a maintenance program and schedule to be established to ensure efficiency of the systems are not affected.
• Impact of sea level rise, shallow ground water levels and increase infiltration to the size of the onsite detention system to be considered.	• Sea level rise, shallow water levels and infiltration rates do not affect the size of underground OSD tanks. Where OSD basins are affected by these factors, storage to be readjusted to suit or basins to be lined to minimise impacts.
• Additional considerations to be paid to how stormwater treatment will be managed on the site. Proposal to go beyond the Council's standard DCP requirements and requirements of Botany Bay Catchment Water Quality Improvement Plan.	• Water quality treatment strategy has been tailored to ensure stormwater will be treated in stages. Independent precincts will ensure that stormwater quality will be in accordance with Sutherland Shire Council's DCP requirements and Botany Bay Catchment Water Quality Improvement Plan. Additional WSUD measures will be provided in the greater site area to ensure compliance with more stringent requirements by ANZECC guidelines and the updated NSW Water Quality Objectives.
• Integrated on-site treatment through Water Sensitive Urban Design (WSUD) measures to be provided during staged release of subdivisions, rather than relying of individual development site provisions.	• WSUD measures for the greater site area will be provided during the release of subdivisions, instead of solely relying of the WSUD measures in the individual precincts.
• Maintenance of bioswale and bio-retention basins to be considered and costed for the life of the project. Early discussions to occur if these areas are dedicated to Council.	• Maintenance schedule and strategy for individual bioswale and bio-retention systems to be developed, in consultation with Sutherland Shire Council where the assets are to be handed over to the Council.
• WSUD provisions are sufficient to address water quantity and quality from the development within the site for the life of the development, mitigating	• Noted. Reflect the work undertaken to address the potential water pollution, including the Stormwater Strategy.

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any potential off-site impacts on sensitive environments.	
• Management of water quality during construction to be considered, with compliance with Landcom's Managing Urban Stormwater.	• Landcom's Managing Urban Stormwater: Soils and Construction Volume 1 and 2 to be consulted to establish required erosion and sediment control measure throughout the construction stage.
• Consideration to be given to updated NSW Water Quality Objectives.	• The design of the WSUD measures, including bioretention systems and wetlands to ensure compliance with the updated NSW Water Quality Objectives. Review of the NSW Water Quality Objectives will be undertaken, once published, and design strategy to be adjusted to account for the updated guidelines.
• The C1 National Parks and Nature Reserves zone to the immediate north of the site not to be relied on as a stormwater mitigation measure. Vegetation buffer to be provided to mitigate impacts.	• Vegetation buffer to be provided between the stormwater outlet and the nature reserve zone to ensure direct impacts to the nature reserve and national park can be mitigated.
• Water quality and quantity design to consider impacts of Climate Change beyond the (2120) 100yr planning ensure water quantity and quality from the site does not impact on surrounding sensitive receiving environments.	• Noted. The design will address the impacts of climate change to the water quality and quantity.
• Proposal to assess the full range of flood events up to the probable maximum flood (PMF). Considerations to be given up to and including 1 in 2000 & 1 in 5000-year flood events.	• The full range of flood events, including 1 in 10, 1 in 20, 1 in 50, 1 in 100, 1 in 500, 1 in 2000, 1 in 5000 and PMF have been assessed in the flood models.
• Guidelines from the new Flood Risk Management Manual 2023 and its associated Flood Risk Management Guidelines to be addressed.	• Noted. The design will address the guidelines from the new Flood Risk Management Manual 2023 and its associated Flood Risk Management Guidelines.
• Evacuation routes to be considered for both within site as well as to and from site. Road servicing the site to demonstrate ability for safe evacuation of residents from the site and from further on the Peninsula.	• Flood model demonstrates Captain Cook Drive is inundated for the Probable Maximum Flood (PMF) event at multiple points. Adoption of shelter in place is recommended during larger flood events.
• Internal road sections have shown to be inundated. Alternate routes for evacuation to be considered.	• Flood model demonstrates Captain Cook Drive is inundated for the Probable Maximum Flood (PMF) event at multiple points. Adoption of shelter in place is recommended during larger flood events.
• On-Site Detention (OSD) discharge appears to be on the adjacent property, which will need to be addressed.	• Noted. The outlet of the site, including the discharge from OSD(s) to be discharged to the north towards Quibray Bay.
• Due to filling of quarry and the time between fill and development, land stability is a concern. Compaction to be considered for long term viability.	• Adequate compaction techniques to be utilised, in coordination with geotechnical consultants, to ensure acceptable compaction standards and land stability can be achieved.
• All buildings to be able to resist forces of floodwater up to probable maximum flood (PMF) levels and have habitable floor levels above the PMF.	• All buildings within the development precincts designed to have habitable floor levels above the PMF. All buildings to be structurally designed to be

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	able to cater for forces of floodwater up to the Probable Maximum Flood (PMF).
• Updated flood model to extend as far as Greenhills to the West and Kurnell to the East. Provision of Captain Cook Drive as the only evacuation route for the peninsula and evacuation from new development to be evaluated.	• The extents of the flood model extended to Greenhills to the west and Kurnell to the East.
• Updated flood model to include times of inundation to enable a decision on whether shelter in place or evacuation off site is the appropriate evacuation method.	• Noted. Times of inundation will be included and addressed as part of the DA submission.
NSW DEPARTMENT OF PRIMARY INDUSTRIES	
• Protection or improvement of water quality through water sensitive urban design, adequate stormwater treatment and best practice erosion and sediment control measures during construction.	• Landcom's Managing Urban Stormwater: Soils and Construction Volume 1 and 2 to be consulted to establish required erosion and sediment control measure throughout the construction stage.
• Keeping stormwater treatment structures, pathways, cycle paths and other infrastructure etc outside the buffer zones mentioned above to maximise biodiversity values and therefore set back more than 100m from the aquatic reserves.	• Buffer zones to be provided between the stormwater outlet and infrastructure and the aquatic reserves to ensure direct impacts to the aquatic reserve can be mitigated.
• Potential impacts to sensitive protected habitats from the discharge of the site to Quibray Bay and the two adjacent aquatic reserves to be considered.	• Monitoring systems at the sensitive protected habitats to be provided prior to construction activities to ensure a base line value for key indicators can be established. WSUD controls to be designed to ensure Neutral or Beneficial Effect (NorBE) can be achieved on the receiving waters.
SUTHERLAND SHIRE COUNCIL	
• The flood study to include figures showing adopted model parameters and locations.	• Adopted flood model parameters and locations have been presented.
• The extent of the flood model to ensure that all contributing catchment areas are modelled such that all runoff to the area is considered.	• The flood analysis ensures all the contributing catchment areas have been modelled.
• Soil infiltration test confirm infiltration rates (loss rates) for the pre- and post-development scenarios as the proposed flood management and modelling is highly dependent on these factors.	• Current models have been run with no infiltration. This is considered to be the conservative approach as it maximises stormwater runoff.
• Modelled roughness values to represent the pre and post development land-uses.	• Roughness values in the model take into considering the corresponding land-uses in the pre-developed and post-developed scenarios, and stated in the report.
• Sea-level rise advised in Council's Sea Level Rise Policy for 2070 and 2100 to be considered.	• Noted. The effect of sea level rise and climate change will be addressed as part of the DA submission.
• Flood modelling and assessment to consider progressive and ultimate development scenarios.	• Noted. Current models assess the current existing and ultimate cases. Additional modelling for the progressive cases will be undertaken once staging of the project has been finalised.

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• The proposed development to mitigate existing flood inundation of the heritage dune access track at southern end of Lindum Street	• Noted. Additional reporting on this area will be provided as part of the DA, as required.
• The proposed strategy incorporates infiltration and aquifer recharge, which is to be demonstrated, to achieve the required flood management outcomes for potential storm events of consecutive events with saturated soil/groundwater profiles.	• Current models have been run with no infiltration. Additionally, due to the nature of the TuFlow software and its ability to model groundwater flows, this is considered to be the conservative approach as it maximises stormwater runoff.
• Drainage outlets to wetland/mangrove areas of Quibray Bay to consider potential future natural variations in ground levels of the area which may affect performance.	• Final design of the stormwater outlet to account for the expected variations in the ground levels at the points of discharge and ensure long term performance can be maintained.
• Potential changes in flood behaviour and consequential impacts to be assessed/mitigated for neighbouring properties, Captain Cook Drive and the downstream receiving environment. Changed flow behaviour includes peak flowrates, peak flood levels, flow velocity, flow volumes, flow duration and frequency for a range of storm events.	• Noted. Any potential changes indicated in the current modelling are indicative only as final base case surface has yet to be determined and final design surface could be amended during the DA process. This will be addressed in the detailed design stage, as required.
• Future parcels to be designed such that they are not inundated in a 1% AEP event as they would be subject to flood controls. Future roads and pathways should be designed to mitigate potential flood hazards.	• Noted. All buildings will be designed to ensure safety of occupants by meeting all required freeboards from flooding to relevant Council and other standards. This will be addressed in the detailed design stage, as required.

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