Bays West
Stormwater & Flooding Report

August 2022

White Bay Power Station and
Robert Street Sub-Precinct

Acknowledgement of Country

Mott MacDonald recognises and respect their cultural heritage beliefs and continuing relationship with the land and surrounding waters. We pay our respect to their Elders past and present. This is, and always will be, Aboriginal land.

Artist - Tom Avery

https://kurranulla.org.au/artists/

Mott MacDonald
383 Kent Street
Sydney
NSW 2000
PO Box Q1678
QVB Sydney NSW 1230
Australia

T +61 (0)2 9098 6800
mottmac.com

Bays West

White Bay Power Station and Robert Street Sub-Precinct Stormwater and Flooding Report

August 2022

Mott MacDonald Australia Pty Limited is a
subsidiary of Mott MacDonald
International Limited. Registered in
Australia, ABN 13 134 120 353

Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	07/02/2022	TC	SC	DF	Preliminary
B	18/02/2022	LZ	SC	DF	Issue
C	01/08/2022	WP	SC	DF	Issue

Document reference: 426320MP02 | C

Information class: Standard

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties.

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

Contents

Tables

Figures

1 Introduction

DPE is currently preparing a Master Plan for White Bay Power Station and Robert St sub-precincts, noting that the Robert St sub-precinct does not form part of the Stage 1 rezoning package. These sub-precincts are to be designed such that the Government's economic, health, education, housing and property and transport objectives are met whilst incorporating quality design, public space and green infrastructure together.

As a part of this process, this stormwater and flooding report has been prepared to support the implementation of the Bays West Master Plan, addressing the stormwater requirements for rezoning, development control and supporting infrastructure for the sub-precinct.

1.1 Catchment and Topography

The proposed White Bay Power Station and Robert Street Sub-Precinct is located within the Inner West LGA in the suburb of Rozelle. Situated at the downstream end of a sub-catchment, it comprises of mostly urban residential lots. The existing catchment area at The Bays precinct can be split into four sub-catchments as summarised below and shown in Figure 1-1:

- The Robert Street sub-catchment has an approximate area of 70.6 ha which includes the White Bay Power Station and part of The Bays development site. Stormwater runoff in the development site falls towards the low-point south-east of the power station. The overland flow path flows around the White Bay Power station into Robert Street continuing downstream east where it overflows through the bridge culvert into the harbour
- The existing stormwater network owned by Port Authority in The Bays development site splits the Port Access Road catchment into the north and south. The northern Port Access Rd catchment of approximately 1.02ha collects stormwater runoff from the road and decommissioned rail track remnants in the southerly direction splitting the Robert St catchment and the south Port Access Rd catchment. Stormwater collected in this catchment is discharged into the harbour through the existing pipe network connecting to the Sydney Water culvert from Robert St
- The southern Port Access Rd catchment collects stormwater from Port Access Rd, Somerville Rd and Solomans Way. The catchment is approximately 2.62ha and discharges water from the pipe system directly to the harbour
- The existing catchment also includes a harbour side bypass sub-catchment area. This catchment area bypasses the existing stormwater network and falls directly into the harbour.

The development site has an elevation typically around three to four metres AHD. Around White Bay it is generally flat with little to no slope and a small section of higher land associated with the Victoria Road embankment in the south-east of the site.

The area directly north and east of the proposed The White Bay Power Station and Robert Street Sub-Precinct is affected by run-off from an adjacent catchment area:

- Overland flow coming through the Mullens / Robert Street intersection crosses through the site in front of the existing White Bay Power Station. Overland flow is likely to surcharge from the existing open channel and overtop to the Robert Street kerb adjacent to the site and spill across the site towards White Bay
- The large existing Sydney Water stormwater culvert under Robert Street (which crosses Port Access Road north of the site) does not have sufficient capacity for the full flows.

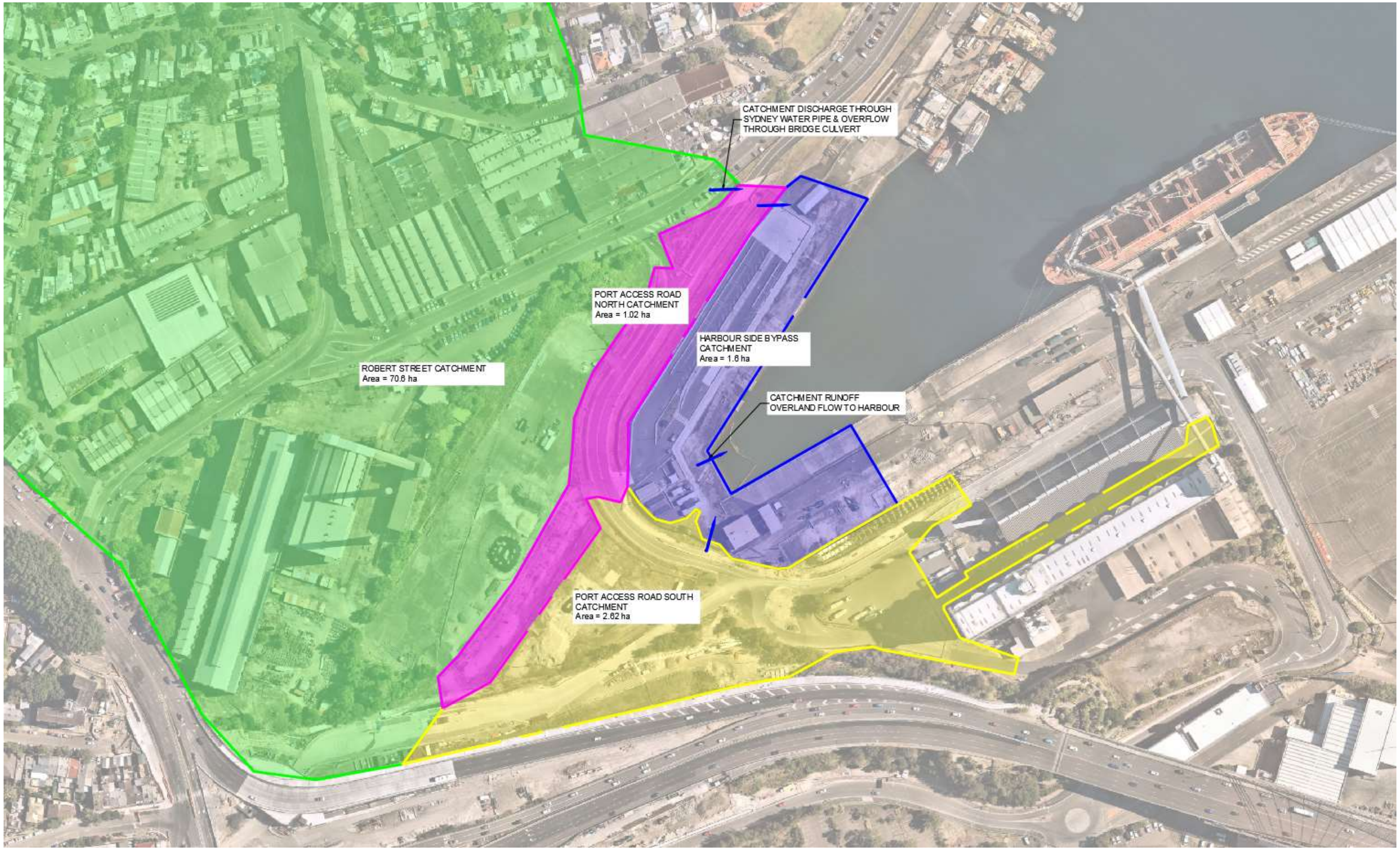


Figure 1-1 White Bay Power Station Existing Catchment

2 Stormwater Drainage

2.1 Stormwater Quantity Design Criteria

The Inner West Council's Leichardt DCP states that new buildings and structures need to minimise the effect on the existing topography on the natural flow of stormwater runoff by integrating the general site layout with the design of the stormwater drainage system.

The drainage has been split into two different systems:

- A minor drainage system of pit and pipes designed to control nuisance flooding and enable effective stormwater management for the site, this has been set at 5% AEP for this design
- A major drainage system that includes overland flow routes through roads, landscape and hardstand areas which has been set at the 1% AEP storm event. This system also incorporates block factors, failures in the minor drainage system and ensures a maximum velocity-depth product of 0.4m^2/s to ensure site safety.

The computer software DRAINS was used for the hydraulic analysis for the existing and proposed scenarios. Stormwater piped capacities have been designed to convey the minor storm event with safe overland flows for the 1% AEP storm event. If the major system cannot meet the safety and flooding criteria, then the capacity of the minor system has been increased.

2.1.1 Climate Change and Extreme Water Levels

Given the proximity of the site to White Bay, consideration is given to the impacts of climate change on drainage requirements. As a part of this extreme water levels have been considered for the design of minor and major storm events. Table 2-1 shows extreme water level values from the Ft. Denison Vulnerability study (Watson et al, 2008).

Table 2-1 Extreme Water Levels for Fort Denison (Watson et al 2008)

Return Period [years]	*Extreme Water Levels [m, AHD]*
10	*1.345*
20	*1.370**
25	*1.382**
50	*1.415*
100	*1.435*

**Estimated via linear interpolation*

NSW Government Guidance has recommended an approximate 0.66 metre sea-level rise by 2100 which has been based on a Representative Concentration Pathway (RCP) of 8.5.

This 0.66 metre increase has been adopted for the purposes of flooding and stormwater assessment however it is noted further in the report that the Probable Maximum Flood levels exceed the projected sea-level rise values and serve as the basis for required civil levels for flood protection.

2.1.2 Rainfall Intensity

The design for the precinct has been undertaken to ensure the effects of climate change have been considered. The climate change effects have been incorporated inline with the AR&R2019 guidelines for rainfall intensity increase predictions for year 2090.

The 2090 interim climate change factor based upon a Representative Concentration Pathway (RCP) 8.5 adopts a 21.3% increase in rainfall intensity at the locality of the proposed works. As such a 1.213 multiplier to rainfall intensities has been applied in determining the runoff and sizing of infrastructure.

2.2 Existing Stormwater Network

Beginning near Beattie Street (north west of the sub-precinct), there exists a trunk culvert running south parallel to Mullens Street. At the intersection of Robert Street and Mullens Street, the culvert changes direction, parallel to Robert Street and conveys the stormwater in an easterly direction before discharging into White Bay near the intersection of Robert Street and Buchanan Street.

The culvert has a maximum dimension size of 5.5 metre x 1.4 metre and is primarily owned by Sydney Water. Along Robert Street, there are several kerb inlet pits and a bridge culvert which collects stormwater and overland flow and directs it into the harbour.

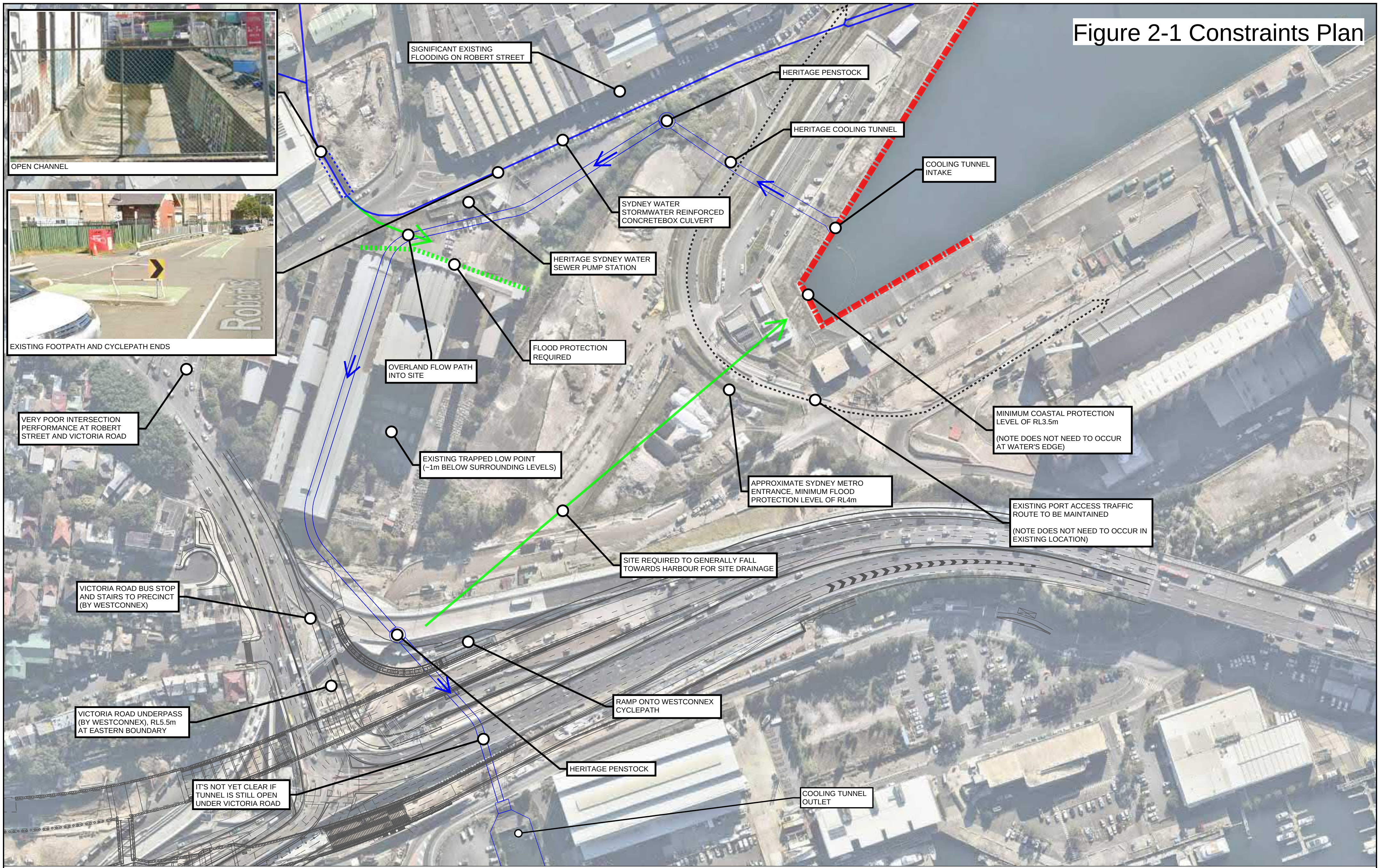
The existing stormwater network along Port Access Road, Sommerville Roads, and Glebe Island Wharf services the Glebe Island Wharf catchment area and are owned by Sydney Harbour Foreshore Authority. Stormwater is captured through a series of kerb inlets on the road and swales directing into headwalls. This stormwater network discharges into White Bay and comprises of pipe sizes ranging from DN300 millimetre to DN575 millimetre.

There are a number of key constraints that affect the design of the site, these are summarised below in Figure 2-1 and include:

- Mainstream flooding from Rozelle and Balmain and along Robert Street.
- A trapped low point out the front of the White Bay Power Station
- Sea level rise and storm surge
- A heritage cooling tunnel and associated penstocks.

The Port Access Rd North catchment includes two grassed swales that directs stormwater into a pit and pipe system and ultimately connects to the trunk drainage system described above. Similarly, Port Access Rd South catchment directs stormwater coming off Port Access Rd, Sommerville Rd and Solomons Way through a series of pit and pipes and ultimately discharges into the harbour.

Figure 2-1 Constraints Plan



100mm AT FULL SIZE   Plot Date & Time: 12/08/21 - 12:01

OFFICIAL

FOR COORDINATION

A	AMD_DESC_1	[XX]	[XX]	[XX]	[DATE]
REV.	AMENDMENT DESCRIPTION	Design by	Verified by	Approved by	Date

SCALE: AS SHOWEN

10 0 10 20 30 40m

1 : 1000 FULL SIZE A1

A1 Original | Co-ordinate System: GDA2020/MGAZONE 56 | Height Datum: AHD | This sheet may be prepared using colour and may be incomplete if copied | NOTE: Do not scale from this drawing.

CLIENT:

AEO Company Name

The information shown on this drawing is for the purposes of the Sydney Metro Project only. No warranty is given or implied as to its suitability for any other purpose. The Service Providers accept no liability arising from the use of this drawing and the information shown thereon for any purpose other than the Sydney Metro Project.

Design company Name

AEO Discipline Description

DRAWN	PGB	12/08/21
DESIGNED	[DESIGNED BY]	[DATE]
DRG CHECK	[DRG CHECKED BY]	[DATE]
DESIGN CHECK	[DESIGN CHECKED BY]	[DATE]
APPROVED	[APPROVED BY]	[DATE]

PROGRAM DESCRIPTION
THE BAYS STATION

EXISTING SITE
AERIAL

FILE No: | SHEET: 1 OF 1 | ©
STATUS: PRELIMINARY/INITIAL DESIGN - CONCEPT DESIGN | EDMS No:
DRG No: Constraints Plan | REV A | VER

2.3 Proposed Stormwater Design

Within the White Bay Power Station and Robert Street Sub-Precinct a drainage system is provided to capture runoff from the proposed precinct. Roof runoff is proposed to drain towards the main trunk culvert that discharges to the harbour.

The drainage system is designed to convey the 5% AEP storm event in accordance with Australian Rainfall & Runoff requirements and considers climate change factors.

As the precinct is located adjacent to the harbour discharge point, Onsite Detention is not required for this development. There are however opportunities to introduce Water Sensitive Design Measures at central locations to improve water quality within the precinct and will be delved more into in Section 3.

A preliminary drainage design has been developed for the purposes of master plan assessment however it is noted that this will be further developed in subsequent design stages. This plan is shown below in Figure 2-2 and the preliminary proposed DRAINS model is shown below in Figure 2-3.

Figure 2-2: Preliminary Stormwater Drainage Strategy

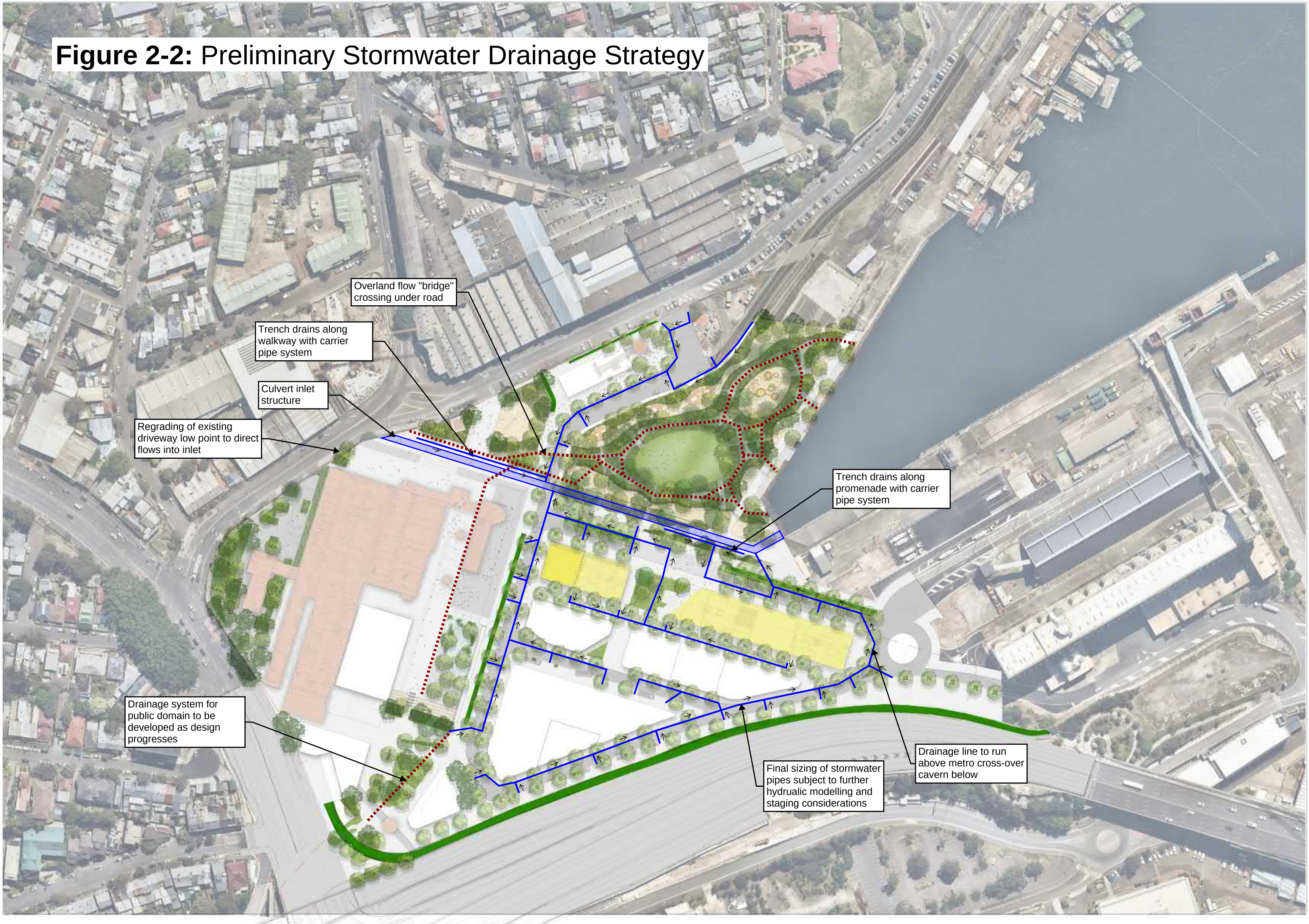
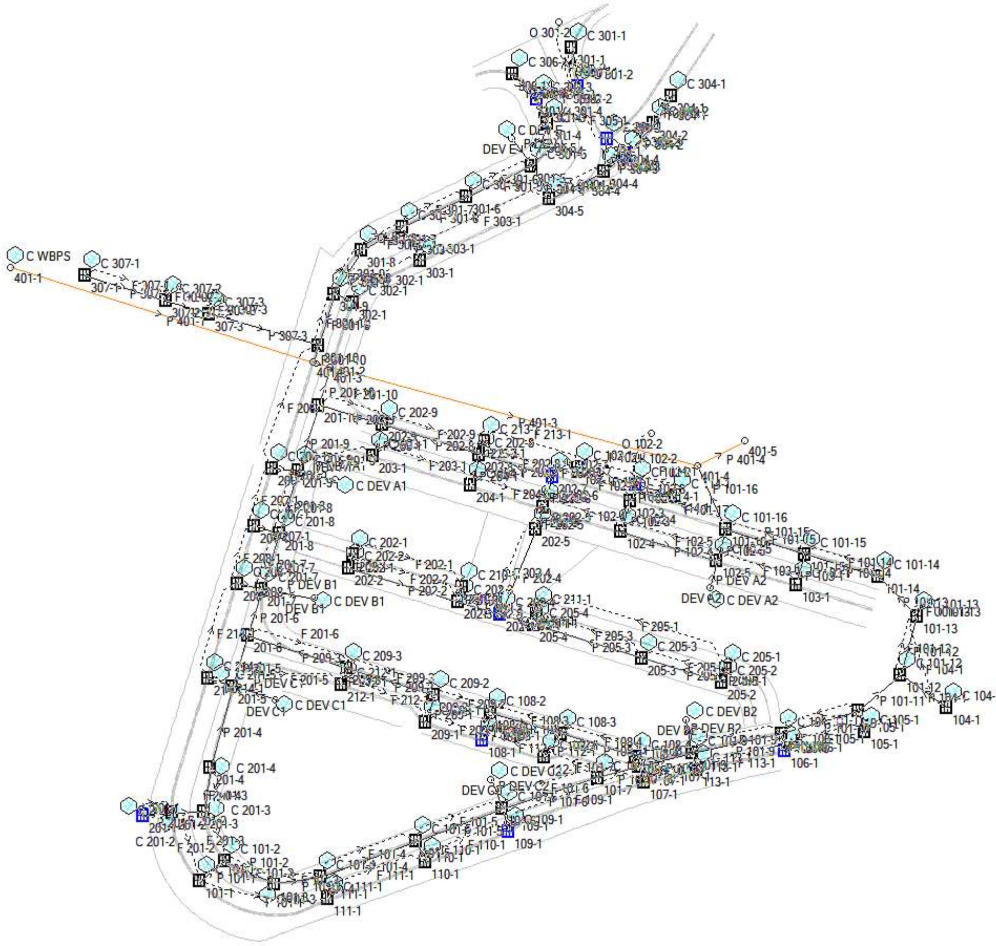


Figure 2-3 Proposed stormwater drainage DRAINS model



The studied catchment area consists of a total area of 4.9 hectare as shown in Figure 2-4. The catchment area excludes the White Bay Power Station, future park and bioretention areas north of the promenade because they discharge directly to the harbour through an overflow route. In the DRAINS model of the proposed drainage system, the following parameters were included:

- Tailwater levels have been adopted for outlet pipes based on the extreme water levels and sea water rise:
  - 5% AEP – RL 2.03 AHD
  - 1% AEP – RL 2.10 AHD
- Climate change rainfall factor of 21.3%

The DRAINS model results indicate that the pit and pipe system has been sized to minimise ponding on the roadway and convey stormwater flows underground to discharge to the harbour. Although the post development flows are greater than the pre-development flows when accounting for high tailwater and climate change factors, the increase in flow rate is not considered to be a design issue as the discharge point is the harbour.

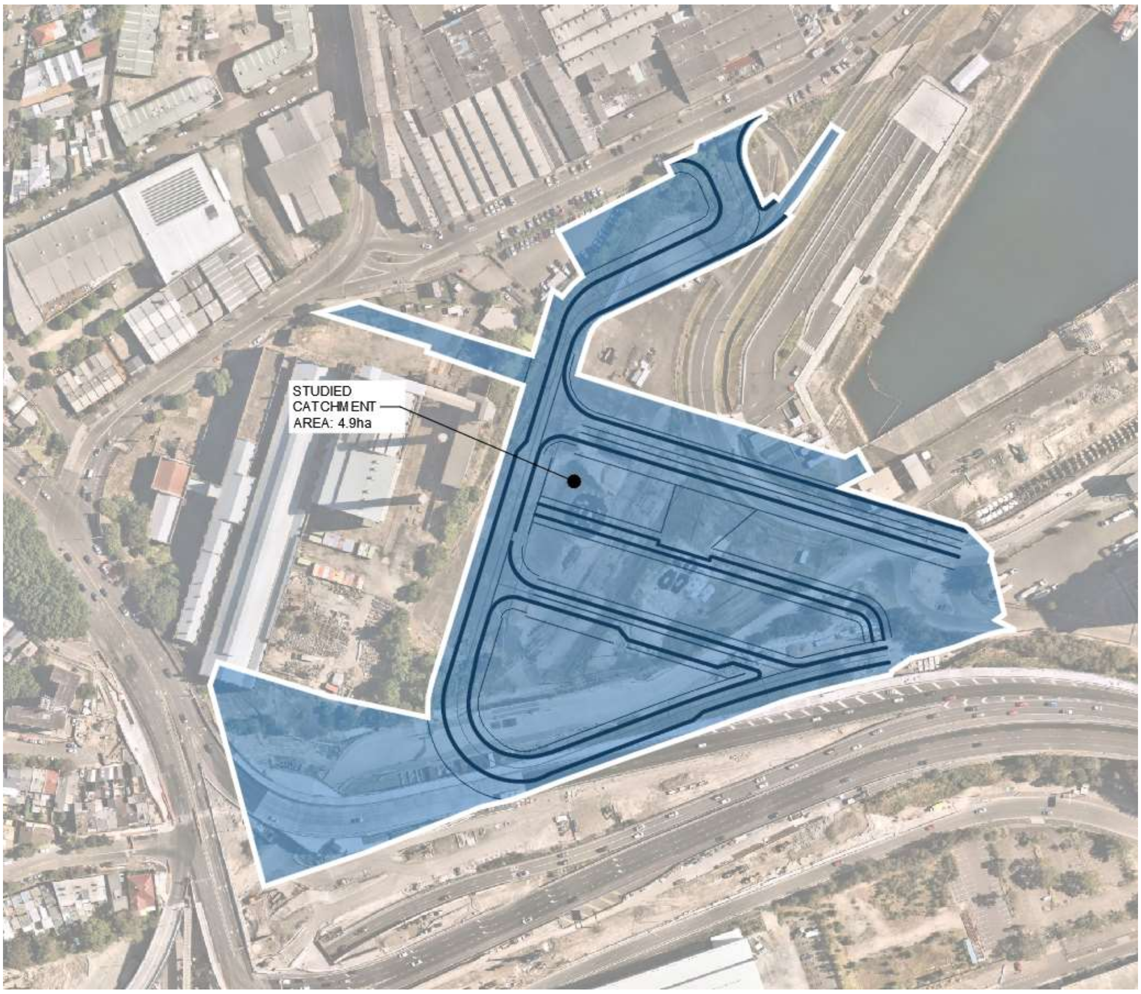
In the 1% AEP major storm event, the DRAINS model shows that the overflow along the roadway is restricted to a safe depth and the velocity-depth product is less than 0.4m^2/s. These results have been summarised in Table 2-2 below.

Table 2-2: DRAINS model results for proposed drainage system

Storm event	Max ponding depth* (m)	Max overflow depth (m)	Max velocity-depth product (m^2/s)
5% AEP	0.077	0.063	0.03
1% AEP	0.088	0.131	0.09

**Max ponding depth at sag pits*

Figure 2-4: Proposed drainage system catchment area



3 Water Quality

The proposed White Bay Power Station and Robert Street Sub-Precinct is located at the downstream end of the White Bay Catchment area. The White Bay watercourse has elevated nutrient and heavy metal concentrations and high turbidity. This is probably due to the upstream catchment which is a high-density residential area, and water quality through the station site and into White Bay is expected to be poor due to the sediments, toxicants and gross pollutants expected from such development.

There are significant opportunities to improve the existing water quality of the site. This can be achieved through the introduction of:

- Bio-swales
- Bio-retention / raingardens
- Centralised rainwater tanks
- Gross Pollutant Trap (GPT)
- StormFilter

Water quality modelling was undertaken using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) software to simulate urban stormwater systems operating at a range of temporal and spatial scales. MUSIC models the total amounts of gross pollutants, phosphorus, nitrogen and total suspended solids produced within various types of catchments.

The Inner West council water quality targets for any new proposed development site are summarised below:

- 90% reduction in the post development mean annual load total gross pollutant (greater than 5 millimetre)
- 85% reduction in the post development mean annual load of Total Suspended Solids (TSS)
- 65% reduction in the post development mean annual load of Total Phosphorus (TP)
- 45% reduction in the post development mean annual load of Total Nitrogen (TN).

It is recommended that as a part of more detailed analysis these standards are further assessed inline with the EPA Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land Use Planning Decisions to identify potential risks of the development to the receiving waterway and potential further mitigations.

3.1 Proposed Water Quality Strategy

This section details the water treatment measures utilised in modelling the proposed treatment train for both public domain and development lot catchments.

Bio-swales

A series of swales are proposed adjacent to the footpaths of the new road network. They will collect stormwater runoff from the footpath and road through slotted kerbs. Stormwater runoff will be treated through the grasses swale to filter gross pollutants and sediment. These swales will be connected to raingardens for the next treatment process.

The following parameters have been typically adopted for grass lined swales:

- Length = 150 m

- Vegetation height = 0.1m
- Bed Slope 1%
- Base Width = 1.0m
- Top Width = 1.8m
- Depth = 0.1m
- Exfiltration rate = 0.0 mm/hr

Bioretention/Raingardens

Bioretention/raingardens are planted filtration system allowing water to temporarily pond and permeate through the ground whilst removing pollutants throughout the process. These treatment systems are planted with nutrient removing plants which provide an effective means of extracting dissolved nitrates and phosphates. A bio-retention system is proposed on the downstream end of the grass swale along the proposed new road to treat runoff. Space has been allocated east of the existing sewer pump station to treat runoff from the existing White Bay Power Station (WBPS).

Pollutant removal rates for treatment basins are not fixed within the MUSIC model, rather they are based on a set of input parameters which determine the effectiveness. In developing the MUSIC model for the site, the following input parameter assumptions were made for the proposed bioretention system, generally in accordance with the recommended defaults listed in WSUD Policy:

- Extended detention depth = 0.1m
- Filter depth = 0.5m
- Saturated hydraulic conductivity = 100mm/hr
- TN content of filter media = 800mg/kg
- Orthophosphate content of filter media = 55mg/kg

Rainwater Tank

Rainwater reuse tank is proposed for the roof catchment from future station box. The parameters utilised in the model with the following parameters utilised for the proposed rainwater tank:

- Volume = 80 kL
- Initial volume = 80 kL
- Reuse demand = 50 kL/day

Gross Pollutant Trap (GPT) Model Parameters

For primary treatment of the stormwater runoff within station areas where the use of green infrastructure treatment is limited, a Cascade Separator or approved equivalenet is to be provided. The Cascade Separator is a device that removes sediment, hydrocarbons, trash, and debris from stormwater runoff. The MUSIC node from Ocean Protect was used with the input data as summarised below in Table 3-1.

Table 3-1 Ocean Protect Cascade Separator GPT – MUSIC Input Parameters

Pollutant	Input	Output	Adopted Rate
Suspended Solids (mg/L)	1000	200	80%
Phosphorus (mg/L)	5	3.5	30%
Nitrogen (mg/L)	10	7	30%
Gross Pollutants (kg/ML)	20	1	95%

StormFilter Model Parameters

The StormFilter is an underground cartridge treatment system which is used to remove suspended solids and other water pollutants from stormwater runoff. Each filtration cartridge provides a membrane surface area which allows runoff to travel through the membrane while removing the pollutants. The MUSIC node from Ocean Protect was used with the input data as summarised below in Table 3-2.

Table 3-2 Ocean Protect StormFilter – MUSIC Input Parameters

Pollutant	Input	Output	Adopted Rate
Suspended Solids (mg/L)	1000	66	93.4%
Phosphorus (mg/L)	10	1.39	86.1%
Nitrogen (mg/L)	100	44.1	55.9%
Gross Pollutants (kg/ML)	14.9	0	100%

It is noted that this product has been chosen for analysis of the system at this stage, an approved equivalent may be adopted as long as the water quality targets are being met.

3.1.1 Water Quality Modelling

The water quality analysis requires historical rainfall data recorded by a pluviography station. As such, pluviograph data from Sydney Airport AMO (66037 – 6-minute interval) was utilised for the site. This station was considered appropriate as it is situated relatively close to the site and contains periods of both dry and wet weather. The pluviography is shown in Table 3-3.

Table 3-3 Sydney Airport Pluviography Data

Station No.	Location	Records	Data Interval
66037	Sydney Airport AMO	1990-1999	6-minute

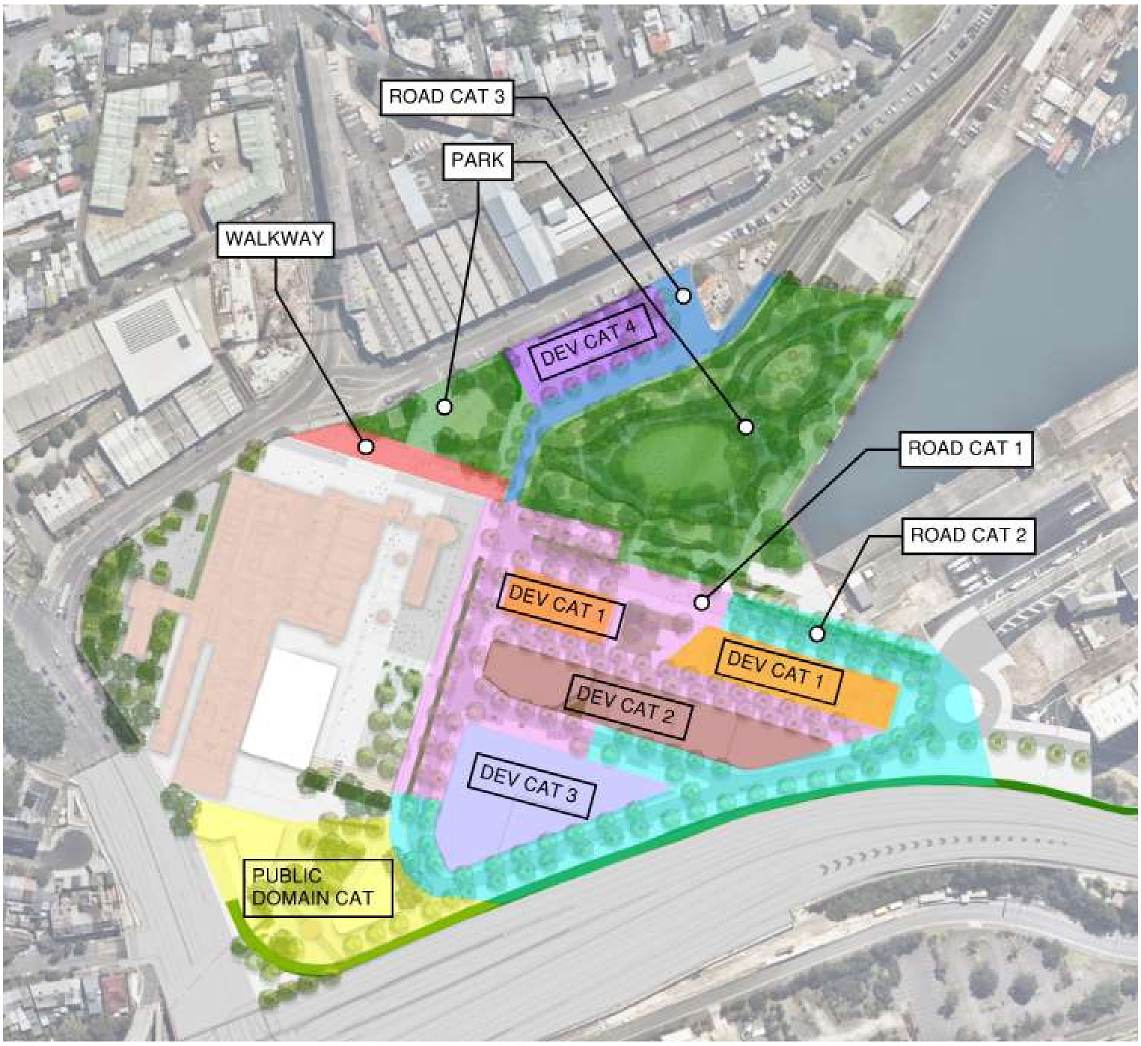
Source: Bureau of Meteorology

The site was divided into catchments based on the layout and topography. The proposed MUSIC catchment breakdown is shown below in Table 3-4 and the public domain catchments are shown in Figure 3-1.

Table 3-4 MUSIC Catchments

Pollutant	Area (ha)	% Impervious Area
DEV CAT 1	0.0554	80
DEV CAT 1 ROOF	0.3581	100
DEV CAT 2	0.3835	95
DEV CAT 3	0.4170	100
DEV CAT 4	0.2972	95
ROAD CAT 1	1.1175	90
ROAD CAT 2	1.0912	90
ROAD CAT 3	0.2795	90
WALKWAY	0.1125	100
PARK	1.5799	20
PUBLIC DOMAIN CAT	0.7661	70

Figure 3-1 Proposed water quality catchment areas used in MUSIC (Public Domain)



The proposed treatment train for the development site is tabulated in Table 3-5 overleaf.

Table 3-5 Water Quality Treatment Train

Catchment	WQ Treatment Train	Swale length (m)	Raingarden Area (m^2)
DEV CAT 1	GPT Cascade 2250, Psorb Stormfilter	-	-
DEV CAT 1 ROOF	80 kL Rainwater Tank	-	-
DEV CAT 2	GPT Cascade 2250, Psorb Stormfilter	-	-
DEV CAT 3	GPT Cascade 2250, Psorb Stormfilter	-	-
DEV CAT 4	GPT Cascade 2250, Psorb Stormfilter	-	-
ROAD CAT 1	-	150	100
ROAD CAT 2	-	150	50
ROAD CAT 3	-	150	50
WALKWAY	-	-	-
PARK	-	-	5565
PUBLIC DOMAIN CAT	-	-	100

The resulting percentage reduction for the Public Domain and Development Lots models for total suspended solids, phosphorus, nitrogen and gross pollutants are summarised in Table 3-6 and Table 3-7 below and shows that target rates are achieved and can meet Councils requirements.

Table 3-6 Water Quality MUSIC Results – Public Domain and Park

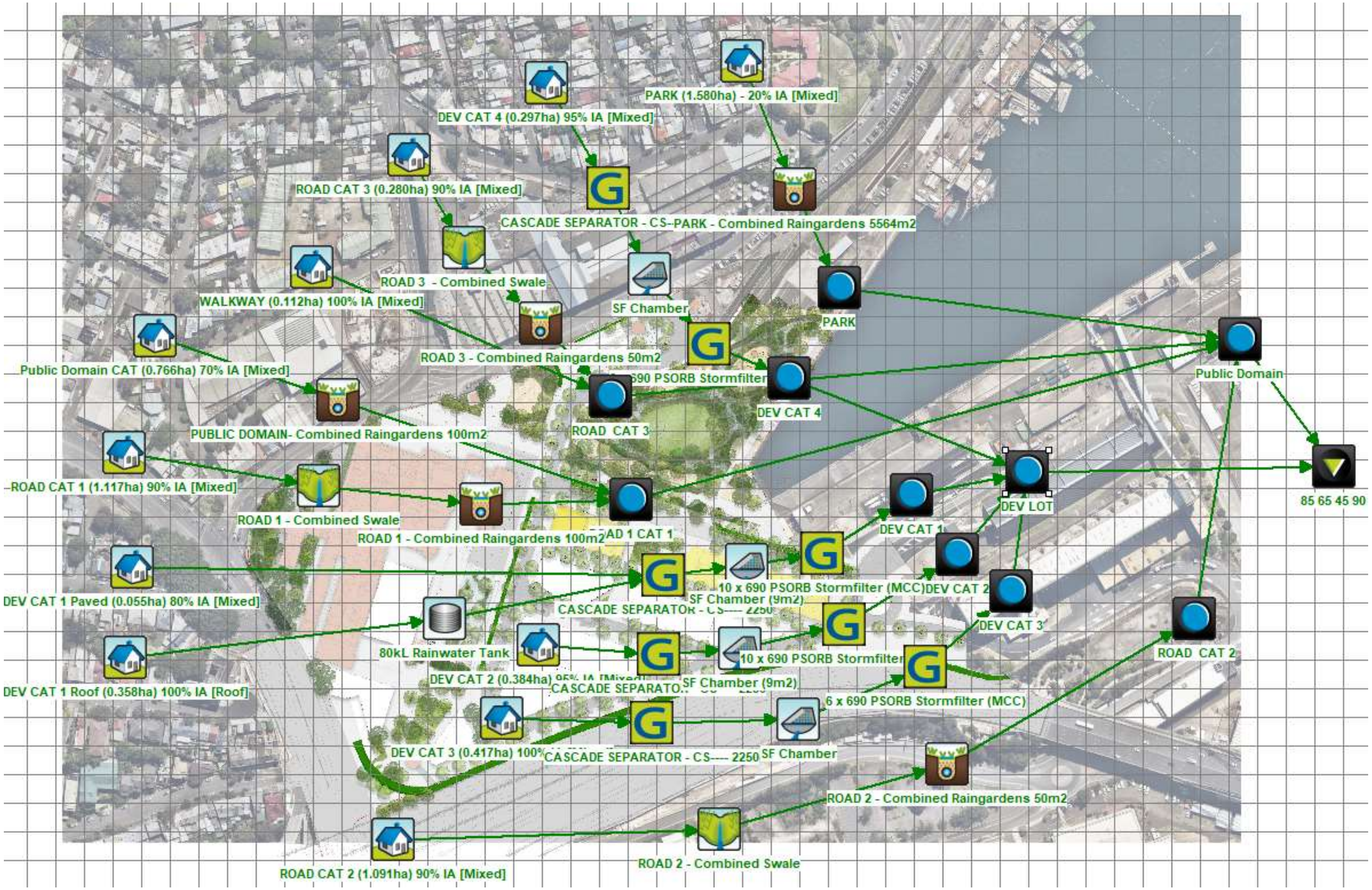
	Sources	Residual Loads	% Reduction	% Target
Flow (ML/yr)	34.0	29.2	14.1	-
Total Suspended Solids (kg/yr)	6.48E3	1.07E3	83.5*	85
Total Phosphorous (kg/yr)	13.6	5.13	62.4*	65
Total Nitrogen (kg/yr)	96.6	43.4	55.1	45
Gross Pollutants (kg/yr)	880	26.9	96.9	90

Table 3-7 Water Quality MUSIC Results – Development Lots

	Sources	Residual Loads	% Reduction	% Target
Flow (ML/yr)	13.4	13.3	0.4	-
Total Suspended Solids (kg/yr)	2.18E3	112	94.9	85
Total Phosphorous (kg/yr)	4.71	1.02	78.3	65
Total Nitrogen (kg/yr)	36.5	13.8	62.2	45
Gross Pollutants (kg/yr)	357	0.00	100.0	90

* - Overall water quality target is met.

Figure 3-2 Proposed Water Quality for the Precinct – MUSIC Model



4 Flooding

4.1 Methodology

A direct rainfall approach has been utilised for the hydrologic assessment of The Bays area. The direct rainfall method involves the application of rainfall depths directly to the two-dimensional model domain. The rainfall depth in a particular timestep is applied to each individual hydraulic model grid cell, and the two-dimensional model calculates the runoff from that cell. The use of rainfall runoff enables the representation of local overland flow paths which is particularly useful and suited to urban, high density catchments. This methodology is also consistent with the previous SOBEK hydraulic model developed for the Leichardt Flood Study for the Leichardt Local Council by Cardo in 2015.

A detailed TUFLOW linked 1D-2D model was developed for the local catchments discharging toward the site. The model topography was based on a combination of LiDAR data captured in 2019 and detailed survey of the site and surrounding area, that was captured in 2021. The local stormwater system was included in the model. Stormwater pipe information, including invert levels, pipe sizes and lengths, were based on a combination of information from dial-before-you dig and detailed survey.

Critical durations and temporal patterns were adopted based on ARR2019 guidelines. The TUFLOW model was initially used to hydraulically assess the full 10 temporal for storm durations ranging from the 10-minute to 6-hour event. Three storm durations were critical durations in the area of interest. The adopted critical for the 1% AEP flood event were the 10-minute (temporal pattern 1), 20-minute (temporal pattern 9) and the 3-hour event (temporal pattern 3). These were hydraulically simulated in the TUFLOW model and the adopted flood results were based on the maximum level of the three storms. Furthermore, the critical durations for the 5% AEP and PMF events were:

- 5% AEP CC – 20 minute (temporal pattern 9), 60 minute (temporal pattern 9), 360-minute (temporal pattern 5)
- 1% AEP CC – 15 minute (temporal pattern 8), 45 minute (temporal pattern 2), 360 minute (temporal pattern 5)
- PMF – 30 minute (Temporal pattern TO98), 60 minute (Temporal Pattern TO98), 90 minute (temporal Pattern DA74B)

4.1.1 Assumptions and Limitations

The overland flow modelling undertaken as part of this study includes assumptions regarding the existing stormwater pit and pipe network, building flood levels and points of connection for building stormwater drainage. Although, every effort has been made taken to ensure that the model accurately represents flooding throughout the study area, it should be noted that there are limitations to the accuracy of the modelling due to these assumptions.

There is no historical flood information, therefore the TUFLOW hydraulic model is uncalibrated for this master plan.

4.1.2 Existing Flooding Conditions

The Leichardt Flood Study (Cardno, 2014) was prepared for Leichardt Council covering the entire Leichardt LGA, including the proposed The White Bay Power Station Sub-Precinct and its catchment. The SOBEK model was used to undertake a range of design event scenarios for the catchment. The model was based on outdated design rainfall and topographic information. Therefore, the model was converted to a updated TUFLOW hydraulic model. The model incorporated updated rainfall information with the latest Intensity-Frequency-Duration (IFD) information and updated topographic data. Additional stormwater pipes that were not in the original SOBEK model were also included in the updated model.

The updated TUFLOW model was used to undertake hydraulic simulations for the 5% Annual Exceedance Probability (AEP) climate change, 1% AEP climate change and the Probably Maximum Flood (PMF). Each scenario adopted an extreme tailwater level of 2.11 metres AHD, which included 1.45 metre extreme storm level within White Bay with the inclusion of 0.66 metres of sea level rise.

The White Bay Power Station and Robert Street Sub-Precinct is located in a flood-prone area. Based on the previous SOBEK modelling, the area is inundated in events as frequent as the 5-year ARI storm. Overland flow is shown to enter the site at an access gate along Robert Street (approx. RL 2.13 metre). Raised surface elevations toward White Bay (along the alignment of the existing access road) provide a barrier to overland flow and cause ponding around the existing power station building.

In the 1% AEP, depths of up to 1 metres occur on Robert Street to the north-west of the site. At the White Bay Power Station, the area surrounding the existing building is inundated by up to 1.1 metres. At the proposed station construction site, the depth is up to 0.23 metres. The water surface level across the construction site is generally flat, as it is ponded behind Port Access Road. Water levels within the flooded areas are generally between 3.1 and 3.3 metres AHD, with localised areas of ponding occurring with higher levels.

In the PMF event, the flooding on Robert Street is up to 2.1 metres. At the White Bay Power up to 2.2 metre and at the proposed station construction site the depth is up to 1.3 metre at the western extent. As with the 100 year ARI flood, the PMF levels are generally consistent across the site and range from 4.2 metres AHD to 4.3 metres AHD.

Flood hazard for the site has been modelled for the site for the three design events assessed. The flood hazard is based on the Australian Rainfall and Runoff 2019 (ARR19) hazard categories. These categories range from H1 to H6 and are based on a combination of flow velocity and depth. A chart showing how the categories are defined is shown in Figure 4-1. The NSW Floodplain Manual descripves High Hazard as areas where there '*possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty in wading safety potential for significant structural damage to buildings*'. This generally relates to H4 to H6 for the ARR19 hazard categories.

In the 1% AEP, there are the localised areas of medium hazard (H3) at the western areas of the construction site and near the low point adjacent to the tunnel excavation area. In the probable maximum flood event, there are areas of high flood hazard (H4 and H5) on the construction site primarily as a result of the flood depth.

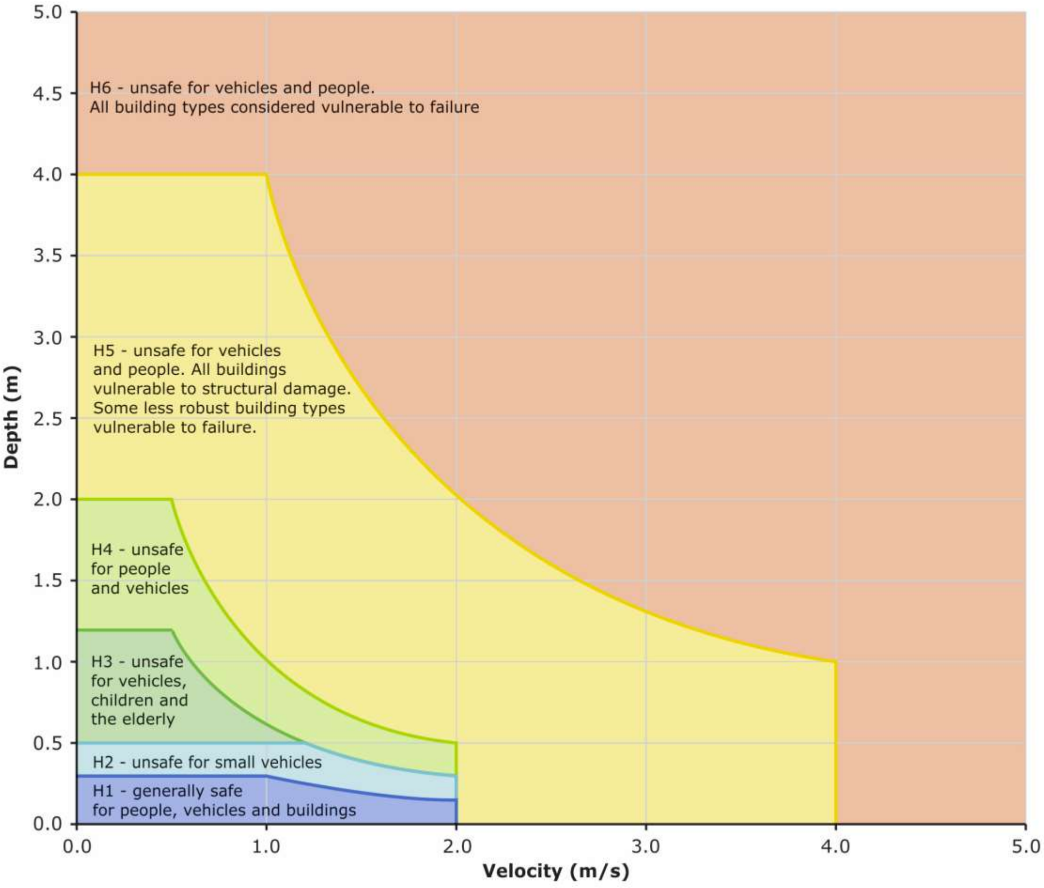
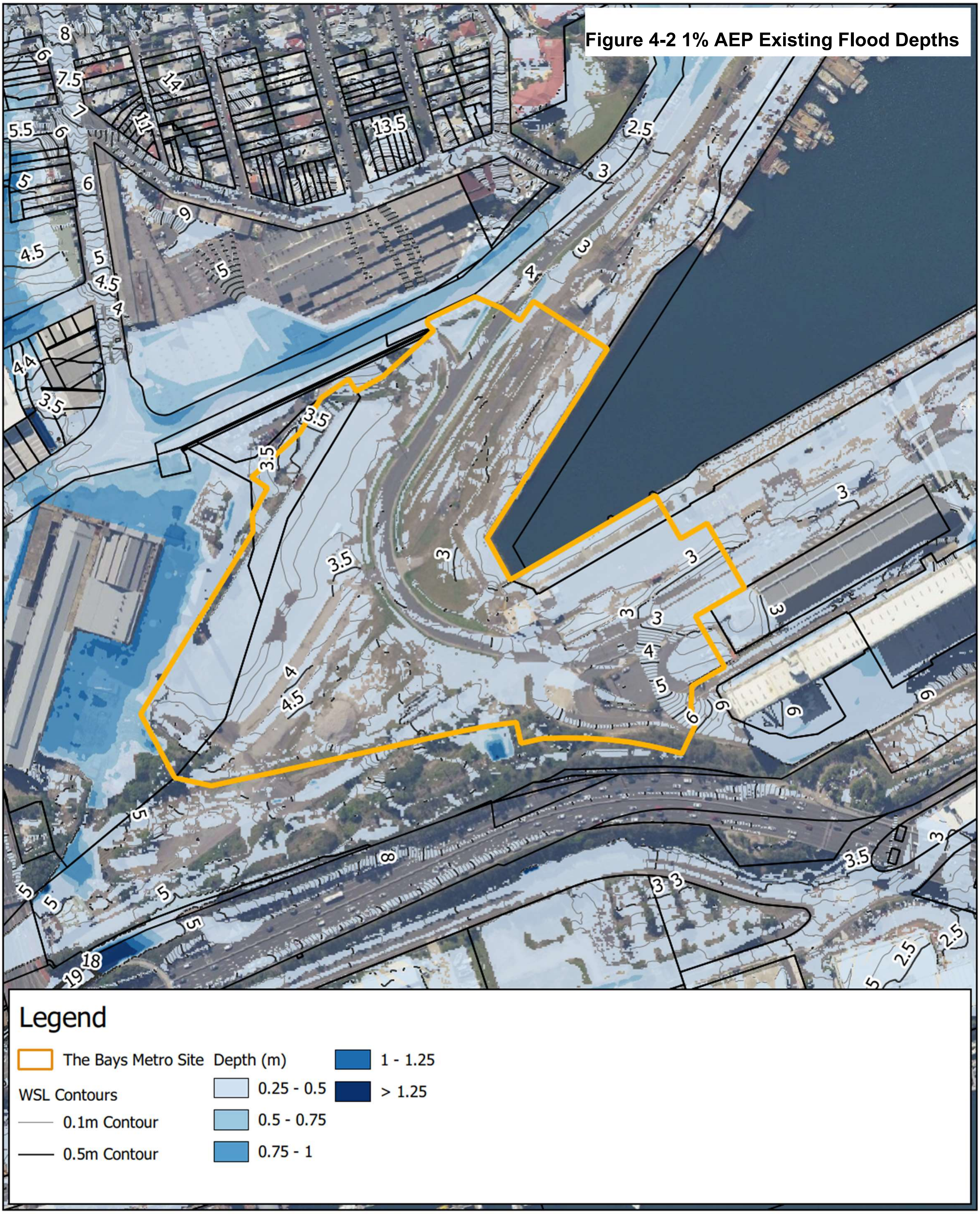


Figure 4-1 Australian Rainfall and Runoff 2019 Flood Hazard Categories

Figure 4-2 1% AEP Existing Flood Depths



TITLE

The Bays
1% AEP Climate Change (HTW) Existing
Flood Depth Map

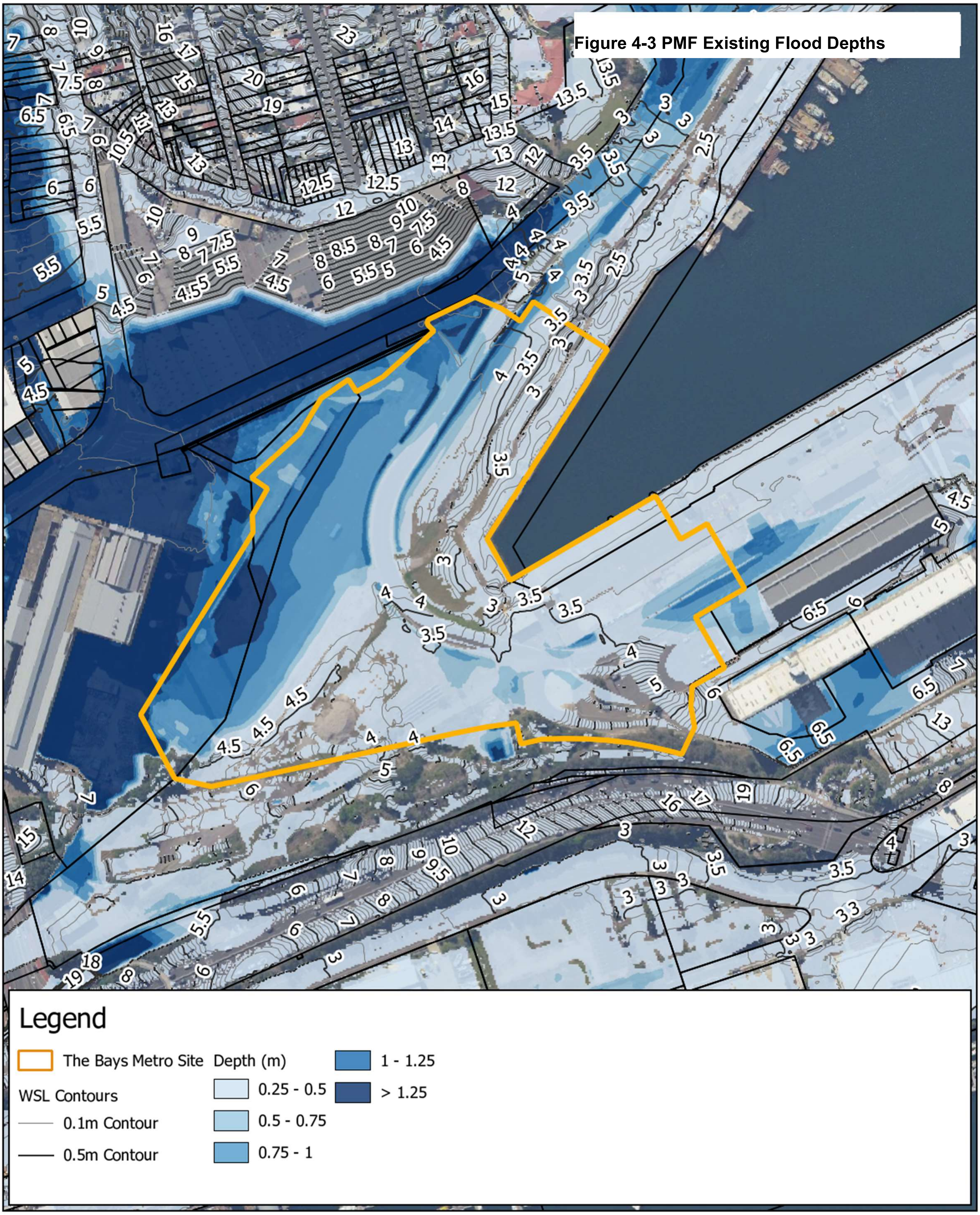
PROJECT

EDS - SWM - The Bays

0 50 100 m

Date	Drawn	Check	Approved	Scale	Rev
10/08/2021	SC			1 : 3000	1

Figure 4-3 PMF Existing Flood Depths



TITLE
The Bays
PMF (HTW) Existing Flood Depth Map

PROJECT
EDS - SWM - The Bays

0 50 100 m

Date	Drawn	Check	Approved	Scale	Rev
10/08/2021	SC			1 : 3000	1

4.2 Post Development Flooding Conditions

The assessment of potential flooding impacts on existing flood regimes has been conducted in accordance with the requirements of the Floodplain Development Manual (NSW Government, 2005), which incorporates the NSW Government's Flood Prone Land Policy. The key objectives of this policy are to identify potential hazards and risks, reduce the impact of flooding and flood liability on owners and occupiers of flood prone property, and to reduce public and private losses resulting from floods. This policy also recognises the benefits of the use, occupation and development of flood prone land.

4.2.1 Sea Level Rise and Coastal Protection

There are a number of factors that contribute to coastal protection requirements for the White Bay Power Station and Robert Street Sub-Precinct, including:

- Water Level Fluctuations, including
    - Astronomical Tides
    - Cyclones/Eastern Cut-off Lows
- Extreme Water Levels
- Sea Level Rise
- Winds and Waves
- Coastal Flood Conditions, including
    - Tsunamis; and
    - Local Storm Surge.

While Tsunamis have the potential to induce coastal flooding at the site during extremely rare events the return the return periods of consequential events are generally above 200 years. The project coastal flooding criteria only include factors with a maximum return period of 100 years (1% AEP or higher).

Similarly, local storm surge, or water level build-up at the seawall due to winds acting in the harbour, is not expected to be significant since the site is located within a relatively deep, short-fetch harbour. Larger-scale water level anomalies due to cyclone/ECL activity are assumed to be included in the extreme value analysis.

The biggest impact results from Sea Level Rise, as a part of the Sydney Metro Stage 1 EIS, they assumed a 0.9 metre (relative to a 1986-2005 baseline) of sea-level rise by 2100 based on recommendations in previous guidance from the NSW Government for assessing climate change impacts in the year 2100 which is based on RCP8.5. For the purposes of this report, the SMW Stage 1 EIS (Jacobs 2020) sea-level rise of 0.9 metre in 2100 has been adopted for use on this initial stormwater and flooding assessment.

Analysis of likely coastal flooding conditions at the site indicates that a coastal protection elevation of 3.35 metre (AHD) is reasonable and appropriate for use during for this precinct. This previous flood elevation included a 1% Annual Exceedance Probability (100-yr) ocean level of 1.45 metre (AHD), sea level rise allowance of 0.9 metre for the year 2100.

It is noted that this 3.35m AHD level is significantly lower than the mainstream PMF flooding depths which are typically applied for basement entrances and the entrance to the Sydney Metro station. As such it can be utilised for coastal protection levels only where there is not also mainstream flooding present.

The current seawall on the White Bay Power Station and Robert Street Sub-Precinct is approximately 2.0 metre AHD, as raising the seawall would be expensive and potentially restrict stormwater flows – it is recommended that coastal protection is achieved through re-grading of the site to ramp up to a minimum 3.35 metre AHD level rather than raising the seawall.

4.3 White Bay Power Station Flood Protection

The existing levels surrounding the White Bay Power Station that are effected by mainstream flooding are shown below in Figure 4-4, the existing 1% AEP levels in Figure 4-5 and the Probable Maximum Flood (PMF) levels in Figure 4-6.

The proposed future use of the White Bay Power Station is not yet known, as such it is proposed to provide passive protection to the White Bay Station up to the Flood Planning Level (FPL). The FPL is a height used to set floor levels for property development in flood prone areas, it is generally defined as the 1% AEP flood level plus an appropriate freeboard.

Freeboard is a height above the 1% AEP flood level that is included in the Flood Planning Level to account for factors such as wind, waves, unforeseen blockages, other localised hydraulic effects. Freeboard is usually 0.5 metre above a flood level and a 0.5 metre freeboard height has been adopted for this design.

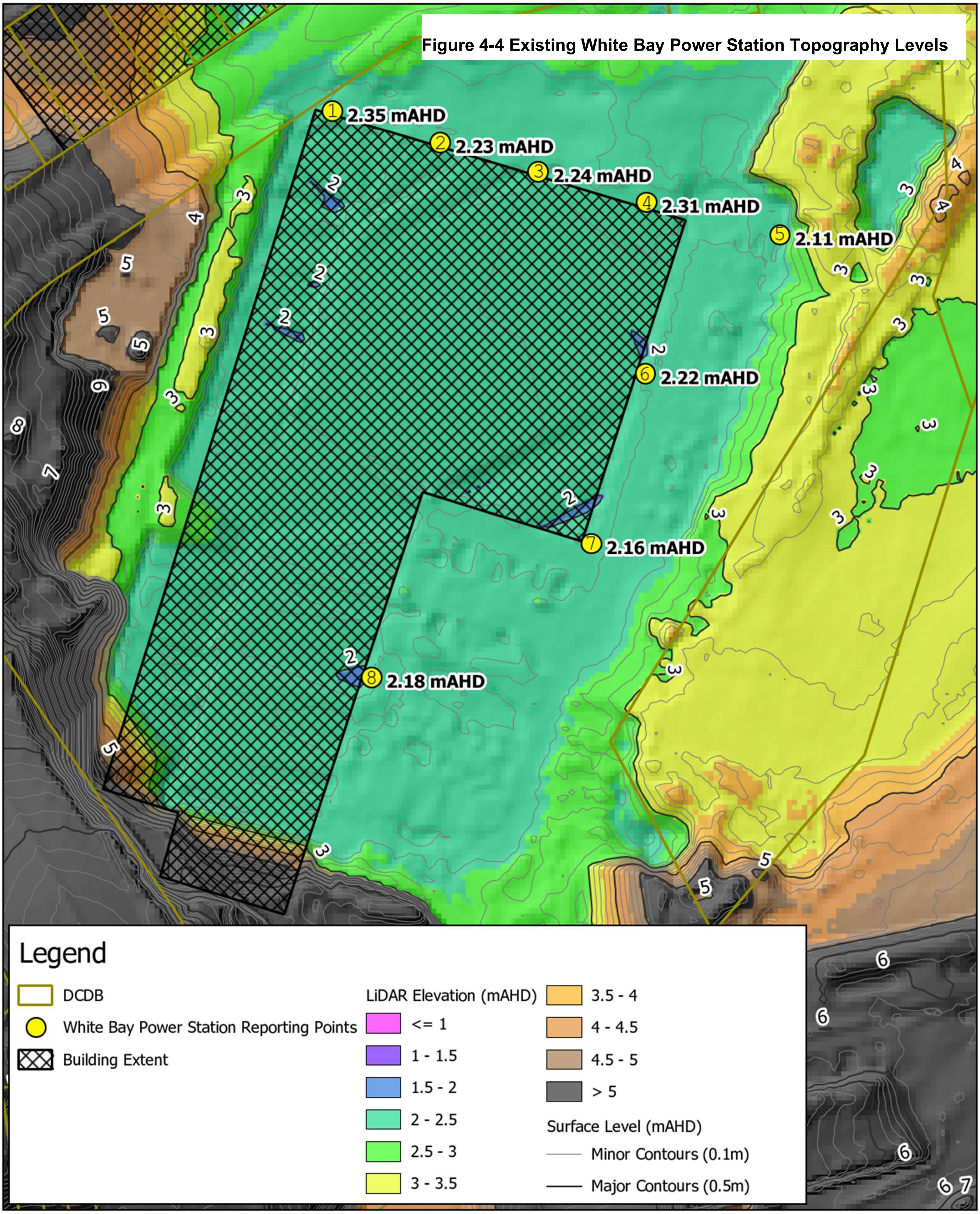
As a part of any future redevelopment of the White Bay Power Station, an internal protection and evacuation strategy will be required to be developed to ensure protection between the FPL and the PMF levels.

The levels shown on the plans are also shown below in Table 4-1.

Table 4-1 White Bay Power Station Flood Levels

Point	Existing Level	1% AEP	FPL Level	PMF Level
1	2.35	3.23	3.73	4.47
2	2.23	3.22	3.72	4.47
3	2.24	3.22	3.72	4.44
4	2.31	3.21	3.71	4.35
5	2.11	3.21	3.71	4.3
6	2.22	3.21	3.71	4.28
7	2.16	3.21	3.71	4.28
8	2.18	3.21	3.71	4.28

Figure 4-4 Existing White Bay Power Station Topography Levels



TITLE

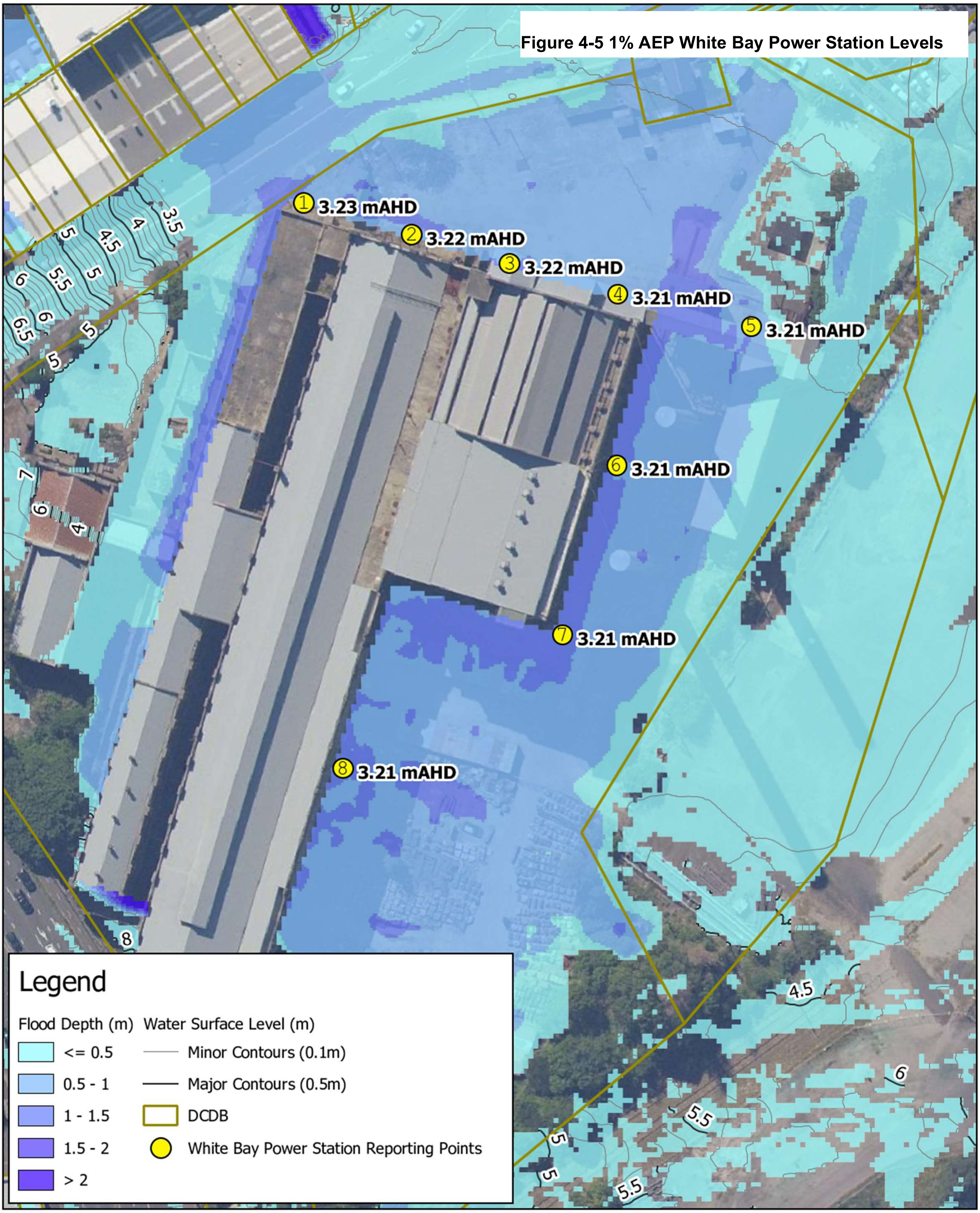
White Bay Power Station Surface Levels (LiDAR)

PROJECT

EDS - SWM - The Bays

Date	Drawn	Check	Approved	Scale	Rev
08/09/2021	SC			1 : 1000	1

Figure 4-5 1% AEP White Bay Power Station Levels



TITLE

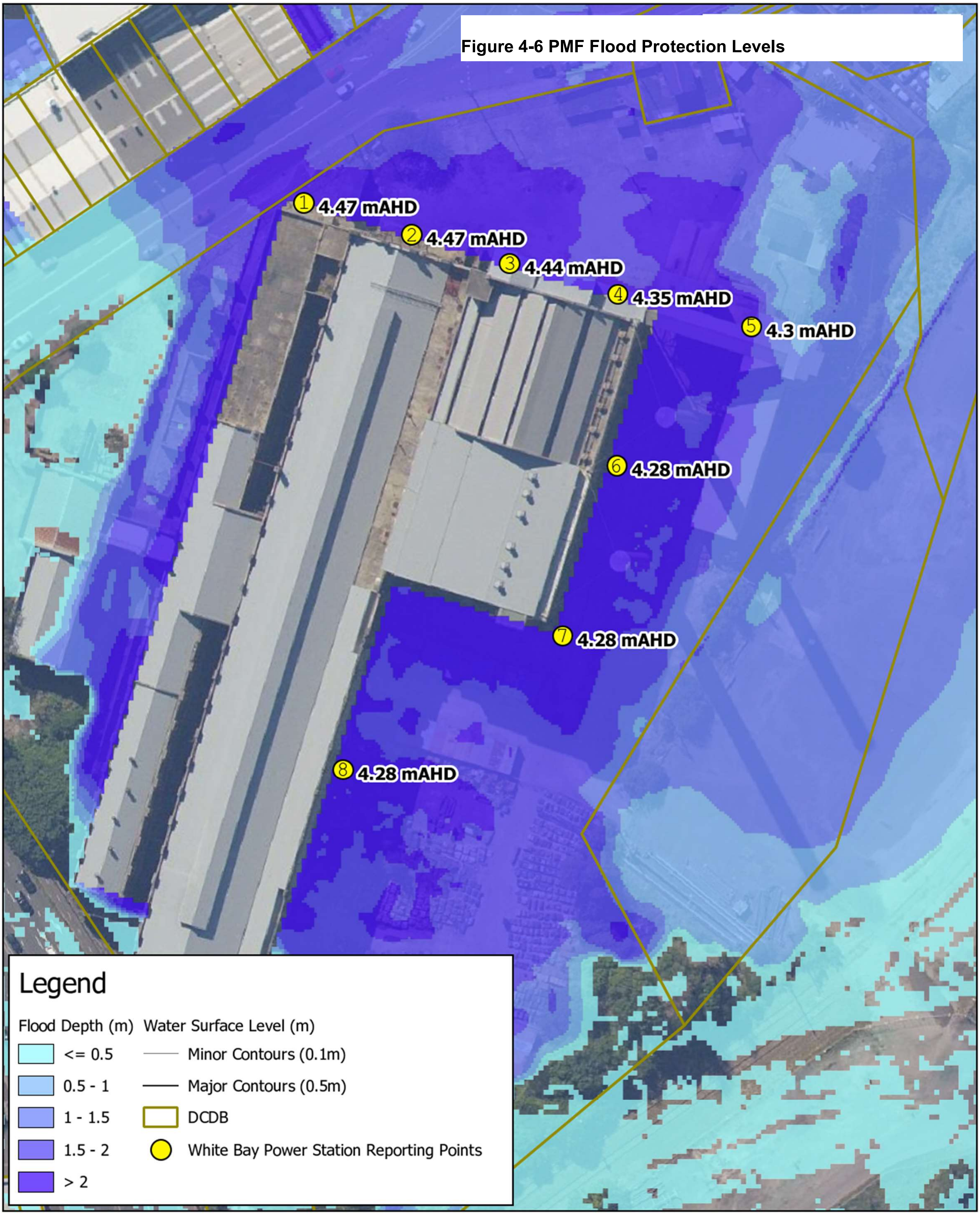
1% AEP Climate Change Existing Flood Depth and Water Surface Level

PROJECT

EDS - SWM - The Bays

Date	Drawn	Check	Approved	Scale	Rev
08/09/2021	SC			1 : 1000	1

Figure 4-6 PMF Flood Protection Levels



TITLE

PMF Existing Flood Depth and Water Surface Level

PROJECT

EDS - SWM - The Bays

0 50 100

MOTT MACDONALD

Date	Drawn	Check	Approved	Scale	Rev
08/09/2021	SC			1 : 1000	1

Ongoing coordination has taken place with the wider Master Planning team to develop a flood protection strategy for the White Bay Power Station and this included modelling the proposed ground surface.

The current strategy for flood protection is to combine a number of flood protection strategies:

- Introduction of a 3.6 metre by 1.2 metre culvert from the intersection of Robert & Mullens Street discharging at the harbour
- Provision of a 10 metre wide overland flow route between the northern end of the Power Station and the heritage sewer pump station, with a minimum internal wall level of 3.73 metre AHD to provide 1% AEP + 0.5 metre flood protection
- A wall structure connecting into the Victoria Road footpath at RL3.73 metre AHD to prevent flood water's entering the northern façade of the building.

These measures are shown in the below figures while the flood maps are shown in Appendix A.

Figure 4-7 White Bay Power Station Flood Protection

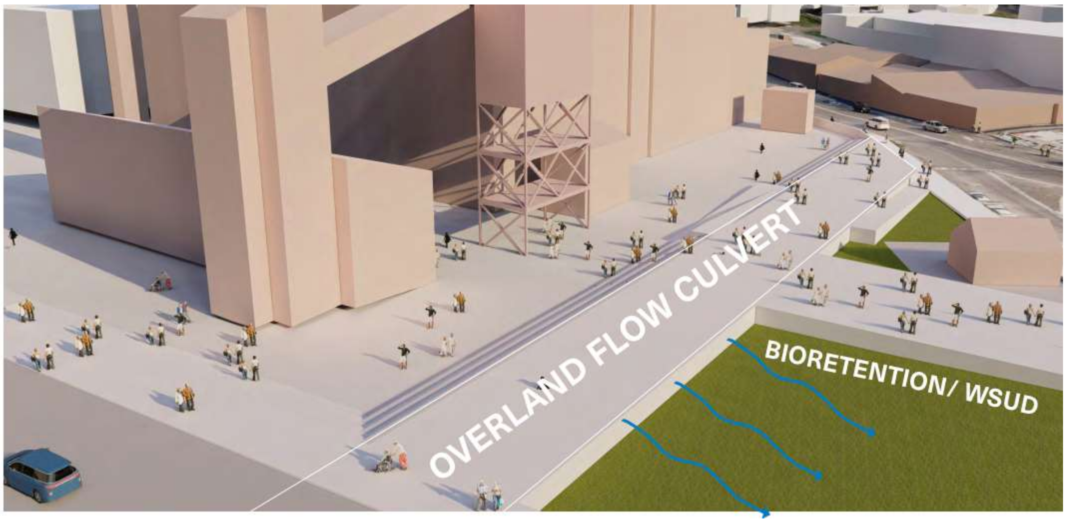


Figure 4-8 White Bay Power Station Flood Protection (3d Model)

5 Conclusion

Preliminary drainage, water quality and flood modelling for the Bays Precinct has been undertaken using the DRAINS, MUSIC and TUFLOW design tools. The TUFLOW model was converted from the previous Leichardt Flood Study and updated with updated site survey and design tin information.

The results of these initial cases have been presented along with a proposed masterplan level stormwater scheme and opportunities for Water Sensitive Urban Design (WSUD) enhancement.

Under current flood conditions, there is significant flooding through the site from Robert Street and potential future flooding from sea level rise and storm surge. A combination of flood mitigation and stormwater infrastructure works are proposed to mitigate these issues:

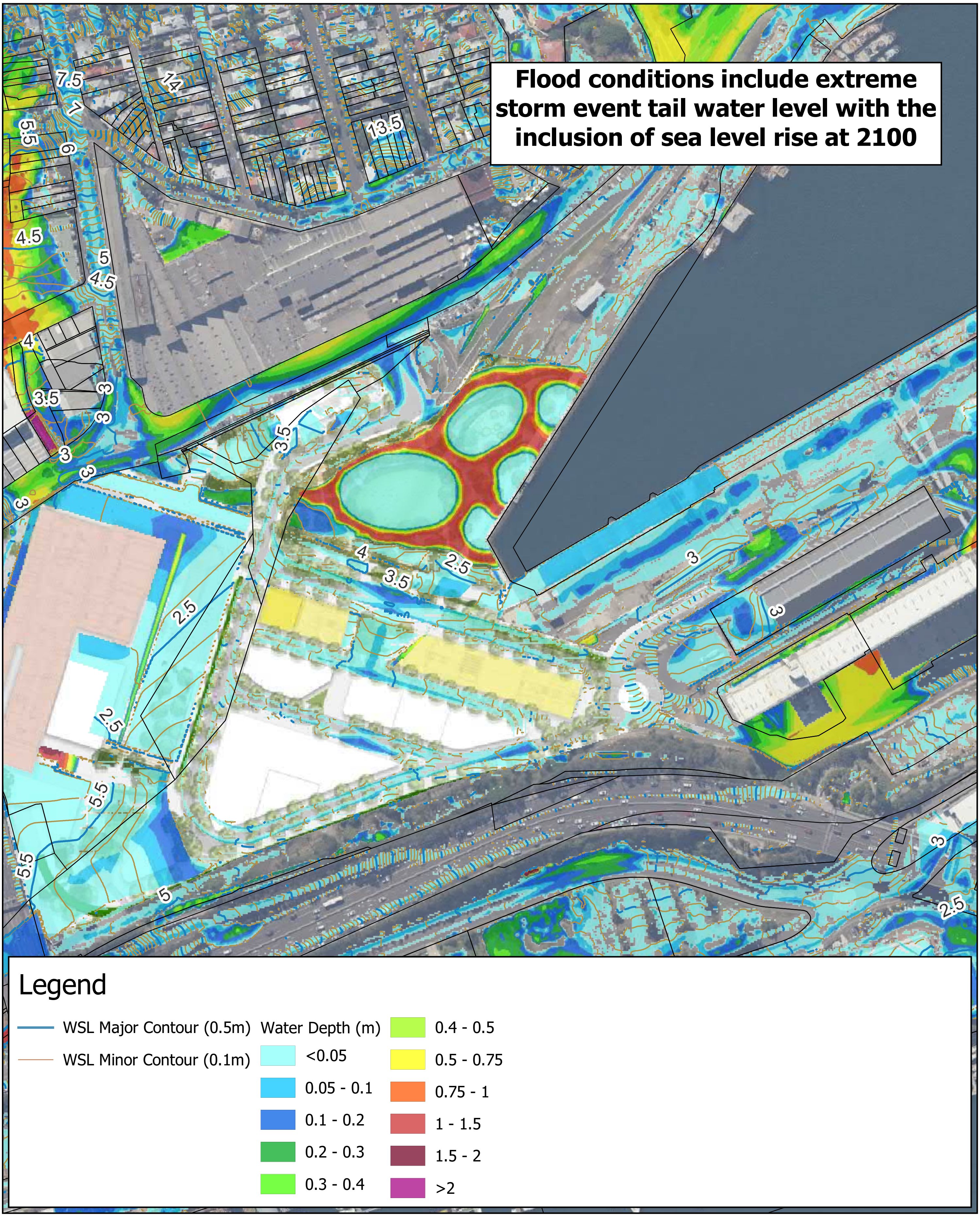
- A new culvert and overland flow path directing existing onsite flows from Robert and Mullens Street through the development to the harbour
- Passive flood protection of the White Bay Power station through increased site levels directing flows into the proposed new culvert and overland flow path
- Increased site levels ramping up from the existing seawall to account for future rises in sea-level
- Establishment of a minor and major drainage system to adequately drain the site
- Introduction of Water Sensitive Design (WSUD) measures to improve existing water quality of the site prior to discharge into the harbour.

Based on the investigations undertaken, solutions exist to adequately drain and flooding risks can be mitigated using appropriate FPLs, setbacks and emergency response frameworks and WSUD measures can be readily implemented for water quality enhancement, the site is suitable to be a mixed-use development comprising residential, commercial, open spaces and community facilities.

It is recommended that during subsequent design stages the design is further progressed with revised flood, stormwater and water quality modelling to confirm the proposed solution and account for the staging of infrastructure.

In addition, future studies can further progress WSUD measures to improve the water quality of the site, serve to improve bio-diversity and align with the precinct’s sustainability objectives.

Appendix A – Developed Case Flood Maps



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

— WSL Major Contour (0.5m)	Water Depth (m)		0.4 - 0.5
— WSL Minor Contour (0.1m)		<0.05	0.5 - 0.75
		0.05 - 0.1	0.75 - 1
		0.1 - 0.2	1 - 1.5
		0.2 - 0.3	1.5 - 2
		0.3 - 0.4	>2

TITLE

Figure 001
5% AEP Climate Change Developed Flood Depth

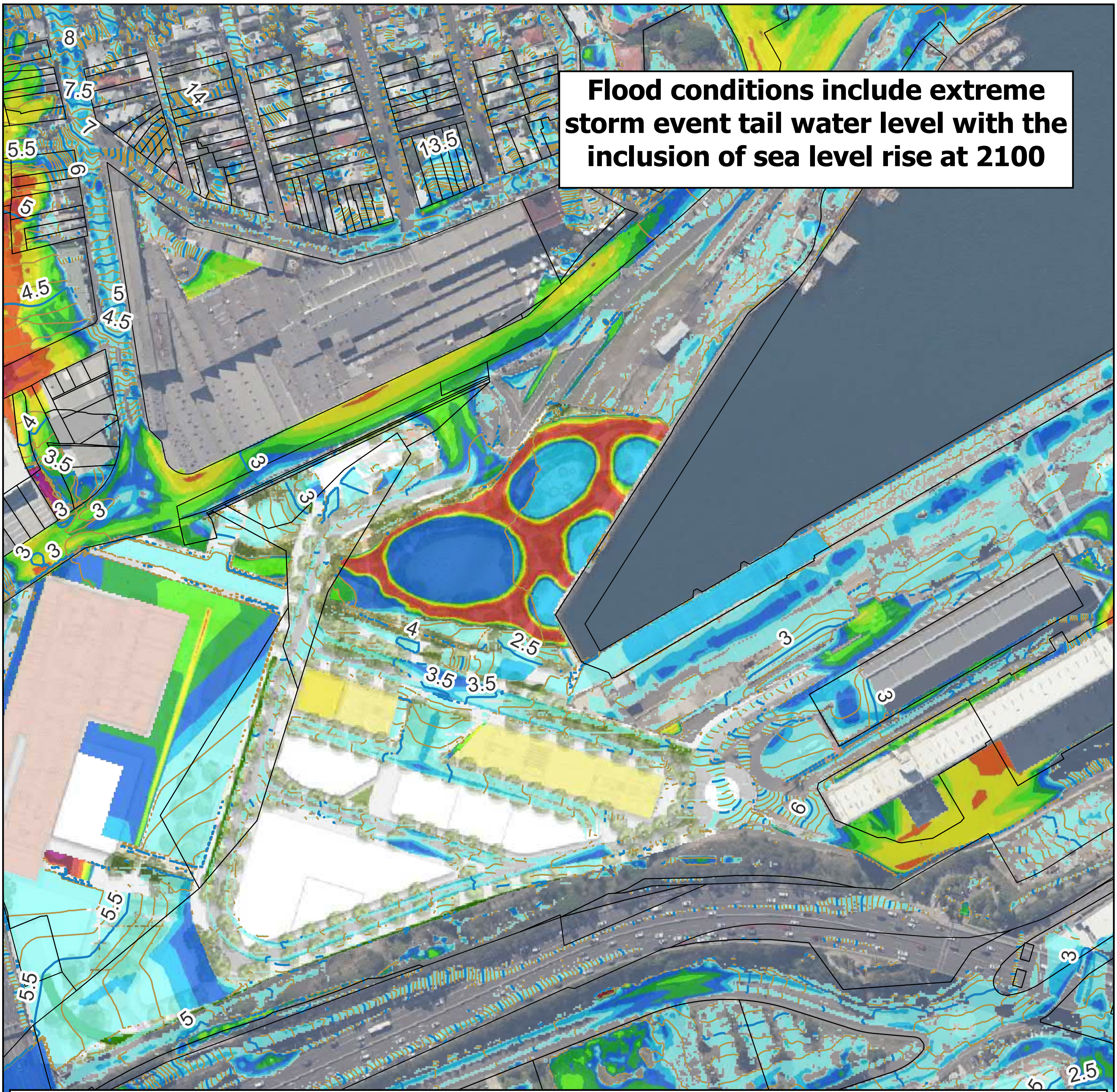
PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

— WSL Major Contour (0.5m)	Water Depth (m)	🟩	0.4 - 0.5
— WSL Minor Contour (0.1m)	🟦 <0.05	🟨	0.5 - 0.75
	🟦 0.05 - 0.1	🟧	0.75 - 1
	🟦 0.1 - 0.2	🟥	1 - 1.5
	🟩 0.2 - 0.3	🟫	1.5 - 2
	🟩 0.3 - 0.4	🟪	>2

TITLE

Figure 002
1% AEP Climate Change Developed Flood Depth

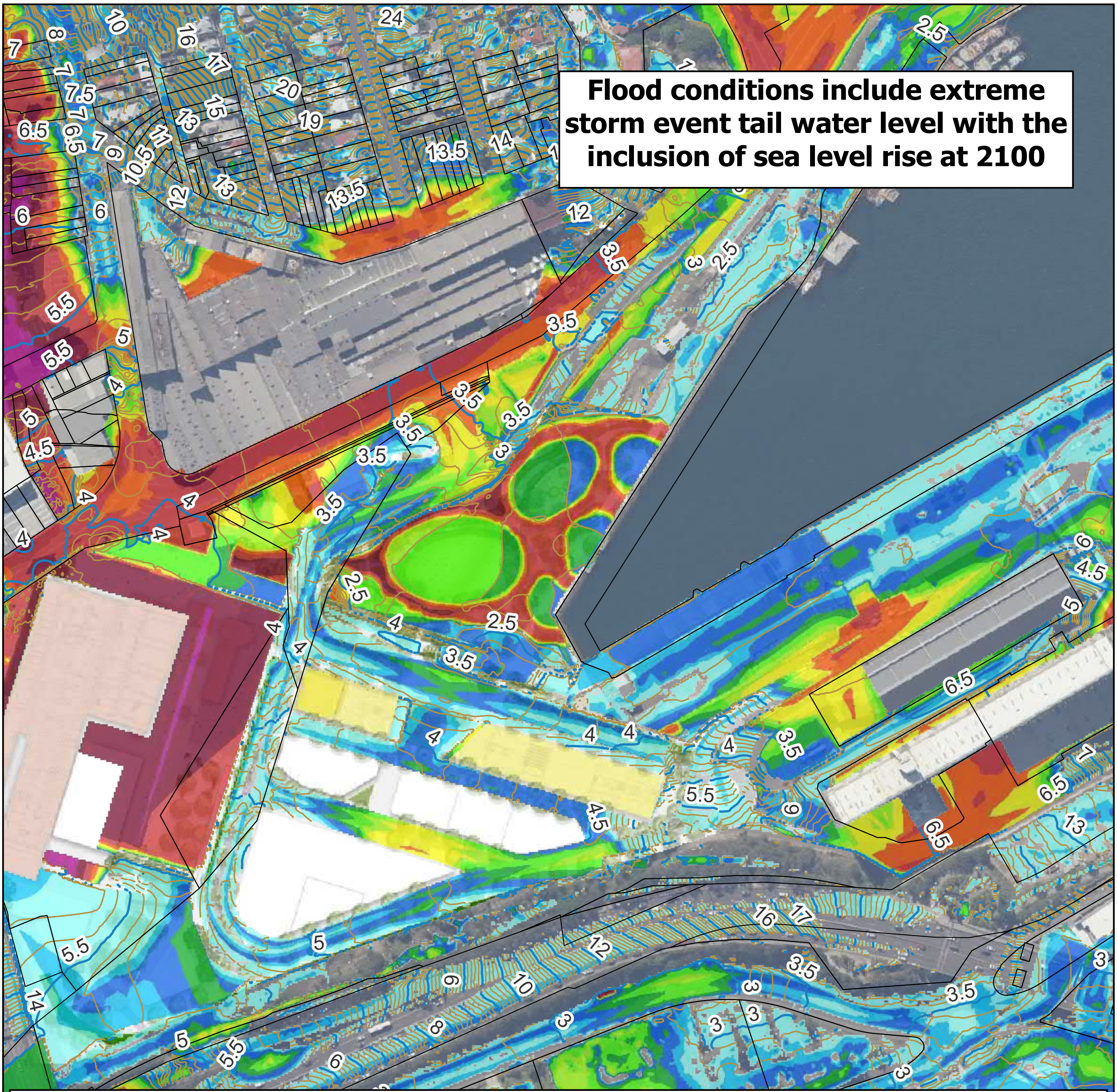
PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT | Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

— WSL Major Contour (0.5m)

— WSL Minor Contour (0.1m)

Water Depth (m)

🟦 <0.05

🟦 0.05 - 0.1

🟦 0.1 - 0.2

🟩 0.2 - 0.3

🟩 0.3 - 0.4

🟩 0.4 - 0.5

🟨 0.5 - 0.75

🟧 0.75 - 1

🟥 1 - 1.5

🟫 1.5 - 2

🟪 >2

TITLE

Figure 003
PMF Climate Change Developed Flood Depth

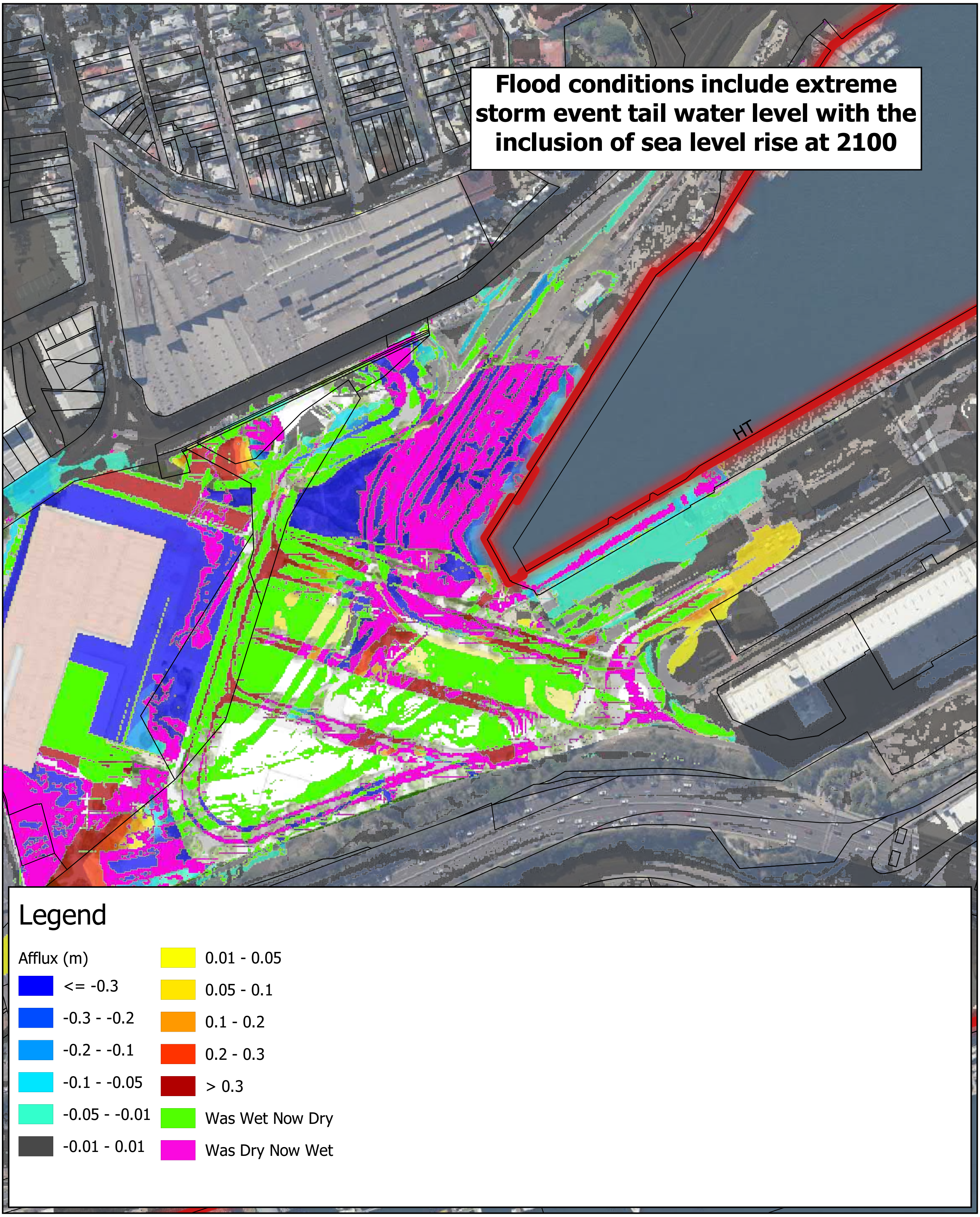
PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT | Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

TITLE

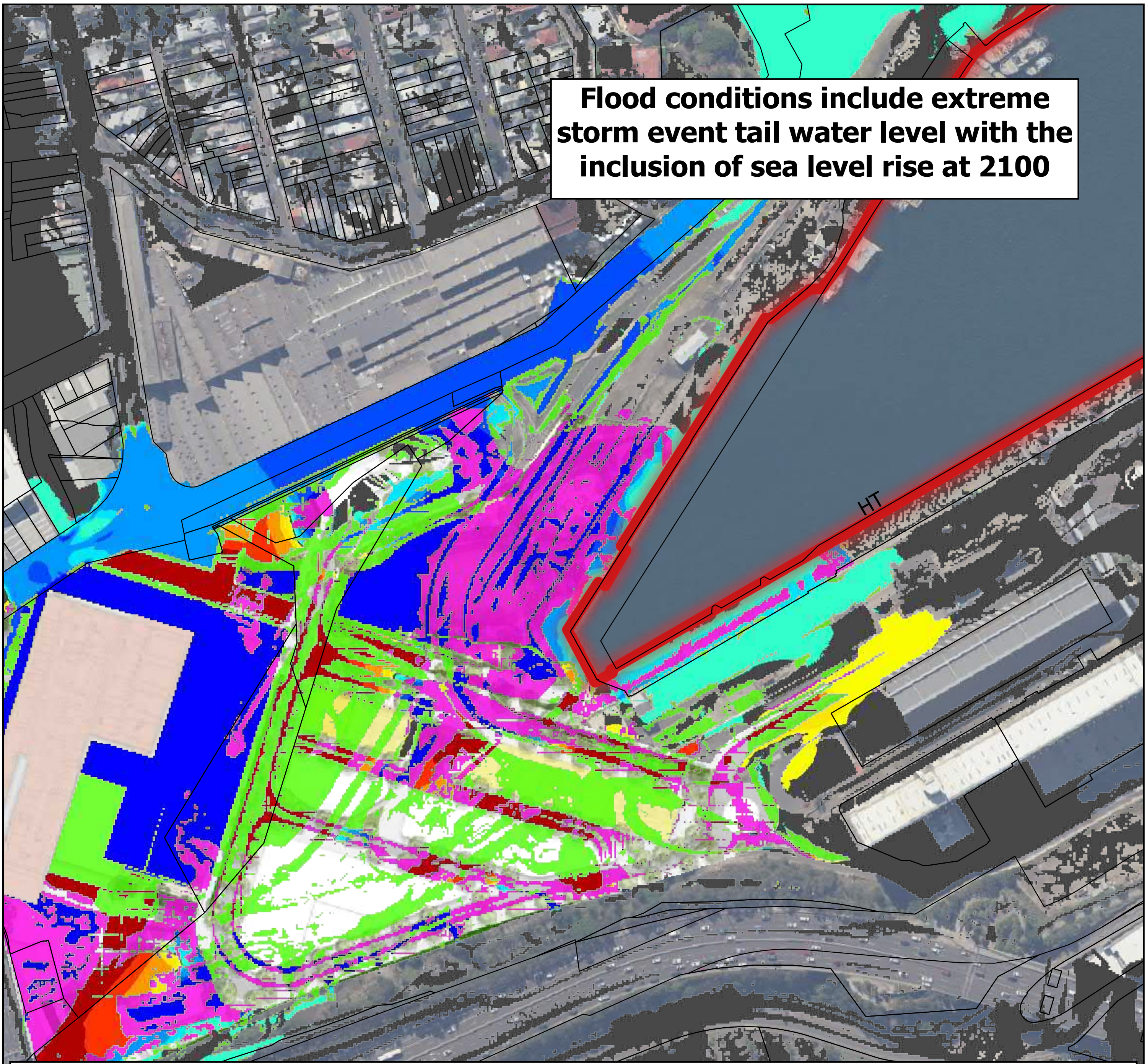
Figure 004
5% AEP Climate Change Developed Change in Flood Levels

PROJECT

EDS - SWM - The Bays

NSW GOVERNMENT | Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

Afflux (m)
- 🟦 <= -0.3
- 🟦 -0.3 - -0.2
- 🟦 -0.2 - -0.1
- 🟦 -0.1 - -0.05
- 🟦 -0.05 - -0.01
- ⬛ -0.01 - 0.01
- 🟨 0.01 - 0.05
- 🟨 0.05 - 0.1
- 🟧 0.1 - 0.2
- 🟥 0.2 - 0.3
- 🟥 > 0.3
- 🟩 Was Wet Now Dry
- 🟪 Was Dry Now Wet

TITLE

Figure 005
1% AEP Climate Change Developed Change in Flood Levels

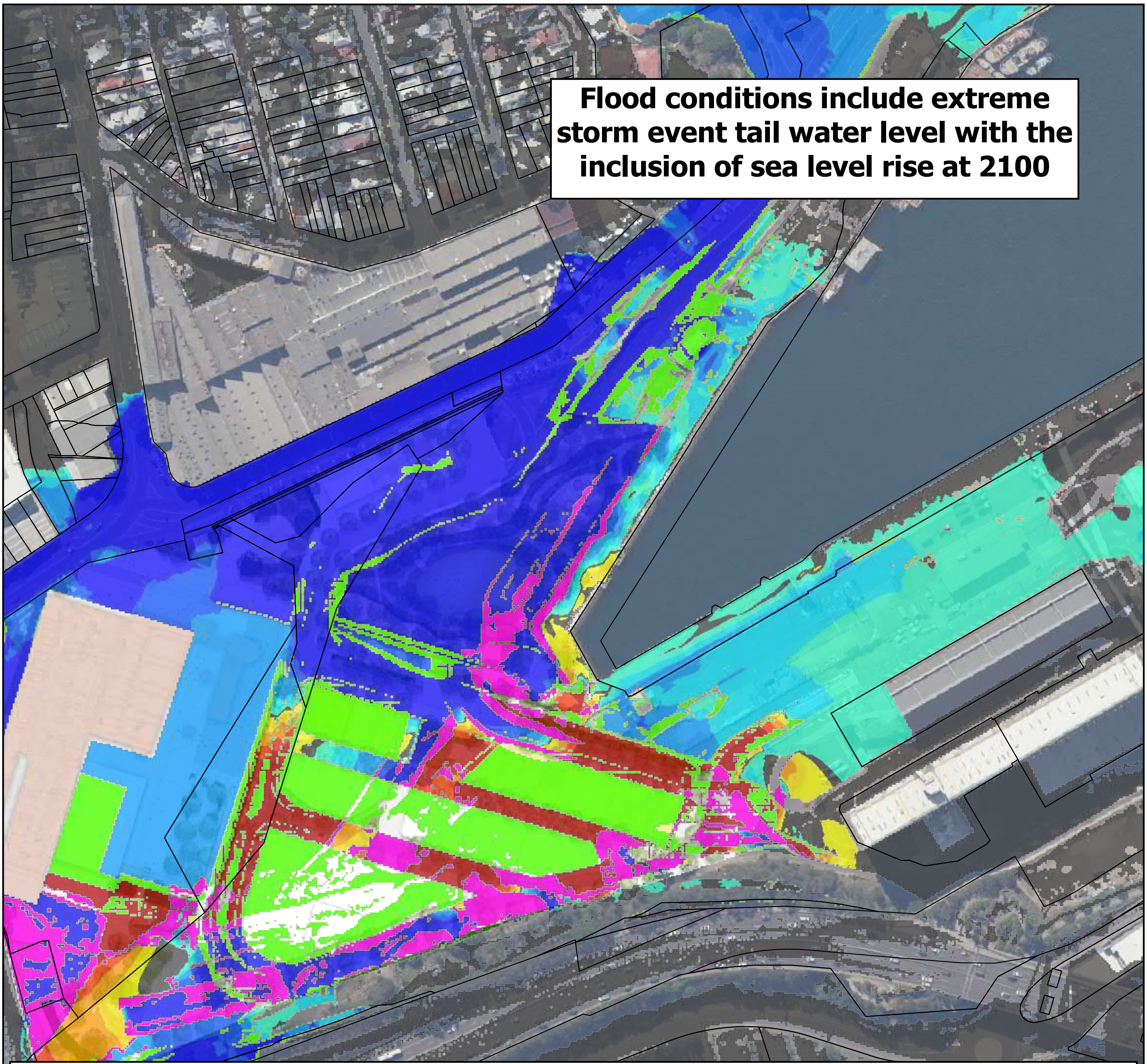
PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT
Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	ME	SC	SB	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

Afflux (m)

🟦	<= -0.3	🟨	0.01 - 0.05
🟦	-0.3 - -0.2	🟨	0.05 - 0.1
🟦	-0.2 - -0.1	🟧	0.1 - 0.2
🟦	-0.1 - -0.05	🟥	0.2 - 0.3
🟩	-0.05 - -0.01	🟥	> 0.3
⬛	-0.01 - 0.01	🟩	Was Wet Now Dry
		🟪	Was Dry Now Wet

TITLE

Figure 006
PMF Developed Change in Flood Levels

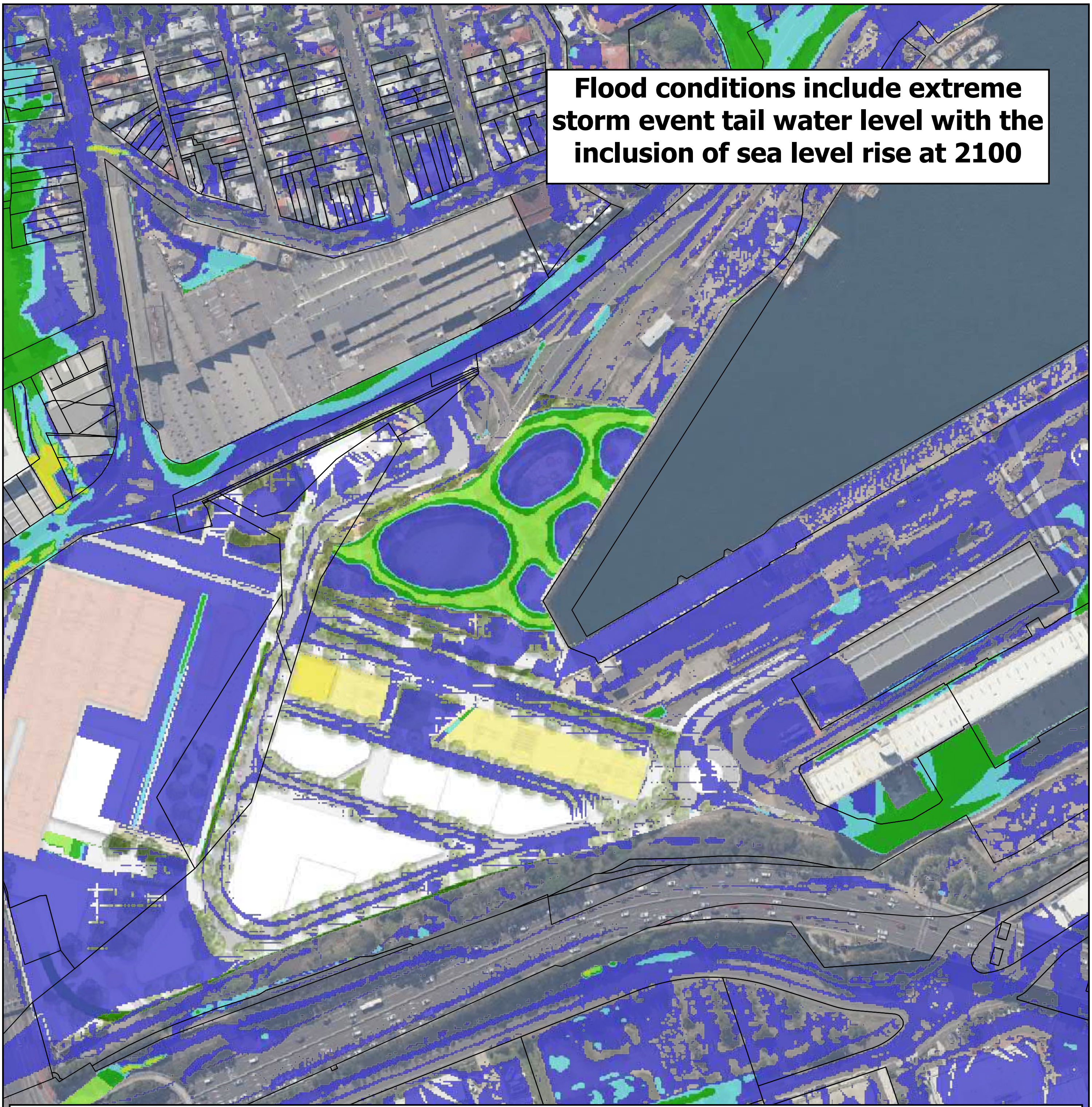
PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT | Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

Flood Hazard
- 🟦 H1
- 🟦 H2
- 🟩 H3
- 🟩 H4
- 🟨 H5
- 🟥 H6

TITLE

Figure 007
5% AEP Climate Change Developed Flood Hazard

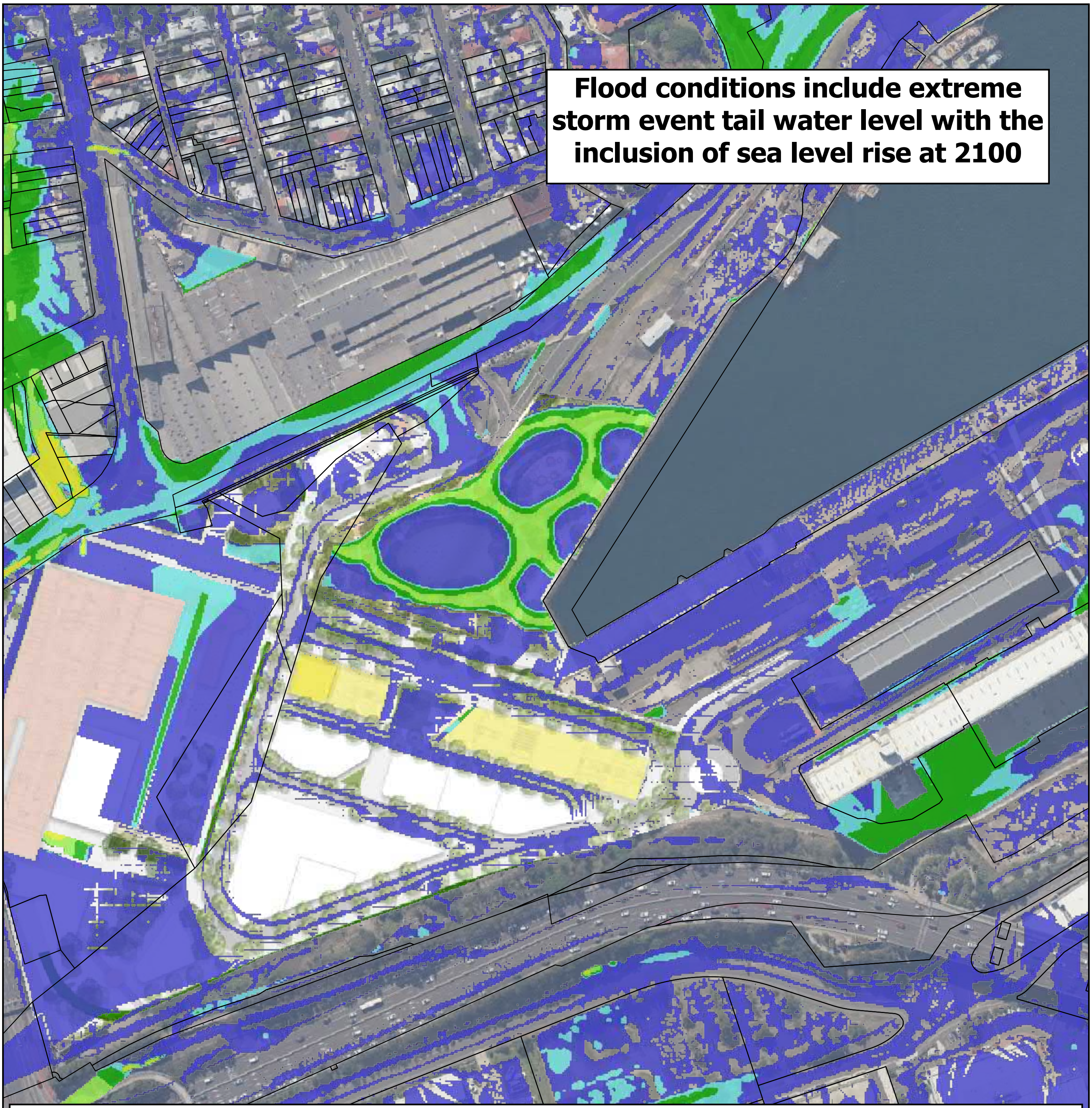
PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

Legend

Flood Hazard
- 🟦 H1
- 🟦 H2
- 🟩 H3
- 🟩 H4
- 🟨 H5
- 🟥 H6

TITLE

Figure 008
1% AEP Climate Change Developed Flood Hazard

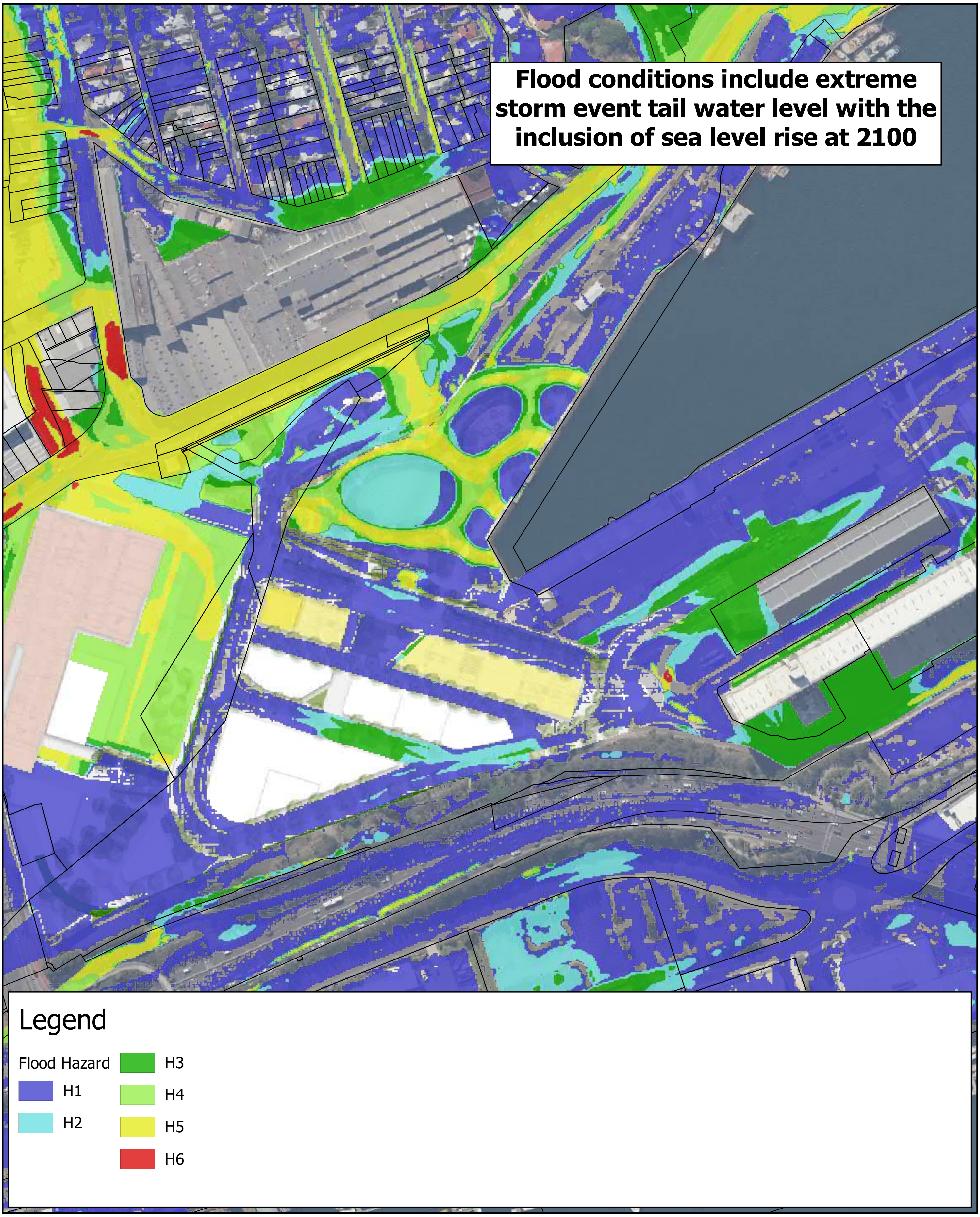
PROJECT

EDS - SWM - The Bays

0 50 100 m

Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1



Flood conditions include extreme storm event tail water level with the inclusion of sea level rise at 2100

TITLE

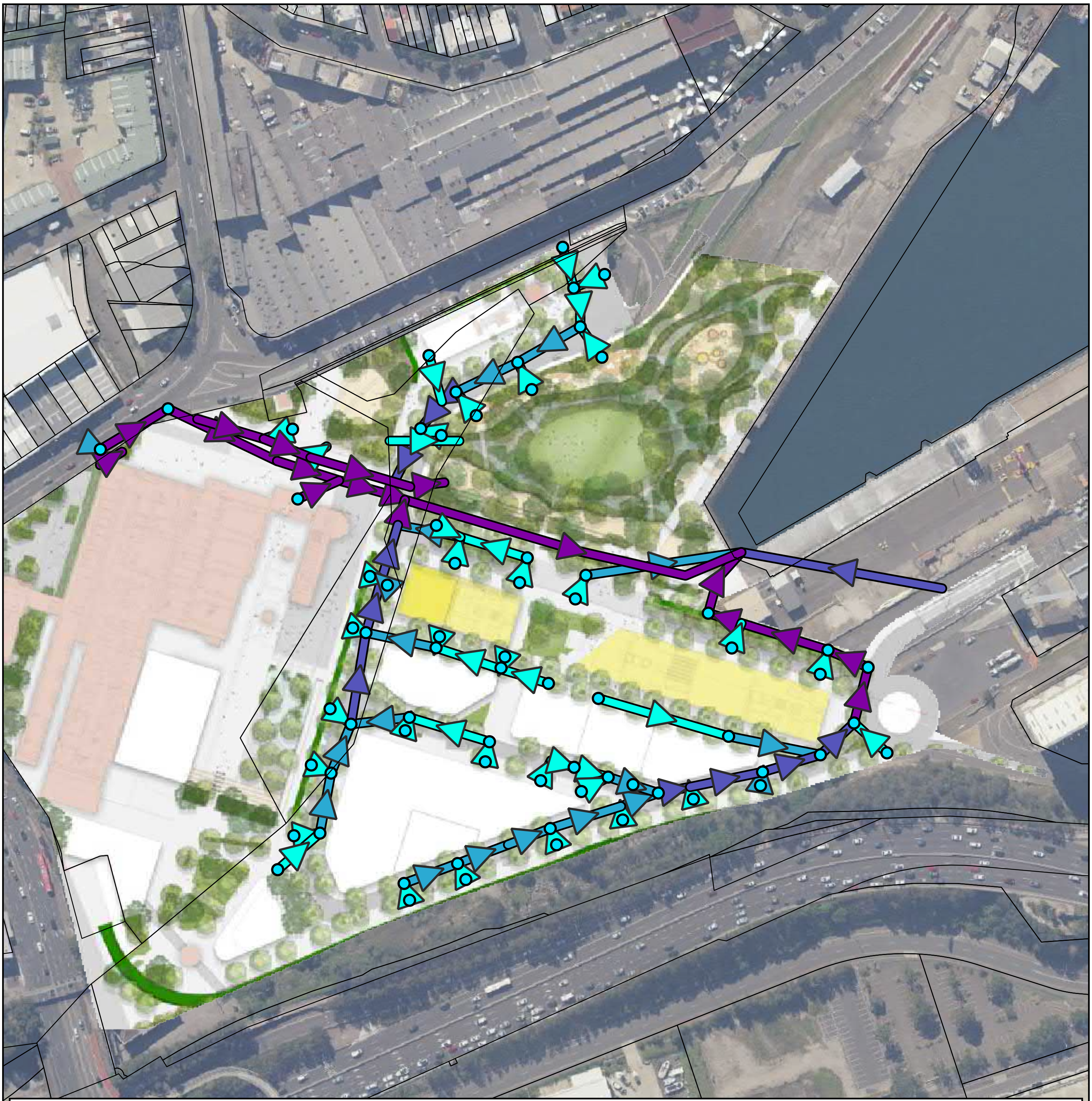
Figure 008
PMF Developed Flood Hazard

PROJECT

EDS - SWM - The Bays

0 50 100 m

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	SB	1 : 3000	1



Legend

Stormwater Network ● Stormwater Inlets

- <= 450mm
- 600 mm
- 900 mm
- > 900mm

TITLE

Figure 010
TBY Developed Pipe Network and Overland Channels

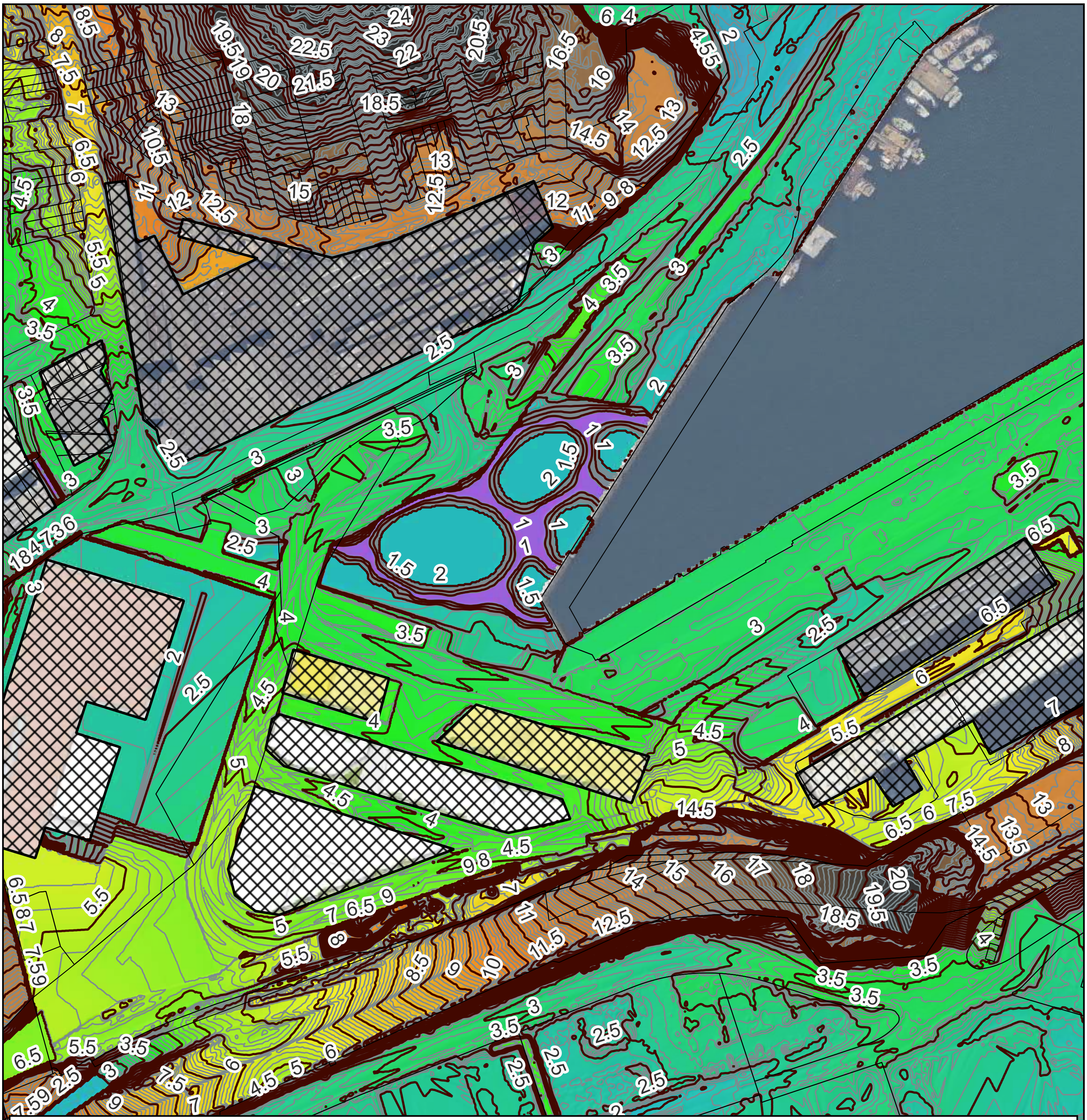
PROJECT

EDS - SWM - The Bays

0 50 100 m

Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	ME	SC	SB	1 : 2500	1



Legend

Elevation (mAHD)
20
0

0.5m Contours
0.1m Contours

▨ Buildings

TITLE

Figure 011
The Bays West Developed Topography

PROJECT

EDS - SWM - The Bays

0 50 100 m

NSW GOVERNMENT Planning, Industry & Environment

Date	Drawn	Check	Approved	Scale	Rev
01/08/2022	SC	DF	DF	1 : 3000	1

This page has been intentionally left blank

mottmac.com

July, 2022