1% AEP FLOOD INVESTIGATION AND FLOOD RISK MANAGEMENT REPORT

Client: **Richard Crookes**

Property: **Lot A DP 405897 (No. 17) Ocean Road, Palm Beach**

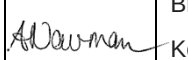
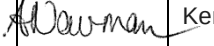
Date: **12 December 2017**

Document Identification

Our Reference: **GO170545**

For and on behalf of ACOR Consultants (CC) Pty Ltd

Quality Information

Version	Description	Date	Author	Signature	Reviewer	Signature
1.0	DRAFT Flood Investigation & Flood Risk Management Report	24/08/2017	Amanda Newman			
2.0	Flood Investigation and Flood Risk Management Report	29/09/2017	Amanda Newman		Bruce Kenny	
3.0	DRAFT Revised Flood Investigation & Risk Management Report	21/11/2017	Amanda Newman		Bruce Kenny	
4.0	Revised Flood Investigation & Risk Management Report	12/12/2017	Amanda Newman		Bruce Kenny	

Suite 2.01, Level 2
4 Ilya Avenue
ERINA NSW 2250

PO Box 3772
Fountain Plaza
ERINA NSW 2250

T 02 4324 3499

www.acor.com.au

ENGINEERS

MANAGERS

INFRASTRUCTURE PLANNERS

DEVELOPMENT CONSULTANTS

Distribution

No. of Copies	Format	Distributed to	Date
1 (v 1.0)	pdf		
1 (v 2.0)	pdf	Geoff Watson @ The Design Section	29/09/2017
1 (v 3.0)	pdf	Peter Horton	21/11/2017
2 (v 4.0)	pdf	Geoff Watson	12/12/2017

TABLE OF CONTENTS

1.0 Introduction 5

1.1 Objective 5

1.2 Site Description 5

1.3 Flood Characteristics 6

2.0 Available Data 7

2.1 Published Flood Data 7

2.2 Survey Data 7

2.3 Design Storm Event Data 7

3.0 Hydrologic Modelling 8

4.0 Hydraulic Modelling 8

4.1 Choice of Hydraulic Model 8

4.2 TUFLOW 1D Model Domain 9

4.3 TUFLOW 2D Model Domain 9

4.3.1 Topography 9

4.3.2 Building Footprint 10

4.3.3 Infiltration 10

4.3.4 Roughness 10

4.4 Boundary Conditions 11

4.4.1 Direct Rainfall 11

4.4.2 Upstream Boundary 11

4.4.3 Downstream Boundary 11

5.0 Flood Model Results 11

5.1 Flood Model Validation 12

5.2 Critical Duration 13

5.3 Design Peak Flood Flow 13

5.4 Design Flood Characteristics 13
5.5 Provisional Flood Hazard 14
5.6 Life Hazard Category 15
5.7 Flood Affectation of the Site 15
6.0 Flood Risk Management 16
6.1 Floor Level 16
6.2 Drainage Infrastructure and Creek Works 17
6.3 Building Components and Structural Soundness 17
6.4 Storage of Goods 18
6.5 Flood Emergency Response 18
6.6 Flood Effects Caused by Development 19
6.7 Car Parking 19
6.8 Pools 19
6.9 Fencing 19
7.0 Conclusion 20
8.0 References 21
9.0 Glossary 22

ANNEXURES

Annexure A Architectural plans prepared by The Design Section Architects, no reference, dated July 2017

Annexure B Survey plan prepared by Lawrence Group Pty Ltd, Job No. 173654, Drawing No. DETL-001, Issue A, dated 13 April 2017

Annexure C 'Flood Information Request – Basic' issued by Northern Beaches Council, dated 10 May 2017

Annexure D ACOR Stormwater Management Plans, Reference GO170545, Drawing No.'s C1 to C5, Issue E, dated 12 December 2017

Annexure E ACOR Flood Plans, Reference GO170545, Sheets F1 to F10, Revision C, dated 20 November 2017

1.0 Introduction

ACOR Consultants (CC) Pty Ltd (ACOR) has been commissioned to prepare a 1% AEP Flood Investigation and Flood Risk Management Report in accordance with the requirements of Pittwater 21 Development Control Plan Amendment 22 (Pittwater 21 DCP) Section B3.11 Flood Prone Land; Northern Beaches Council Flood Prone Land Design Standard; Flood Emergency Response Planning for Development in Pittwater Policy; and Pittwater Local Environmental Plan 2014 (Amendment No 8) (Pittwater LEP 2014) Part 7.3 and 7.4. The Flood Investigation Report and Flood Risk Management Plan is supported by a flood study which investigates flood behaviour throughout the overland flooding catchment impacting the subject site. This includes the analysis of:

- Surface runoff across the catchment;
- Flooding towards the lower part of the catchment; and
- Backwater flooding impact on the subject site.

A two-dimensional computer model of the catchment was established to analyse overland flood behaviour under existing and proposed catchment conditions. The model provides information on the extent of flood inundation, flood depths and flood velocities throughout the catchment for the 1% AEP overland flood event. Results from this study form the technical basis for the subsequent flood risk management plan which identifies problem areas and investigates options to reduce the risk of flooding.

1.1 Objective

The objective of the study is to define local overland flooding in accordance with the Floodplain Development Manual (NSW DIPNR 2005) and Pittwater 21 DCP Section B3.11. It involved the following steps:

- Attend the site to assess the anticipated extent and nature of flooding and identify hydraulic controls likely to impact on flooding behaviour;
- Develop hydrologic model to determine 1% AEP flood hydrographs;
- Develop hydraulic model to determine 1% AEP flood levels, velocities and hazard categories; and
- Review flooding behaviour and provide recommendations to ensure that future redevelopment of the site will meet flood compatibility standards.

1.2 Site Description

The subject site is known as Lot A DP 405897 (No. 17) Ocean Road, Palm Beach. The site is located at the intersection of Ocean Road and Palm Beach Road, being on the western side of Ocean Road and the southern side of Palm Beach Road. Development surrounding the site is mainly residential. Palm Beach is located to the east of the site, on the opposite side of Ocean Road.

The site is a developed site of area 879 square metres and is zoned R2 Low Density Residential (Pittwater Council 2017a). Current development on site consists of a single storey residence and detached garage.

The site falls to the east, towards Ocean Road. Elevations on site are generally within the range 4.5 m AHD to 7.1 m AHD.

The site owner proposes to demolish the existing dwelling and construct a two storey residence with attached garage. The principal details of the proposed development and site improvements are depicted in architectural plans prepared by The Design Section Architects (copy enclosed under Annexure A).

1.3 Flood Characteristics

The subject site is impacted by overland flows draining towards the ocean. Land use within the overland flow catchment is mainly residential. Elevations within the overland flow catchment are generally within the range 0 m AHD to 80 m AHD.

Flood behaviour at the site is described within 'Flood Information Request – Basic Purpose' issued by Northern Beaches Council, dated 10 May 2017 (copy enclosed under Annexure C). The document describes the behaviour of the 1% AEP floodwaters and the PMF floodwaters.

The 1% AEP floodwaters impact the property at elevations within the approximate range 4.70 m AHD to 6.85 m AHD, resulting in partial inundation of the site to depths between 0.00 m and 0.25 m. The 1% AEP floodwaters pose Low Hazard to occupants of the site, with Life Hazard Category within the range H1 to H2. The 1% AEP floodwaters fall within the Flood Storage hydraulic category.

The PMF floodwaters impact the property at elevations within the approximate range 4.80 m AHD to 6.95 m AHD, resulting in partial inundation of the site to depths between 0.00 m and 0.35 m.

The site falls partly within the Medium Risk precinct and partly within the Low Risk precinct. The Flood Planning Level (FPL) varies across the site. The FPL is to provide 0.3 m freeboard to the 1% AEP floodwaters with a depth of 0.3 m or less, increasing to 0.5 m freeboard where the 1% AEP floodwaters exceed 0.3 m.

The site is impacted by Coastline Hazard. The impacts of Coastline Hazard on the site and the proposed development are addressed within 'Coastline Risk Management Report in Relation to 17 Ocean Road Palm Beach' prepared by Horton Coastal Engineering Pty Ltd, reference lrJ0085, dated 12 December 2017. The Coastline Planning Level applicable to the proposed development is 5.3 m AHD (Horton Coastal Engineering Pty Ltd 2017), which exceeds the FPL at the eastern site boundary.

2.0 Available Data

This flood study used topographic, flooding and rainfall data obtained from a number of sources. The origin and types of information underpinning the assumptions used in this study are presented below.

2.1 Published Flood Data

Published flood information is contained within 'Flood Information Request – Basic Purpose' issued by Northern Beaches Council, dated 10 May 2017 (copy enclosed under Annexure C). The document describes the behaviour of the 1% AEP floodwaters and the PMF floodwaters, as outlined in Section 1.3.

The performance of the site specific flood model, developed in Sections 3 and 4, can be validated against the description of 1% AEP flooding provided in the 'Flood Information Request – Basic Purpose' and summarised following. The 1% AEP floodwaters impact the property at elevations within the approximate range 4.70 m AHD to 6.85 m AHD, resulting in partial inundation of the site to depths not exceeding 0.25 m. The 1% AEP floodwaters pose Low Hazard to occupants of the site, with Life Hazard Category within the range H1 to H2.

2.2 Survey Data

Survey information adopted for this study has been collated from the following sources:

- ALS survey provided by the NSW Land and Property Information Department (NSW LPI);
- GIS layers of cadastre and satellite imagery provided by the NSW LPI;
- Site survey prepared by Lawrence Group Pty Ltd, Job No. 173654, Drawing No. DETL-001, Issue A, dated 13 April 2017 (copy enclosed under Annexure B).

2.3 Design Storm Event Data

This study uses design rainfall intensity-frequency-duration (IFD) data, derived for the latitude and longitude of the site. This IFD data was issued by the Hydrometeorological Advisory Service of the Australian Bureau of Meteorology in April 1997.

The IFD data provides average rainfall intensities of design storm events for recurrence intervals up to and including the 1% AEP event.

Uniform areal distribution of design storms has been assumed for the catchment due to its small area. Rainfall depths and temporal patterns were developed for the 1% AEP design storm events using techniques described in Australian Rainfall and Runoff (Pilgrim 1998). Estimated average design storm rainfall intensities for the full range of 1% AEP storm events considered are presented in Table 1.

Table 1: Average design rainfall intensities.

Duration	Intensity (mm/hr)	Duration	Intensity (mm/hr)
5 min	256.4	30 min	125.2
10 min	201.6	45 min	102.5
15 min	171.2	1 hour	88.4
20 min	151.1	90 min	69.2
25 min	136.5	2 hour	58.0

3.0 Hydrologic Modelling

Hydrologic modelling was undertaken within TUFLOW using the Direct Rainfall ('rainfall on the grid') methodology. In the hydraulic model, rainfall is applied directly to the 2D terrain, and the hydraulic model automatically routes the flow as determined by the elevation and roughness grids and any included 1D pipeline network.

Direct rainfall modelling is a relatively new feature of hydraulic modelling and it is still being tested on a number of catchments to ensure it is reliably representing the flood behaviour of a given catchment. Runoff is generated over the entire catchment, rather than the more traditional approach of calculating an inflow hydrograph and lumping this in at an assumed location(s). This 'direct rainfall' approach means the whole catchment will be 'wet' and the hydraulic modelling results need to be filtered to show only those cells that genuinely represent areas of catchment flooding. This was achieved by only mapping inundation at cells with a flood depth greater than 0.05 metres.

Direct rainfall was applied to the area indicated as '2D model domain' in Figure 1 (refer GO170545/F1/C, copy enclosed under Annexure E). The design storm events applied to the catchment are the design storm events described in Section 2.3. During hydrologic and hydraulic modelling of the catchment, 100% blockage of Council's piped drainage system was assumed.

4.0 Hydraulic Modelling

A TUFLOW 1D/2D model was used to hydraulically route flows through the catchment and to derive flow depths, velocities and hazard for the pre-development and post-development scenarios. This section describes the hydraulic modelling approach and hydraulic model development.

4.1 Choice of Hydraulic Model

Different hydraulic modelling approaches can be applied according to the floodplain's hydraulic characteristics and the objectives of the study. The simpler methods lump the left and right overbank floodplain areas and the main channel into a one-dimensional (1D) representation. This approach is relatively simple and computationally fast, and is generally appropriate for modelling flows through pipe networks and straight sections of formed open channel. The main limitation of such 1D modelling approaches is that flow is assumed to occur in a linear direction, and the water levels across the floodplain are assumed to be at the same level as the main channel.

A more detailed two-dimensional (2D) approach is recommended in areas where significant differences can occur between the channel flood level and the floodplain flood levels. This approach is also preferable where separate flow paths and flow around catchment obstructions occur, as is the case in this study. This is a more complex analysis, which requires greater data requirements and computational resources.

The TUFLOW 1D/2D model was chosen to model the catchment hydraulics. This modelling system dynamically couples the one-dimensional and two-dimensional flow paths in the floodplain.

4.2 TUFLOW 1D Model Domain

The effects of the piped drainage network within the catchment was not represented in the TUFLOW model, as described in Section 3. In this regard, there is no 1D model domain in the flood model.

4.3 TUFLOW 2D Model Domain

The 2D hydraulic model domain covers the area indicated as '2D model domain' in Figure 1 (refer GO170545/F1/C, copy enclosed under Annexure E). A square grid was utilised for this study, with a grid size of 2 m. Each grid element contains information on ground topography (see Section 4.3.1), surface resistance to flow (see Section 4.3.4) and initial water level.

The grid cell size of 2 metres is considered to be sufficiently fine to appropriately represent the variations in floodplain topography and land use within the study area. It should be noted that TUFLOW samples elevation points at the cell centres, mid-sides and corners, as a consequence a 2 m square cell size results in surface elevations being sampled every 1 m.

Linear features that potentially influence flow behaviour, such as gullies and levees were incorporated into the topography using 3D 'breaklines' to ensure that these were accurately represented in the model. It is noted that although brick walls and fences could also significantly affect local overland flow paths, these have not been explicitly incorporated into the model in urban areas unless deemed critical to the study, and were instead considered in the setting of appropriate Manning's 'n' values for these areas.

4.3.1 Topography

A 1 m grid Digital Elevation Model (DEM) was generated for the catchment using ALS survey data. This DEM was used to represent ground elevations throughout the catchment.

The site presently has solid walls on or near the site boundaries. The walls along the southern and western site boundaries have the potential to prevent floodwaters from entering the subject site and prevent stormwater flows within the site from entering the southern neighbouring site known as No. 18 Ocean Road. We understand the walls

have been structurally assessed and are capable of withstanding he loads imposed by the 1% AEP floodwaters. In this regard the existing southern and western solid boundary walls have been explicitly incorporated into the flood model using 3D 'breaklines'.

Land use categories were assigned to areas of the catchment based on examination of aerial photography and satellite imagery. These land use categories were used to assign roughness and infiltration parameters during modelling. Further detail on the modelling of infiltration and catchment roughness is contained in Section 4.3.3 and Section 4.3.4 respectively.

4.3.2 Building Footprint

The footprints of buildings surrounding critical flow paths are modelled as blocked elements within the 2D domain. Building footprints were digitised and removed from the active 2D domain to prevent floodwaters entering buildings. Building outlines were determined from aerial photographs and site survey.

In general, buildings far away from the subject site or far from critical flow paths were modelled at ground level with other landform disturbances by adjusting the Manning's 'n' hydraulic roughness value (see Section 4.3.4).

4.3.3 Infiltration

Infiltration losses were modelled using an Initial Loss/Continuing Loss (IL/CL) infiltration model. Initial losses and continuing loss rates were defined for each land use category and are based on the losses in Council's adopted 'Pittwater Overland Flow Mapping and Flood Study' (Cardno 2013) and Council's adopted flood study for the neighbouring Careel Creek catchment (WMAwater 2013). The adopted loss parameters are presented in Table 2 in Section 4.3.4, alongside the roughness parameters, for each land use category.

4.3.4 Roughness

The hydraulic roughness of a material is an estimate of the resistance to flow and energy loss due to friction between a surface and the flowing water. A higher hydraulic roughness indicates more flow resistance; for example, a concrete path has a lower hydraulic roughness than a rough vegetated channel as water flows more freely over concrete than through a vegetated channel. Roughness in TUFLOW is modelled using the Manning's 'n' roughness co-efficient.

The catchment land use parameters are based on the land use parameters presented in Council's adopted 'Pittwater Overland Flow Mapping and Flood Study' (Cardno 2013) and Council's adopted flood study for the neighbouring Careel Creek catchment (WMAwater 2013). Table 2 overleaf lists the adopted Manning's roughness for each land use.

Table 2: Adopted roughness and infiltration parameters (Cardno 2013; WMAwater 2013)

Land use category	Initial loss (mm)	Continuing loss (mm/hr)	Manning's n
Open space	5.0	2.5	0.030
Roads	0.0	0.0	0.025
Coastline	5.0	2.5	0.030
Bushland	5.0	2.5	0.080
Residential and urban land (excluding buildings)	5.0	2.5	0.040

4.4 Boundary Conditions

This section describes the boundary conditions imposed upon the model. Typical model boundary conditions include flows entering the model domain from upstream, backwater effects from hydraulic controls such as chokes and streams downstream, and the flow predicted through the model domain by a separate hydrologic model.

4.4.1 Direct Rainfall

A direct rainfall boundary condition was applied to the area indicated as '2D model domain' in Figure 1 (refer GO170545/F1/C, copy enclosed under Annexure E). The direct rainfall method is described in Section 3.

4.4.2 Upstream Boundary

The use of direct rainfall and the selected 2D model domain means hydrologic and hydraulic modelling commenced at the top of the catchment. As such, no upstream boundary conditions were applied.

4.4.3 Downstream Boundary

A stage-discharge (water level versus flowrate) curve was adopted as the downstream boundary condition. This stage-discharge relationship was generated by TUFLOW by specifying a downstream boundary slope.

5.0 Flood Model Results

This section summarises the results of the hydrologic and hydraulic modelling of overland flows within the catchment. The 1% AEP overland flood event critical duration and peak flowrate through the catchment are presented. The behaviour of the 1% AEP overland floodwaters within the vicinity of the subject site are described in general terms, and the impact of overland flooding on the subject site is discussed. Measures to address the risk posed by flooding at the site are presented in Section 6.

5.1 Flood Model Validation

Published 1% AEP flood information is contained within 'Flood Information Request – Basic Purpose' issued by Northern Beaches Council, dated 10 May 2017 (copy enclosed under Annexure C). The document provides information regarding the 1% AEP flood extents, flood depth, provisional hazard and Life Hazard category which can be used to validate the performance of the ACOR flood model.

As no information is provided regarding the 1% AEP floodwater velocities and 1% AEP flowrate through the site, the validation of ACOR's flood model will be limited to flood extents, depths and hazard categorisations within and in the immediate vicinity of the site. A summary of flood depths, levels and hazard categories is provided in Table 3 below.

Table 3: Comparison of modelled 1% AEP flood behaviour.

Item	Council model	ACOR model
Flood level	4.70 m AHD to 6.85 m AHD	4.6 m AHD to 6.9 m AHD
Flood depth	0.00 m to 0.25 m	0.00 m to 0.25 m
Provisional hazard	Low	Low
Life Hazard category	H1 to H2	H1

Table 3 reveals the 1% AEP flood levels, depths and hazard categorisations predicted by ACOR's flood model are generally in agreement with Council's adopted flood model. However, the inundation extents predicted by ACOR's flood model, depicted in Figure 2 (refer GO170545/F2/C, copy enclosed under Annexure E), are quite different to the 1% AEP inundation extents depicted in 'Flood Map B: Flooding – 1% AEP Extent' of 'Flood Information Request – Basic Purpose' issued by Northern Beaches Council, dated 10 May 2017 (copy enclosed under Annexure C). This is largely due to the ACOR model accounting for the solid southern and western boundary wall impact on flows. We note that when the boundary walls are removed from the ACOR model, the ACOR model depicts inundation depths within the range 0.05 m to 0.25 m in all but one of the locations where Council has provided flood level points. We believe the difference in inundation extents is not indicative of a serious disagreement of ACOR's model and Council's adopted model; and can be adequately explained by differences in methodology, including the method used for accounting for the impact of buildings and solid fences on overland flows, digitisation of building footprints, digitisation of land use categories and the cut off depth applied to the modelled output.

Based on the foregoing, we are of the view that the ACOR flood model produces an appropriate description of 1% AEP flood behaviour within the catchment and is fit for purpose.

5.2 Critical Duration

The design storm from Table 1 which produced the highest peak discharge through the site was selected as the critical duration storm event. The critical duration for the 1% AEP storm event is 1.5 hours.

5.3 Design Peak Flood Flow

The 1% AEP peak flowrate passing through the site is 0.36 m^3/s when the solid boundary walls re omitted from the model and 0.07 m^3/s when the solid boundary walls are included in the model. The peak flowrate occurs approximately 30 minutes after the commencement of rainfall.

5.4 Design Flood Characteristics

The flood velocity, flood depth, provisional flood hazard and life hazard category of the 1% AEP flood event were mapped for the existing and proposed site conditions. The following flood maps depicting 1% AEP flood behaviour are enclosed under Annexure E:

- Figure 2. Pre-development 1% AEP flood depth and level plan (refer GO170545/F2/C);
- Figure 3. Pre-development 1% AEP flood velocity plan (refer GO170545/F3/C);
- Figure 4. Pre-development 1% AEP flood provisional hydraulic hazard plan (refer GO170545/F4/C);
- Figure 5. Pre-development 1% AEP flood life hazard plan (refer GO170545/F5/C);
- Figure 6. Post-development 1% AEP flood depth and level plan (refer GO170545/F6/C);
- Figure 7. Post-development 1% AEP flood velocity plan (refer GO170545/F7/C);
- Figure 8. Post-development 1% AEP flood provisional hydraulic hazard plan (refer GO170545/F8/C);
- Figure 9. Post-development 1% AEP flood life hazard plan (refer GO170545/F9/C); and
- Figure 10. Post-development 1% AEP flood level difference plan (refer GO170545/F10/C).

The 1% AEP floodwaters impact the solid western boundary fence at elevations between 6.9 m AHD and 7.2 m AHD and do not overtop the wall in both pre- and post-development scenarios. In both pre- and post-development scenarios, the majority of the floodwaters are conveyed within the gutter of Palm Beach Road and through adjacent sites.

The 1% AEP floodwaters impact the intersection of Palm Beach Road and Ocean Road at elevation 4.6 m AHD, flooding ground adjacent to the eastern site boundary. During the 1% AEP flood event, the depth of floodwaters within the sag point of the intersection reach depths up to 0.75 m. Velocities within the sag are less than 0.5 m/s. While the 1% AEP floodwaters within the intersection of Palm Beach Road and Ocean Road create Low Hazard conditions, the southbound lane of Ocean Road is flooded to a depth which is unsafe for vehicles (H3 life hazard). The northbound lane of Ocean Road is expected to be trafficable to larger cars, 4WD

vehicles and all persons (H2 life hazard) throughout the 1% AEP flood event. In this regard, we are of the view that effective pedestrian and vehicle access is available from the site during the 1% AEP flood event.

Minor stormwater flows less than 0.2 m deep with velocity less than 0.5 m/s flow through the site during the 1% AEP storm event.

The proposed development results in changes in the 1% AEP floodwater levels at the site less than 0.1 m. The 1% AEP flood levels at other locations within the floodplain are not affected by the proposed development.

5.5 Provisional Flood Hazard

The degree of Provisional Hazard attributed to flooding at the subject site is a function of Hydraulic Hazard (relating to the depth and velocity of floodwaters) and is adjusted to account for the following factors:

- Size of flood;
- Effective warning time;
- Flood awareness;
- Rate of rise of floodwater;
- Duration of flooding;
- Evacuation problems;
- Effective flood access; and
- Type of development.

Hazard categories are defined as either high, intermediate or low hazard and are based on the guidelines outlined in the Floodplain Development Manual (NSW DIPNR 2005) and in particular Figure L.2.

The 1% AEP stormwater flows pose Low Hazard to occupants of the site in both pre- and post-development scenarios.

Low Hazard pedestrian and vehicle access is available from the site during the majority of the 1% AEP flood event. Palm Beach Road poses High Hazard conditions between Florida Road and Livistona Lane for a period of 5 to 10 minutes during the 1% AEP flood event. Access from the proposed driveway along Ocean Road is Low Hazard for the entire 1% AEP flood event. Based on the foregoing, we are of the view that reliable pedestrian and vehicular access is generally available from the site during the 1% AEP flood event.

5.6 Life Hazard Category

The Life Hazard Category attributed to flooding at the subject site is based upon the Hazard Vulnerability Classification of the floodwaters. The Hazard Vulnerability Classification is a function of the Hydraulic Hazard (relating to the depth and velocity of floodwaters) and is adjusted to account for the vulnerability of the community and community assets to damage or danger when interacting with floodwaters. Hazard Vulnerability Classifications are determined based on the guidelines provided in 'Technical flood risk management guideline: Flood hazard' (Attorney-General's Department 2014) and in particular Figure 6. The available Hazard Vulnerability Classifications are described in Table 4 below.

Table 4: Description of Hazard Vulnerability Classifications (Attorney-General's Department 2014).

Hazard vulnerability classification	Description
H1	Generally safe for all people, vehicles and buildings.
H2	Unsafe for small vehicles. Generally safe for people and buildings.
H3	Unsafe for vehicles, children and the elderly. Generally safe for able-bodied adults.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

The 1% AEP stormwater flows impacting the site are classified as Life Hazard category H1 in both pre- and post-development scenarios.

Palm Beach Road exceeds the stability limit for vehicles (i.e. exceeds H2) between Florida Road and Livistona Lane for a period of 5 to 10 minutes during the 1% AEP flood event. The intersection of Ocean Road and Palm Beach Road exceeds the stability limit for small vehicles (i.e. exceeds H1) during most of the 1% AEP flood event; however, the northbound lane of Ocean Road remains trafficable to all people, larger cars and 4WD vehicles. Access along Ocean Road south of Palm Beach Road is generally H1 throughout the 1% AEP flood event. Based on the foregoing, we are of the view that reliable pedestrian and vehicular access is generally available from the site during the 1% AEP flood event.

5.7 Flood Affectation of the Site

The site is impacted by minor stormwater flows during the 1% AEP storm event. The 1% AEP stormwater flows on site are less than 0.2 m deep and have velocity less than 0.5 m/s.

The solid boundary fences along the southern and western boundaries prevent floodwaters from entering the site. The 1% AEP floodwaters impact the solid western boundary fence at maximum elevation 7.2 m AHD. The solid fence extends above the FPL of 7.5 m AHD.

Reliable pedestrian and vehicle access from the site is available during the 1% AEP flood event, with the 1% AEP floodwaters posing Low Hazard conditions and Life Hazard H1-H2 conditions for the majority of the 1% AEP flood event.

The 1% AEP stormwater flows pond against the upstream wall of the proposed dwelling at elevation 6.4 m AHD, at a depth of less than 0.2 m. We are of the view that such stormwater flows will be able to be managed by an appropriately designed on site stormwater drainage system, to be designed by others. Based on the foregoing, the site is not impacted by 1% AEP floodwaters, and the dwelling is protected above the FPL by the solid boundary walls.

The proposed development results in increases of less than 0.1 m in the 1% AEP floodwater levels at the site. The 1% AEP flood levels at other locations within the floodplain are not affected by the proposed development.

6.0 Flood Risk Management

The behaviour of the 1% AEP floodwaters at the site has been described in Section 5 for pre- and post-development site conditions. The site falls within the Medium Flood Risk Precinct. The FPL applicable to the site varies from 7.5 m AHD at the western site boundary to 5.6 m AHD at the eastern site boundary. The FPL provides 0.3 m freeboard to the 1% AEP flood level. The FPL is higher than the PMF flood level.

Based on the foregoing we offer the following response, having due regard for the requirements of Pittwater 21 DCP Section B3.11 Flood Prone Land; Northern Beaches Council Flood Prone Land Design Standard; Flood Emergency Response Planning for Development in Pittwater Policy; Pittwater LEP 2014 Part 7.3 and 7.4 and the Floodplain Development Manual (NSW DIPNR 2005).

6.1 Floor Level

The proposed ground floor level is 4.8 m AHD. While this is below the FPL, we note that the ground floor level is flood protected to the FPL by means of a deflection and wave barrier wall system, refer ACOR Stormwater Management Plans, Reference GO170545, Drawing No.'s C3 to C4, Issue E, dated 12 December 2017 (copy enclosed under Annexure D). The use of a deflection wall to flood proof the ground floor level to the FPL is not in contradiction to control F2 as the site is not located within a floodway or flood storage area, and the development has been shown through site specific flood study to not adversely impact flood affectation of surrounding properties.

The proposed first floor level is 7.7 m AHD. The floor level provides a minimum of 1.3 m freeboard to the post-development 1% AEP stormwater flows through the site and is above the FPL. The proposed floor level provides a minimum of 0.7 m freeboard to the PMF floodwaters.

In this regard, we are of the view that the proposed floor levels satisfy the requirements of control F of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.2 Drainage Infrastructure and Creek Works

The proposed development does not include works on drainage infrastructure or natural creeks. In this regard, control B of Pittwater 21 DCP Section B3.11 Flood Prone Land is not applicable to the proposed development.

6.3 Building Components and Structural Soundness

The proposed deflection wall system is to be capable of withstanding the forces of the 1% AEP floodwaters plus 0.5 m freeboard, including hydrostatic, hydrodynamic, wave action, buoyancy and debris impact forces. The design should be certified by a practicing Structural Engineer.

The proposed development is to be constructed of flood compatible building materials where the development is not flood protected to a level at or above the FPL. Extensive guidance on flood compatible building materials and methods is provided in 'Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas' (HNFMSC 2006); a selection of the flood compatible materials and practices described in this resource, supplemented with additional guidance provided in Pittwater 21 DCP Section B3.11 Flood Prone Land, is summarised below.

Flood compatible deflection wall materials include reinforced or mass concrete and masonry.

The proposed dwelling is flood protected to a level at or above the FPL by the proposed deflection and wave barrier wall system, refer ACOR Stormwater Management Plans, Reference GO170545, Drawing No.'s C3 to C4, Issue E, dated 12 December 2017 (copy enclosed under Annexure D). As such, it is not required to be constructed of flood compatible building materials.

Connection to mains power supply, including metering equipment should be located above the FPL.

All electrical wiring, switches and outlets which are not flood protected by the deflection and wave barrier walls should, where possible be located above the FPL. All wiring, connections and conduit below the FPL should be suitable for submergence in water. Conduits shall be installed so they will be self-draining in the event of flooding.

Heating and air-conditioning systems, including fuel supply and ducting, should be installed above 7.5 m AHD. Where this is not possible, they should be installed in such a manner as to minimise damage from submersion. This may be achieved through measures such as access for cleaning and draining of water after flood events, manually operated cut off valves for fuel supply lines and ducts, securely fastening heating equipment and fuel storage tanks to prevent buoyancy and movement, and venting of fuel supply tanks at an elevation of 7.55 m AHD.

If the above structural soundness requirements and flood compatible building guidelines are adhered to, it is our view the proposed development will comply with the requirements of control C of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.4 Storage of Goods

It is anticipated that goods and materials which are susceptible to water damage, may become hazardous or potentially pollute floodwaters will be stored within the proposed dwelling and garage. We note that the proposed dwelling and garage provide space for storage of goods and materials above, or flood protected to, the FPL. In this regard, we are of the view that the proposed development satisfies the requirements of control D of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.5 Flood Emergency Response

The proposed development is located within the H1 to H2 Flood Life Hazard Category, refer 'Flood Map A: Flood Life Hazard Category' of 'Flood Information Request – Basic Purpose' issued by Northern Beaches Council, dated 10 May 2017 (copy enclosed under Annexure C). As such, the Flood Emergency Response Planning for Development in Pittwater Policy does not apply.

The State Emergency Service of New South Wales (NSW SES) is responsible for providing flood updates and issuing Flood Evacuation Warnings and Flood Evacuation Orders. Flood information issued by the NSW SES may be received by local, radio and television news, SMS messaging, Facebook and door-knocking in affected communities. The timing for evacuation of persons is to be established in consultation with the NSW SES.

In the event that the 1% AEP flood event is expected to be exceeded, strategies should be adopted in accordance with NSW Government operational guidelines and SES Emergency Evacuation operational guidelines.

Reliable pedestrian and vehicular access is available from the site during the 1% AEP flood event, refer Sections 5.5 and 5.6.

Additionally, we note the proposed development provides habitable floor spaces which are located above the PMF flood level of 6.95 m AHD, or flood protected to a level above the PMF flood level of 6.95 m AHD, permitting occupants of the proposed dwelling to shelter within the dwelling for all flood events up to and including the PMF flood event.

In this regard, we are of the view that the proposed development satisfies the requirements of control E of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.6 Flood Effects Caused by Development

The proposed development uses deflection and wave barrier walls to minimise the exposure of the proposed dwelling to the 1% AEP floodwaters, refer ACOR Stormwater Management Plans, Reference GO170545, Drawing No.'s C3 to C4, Issue E, dated 12 December 2017 (copy enclosed under Annexure D). Due to the presence of existing solid boundary walls which prevent floodwaters from entering the site, the proposed development has been shown through site specific flood study to not increase flood affectation elsewhere within the floodplain, refer Section 5.7.

In this regard, we are of the view that the proposed development satisfies the requirements of control A of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.7 Car Parking

The proposed garage floor level is 4.68 m AHD. We note this floor level is below the FPL; however, the garage is protected from inundation to the FPL by means of deflection and wave barrier walls and a driveway crest with level 5.3 m AHD.

The raising of the driveway crest has been demonstrated through site specific flood study to have no adverse impact on the behaviour of floodwaters elsewhere within the floodplain.

In this regard, we are of the view that the proposed development satisfies the requirements of control G of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.8 Pools

A pool is proposed as part of the proposed development. We note that the proposed pool level of 6.85 m AHD is not flush with natural ground level. We note that site specific flood study has demonstrated the proposed development does not increase flood affectation on surrounding properties.

The 1% AEP flood level at the upstream face of the pool is 6.2 m AHD. The FPL at the upstream face of the pool is 6.5 m AHD.

We envision the pool equipment, including pumps and chemicals, will be flood protected to a level at or above the FPL by the deflection wall system, refer ACOR Stormwater Management Plans, Reference GO170545, Drawing No.'s C3 to C4, Issue E, dated 12 December 2017 (copy enclosed under Annexure D). In this regard, we are of the view that the proposed development satisfies the requirements of control I of Pittwater 21 DCP Section B3.11 Flood Prone Land.

6.9 Fencing

The proposed fencing includes flood deflection and wave barrier walls, refer ACOR Stormwater Management Plans, Reference GO170545, Drawing No.'s C3 to C4, Issue E, dated 12 December 2017 (copy enclosed under Annexure D). We note that the deflection and wave

barrier walls alter the conveyance of floodwaters through the site; however, a site specific flood study has demonstrated that the proposed deflection walls and wave barriers do not increase flood affectation on surrounding properties. In this regard, we are of the view that the proposed development satisfies the requirements of control H of Pittwater 21 DCP Section B3.11 Flood Prone Land.

7.0 Conclusion

The selection and development of the 1% AEP flood model has been described in Sections 2 to 4 of this report. Flood modelling results were presented and discussed in Section 5 and Flood Risk Management measures were described in Section 6.

Flooding within the overland flow catchment is indicative of flash flooding, whereby floodwaters rise rapidly and recede rapidly. The site is not impacted by 1% AEP overland floodwaters. Existing solid walls located on the southern and western site boundaries prevent floodwaters from entering the site and protect the proposed dwelling above the overland flood FPL. The proposed development includes adjustments to the driveway and boundary fences in the eastern half of the site to protect the proposed dwelling above the FPL for wave surge.

The 1% AEP overland floodwaters do not impact the site, however access to the site via Ocean Road is affected by the 1% AEP floodwaters. 1% AEP overland floodwaters impact Ocean Road at 4.6 m AHD. While the southbound lane of Ocean Road is not trafficable during the 1% AEP overland flood event, the northbound lane is trafficable by larger cars, 4WD vehicles and pedestrians. In this regard, reliable pedestrian and vehicular access is available from the site during the 1% AEP overland flood event.

The FPL for the proposed development varies between 7.5 m AHD at the western site boundary and 5.6 m AHD at the eastern site boundary. The FPL provides 0.3 m freeboard to the 1% AEP flood level. The FPL is higher than the PMF flood level.

It is proposed to protect the proposed development from inundation by overland floodwaters and wave action by means of deflection and wave barrier walls extending to a height at or above the FPL, and locally regrading the eastern part of the site to achieve minimum ground levels of 5.3 m AHD.

The proposed ground floor level of 4.8 m AHD is flood protected to a level at or above the FPL by means of the proposed deflection and wave barrier wall system. The proposed first floor level is 7.7 m AHD, providing a minimum of 1.3 m freeboard to the 1% AEP stormwater flows, and a minimum of 0.7 m freeboard to the PMF floodwaters.

The proposed deflection and wave barrier wall system is to be capable of withstanding the forces of the 1% AEP floodwaters plus 0.5 m freeboard, including hydrostatic, hydrodynamic, wave action, buoyancy and debris impact forces. Guidance on appropriate flood compatible building materials is given in Section 6.3. Sufficient space is available within the proposed dwelling to store goods and materials above the FPL.

The proposed garage is protected to the FPL by the proposed deflection and wave barrier walls and driveway crest.

The proposed development will increase 1% AEP flood levels by 0.0 m to 0.1 m within the site. The proposed development has been demonstrated through site specific flood study to not increase the flood affectation of other sites within the floodplain.

Based on the foregoing, we are of the view that the proposed development generally complies with the Pittwater 21 Development Control Plan Amendment 22 (Pittwater 21 DCP) Section B3.11 Flood Prone Land; Northern Beaches Council Flood Prone Land Design Standard; Flood Emergency Response Planning for Development in Pittwater Policy; and Pittwater Local Environmental Plan 2014 (Amendment No 7) (Pittwater LEP 2014) Part 7.3 and 7.4 provisions for sites affected by flooding.

8.0 References

Attorney-General's Department. (2014). *Technical flood risk management guideline: Flood hazard*. Barton, ACT: Author.

Cardno. (2013). *Pittwater Overland Flow Mapping and Flood Study* (W4936). St Leonards, NSW: Author.

Hawkesbury-Nepean Floodplain Management Steering Committee (HNFMSC). (2006). *Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas*. Parramatta, NSW: Author. Available from http://www.ses.nsw.gov.au/content/documents/pdf/resources/Building_Guidelines.pdf

New South Wales Department of Infrastructure, Planning and Natural Resources (NSW DIPNR). (2005). *Floodplain Development Manual: the management of flood liable land*. Sydney, NSW: Author.

Northern Beaches Council. (2017). *Flood Information Request – Multipurpose*.

Northern Beaches Council. (n.d.). *Flood Prone Land Design Standard*.

Pilgrim D H (Ed.). (1998). *Australian Rainfall and Runoff*. Barton, ACT: Institution of Engineers Australia.

Pittwater Council. (2017a). *Pittwater Local Environmental Plan 2014 (Amendment No 8)*.

Pittwater Council. (2017b). *Pittwater 21 Development Control Plan Amendment 22*.

WMAwater. (2013). *Careel Creek Catchment Flood Study: Final Report*. Sydney, NSW: Author.

9.0 Glossary

Terminology in this Glossary has been derived or adapted from the Floodplain Development Manual (NSW DIPNR 2005), where appropriate.

Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, expressed as a percentage.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level.
Average recurrence interval (ARI)	The long-term average number of years between the occurrence of a flood as big as or larger than the selected event.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location.
Design flood	A flood event to be considered in the design process.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.
Flood hazard	A measure of the floodwaters potential to cause harm or loss. Full definitions of hazard categories are provided in Appendix L of the Floodplain Development Manual (NSW Government, 2005). In summary: • High: conditions that pose a possible danger to personal safety; evacuation by trucks difficult; able-bodied adults would have difficulty wading to safety; potential for significant structural damage to buildings.

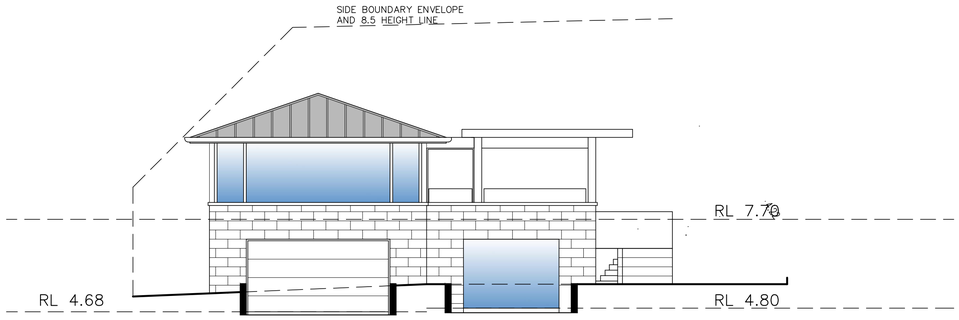
	• Low: conditions such that people and their possessions could be evacuated by trucks; able-bodied adults would have little difficulty wading to safety.
Flood planning area	The area of land below the FPL and thus subject to flood related development controls.
Flood planning levels (FPLs)	Combinations of flood levels (derived from significant historical flood events or floods of specific ARIs) and freeboards selected for floodplain risk management purposes, as determined in management studies and incorporated in management plans.
Floodplain, flood-prone land	Land susceptible to inundation by the probable maximum flood (PMF) event, i.e. the maximum extent of flood liable land.
Floodplain risk management options	The measures that might be feasible for the management of a particular area of the floodplain.
Freeboard	Provides reasonable certainty that the risk exposure selected in deciding on a particular flood chosen as the basis for the FPL is actually provided. It is a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. (See Section K5 of Floodplain Development Manual).
Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydraulic category	A classification of floodwater hydraulic behaviour. The categories are:
	• Floodway: those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways

	are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels. • Flood storage: those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. • Flood fringe: remaining area of flood-prone land after floodway and flood storage areas have been defined
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Local overland flooding	Inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.
Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood (PMF)	The PMF is the largest flood that could conceivably occur at a particular location.
Probable Maximum Precipitation (PMP)	The PMP is the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location.
Probability	A statistical measure of the expected frequency or occurrence of flooding.

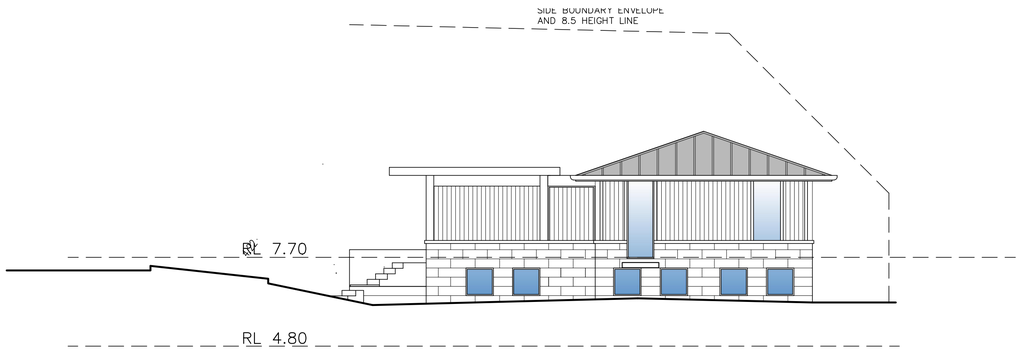
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.

ANNEXURE A

Architectural plans prepared by The Design Section Architects
No reference
Dated July 2017

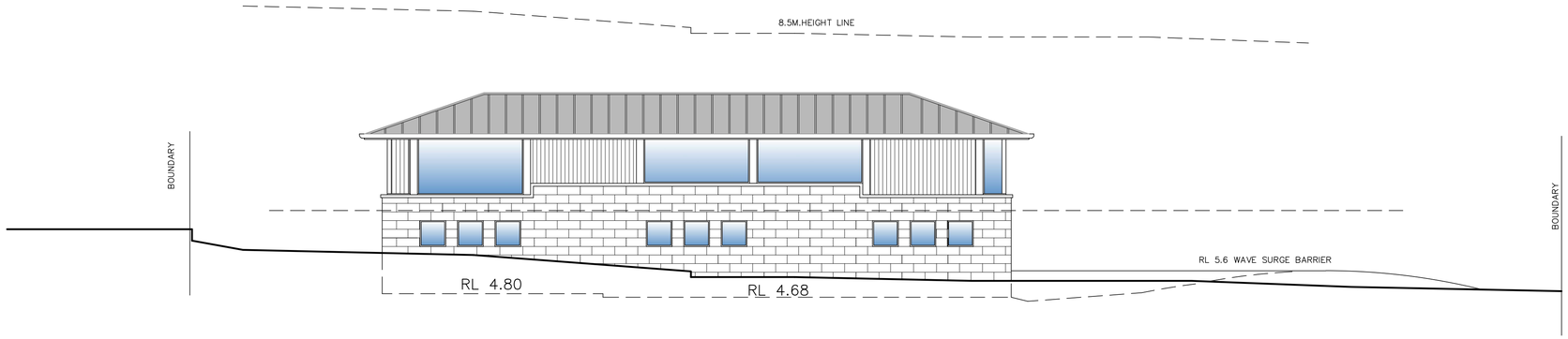


EAST ELEVATION



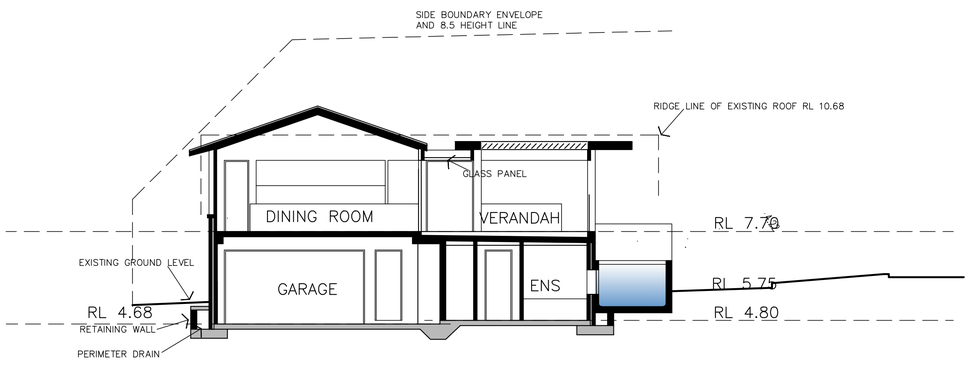
WEST ELEVATION

RL 0.0

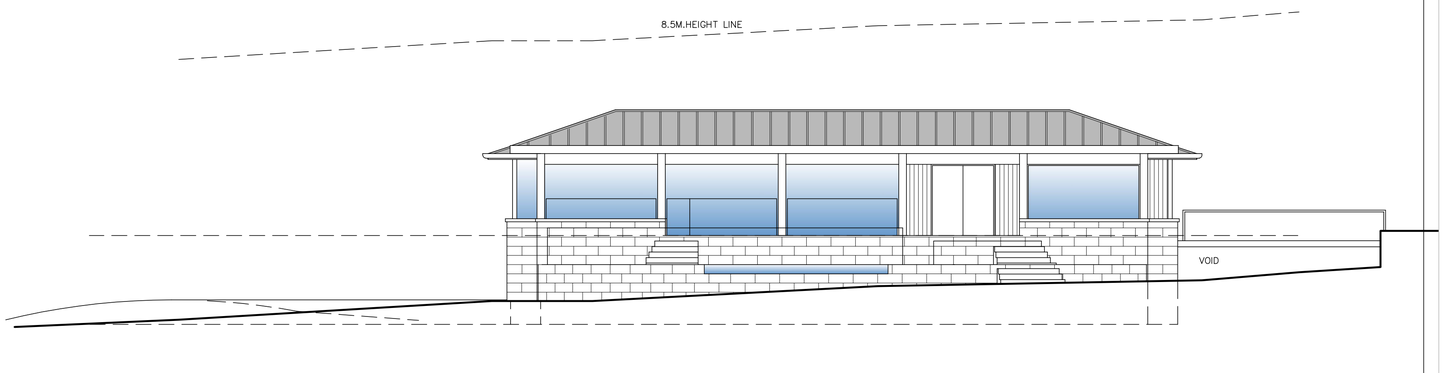


SOUTH ELEVATION

RL 0.0



CROSS SECTION



NORTH ELEVATION

RL 0.0

SKETCH ELEVATIONS

NEW HOUSE FOR RICHARD & LYNNE CROOKES AT 17 OCEAN RD PALM BEACH

THE DESIGN SECTION ARCHITECTS

SCALE: 1:100 DATE: JULY 2017

PALM BEACH ROAD

OCEAN ROAD

LOT A
DP 405897
878.9m²

LOT 106 DP 6937

LOT B DP 405897

25815

FOOTPRINT OF EXISTING HOUSE

POOL

PLANT RM

SHR RM

ENSUITE

WINDOW

DUMB WAITER

BEDROOM 1
5.2X4.6

TERRACE
4.5X4.0
RL 4.70

W'ROBE

STORAGE SHELVING

CUPBOARD

LAUNDRY

CHUTE

RL 4.80

UP

GARAGE
13.0X6.5

RL 4.68

MEDIA/BUNK RM
7.4X4.8

STORAGE CUPBOARD

GRASS

Area 172.692 sq m

Area 90.723 sq m

Area 336.609 sq m

SETBACK LINES

GARDEN

WAVE RUNUP LEVEL 5.6 AHD
COUNCIL FLOOD LEVEL 550 ABOVE G.L.

BM NAIL
TOP KERB
4.35 (AHD)

APPROX 9'30"

35.13

49.11

59'

19.92

335°

63°

123°

245°

03'

00"

08'

00°

1.5m HIGH BRICK WALL

3m HIGH BLOCK WALL

3m HIGH HEDGE

CONC DRAIN PIT

OVERHEAD el

ELECTRICITY el

HT=4

CONCRETE KERB AND GUTTER

KIP

SIGN

TEL

HYD
SV
HYD

TL

WM

STONE RET. WALL

LOW BRICK WALL

LOW STONE WALL

HIGH WALL

BLOCK WALL

ELEC TURRET

BRICK WALL

GUTTER 8.30

BRICK GRANNY FLAT
RIDGE 9.55

ONE & TWO STOREY
SANDSTONE &
WEAHERBOARD HOUSE
METAL ROOF
No.15

PORCH

GUTTER 10.95

RIDGE 10.0
BOT 8.27

GUTTER 10.92

TOP 10.65
BOT 9.35

TOP 10.66
BOT 9.30

TOP 10.65
BOT 9.42

RIDGE 12.3

RIDGE 12.10

BALCONY 8.70

RIDGE 8.81
SANDSTONE GARAGE

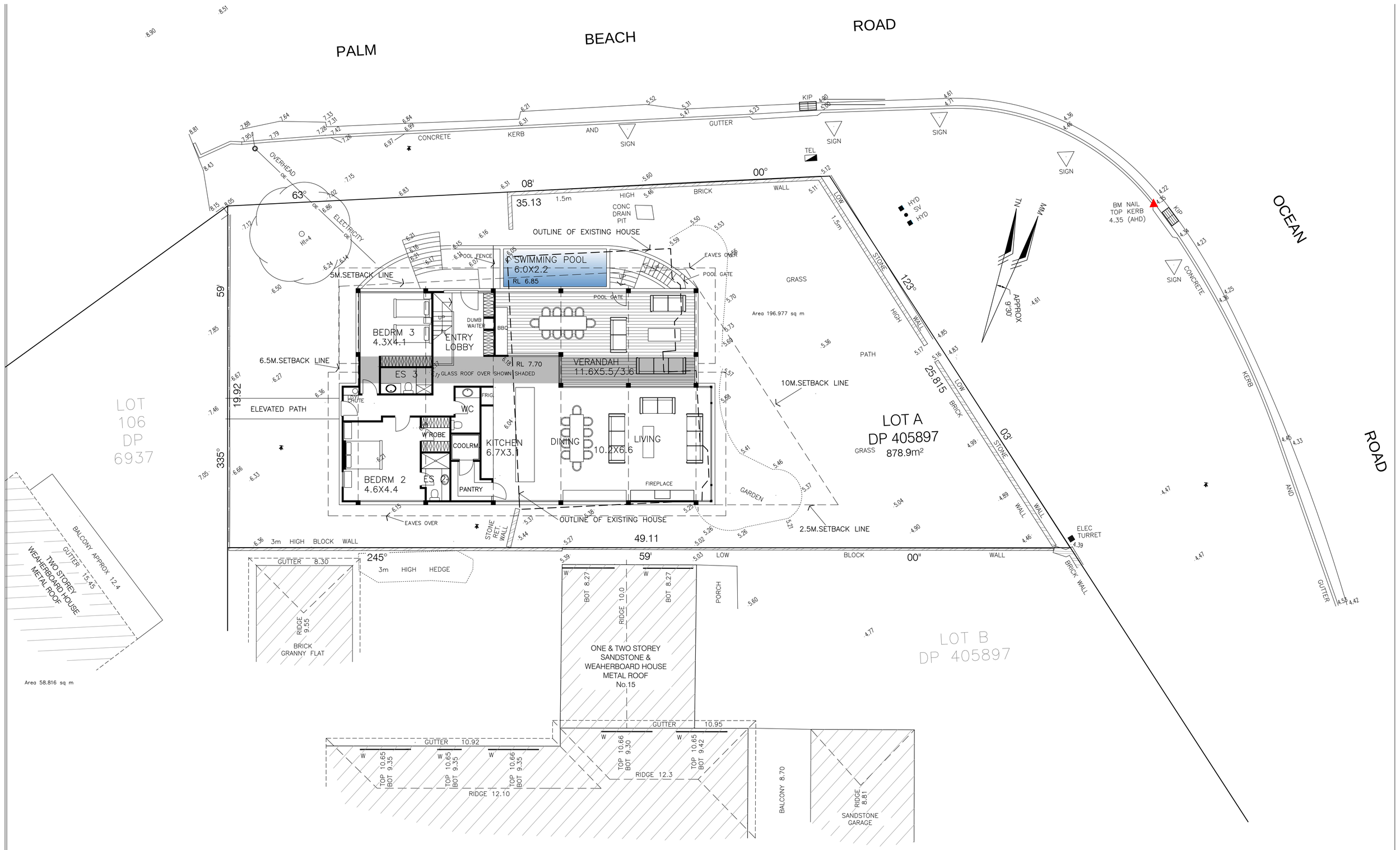
BALCONY APPROX 12.4
GUTTER 15.45
TWO STOREY
WEAHERBOARD HOUSE
METAL ROOF

PLAN LOWER LEVEL

NEW HOUSE FOR RICHARD & LYNNE CROOKES AT 17 OCEAN RD PALM BEACH

THE DESIGN SECTION ARCHITECTS

SCALE: 1:100 DATE: JULY 2017



PLAN LIVING LEVEL

NEW HOUSE FOR RICHARD & LYNNE CROOKES AT 17 OCEAN RD PALM BEACH

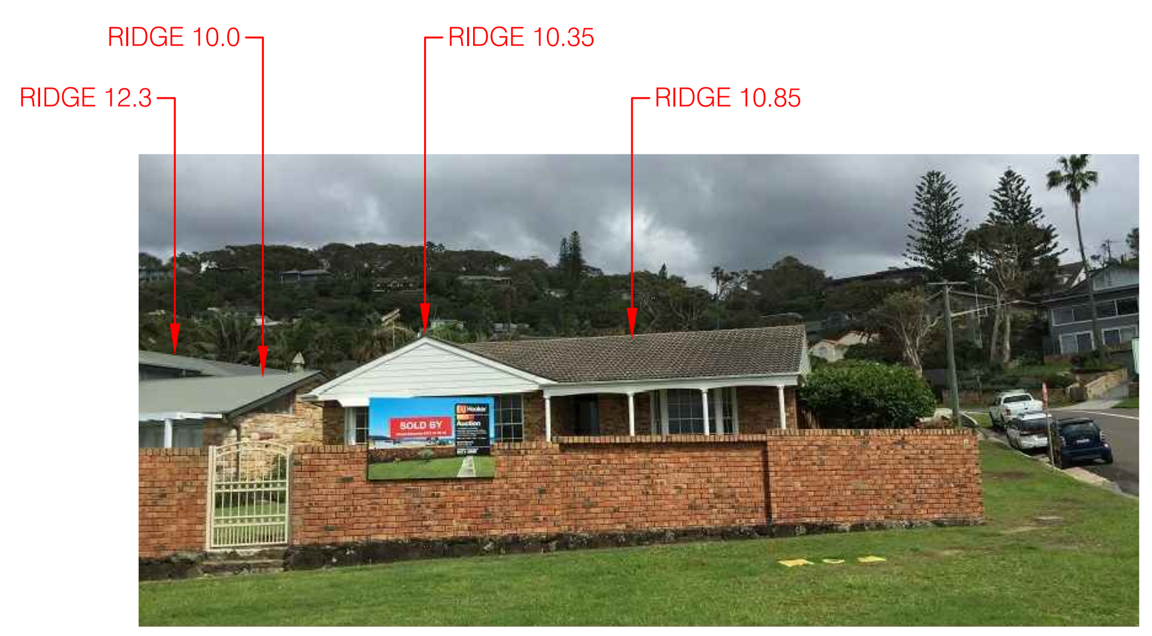
THE DESIGN SECTION ARCHITECTS

SCALE: 1:100 DATE: JULY 2017

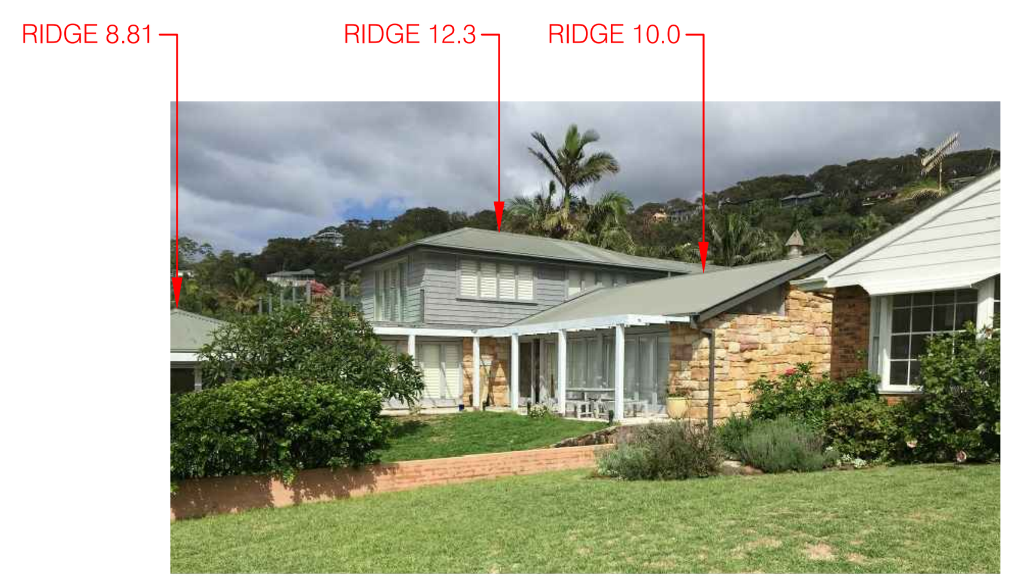
ANNEXURE B

Survey plan prepared by Lawrence Group Pty Ltd
Job No. 173654
Drawing No. DETL-001
Issue A
Dated 13 April 2017

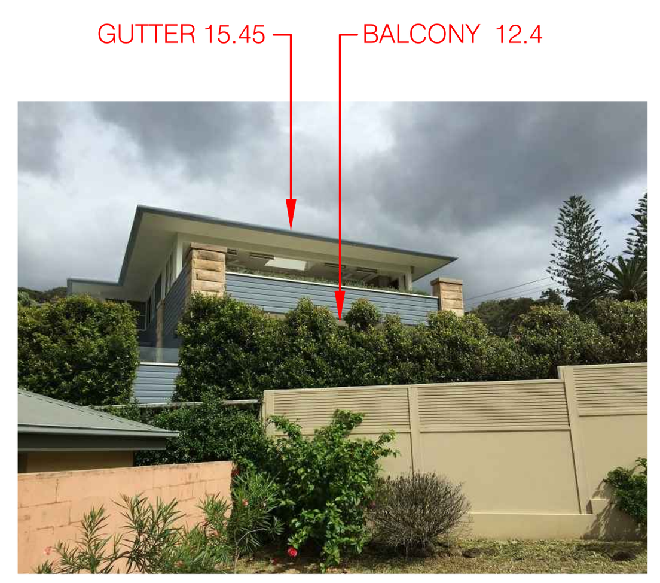
SMH
PALM
BEACH
ROAD
OCEAN
ROAD
TN
MN
APPROX 9°30'
CONCRETE
KERB
AND
GUTTER
SIGN
KIP
TEL
DRIVEWAY
OVERHEAD
ELECTRICITY
HYD
SV
BM NAIL
TOP KERB
4.35 (AHD)
63°
08'
00°
35.13
1.5m HIGH BRICK WALL
CONC DRAIN PIT
123°
LOW STONE WALL
HIGH STONE WALL
59°
19.92
335°
LOT 106
DP 6937
GRASS
BRICK GARAGE
GUTTER 8.65
RIDGE 10.10
ROOF OVER CONCRETE PATIO
RIDGE 10.85
SINGLE STOREY
BRICK HOUSE
TILE ROOF
No.17
FLOOR 6.34
PATIO 6.29
GUTTER 8.6
RIDGE 10.35
GARDEN
CONCRETE PATH
LOT A
DP 405897
878.9m²
25.815
LOW BRICK
03'
3m HIGH BLOCK WALL
STONE RET WALL
49.11
59'
245°
3m HIGH HEDGE
LOW BLOCK WALL
00°
ELEC TURRET
BRICK WALL
BRICK GRANNY FLAT
RIDGE 9.55
GUTTER 8.30
BALCONY APPROX 12.4
GUTTER 15.45
TWO STOREY WEATHERBOARD HOUSE METAL ROOF
ONE & TWO STOREY
SANDSTONE &
WEATHERBOARD HOUSE
METAL ROOF
No.15
BOT 8.27
RIDGE 10.0
PORCH
GUTTER 10.92
RIDGE 12.10
GUTTER 10.95
RIDGE 12.3
BALCONY 8.70
RIDGE 8.81
SANDSTONE GARAGE
LOT B
DP 405897



PHOTOGRAPH LOCATION 1



PHOTOGRAPH LOCATION 2



PHOTOGRAPH LOCATION 3

Notes:

No boundary survey has been undertaken.
Bearings and dimensions are from title only and are subject to confirmation by boundary survey.

Bearings relate to Magnetic Meridian taken from DP 405897 / SCIMS.
See North Point for approximate relationship to True North.

Dimensions and area(s) shown are approximate only and are subject to confirmation by boundary survey.

Services shown are indicative only. Positions are based on surface indicator(s) located during field survey. Confirmation of the exact position should be made to the relevant authorities prior to any excavation work. Other services may exist which are not shown.

Levels are based on Australian Height Datum (AHD)
using PM 6903
with a reduced level 4.271
Class LB
Order L2

Ridge, Eave, Gutter, Parapets, Windows & Doors heights have been obtained by an indirect method and are accurate to ± 0.05m.

Adjoining buildings have been plotted for diagrammatic purposes only.

veris

Head Office (NSW)
Level 1, 183 Ourimbah Road
Mosman NSW 2088
PO Box 198, Cremorne NSW 2090

T: 1300 765 315
F: 1300 765 316
E: info@veris.com.au
W: www.veris.com.au

Lawrence Group Pty Ltd
A Veris Company
ABN 16 106 359 317

Issue	Amendment	Date

LEGEND

CLIENT
RICHARD CROOKES

PROJECT
17 OCEAN ROAD
PALM BEACH

DRAWING TITLE
DETAIL & LEVEL SURVEY

TITLE INFORMATION

Lot:	LOT A
Plan No:	DP 405897
Title / Folio:	A/405897
L.G.A.:	NORTHERN BEACHES
Parish:	NARRABEEN
County:	CUMBERLAND

QUALITY ASSURANCE

Surveyor:	BJ		
Drawn:	AK		
Checked by:	BJ	Date:	13/04/17
Approved by:	SL	Date:	13/04/17

Date of Survey:	05/04/17	Date of Plan:	13/04/17
Datum:	AHD	Co-ords:	
Scale:	1:125	(Original size A1)	
Cad ref:	173654-DETL-001A.DWG	Sheet	1 of 1
JOB NUMBER	173654	DRAWING NUMBER / ISSUE	DETL-001/A

ANNEXURE C

‘Flood Information Request – Basic’ issued by Northern Beaches Council
Dated 10 May 2017

NORTHERN BEACHES COUNCIL

FLOOD INFORMATION REQUEST – BASIC PURPOSE

Property: 17 Ocean Road, Palm Beach, Palm Beach
Lot DP: A//405897
Issue Date: 10 May 2017
Flood Study Reference: 2016 Draft Avalon to Palm Beach Floodplain Risk Management Study and Plan

---

A property can be impacted by more than one Category of flooding.

Flood Categories defined by the Pittwater 21 Development Control Plan include:

- **Flood Category 1 Areas-** Properties identified on the Flood Hazard Maps and located within Primary Floodplain Areas where the lowest point of the property is affected by the Flood Planning Level (FPL) (1% AEP flood level plus 500mm Freeboard). Flood Category 1 areas are further defined under flood hazard subcategories of high hazard and low hazard.
- **Flood Category 2 Areas-** Properties identified on the Flood Hazard Maps where the lowest point of the property lies above the Flood Planning Level but below the level of the Probable Maximum Flood.
- **Flood Category 3 Areas-** Properties generally located outside or adjacent to the Primary Floodplain Areas that are affected by flooding hazards associated with major stormwater drainage systems, local overland flow paths or drainage easements. Flood Category 3 Areas are further defined under the subcategories of Overland Flow Path – Major and Overland Flow Path – Minor.

Flood Information for lot:

Flood Life Hazard Category

Minimum life hazard category: H1-H2

Maximum life hazard category: H1-H2

Flood Category 1 (Mainstream Flooding) – See Flood Map C

Flood Category 3[5] (Overland Flow) – See Flood Map E

1% Annual Exceedance Probability (1% AEP): See Flood Map B

1% AEP Overland Flow Maximum Water Level[3&4]: 6.85m AHD

1% AEP Overland Flow Maximum Depth from Natural Ground Level[3&4]: 0.25m

Flood Planning Level[1,2 &4]: 0.5m above the 1% AEP overland flow extent with depth greater than 0.3m and 0.3m above the 1% AEP overland flow extent with depth 0.3m and less.

1% AEP Overland Flow Provisional Flood Hazard: See Flood Map F

1% AEP Overland Flow Hydraulic Categorisation: See Flood Map G

Flood Category 2 (PMF) – See Flood Map D

Probable Maximum Flood (PMF) Level[2]: 6.95m AHD (See Flood Map D)

PMF Maximum Depth from natural ground level: 0.35m

[1]Intensification of development requires the consideration of climate change impacts which may result in higher planning levels than those indicated on this flood advice.
[2]Special Flood Protection developments require a higher planning level using the higher of the PMF or FPL/minimum floor level.
[3]The flood information does not take into account any local overland flow issues with a depth below 0.15m nor private stormwater drainage systems.
[4]Overland flow water levels may vary across a sloping site, resulting in variable minimum levels across the site.
[5]The applicable Flood Category 3 classification applied for the purpose of development assessment unless otherwise demonstrated in the Flood Risk Management Report that a different classification should apply (dependent on the location of the proposed development).

General Notes:

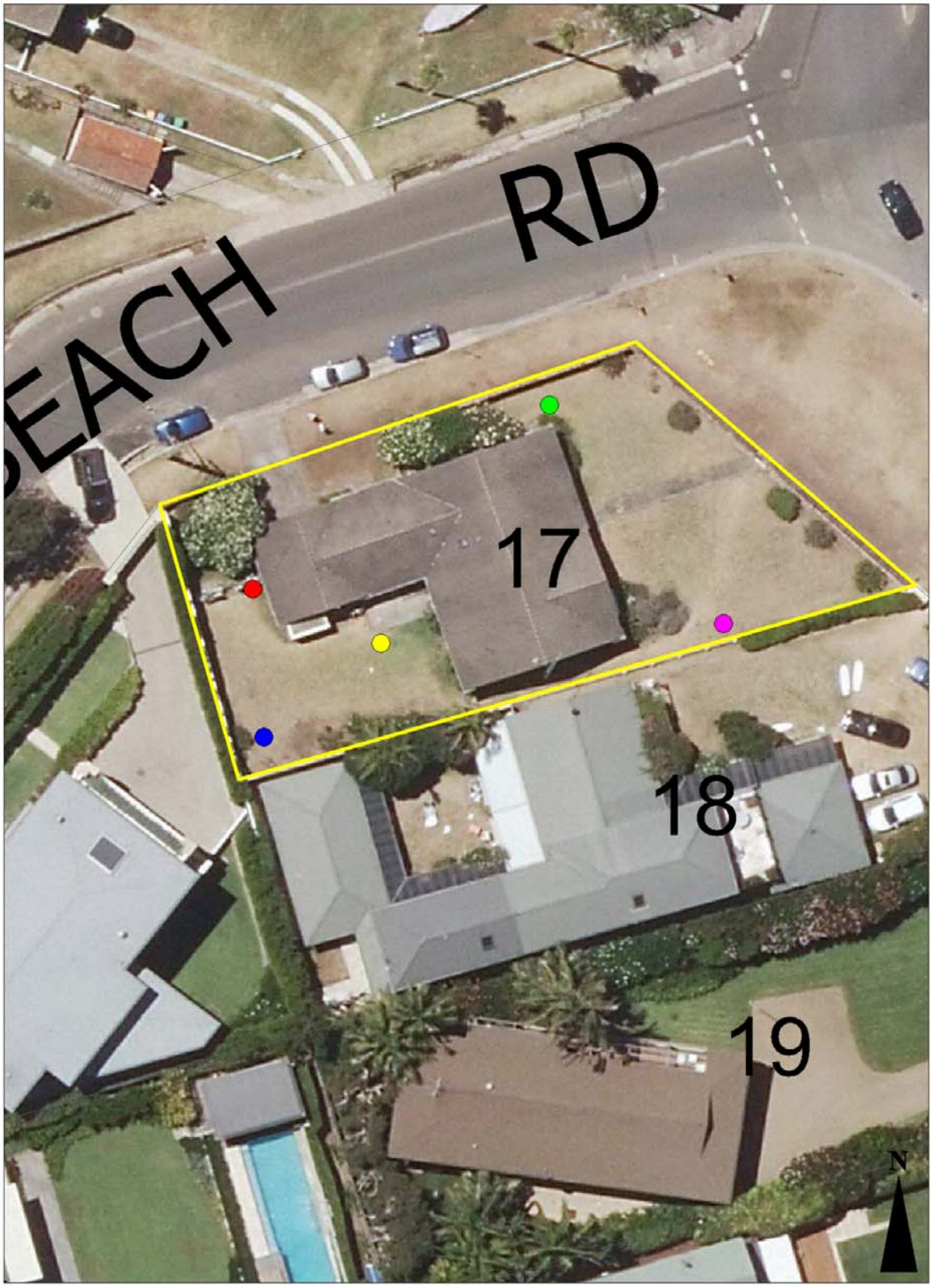
- All levels are based on Australian Height Datum (AHD) unless otherwise noted.
- The source information on this advice was obtained from numeric modelling prepared by consultants for Northern Beaches Council for existing site conditions at the time of the flood study. Separate review and flood model verification has not been undertaken by Council.
- The interpolated information is for the purpose of planning only. Detailed flood data for individual land areas were not determined from the exercise.
- Flood models only approximate flood behaviour. Site specific ground and building survey levels should be used to relate flood levels and to assess the impact of flooding. A site specific flood study/risk assessment may be required for any future development. Care and expertise is required in the interpretation of these flood levels. Engage a suitably qualified engineer to assist you in this matter.
- You need to refer to the Pittwater 21 DCP flood development controls, if you are planning to lodge a Development Application.The advice may be reviewed and amended by Northern Beaches Council in the course of assessment of a specific development application.
- While this advice is periodically updated, it is possible that the Council holds further information dealing with the flooding which has not been incorporated into the above advice.
- Estuarine/coastal inundation has not been taken into account in the flood information.
- Council is currently updating the 2013 Overland Flow Flood Study for this Area and as such the property's flood classification and flood level may be subject to changes as a result of the updated flood modelling.

FLOOD MAP A: FLOOD LIFE HAZARD CATEGORY

Notes:

- Refer to Pittwater 21DCP for 'Flood Emergency Response Planning for Development in Pittwater Policy (Appendix 15) for additional information on the Flood Life Hazard Categories and Pittwater 21 DCP Control B3.25.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source Near Map 2014) are indicative only.

FLOOD LEVEL POINTS



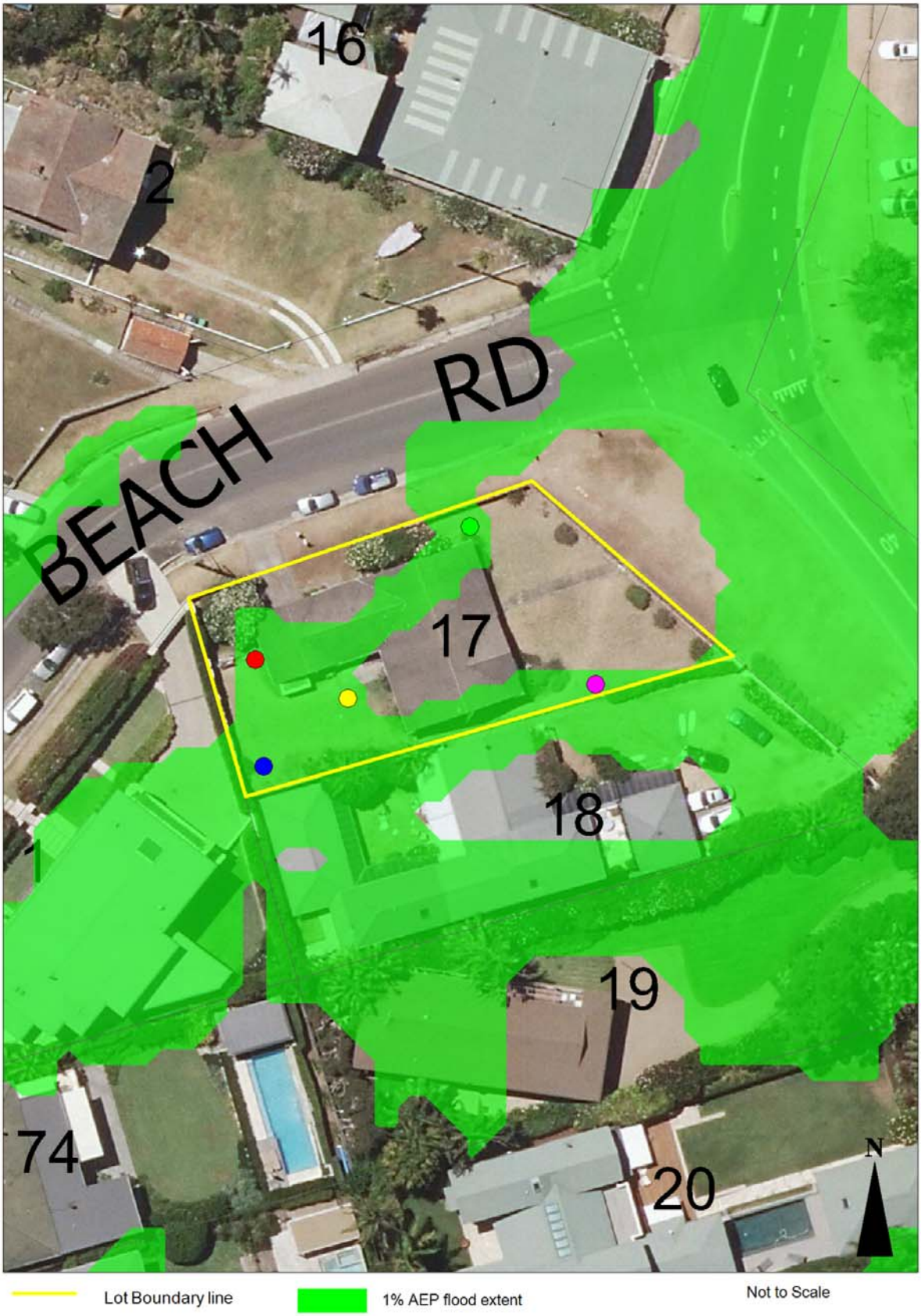
Note: Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source: Near Map 2014) are indicative only

Flood Levels

	1% AEP Max Water Level (m AHD)	1% AEP Max Water Depth (m)	PMF Max Water Level (m AHD)	PMF Max Water Depth (m)
●	6.6	0.15	6.65	0.25
●	6.35	0.2	6.4	0.25
●	6.15	0.15	6.2	0.2
●	5.5	0.1	5.55	0.15
●	5.15	0.15	5.25	0.2

WL – Water Level
PMF – Probable Maximum Flood

FLOOD MAP B: FLOODING - 1% AEP EXTENT



Notes:

- Extent represents the 1% annual Exceedance Probability (AEP) flood event.
- Flood events exceeding the 1% AEP can occur on this site.
- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source Near Map 2014) are indicative only.

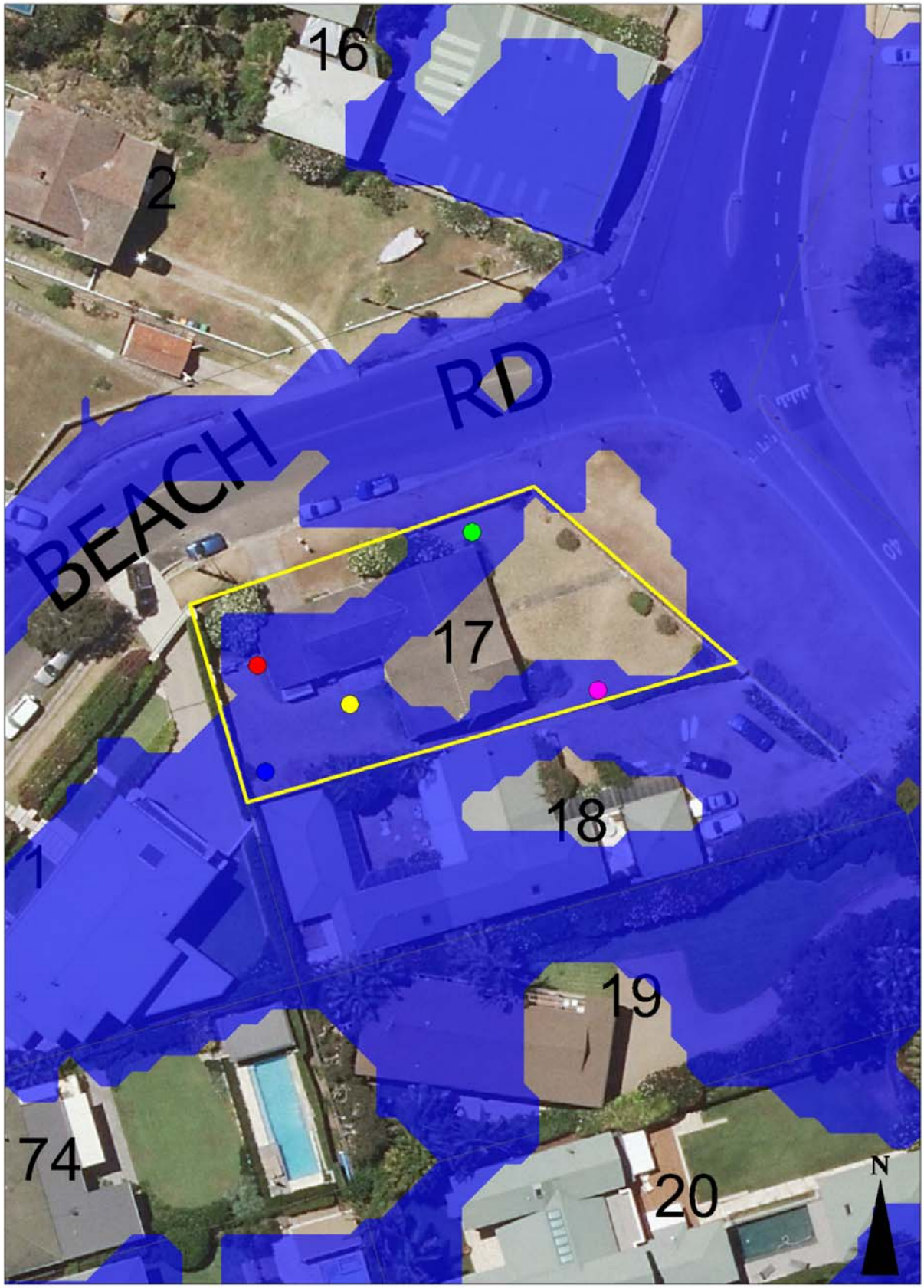
FLOOD MAP C: MAINSTREAM FLOODING – FPL EXTENT

This Property is currently not identified as being affected by Mainstream flooding based off the 2013 Careel Creek Flood Study. Council is however undertaking a review of this model/Flood Study, and as a result this property's flood classification may change because of the update to the mainstream model.

Notes:

- Extent represents the 1% annual Exceedance Probability (AEP) flood event + freeboard.
- Mainstream FPL – Mainstream Flood Planning Level includes the 0.5m freeboard on the 1% AEP extent for planning purposes.
- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source Near Map 2014) are indicative only.

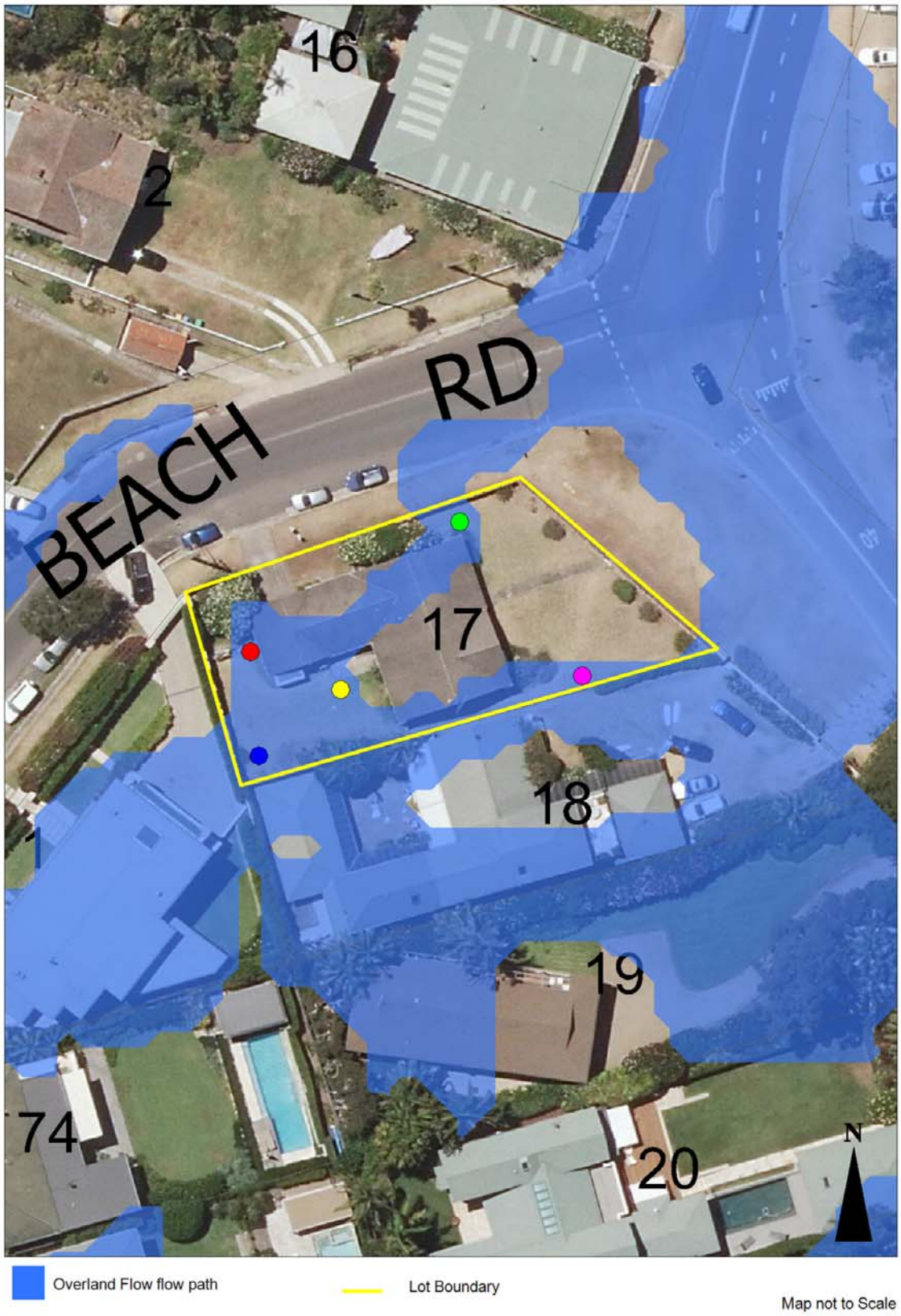
FLOOD MAP D: PROBABLE MAXIMUM FLOOD EXTENT



Notes:

- Extent represents the Probable Maximum Flood (PMF) flood event.
- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source Near Map 2014) are indicative only.

FLOOD MAP E: OVERLAND FLOW EXTENT



Notes:

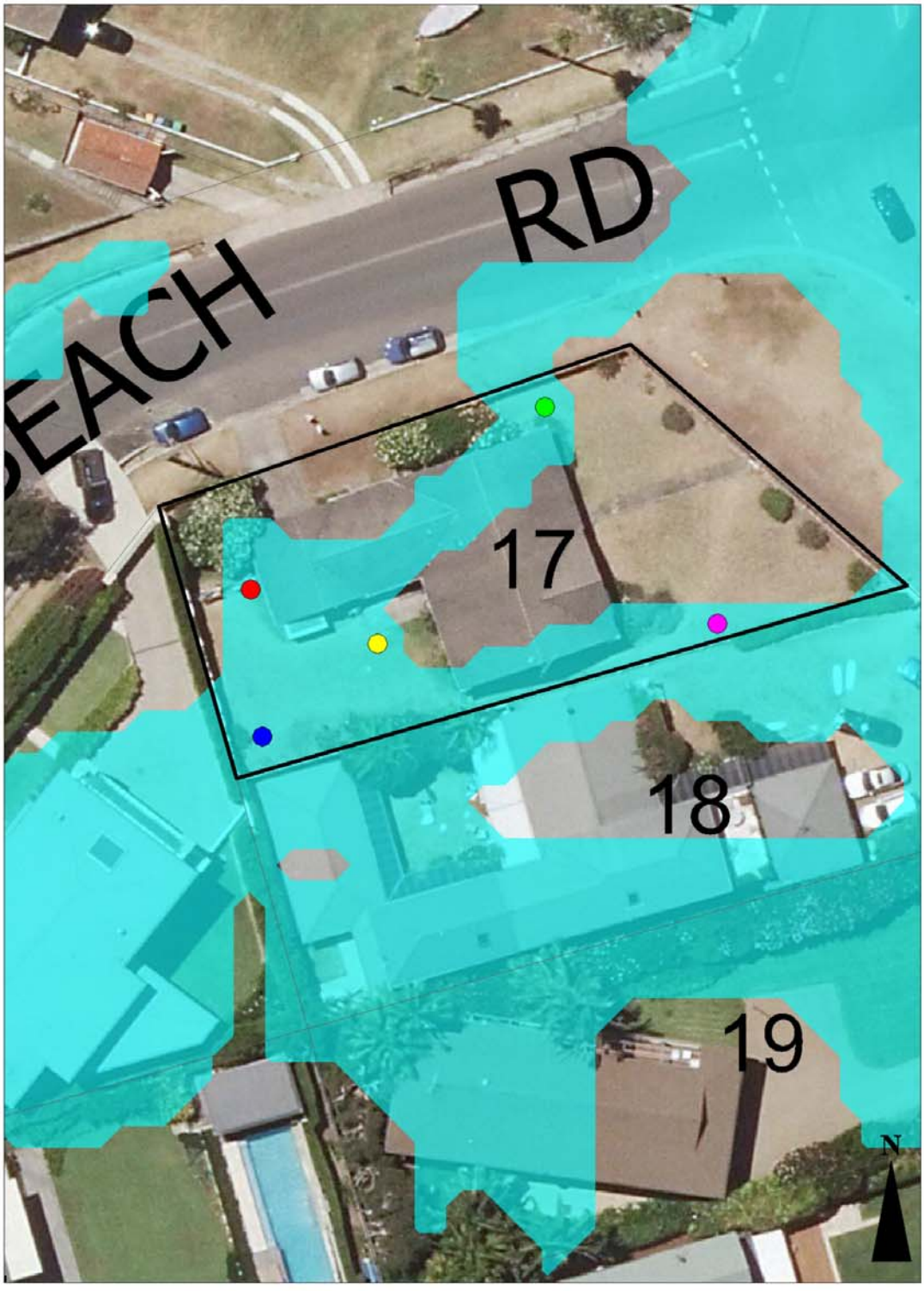
- Extent represents the 1% annual Exceedance Probability (AEP) flood event.
- Overland Flow Path Major includes a fixed 5m horizontal planning buffer on the 1% AEP extent for planning purposes.
- Extent does not include climate change.
- Areas not identified on the above Flood Map are likely to experience inundation of depths up to 0.14m.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source Near Map 2014) are indicative only.

FLOOD MAP F – 1% AEP FLOOD HAZARD EXTENT MAP

Notes:

- Extent represents the 1% annual Exceedance Probability (AEP) flood event.
- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source: NearMap 2014) are indicative only.

FLOOD MAP G – 1% AEP FLOOD HYDRAULIC CATEGORY EXTENT MAP



Notes:

- Extent represents the 1% annual Exceedance Probability (AEP) flood event.
- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source: NearMap 2014) are indicative only.

FLOOD MAP – FLOOD RISK PRECINCTS

Notes:

- Extent does not include climate change.
- Cadastre Lines (Source: NSW Government Land and Property Information), flood levels/extents (Source: Flood study reference) and aerial photography (Source: NearMap 2014) are indicative only.

ANNEXURE D

ACOR Stormwater Management Plans
Reference GO170545
Drawing No.'s C1 to C5
Issue E
Dated 12 December 2017

PROPOSED DEVELOPMENT
No.17 OCEAN ROAD, PALM BEACH
STORMWATER MANAGEMENT PLANS

LEGEND

	DENOTES ON-SITE DETENTION TANK
	DENOTES ON-SITE RETENTION TANK
	DENOTES DWELLING FOOTPRINT
SW	DENOTES 100mm DIA. STORMWATER/SURFACE WATER SYSTEM PIPE AT 1% MIN. GRADE U.N.O.
RW	DENOTES 100mm DIA. FULLY SEALED RAINWATER SYSTEM PIPE U.N.O.
150 RW	DENOTES RAINWATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.
150 SW	DENOTES STORMWATER/SURFACE WATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.
65 WRM	DENOTES RISING MAIN AND PIPE DIA. U.N.O.
100 SS	DENOTES SUBSOIL DRAINAGE LINE AND DIA. WRAPPED IN GEOFABRIC U.N.O.
DP	DENOTES DOWNPIPE
IO	DENOTES INSPECTION OPENING WITH SCREW DOWN LID AT FINISHED SURFACE LEVEL
CO	DENOTES INSPECTION OPENING WITH SCREW DOWN LID AT FINISHED SURFACE LEVEL FOR SYSTEM FLUSHING PURPOSES
	STORMWATER PIT - SOLID COVER
	STORMWATER PIT - GRATED INLET
	DENOTES GRATED DRAIN
	DENOTES ABSORPTION TRENCH
	NON RETURN VALVE
	PUMP
	STOP VALVE (ISOLATION VALVE)
	240v REQUIRED
IL23.31	DENOTES LEVEL OF INLET /OUTLET OF STORMWATER PIPE. NOTE: UNLESS NOTED OTHERWISE, THE BASE OF THE PIT IS THE SAME AS THE PIPE INLET/OUTLET.

DIAL BEFORE YOU DIG

DIAL BEFORE YOU DIG www.1100.com.au

IMPORTANT: THE CONTRACTOR IS TO MAINTAIN A CURRENT SET OF "DIAL BEFORE YOU DIG" DRAWINGS ON SITE AT ALL TIMES.

GENERAL NOTES

1. THESE PLANS SHALL BE READ IN CONJUNCTION WITH OTHER RELEVANT CONSULTANTS' PLANS, SPECIFICATIONS, CONDITIONS OF DEVELOPMENT CONSENT AND CONSTRUCTION CERTIFICATE REQUIREMENTS. WHERE DISCREPANCIES ARE FOUND ACOR CONSULTANTS (CC) MUST BE CONTACTED IMMEDIATELY FOR VERIFICATION
2. WHERE THESE PLANS ARE NOTED FOR DEVELOPMENT APPLICATION PURPOSES ONLY, THEY SHALL NOT BE USED FOR OBTAINING A CONSTRUCTION CERTIFICATE NOR USED FOR CONSTRUCTION PURPOSES
3. SUBSOIL DRAINAGE SHALL BE DESIGNED AND DETAILED BY THE STRUCTURAL ENGINEER. SUBSOIL DRAINAGE SHALL NOT BE CONNECTED INTO THE STORMWATER SYSTEM IDENTIFIED ON THESE PLANS UNLESS APPROVED BY ACOR CONSULTANTS (CC)

STORMWATER CONSTRUCTION NOTES

1. ALL WORK SHALL BE CARRIED OUT IN ACCORDANCE WITH AS/NZS 3500 (CURRENT EDITION) AND THE REQUIREMENTS OF THE LOCAL COUNCIL'S POLICIES AND CODES
2. THE MINIMUM SIZES OF THE STORMWATER DRAINS SHALL NOT BE LESS THAN DN90 FOR CLASS 1 BUILDINGS AND DN100 FOR OTHER CLASSES OF BUILDING OR AS REQUIRED BY THE REGULATORY AUTHORITY
3. THE MINIMUM GRADIENT OF STORMWATER DRAINS SHALL BE 1%, UNLESS NOTED OTHERWISE
4. COUNCIL'S TREE PRESERVATION ORDER IS TO BE STRICTLY ADHERED TO. NO TREES SHALL BE REMOVED UNTIL PERMIT IS OBTAINED
5. PUBLIC UTILITY SERVICES ARE TO BE ADJUSTED AS NECESSARY AT THE CLIENT'S EXPENSE
6. ALL PITS TO BE BENCHED AND STREAMLINED. PROVIDE STEP IRONS FOR ALL PITS OVER 1.2m DEEP
7. MAKE SMOOTH JUNCTION WITH ALL EXISTING WORK
8. VEHICULAR ACCESS AND ALL SERVICES TO BE MAINTAINED AT ALL TIMES TO ADJOINING PROPERTIES AFFECTED BY CONSTRUCTION
9. SERVICES SHOWN ON THESE PLANS HAVE BEEN LOCATED FROM INFORMATION SUPPLIED BY THE RELEVANT AUTHORITIES AND FIELD INVESTIGATIONS AND ARE NOT GUARANTEED COMPLETE NOR CORRECT. IT IS THE CLIENT & CONTRACTOR'S RESPONSIBILITY TO LOCATE ALL PRIOR TO CONSTRUCTION
10. ANY VARIATION TO THE WORKS AS SHOWN ON THE APPROVED DRAWINGS ARE TO BE CONFIRMED BY ACOR CONSULTANTS (CC) PRIOR TO THEIR COMMENCEMENT

RAINWATER RE-USE SYSTEM NOTES

1. RAINWATER SUPPLY PLUMBING TO BE CONNECTED TO OUTLETS WHERE REQUIRED BY BASIX CERTIFICATE (BY OTHERS)
2. TOWN WATER CONNECTION TO RAINWATER TANK TO BE TO THE SATISFACTION OF THE REGULATORY AUTHORITY. THIS MAY REQUIRE PROVISION OF:
   2.1. PERMANENT AIR GAP
   2.2. BACKFLOW PREVENTION DEVICE
3. NO DIRECT CONNECTION BETWEEN TOWN WATER SUPPLY AND THE RAIN WATER SUPPLY
4. AN APPROVED STOP VALVE AND/OR PRESSURE LIMITING VALVE AT THE RAINWATER TANK
5. PROVIDE AT LEAST ONE EXTERNAL HOSE COCK ON THE TOWN WATER SUPPLY FOR FIRE FIGHTING
6. PROVIDE APPROPRIATE FLOAT VALVES AND/OR SOLENOID VALVES TO CONTROL TOWN WATER SUPPLY INLET TO TANK IN ORDER TO ACHIEVE THE TOP-UP INDICATED ON THE TYPICAL DETAIL
7. ALL PLUMBING WORKS ARE TO BE CARRIED OUT BY LICENSED PLUMBERS IN ACCORDANCE WITH AS/NZS3500.1 NATIONAL PLUMBING AND DRAINAGE CODE
8. PRESSURE PUMP ELECTRICAL CONNECTION TO BE CARRIED OUT BY A LICENSED ELECTRICIAN
9. ONLY ROOF RUN-OFF IS TO BE DIRECTED TO THE RAINWATER TANK . SURFACE WATER INLETS ARE NOT TO BE CONNECTED
10. PIPE MATERIALS FOR RAINWATER SUPPLY PLUMBING ARE TO BE APPROVED MATERIALS TO AS/NZS3500 PART 1 SECTION 2 AND TO BE CLEARLY AND PERMANENTLY IDENTIFIED AS 'RAINWATER'. THIS MAY BE ACHIEVED FOR BELOW GROUND PIPES USING IDENTIFICATION TAPE (MADE IN ACCORDANCE WITH AS2648) OR FOR ABOVE GROUND PIPES BY USING ADHESIVE PIPE MARKERS (MADE IN ACCORDANCE WITH AS1345)
11. EVERY RAINWATER SUPPLY OUTLET POINT AND THE RAINWATER TANK ARE TO BE LABELED 'RAINWATER' ON A METALLIC SIGN IN ACCORDANCE WITH AS1319
12. ALL INLETS AND OUTLETS TO THE RAINWATER TANK ARE TO HAVE SUITABLE MEASURES PROVIDED TO PREVENT MOSQUITO AND VERMIN ENTRY

SHEET INDEX

COVER SHEET & NOTES	SHEET C1
STORMWATER MANAGEMENT GENERAL PLAN	SHEET C2
STORMWATER MANAGEMENT DETAIL PLAN SHEET 1 OF 2	SHEET C3
STORMWATER MANAGEMENT DETAIL PLAN SHEET 2 OF 2	SHEET C4
STORMWATER MANAGEMENT DETAILS SHEET No.1	SHEET C5

NORTHERN BEACHES COUNCIL REQUIREMENTS
PITTWATER REQUIREMENTS

SITE AREA (m^2)	878.9
PROPOSED DWELLING AREA (m^2)	353
PROPOSED DRIVEWAY + PATH AREA (m^2)	49.1
POST DEVELOPMENT IMPERVIOUS AREAS (m^2)	402.1

PROVIDE 5000L RAINWATER RE-USE, IN ACCORDANCE WITH BASIX REQUIREMENT

1. OSD NOT REQUIRED AS SITE IS FLOOD AFFECTED.

DESIGN PREPARED IN ACCORDANCE WITH PITTWATER COUNCIL'S DCP 21 - SECTION B5.7, AR&R AND AS/NZS 3500.

SHEET INDEX

DEVELOPMENT APPLICATION ISSUE
NOT FOR CONSTRUCTION

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by: L.D APPLEYARD MIE Aust CPEng (CIVIL / STRUCTURAL)

Issue	Description	Date	Drawn	Approved
E	DEVELOPMENT APPLICATION ISSUE	12.12.17	SJ	BK
D	DEVELOPMENT APPLICATION ISSUE	07.12.17	SJ	BK
C	DEVELOPMENT APPLICATION ISSUE	21.11.17	SJ	BK
B	DEVELOPMENT APPLICATION ISSUE	01.10.17	SJ	LDA

1cm at full size

North

Client: CROOKES

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
No.17 OCEAN ROAD
PALM BEACH

Drawing Title: COVER SHEET & NOTES

Drawn	Date	Scale A1	Q.A. Check	Date
SJ	14.08.17	AS NOTED	-	-

Designed	Project No.	Dwg. No.	Issue
BK	GO170545	C1	E

WARNING
LOCATION AND DEPTH OF ALL UNDERGROUND SERVICES TO BE INVESTIGATED WITH THE RELEVANT AUTHORITIES PRIOR TO COMMENCING WORK

DISCHARGE STORMWATER TO EXISTING PIT TO THE SATISFACTION OF COUNCIL
MAKE GOOD EXISTING CONSTRUCTION
INVERT LEVEL OF OUTLET SHALL BE SITE CONFIRMED PRIOR TO COMMENCEMENT OF WORK.
DESIGN INVERT: IL 3.91 NOM.

CROSSOVER AND DRIVEWAY TO BE IN ACCORDANCE WITH COUNCIL REQUIREMENTS. THE LEVELS AND DESIGN OF THE CROSSOVER AND DRIVEWAY SHALL BE BY OTHERS.

PALM BEACH ROAD

OCEAN ROAD

PROPOSED LOWER LEVEL FFL RL.4.80

TERRACE FFL RL.4.70

GARAGE FFL RL.4.68

POOL

NEW DRIVEWAY

LOT A DP 405897

LOT B DP 405897

LOT 106 DP 6937

878.9m²

BRICK GRANNY FLAT

ONE & TWO STOREY SANDSTONE & WEATHERBOARD HOUSE METAL ROOF No.15

BM NAIL TOP KERB 4.35 (AHD)

ELEC TURRET

BALCONY APPROX 12.41

GUTTER 15.45

GUTTER 8.30

GUTTER 10.95

3m HIGH HEDGE

3m HIGH BLOCK WALL

1.5m HIGH BRICK WALL

1.5m LOW STONE WALL

LOW BRICK WALL

STONE RET. WALL

CONCRETE PATH

CONCRETE AND KERB GUTTER

GRASS

GARDEN

DRIVEWAY

OVERHEAD ELECTRICITY

CONC DRAIN PIT

HYD SV HYD

TEL

SIGN

KIP

O HI=4

RIDGE 10.0

BOT 8.27

BOT 8.27

PORCH

REFER DETAIL PLAN SHEET C3

REFER DETAIL PLAN SHEET C4

C4

STORMWATER LEGEND

- RW — DENOTES 100mm DIA. FULLY SEALED UNDERGROUND RAINWATER SYSTEM PIPE U.N.O.
- SW — DENOTES 100mm DIA. UNDERGROUND STORMWATER / SURFACE WATER SYSTEM PIPE AT 1% MIN. GRADE U.N.O.
- 150 RW — DENOTES RAINWATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.
- 150 SW — DENOTES STORMWATER/SURFACE WATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.

STORMWATER MANAGEMENT - GENERAL PLAN

SCALE - 1:100/A1, 1:200/A3

0 1 2 4 6 8 10m

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by: L.D APPLEYARD MIE Aust CPEng (CIVIL / STRUCTURAL)

Issue	Description	Date	Drawn	Approved
E	DEVELOPMENT APPLICATION ISSUE	12.12.17	SJ	BK
D	DEVELOPMENT APPLICATION ISSUE	07.12.17	SJ	BK
C	DEVELOPMENT APPLICATION ISSUE	21.11.17	SJ	BK
B	DEVELOPMENT APPLICATION ISSUE	01.10.17	SJ	LDA

1cm at full size

North

Client: CROOKES

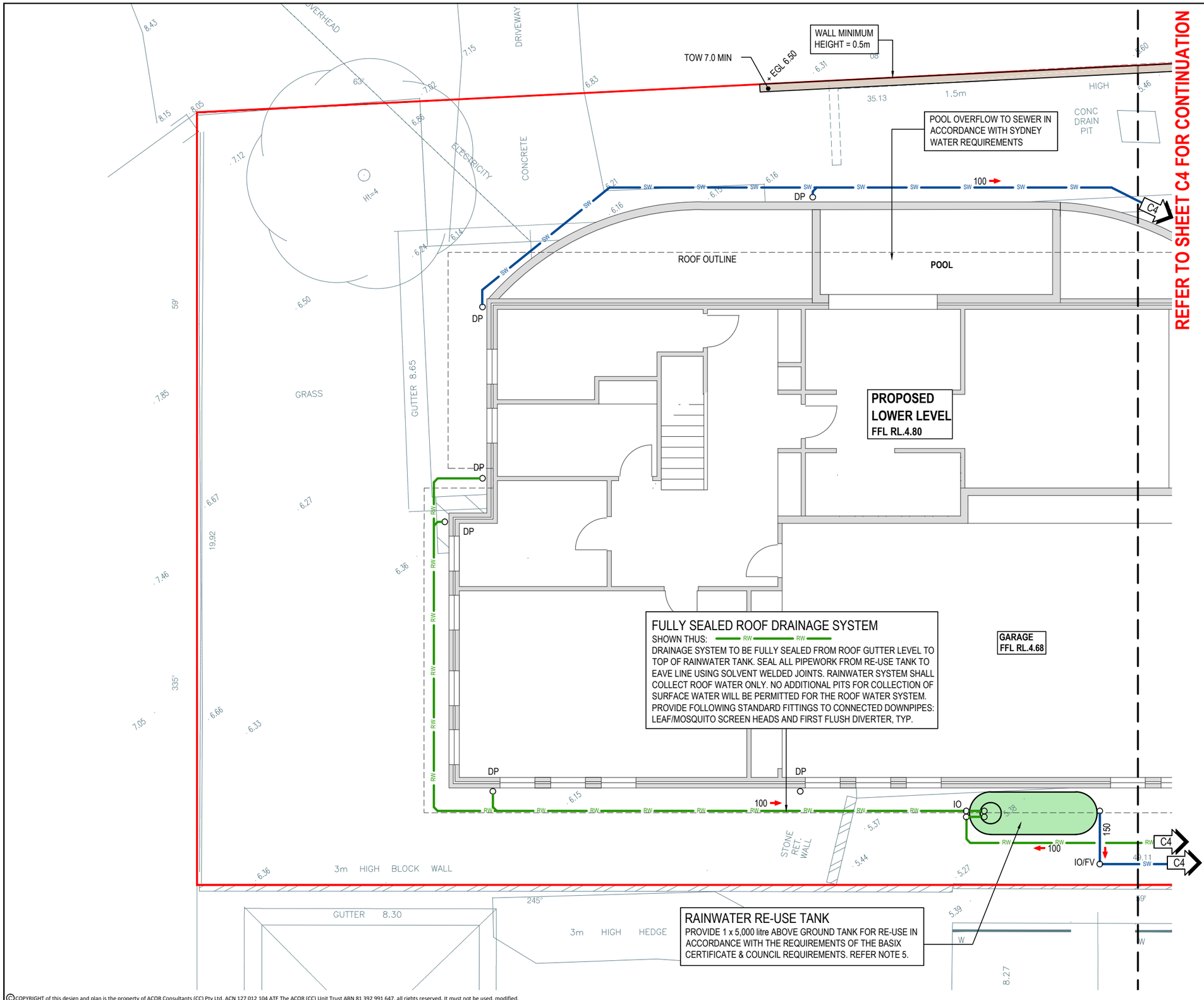
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
No.17 OCEAN ROAD
PALM BEACH

Drawing Title: STORMWATER MANAGEMENT GENERAL PLAN

Drawn	Date	Scale	Q.A. Check	Date
SJ	14.08.17	AS NOTED A1	-	-

Designed	Project No.	Dwg. No.	Issue
BK	GO170545	C2	E



NOTES:

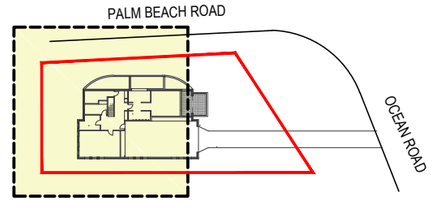
1. TOP OF GRATE LEVELS HAVE BEEN DETERMINED FROM THE SURVEY DETAIL PROVIDED. FOLLOWING EARTHWORKS AND BENCHING, VALIDITY OF GRATE LEVELS SHOULD BE ASSESSED AND ADJUSTED AS REQUIRED TO MEET THE INTENT OF THE DESIGN. WHERE IN DOUBT CONTACT THE DESIGN ENGINEER.
2. LANDSCAPE SURFACE DRAINAGE SYSTEM TO DETAIL BY OTHERS. THIS SYSTEM IS TO BE INTEGRATED WITH ANY LANDSCAPE REQUIREMENTS. THE COLLECTION OF LANDSCAPE STORMWATER SHALL BE CONVEYED BY A SEPARATE SYSTEM OF PITS AND PIPES. NO CONNECTION IS ALLOWED INTO THE RAINWATER PIPE SYSTEM IDENTIFIED AS SHOWN RW RW
3. THE LOCATIONS OF DOWNPIPES SHOWN ON THIS DRAWING ARE INDICATIVE AND WILL NEED TO BE SITE VERIFIED BY THE BUILDER. ALL DOWNPIPES TO BE 90mm MIN. DIA. U.N.O. IF CHANGES ARE MADE TO THE NUMBER OR POSITION OF DOWNPIPES THE DESIGN ENGINEER SHALL BE CONTACTED FOR VERIFICATION.
4. FOR CHARGED/SEALED LINES PROVIDED APPROPRIATE CLEAN OUT FACILITY AT LOW POINTS OF SYSTEM, TYP.
5. INSTALL RAINWATER TANK IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION, AS/NZS 3500, AND COUNCIL'S GUIDELINES. REFER SHEET C4 FOR DETAIL.
   FINAL LOCATION OF TANK TO BE SITE CONFIRMED.

   PROVIDE TANK RE-USE PUMP CONTROL UNIT TO MANUFACTURERS SPECIFICATION. PROVIDE FIRST FLUSH DEVICE OR EQUIVALENT PRIOR TO DISCHARGING TO TANK.

LEGEND

- DENOTES WAVE RUN-UP BARRIER WALLS.
- TOW 5.80 — DENOTES TOP OF WALL LEVEL AS NOTED ON PLAN
- IO/FV — PROVIDE IN-LINE FLAP VALVE WITH IO
- RW — DENOTES 100mm DIA. FULLY SEALED UNDERGROUND RAINWATER SYSTEM PIPE U.N.O.
- SW — DENOTES 100mm DIA. UNDERGROUND STORMWATER / SURFACE WATER SYSTEM PIPE AT 1% MIN. GRADE U.N.O.
- 150 RW — DENOTES RAINWATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.
- 150 SW — DENOTES STORMWATER/SURFACE WATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.

LOCATION PLAN



This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by: L.D APPLEYARD MIE Aust CPEng (CIVIL / STRUCTURAL)

Issue	Description	Date	Drawn	Approved
E	DEVELOPMENT APPLICATION ISSUE	12.12.17	SJ	BK
D	DEVELOPMENT APPLICATION ISSUE	07.12.17	SJ	BK
C	DEVELOPMENT APPLICATION ISSUE	21.11.17	SJ	BK
B	DEVELOPMENT APPLICATION ISSUE	01.10.17	SJ	LDA

1 0 1cm at full size 10cm

North

Client: CROOKES

ACOR CONSULTANTS
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
No.17 OCEAN ROAD
PALM BEACH

Drawing Title: STORMWATER MANAGEMENT DETAIL PLAN - SHEET 1 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
SJ	14.08.17	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	GO170545		C3	E

REFER TO SHEET C3 FOR CONTINUATION

WALL MINIMUM HEIGHT = 0.5m

TOW 5.62 MIN

BRICK WALL

FOR ALL DOWNPIPES REFER TO NOTE 3.

FOR LANDSCAPE SURFACE STORMWATER DRAINAGE SYSTEM REFER TO NOTE 2

SURFACE GRADING TO BE IN ACCORDANCE WITH REPORT PREPARED BY HORTON COASTAL ENGINEERING (SECTION 7)

WAVE BARRIER WALL IN ACCORDANCE WITH REPORT PREPARED BY HORTON COASTAL ENGINEERING

PIT P3 - SURFACE OUTLET
450 SQUARE PIT WITH LIGHT DUTY GRATED INLET
TOP OF GRATE - 4.70 nom

TERRACE
FFL RL.4.70

IL 4.280

CONCRETE PATH

LANDSCAPE RETAINING WALL

TOW 5.30 MIN.

IO/FV

LOT A
DP 405897
878.9m²

TOW 5.30 MIN.

IL 4.070

PIT P2 - BOUNDARY PIT
600 SQUARE PIT WITH LIGHT DUTY GRATED INLET
TOP OF GRATE - 5.06 nom

TOW 5.30 MIN

PROVIDE SOLID SLIDING GATE IN ACCORDANCE WITH HORTON COASTAL ENGINEERING REPORT (SECTION 7).
NOTE: 100mm GAP UNDER GATE

GARAGE
FFL RL.4.68

-8%
5.0 %
10.0 %
0 %
-10.2 %
-1.1 %
GRADE UP
GRADE UP
GRASS NEW
DRIVEWAY

TOW 5.30 MIN

TOW 5.30 MIN.

TOW 5.30 MIN

CONSTRUCT 200 WIDE GRATED BOX DRAIN MIN 150 DEEP INVERT TO GRADE TO OUTLET AT A MINIMUM GRADE OF 2% TOP OF GRATE 4.610 nom

LOCALLY REGRADE TO ACHIEVE A MINIMUM FINISHED SURFACE LEVEL OF RL 5.30. SITE TO GRADE TOWARDS FRONT BOUNDARY

1200mm LONG BY 150mm HIGH OPENING IN BASE OF WALL TO ALLOW FLOW OF SURFACE WATER OUT OF SITE.
BASE OF OPENING RL 4.420

ROOF OUTLINE

DP

IO

1500

TOW 5.30 MIN

IL 4.21

ELEC TURRET

PROVIDE IO FOR CLEANOUT AT LOW POINT IN SYSTEM. TYP.

PIT P1 - JUNCTION PIT
450 SQUARE PIT WITH LIGHT DUTY GRATED INLET
TOP OF GRATE - 4.44 nom

STORMWATER MANAGEMENT - DETAIL PLAN

SCALE - 1:50/A1, 1:100/A3

0 0.5 1 2 3 4 5m

NOTES:

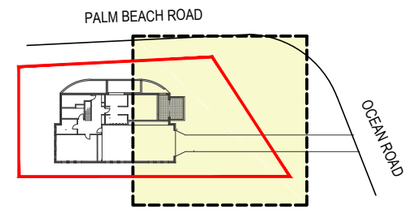
1. TOP OF GRATE LEVELS HAVE BEEN DETERMINED FROM THE SURVEY DETAIL PROVIDED. FOLLOWING EARTHWORKS AND BENCHING, VALIDITY OF GRATE LEVELS SHOULD BE ASSESSED AND ADJUSTED AS REQUIRED TO MEET THE INTENT OF THE DESIGN. WHERE IN DOUBT CONTACT THE DESIGN ENGINEER.
2. LANDSCAPE SURFACE DRAINAGE SYSTEM TO DETAIL BY OTHERS. THIS SYSTEM IS TO BE INTEGRATED WITH ANY LANDSCAPE REQUIREMENTS. THE COLLECTION OF LANDSCAPE STORMWATER SHALL BE CONVEYED BY A SEPARATE SYSTEM OF PITS AND PIPES. NO CONNECTION IS ALLOWED INTO THE RAINWATER PIPE SYSTEM IDENTIFIED AS SHOWN RW RW
3. THE LOCATIONS OF DOWNPIPES SHOWN ON THIS DRAWING ARE INDICATIVE AND WILL NEED TO BE SITE VERIFIED BY THE BUILDER. ALL DOWNPIPES TO BE 90mm MIN. DIA. U.N.O. IF CHANGES ARE MADE TO THE NUMBER OR POSITION OF DOWNPIPES THE DESIGN ENGINEER SHALL BE CONTACTED FOR VERIFICATION.
4. FOR CHARGED/SEALED LINES PROVIDED APPROPRIATE CLEAN OUT FACILITY AT LOW POINTS OF SYSTEM, TYP.
5. INSTALL RAINWATER TANK IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION, AS/NZS 3500, AND COUNCIL'S GUIDELINES. REFER SHEET C4 FOR DETAIL.
   FINAL LOCATION OF TANK TO BE SITE CONFIRMED.

   PROVIDE TANK RE-USE PUMP CONTROL UNIT TO MANUFACTURERS SPECIFICATION. PROVIDE FIRST FLUSH DEVICE OR EQUIVALENT PRIOR TO DISCHARGING TO TANK.

LEGEND

- DENOTES WAVE RUN-UP BARRIER WALLS.
- TOW 5.80 — DENOTES TOP OF WALL LEVEL AS NOTED ON PLAN
- IO/FV — PROVIDE IN-LINE FLAP VALVE WITH IO
- RW — DENOTES 100mm DIA. FULLY SEALED UNDERGROUND RAINWATER SYSTEM PIPE U.N.O.
- SW — DENOTES 100mm DIA. UNDERGROUND STORMWATER / SURFACE WATER SYSTEM PIPE AT 1% MIN. GRADE U.N.O.
- 150 RW — DENOTES RAINWATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.
- 150 SW — DENOTES STORMWATER/SURFACE WATER PIPE AND DIA. WHEN PIPE EXCEEDS 100mm DIA.

LOCATION PLAN



This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by: L.D APPLEYARD MIE Aust CPEng (CIVIL / STRUCTURAL)

Issue	Description	Date	Drawn	Approved
E	DEVELOPMENT APPLICATION ISSUE	12.12.17	SJ	BK
D	DEVELOPMENT APPLICATION ISSUE	07.12.17	SJ	BK
C	DEVELOPMENT APPLICATION ISSUE	21.11.17	SJ	BK
B	DEVELOPMENT APPLICATION ISSUE	01.10.17	SJ	LDA

1 0 1cm at full size 10cm

North

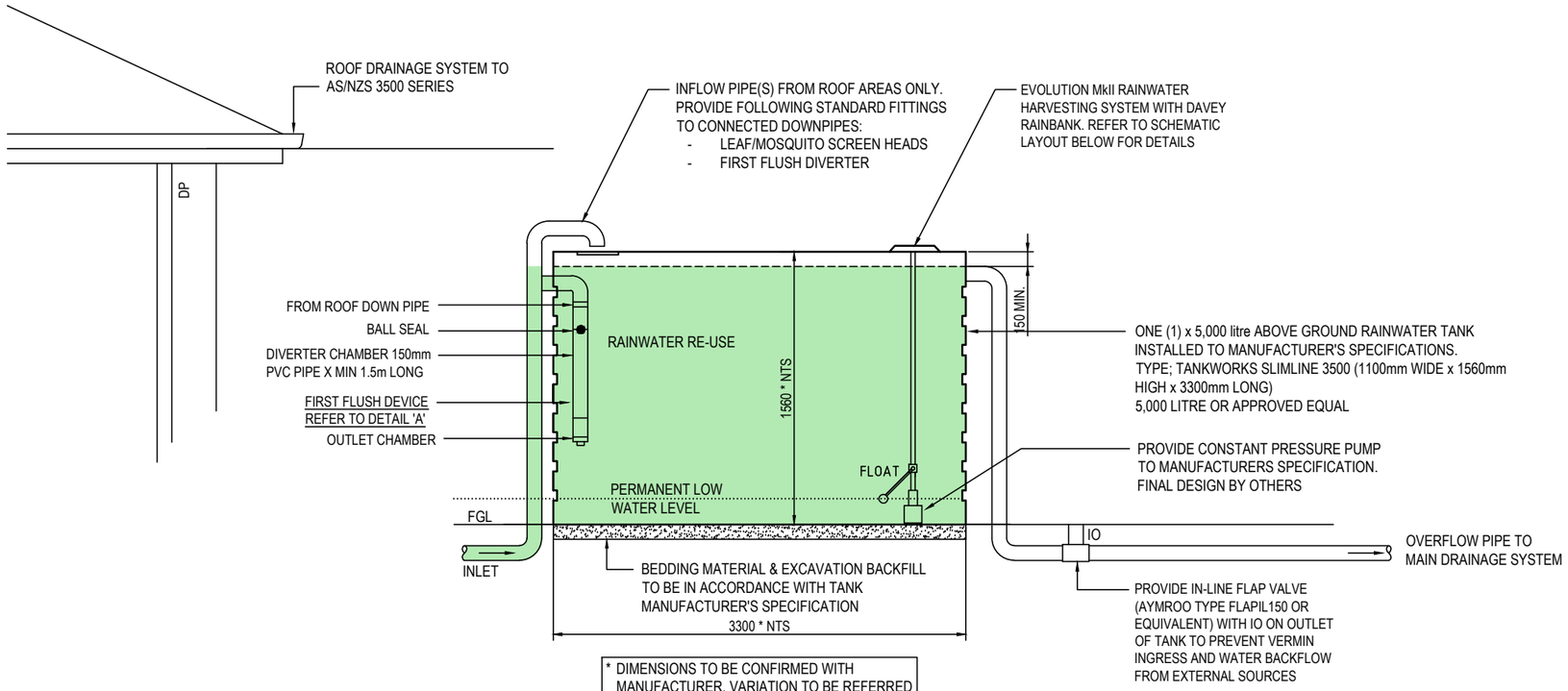
Client: CROOKES

ACOR CONSULTANTS
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
No.17 OCEAN ROAD
PALM BEACH

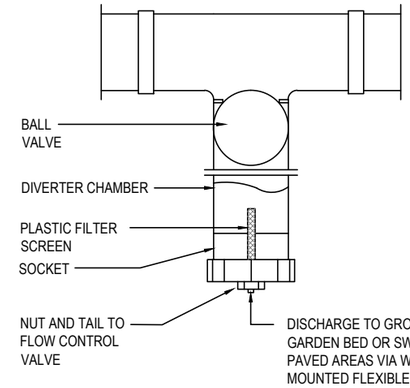
Drawing Title: STORMWATER MANAGEMENT DETAIL PLAN - SHEET 2 OF 2

Drawn	Date	Scale A1	Q.A. Check	Date
SJ	14.08.17	AS NOTED	-	-
Designed	Project No.	Dwg. No.	Issue	
BK	GO170545	C4	E	



* DIMENSIONS TO BE CONFIRMED WITH MANUFACTURER, VARIATION TO BE REFERRED TO THE DESIGN ENGINEER FOR VALIDATION

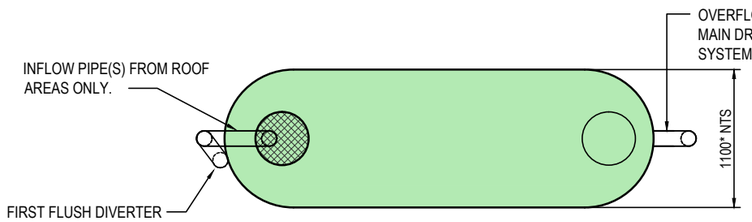
ABOVE GROUND RAINWATER RE-USE TANK ELEVATION
NOT TO SCALE



FIRST FLUSH DIVERTER
MAKE PROVISION FOR THE TREATMENT OF SLOW RELEASE WATER DISCHARGE FROM DIVERTER OUTLET. DO NOT ALLOW DISCHARGE TO POND ON SOIL

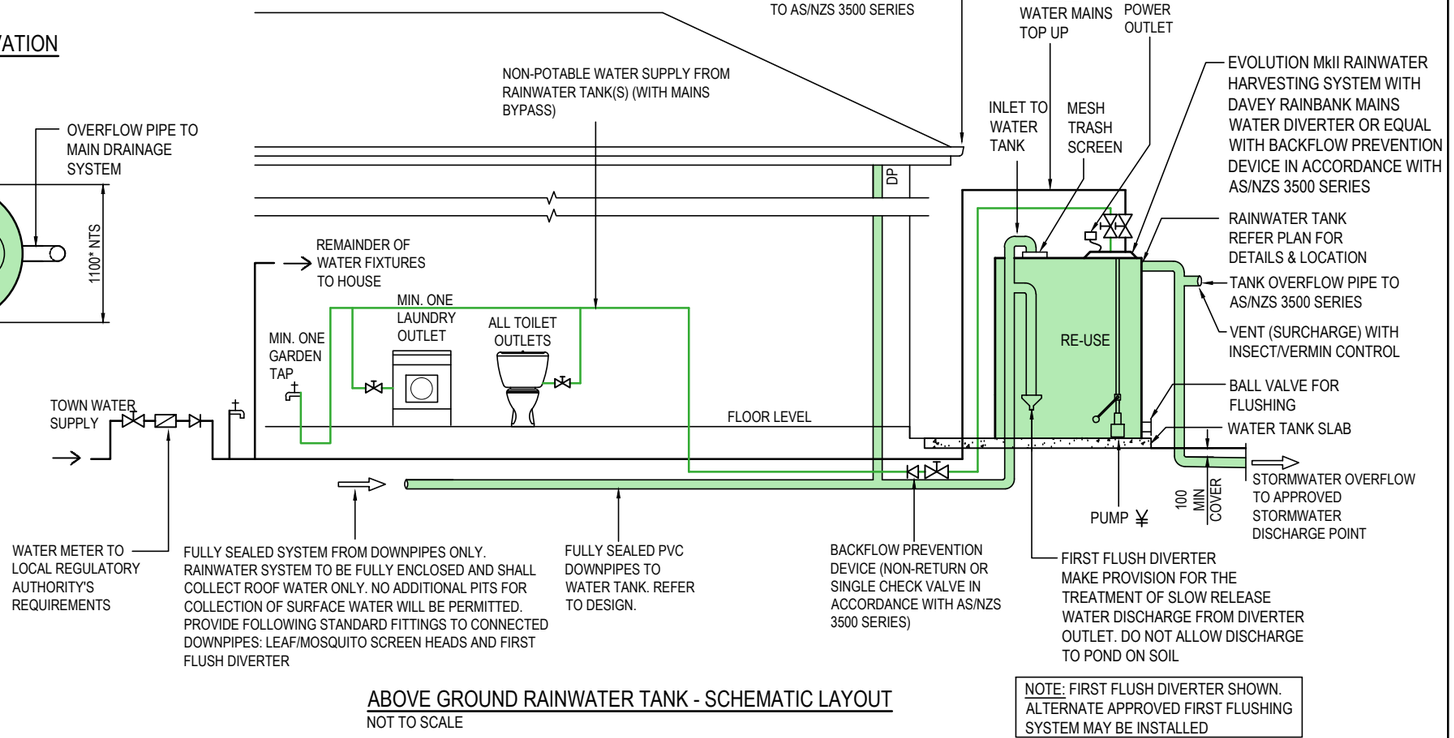
NOTE: FIRST FLUSH DIVERTER SHOWN. ALTERNATE APPROVED FIRST FLUSHING SYSTEM MAY BE INSTALLED

DETAIL 'A'
NTS



RAINWATER RE-USE TANK PLAN
NOT TO SCALE

TYPICAL WARNING SIGN
SCALE N.T.S
* EVERY EXTERNAL SUPPLY OUTLET FROM RAINWATER RE-USE TANK TO BE LABELED WITH METALLIC WARNING SIGN



NOTE: FIRST FLUSH DIVERTER SHOWN. ALTERNATE APPROVED FIRST FLUSHING SYSTEM MAY BE INSTALLED

ABOVE GROUND RAINWATER TANK - SCHEMATIC LAYOUT
NOT TO SCALE

This drawing has been assigned an electronic code that signifies the drawing has been checked and approved by: L.D APPLEYARD MIE Aust CPEng (CIVIL / STRUCTURAL)

Issue	Description	Date	Drawn	Approved
E	DEVELOPMENT APPLICATION ISSUE	12.12.17	SJ	BK
D	DEVELOPMENT APPLICATION ISSUE	07.12.17	SJ	BK
C	DEVELOPMENT APPLICATION ISSUE	21.11.17	SJ	BK
B	DEVELOPMENT APPLICATION ISSUE	01.10.17	SJ	LDA

0 10cm at full size 100cm

North

Client: CROOKES

ACOR CONSULTANTS
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

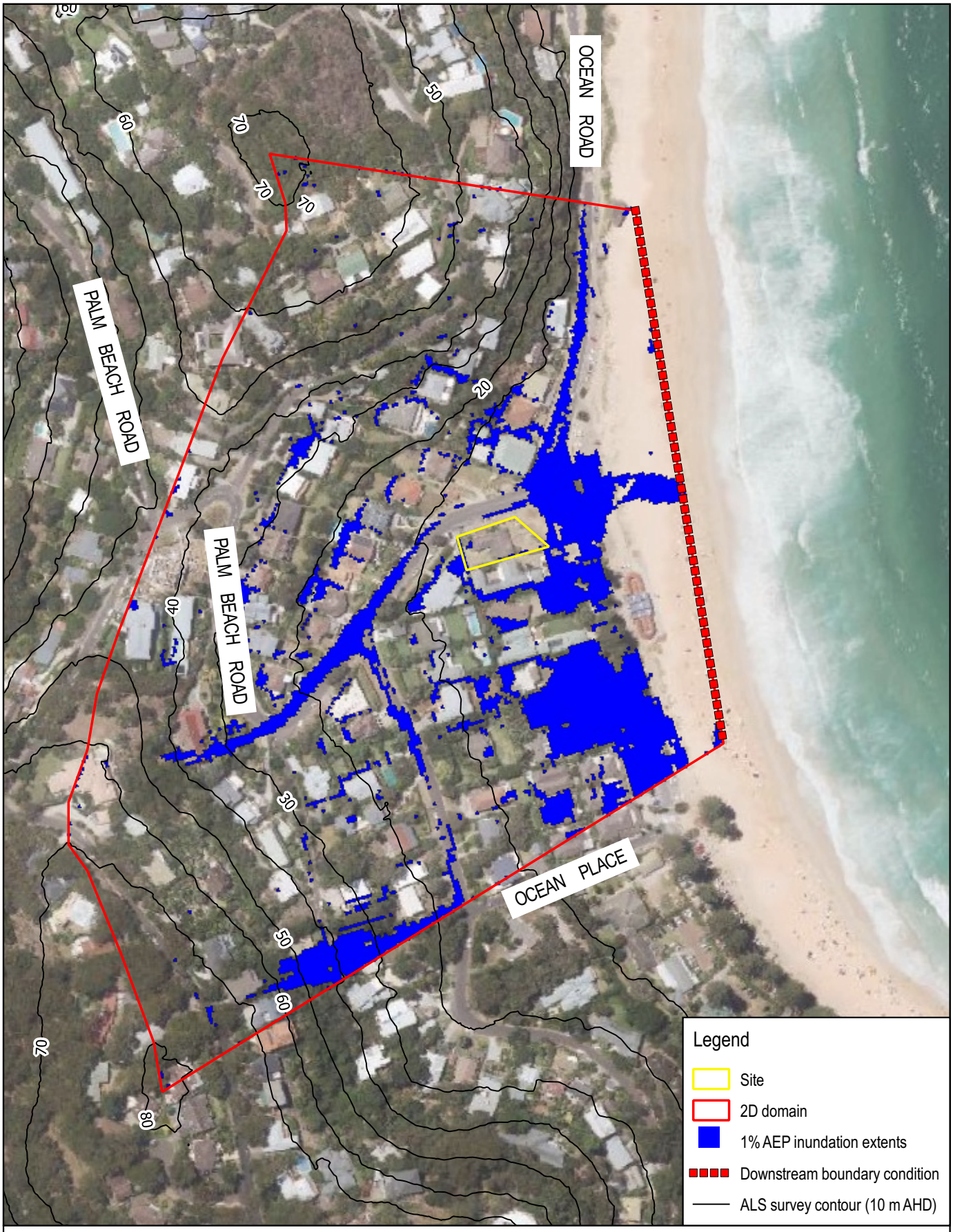
Project: PROPOSED RESIDENTIAL DEVELOPMENT
No.17 OCEAN ROAD
PALM BEACH

Drawing Title: STORMWATER MANAGEMENT DETAILS SHEET No.1

Drawn	Date	Scale A1	Q.A. Check	Date
SJ	14.08.17	AS NOTED	-	-
Designed	Project No.		Dwg. No.	Issue
BK	GO170545		C5	E

ANNEXURE E

ACOR Flood Plans
Reference GO170545
Sheets F1 to F10
Revision C
Dated 20 November 2017



Title: FIGURE 1. TUFLOW MODEL PLAN

ACOR CONSULTANTS

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

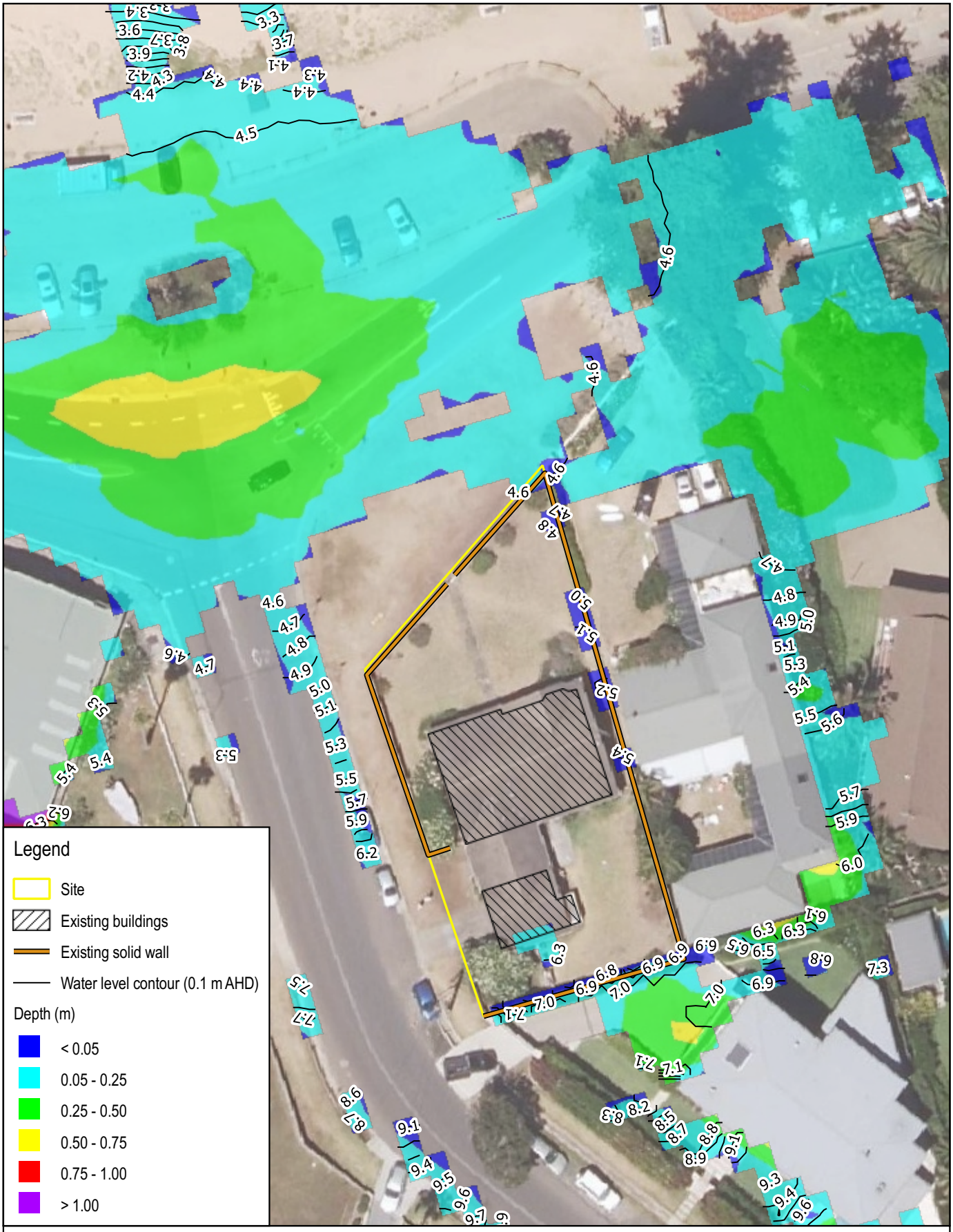
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F1	C	20.11.2017	BK	AN	1:3000



Title: FIGURE 2. PRE-DEVELOPMENT 1% AEP FLOOD DEPTH AND LEVEL PLAN

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

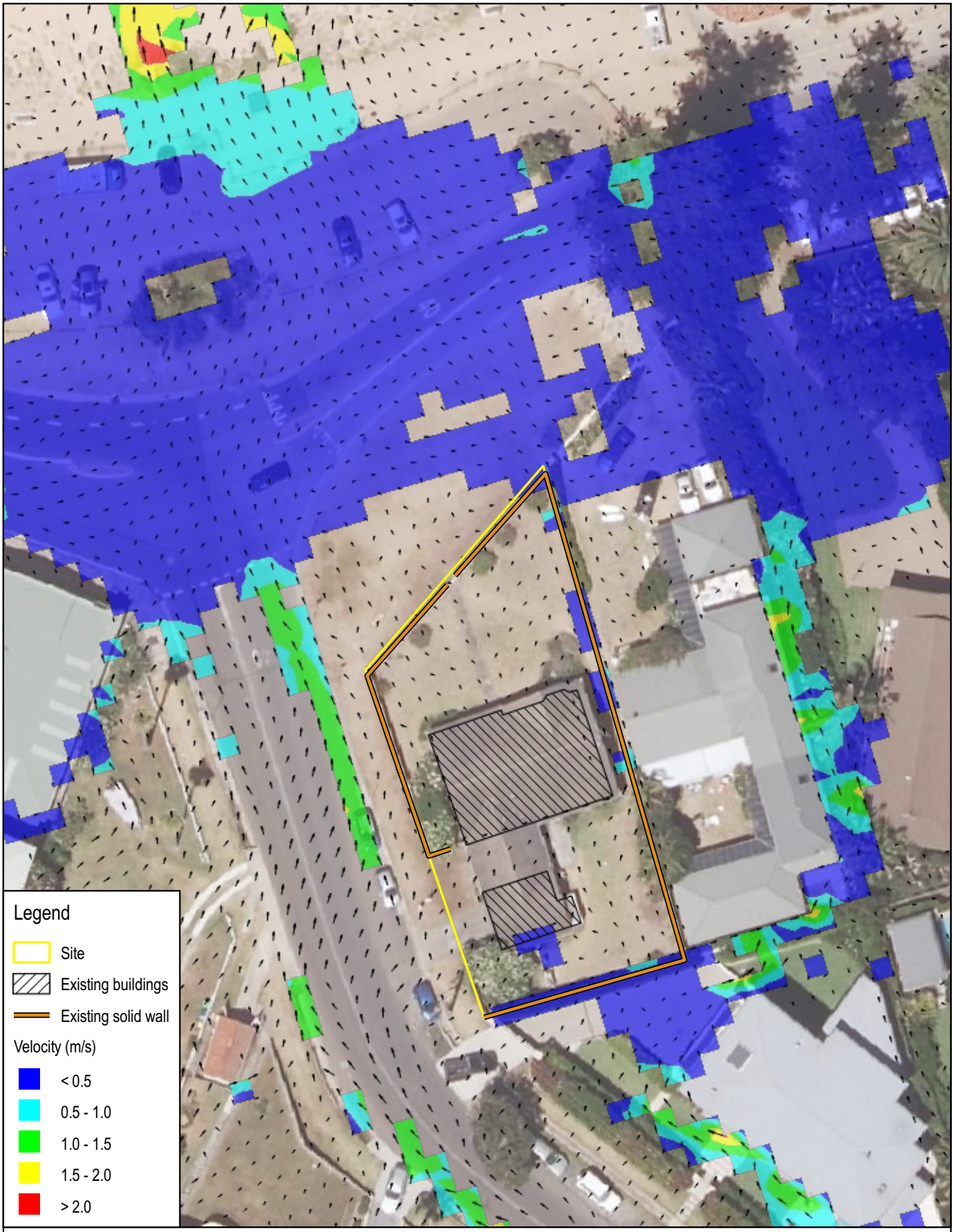
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F2	C	20.11.2017	BK	AN	1:500



Title: FIGURE 3. PRE-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN

ACOR CONSULTANTS

ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

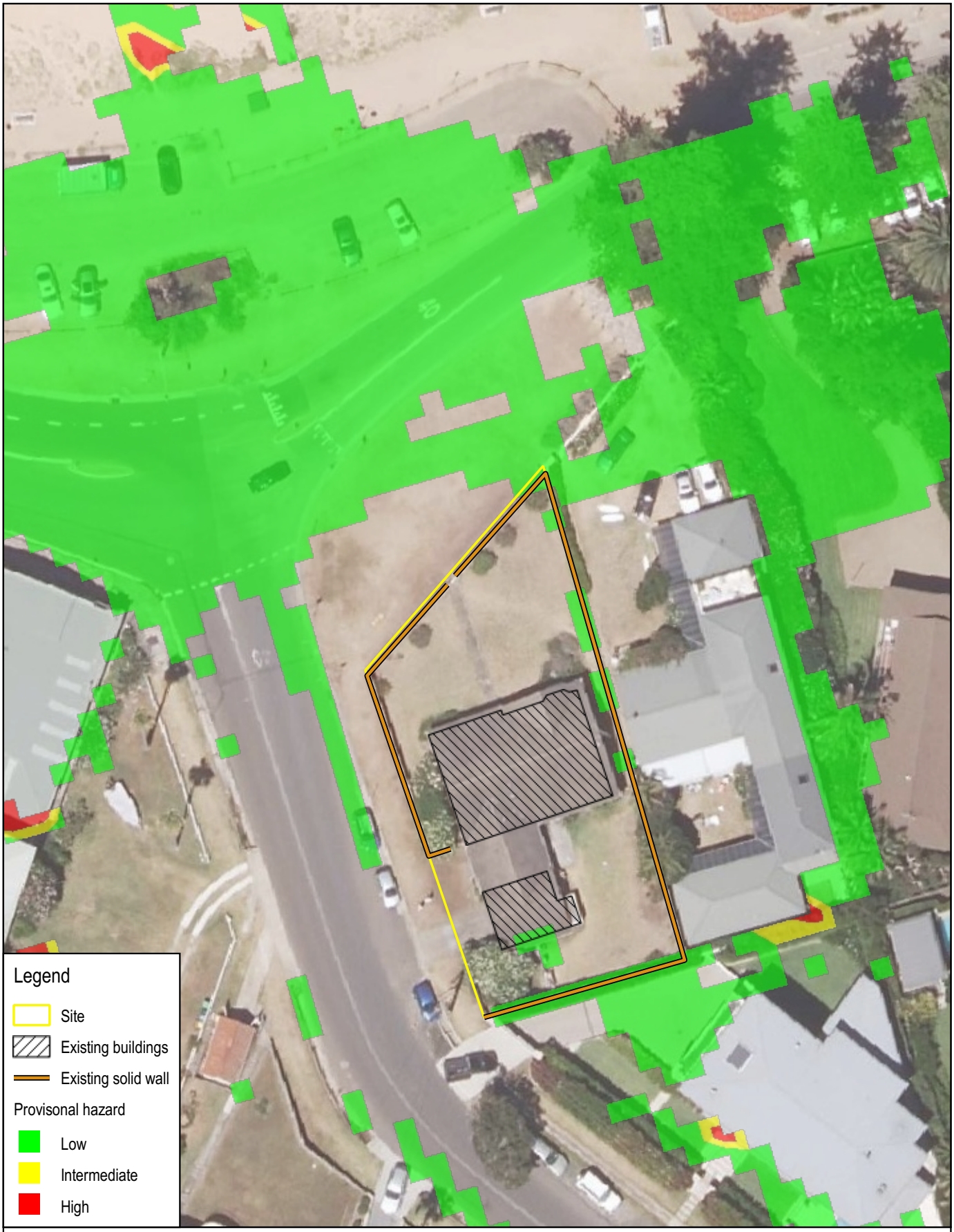
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F3	C	20.11.2017	BK	AN	1:500



Title: FIGURE 4. PRE-DEVELOPMENT 1% AEP FLOOD PROVISIONAL HYDRAULIC HAZARD PLAN

ACOR CONSULTANTS
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

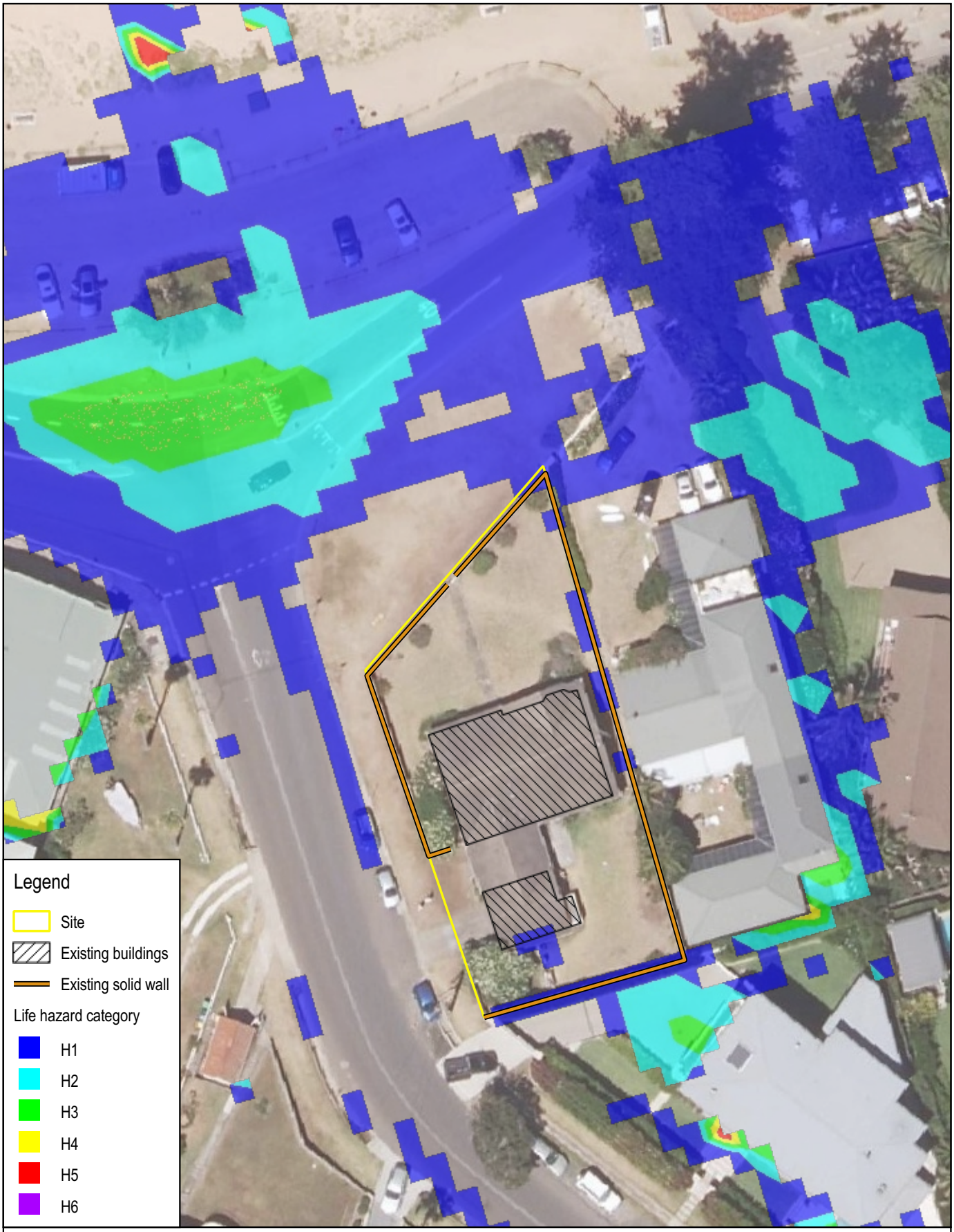
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F4	C	20.11.2017	BK	AN	1:500



Title: FIGURE 5. PRE-DEVELOPMENT 1% AEP FLOOD LIFE HAZARD PLAN

ACOR CONSULTANTS

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

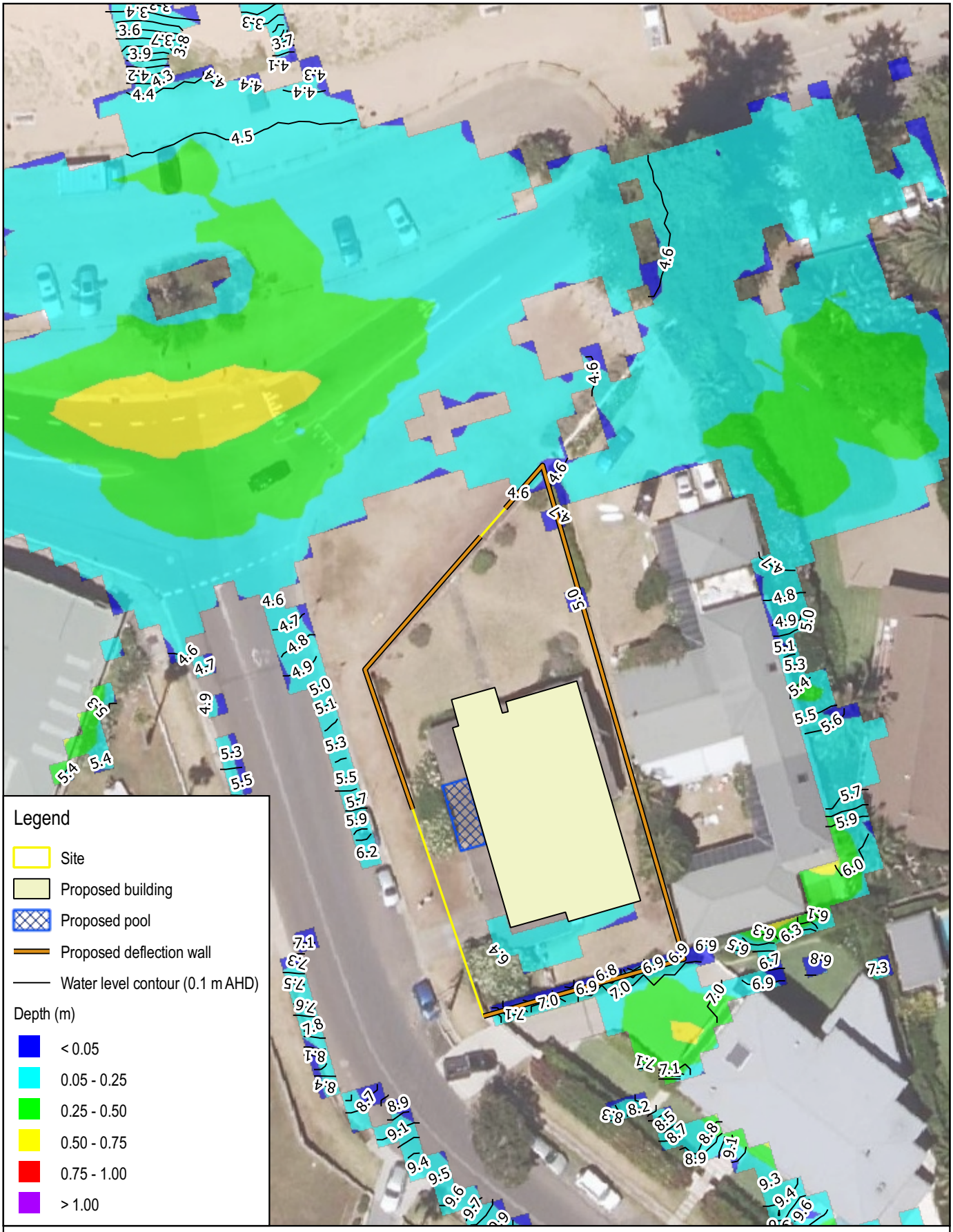
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F5	C	20.11.2017	BK	AN	1:500



Title: FIGURE 6. POST-DEVELOPMENT 1% AEP FLOOD DEPTH AND LEVEL PLAN

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

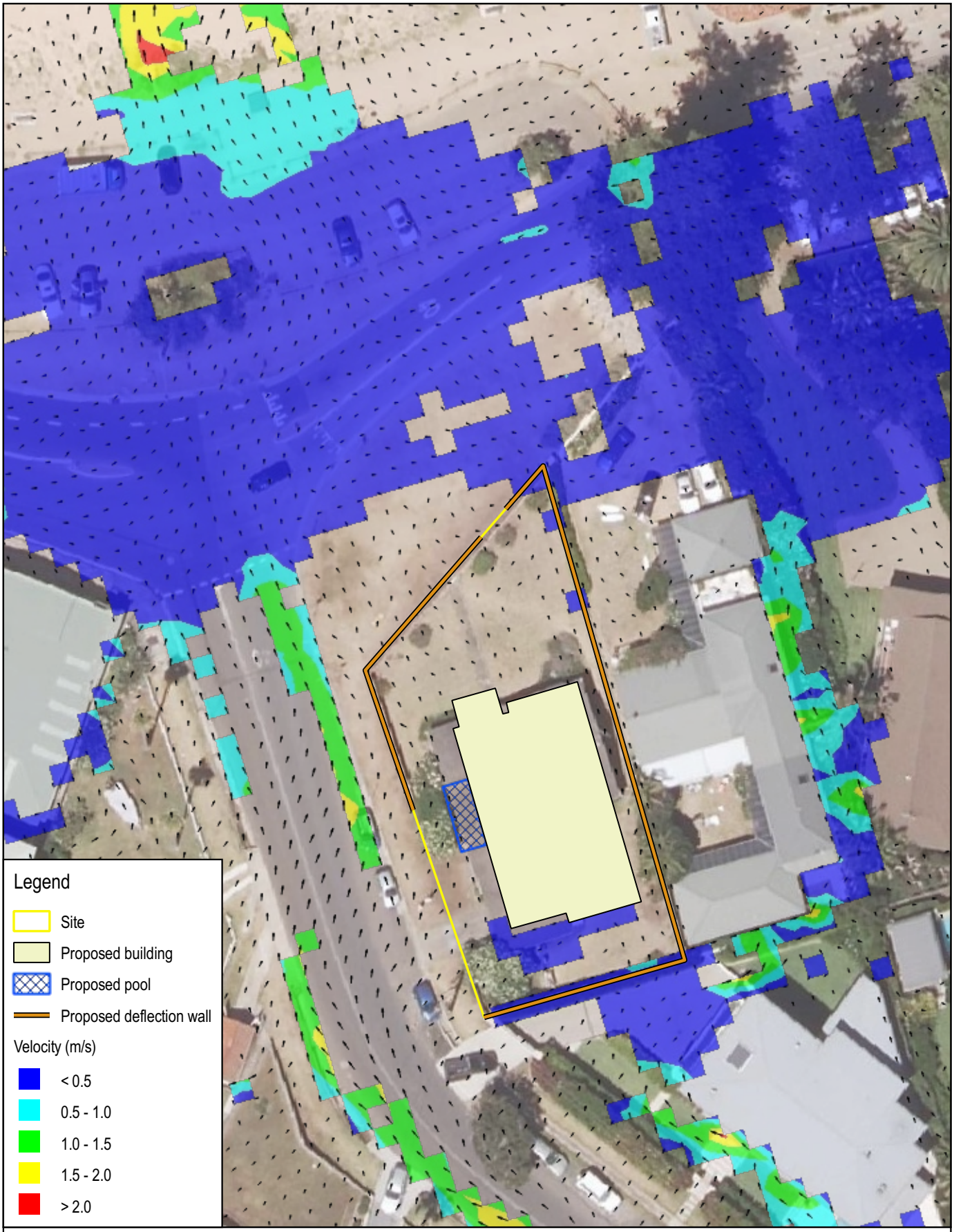
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F6	C	20.11.2017	BK	AN	1:500



Title: FIGURE 7. POST-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN

ACOR CONSULTANTS
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

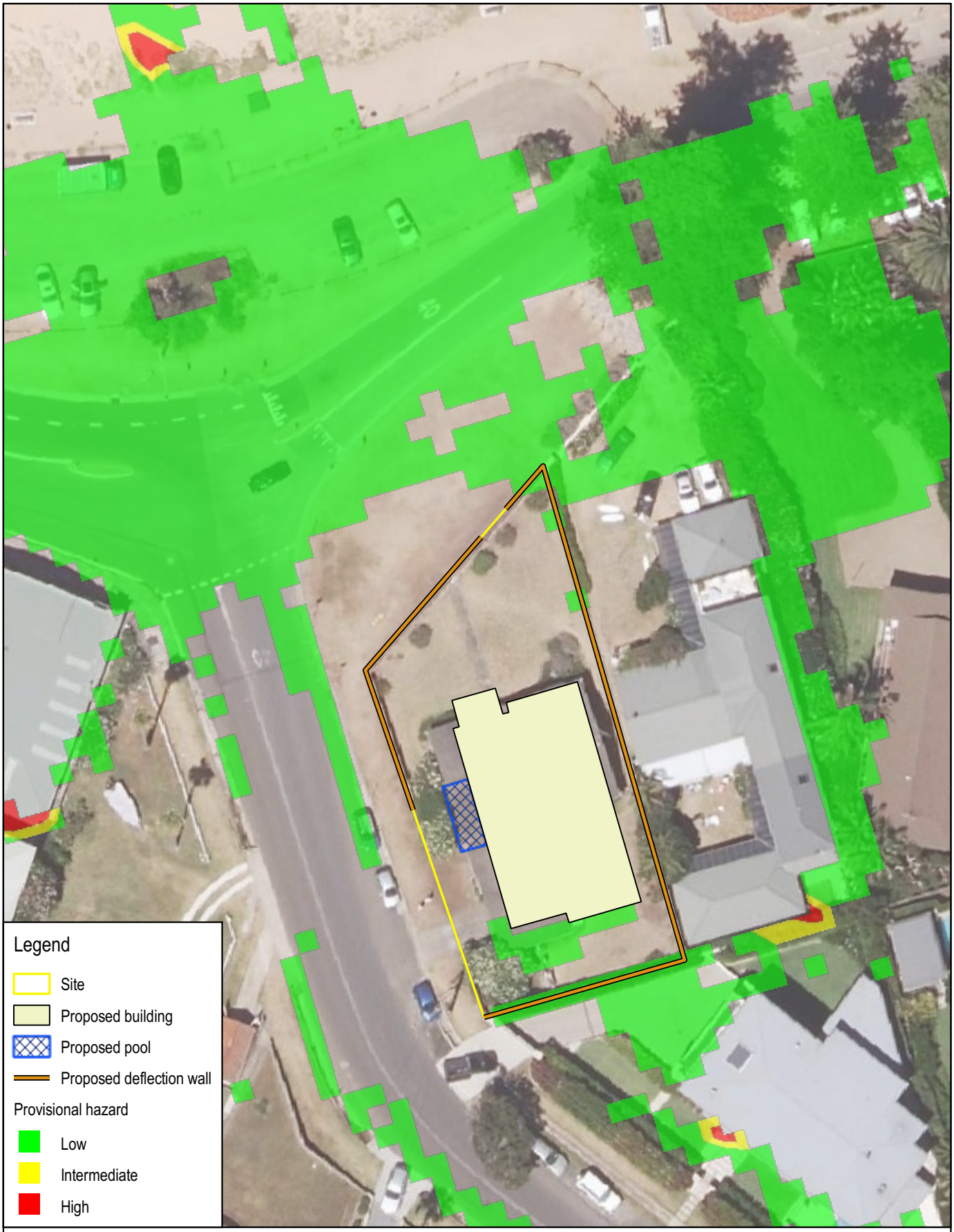
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F7	C	20.11.2017	BK	AN	1:500



Title: FIGURE 8. POST-DEVELOPMENT 1% AEP FLOOD PROVISIONAL HYDRAULIC HAZARD PLAN

ACOR CONSULTANTS
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

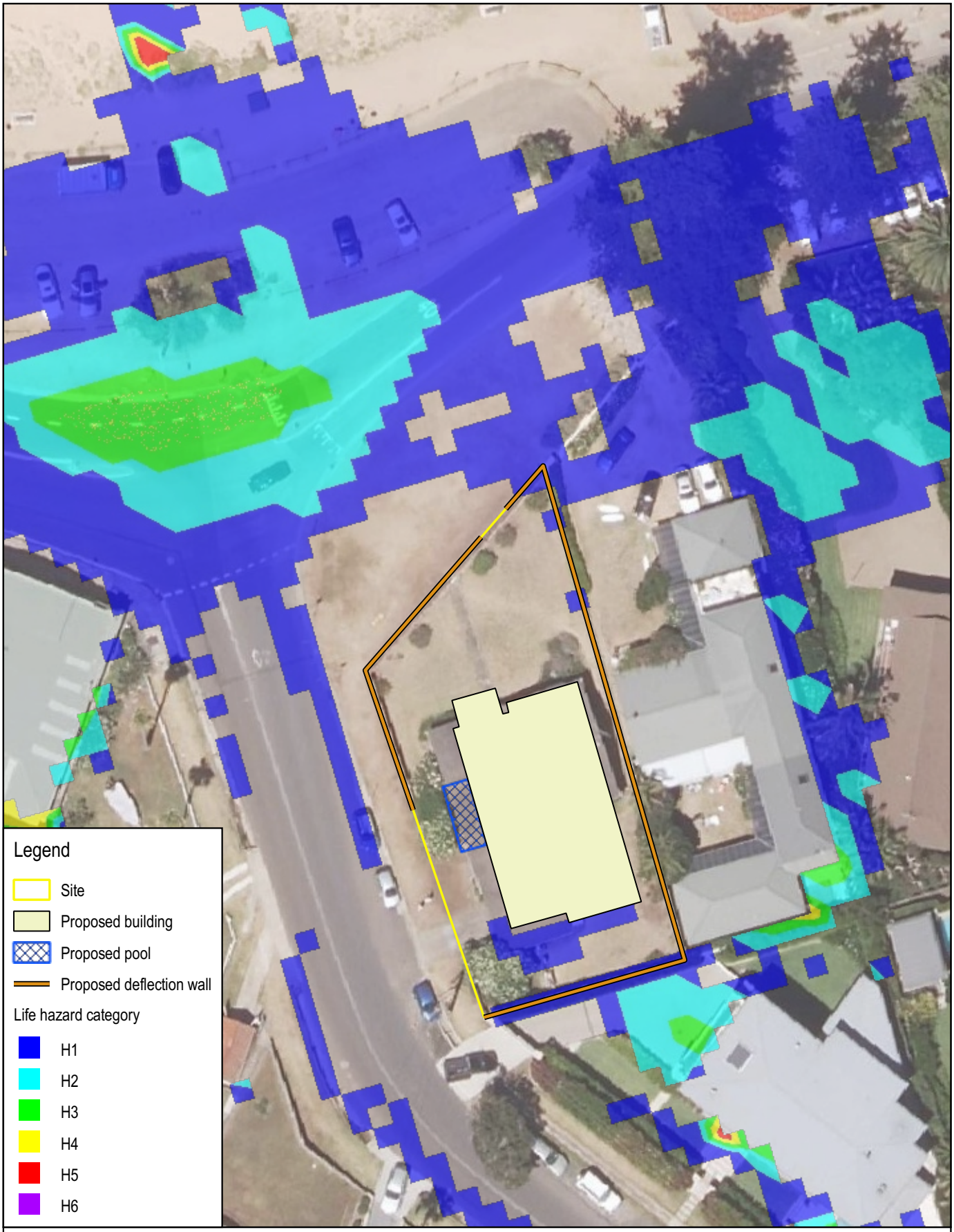
ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F8	C	20.11.2017	BK	AN	1:500



Title: FIGURE 9. POST-DEVELOPMENT 1% AEP FLOOD LIFE HAZARD PLAN

ACOR CONSULTANTS

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

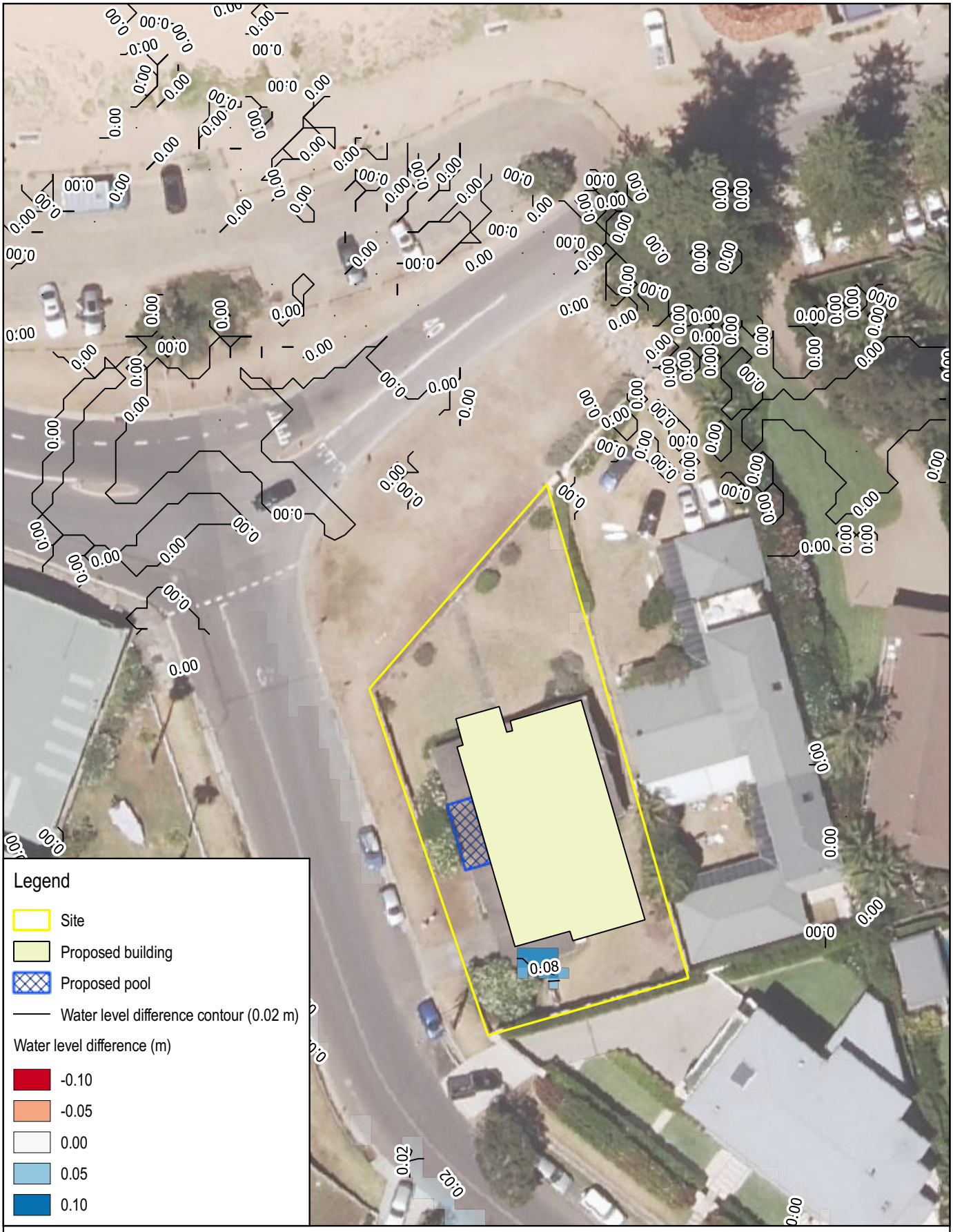
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F9	C	20.11.2017	BK	AN	1:500



Title: FIGURE 10. POST-DEVELOPMENT 1% AEP FLOOD LEVEL DIFFERENCE PLAN

ACOR CONSULTANTS
ENGINEERS | MANAGERS | INFRASTRUCTURE PLANNERS | DEVELOPMENT CONSULTANTS

ACOR Consultants (CC) Pty Ltd
Platinum Building, Suite 2.01, 4 Ilya Avenue
ERINA NSW 2250, Australia
T +61 2 4324 3499

Project: PROPOSED RESIDENTIAL DEVELOPMENT
LOT A DP 405897 (No. 17)
OCEAN ROAD
PALM BEACH

Client: CROOKES

North:

Job Number:	Sheet:	Revision:	Date:	Designed:	Drawn:	Scale:
GO170545	F10	C	20.11.2017	BK	AN	1:500