HYDRACOR
CONSULTING ENGINEERS

Flood Investigation Report

For Proposed Alterations & Additions

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Project address:	**Lot 23 DP 13900 (No. 15) Playfair Road North Curl Curl**
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VERSION HISTORY

Version	Date	Purpose	Prepared By	Approved By
1.0	25.11.2024	Issue for Review	Isaac Kan	
2.0	11.12.2024	Issue for Approval	Isaac Kan	Bruce Kenny

Review Panel	
Division/Office	**Name**

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Annexures

1 Introduction

HYDRACOR Consulting Engineers Pty Ltd has been commissioned to prepare a Flood Investigation Report in accordance with the requirements of Northern Beaches Council Water Management for Development Policy; Warringah Development Control Plan Section E11 Flood Prone Land and Clause 5.21 of Warringah Local Enivornmental Plan 2011 (Warringah LEP 2011). The Flood Investigation Report 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.
- 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 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 Flood Risk Management Manual (NSW DPIE 2023) and Warringah Development Control Plan Section E11. 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 provisional hazard categories.
- 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 23 DP 13900 (No. 15) Playfair Road, North Curl Curl. The site is located on the eastern side of Playfair Road and located amongst low to medium residential development. Land use on Playfair Road consists of R2 Low Density Residential.

The site is a developed site of area 864 square metres and falls generally from Playfair Road to the rear of the property. We note a drainage depression traverses the rear of the site from north to south. Elevations on site are generally within the range RL 16.80 m AHD to RL 14.25 m AHD. Current site improvements include a single residential dwelling, garage and studio.

There is an existing Council easement on the site which contains a 675mm diameter pipe. The easement enters the subject site along the western boundary and leaves approximately hallway along the southern boundary.

The applicant proposes demolition of the existing studio and alterations and additions to the existing dwelling. The primary features of the proposed development are depicted on Architectural Plans prepared by Building Design & Technology Pty Ltd, received 6 November 2024.

1.3 Flood characteristics

The site is located within a local, heavily urbanised overland flow catchment. The local overland flow extents are depicted on TUFLOW Model Plan, reference GO160285, Sheet F1, Revision A (copy enclosed under Annexure A The subject site lies downstream of a catchment comprising 3.4 hectares. We note the 1% AEP flow arriving at Playfair Road is approximately 2.2 cumecs.

We note under existing conditions, there is an opportunity for a portion for floodwaters to overtop the kerb and enter the subject site via the neighbouring vehicular crossover on 13 Playfair Road. 1% AEP flows arriving at the north-western boundary is 1.15 cumecs. We note there is a second overland flow path where 1% AEP floodwaters enter the site through the drainage depression in the east of the site. The 1% AEP flow conveyed by this flow path in the vicinity of the northern boundary of the subject site is 1.0 cumecs.

We note the business development centre fronting the northern side of Pitt Road has been modelled as fully blocked with a 1.5 metre overland flow path provided between 140 and 142 Pitt Road. This causes backwater effects affecting the properties of 13 to 19 Playfair Road.

The total 1% AEP flowrate impacting the subject site is 2.15 cumecs. We refer to plan reference GO160285, Sheet F2, Revision A (copy enclosed under Annexure A) which identifies the extent of flood inundation.

2 Available Data

This flood study used topographic and flood related 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

Overland flow behaviour occurring near the site is the subject of ‘Greendale Creek Flood Study’ prepared by WMA Water, project No. 118094, Revision 4 dated July 2023 (WMA Water 2023).

We have reviewed flood mapping prepared in Council’s flood study and confirm that our flood model results are within acceptable tolerances and produce similar results to Council’s Greendale Creek Flood Study. The primary differences in our hydraulic modelling results compared to Council’s study occur due to the use of current aerial survey and blockage choke of the business development centre fronting the northern side of Pitt Road which has been incorporated into our model.

Based on the foregoing, it is our view that the HYDRACOR flood study which forms the basis of this report is consistent with Council’s flood study and is deemed fit for purpose.

2.2 Survey data

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

- 1 m gridded DEM derived from LIDAR data provided by NSW Spatial Services.
- GIS layers of cadastre and satellite imagery provided by NSW Spatial Services
- High resolution aerial imagery provided by NearMap.

3 Hydrologic Modelling

This section describes the adopted hydrologic modelling approach and hydrologic model development.

3.1 Hydrologic modelling approach

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, 100% blockage of Council's drainage system was assumed for all hydraulic simulations.

3.2 Design storm event data

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

The IFD data provides design rainfall burst depths of design storm events for recurrence intervals up to and including the 1% AEP event. Due to the small size of the study area, uniform spatial distribution of rainfall was assumed, and the aerial reduction factor was set to 1. Rainfall depths and temporal patterns were developed for the 1% AEP storm event using techniques described in ARR 2019.

In accordance with the guidance provided in ARR 2019, pre-burst rainfall was applied to the catchment. A uniform pre-burst temporal pattern was adopted, with pre-burst rainfall occurring for 30 minutes prior to the storm burst. The pre-burst rainfall depth for durations less than 1 hour was calculated using the 1 hour duration pre-burst ratio.

Design storm rainfall pre-burst, burst and total storm depths for the full range of storm events considered are presented in Table 1.

Table 1: Design 1% AEP storm rainfall depths

	1% AEP		
Duration	Pre-burst	Burst	Total
5 min	6.2	21.8	28.0
10 min	10.2	36.0	46.2
15 min	12.8	45.3	58.1
20 min	14.7	51.9	66.6
25 min	16.1	56.9	73.0
30 min	17.2	60.8	78.0
45 min	19.6	69.5	89.1
1 hour	21.4	75.7	97.1
1.5 hour	21.0	85.1	106.1
2 hour	22.0	92.8	114.8
3 hour	23.7	106	129.7
4.5 hour	24.7	124	148.7

3.3 Design rainfall losses

Design rainfall 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 loss rates adopted in Ball et al. (2019), the ARR Datahub and advice provided in NSW OEH (2019). Design rainfall loss parameters are provided in Table 2.

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 rainfall loss parameters during modelling.

Table 2: Loss model parameters.

Land use	Initial loss (mm)	Continuing loss (mm/hr)
Road	0	0
Residential (including building)	11.2	0.8
Heavy Vegetation	28	0.8

3.4 Critical duration

In accordance with the procedure described in Australian Rainfall and Runoff, an ensemble of 10 temporal patterns was run through the hydrologic model for storm durations 10 minute to 4.5 hours for the 1% AEP storm event. The median water profile was determined for each duration.

A maximum water level profile was determined for the hydrologic model domain. The maximum profile was determined from the pool of median water level profiles and the 5 minute duration water level profile. The duration resulting in the highest median water level at a given point in the hydrologic model domain was taken to be the critical duration storm event for that location.

Based on the foregoing, the 15 minute duration 1% AEP storm event was found to be the critical duration for flows in the vicinity of the site.

4 Hydraulic Modelling

A TUFLOW 1D/2D 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 2D model was chosen to model the catchment hydraulics.

4.2 TUFLOW 1D model domain

Council's piped drainage system was modelled as fully blocked in this study. In this regard, there is no 1D model domain within the TUFLOW model adopted for this report.

4.3 TUFLOW 2D model domain

The 2D hydraulic model domain covers the area indicated as '2D Model Domain' in TUFLOW Model Plan (refer GO160285/F1/A, copy enclosed under Annexure A). A square grid was utilised for this study, with a grid size of 0.5 m. Each grid element contains information on ground topography (see Section 4.3.1), surface resistance to flow (see Section 4.3.3) and initial water level.

The grid cell size of 0.5 m 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 0.5 m square cell size results in surface elevations being sampled every 0.25 m.

Quadtree mesh refinement allows for recursive division of square TUFLOW cells into four smaller squares. This provides the ability to increase the grid resolution of the model in urban areas, complex and critical flowpaths, while elsewhere a larger grid cell size can be applied. A quadtree mesh was then used to transition to a 1 m cell size in the road and 2 m cell size for the rest of the floodplain that is mainly composed of urban developments.

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.

4.3.2 Building footprint

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 4.3.3).

To appropriately manage 1% AEP flood impacts resulting from the proposed development, elements of the building should be constructed as a suspended structure comprising an open subfloor area. These elements were modelled as a partial obstruction using a 'cell width factor' of 0.8 which limits the flow of water to 80% (20% blockage). The 20% blockage represents the overland flow obstruction resulting from structural elements within the subfloor.

4.3.3 Hydraulic roughness

Hydraulic roughness in TUFLOW is modelled using the Manning's 'n' roughness co-efficient. Land use categories were assigned to areas of the catchment based on examination of aerial photography and satellite imagery and used to assign hydraulic roughness parameters. Table 3 lists the adopted Manning's n values for each land use.

Table 3: Adopted roughness parameters.

Land use	Manning's n
Residential	0.08

Road	0.02
Heavy Vegetation	0.15

4.4 Boundary conditions

This section describes the boundary conditions imposed upon the hydraulic 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 boundary

A direct rainfall boundary condition was applied to the area indicated as '2D Model Domain' in TUFLOW Model Plan (refer GO160285/F1/A, copy enclosed under Annexure A). The direct rainfall method is described in Section 3.

4.4.2 Stage-discharge 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 water surface slope.

5 Flood Model Results

This section summarises the results of the hydrologic and hydraulic modelling of 1% AEP flows within the catchment. The peak flowrate through the site is presented and the behaviour of overland flows within the vicinity of the subject site are described in general terms.

5.1 Design flowrates

The peak 1% AEP flowrate arriving at the northern boundary of the subject site is approximately 2.15 m^3/s which occurs 43 minutes after commencement of rainfall.

5.2 Design flood characteristics

The water level, depth, velocity and hazard of the 1% AEP overland floodwaters in the vicinity of the subject site were mapped for both pre- and post-development scenarios. The following maps are enclosed under Annexure A :

- Pre-development 1% AEP flood depth and level plan (refer GO160285/F2/A)
- Pre-development 1% AEP flood velocity plan (refer GO160285/F3/A)
- Pre-development 1% AEP provisional flood hazard plan (refer GO160285/F4/A)
- Pre-development 1% AEP flood hazard vulnerability classification plan (refer GO160285/F5/A)
- Post-development 1% AEP flood depth and level plan (refer GO160285/F6/A)
- Post-development 1% AEP flood velocity plan (refer GO160285/F7/A)
- Post-development 1% AEP provisional flood hazard plan (refer GO160285/F8/A)
- Post-development 1% AEP flood hazard vulnerability classification plan (refer GO160285/F9/A)

5.2.1 1% AEP Storm Event – Existing Conditions

Under existing conditions, the 1% AEP floodwaters impact the subject site at elevations RL 17.00 m AHD to RL 15.50 m AHD, partially inundating the site to depths up to 0.70 m and generally less than 0.50 m. The drainage depression to the rear of the site is inundated to depths up to 0.70 m and is governed by the backwater effects due to the choke blockage of the business development centre found in Pitt Road. 1% AEP floodwater velocities are high along the northern and southern side setbacks of the subject site, locally exceeding 1.8 m/s and 1.4 m/s respectively. Velocities are generally less 0.8 m/s elsewhere within the subject site.

1% AEP floodwaters within the subject site are generally low (H1-H2). We note the presence medium – high hazard (H3 – H4) within the drainage depression which corresponds to the higher depths and also along the side setbacks which corresponds with high velocities.

5.2.2 1% AEP Storm Event – Developed Conditions

Under proposed conditions, the 1% AEP floodwaters impact the subject site at elevations RL 17.00 m AHD to RL 15.50 m AHD, partially inundating the site to depths up to 0.90 m and generally less than 0.50 m. The drainage depression to the rear of the site is inundated to depths up to 0.70 m and is governed by the backwater effects due to the choke blockage of the business development centre found in Pitt Road. We note 1% AEP floodwater velocities are high along the northern and southern side setbacks of the subject site, locally exceeding 1.8 m/s and 1.4 m/s respectively. Velocities are generally less 0.8 m/s elsewhere within the subject site.

1% AEP floodwaters within the subject site are generally low (H1-H2). We note the presence medium – high hazard (H3 – H4) within the drainage depression which corresponds to the higher depths and also along the side setbacks which corresponds with high velocities.

5.3 Impact of the proposed development

The impact of the proposed development on 1% AEP floodwaters are depicted in the following map enclosed under Annexure A

- Post-development 1% AEP flood level impact plan (refer GO160285/F10/A)

The proposed development results in negligible change to existing flood behaviour surrounding the development.

5.4 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). The true hazard attributed to flood behaviour is based on provisional hazard ratings which have been 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.
- Type of development.

Provisional flood hazard has been determined using the provisional hydraulic categories described in the Appendix L of Floodplain Development Manual (NSW DIPNR 2005), refer Section 5.4.1, and the hazard vulnerability classification system described in Australian Disaster Resilience Guideline 7-3: Flood Hazard (AIDR 2017), refer Section 5.4.2.

5.4.1 NSW Floodplain Development Manual

The NSW Floodplain Development Manual assigns provisional hazard categories of low, intermediate or high to floodwaters based on the velocity and depth of flows. The relationship between depth, velocity and hazard is presented in Figure L.2 of NSW DIPNR (2005) which is reproduced in Figure 1.

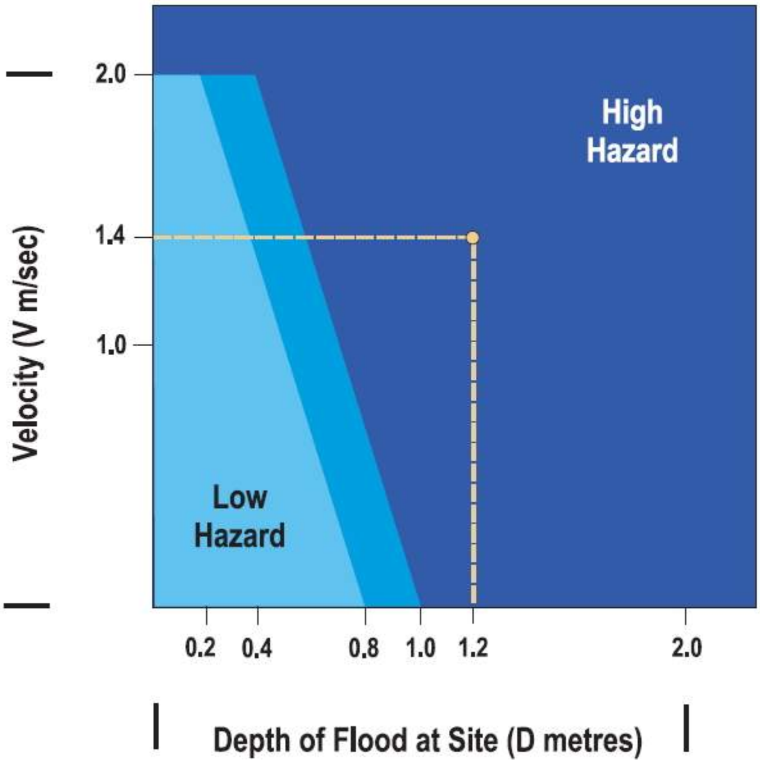

Figure 1: Provisional flood hazard (NSW DIPNR 2005).

5.4.2 AIDR Guideline 7-3

'Australian Disaster Resilience Guideline 7-3: Flood Hazard' (AIDR 2017) assigns hazard vulnerability classifications based on the depth and velocity of floodwaters, accounting for the vulnerability of the community and community assets to damage or danger when interacting with floodwaters. The relationship between depth, velocity and hazard vulnerability classification is depicted in Figure 6 of AIDR (2017), reproduced in Figure 2 and summarised in Table 4.

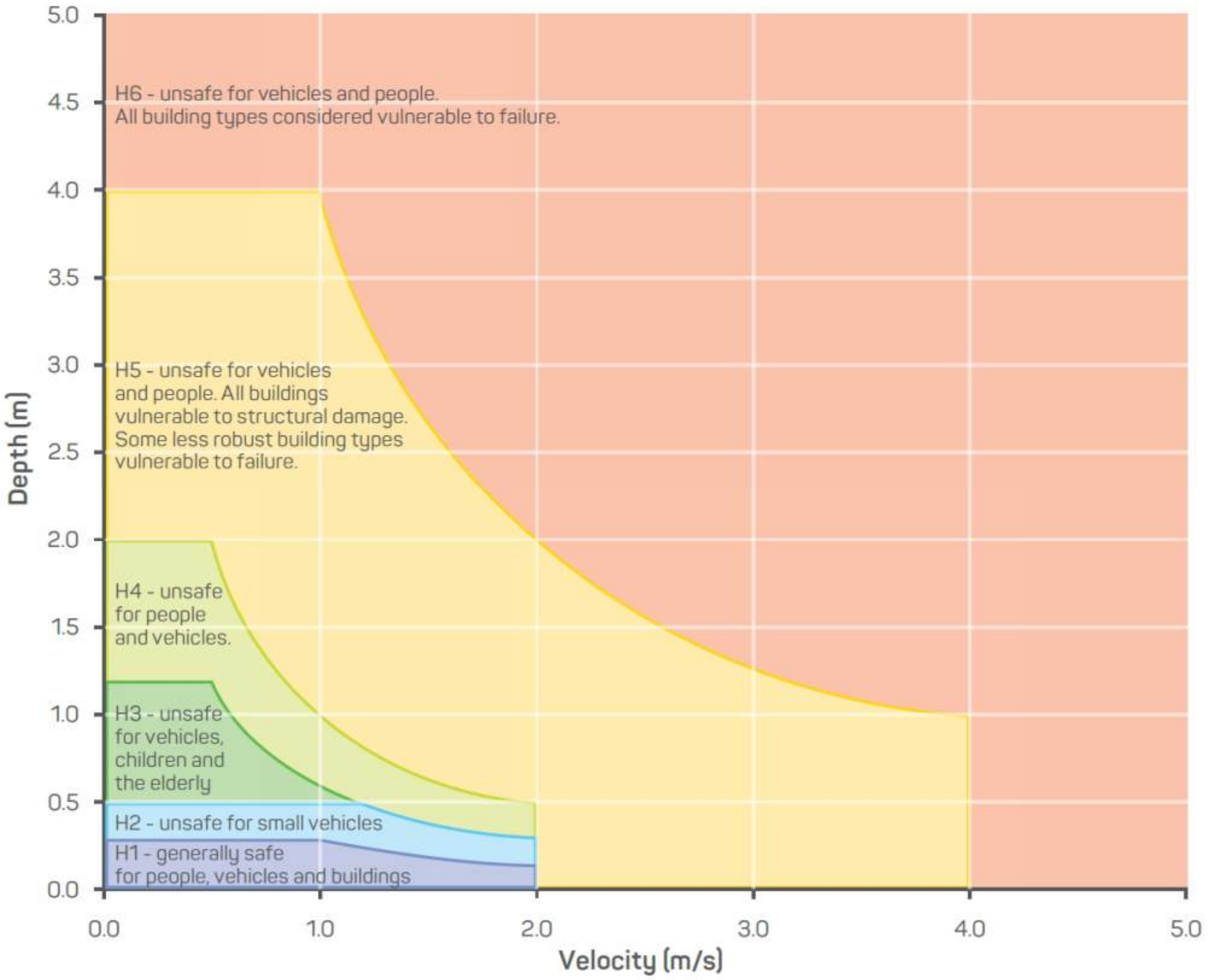

Figure 2: Hazard vulnerability classification (AIDR 2017).

Table 4: Description of hazard vulnerability classifications (AIDR 2017).

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.

6 Flood Risk Management

Based on the foregoing, we offer the following response, having due regard for the requirements of Warringah Development Control Plan Section E11 Flood Prone Land and 'Flood Risk Management Manual: the management of flood liable land' (NSW DPIE 2022b).

6.1 Land use and Northern Beaches Flood Planning Precincts

We refer to Northern Beaches Council Hazard map for the site and note the subject site is categorised as residential use and is located within the Low and Medium Flood Risk Precinct. We note the existing dwelling is positioned within the extent of the medium flood risk precinct hence, we have regarded this application as a Medium Flood Risk Precinct.

		Medium Flood Risk Precinct				
		Vulnerable & Critical Use	Residential Use	Business & Industrial Use	Recreational & Environmental Use	Subdivision & Civil Works
A	Flood effects caused by Development	A1 A2	A1 A2	A1 A2	A1 A2	A1 A2
B	Building Components & Structural	B1 B2 B3	B1 B2 B3	B1 B2 B3	B1 B2 B3	
C	Floor Levels	C2 C3	C1 C3 C4 C6	C1 C3 C4 C6 C7	C3	C5
D	Car Parking	D1 D2 D3 D4 D7	D1 D2 D3 D4 D5 D6	D1 D2 D3 D4 D5 D6	D1 D2 D3 D4 D5 D6	D1
E	Emergency Response	E1 E2	E1	E1	E1	E3
F	Fencing	F1	F1	F1	F1	F1
G	Storage of Goods	G1	G1	G1	G1	
H	Pools	H1	H1	H1	H1	H1

6.2 Flood effects caused by development

We refer to Section 5.3 for description of the impact of the proposed development. Based on the foregoing, the proposed development will not result in adverse impacts on adjoining properties during the 1% AEP flood event.

6.3 Floor Levels

In accordance with the requirements of Northern Beaches Council Water Management for Development Policy and Warringah Development Control Plan Section E11 Flood Prone Land, all habitable floor levels must be located above the Flood Planning Level (FPL).

The 1% AEP flood level applicable to the site varies from RL 16.85 m AHD at the upstream western face of the existing dwelling to RL 15.55 m AHD along the eastern face of the proposed alterations and additions.

Based on the foregoing, the proposed finished floor levels, and applicable Flood Planning Level for the relevant building elements in accordance with Council's Stormwater Management Policy are depicted in Table 5.

Table 5: Flood Level Compliance.

Unit/Building Element	Maximum 1% AEP flood level (m AHD)	Maximum floor level required (m AHD)	Freeboard provided to 1% AEP flood level (m)	Floor level or Protection level proposed (m AHD)
Kitchen and Dining	15.60	16.10	0.5	16.25
New Bedroom 1 & 2	16.45	16.95	0.5	17.08 (Existing floor level)
Patio	15.50	16.00	0.5	16.15
Games Room	16.00	16.50	0.5	17.08 (Existing floor level)

We note the existing bedrooms and garage remain unchanged and as such flood planning controls are not applicable. Consequently we are of the view that the proposed finished floor levels will meet the intent of the DCP.

6.4 Building components and Structural

The proposed building should be constructed from flood compatible materials to the relevant FPL noted in Table 5 for each building element. 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) and 'Construction of Buildings in Flood Hazard Areas' Standard and Information Handbook (ABCB 2012a, b); a selection of the flood compatible materials and practices described in these resources is summarised below.

Flood compatible floor and sub-floor materials include reinforced or mass concrete, masonry, steel with corrosion resistant coatings and selected types of timber. Steel sub-floor structures should be constructed from open sections where possible and have holes drilled into the bottom steel plates to allow water to drain from the frame in the event of immersion.

Suspended timber sub-floor structures constructed of Class 1 (highly durable), Class 2 (durable) or H3 treated timber are flood compatible; however engineered timber products should not be used unless certified by the manufacturer as being suitable for 96-hour immersion. Hardwood strip flooring with low shrinkage rates is recommended for a timber floor option, with the next best option being marine or exterior grade plywood. Particleboard flooring is not a flood compatible material. Adequate ventilation needs to be provided to timber floors to allow the timbers to dry after flood events to minimise long term timber damage; this may require any under floor insulation to be removable in the event of floodwaters reaching the insulation.

Ancillary structures such as steps and pergolas shall be constructed of water tolerant materials such as masonry sealed hardwood and corrosion resistant metals. Copper Chrome Arsenate (CCA) treated timber is not a flood compatible material.

Connection to mains power supply, including metering equipment should be located above the applicable FPL. All electrical wiring, switches and outlets should, where possible be located above the applicable FPL. Earth core leakage systems or safety switches are to be installed. All electrical installations below the applicable FPL, including wiring, connections and conduit, should be suitable for submergence in water or appropriately waterproofed. Conduits shall be installed so they will be self-draining in the event of flooding.

6.5 Subfloor obstruction allowances

Our modelling and flood impact assessment has considered a subfloor blockage allowance of 20%. Subsequently, any use of screening or flood louvers installed to enclose the subfloor area shall provide a minimum of 80% openings.

6.6 Car Parking

The note the existing garage will retain the same floor level at RL 15.95 m AHD.

6.7 Storage of Goods

Hazardous goods and materials which are susceptible to water damage are to be stored above RL 16.25 m AHD. We note materials which may become hazardous or potentially pollute floodwaters or which are highly susceptible to water damage are not to be stored below the FPL.

6.8 Fencing

We recommend that any new fencing constructed below RL 15.60 m AHD not specifically designed to alter flooding behaviour on the site be designed to accommodate the unimpeded passage of flood waters.

6.9 Emergency Response

The NSW SES is responsible for providing flood updates and issuing Evacuation Warnings and Evacuation Orders. Evacuation Warnings are issued when the NSW SES issues a “Watch and Act: Prepare to evacuate” warning, and provide advance notice of a possible need to evacuate and give residents time to prepare for evacuation. Evacuation Orders are issued when the NSW SES issues an “Emergency Warning: Evacuate now” or “Emergency Warning: Evacuate [before time]” warning, and notify residents that evacuation is necessary and they must leave now in order to reach safety before roads are cut. Evacuation Orders are not always preceded by an Evacuation Warning.

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, or through the NSW SES website. The timing for evacuation of persons is to be established in consultation with the NSW SES.

We note the access to and from the dwelling is impacted by H1 to H3 floodwaters with the majority of access impacted by H1 – H2 floodwaters. In this regard, the site has reliable large vehicular and pedestrian access and egress to the south of Playfair Road during the 1% AEP flood event.

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 NSW SES Emergency Evacuation operational guidelines.

7 Conclusion

Based on the foregoing, we have formed the view that the proposed development generally complies with the intent of the flood related development controls of Northern Beaches Council Water Management for Development Policy; Warringah Development Control Plan Section E11 Flood Prone Land and Clause 5.21 of Warringah Local Environmental Plan 2011 (Warringah LEP 2011) for a development of this nature.

Yours faithfully,
HYDRACOR Consulting Engineers Pty Ltd

Isaac Kan

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8 References

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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.

9 Glossary

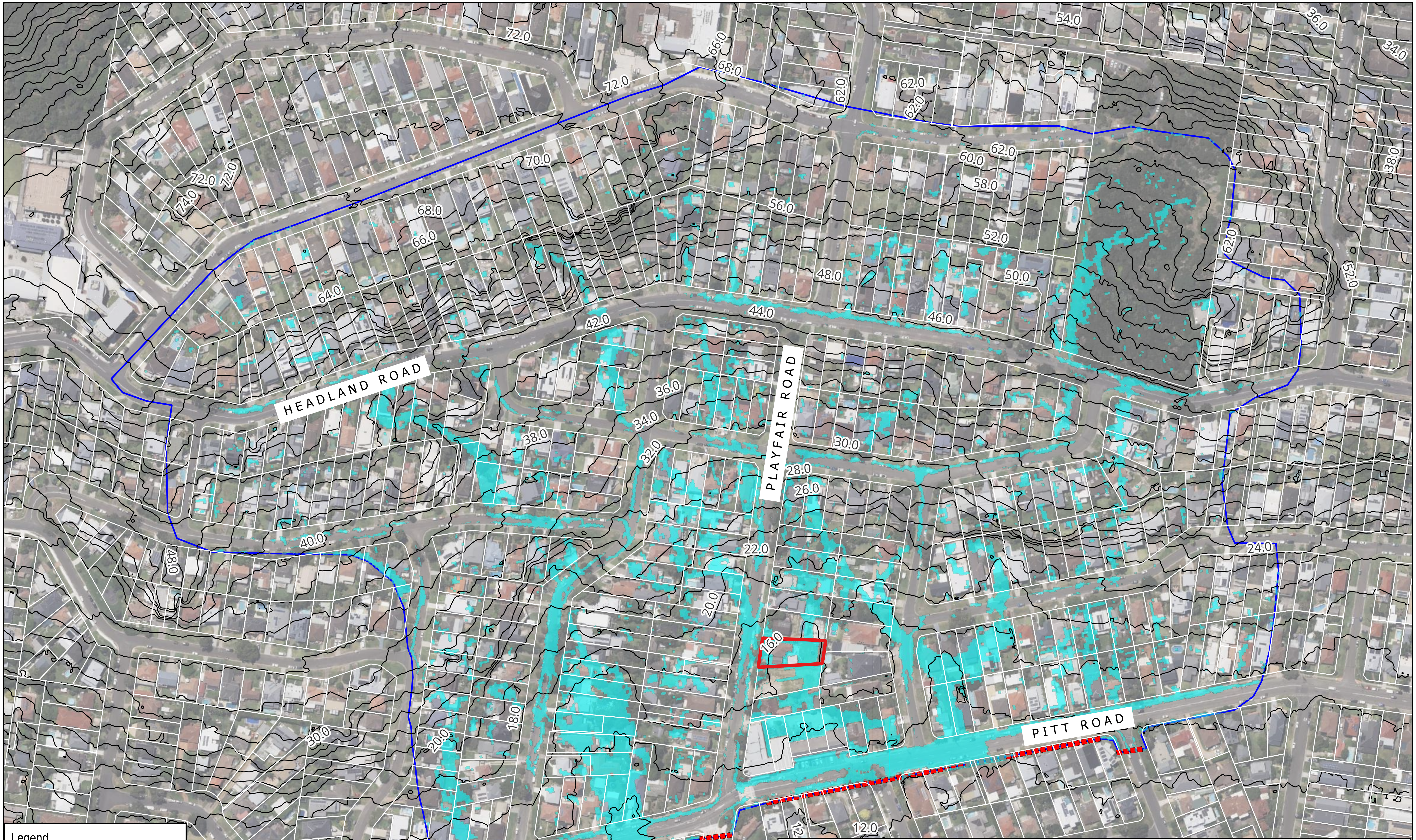
Terminology in this Glossary has been derived or adapted from the Floodplain Development Manual (NSW DIPNR 2005), where appropriate.

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.
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 HYDRACOR Consulting Engineers Pty Ltd Flood Plans, Reference GO160285F, Sheets F1 to F10, Revision A, Dated 25 November 2024



Title: TUFLOW MODEL PLAN						
HYDRACOR CONSULTING ENGINEERS	HYDRACOR CONSULTING ENGINEERS Pty Ltd Platinum Building, Suite 2.01, 4 Ilya Avenue ERINA NSW 2250, Australia T +61 2 4324 3499	Project: PROPOSED ALTERATIONS & ADDITIONS No. 15 PLAYFAIR ROAD NORTH CURL CURL Client: CHRIS BENNY				North:
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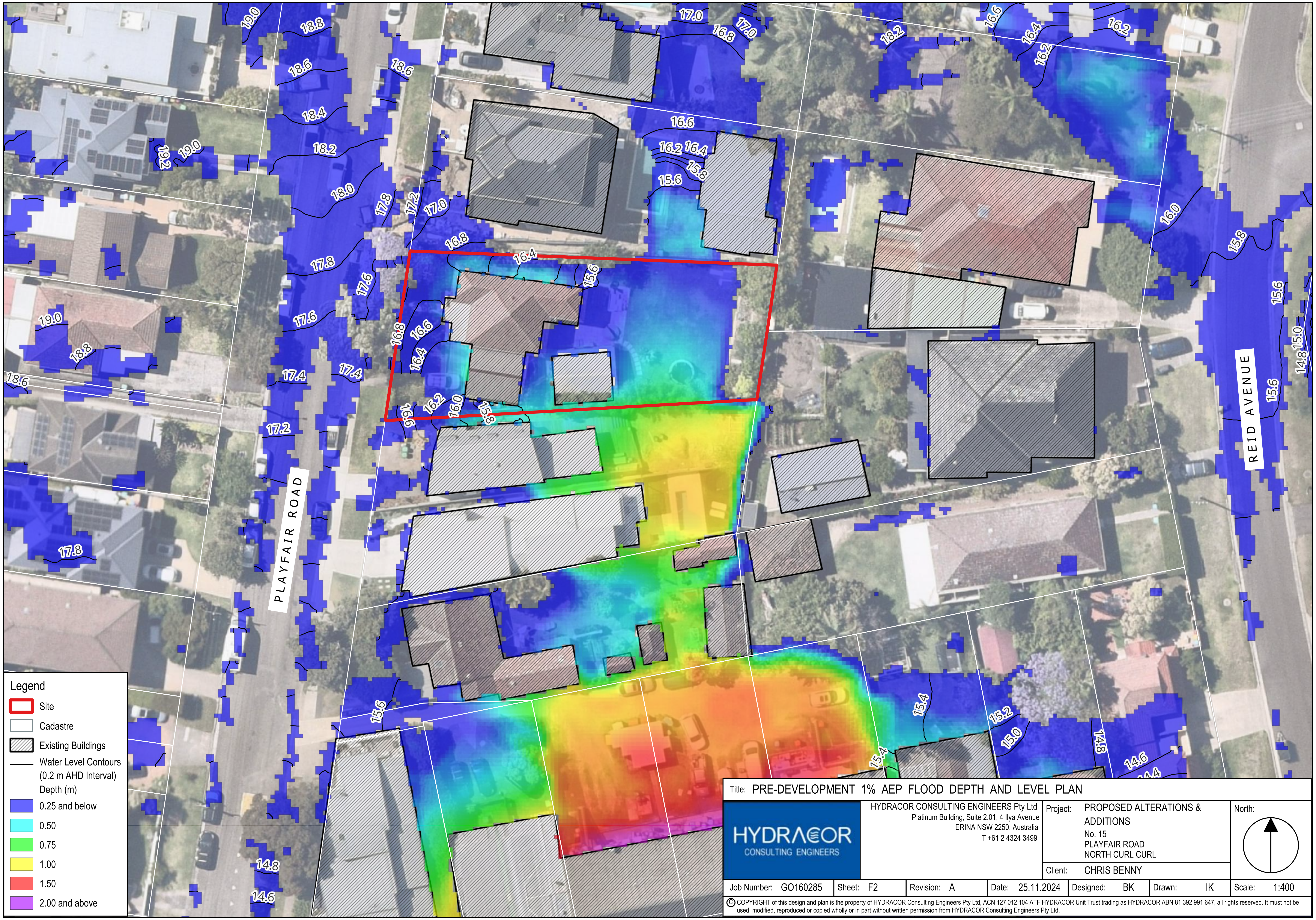

Title:	PRE-DEVELOPMENT 1% AEP FLOOD DEPTH AND LEVEL PLAN

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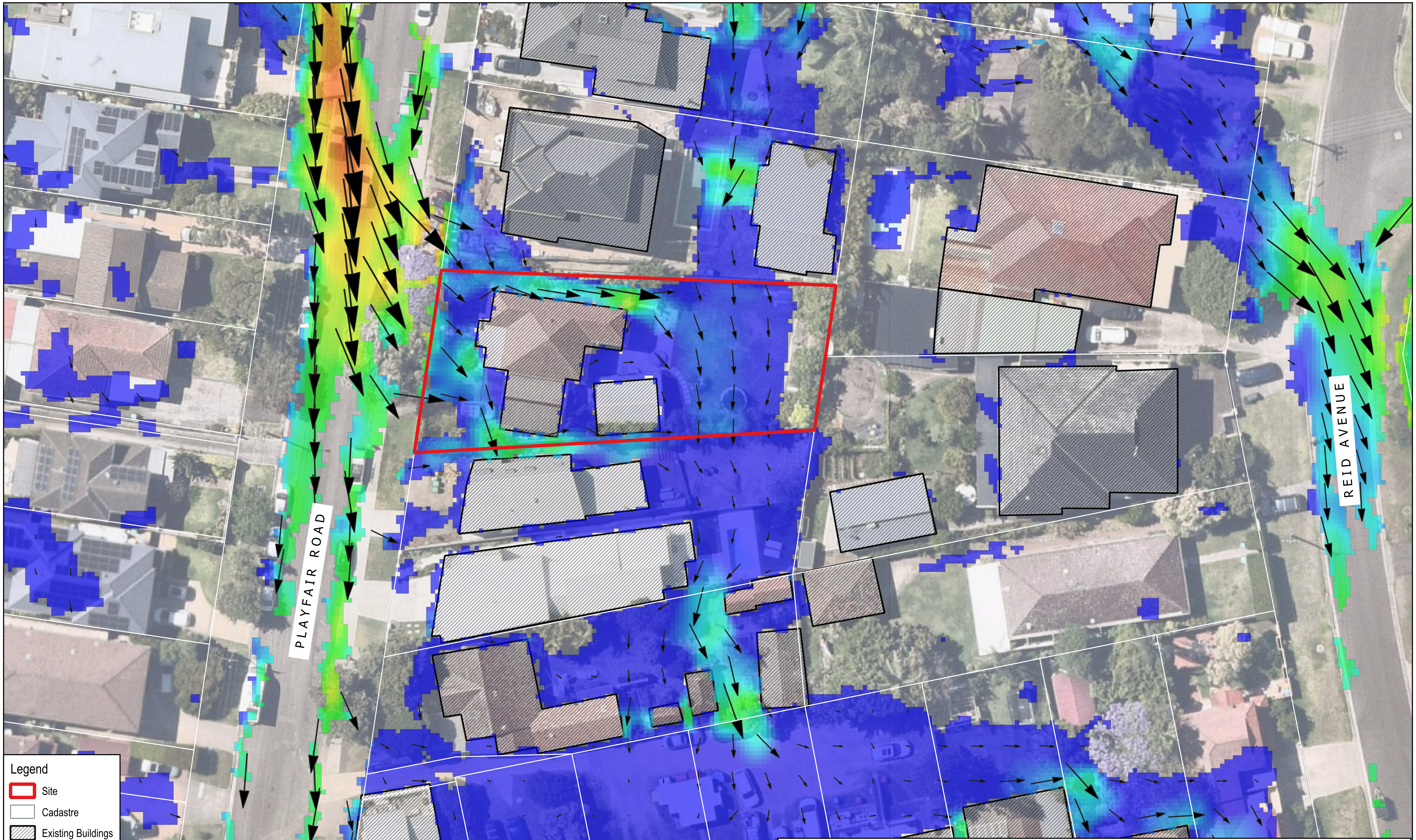

Title: PRE-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN

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North:

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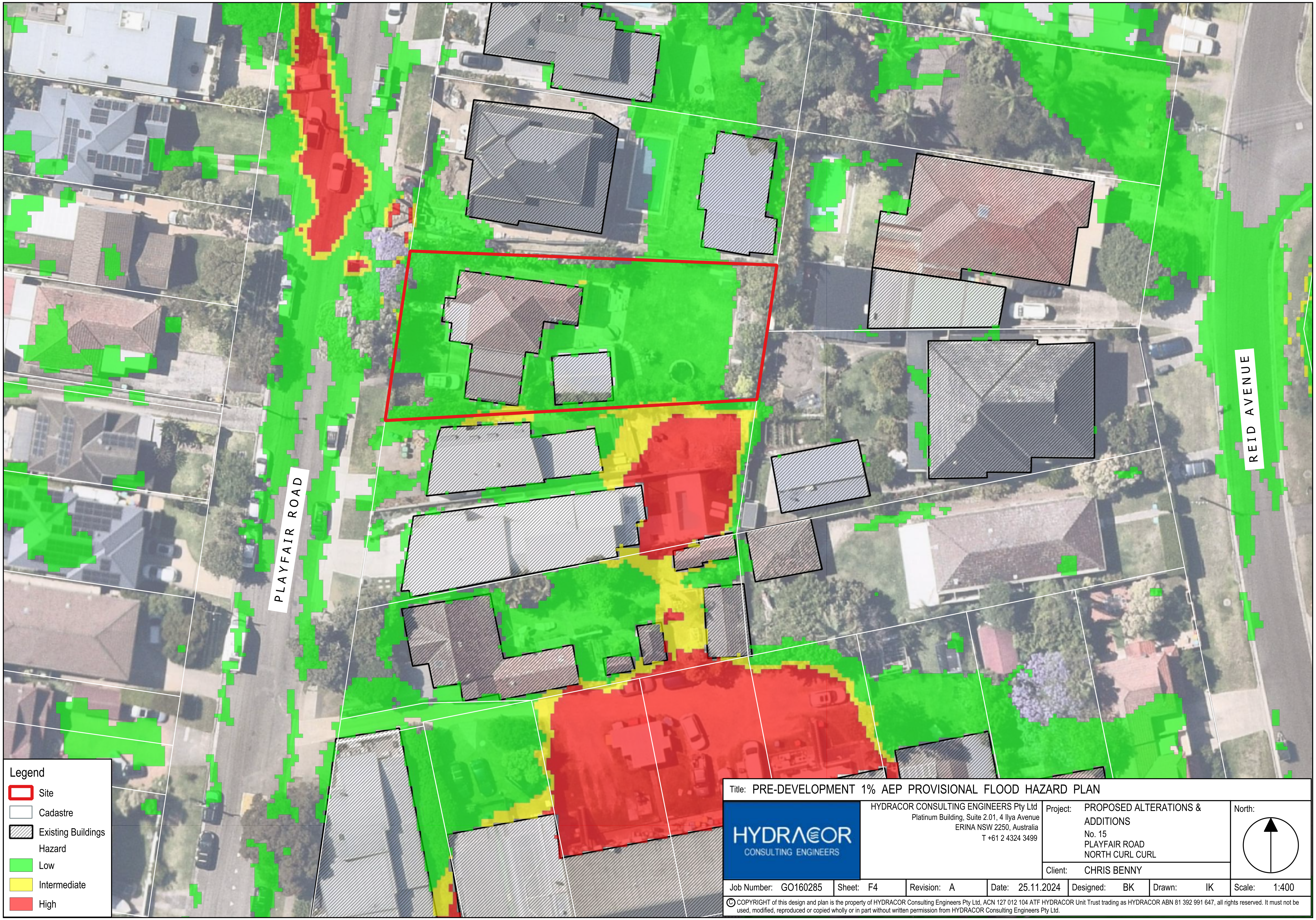

Title:	PRE-DEVELOPMENT 1% AEP PROVISIONAL FLOOD HAZARD PLAN

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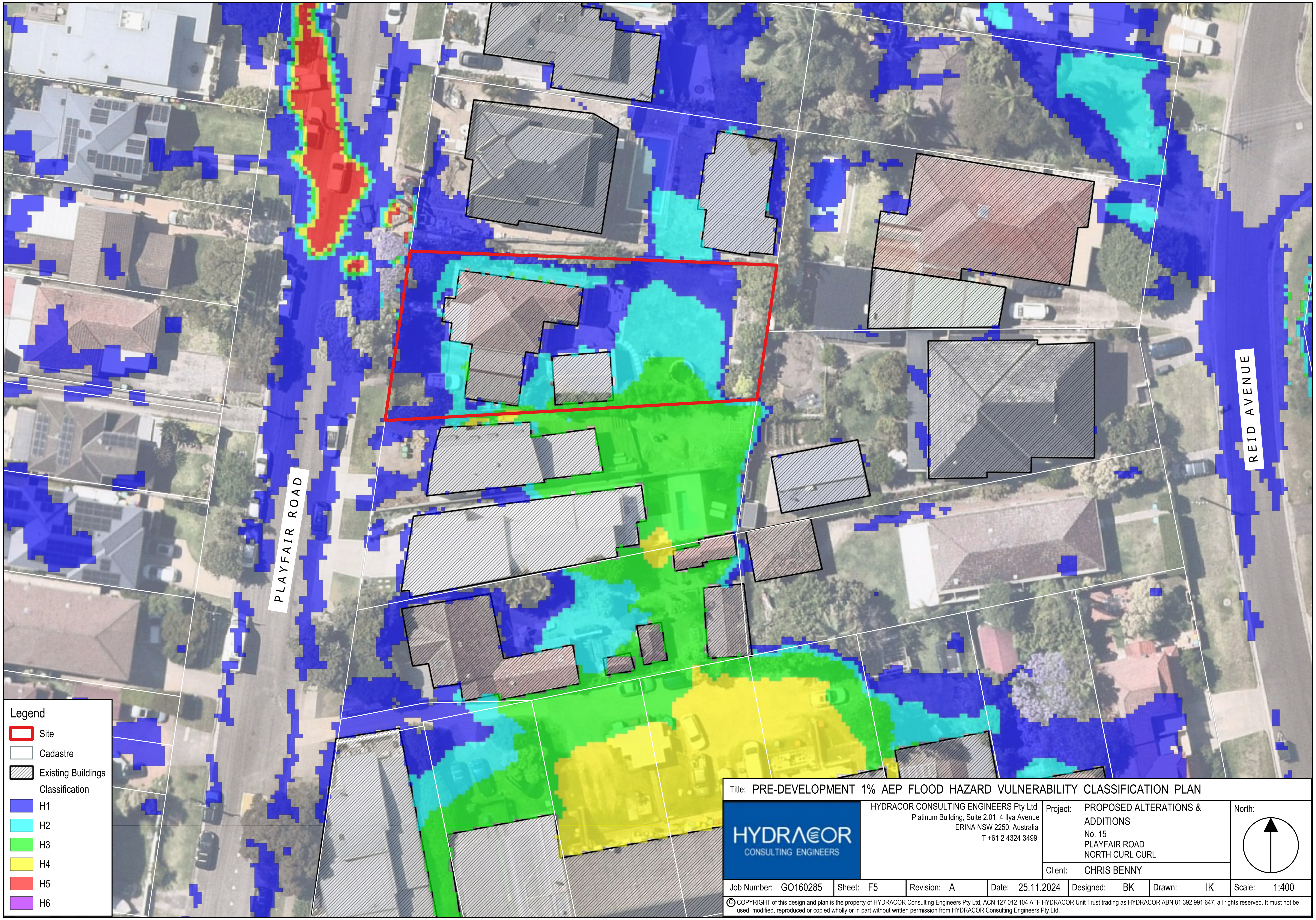

Title: PRE-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY CLASSIFICATION PLAN

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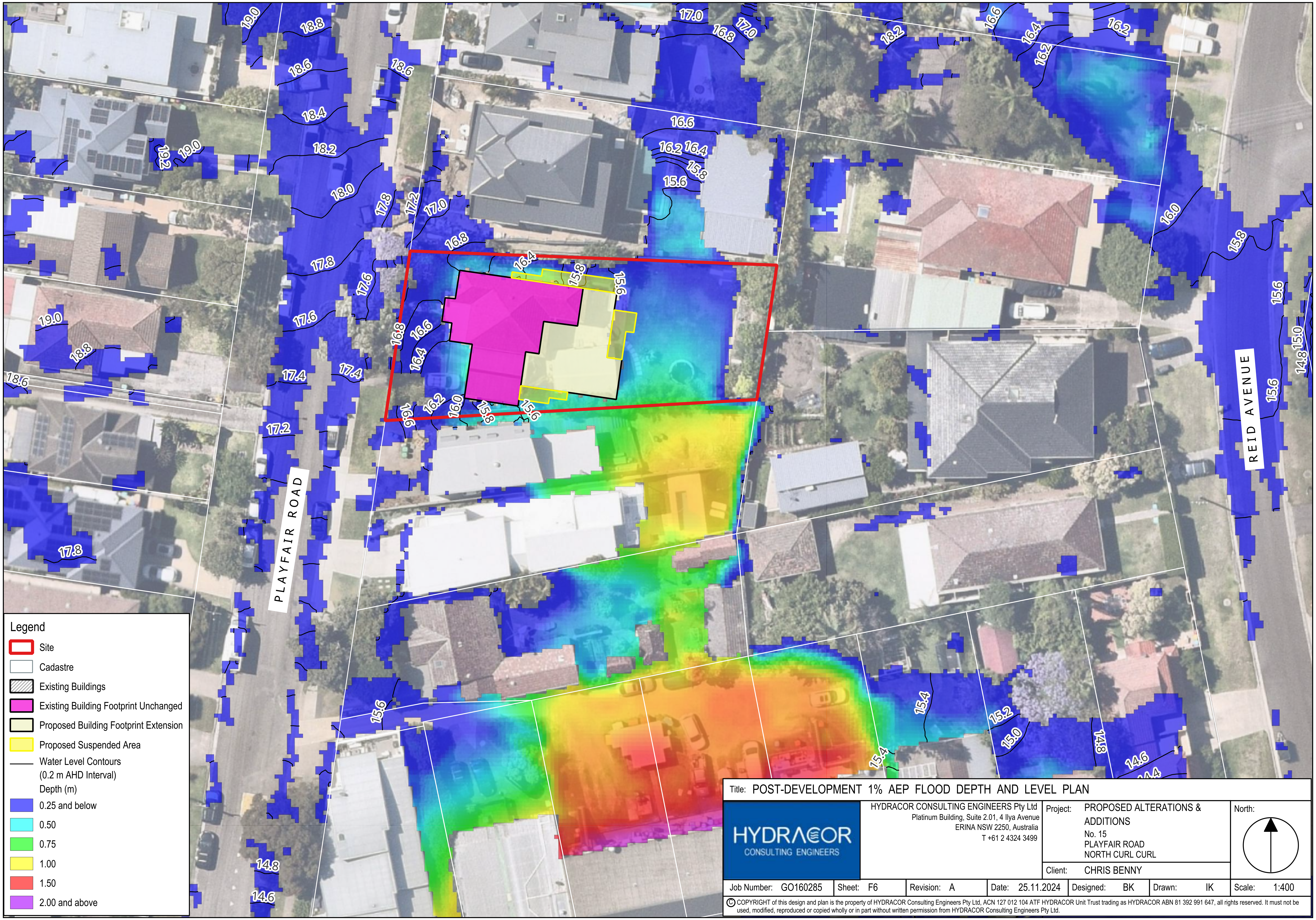

Legend

- Site
- Cadastre
- Existing Buildings
- Existing Building Footprint Unchanged
- Proposed Building Footprint Extension
- Proposed Suspended Area
- Water Level Contours (0.2 m AHD Interval)

Depth (m)

- 0.25 and below
- 0.50
- 0.75
- 1.00
- 1.50
- 2.00 and above

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

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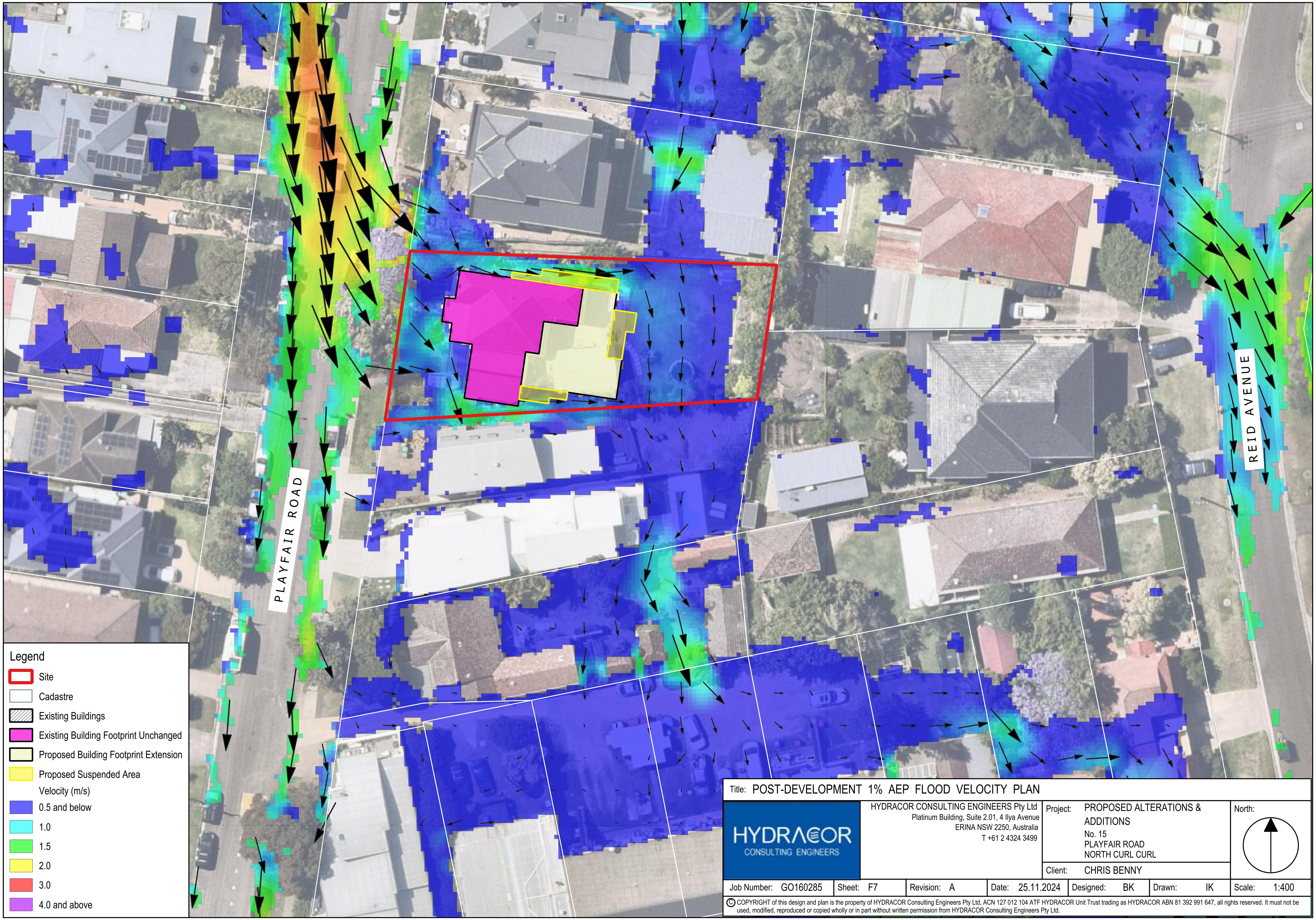

Title: POST-DEVELOPMENT 1% AEP FLOOD VELOCITY PLAN

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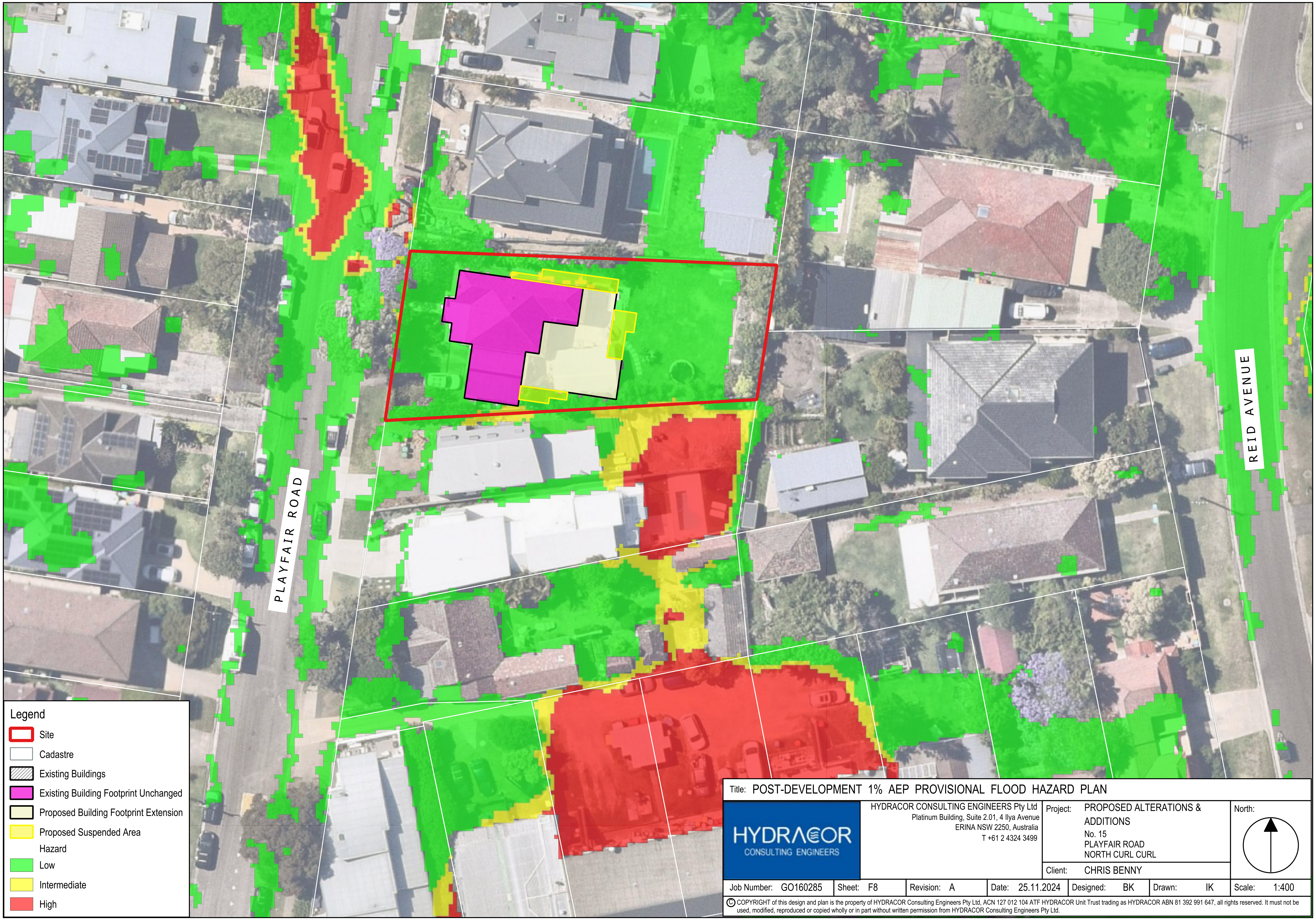

Title: POST-DEVELOPMENT 1% AEP PROVISIONAL FLOOD HAZARD PLAN

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Client: CHRIS BENNY

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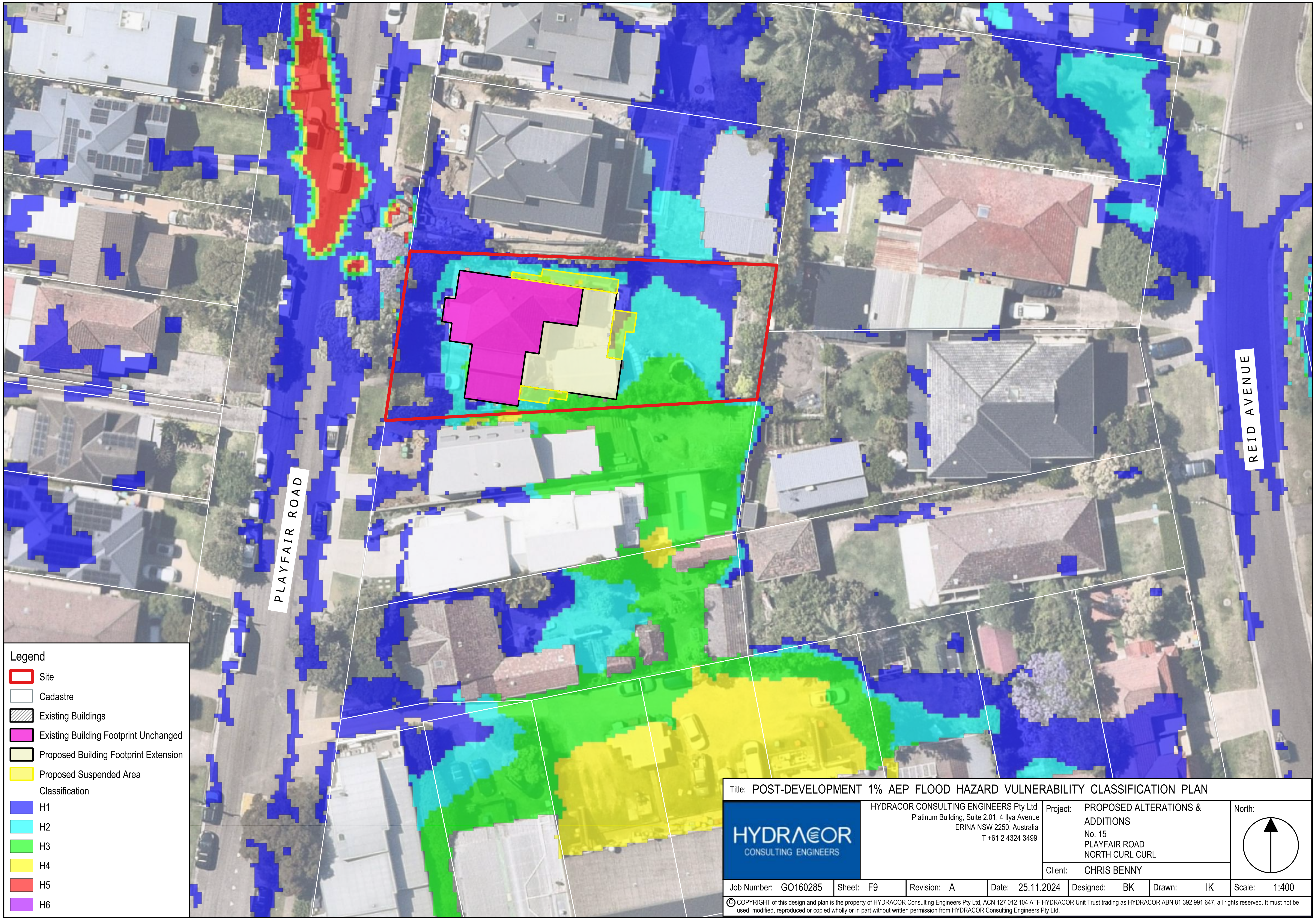

Title: POST-DEVELOPMENT 1% AEP FLOOD HAZARD VULNERABILITY CLASSIFICATION PLAN

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North:

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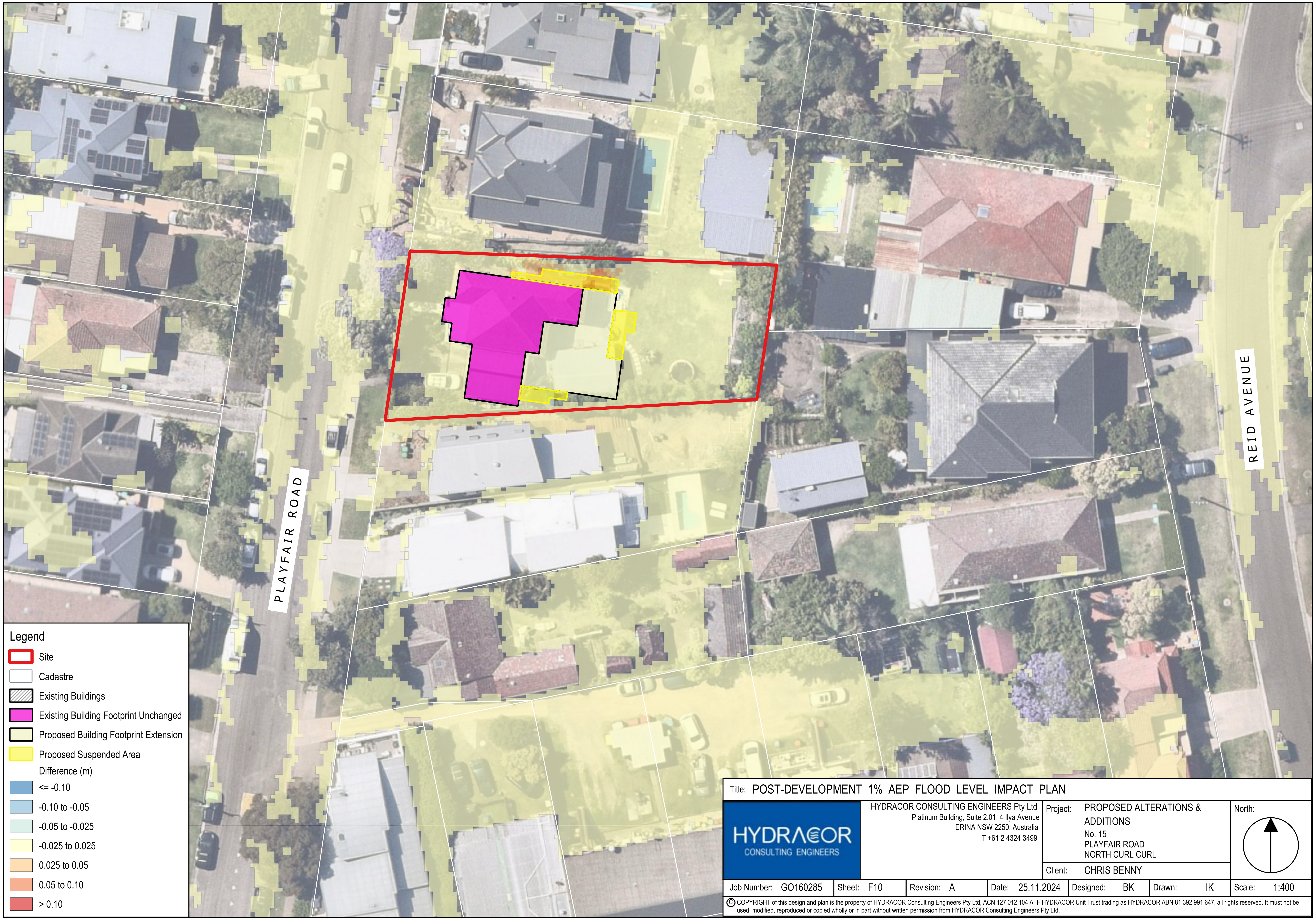

Title: POST-DEVELOPMENT 1% AEP FLOOD LEVEL IMPACT PLAN

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Job Number: GO160285	Sheet: F10	Revision: A	Date: 25.11.2024	Designed: BK	Drawn: IK	Scale: 1:400