Job Number: *210096*
Date: *1st February 2024*

GRC Hydro
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Sydney NSW 2000

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Isabella Stewart and James Georgiades
Warren Smith Consulting Engineers
Level 20, 66 Goulburn Street
SYDNEY NSW 2000

Dear Isabella and James,

Re: Development of 8 Forest Road, Warriewood– Flood Assessment

Thank you for providing GRC Hydro with the opportunity to undertake a flood assessment and flood plan for the above referenced site.

INTRODUCTION

Development is proposed for 8 Forest Road, Warriewood (the site) situated in Northern Beaches Council (Council) Local Government Area.

Modelled work reported upon herein has been carried out using a TUFLOW model built for the site by Martens in February 2017.

This letter updates the previous flood assessment for the proposed works (Date: 26/09/2022) with an open channel swale instead of a DN1500mm pipe to drain floodwater safely around the site.

PREVIOUS STUDIES

Martens has prepared a flood report to support a development application (DA) for a proposed medium density residential development at 8 Forest Road, Warriewood NSW in February 2017. Key objectives of the report include the following:

1. Develop catchment hydrology (RAFTS model) and determine critical storms for the 1 in 2 year Average Recurrence Interval (ARI), 1 in 5 year ARI, 1 in 100 year ARI (with and without climate change scenario) and Probable Maximum Flood (PMF) events.
2. Develop existing and proposed conditions site TUFLOW 1D/2D hydraulic model to determine flood extents, depths, water levels, hydraulic hazard and inundation durations.

However, only the proposed model has been provided. The existing model has been rebuilt by GRC Hydro using the following:

1. LiDAR data (Date: June 2020);
2. Bathymetry data from Martens' model;
3. Material and bridge layers from Martens' model; and
4. The hydrological results and model boundary conditions from Martens' model

The results showed minimal differences compared with the existing condition mapped by Martens.

EXISTING FLOOD BEHAVIOUR

The total catchment of the site is 81.6 hectares. Flooding occurs when heavy rainfall over the catchment accumulates in Narrabeen Creek, which then drains into Mullet Creek and Narrabeen Lagoon. Separately, runoff that occurs before it reaches the creek is categorised as overland flooding. Mainstream flooding in Narrabeen Creek does not inundate the proposed development area in all events up to and including the PMF. The site is only affected by overland flooding from upstream.

Figures 01 and 02 shows the 1% AEP existing flood depths, levels and hazards in the vicinity of the subject site. PMF flood behaviour has been mapped in Figures 03 and 04.

PROPOSED DEVELOPMENT

The proposed work includes the earthworks plan (Received from Warren Smith Consulting Engineers Feb 2024) and an additional drawing detailing the proposed swale (Received from Warren Smith Consulting Engineers Feb 2024).

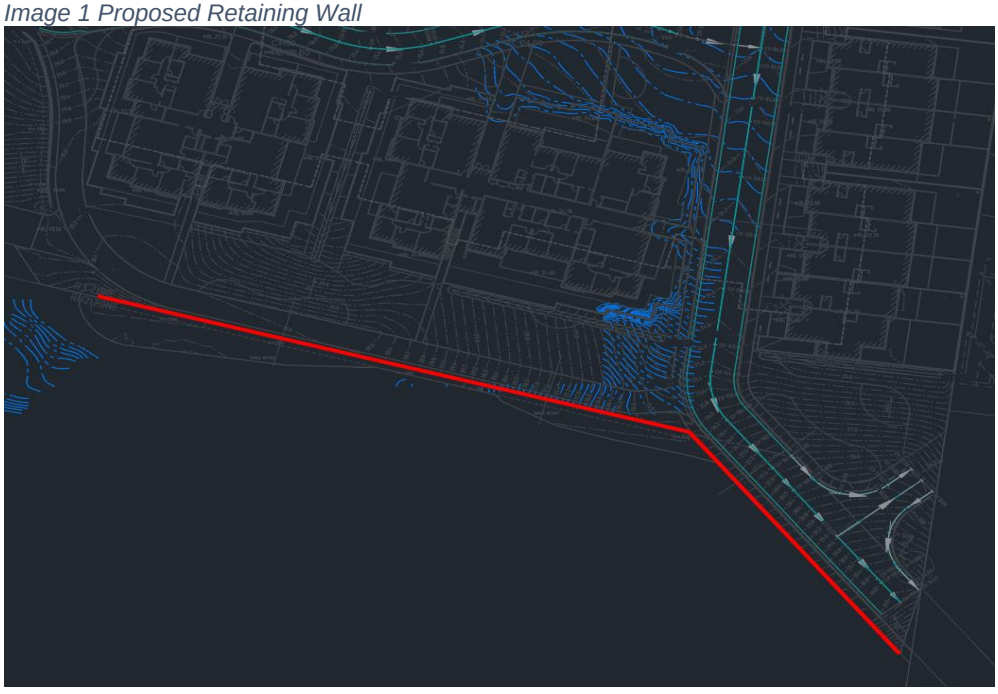
The proposed design was implemented in the TUFLOW model based on the following information:

- Proposed earthworks;
- Designed stormwater network,
- A retaining wall in the south of the lot,
- 4 metre wide weir through the retaining wall into the proposed swale,
- Proposed swale with material types, chainage and slopes.

The proposed retaining wall is located on the south of the site as shown below. By applying 0.5 m freeboard to the 1% AEP levels, the wall is proposed to be 30.80 m AHD.

The swale was tested as both a vegetated swale and a rock lined swale. Results show a minimal difference in results between the two. We can conclude the flood results are insensitive to the material types chosen for the swale.

Image 1 Proposed Retaining Wall



Figures 05 and 06 shows the 1% AEP proposed flood behaviours in the vicinity of the subject site.

FLOOD IMPACT ASSESSMENT

A flood impact assessment has been undertaken which assessed the impact of the proposed development on the 1% AEP levels, as well as reviewing impacts on Narrabeen Creek including velocity, hydrograph shape and timing.

The flood level impacts associated with the proposed development are shown in Figure 07. These impacts present the changes between the existing and proposed conditions for the 1% AEP.

The impact map shows that impacts are contained to Narrabeen Creek and Jubilee Ave, and downstream of Jubilee Ave the water levels return to a neutral state (i.e. no change in flood levels). The largest impact in Narrabeen Creek is a change from 21.26m AHD to 21.41m AHD, which is a 0.7% increase in water level. The impacts on Jubilee Ave are a +0.027m increase and do not change the trafficability of the road. Beneficial impacts are shown in Bert Cl.

These impacts are not due to any extra floodwater due to the development, as the basins manage all runoff from the site. The impacts are only due to a shift of the site outflow between existing and proposed conditions.

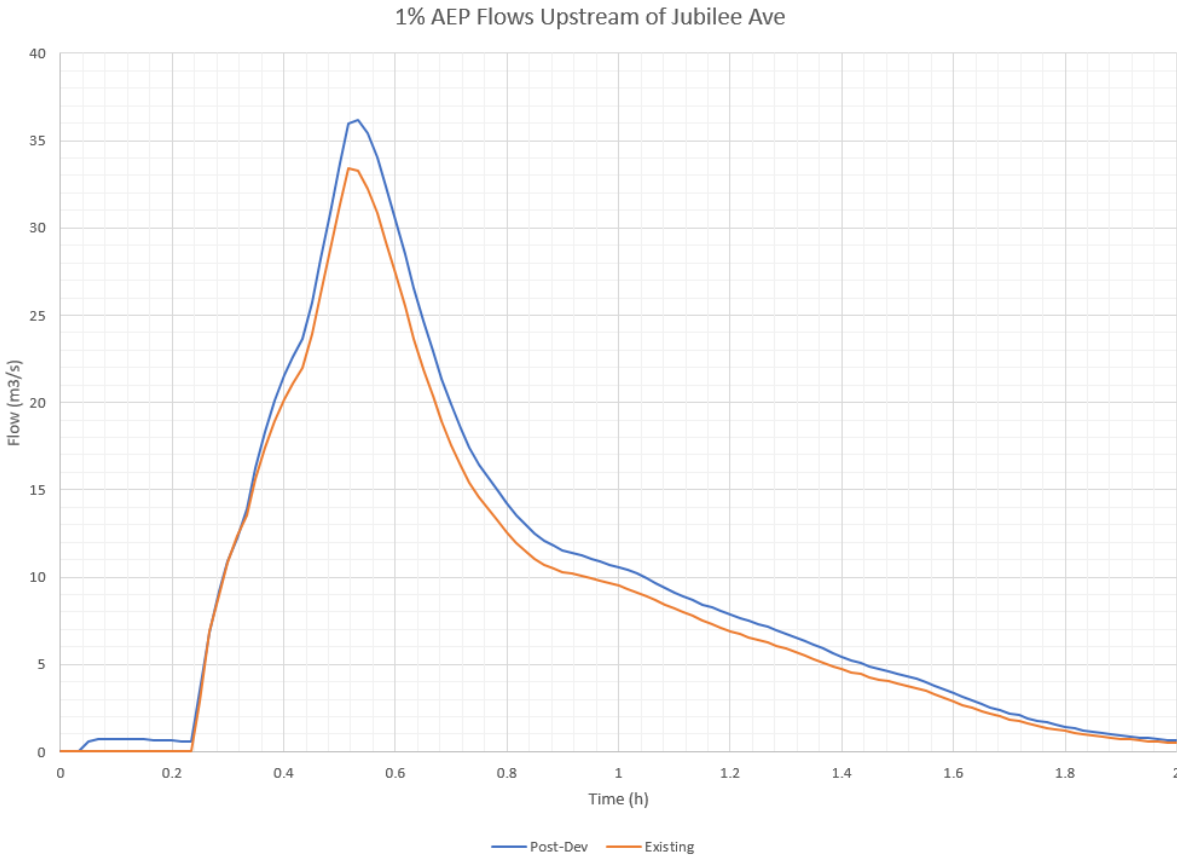
In addition to the water level impact assessment, additional potential impacts in Narrabeen Creek have been reviewed due to the importance to maintain similar flooding behaviour in main waterways for environmental purposes. Table 1 details the peak flows under existing conditions and proposed conditions for a location upstream of Jubilee Ave, and for downstream of Jubilee Ave.

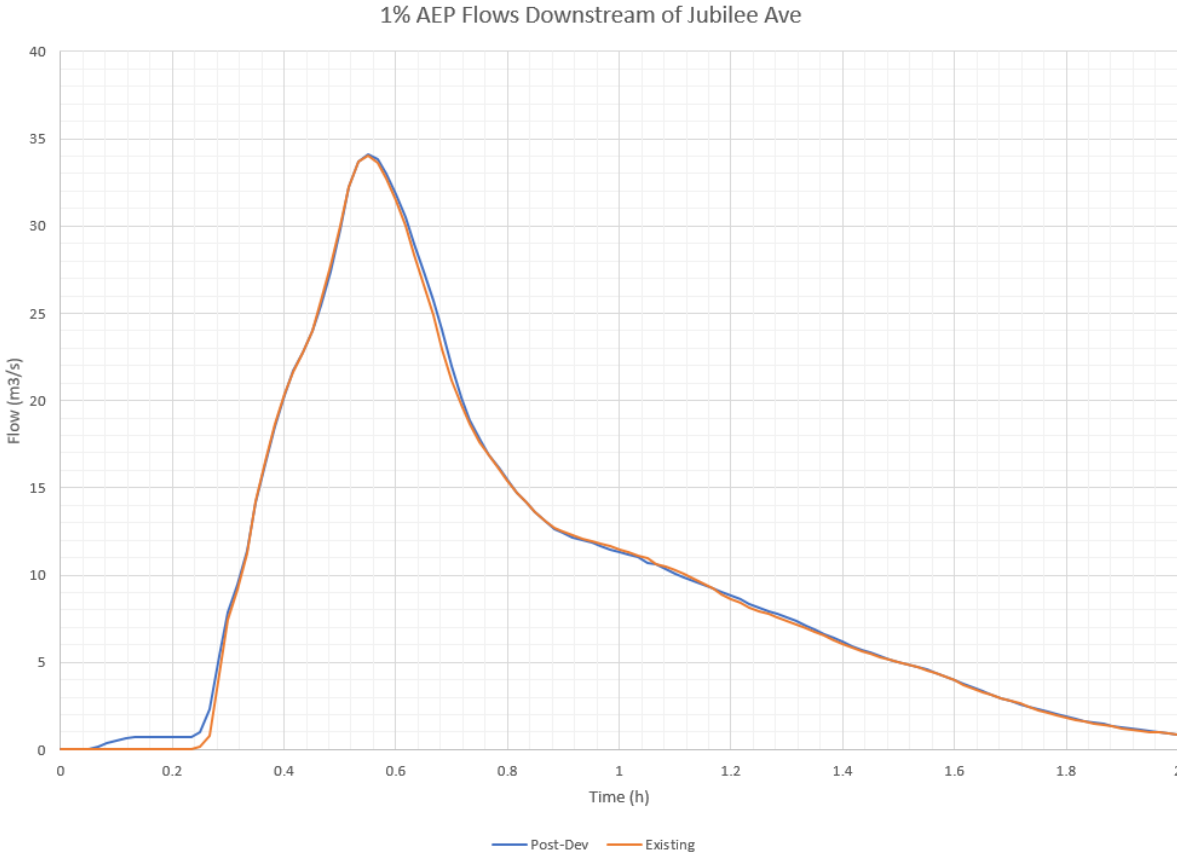
Location	Flows (m3/s)		Change from Existing Conditions	
	Existing	Post-Dev	m3/s	%
Upstream of Jubilee Ave	33.4	36.2	+2.8	+8
Downstream of Jubilee Ave	34.1	34.1	< +0.7	+1

As shown in Table 1, the change of flow is a localised impact due to the shift of the site outflow. Downstream of Jubilee Ave, flows return to close to existing conditions with the development in place. This is further supported by the hydrographs presented in Image 2. These show minimal change to the shape of the hydrograph, peak flow, and timing downstream of Jubilee Ave.

Overall, these impacts are benign as they represent a very minor relative increase in the levels and flows in Narrabeen Creek, the increases in water level do not increase the flood extent beyond the creek area, and the impacts do not propagate downstream any further than Jubilee Ave.

Image 2 1% AEP Flows in Narrabeen Creek





CONCLUSIONS

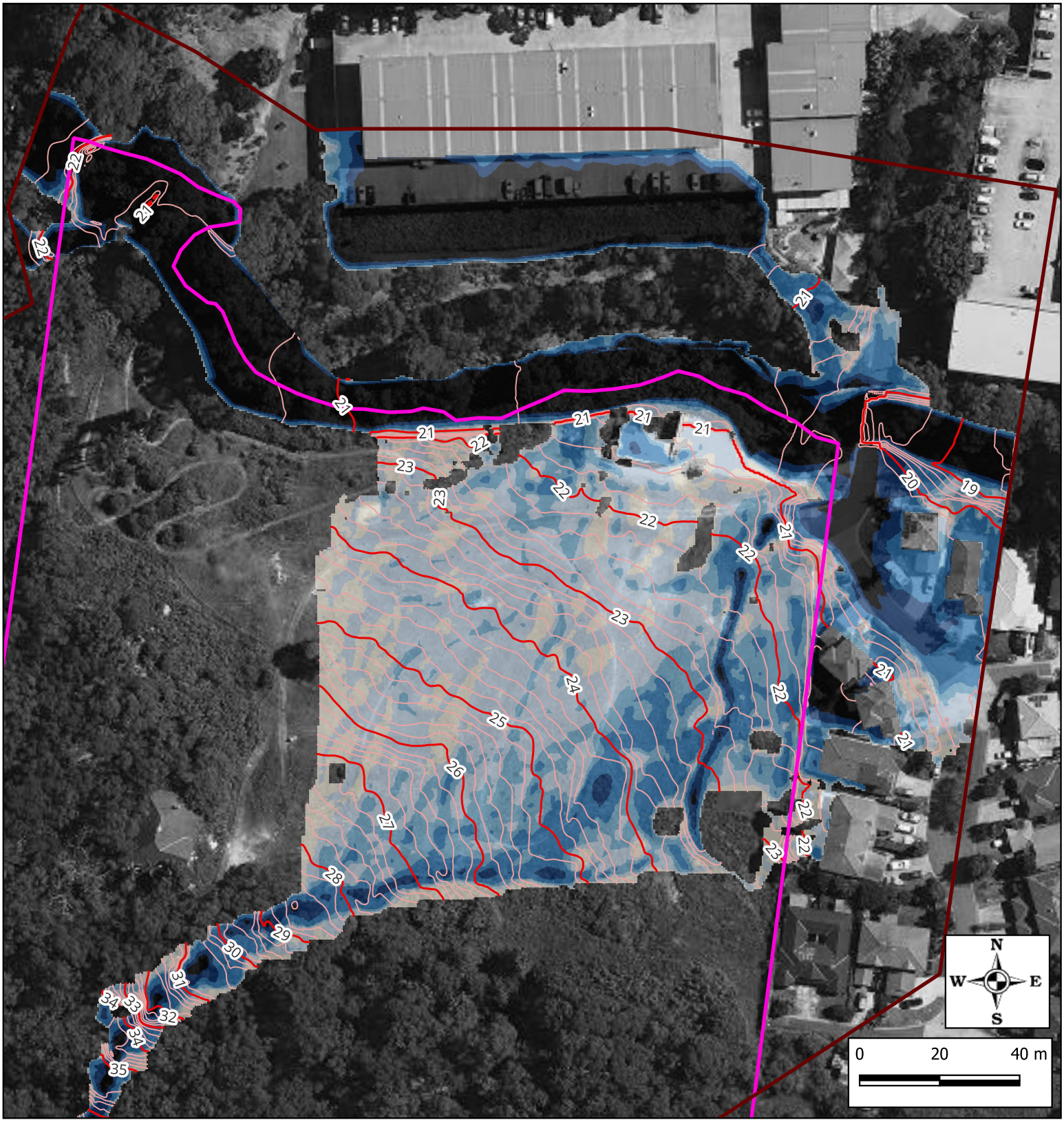
An adapted form of Martens' TUFLOW model has been used to analyse the proposed development at 8 Forest Road, Warriewood. Model analysis shows that the proposed development will cause trivial impacts on Narrabeen Creek downstream of Jubilee Ave and minimal local impacts to flood behaviour in Narrabeen Creek. No offsite impacts are expected on private land or property.

Please do not hesitate to contact me either by email or phone if you require any further clarification on the information presented above.

Yours Sincerely,

Steve Gray
Director
Email: gray@grchydro.com.au
Tel: +61 413 631 447

FIGURES



Legend

- 2D Model Extent
- Site Extent

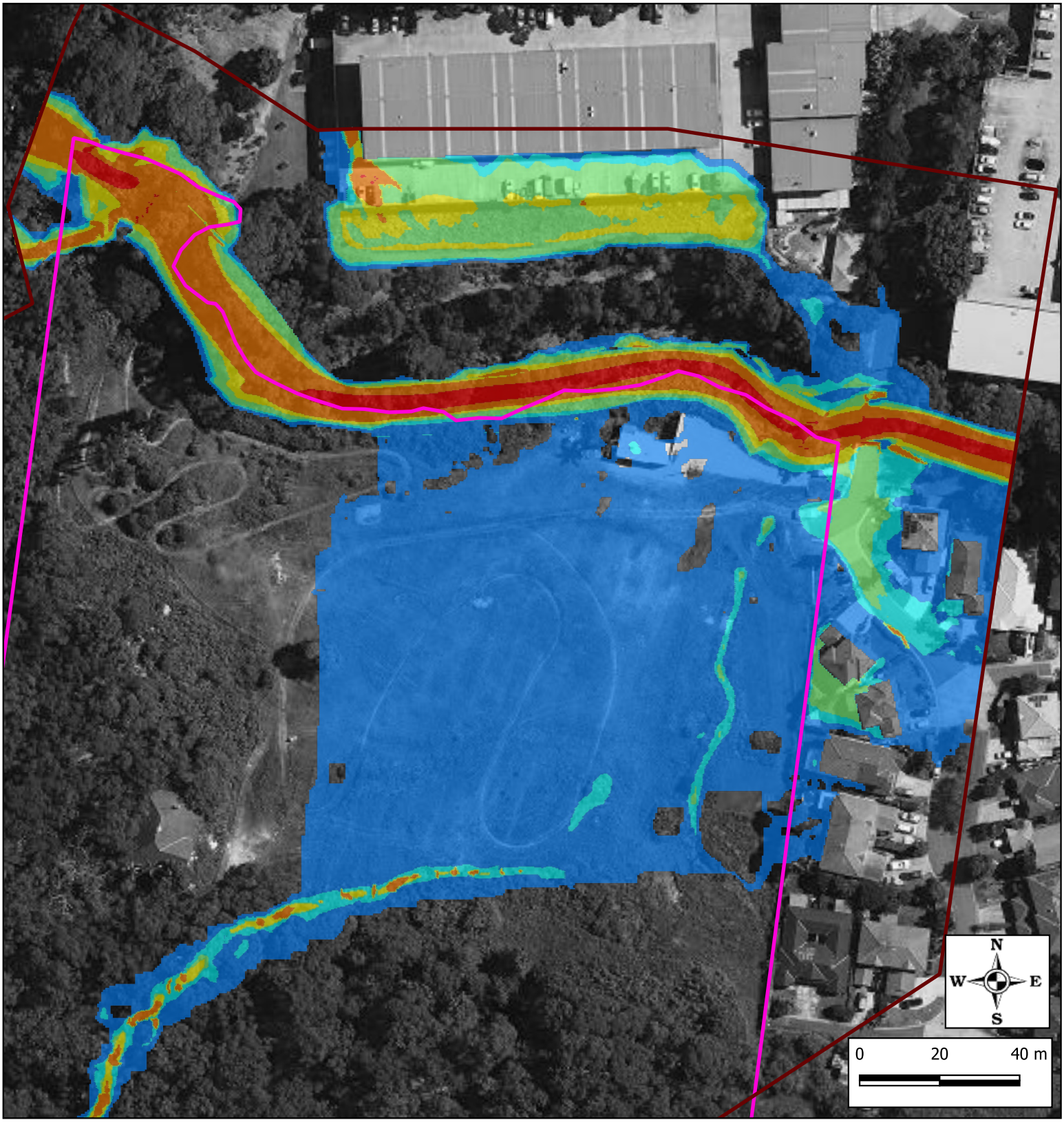
Depth (m)

- <= 0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- > 0.50

- Major Contour (1.0m interval)
- Minor Contour (0.2m interval)

TITLE: **1% AEP - Peak Depths and Levels for Existing Conditions**		
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No. **210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No. **01**

grc HYDRO



Legend

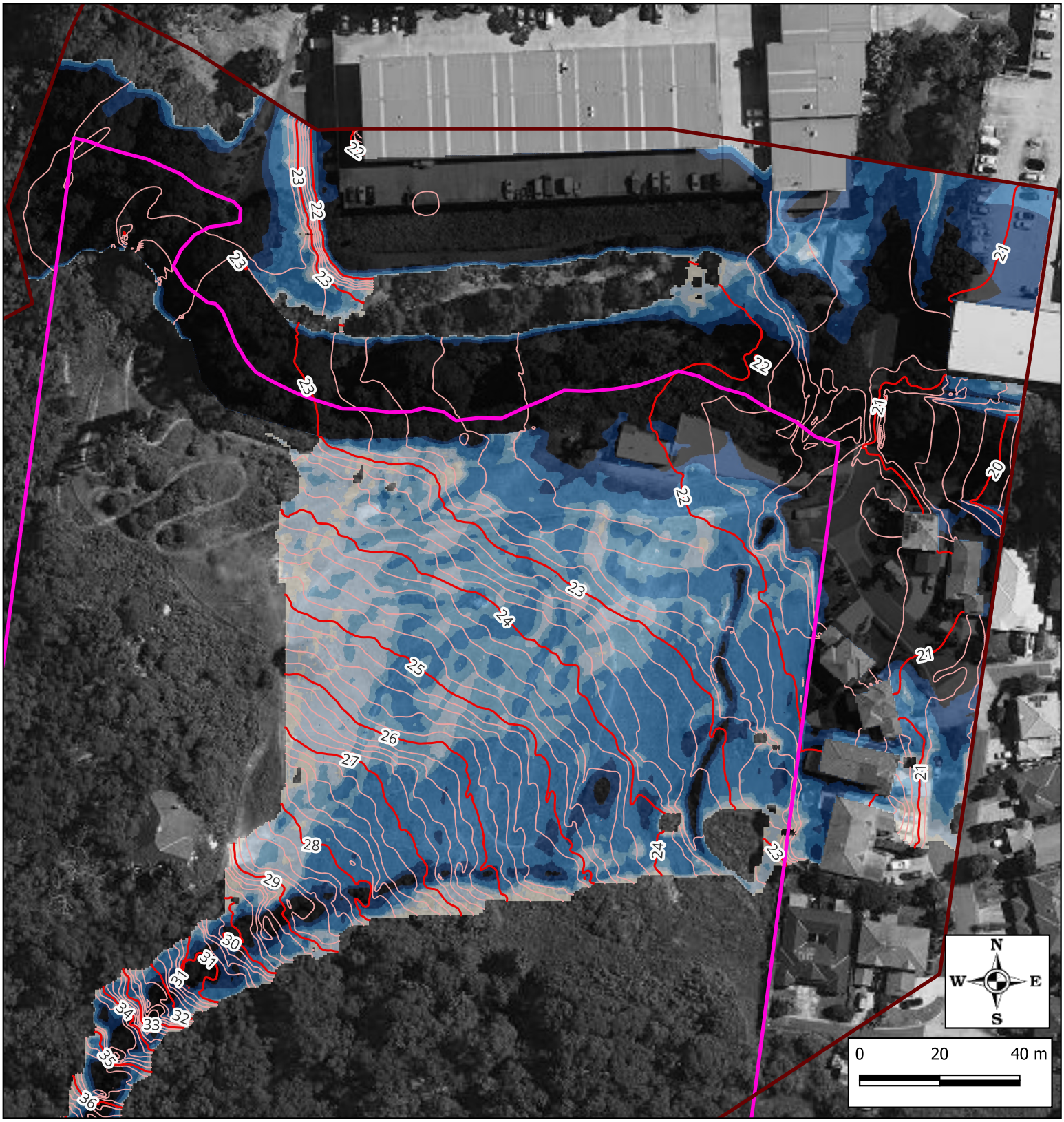
- 2D Model Extent
- Site Extent

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

TITLE: **1% AEP - Peak Hazard Categories for Existing Conditions**			
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No.	**210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No.	**02**

grc HYDRO



Legend

2D Model Extent

Site Extent

Depth (m)

<= 0.01

0.01 - 0.05

0.05 - 0.10

0.10 - 0.30

0.30 - 0.50

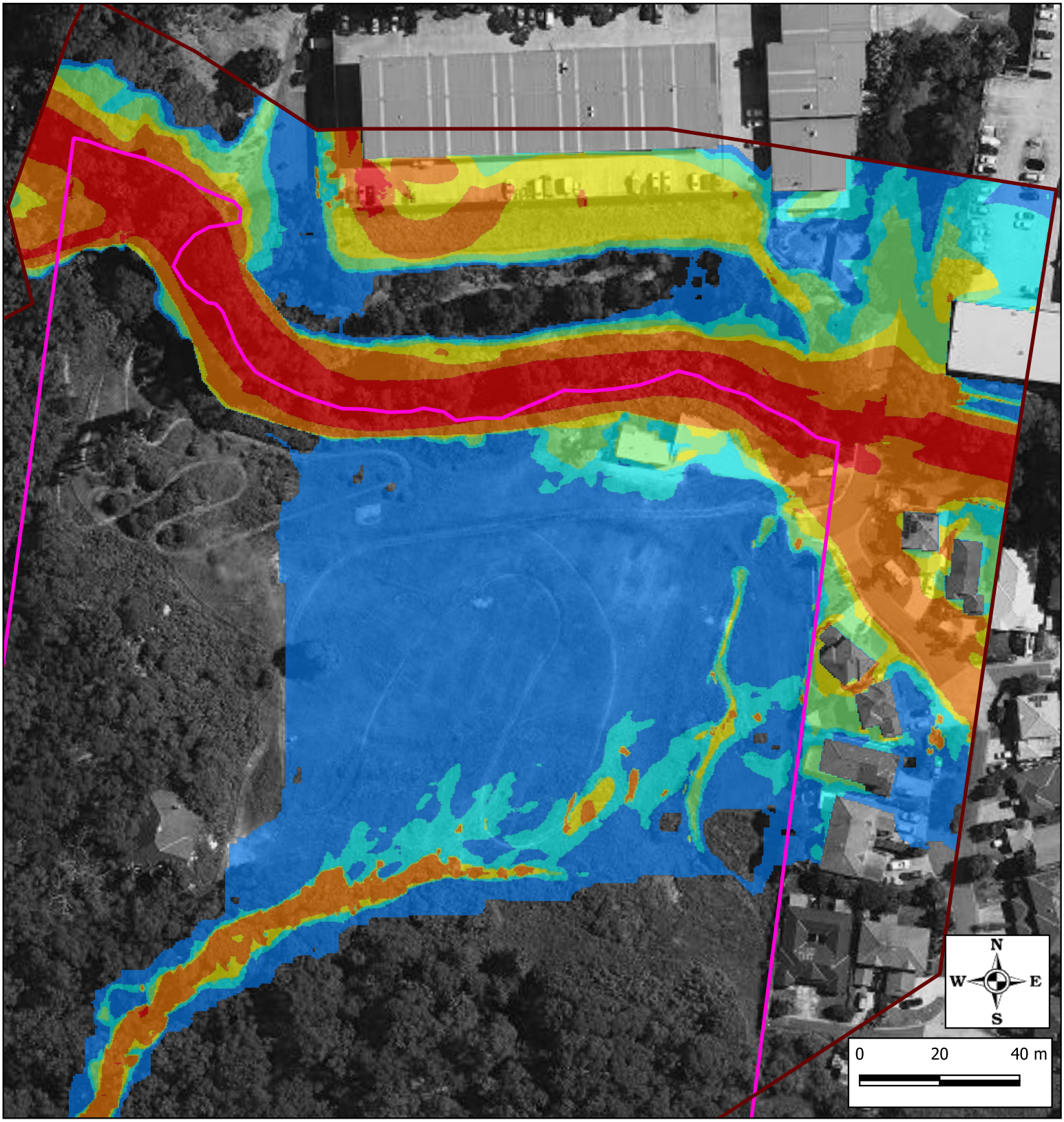
> 0.50

Major Contour (1.0m interval)

Minor Contour (0.2m interval)

TITLE: **PMF - Peak Depths and Levels for Existing Conditions**		
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No. **210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No. **03**

grc HYDRO



Legend

- 2D Model Extent
- Site Extent

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

TITLE: **PMF - Peak Hazard Categories for Existing Conditions**		
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No. **210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No. **04**

grc HYDRO

Legend

- 2D Model Extent
- Site Extent
- Proposed Wall

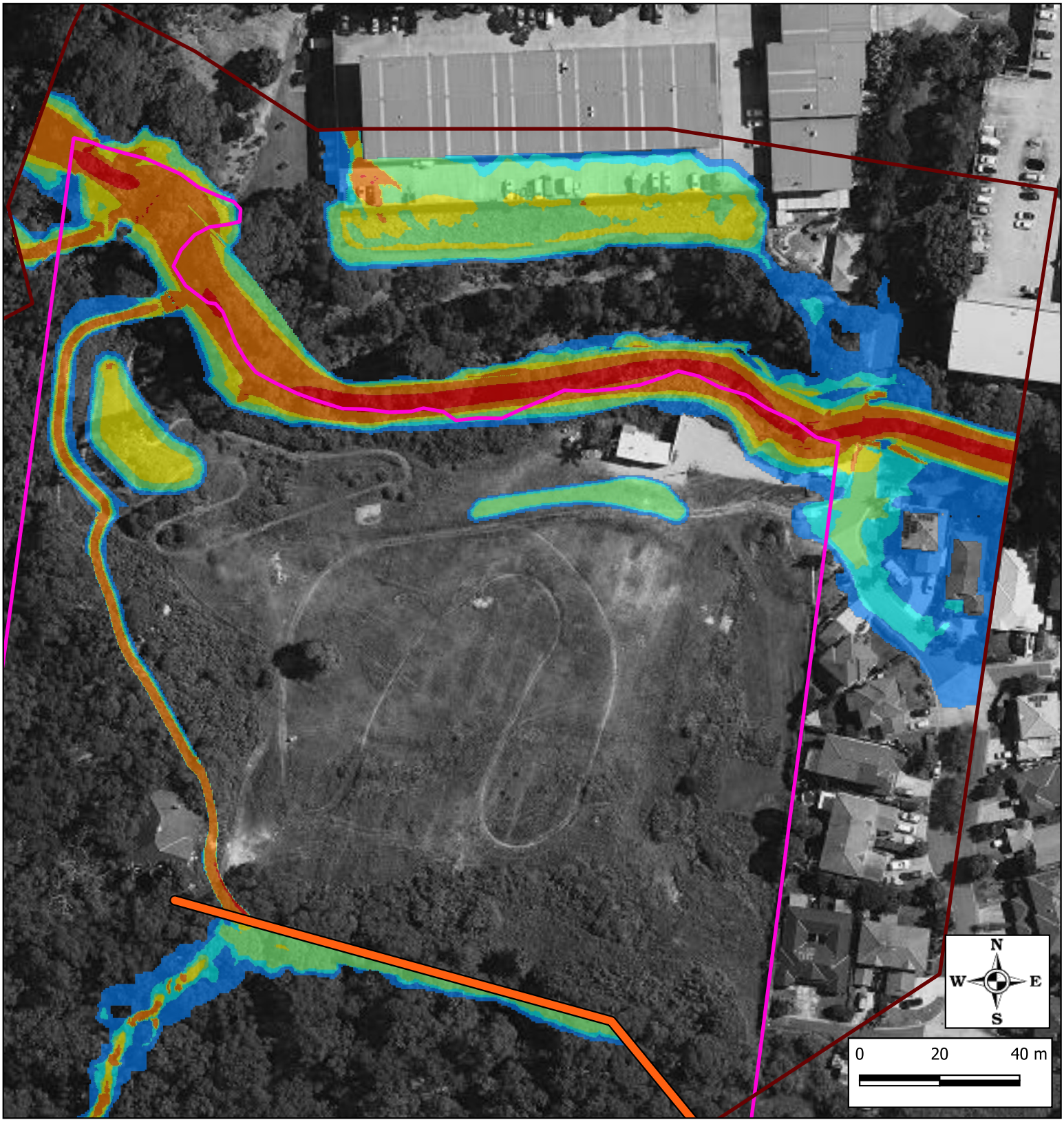
Depth (m)

- <= 0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- > 0.50

- Major Contour (1.0m interval)
- Minor Contour (0.2m interval)

TITLE: **1% AEP - Peak Depths and Levels for Proposed Conditions**		
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No. **210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No. **05**

grc HYDRO



Legend

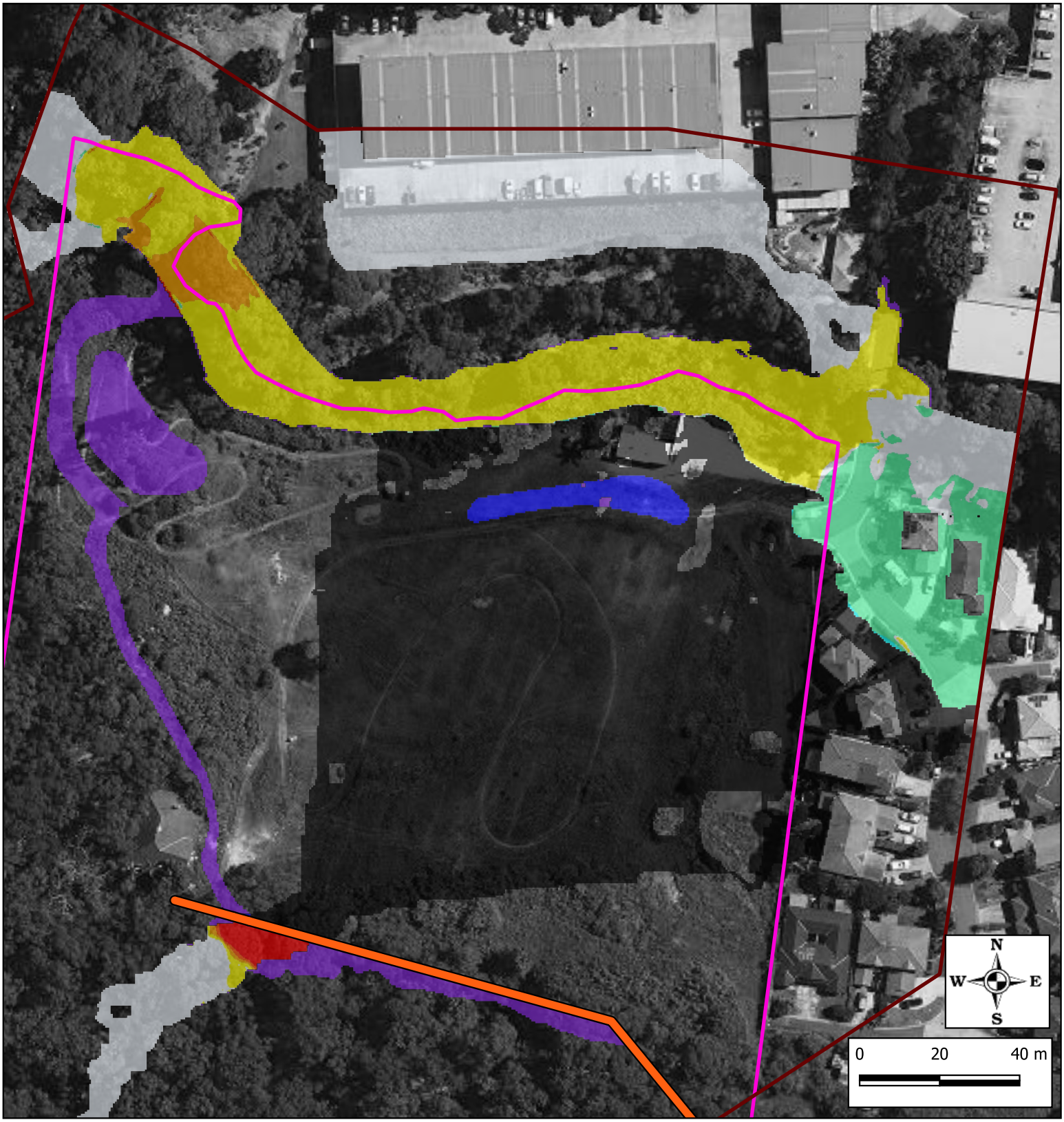
- 2D Model Extent
- Site Extent
- Proposed Wall

Hazard Category

- H1
- H2
- H3
- H4
- H5
- H6

TITLE: **1% AEP - Peak Hazard Categories for Proposed Conditions**		
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No. **210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No. **06**

grc HYDRO



Legend

2D Model Extent

Site Extent

Impact (m)

< -0.3	-0.1 to -0.01	0.2 to 0.3
-0.3 to -0.2	No Impact	> 0.3
-0.2 to -0.1	0.01 to 0.1	No Longer Flooded
	0.1 to 0.2	Newly Flooded

TITLE: **1% AEP - Water Level Impacts**		
PROJECT: **8 Forest Rd, Warriewood**		PROJECT No. **210096**
DATE: **02-2024**	SCALE: **1:1,300**	FIGURE No. **07**

grc HYDRO