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Dear David,

Re: Flood Investigation for 187 Slade Road, Bexley North

1. Introduction

Development is proposed for the subject site located at 187 Slade Road, Bexley North. The site is located in an urban area with a 28-hectare upstream catchment. Under current conditions the site is affected by minor flooding from the carpark to the south-west and from Sarsfield Circuit. The location of the site is shown in Figure 1.

GRC Hydro have been engaged by Planning Ingenuity to investigate the Site's existing flood liability in relation to Council's planning policies to assess the suitability of development for the site.

2. Previous Studies

The Bardwell Creek 2D Flood Study Review was undertaken by WMAwater in 2018. This study used a hydrologic model (WBNM) and hydraulic model (TUFLOW) to model design flood behaviour for events ranging from the 20% Annual Exceedance Probability (AEP) to the Probable Maximum Flood (PMF). The modelling system was calibrated and validated to historic events. These models were found to adequately represent flood behaviour in the study area.

The TUFLOW model results were used as the basis for investigating flooding as part of this study. Some model amendments were made by GRC Hydro, in the vicinity of the Subject Site based on observations from site visits and local knowledge of the area. The key model amendment was to facilitate the existing overland flow path through 232 Slade Road which had previously been blocked out of the model and exacerbated flood levels. Site visit revealed that the building basement is designed to allow flood water throughout the building and discharge into the railway line to the north (see Figure 2).

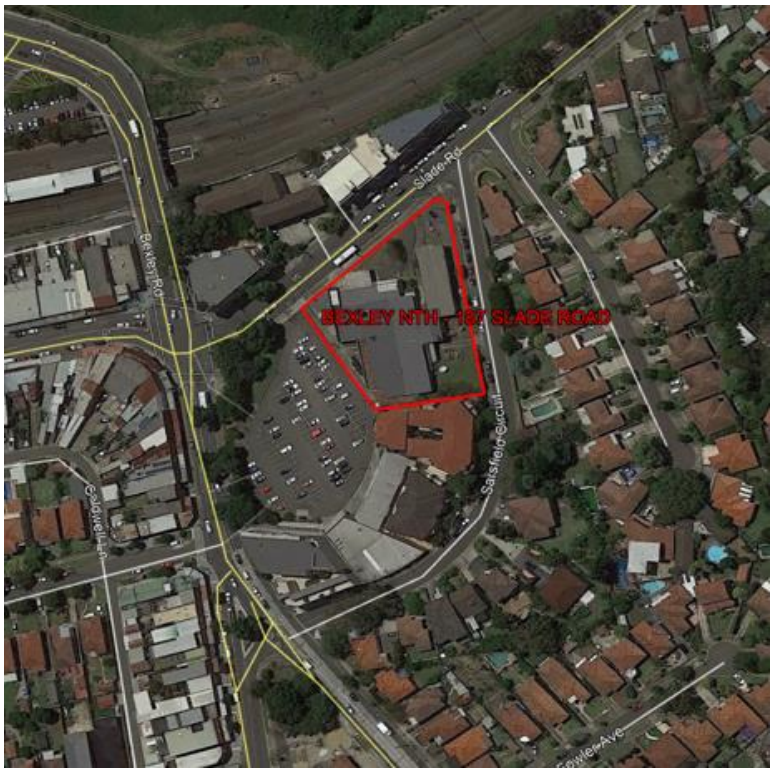

Figure 1: Project Site Location - 187 Slade Road - Bexley North

Figure 2: View of property in 232 Slade Road from Slade Road

3. Existing Flood Behaviour

The site experiences flooding when rainfall in the catchment to the south exceeds the stormwater capacity and overland flow flows generally from south to north. Both the car park to the west and Sarsfield Circuit convey overland flow. The site's upstream catchment is shown in Figure 3. Runoff from this catchment arrives at the intersection of Sarsfield Circuit and Bexley Road, flowing north. The flow is then split between Sarsfield Circuit and Bexley Road, with the latter flowing into the car park adjacent to the site.

Figure 4 shows the 1% AEP flood depths in the vicinity of the Site. On the site boundary, flood depths range from 0.1 to 0.2 m on Sarsfield Circuit while along the western boundary there are depths of around 0.15m to 0.6 m (measured in the sag point into the car park area). On Slade Road depths range from 0.1m to 0.6m (measured in the Slade Road Sag point in front of building in 232 Slade Road). The figure also shows stormwater drainage in the vicinity of the site, including a 900 mm diameter drain that runs underneath the site.

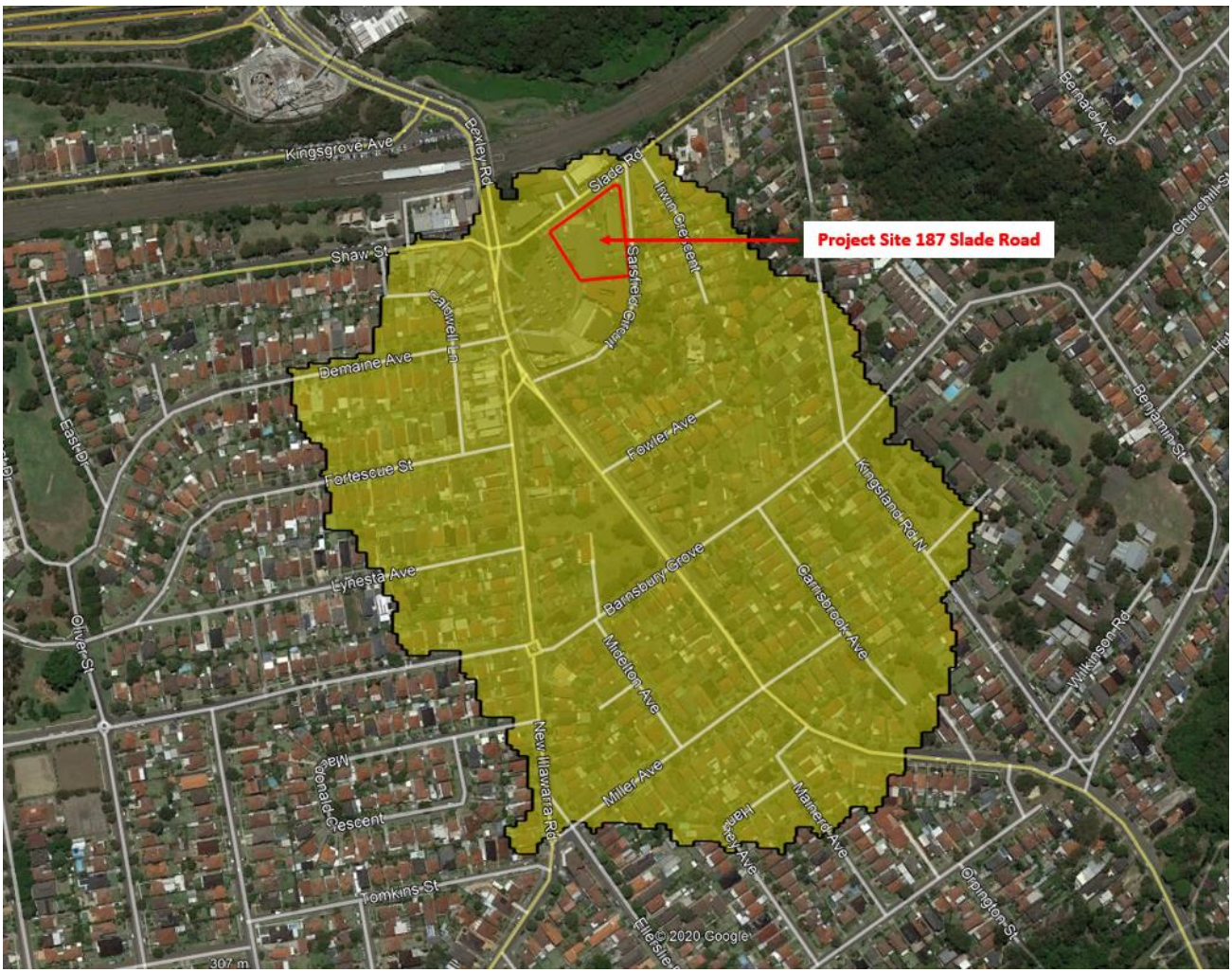

Figure 3: Subject site upstream catchment (27.8ha)

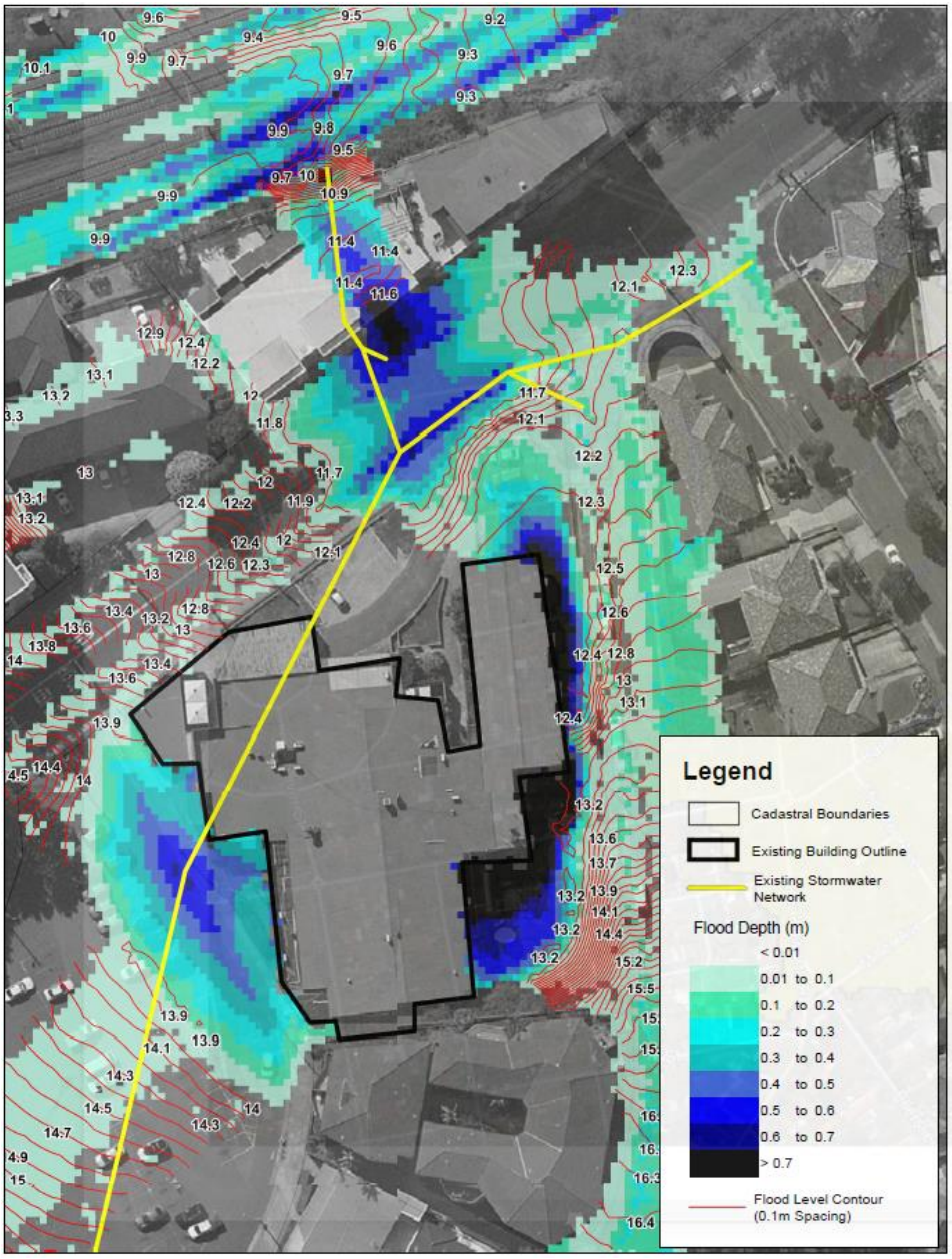

Figure 4: 1% AEP flood depth – existing case

Model results indicate that the relatively new development at the corner of Sarsfield Circuit and Bexley Road (building at 2-6 Sarsfield Circuit) redirected flow on to Sarsfield Circuit that would have otherwise continued on Bexley Road. This has likely contributed to the flood risk at the subject site.

4. Flood Assessment of Proposed Development

The planning proposal is for an intensification of use of the subject site whilst maintaining the existing use. The proposed construction consists of two new buildings. The area between the eastern and western block (Laneway) is a publicly accessible open space. The proposed habitable surface is 2852m², around 600m² higher than the existing. Three basement levels are proposed with car access from Sarsfield Circuit at location shown in Figure 5.

Figure 5: Proposed Development. Ground Level Concept Plan (left) and FPL (Right)

The proposed development contains several features to replicate the existing flood behaviour and avoid flood level impacts. The features are shown in Figure 6 and are as follows:

1) **Diversion Pipe Size upgrade**: the existing 900 mm dia. stormwater pipe that currently runs underneath the site will be diverted to follow the site boundary. The diverted pipe will be increased in size to 1200 mm diameter. This will reduce friction losses and increase the pipe storage effect, reducing the hydraulic grade line and the potential impact in the car park area.
2) **Grassed Swale on the eastern side of the development**: the proposed swale (2m wide and 0.5 to 0.7m depth) conveys water from Sarsfield Circuit into a new proposed detention tank located on the north-eastern corner of the new development. Crossing of the ramp to the proposed building basement is achieved by 2 x 500mm dia. pipes;
3) **Detention Tank**: a 350m³ detention tank stores the flood water smoothing the peak hydrograph and mitigating the flood impact. The Tank will receive water from the proposed grassed swale and from the surface via grated openings on its top slab. It will be connected to an existing stormwater pit on Slade Road.

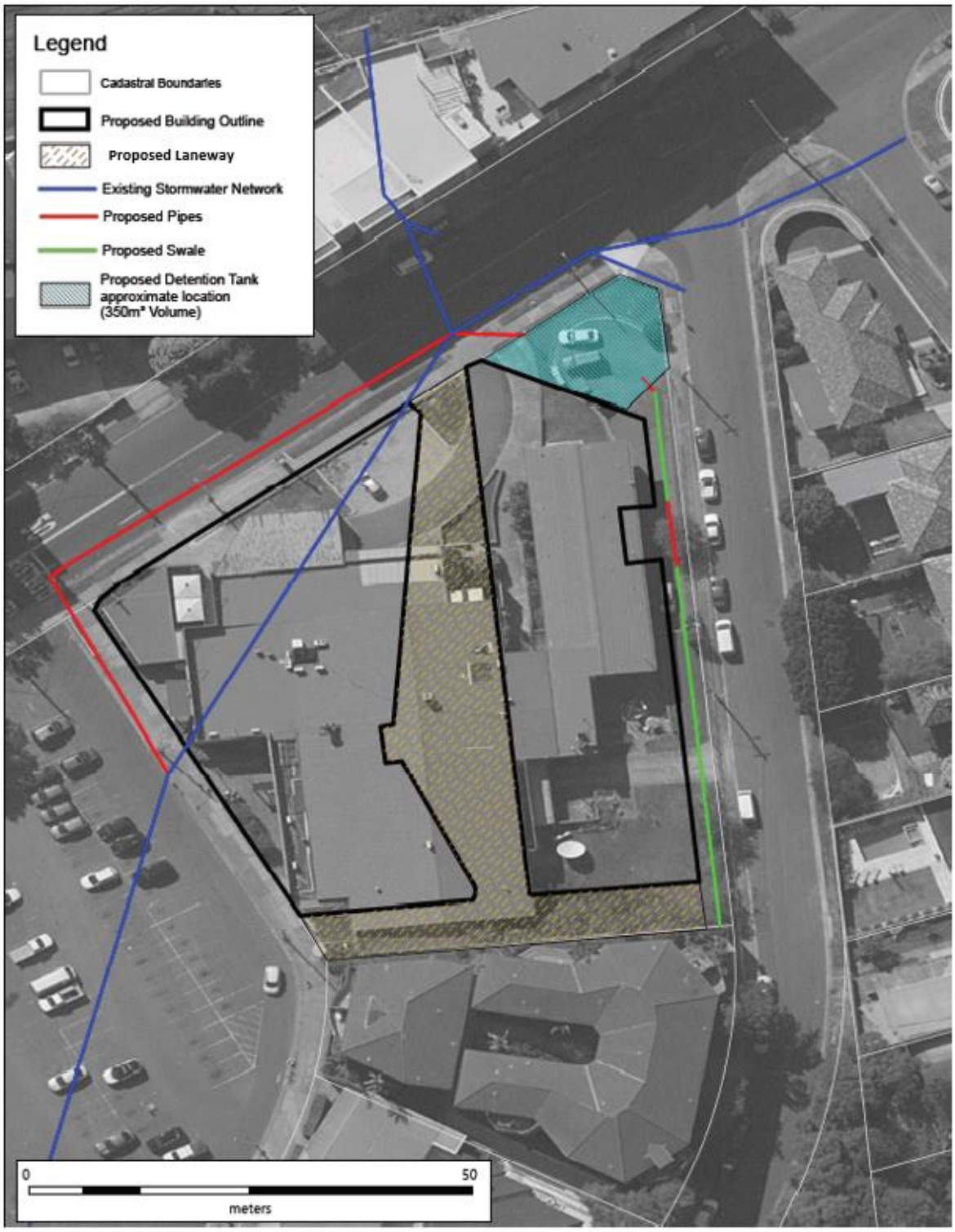

Figure 6: Proposed Flood Mitigation Measures

5. Relevant Planning Policy

Rockdale Development Control Plan

The Rockdale Council Development Control Plan (DCP) 2011 was adopted and is applicable for this development. Development control pertaining to Flood Risk Management can be found in Section 4.1.3 Water Management and are outlined below:

3. *Development must comply with Council's – Flood Management Policy which provides guidelines of controlling developments in different flood risk areas. It should be read in conjunction with the NSW Government's 'Floodplain Development Manual 2005'.*
4. *The filling of land up to the 1:100 Average Recurrence Interval (ARI) flood level (or flood storage area if determined) is not permitted, unless specifically directed by Council in very special and limited locations. Filling of land above the 1:100 ARI up to the Probable Maximum Flood (PMF) (or in flood fringe) is discouraged however it will be considered providing it does not adversely impact upon flood behaviour.*
5. *Development should not adversely increase the potential flood affectation on other development or properties, either individually or in combination with the cumulative impact of similar developments likely to occur within the same catchment.*
6. *The impact of flooding and flood liability is to be managed, to ensure the development does not divert the flood waters, nor interfere with flood water storage or the natural functions of waterways. It must not adversely impact upon flood behaviour.*
7. *A flood refuge may be required to provide an area for occupants to escape to for developments where occupants require a higher standard of care. Flood refuges may also be required where there is a large difference between the PMF and the 1 in 100-year flood level that may place occupants at severe risk if they remain within the building during large flood events.*

Rockdale Local Environmental Plan 2011

Section 6.6 Flood Planning for the Rockdale Local Environmental Plan (LEP) outlines flood related controls relevant to the proposed development. These controls are provided below.

6.6 Flood planning

(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to:

(a) land that is shown as "Flood planning area" on the Flood Planning Map, and

(b) other land at or below the flood planning level.

(3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the Floodplain Development Manual (ISBN 0 7347 5476 0), published in 2005 by the NSW Government, unless it is otherwise defined in this clause.

(5) In this clause:
flood planning level means the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard.

Flood Planning Map means the Rockdale Local Environmental Plan 2011 Flood Planning Map.

The Flood Planning Map from the Rockdale LEP does not highlight the subject site as within the Flood Planning Area. This map is shown in Figure 7.

Figure 7:Rockdale LEP Flood Planning Area (subject site outlined in red – not tagged)

6. Impact of the Proposed Development

The proposed development was schematised in the hydraulic model (TUFLOW). The development was represented as a 'proposed' scenario that modified the building footprints and drainage features around the site, as described in the previous section. The hydraulic model was then used to assess the impact of the development on existing flood behaviour. The impact in the 1% AEP event is shown in Figure 8.

The figure shows that the building has a localised effect on the existing flood behaviour. On the west side of the building there is a slight decrease in flood level of less than 0.1 m. While there is a slight loss of flood storage (black area) this is offset by the increased stormwater capacity. On Sarsfield Circuit there is also a loss of flood storage against the building, however it is offset by the detention tank and there is only a localised adverse impact. The adverse impact is around 0.1 m, and up to 0.3 m, and does not occur on private property.

Overall, in regard to flood impact, the proposed development has minimal and localised impacts on flood behaviour and does not result in significant flood impacts to other properties. It will not result in increased requirement for government spending on flood mitigation measures.

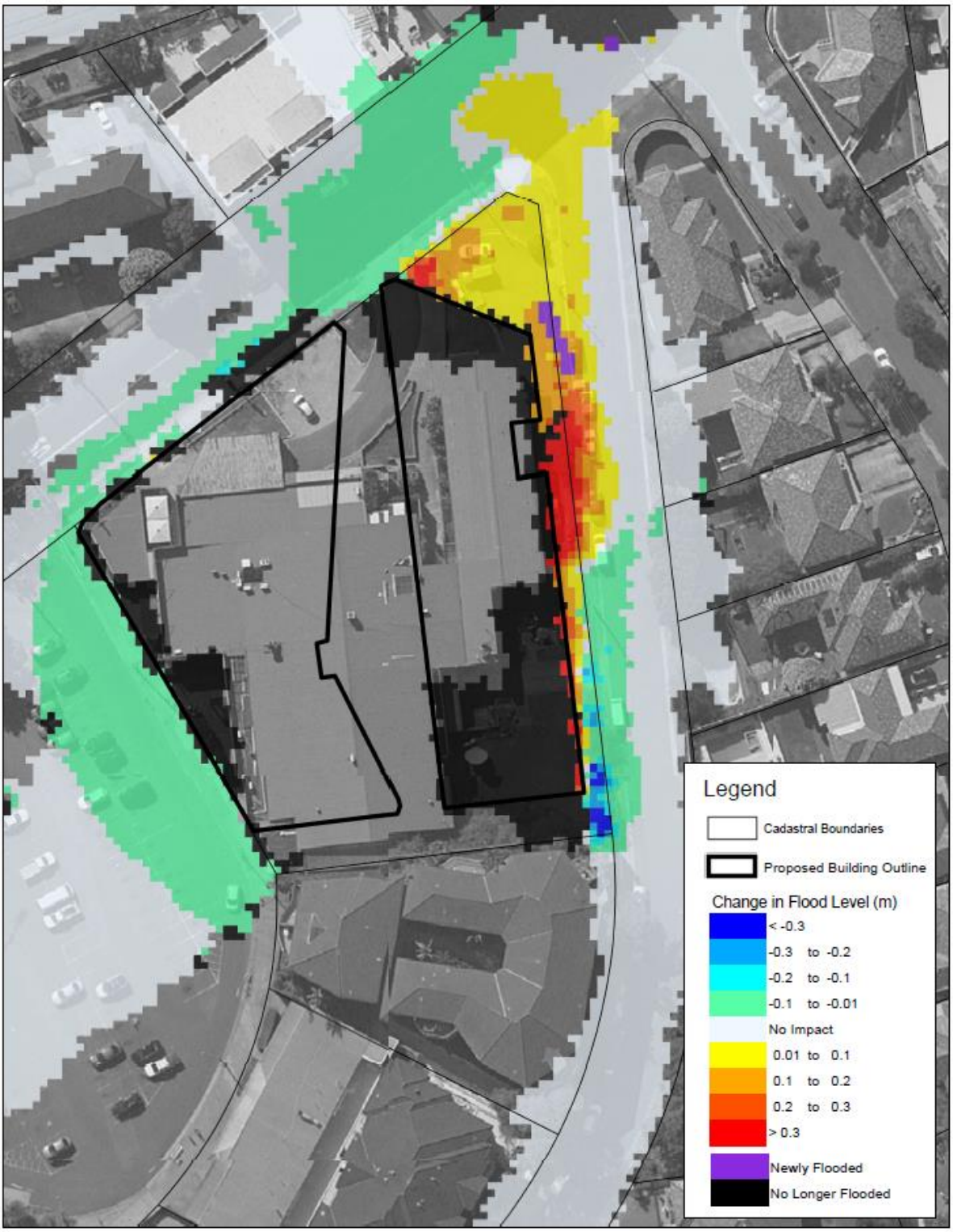

Figure 8: Flood Impact Map with Mitigation Measures

7. Minimum Floor Level Requirements

Whilst the site is flood liable in the 1% AEP event, flood risk itself is minimal. Flood depths are transitory (duration is limited), hazard is relatively minor owing to relative shallowness of flood waters. There is no expectation that flood waters cannot be managed such that risk to life can be managed. Far from being mainstream flooding which can pose a risk to life the flood affectation would more accurately be characterised as being overland flow (stormwater / flood fringe). Few depressed areas at south-east of the site which are currently characterised as being flood storage will be blocked by the proposed development: the proposed detention tank will compensate this loss of storage volume.

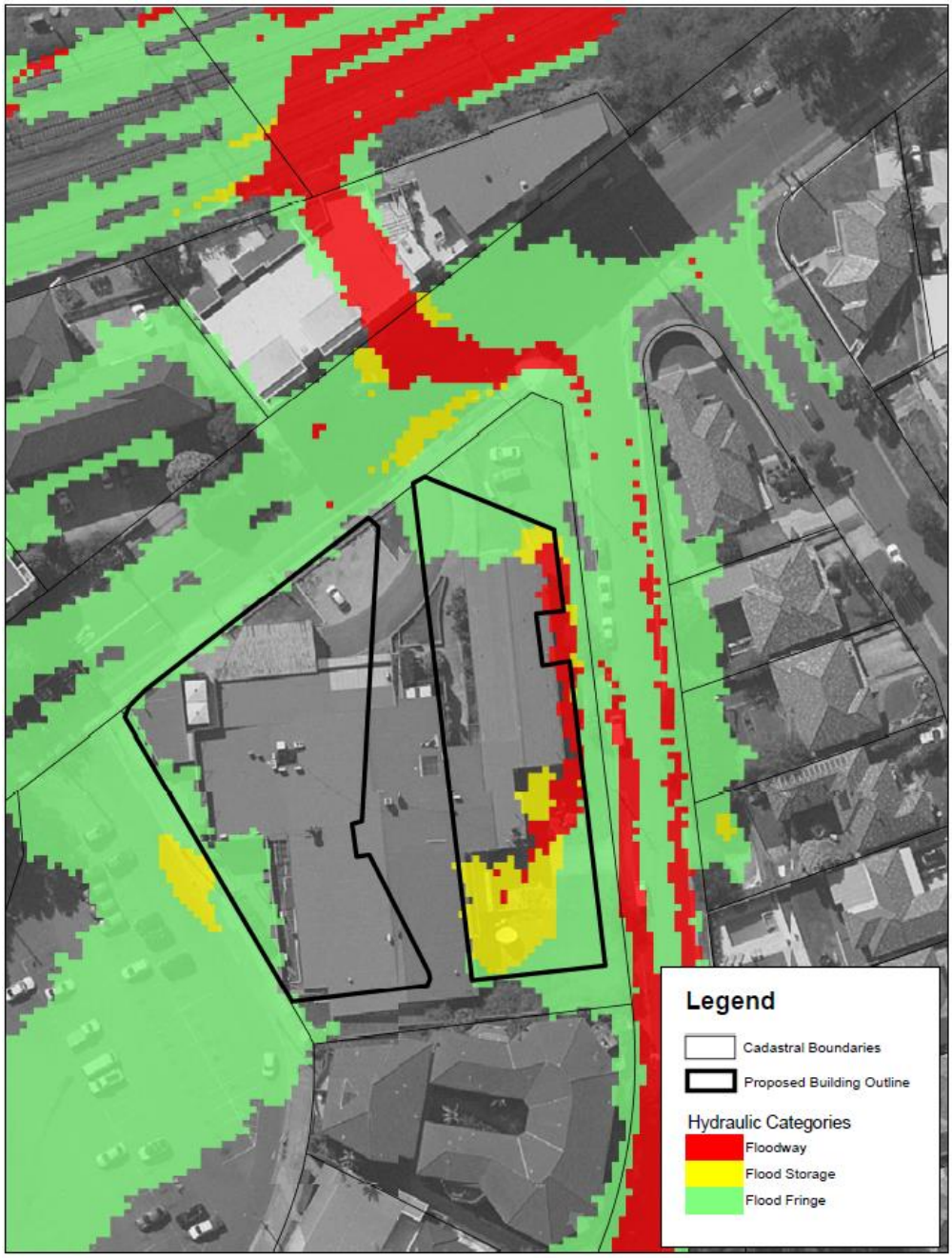

Figure 9: Flood Categories (1%AEP)

The main issue for any development will be achieving a complaint outcome in regard to flood impact. Other issues related to flood related development controls that seek to ensure appropriate development inclusive of levels etc. will be achieved easily. For example:

- Compliance with floor height controls;
- Compliance with controls relating to building resilience.

The PMF (Probable Max Flood) is a consideration in building design and risk management. The Floodplain Development Manual (2005) , defines the PMF as " *[…] the largest flood that could conceivably occur at a particular location, usually estimated from Probable Maximum Precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions. Generally, it is not physically or economically possible to provide complete protection against this event […]"*

The PMF provides an upper limit of flooding. As can be seen from results in Figure 10, the PMF does not scale excessively at the site with PMF levels being 0.2 to 0.4 m higher than 1% AEP levels at the Sarsfield Circuit frontage of the building (where basement entry is located). For this reason, it was possible to provide flood protection at Site even against the PMF.

Location	1%AEP Level [mAHD]	PMF Level [mAHD]	FPL [mAHD]
South-West of Project Site (parking area East of Project Site)	13.86	14.53	15.00*
South-East of Project Site (on Sarsfield Circuit)	15.45	15.85	15.85
Car Park Basement Entrance (on Sarsfield Circuit)	13.09	13.20	13.39
North of Project Site (on Slade Road)	11.66	13.00	13.00

**= max FPL at the top of the ramp*

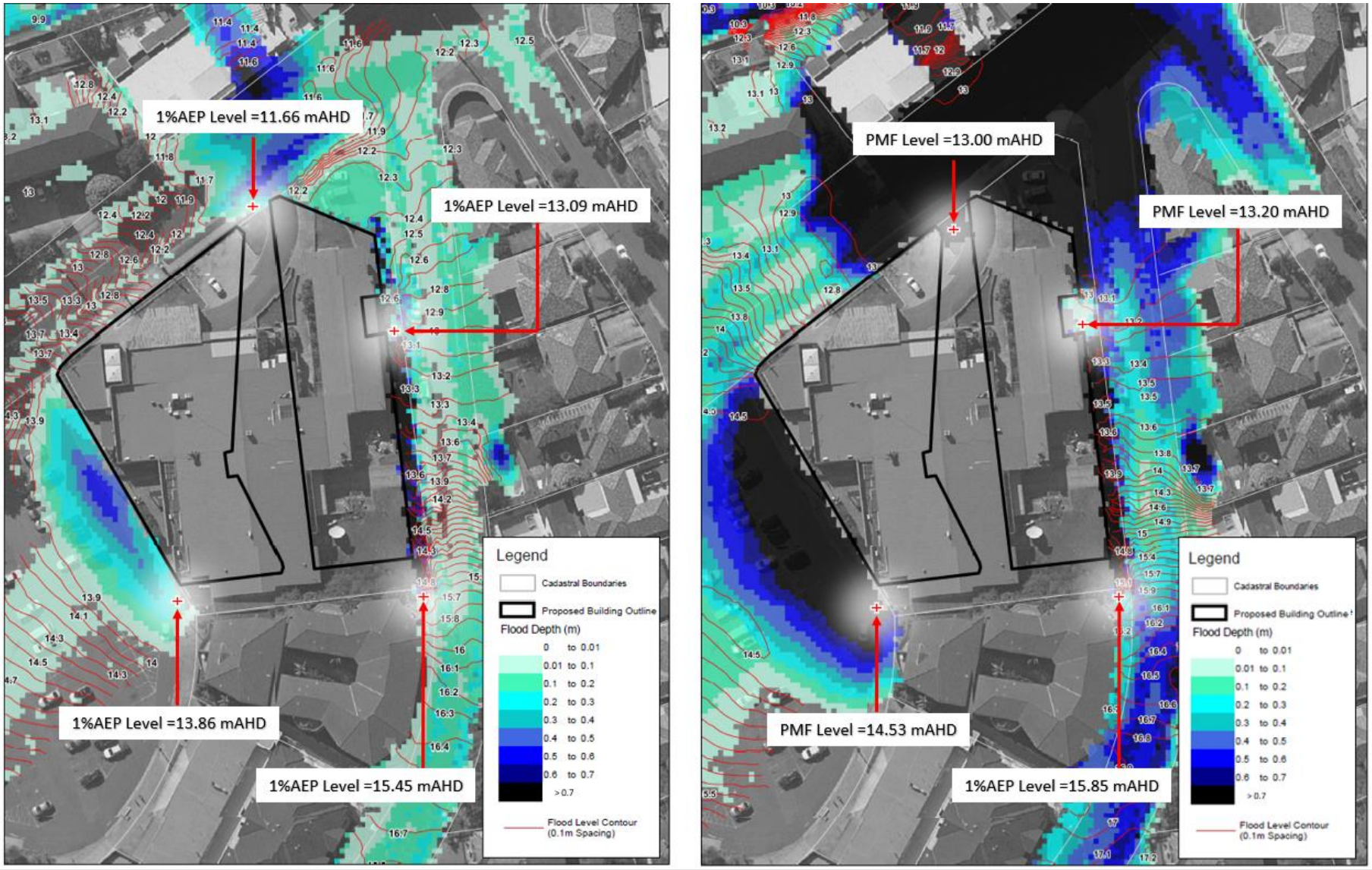

Figure 10: 1%AEP (Left) and PMF (Right) Flood depth Maps

8. Flood Risk Assessment

The potential risk to life as a result of flooding can be ascertained by assessing the flood hazard. Flood hazard can be quantified by considering the flood depth and velocity in combination (AIDR, 2017).
The hazard categories based on the Australian Emergency Management Institute (2014) of Figure 11 were considered.

Available warning time for the site is short due to the small size of the catchment upstream of the site, leading to a "flash flood" classification. Review of the flood models found that the 1%AEP peak flood flow occurs approximately 10 minutes after the rainfall peak which leaves little time for flood evacuation and preparation. Evacuation of the buildings could potentially result in people entering hazardous floodwater areas. For flash flood catchments, the provision of an effective flood warning service is not available due to the difficulties with its prediction. A benefit of the flash flood setting is that the duration of flooding is typically short with hazardous flooding to typically last less than one hour.

Figure 12 are the 1%AEP flood hazard maps for the Existing and Proposed Scenario. It can be observed that the proposed developments does not increase flood hazard. Also, hazard along the escape routes on Slade road is generally low, being globally classified as H1 level. Higher hazard level along the eastern side of the proposed development is due to the proposed swale.

Figure 13 are the PMF flood hazard maps for the Existing and Proposed Scenario. Although significant flow path is only likely to occur in rare flood events, the type of potential flow presents a significant risk to people and vehicles. An analysis of the PMF event therefore yields the requirement that people are not moving around the site once a certain threshold of depth is crossed. It is clear, however, that this threshold event will occur rarely (less often than once per one hundred years).

The Site access is limited by the trafficability of Slade Road, which is classified as H5 as per flood hazard category. Therefore, shelter-in-place for site occupants is recommended during flood event.

It shall be noted that, given the nature of public accessibility of the proposed Laneway, the proposed Site will represent a safe refuge for people caught by flash flooding.

9. Building Materials

All materials below PMF level in the proposed development shall be flood compatible.
No electrical equipment or wiring shall be installed below PMF level.

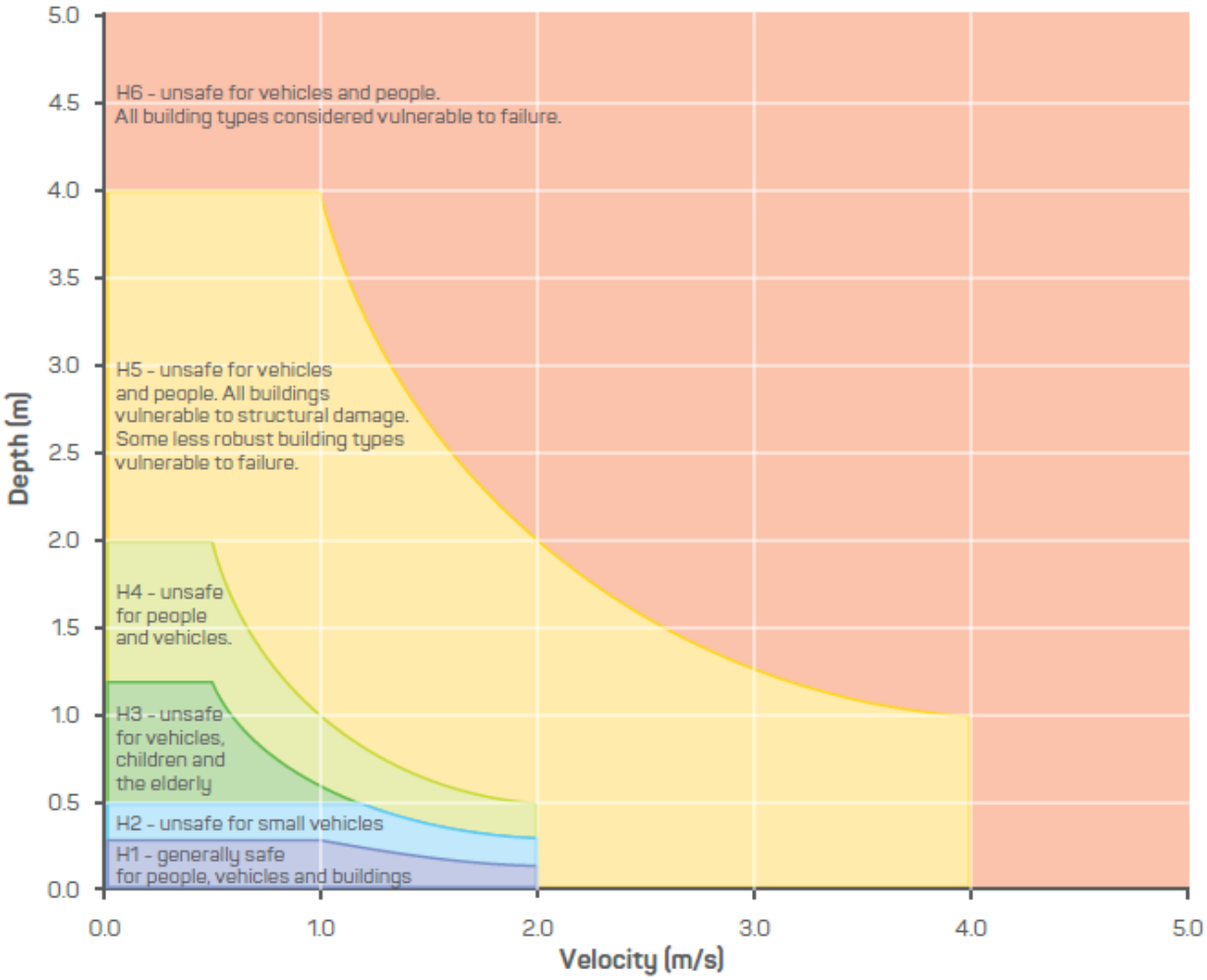

Figure 11: Flood Hazard Category by Australia Emergency Management Institute (2014)

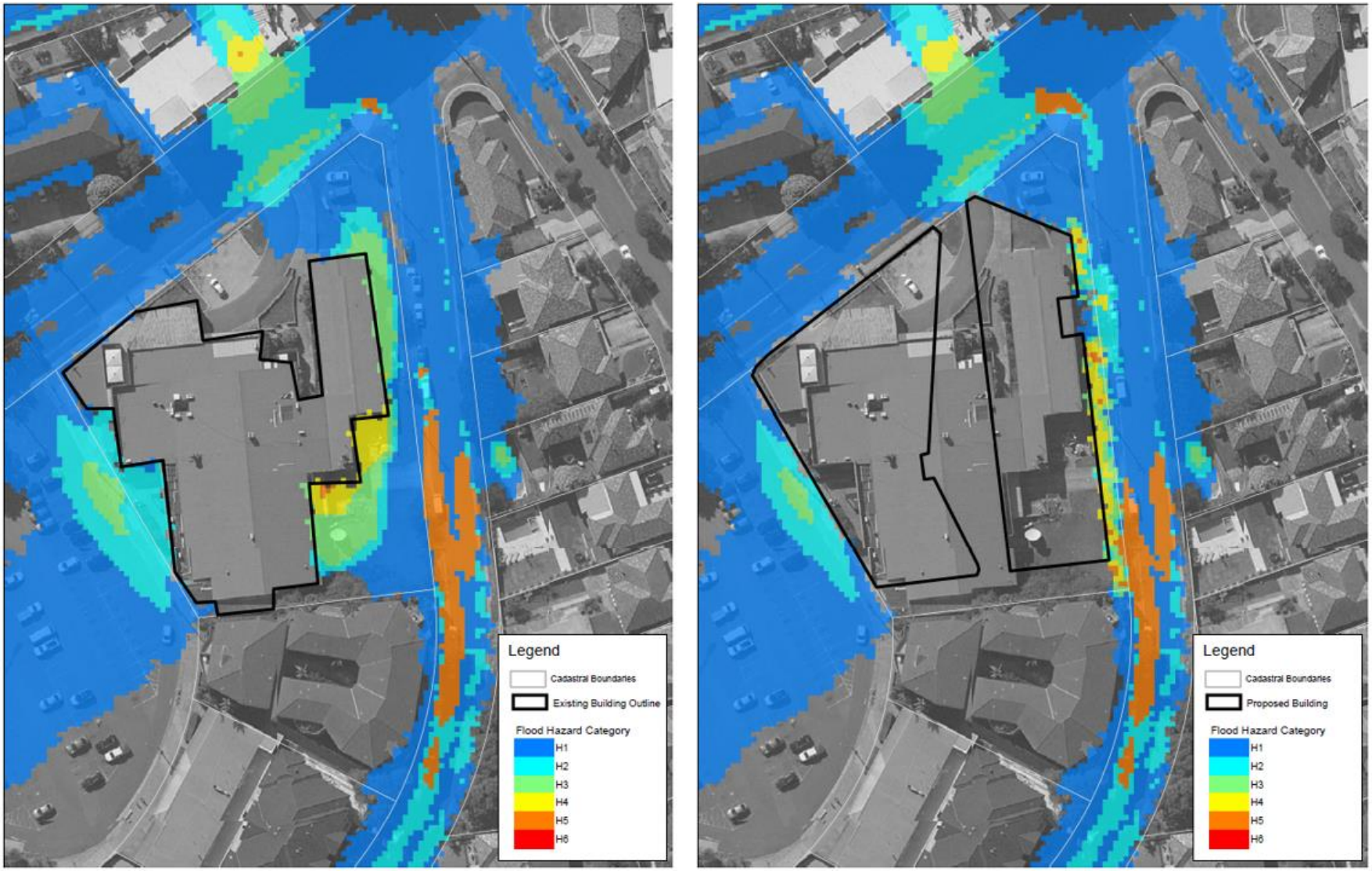

Figure 12: 1%AEP flood Hazard Map. Existing Scenario (Left) and Proposed Scenario (Right)

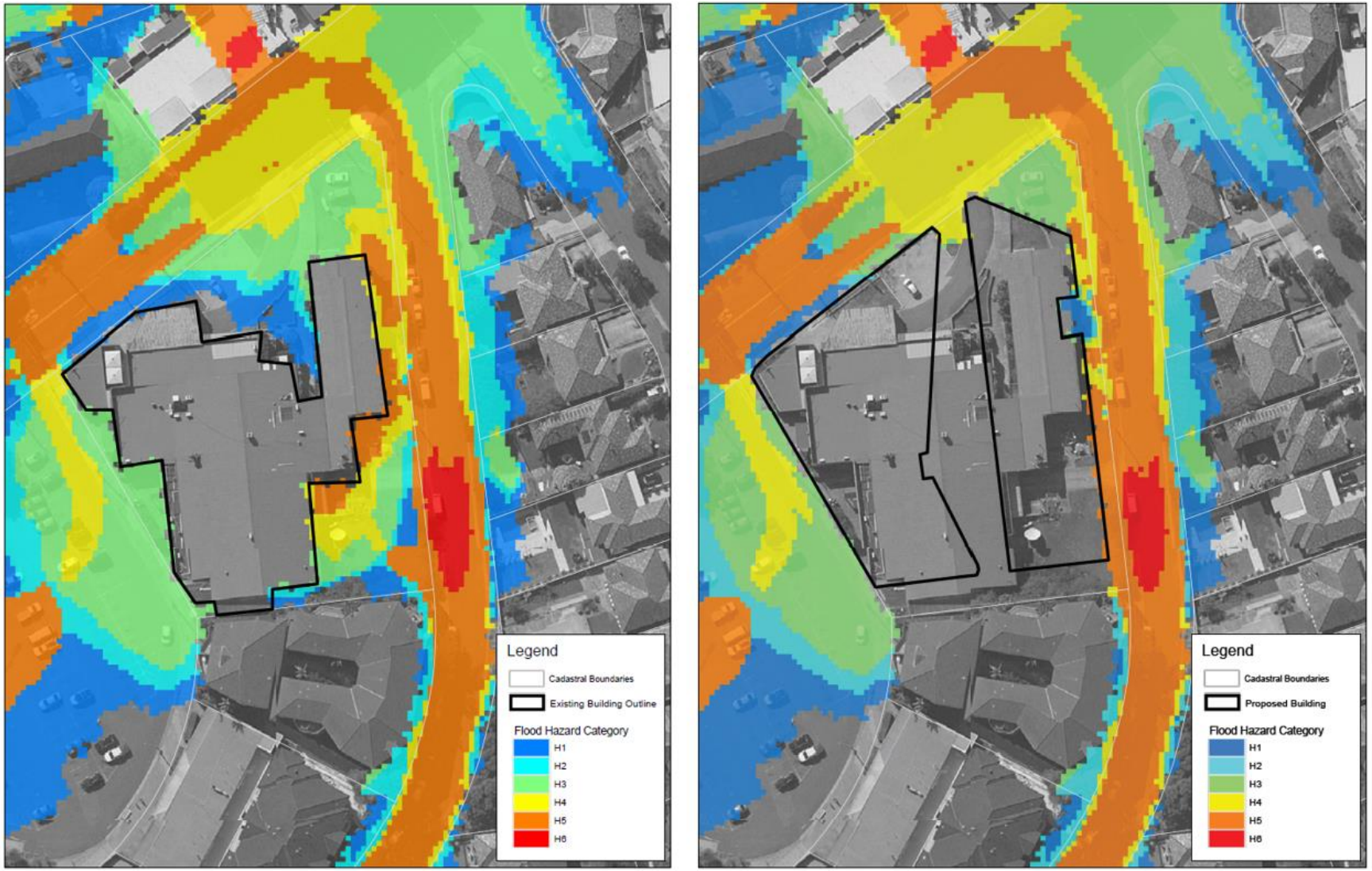

Figure 13: PMF flood Hazard Map. Existing Scenario (Left) and Proposed Scenario (Right)

10. Flood Management Plan

Due to the limited available warning time and the associated risk of people driving or walking through flood waters, it is not recommended that people evacuate the site during times of flood and that shelter-in-place policy be adopted.

10.1 Preparedness

Preparation for flooding are to be incorporated into the management of the site. These measures shall be communicated to the staff of the retails and to all residents in the buildings to ensure that the site is prepared for flooding when it occurs. The preparatory measures are as follows:

- Keep a hard copy and digital version of this Flood Management Plan;
- Brief retails' staff of its content on an annual basis, or more frequently if staff turnover is high. There should always be at least one employee familiar with the Plan on duty whilst the retails are open;
- Brief resident of the buildings with the content of the Plan;
- Design temporary warning signage to marshal site occupants during a flood including warning signs to not let people leave the site during flood;
- Maintain a loudspeaker system inside the site that can be used for announcements during a flood.

10.2 During a Flood

The main responsibility during a flood are to notify emergency services, to marshal site occupants into safe areas and assist those impacted by floodwaters.

The main risk is estimated to be to those leaving the site end entering areas of high flood hazard.

The actions to be taken by the site management, in chronological orders, are:

1) Call the State Emergency Service and advice that the site is flooding and that assistance may be required;
2) Erect temporary warning signs at each site exit stating to remain within the site;
3) Turn off buildings power to reduce the risk of electrocution;
4) Announce (over the loudspeaker and in-person) to occupants of the site that flooding is occurring outside and to remain calm and stay within the site area until flooding passes. The Site should not be evacuated during flood event as the greatest flood risk is experienced in the surrounding roads.
5) Ensure that no one is in the Basement areas;
6) Check outside if any vehicles or pedestrian have been caught in floodwaters or injured. Assist them if safe to do so (fast moving or deep floodwaters should be avoided) and if injuries are noted, call an ambulance;
7) Assist the elderly or those with children in finding a safe area to wait within the building.

10.3 Recovery

Once the floodwater subsides, announce that it is safe to now leave the building and car park, and take down the signage. Attend to occupants that are injured or show symptoms of shock. Call emergency 000 for assistance if required. If electrical or gas services have been inundated do not turn these appliances on until they have been checked by a qualified electrician or gas fitter.

Following the flood event, the site management should liaise with shop staff to understand the consequence of the flood event, including where repairs are required. This plan should then be reviewed

and updated if necessary, with any lesson learned. Damages to building, car park or other assets will be dealt with following the flood and they are not the focus of this plan.

11. Conclusion and Recommendations

In summary then:

- GRC Hydro have done extensive work on flood modelling at the site for a previous Development Application;
- Since that time Council have provided an improved Council modelling tool that is suitable for site analysis;
- The site is flood liable albeit to overland flows or what would tend to be called stormwater;
- Council stormwater assets on the site currently lie under buildings – the re-development is an opportunity to put such assets in locations where they can be accessed should maintenance be required;
- Site's flood liability is very much affected by a re-distribution of flow that resulted from a 2010 development approved at the corner of Sarsfield Circuit and Bexley Road;
- Flood liability of the site means that compliance with DCP controls is required to be achieved by any development;
- Compliance with risk management requirements (appropriate floor levels, building materials etc.) is straightforward;
- Compliance with impact consent conditions required the following mitigation measures:
    - Site Storage via detention Tank;
    - Swale on the eastern side of the development; and
    - Pipe diversion on Slade Road.

Yours Sincerely,

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Director

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