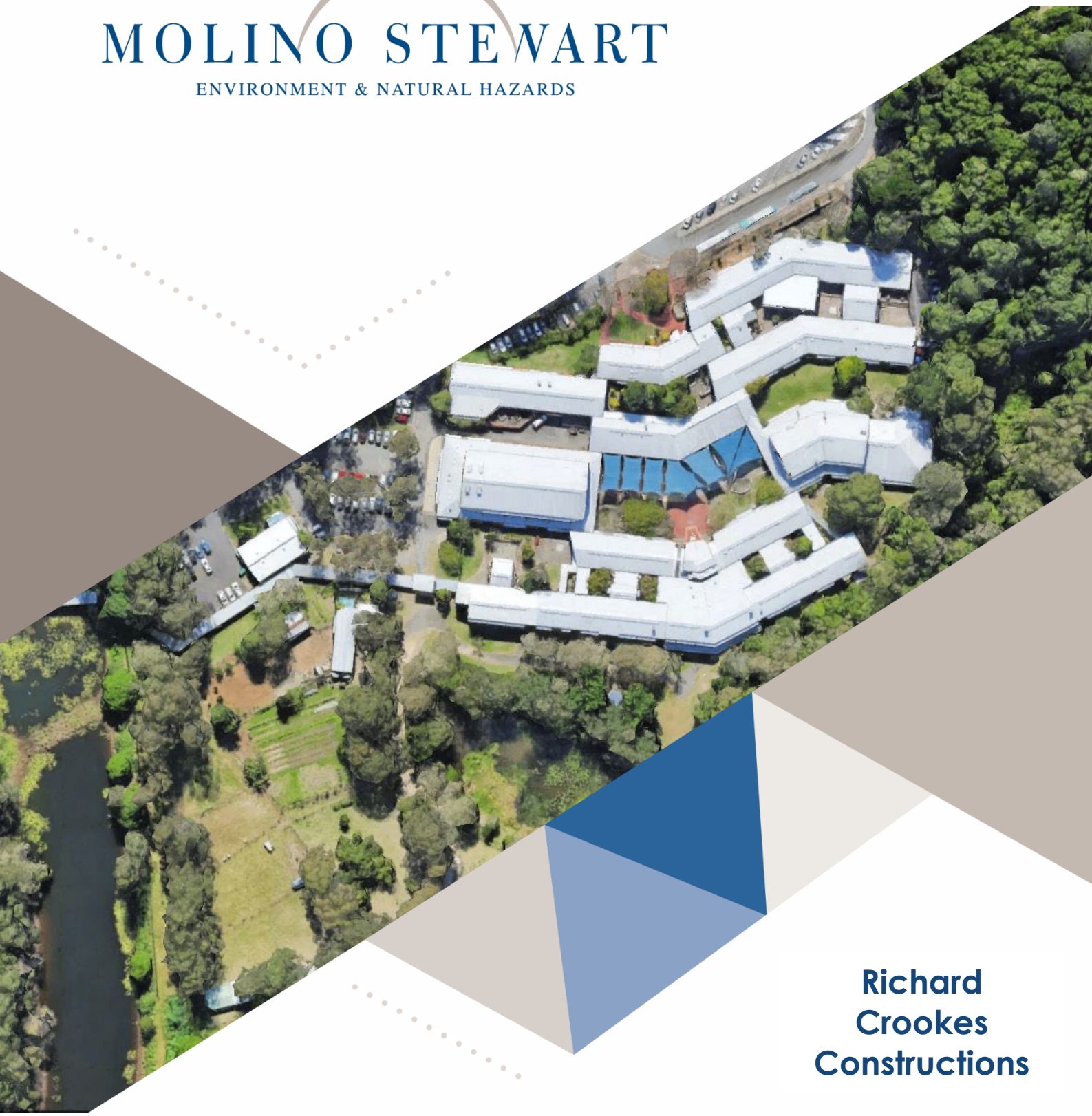
MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS



Richard Crookes Constructions

Kingscliff High School

Flood Emergency Response Plan

Final

Kingscliff High School

Flood Emergency Response Plan

Final

Client: Richard Crookes Constructions

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Document Control

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Date	Version	Name	Comments
22/11/2021	1.0	Rhiannon Garrett	Draft for internal review
26/11/2021	1.1	Steven Molino	Draft for client review
2/12/2021	2.0	Steven Molino	Final incorporating client comments
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Document Approval

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Name	Steven Molino
Position	Principal
For Richard Crookes Constructions	
Name	Angela Wang
Position	Design Manager

Contents

List of Figures

1 | Compliance Table

Table 1: Compliance table showing the sections of this report that address the conditions of consent.

Condition of consent	Section of report addressing condition
B15(i) The CEMP must include a Flood Emergency Response	5 & 6
B21(a) The FERSP must be prepared by a suitably qualified and experienced person(s)	Appendix 1
B21(b) The FERSP must address the provisions of the *Floodplain Risk Management Guidelines* (EESG)	2 - 6
B21(c)(i) the flood emergency responses for both construction phases of the development	5.4 & 6
B21(c)(ii) predicted flood levels	4.4.1, 4.5.1
B21(c)(iii) flood warning time and flood notification	4.4.2, 4.5.2, 5.2
B21(c)(iv) assembly points and evacuation routes	5.3, 5.4
B21(c)(v) evacuation and refuge protocols	5.4, 6
B21(c)(vi) awareness training for employees and contractors and users/visitors	6.1

2| Introduction

2.1 Context

Richard Crookes Constructions has been engaged to undertake construction of upgrades to Kingscliff High School at 33 Oxford St, Kingscliff. These upgrades include the construction of several new buildings and extensions to existing buildings and are intended to increase the student capacity to approximately 1,400 students. The site is subject to overland flows and to flooding from Cudgen Creek.

Condition B15 of the State Significant Development Application (SSD-8744305) conditions of consent for the works states:

> *Prior to commencement of construction, the Applicant must submit a Construction Environmental Management Plan (CEMP) to the Certifier and provide a copy to the Planning Secretary for information. The CEMP must include, but not be limited to, the following:*
>
> > *…(i) Flood Emergency Response (see condition B21)…*

Condition B21 states:

> *The Flood Emergency Response Sub-Plan (FERSP) must address, but not be limited to, the following:*
>
> > *(a) be prepared by a suitably qualified and experienced person(s);*
> >
> > *(b) address the provisions of the Floodplain Risk Management Guideline (EESG);*
> >
> > *(c) include details of:*
> >
> > > *(i) the flood emergency responses for both construction phases of the development;*
> > >
> > > *(ii) predicted flood levels;*
> > >
> > > *(iii) flood warning time and flood notification;*
> > >
> > > *(iv) assembly points and evacuation routes;*
> > >
> > > *(v) evacuation and refuge protocols; and*
> > >
> > > *(vi) awareness training for employees and contractors and users/visitors.*

In addition, Condition D39 requires the preparation of an operational Flood Emergency Management Plan.

The school already has a flood emergency management and evacuation plan for its operation. Richard Crookes Constructions has engaged Molino Stewart to prepare a Flood Emergency Response Plan (FERP) for the construction period of upgrades to Kingscliff High School.

2.2 Scope of this Report

This document is a Flood Emergency Response Plan (FERP) for the construction period of upgrades to Kingscliff High School at 33 Oxford St, Kingscliff that provides a procedure for safe evacuation in the event of a flood. The report covers:

- A Compliance Table
- Site description
- Flood risks and behaviour
- Flood warning
- Evacuation triggers and actions

- A Flood Emergency Response Plan (FERP)

3| Site Details

3.1 Locality

Kingscliff High School is located at 33 Oxford St, Kingscliff, NSW, east of the Kingscliff TAFE NSW campus (Figure 1). The school is on the northern bank of Cudgen Creek.

Figure 1: Locality map of Kingscliff High School (GHD, 2021)

3.2 Site layout and access during construction

Construction will proceed in two stages, and as such the site offices and facilities will have different configurations for the two stages. These facilities will include:

- Perimeter fencing and hoarding
- Vehicle and personnel gates
- Temporary power, water and lighting
- Temporary lock-up
- Sheds:
  - Richard Crookes Site Office
  - Induction/Meeting Room
  - First Aid Shed
  - Lunch Sheds
  - Ablution and wash-up facilities
- Bunded flammable goods store/lock-up
- Unloading areas

During construction there will be a maximum of 80 people on the construction site at any one time. This does not include school students and staff using the school facilities on the wider site.

Construction hours will be between 7am - 6pm Monday to Friday and 8am - 1pm on Saturdays.

3.2.1 Stage 1

The first stage will involve demolition, construction of the library, extension of the administration building, construction of the CAPA building, construction of the COLA and external works.

The site layout during this stage is shown in Figure 2. Several work zones will be established, the largest of which is to the west of the driveway through the school and will contain the site office and other sheds. There will also be four smaller work zones established to the east of the access driveway.

Vehicular access will be maintained along the driveway from Oxford St to the netball courts south-west of the main school buildings. Pedestrian access between Oxford St and the rear of the school will be maintained via various routes between the school buildings east of the driveway.

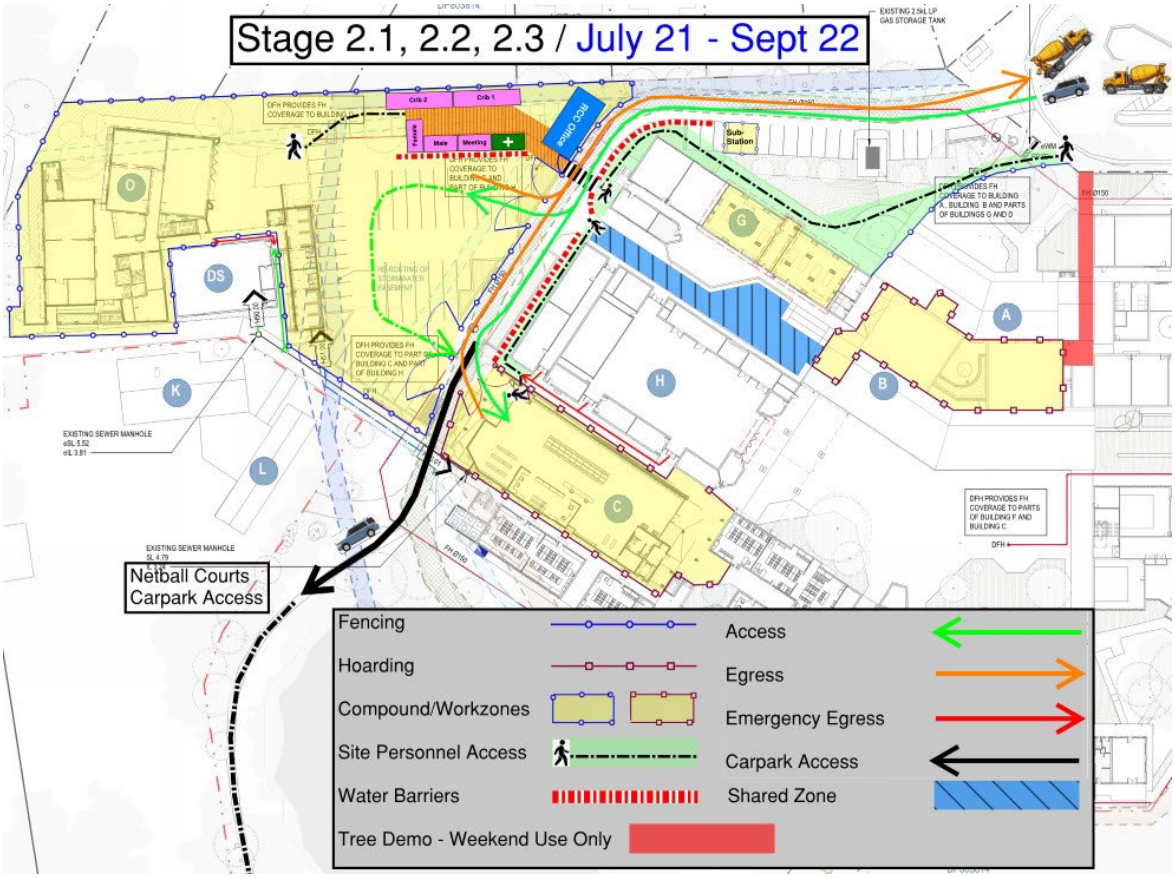

Figure 2: Site layout during Stage 1 (Richard Crookes Constructions, 2021)

3.2.2 Stage 2

The second stage will involve the refurbishment of Block C. The site layout during this stage is shown in Figure 3. Aside from a loading zone along the driveway next to Block H, the only work zone will be around the southern school buildings east of the driveway. The site office and other sheds will be located at the western end of this work zone.

Vehicular access will be maintained along the driveway from Oxford St to the netball courts south-west of the main school buildings. Pedestrian access between Oxford St and the rear of the school will be maintained via the driveway and the areas west of the driveway.

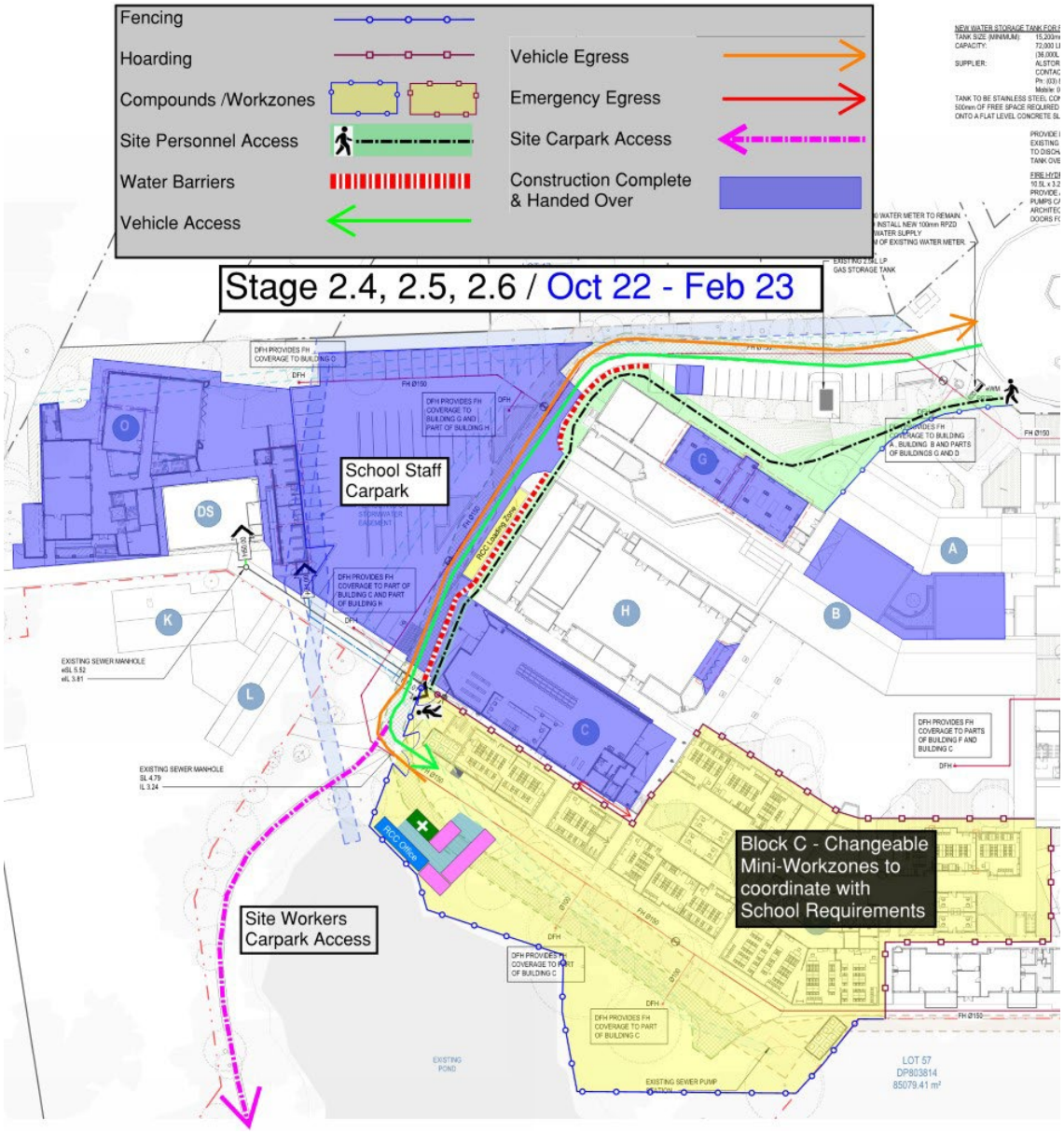

Figure 3: Site layout during Stage 2 (Richard Crookes Constructions, 2021)

4| Flood Risks

4.1 Flood Generating Weather

The seasonality of flooding in the region is the result of two distinct weather patterns: ex-tropical cyclones and intense tropical low depressions close to the coast.

In the early months of the year, tropical cyclones originating in the Coral Sea may move south and there have been occasions when the path of a cyclone has produced rains of duration and intensity to produce flooding of creek catchments in north-east NSW.

Another potential cause of flooding is the development of intense depressions close to the coast which usually form off either southern Queensland or northern NSW in a trough from the Coral Sea or from a shallow system.

Depressions can develop at any time of year but are most likely when sea surface temperatures are high and the air is humid. Therefore, most floods occur in the summer months and over the first half of the year.

Rainfall patterns are also dependent on weather patterns that occur throughout the year. Flooding is more prevalent in a La Nina year when rainfall is significantly greater than the mean average rainfall.

Thunderstorms, which generally occur during the summer, can also result in localised flooding which could impact specifically on the site.

4.2 Flood Probabilities

Flood probability can be expressed in more than one way. For example, a flood may be described as having a 100-year Average Recurrence Interval (ARI). This means that over many thousands of years, a flood of this magnitude would occur on average once in 100 years. This does not mean that a flood of this size only occurs once every 100 years. It is possible to have floods of this size in consecutive years or even two in the same year. This happened in several locations in Victoria in 2010 and 2011.

Another way of expressing flood probability is in terms of Annual Exceedance Probability (AEP). A 100-year ARI flood has roughly a 1 in 100 AEP. That is, each year and every year it has a 1 in 100 or 1% chance of being reached or exceeded. This is perhaps a more helpful way of thinking about flood probabilities. A flood with a 1% AEP has about a 1 in 2 chance of being reached or exceeded in the average person's lifetime, the same probability of tossing a coin and getting a head.

Bigger floods can and do occur. There were several floods with greater than a 1% AEP experienced in Eastern Australia in early 2011. Some, in Queensland, reached levels which have a 1 in 2,000 (0.05%) AEP. A flood with a 1 in 500 (0.2%) AEP has about a 1 in 6 chance of being reached or exceeded in the average person's lifetime, the same as tossing a die and getting a 6.

The largest flood that can occur is referred to as the Probable Maximum Flood (PMF). Although it has a very low probability of occurring in any one year (1 in 10,000 or less), events approaching a PMF have been recorded. Flooding may occur at any time of year and at any time of day.

4.3 Site Flooding

The site is subject to both local overland flooding and to regional creek flooding of Cudgen Creek. Hydraulic modelling conducted by GHD (2021) simulates the impact of the upgrades on overland flow in the local catchment.

4.4 Local Overland Flooding

4.4.1 Flood Depths and Levels

(a) 1% AEP

In the 1% AEP the access driveway is flooded between Oxford St and Block C to depths of between 0.1 and 0.5 m (Figure 4 and Figure 5). Along this driveway the greatest flood depths of up to 0.5 m occur near the north-western corner of Block G and next to Block C. The driveway south of Block L is flood free, as is the netball court carpark.

During Stage 1 of construction the large work zone west of the driveway would be flood free in its western half in the 1% AEP, including the emergency egress route north of the DS building (Figure 2, Figure 4 and Figure 5). The eastern side of the staff carpark, however, will be flooded to depths exceeding 0.5 m. The area containing most of the sheds would have flood depths of less than 0.05 m, although the site office itself would flood to a depth of 0.3 - 0.4 m.

In the 1% AEP event the sub-station north of Block G will flood to depths of up to 0.1 m (Figure 2, Figure 4 and Figure 5). The Block G work zone will not flood as it consists of works within an existing building. In early phases of Stage 1 the Block C work zone may flood to depths of up to 0.5 m, although the access point will only flood to depths of up to 0.2 m. Once surface elevations in this work zone have been altered this area will not flood. Similarly, the work zone between Blocks A and B will flood to depths of up to 0.2 if a 1% AEP event occurs early in construction, but will not flood once surface elevations have been raised. The eastern end of this work zone will only flood to depths of 0.05 m.

During Stage 2 of construction the southern section of the work zone would be flooded to depths of up to 0.4 m (Figure 3, Figure 4, Figure 5). The flooding would be deepest in the area of the site office and other sheds, although depths near the access point to this work zone would not exceed 0.2 m. The loading zone along the access driveway would flood to depths of up to 0.2 m.

(b) PMF

In the PMF the access driveway is entirely flooded from its intersection with Oxford St to south of Block L, with a large section (from the northern side of Block G to the southern end of the school staff carpark) submerged to depths exceeding 0.5 m (Figure 6 and Figure 7). The driveway south of Block L is still flood free, as is the netball court carpark.

During Stage 1 of construction the large work zone west of the access driveway would be flooded mostly to depths less than 0.2 m, although the eastern side of the staff carpark would reach depths greater than 0.5 m (Figure 2, Figure 6 and Figure 7). The emergency egress route north of the DS building will only flood to depths of less than 0.2 m.

The sub-station would flood to depths of up to 0.3 m (Figure 2, Figure 6 and Figure 7). The Block C work zone would flood to depths exceeding 0.5 m if a 1% AEP event occurred prior to surface levels in this work zone being altered, as would the access point to this work zone. The work zone between Blocks A and B will flood to depths of up to 0.4 m before surface levels are altered, although most of the work zone will only have flood depths of less than 0.2 m. The area immediately to the east of this work zone would have a maximum flood depth of 0.2 m.

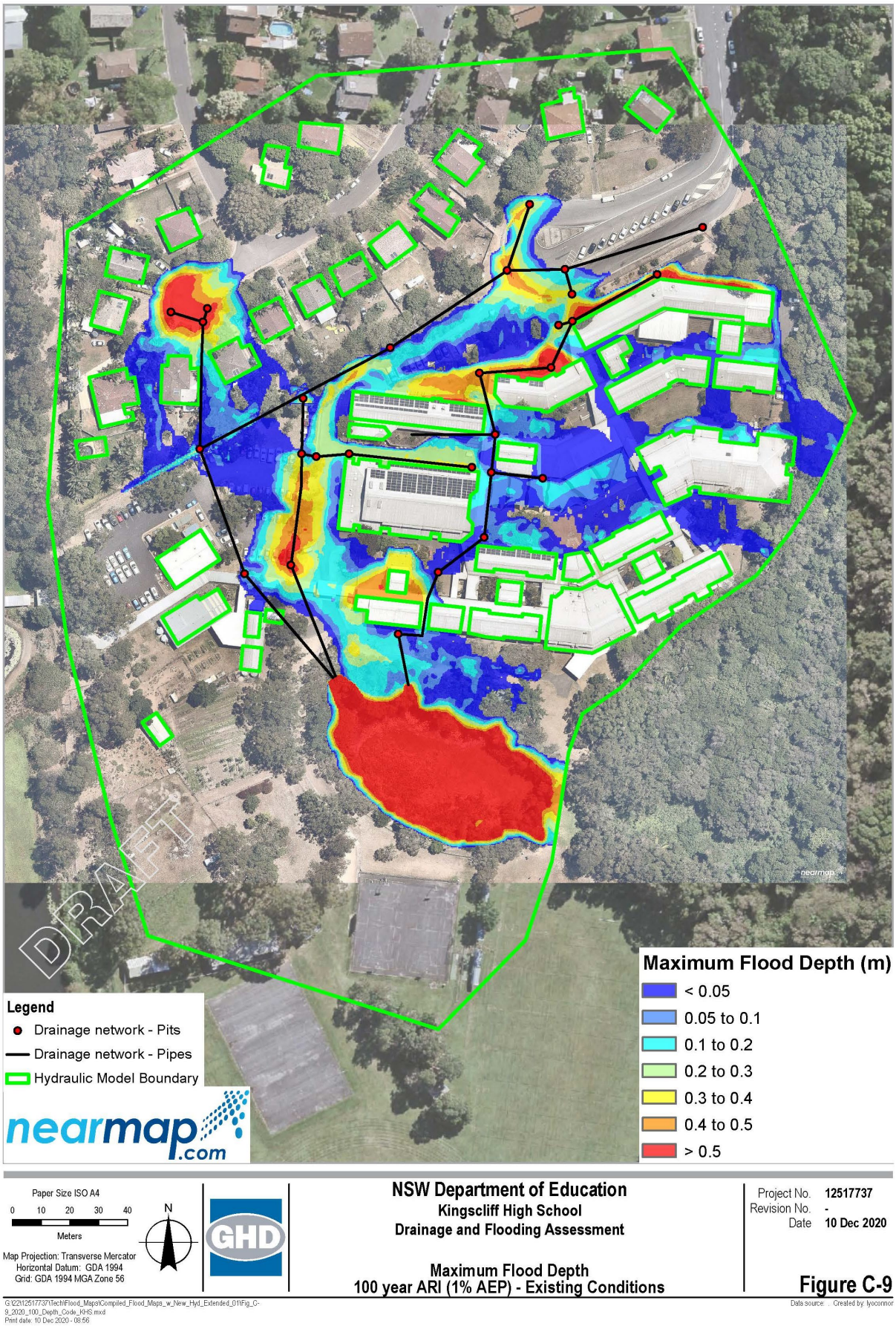

Figure 4: Overland flow 1% AEP flood depths – existing conditions (GHD, 2021)

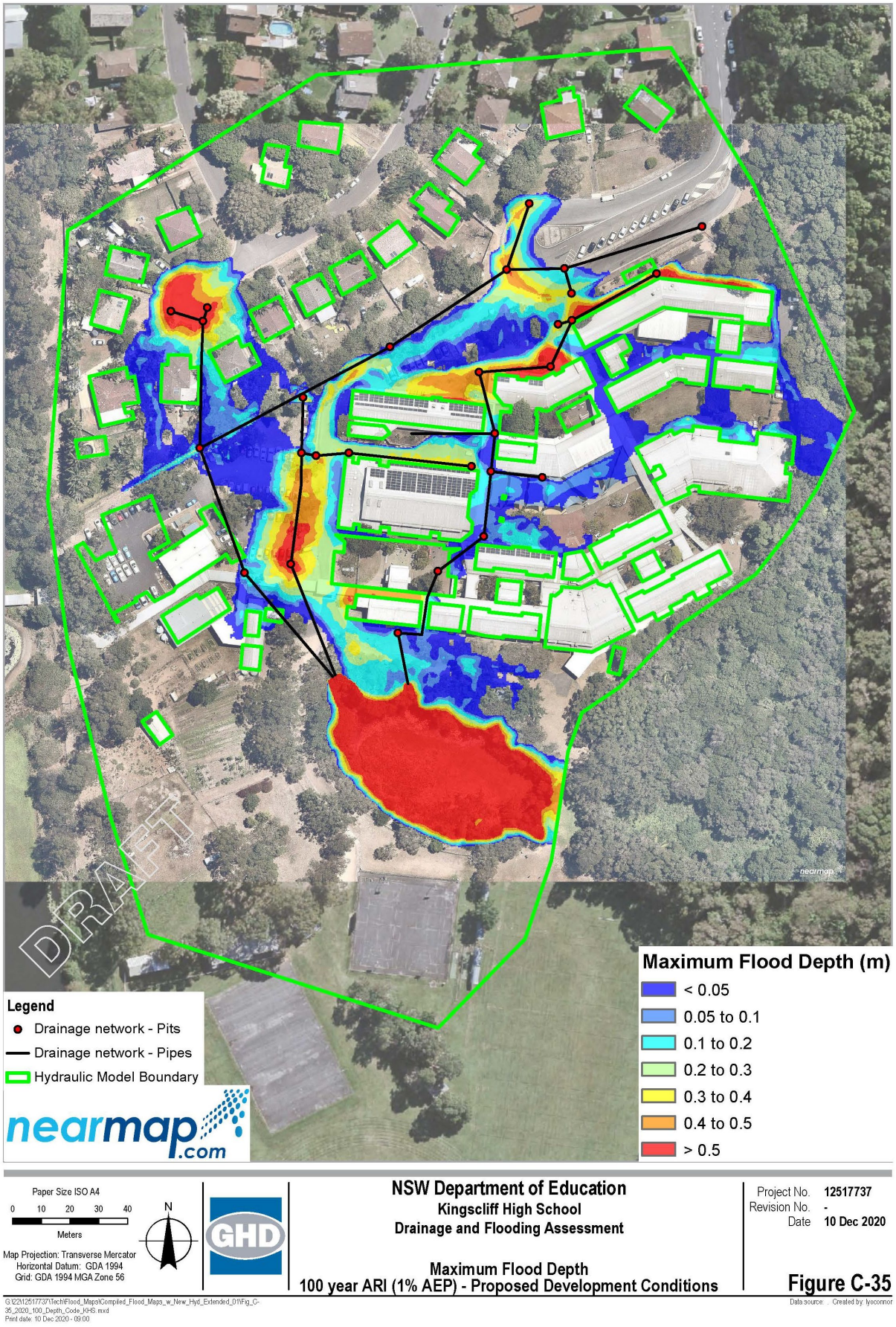

Figure 5: Overland flow 1% AEP flood depths – post-development (GHD, 2021)

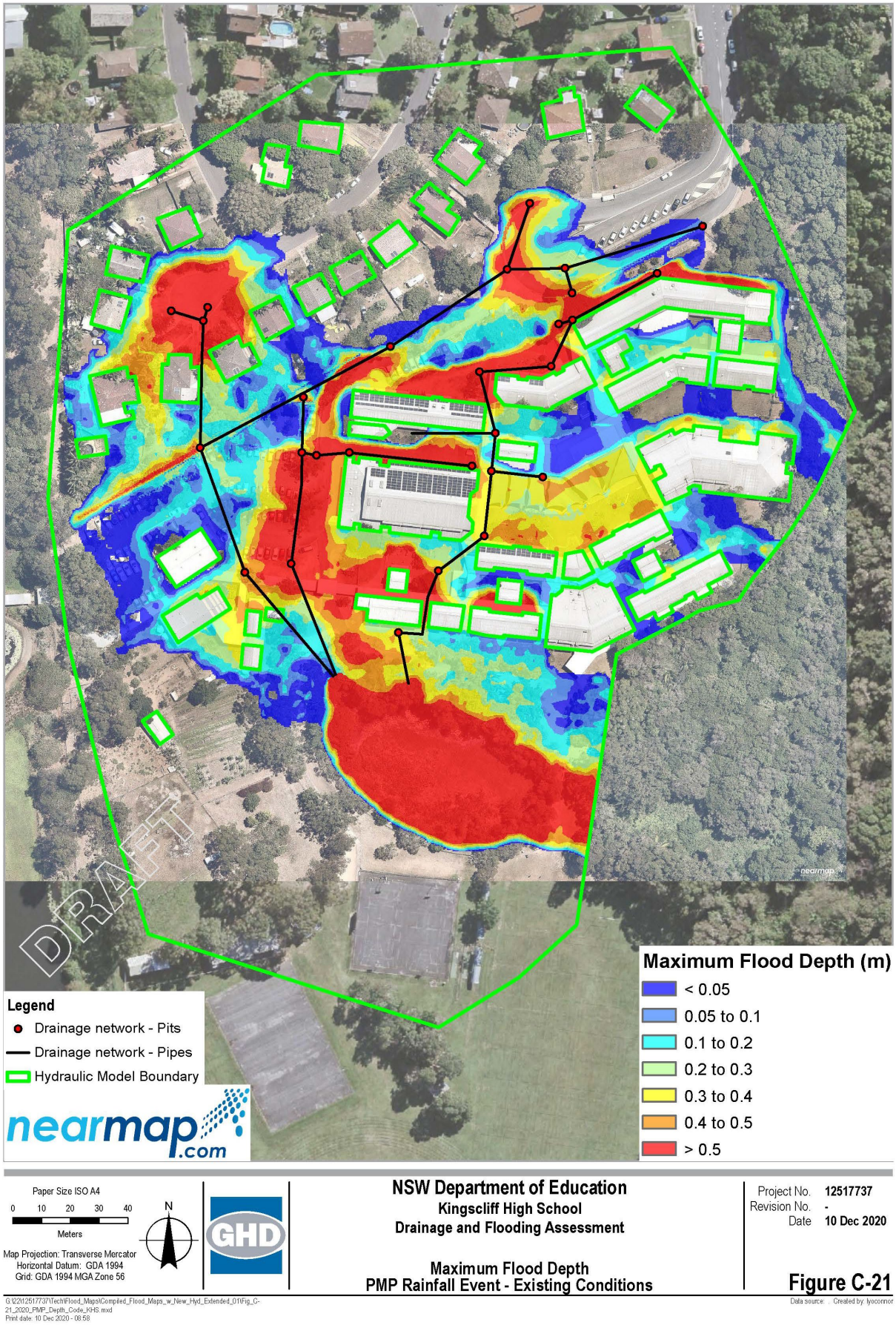

Figure 6: Overland flow PMF flood depths - existing conditions (GHD, 2021)

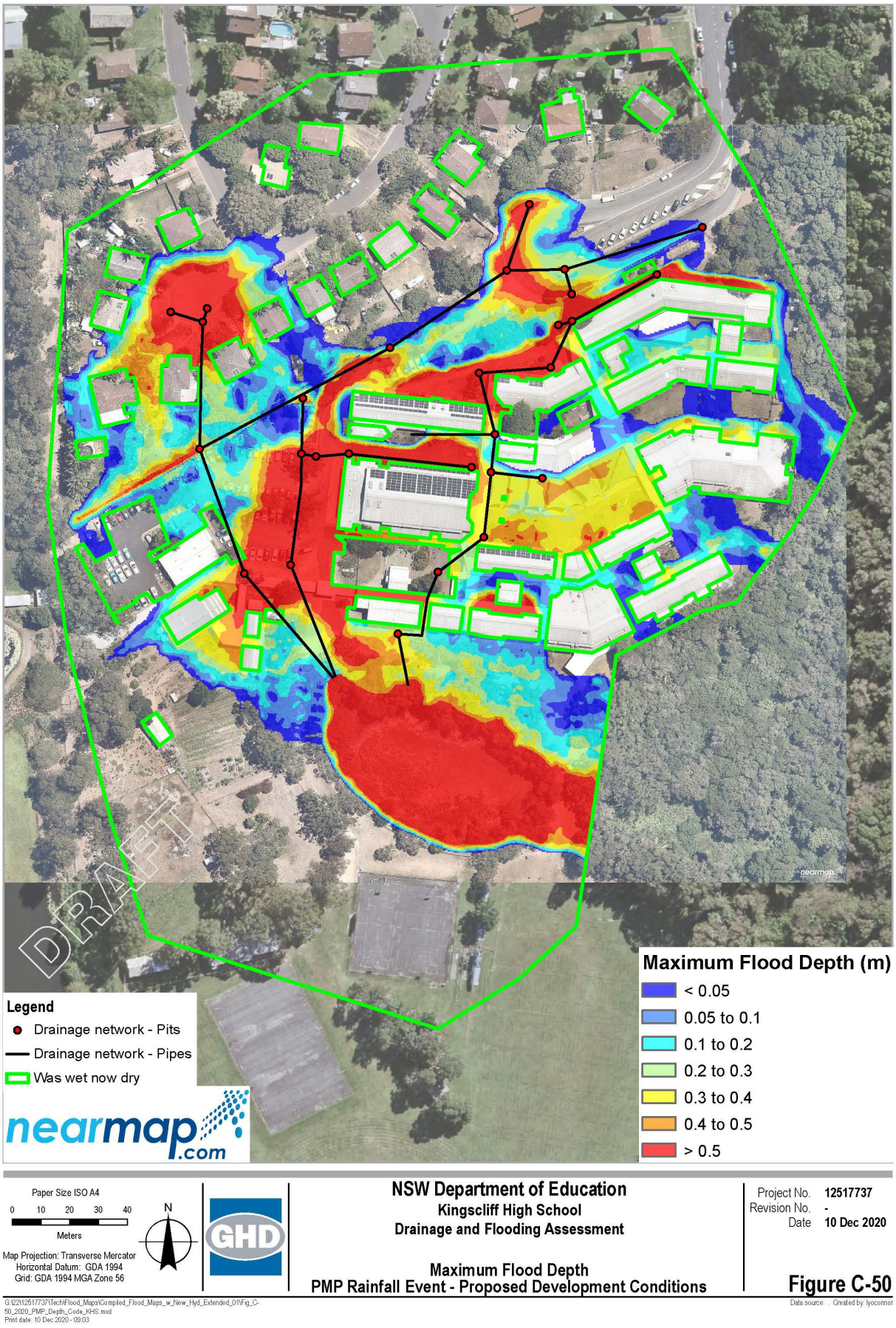

Figure 7: Overland flow PMF flood depths - post-development (GHD, 2021)

During Stage 2 of construction most of the work zone will flood (Figure 3, Figure 6 and Figure 7). In the east flood depths will only reach 0.2 m, but in the west the area with the site office and sheds will have flood depths exceeding 0.5 m in the PMF. The access point to the work zone would also be flooded to depths exceeding 0.5 m. The loading zone along the access driveway would flood to depths greater than 0.5 m.

4.4.2 Duration and Rate of Rise

The design PMF event should be used to identify rates of rise as smaller events could rise this quickly in their early stages, depending on the spatial and temporal distribution of rainfall. The use of PMF rates of rise represents a worst case scenario and is used by the NSW SES in its evacuation planning.

A hydrograph of the local overland flooding PMF event at the southern end of the staff carpark indicates that the PMF event rises at a rate of 0.10 m/min, peaking approximately 12 minutes after the start of the rainfall event (Figure 8). In this event the area remains flooded for a total of approximately 42 minutes before the floodwaters drain away.

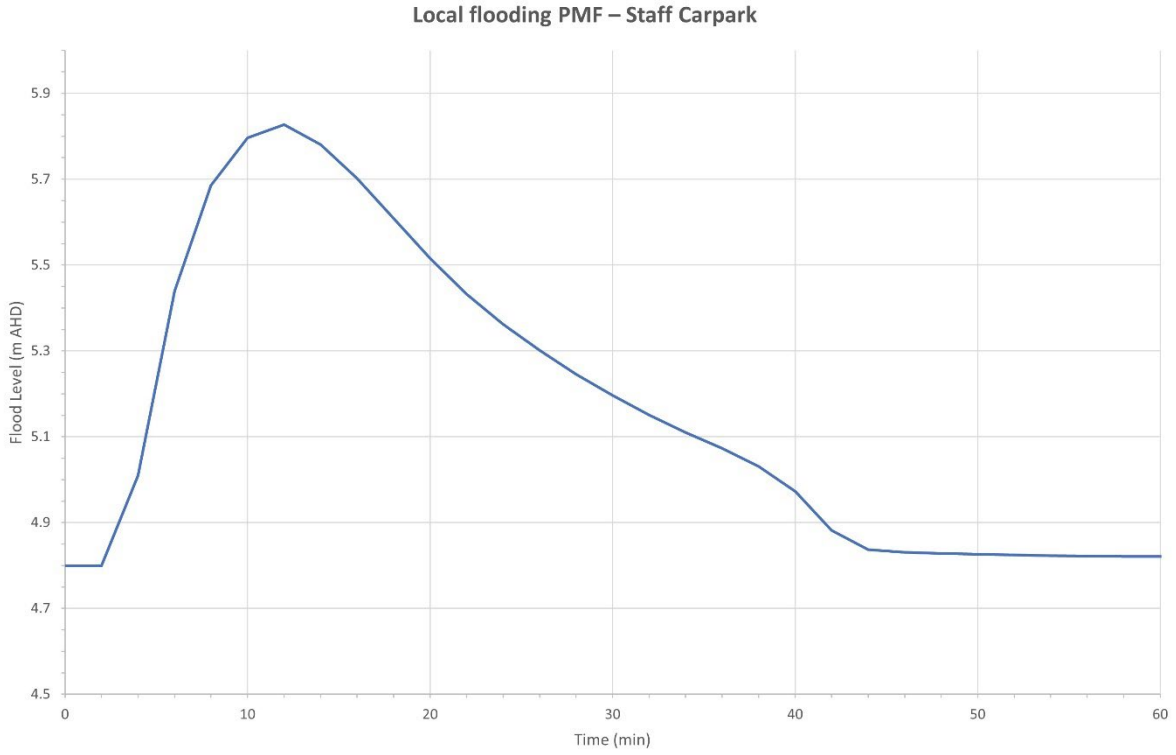

Figure 8: Hydrograph of PMF event for local flooding at the southern end of the staff carpark

4.5 Regional Flooding

4.5.1 Flood Depths and Levels

(a) 1% AEP

During the 1% AEP flood of Cudgen Creek flood levels do not reach the school buildings, the work zones or the netball courts carpark.

(b) PMF

In the PMF flood levels peak at 5.2 m AHD and floodwaters only reach the southern margin of the main school buildings (Figure 9). The access driveway would be flooded by up to 2 m south of Block L, cutting vehicular access between the netball courts carpark

and Oxford St. However, the netball courts carpark itself would remain flood free. Part of the access driveway adjacent to Block H would flood to depths of less than 0.3 m.

During Stage 1 of construction the regional flooding PMF would flood the south-eastern corner of the western work zone by up to 0.3 m (Figure 2 and Figure 9). However, the rest of this work zone, including the northern access point and the site sheds, would remain flood free. Part of the Block C work zone would flood up to 0.3 m, although the access point would also remain flood free.

During Stage 2 of construction most of the work zone would experience flooding, with depths in some areas potentially reaching 2 m (Figure 3 and Figure 9). Flood depths at the access point to the site would reach up to 0.3 m. The loading zone along the access driveway would be flood free.

4.5.2 Duration and Rate of Rise

A hydrograph of the regional flooding PMF event on the eastern bank of Cudgen Creek directly opposite Kingscliff High School indicates that the PMF event rises at an average rate of 0.16 m/h (Figure 10). It starts to flood the south-eastern corner of the staff carpark (with a minimum elevation of 4.85 m AHD) approximately 30 hours after the start of the rainfall event and the carpark remains flooded for 10.5 hours.

The PMF would start flooding the southern part of the Stage 2 work zone when the flood level reached approximately 4.0 m AHD, which would occur 25.5 hours after the start of the rainfall event. Parts of this work zone would remain inundated for 24 hours.

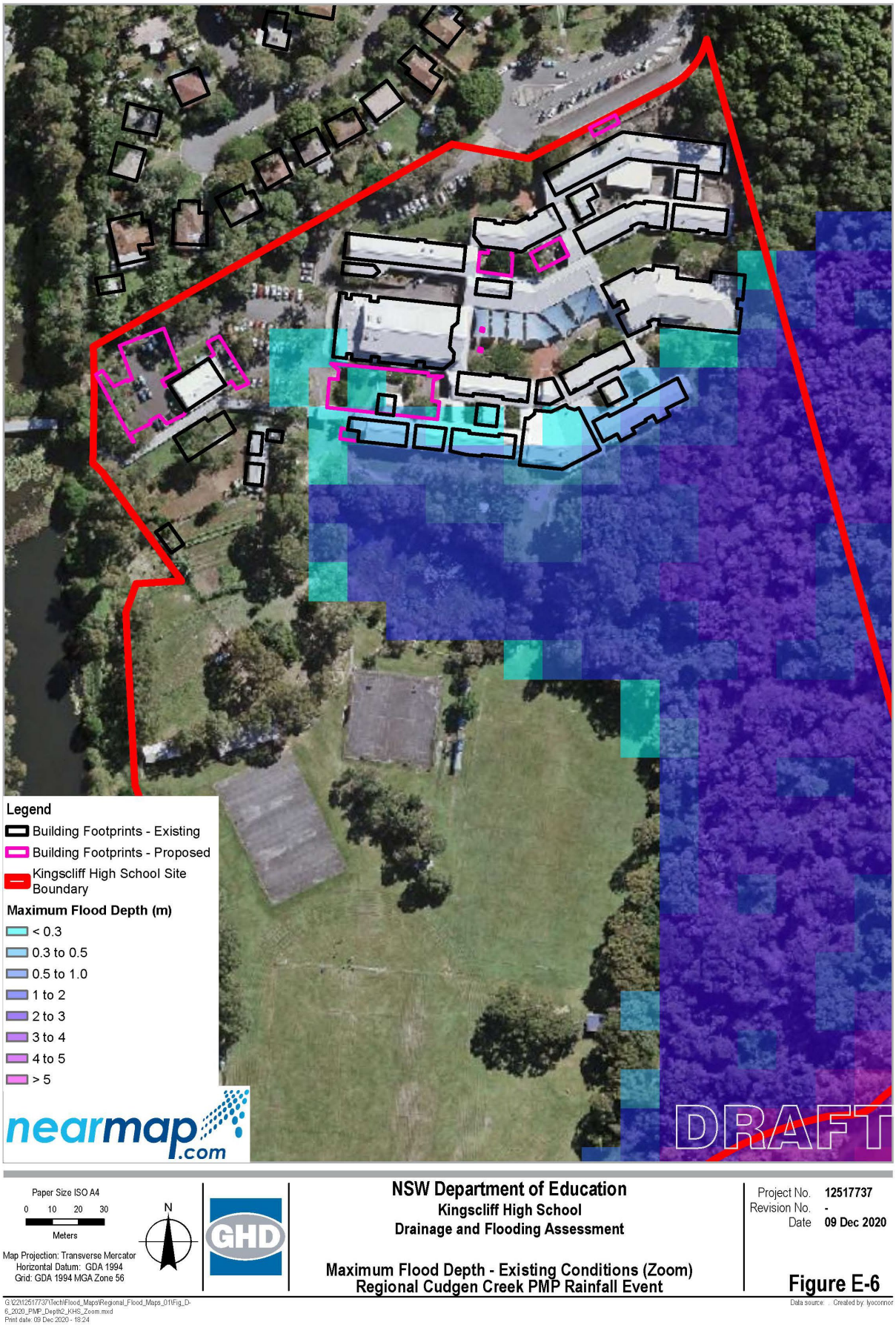

Figure 9: Regional flooding Cudgen Creek PMF flood depths (GHD, 2021)

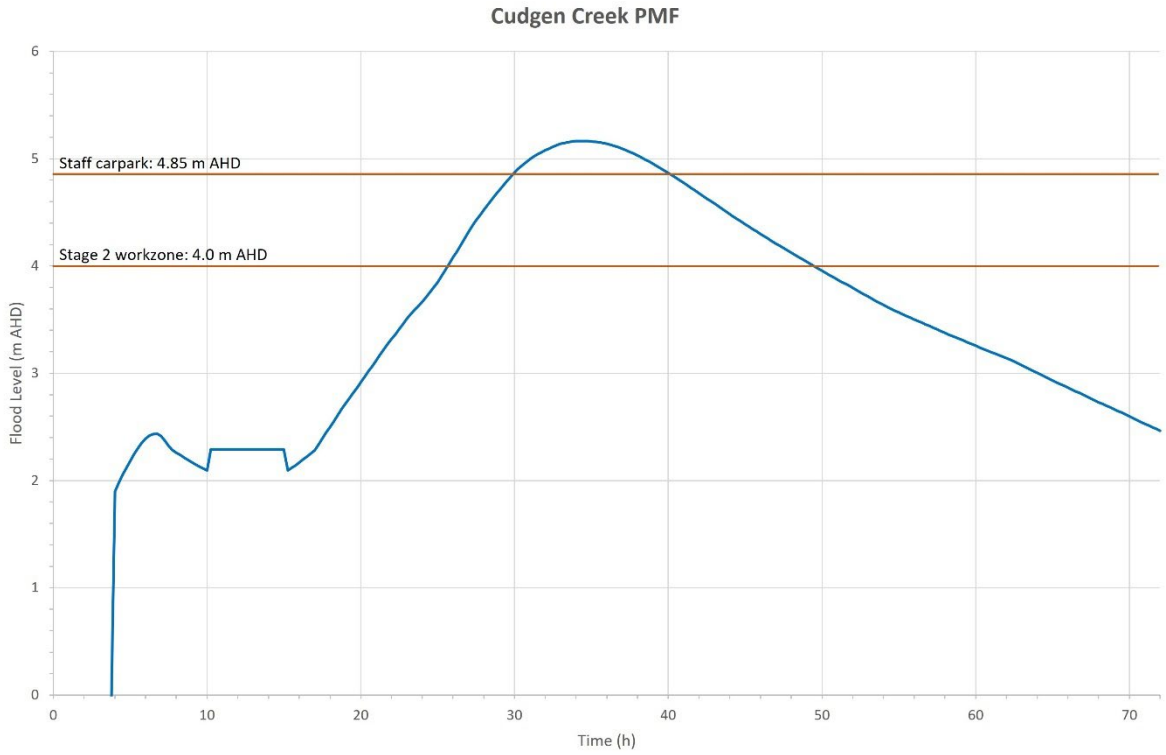

Figure 10: Hydrograph of PMF event for regional flooding

5| Flood Emergency Response

5.1 Emergency Response Philosophy

This Plan recognises that protection of life is of critical and primary importance. Consistent with any emergency protocol, the protection of all lives is the first priority and the protection of property is second.

The proposed response to a flood is to evacuate the construction site by foot or shelter inside buildings or sheds with raised floor levels on site as soon as rising water is observed. Any evacuation can stop as soon as floodwaters recede on site.

5.2 Evacuation Triggers

There will be no available flood warning other than seeing rising water on site.

5.2.1 Bureau of Meteorology

While there are no available flood warnings, the Bureau of Meteorology (BoM) has a number of generalised warning products that could provide an indication of an increased flood threat at the site.

Forecast rainfall maps can be used to estimate the amount of rain expected to fall over the next four days, as well as the next 24 hours. This information is available at:
http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp

The BoM also issues weather warnings for New South Wales and these can be found at the following link:
http://www.bom.gov.au/nsw/warnings/

A few useful warning products offered by the BoM include:

(a) Severe Weather Warnings

The BoM issues Severe Weather Warnings whenever severe weather is occurring in an area or is expected to move into an area. The warnings describe the area under threat and the expected hazards. Warnings are issued with varying lead-times, depending on the weather situation, and range from just an hour or two to 24 hours or sometimes more. The key subtype of Severe Weather Warning to be monitored for the site are warnings with reference to the Northern Rivers forecast district. Severe Weather Warnings may also include other conditions such as damaging winds.

(b) Severe Thunderstorm Warnings

A severe thunderstorm may produce intense rain and flash floods, hail, damaging winds, and even tornadoes. The BoM provides two types of Severe Thunderstorm Warnings:

- Detailed Severe Thunderstorm Warnings. These are issued for capital cities only with up to 60 minutes of notice, and provide more specific information on individual severe thunderstorm locations;
- Broad-based State-wide Warnings. These are based on broad areas such as the Bureau's weather forecast districts, and are issued with up to 3 hours' notice.

(c) Flood Watches

Flood Watches are an early advice of increased flood risk over a catchment by the Bureau up to four days in advance of large-scale weather systems that have the potential to cause flooding. Flood Watches are distributed to the media by the Bureau and are published on the Bureau website. The BoM Flood Watch Area relevant to the site is area 64 "Brunswick River and Marshalls Creek". A map of the BoM Flood Watch Areas for New South Wales can be found at the following link:

http://www.bom.gov.au/water/floods/image/BOM_Flood_Watch_Areas_map_NewSouthWales_2017.pdf?=v3

(d) Tropical Cyclone Watch

BoM Tropical Cyclone Watches are an early advice of increased cyclone risk, which have the potential to cause flooding.

5.3 Flood Assembly Points

As overland flooding has the potential to cut access between the work zones to the east and west of the access driveway, two flood assembly points have been nominated (Figure 11). The first (Assembly Point A) is the netball courts carpark (the construction carpark) south-west of the main school buildings. The second (Assembly Point B) is the carpark in front of the school on Oxford St.

5.4 Flood Evacuation Routes

5.4.1 Stage 1

If flooding occurs on site during Stage 1 of construction, personnel in the Block G work zone, the work zone between Blocks A and B and the Block C work zone should evacuate east and then northwards to Assembly Point B (Figure 12).

Personnel in the work zone to the west of the access driveway should evacuate south to Assembly Point A. If the access driveway is free of flood waters, site personnel may proceed to evacuate the site by vehicle. If the driveway is flooded, personnel should wait until floodwaters have receded before driving off site. No one should drive through floodwaters.

The evacuation routes shown in Figure 12 should be followed to minimise the risk of walking through hazardous floodwaters.

Personnel should not shelter in the site office as it is at risk of flooding to depths of up to 0.5 m during Stage 1. If evacuation fails, personnel can shelter in buildings or structures on site with elevated floor levels.

5.4.2 Stage 2

If flooding occurs on site during Stage 2, personnel in the work zone south of the main school buildings should evacuate south-west to Assembly Point A (Figure 12) only if the access driveway is free of flooding between this work zone and the netball courts. If the access driveway through the school is still free of flood waters when personnel have reached their vehicles, they may proceed to evacuate the site by vehicle. If the driveway is flooded, personnel should wait until floodwaters have receded before driving off site. No one should drive through floodwaters.

On the other hand, if floodwaters along the access driveway prevent evacuation from the work zone to Assembly Point A, personnel should instead evacuate north-east from the work zone to Assembly Point B.

The evacuation routes shown in Figure 12 should be followed to minimise the risk of walking through hazardous floodwaters.

Personnel should not shelter in the site office or in the sheds on site as these are at risk of flooding to depths exceeding 0.5 m. If evacuation fails, personnel can shelter in buildings or structures on site with elevated floor levels.

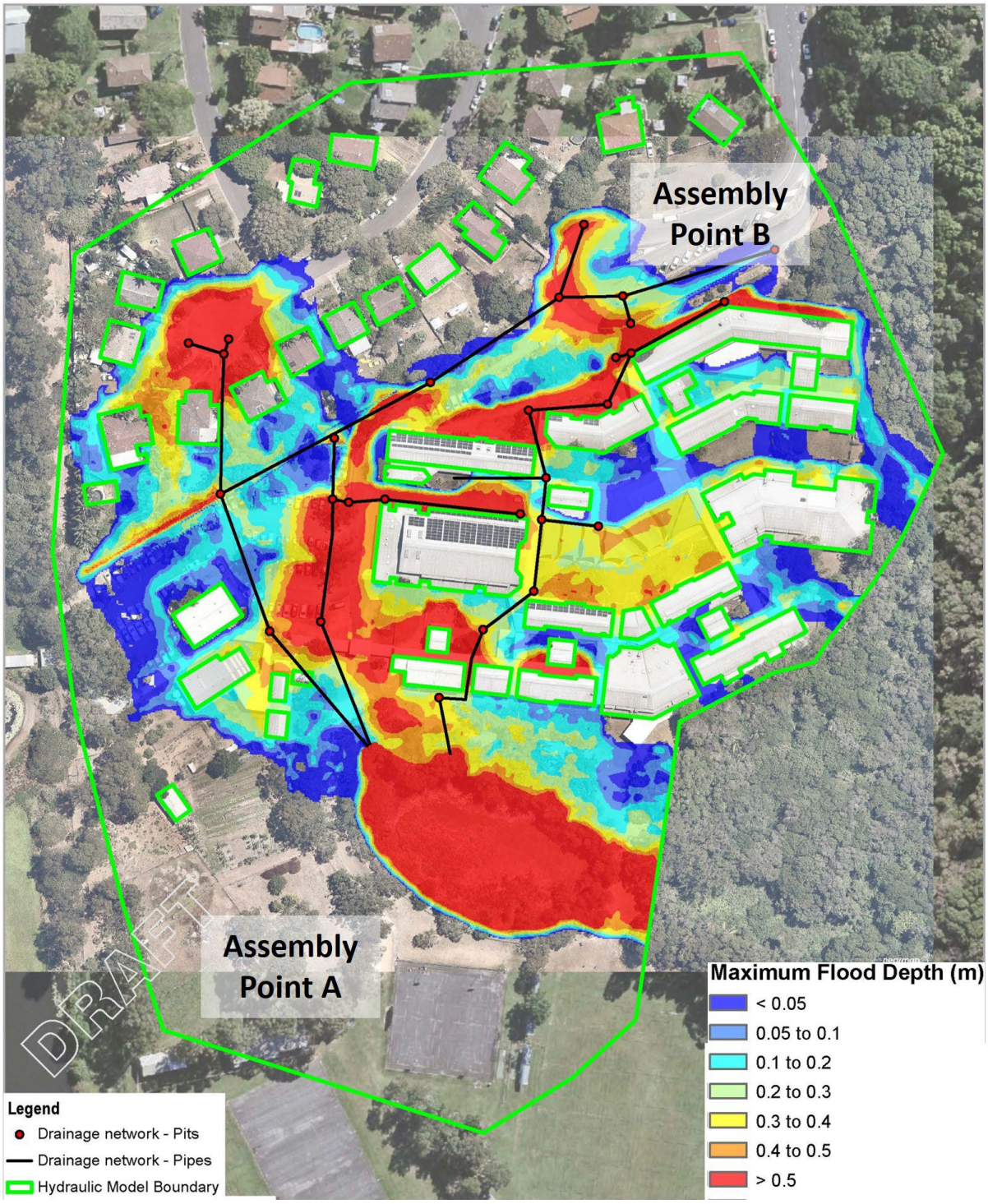

Figure 11: Assembly points shown on flood depth map for overland flow PMF event under existing conditions. Base map from GHD (2021).

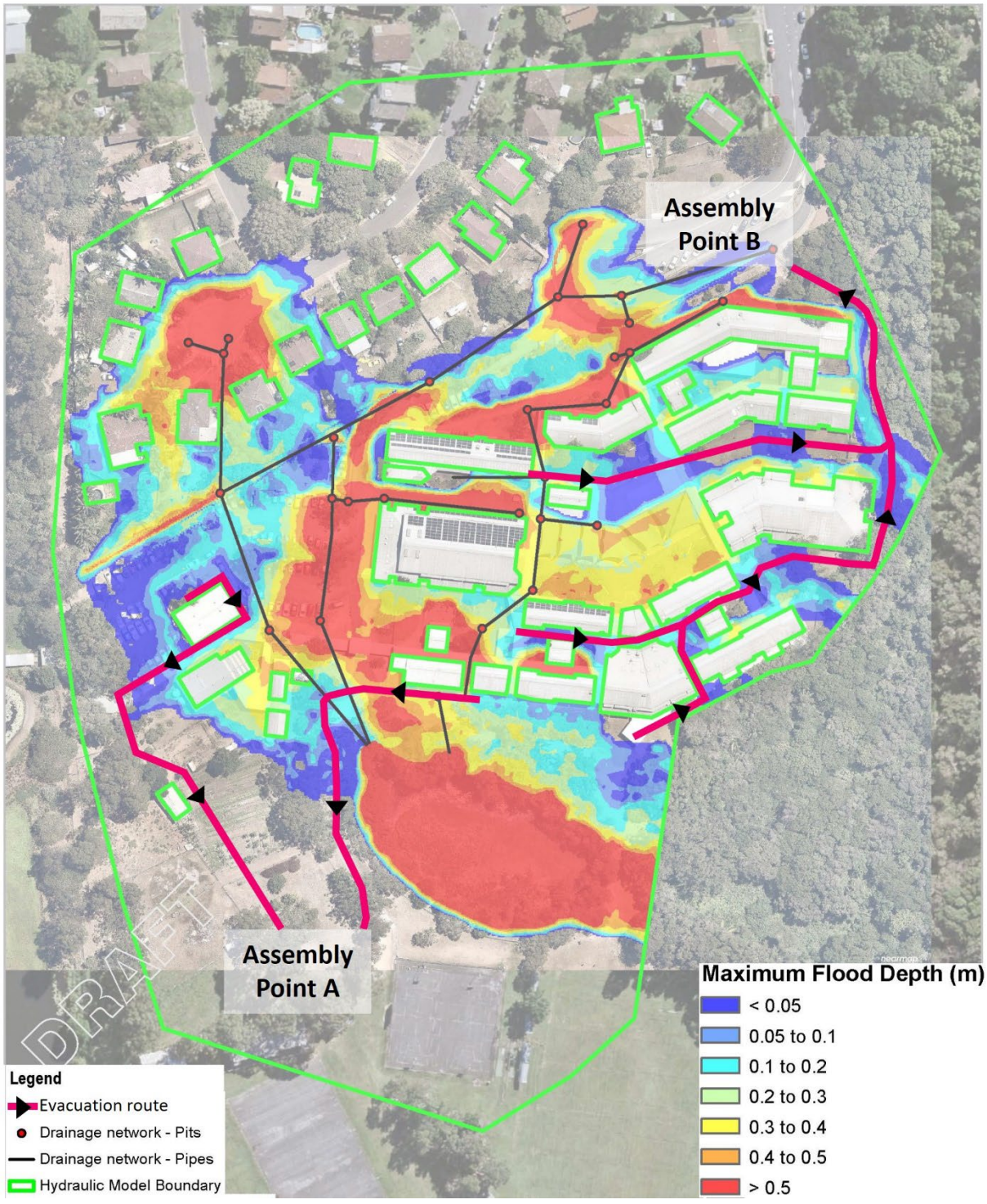

Figure 12: Evacuation routes shown on flood depth map for overland flow PMF event under existing conditions. Base map from GHD (2021).

6 | Flood Emergency Response Plan

This section describes the flood emergency plan requirements and the actions to be undertaken before, during and after a flood to reduce risks to personnel on site to an acceptable level.

6.1 What to Do in a Flood Emergency

6.1.1 Before a Flood

Trigger for action: Always

Actions

- Actions from Section 6.1.3 of this report will be included in the WHS site induction.

6.1.2 When a Flood is Possible

Trigger for action: Heavy rainfall is forecast

Actions

- There is low probability of construction work areas, plant or materials being damaged by flooding. Therefore, there are no special actions required for their protection.
- The site supervisor should remind staff of the flood evacuation routes and assembly points

6.1.3 During a Flood

Trigger for action: Rising overland floodwaters are observed on site (ie. rising water is observed while water is flowing downhill from the front of the school)

Actions

- Personnel should evacuate on foot to either Assembly Point A or Assembly Point B (see Figure 12 for evacuation routes)
- Do not drive through floodwaters. If the access driveway is flooded, wait for floodwaters to recede before driving off-site. Floodwaters should recede within an hour
- If personnel fail to evacuate the site, they should shelter in buildings or structures with elevated ground floor levels
- Do not shelter in the site office
- If flooding occurs during Stage 2, do not shelter in any of the site sheds.

Trigger for action: The site is threatened by flooding by Cudgen Creek (i.e. floodwaters are observed rising from the south)

Actions

- Personnel should evacuate on foot to either Assembly Point A or Assembly Point B (see Figure 12 for evacuation routes)
- Leave the site via the main entrance, either by car or by foot
- Do not drive through floodwaters on site or off site
- If the access driveway is flooded, wait for floodwaters to recede before driving off-site. Floodwaters should recede within 24 hours
- If personnel fail to evacuate the site, they should shelter in buildings or structures with elevated ground floor levels

- If flooding occurs during Stage 1 it is safe to wait in the site sheds or at Assembly Point A (the netball courts carpark) for floodwaters to recede
- If flooding occurs during Stage 2, do not shelter in any of the site sheds or the site office. It is safe to wait at Assembly Point A for floodwaters to recede.

6.1.4 After a Flood

Trigger for action: Floodwaters have receded and no longer threaten the site

Actions

- Richard Crookes Construction will organise access to the site making sure that any precautionary measures recommended by the NSW SES are put in place
- Extra care will be taken of potential slips on a muddy floor if floodwaters have entered the ground floor of buildings
- All flood-affected parts of the site will be appropriately cleaned and utilities checked by professionals before construction can recommence
- A hazard assessment will be undertaken for the clean-up, safe work methods statements will be prepared and personal protective equipment supplied consistent with the known hazards which can be associated with floods:
    - Slips, trips and falls;
    - Sharp debris;
    - Venomous animals;
    - Contaminated water and sediments.
- Following the re-commencement of construction activities, a de-brief will be held with key management staff and may involve Council flood staff or the local NSW SES. The flood event and response including the use of this FERP and any emergency procedures will be reviewed
- Changes may be made to this Plan and the requirements for future emergency response should the review identify any improvements which may be made.

References

GHD (2021). SINSW01427-20 – Kingscliff High School Flooding Assessment Phase 2.

Richard Crookes Constructions (2021). Construction Management Plan – Kingscliff High School.

Appendix 1 | Curriculum Vitae

STEVEN MOLINO

Current Role

Company Principal

Qualifications

Bachelor of Science (Physical Geography and Environmental Chemistry). University of New South Wales

Bachelor of Engineering (Civil) (Hons). University of New South Wales

Exemplar Global Certified Lead Environmental Auditor (13515)

Affiliations

Member, Engineers Australia

Registered Professional Engineer NPER 3 Civil and Environmental (1053737)

Role: Project Director and Emergency Management Specialist

My Accountabilities on this Project

- Ensuring that all aspects of the project meet client expectations
- Allocating necessary resources to ensure milestones are met
- Expert input to project deliverables
- Quality Assurance of deliverables

Why my track record, experience and character makes me ideally suited to this project:

I have been working in floodplain management since 1991 including in the highest risk floodplains in Australia. Having researched and developed methodologies for flood damage assessment, I have estimated flood damages using databases of more than 20,000 properties on more than one occasion. My expertise in flood warning, emergency planning and evacuation analysis is recognised internationally and I helped the NSW SES refine and implement its evacuation timeline model which I have used for populations of up to 75,000. I have developed flood emergency response plans for numerous premises and developed the Business FloodSafe toolkit used by the NSW and Victoria SES. I have evaluated several flood warnings and evacuations in NSW and Victoria. My technical expertise, analytical skills and ability to communicate technical concepts have been used to good effect in floodplain management, option evaluation and expert testimony in Queensland, New South Wales and Victoria.

Lessons learnt from my past project experience that will be relevant on this program:

My extensive experience utilising the NSW SES Timeline Evacuation Model in developing evacuation plans for numerous developments has provided me with intimate knowledge of evacuation planning and risk assessment.

Track Record & Relevant Experience

***Project*:** **Evacuation Assessment Tool and Guideline**

Client/Location: NSW State Emergency Service – Wollongong

Role & Company: Project Director and Evacuation Modelling Specialist, Molino Stewart

Duration of Role: Mar – Dec 2012 Value: $ 50K

Description of Project:

The NSW SES has developed the Flood Evacuation Timeline as a method for planning the evacuation of communities during floods. It can be used to highlight the critical stages of the evacuation and subsequently improve planning for flood events. Additionally, the method can be used by councils and developers in the development planning process by applying the tool to proposed development. This project took the method developed by the SES and developed a technical guideline for implementing the methodology as well as a user friendly Excel-based tool to implement it

Key Relevant Tasks Performed:

- Refinement of the timeline evacuation methodology to include consideration of traffic convergence and pedestrian evacuation
- Verification of SES recommended assumptions
- Creation of a spreadsheet based tool
- Writing of a guide on how to undertake evacuation modelling using the tool.

Outcomes & Accomplishments Achieved:

- Simple to use tool with clear steps for inputting data
- A tool which provides detailed calculations but also a concise summary of the analysis
- Detailed guideline explaining the model concept, potential data sources, logic of assumptions, how to use the tool and how to interpret the outputs

North West Sector Flood Evacuation

Client/Location: NSW Department of Planning

Role & Company: Project Manager and Flood Specialist, Molino Stewart

Duration of Role: 2009 – Feb 2011 Value: $50K

Description of Project:

Proposed development on the floodplain of the Hawkesbury-Nepean River presents significant challenges to flood evacuation on an arguably over developed floodplain. The NSW Department of Planning commissioned Molino Stewart to develop a regional flood evacuation model, using the NSW SES Timeline Evacuation Model, of all urban areas within the floodplain. The purpose of the model was to inform planning of regional evacuation and evacuation infrastructure needs and determine the capacity for future development across the floodplain.

Key Relevant Tasks Performed:

- Determination of the at-risk population within the Hawkesbury-Nepean floodplain
- Development of a regional flood evacuation model for the Hawkesbury-Nepean floodplain, which includes some 75,000 residents.
- Evaluation of the capacity of evacuation routes, both now and into the future
- Determination and assessment of options for evacuation route upgrades

Outcomes & Accomplishments Achieved:

- Development of large scale evacuation model with consideration of traffic convergence issues
- Statistical data analysis and parameterisation of variables
- Determination of critical locations along evacuation routes
- Identification and assessment of potential evacuation route upgrades
- Clear reporting of methodologies and outcomes

Project:	**North Byron Parklands – Flood Emergency Response Plan**
Client/Location:	North Byron Parklands, NSW
Role & Company:	Project Manager, Molino Stewart
Duration of Role:	April 2011 – April 2013 Value: $35k

Description and Relevance of Project:

Splendour in the Grass is one of Australia's premier music events and had been held in Byron Bay for several years. It had outgrown its original venue and North Byron Parklands was purchased with the view to develop it as the new venue for Splendour in the Grass. The parklands are expected to host events ranging in size from 300 people to 50,000 people, which would involve the development of permanent infrastructure. The site lies on two floodplains divided by a ridgeline. Molino Stewart was commissioned by the North Byron Parklands owners to develop a flood emergency response plan and advice on flood risk mitigation measures.

Key Relevant Tasks Performed:

- Identified flood safety risks associated with events at the North Byron Parklands
- Quantified numbers of at risk persons, likelihood of flood events occurring and possible consequences of not implementing a flood risk management plan
- Evaluated risks and identified possible controls to mitigate risks
- Developed and undertook Evacuation Timeline Modelling for larger events
- Designed and installed a flash flood warning system which was integrated into existing Bureau of Meteorology gauging infrastructure.
- Prepared a detailed Flood Emergency Response Plan for use before, during and after events.

Outcomes & Accomplishments Achieved:

- Flood risks accurate identified
- Flood risk mitigation options identified and evaluated
- Warning system installed and commissioned
- Practical emergency evacuation plan developed

Project:	**Review of Total Flood Warnings – Sept 2010 – Feb 2011**
Client/Location:	Victoria Floods Review – Victoria
Role & Company:	Project Director, Molino Stewart
Duration of Role:	June 2011 – Sept 2011 Value: $60,000

Description and Relevance of Project:

Between September 2010 and February 2011 there was extensive flooding across almost all of Victoria with 400 towns being flooded, many two or three times. Record flooding occurred on many of the river systems, thousands of residents were advised to evacuate but many were caught unawares by the rapidly rising floodwaters and others did not appreciate just how high the water could come. The Victoria Floods Review was established to investigate all aspects of the floods and make recommendations to the State Government on how the communities and emergency service agencies could be better prepared and changes needed to be made in flood warning and recovery to reduce the extent of damages in the future. Molino Stewart was engaged to prepare a report on all aspects of flood warning from data collection, through forecasting and warning dissemination to community response to warnings. A sample of events across several catchments from September 2010 to February 2011 were investigated.

Key Relevant Tasks Performed:

- Developed methodology for evaluating the accuracy and timeliness of Bureau of Meteorology flood forecasts and applied to several key gauges across the sample events investigated
- Identified how data collection networks and flood forecasting methodologies contributed to warning outcomes
- Interviewed key stakeholders involved in the warning process including forecasters, incident controllers, intelligence officers and local commanders
- Reviewed community feedback and media reporting of events to gauge how well messages were received, understood and acted upon
- Reported findings

Outcomes & Accomplishments Achieved:

- Final Victoria Floods Review Report and its recommendations strongly reflected the findings of our investigations.

***Project*:**	**Hawkesbury-Nepean Flood Damages Assessments**
Client/Location:	Infrastructure NSW – Sydney, NSW
Role & Company:	Project Manager, Molino Stewart
Duration of Role:	May 2012 – May 2014 Value: $700,000

Description and Relevance of Project:

As part of the 20 Year Sydney Infrastructure Strategy, Infrastructure NSW investigated the flooding impacts in the Hawkesbury Nepean Valley and the potential for these to be reduced through construction of mitigation infrastructure. Molino Stewart was engaged in determining the potential flood damages and the benefits of various mitigation options. This included significant updates to 20 year old residential, commercial and industrial property databases and liaison with infrastructure owners to obtain updates on previous work undertaken by Molino Stewart about how these would be affected by flooding. I was the Project Manager and had a hands-on role in guiding and checking the data updates and the flood damage calculations due to my long history with damages assessment in the Valley.

Key Relevant Tasks Performed:

- Developed methodology for updating the property database which now includes approximately 30,000 buildings, including key attributes such as building type, size, number of stories and floor levels
- Conducted international literature search into best practice methodologies for estimating flood damages for residential, commercial and industrial properties as well as a range of infrastructure asset types
- Estimated damages to future development using subdivision plans, planning schemes and release areas
- Compiled aggregated damages across 400km^2 of floodplain, along 150km of river, for 13 asset classes for 11 flood frequencies for 13 different mitigation options for existing and future development scenarios
- Prepared standard economic analyses of mitigation options using AAD and NPV
- Prepared report and presented findings

Outcomes & Accomplishments Achieved:

- The work was undertaken in three stages from preliminary estimates, to more detailed estimates for a broad range of options to detailed analysis for optimising a preferred option.

Project:	**Moreton Bay Regional Flood Database**
Client/Location:	Moreton Bay Regional Council – SE Qld
Role & Company:	Strategic Advisory Group Member, Molino Stewart
Duration of Role:	June 09 – June 2013 Value: $100k

Description and Relevance of Project:

Moreton Bay Regional Council embarked on an Australian first process of developing a comprehensive LGA-wide GIS database of topographic data and using that along with one hydrological modelling program, one hydraulic modelling program, and consistent assumptions across all catchments, to simultaneously produce flood models for 13 catchments covering 2,000km^2. The outputs were then used to inform floodplain planning, emergency response and community education.

Key Relevant Tasks Performed: *Member of Strategic Advisory Group guiding the project development and implementation;*

- Technical expert providing advice on landuse planning, emergency planning, warning and community education;
- Author of floodplain management framework.

Outcomes & Accomplishments Achieved:

- Collection and collation of GIS layers for elevation, bathymetry, streams, land cover, floor levels, bridges and culverts, roads and critical infrastructure
- 75% of catchments modelled, calibrated and verified in less than 3 years;
- Development of a leading practice, risk-based floodplain planning framework for urban development and infrastructure planning;
- Creation of a cutting edge web-based interface for communicating flood risk at a community wide and individual property level

Project:	**Penrith CBD Floodplain Risk Management Study and Plan**
Client/Location:	Penrith CBD
Role & Company:	Project Director and Senior Hazard Analyst, Molino Stewart
Duration of Role:	October 16 – Ongoing Value: $170,000

Description and Relevance of Project:

Molino Stewart was engaged to lead the preparation of the new Floodplain Risk Management Study and Plan for Penrith CBD. The work built upon a flood study covering a 34km^2 catchment with very high resolution, which however required extensive review and upgrades. As part of the project, Molino Stewart led an innovative bottom-up approach to community engagement, based on "drop in" session, use of community forums and dedicated communication channels to reach out to specific stakeholders, including the developer community and the Chamber of Commerce. Additional tasks included the identification and evaluation of flood mitigation options. This resulted in advanced strategic planning and emergency response measures to balance high-rise redevelopment and flood risk, and may adopt a shelter in place approach where appropriate.

Key Relevant Tasks Performed:

- Review and updated of flood models
- Community engagement
- Flood damages assessment and mapping

- Analysis of related environmental and social Issues
- Evaluation of flood mitigation options, including cost benefit analysis
- Public exhibition preparation and reporting
- Direct liaison with key stakeholders including the relevant NSW State Agencies
- Reporting

Project:	**Bow Bowing Bunbury Curran Creek (BBBC) Floodplain Risk Management Study and Plan**
Client/Location:	Campbelltown LGA (NSW)
Role & Company:	Project Director
Duration of Role:	2015 – 2019 Value: $240,000

Description and Relevance of Project:

The Bow Bowing Bunbury Curran Creek catchment (90km²) is located in the City of Campbelltown (population 150,000), 53km south west of the Sydney CBD. The catchment is a mixture of rural, residential, commercial, industrial and open space land use. It is predominantly residential land use with large areas of open space. There are significant localised industrial areas at both Minto and Ingleburn. The main commercial hubs are in Campbelltown/Macarthur and Ingleburn. Large parts of the area are proposed for urban renewal as part of the Glenfield to Macarthur Growth Corridor.

Molino Stewart was engaged to prepare the Floodplain Risk Management Study and Plan for the whole of the catchment.

Key Relevant Tasks Performed:

- Project management
- Review and updated of flood models
- Community engagement
- Flood damages assessment and mapping
- Analysis of related environmental and social Issues
- Evaluation of flood mitigation options, including cost benefit analysis
- Advice on the adaptation of future urban growth and intensification in a way which reduces existing flood problems
- Public exhibition preparation and reporting
- Direct liaison with key stakeholders including the relevant NSW State Agencies
- Reporting

Track Record & Relevant Experience

The following is a selection of recent projects from my 30 year career which are relevant to this project.

- **Shelter in Place Policy (Fairfield City Council)** Although there has been numerous initiatives since to mitigate flood impacts in this Western Sydney LGA, there remains a legacy of urban areas with significant flood risks. One of the risks which must be managed is risk to life and this has become an issue of considerable debate in recent decades. Currently the NSW SES supports a policy of evacuation with shelter in place only being promoted for existing development where evacuation cannot be effected without increasing risk to life. However, a blanket ban on sheltering in place for any new development is not practical in Fairfield LGA, where warning times are short and evacuation routes are cut early in floods. Council engaged Molino-Stewart to assist in the development of a Shelter in Place Policy that can guide redevelopment and work with its planning instruments and Residential Development Strategy.

- **Three Tributaries Floodplain Risk Management Study and Plan (Fairfield City Council).** Engaged by Fairfield Council to undertake the Floodplain Risk Management Study and the development of a Draft Floodplain Risk Management Plan for the three major tributaries of Prospect Creek within the Fairfield LGA, NSW. The Project addresses the flooding, environmental and planning issues associated with the management of flood prone land within the catchment areas of the tributaries, as well as assessing the status of the detention basins within the catchment.
- **On-Site Flood Emergency Plan Guidelines (City of Gold Coast)** The City of Gold Coast is highly exposed to the risk from storm surge and riverine and flash floods and it is estimated that there are 50,000 people living in premises affected by the 1% average exceedance probability (AEP) flood. New development in flood-affected areas needs to comply with the relevant Flood Overlay Code. This includes minimum requirements in relation to access and evacuation. However, a decision by the Queensland Planning and Environment Court (Arora Construction v. Gold Coast City Council) determined that measures to facilitate sheltering in place rather than evacuation, including a Flood Emergency Management Plan (FEMP), are an acceptable alternative solution to reduce risk to life. This project developed guidelines for FEMPs.
- **Parramatta CBD Flood Evacuation Analysis (Parramatta City Council)** One of the main constraints to development in Parramatta CBD is the risk of flash flooding from the Parramatta River and its tributaries, which make planning flood emergency responses difficult. The aim of this study was to identify the most suitable flood emergency response strategy for Parramatta CBD, under existing and future population and employment conditions. This was achieved by comparing three possible evacuation strategies: (1) by vehicle at street level, (2) on foot using a network of elevated walkways, and (3) Shelter In Place. The analyses considered different flood events, development scenarios and times of day that flooding might occur and used multi criteria analysis to identify a preferred option.
- **Detention Basin Dam Safety Surveillance (The Hills Shire Council)** Undertaking regular surveillance of 22 flood detention structures including three which are prescribed dams. Overseeing geotechnical assessments and dam failure analyses and preparing DSEPs.
- **Splendour In the Grass Flood Emergency Response Plan (North Byron Parklands)** A new site for this music festival, which attracts up to 50,00 patrons, has a high flood risk. Designed and oversaw installation of a flood warning system and developed a flood emergency response plan which needed to be implemented in the first year that the festival was held on the new site.
- **Food Outlet Flood Emergency Response Plans (SBA Architects).** Developed flood emergency response plans fro retail food outlets which are subject to flash flooding in Newcastle.
- **VICSES Role in Flood Education and Warning (Victorian State Emergency Service):** Reviewed the role of the SES in flood education and flood warning with recommendations to SES Board on appropriate actions and resources to improve both through SES initiatives.
- **Flood Emergency Response Plan (SBA Architects).** Project managed the development of a flood emergency response plan for a proposed KFC restaurant in Newcastle. This included an analysis of potential flooding, determination of evacuation routes and flood response and the set up of a SES Business FloodSafe Plan and account for the site.
- **Penrith Panthers Redevelopment (Panthers Group):** Developed a flood emergency response plan for the proposed redevelopment of the 70ha site and prepared premises specific plans to accompany each new development proposed for the site..
- **Riverstone West Flood Emergency Response Plan (Paclib):** Developed a flood emergency response plan for a proposed 300ha industrial and commercial development.
- **North Coast Evacuation Evaluation (NSW State Emergency Service):** Conducted door to door survey of properties on the NSW North Coast following a major flood to determine the effectiveness of flood and evacuation warnings and gauge community attitudes to flood risks and response.
- **High Rise Development Flood Response (Minter Ellison):** Assessed flood emergency evacuation and flood response planning for a proposed 270 apartment and commercial complex as part of a Planning and Environment Court appeal.

- **Caravan Park Flood Response Guidelines (Shoalhaven City Council):** Worked with Bewsher Consulting to develop flood response guidelines for about 40 flood prone caravan parks in the Shoalhaven Region.
- **Comparative Evaluation of Warning Technologies (State Emergency Service).** Investigated and compared old, new and emerging technologies for disseminating flood alert and warnings.
- **Nursing Home Flood Response Plan Review (Gold Coast City Council):** A proposed expansion of a 300 person nursing home and retirement village in the Nerang Valley required the development of a comprehensive flood response plan. Provided an independent review of the plan suggesting significant changes to assumptions and actions
- **Paradise Dam Emergency Planning Review** (Sunwater) The cost of upgrading Paradise Dam to meet contemporary dam safety standards was difficult to justify economically and the Board of Sunwater wanted to explore whether improvements to dam safety could achieve the same outcomes at a reduced cost. Molino Stewart was engaged to undertake an international e review to investigate the premise that improving emergency management response capability would reduce the dam safety risk profile. In particular, the literature review was to focus on whether an improved Emergency Action Plan could be relied upon to deliver a quantifiable reduction in loss of life.