Flooding Issues at 1 to 7 Queens Bridge Street

Amendment C305 to the Melbourne Planning Scheme

30 June 2020

Report Author:	Dr Andrew McCowan
Title:	Flooding Issues at 1-7 Queens Bridge Street
Address of Property:	1 to 7 Queens Bridge Street, Southbank
Report Prepared For:	Crown Resorts
Instructed By:	Ashurst
Panel Hearing:	Amendment C305 to the Melbourne Planning Scheme
Date of Report	30 June 2020
Document Name	20010366_R01v01

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800
Fax (03) 9558 9365
ACN 093 377 283
ABN 60 093 377 283

CONTENTS

2010366_R01v01

1 STATEMENT OF ENGAGEMENT, QUALIFICATION, EXPERIENCE AND EXPERTISE

I, Dr Andrew McCowan, have prepared this report at the request of Ashurst . In this respect, I note that:

- I am a Director and Senior Principal Engineer at Water Technology Pty Ltd.
- I have over forty years of experience as a specialist water and coastal engineer. A summary of my relevant qualifications and experience is provided in Section 2.
- My report has been prepared as an independent and impartial report.
- I have read and understood **Planning Panels Victoria's** Guide to Expert Evidence Expert and have prepared my report in accordance with the Guide.
- My report is given independently to assist the Panel in relation to the determination and resolution of the matter. I accept that my paramount duty is to the Panel and not to any individual of the proceedings or other person retaining me as an expert witness.
- I have relied upon many documents in formulating my opinion. A non-exhaustive list of these documents is included in Section 4.

With my qualifications and experience, I believe I am well qualified to provide an expert opinion on flooding related issues at 1 to 7 Queens Bridge Street, Melbourne.

2010366_R01v01

2 REPORT AUTHOR

Dr Andrew McCowan
Senior Principal Engineer

Water Technology Pty Ltd
15 Business Park Drive, Notting Hill VIC 3168

Qualifications

- B.E. (Hons), Monash University, 1974
- Grad. Dip. Hyd. Eng. (Distn), I.H.E., Delft (the Netherlands), 1977
- Endorsement to the Diploma for Ground Water Recovery, 1977
- PhD, Monash University, 1992

Affiliations

- Chartered Professional Engineer
- Fellow, Institution of Engineers Australia
- Member, River Basin Management Society
- Member, International Association for Hydraulic Research
- Member, Authors Panel, Australian Rainfall and Runoff 2019
- Member, Victorian Coastal Council's Science Panel
- Corresponding Member, Engineers Australia's National Committee on Coastal and Ocean Engineering
- Corresponding Member and immediate past Chairman, Engineers Australia's National Committee on Water Engineering

Areas of Expertise

Key areas of expertise relevant to this report are summarised below.

- Assessment of water and flooding related issues associated with residential, canal estate and wetland development proposals;
- Hydraulic modelling of flood flows for major flood studies, including assessment of existing problems and evaluation of alternative floodplain management options;
- Flooding and inundation assessments for insurance claims; and
- Expert witness for water and flooding related issues at environmental effects panels, planning panels and civil hearings.

2010366_R01v01

2.1 Report Contributor

Bertrand Salmi
Principal Engineer

Water Technology Pty Ltd
15 Business Park Drive, Notting Hill VIC 3168

Qualifications

- Water Resource Engineering Management, Heriot Watt (Scotland), 2005
- BSc Ecological Sciences (Hon: Environmental Sciences), University of Edinburgh (Scotland), 2006

Affiliations

- Member, Stormwater Victoria

Areas of Expertise

Key areas of expertise relevant to this report are summarised below:

- Hydrologic and water quality modelling of drainage and stormwater studies, including assessment of existing problems and evaluation of alternative management options.
- Assessment of surface water related issues associated with developments.

Scope of Contribution

Bertrand assisted me in the preparation of my report. His assistance included data review and figure preparation under my supervision.

3 SCOPE OF THIS REPORT

With respect to the proposed Amendment C305 to the Melbourne Planning Scheme, I have been engaged by Ashurst to act as an independent expert on drainage and flooding issues related to the Queens Bridge Hotel, located at 1-7 Queens Bridge Street, Southbank. In particular, I have been asked to prepare an expert witness statement, and appear as an expert witness, at the panel hearing for Planning Scheme Amendment C305.

In the preparation of my evidence, I have been requested to:

- Assess flooding and flood response assuming the existing fabric of Queens Bridge Hotel is retained, as compared to the ability to deal with flooding if a new development was built to best practice standards; and
- Prepare the report in light of the Planning Panel Victoria's Guide to expert evidence.

4 BASIS OF THIS REPORT

My report is based on:

- A site inspection carried out on 5 April 2020.
- Review of Amendment C305 to the Melbourne Planning Scheme supporting information
- Site information and previous technical reports, including:
  - Enth Degree Architects (2005) Plans of the Queens Bridge Hotel
  - Lex Carter Architects (1997) Plans of Proposed Alterations to the Queens Bridge Hotel
  - Bosco Jonson (2014) Feature and Level Survey of 1-25 Queens Bridge Street
  - Cardno (2017) Flood Risk Report
  - Water Technology (2017) Peer Review of Cardno's Flood Risk Report (A McCowan)
  - Melbourne Water (2016) Advice on the 1% AEP flood levels for the site.
  - Adams, J.R. (1987) Tide Levels During November-December 1934 Flood
- Review of additional available information, including:
  - LiDAR (survey) and VicMap data
- Relevant guidelines and standards, including:
  - DELWP's Guidelines for Development in Flood Affected Areas (2019)
  - DELWP's Victorian Coastal Strategy (2014)
  - Melbourne Water's Planning for Sea Level Rise Guidelines (2017)
  - SES and City of Melbourne's Flood Emergency Plan (2012)

This report has been prepared in accordance with Planning Panels Victoria's "*Guide to Expert Evidence*". I have read the Guide and am aware of my overriding duty to assist the Panel on matters relevant to my expertise.

5 SITE DESCRIPTION

5.1 Locality

The Queens Bridge Hotel (the Hotel) is located at 1 to 7 Queens Bridge Street, Southbank (the Site). It is located on the east side of the northern end of Queens Bridge Street, approximately 90m from the south bank of the Yarra River, as shown in Figure 1. The Site is zoned Capital City Zone (CCZ3) and is covered by a Parking Overlay (PO1). It is also covered by a range of Design and Development Overlays (DDO1, DDO3, DDO4 and DDO10). These relate mostly to promoting pedestrian safety and amenity, and to the built form.

A land subject to inundation overlay (LSIO) covers the Yarra River to the north and there is a Special Building Overlay (SBO) over parts of Flinders Street and Elizabeth Street on the north side of the river. Although there are no flooding overlays on the Site, it is subject to flooding, as detailed Section 6.

As part of the proposed Planning Scheme Amendment C305, the City of Melbourne is proposing that 1 to 7 Queens Bridge Street be added to the Heritage Overlay (HO).

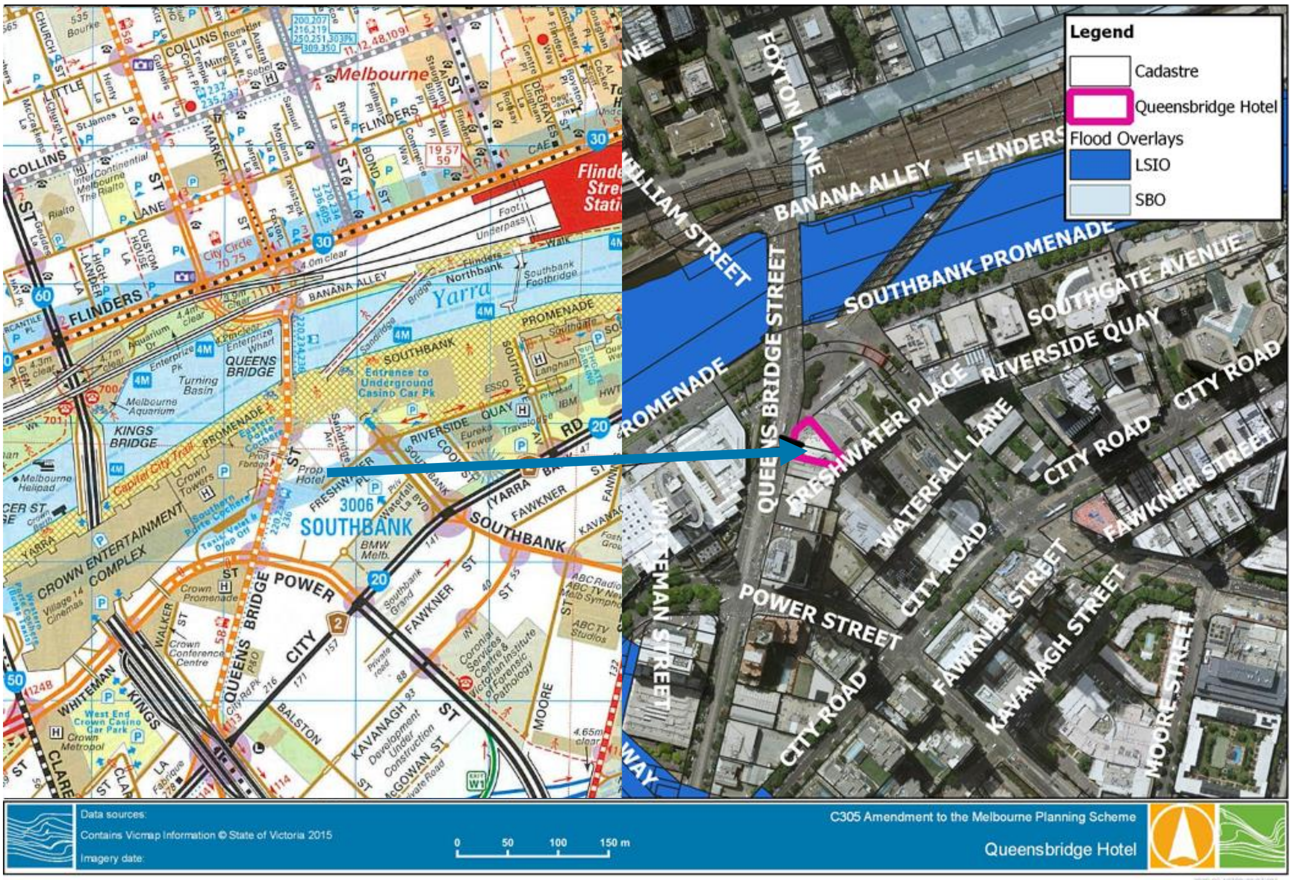


Figure 5-1 Location of the Queens Bridge Hotel at 1 to 7 Queens Bridge Street

2010366_R01v01

5.2 The Hotel

The Hotel faces westwards and north-westwards onto Queens Bridge Street. It has three floors, as well as a basement car park and a cellar. It is currently vacant and disused. Figure 5-2 presents a view of the Hotel from the centre of Queen Bridge Street. Public access is via doors that open onto the footpath at the northwest corner and along the western side of the building. Access to the cellar is via a service entry near the northern corner of the building (behind and to the left of the car in Figure 5-2). Access to the basement carpark is provided via a driveway leading off from Queens Bridge Street (in the centre-left foreground of Figure 5-2).

Figure 5-2 The Hotel

2010366_R01v01

5.3 Topography

General Area

The topography of the general area, and that of Queens Bridge Street in the vicinity of the Hotel, is presented in Figure 5-3. This shows that much of Southbank is low-lying and has ground elevations of less than 2.0m to Australian Height Datum (AHD). Further, the section of Queens Bridge Street between Power Street and Southbank Promenade typically has road and footpath levels in the range of 0.8m to 1.5m AHD. To put these levels in perspective, I note that Mean Sea Level (MSL) in Port Phillip Bay and in the lower (tidal) section of the Yarra River is 0.0m AHD. That is, the ground levels throughout much of the area of interest are not much higher than MSL in the adjacent section of the Yarra River.

Figure 5-3 also shows that the ground levels increase at the northern end of Queens Bridge Street, adjacent to Soutbank Promenade, before it crosses the Yarra River at Queens Bridge. As a result, there is no natural overland flow path for surface water flows from Queens Bridge Street northwards to the Yarra River.

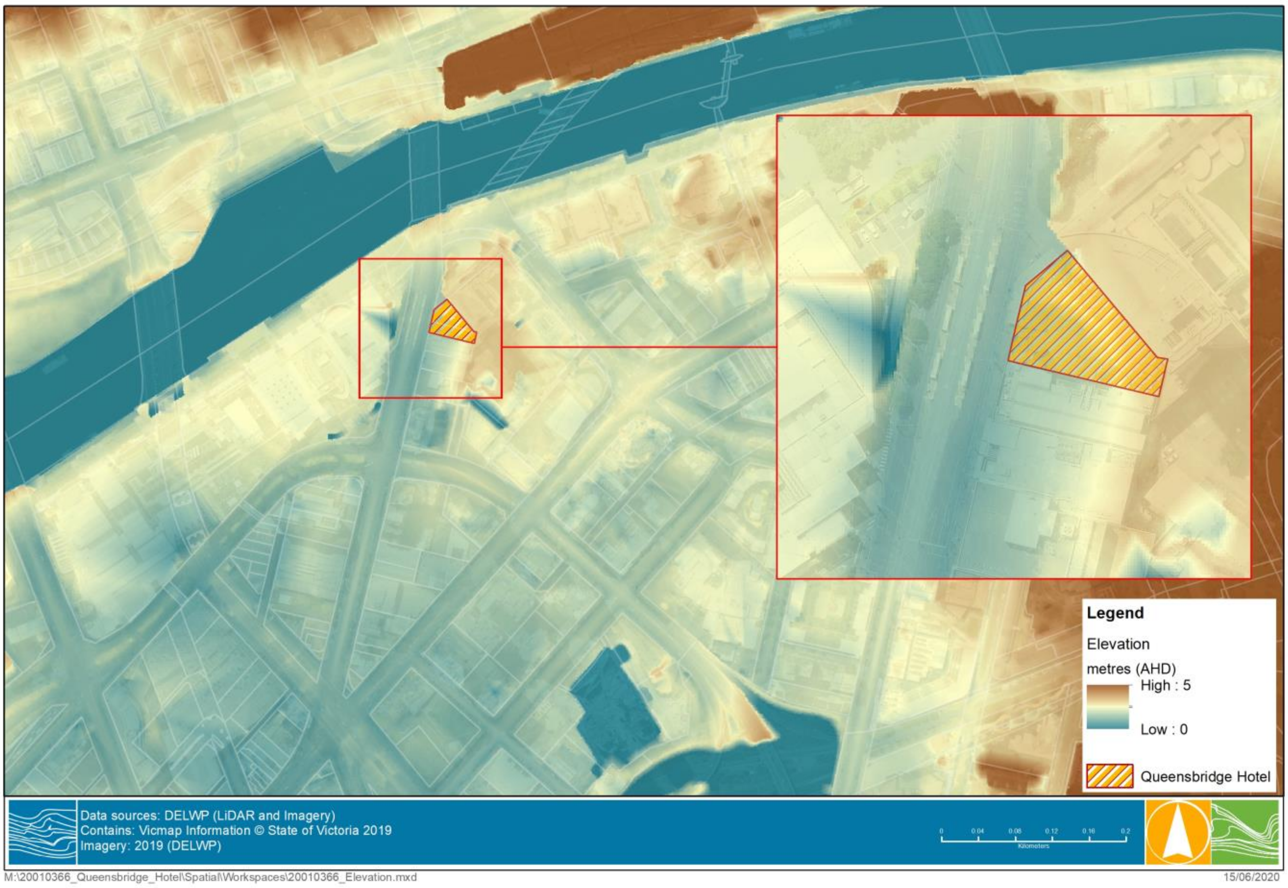


Figure 5-3 Topography of Southbank and Queens Bridge Street (DELWP, 2019)

The Hotel

More details of the topography in the vicinity of the Hotel are given in a Feature and Level Survey by Bosco Jonson (2014). Part of this survey plan is presented in Figure 5-4. This shows:

- Footpath levels along the western side of the Hotel increasing from just below 1.2m AHD in the south to between 1.42m and 1.47m AHD at the entrance in the northwest corner;
- Footpath levels in the vicinity of the service entrance of around 1.5m AHD; and
- Driveway levels leading up to and near the top of the ramp down into the car park of around 1.5m AHD.

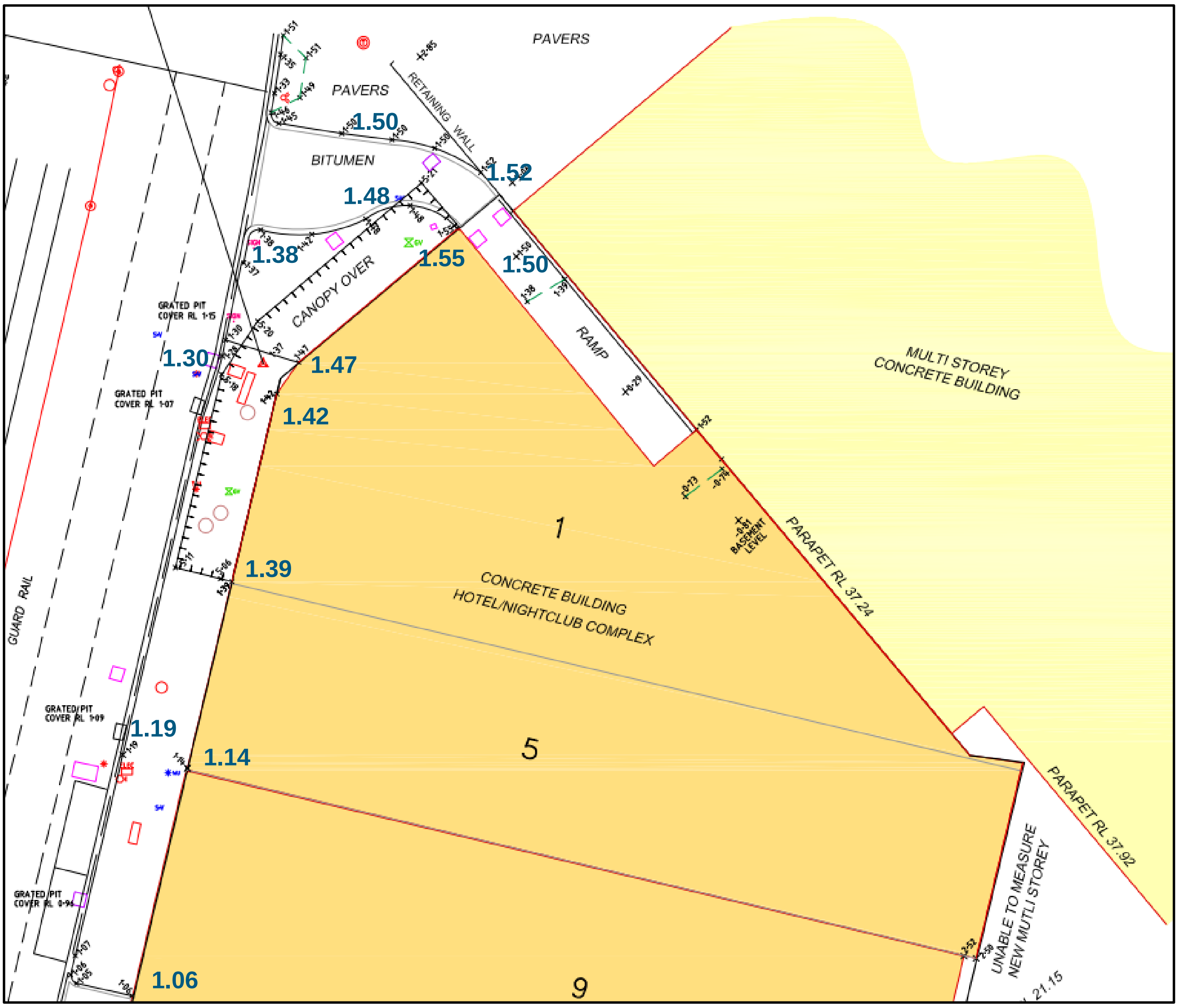


Figure 5-4 Ground Elevations Adjacent to the Hotel (Bosco Jonson, 2014) (selected levels enlarged in blue)

6 FLOODING AT THE HOTEL

Previous work by Cardno (2017) identified three independent mechanisms for flooding at Queens Bridge Street. These were:

- Riverine flooding due to flood flows down the Yarra River
- Storm tide flooding due to storm tide elevations in Port Phillip Bay and the lower Yarra River; and
- Stormwater flooding due to rainfall over the local catchment.

Additionally, Water Technology (2017) showed that flooding in the Yarra River can coincide with storm tides in Port Phillip Bay.

Further, flooding in the area will be exacerbated in the future due to the increases in mean sea level and the increases in rainfall intensities that are expected as a result of Climate Change.

6.1 Riverine Flooding

The 1934 Flood is the most extreme flood to have occurred in the Yarra River in recorded history. It was caused by more than 48 hours of continuous heavy rainfall throughout the catchment. It resulted in extensive overbank flooding with the Yarra becoming *"a series of vast lakes connected by swirling rapids"* from Warburton to Melbourne (the Argus, 3 Dec 1934).

As the flood of record, Melbourne Water places a lot of emphasis on 1934 flood levels as being a reliable indicator of extreme flood levels within the Yarra River. There is an argument that the flows in the 1934 flood were so much greater than those in any subsequent flood in the Yarra that the 1934 flood should be rated as being significantly rarer than the 1% AEP (Annual Exceedance Probability) flood. In this respect, I note that a flood of almost similar magnitude occurred in 1891, and that a major flood of similar or greater magnitude was also reported in 1863.

Melbourne Water's 1% AEP flood level for the Yarra River at Queens Bridge Street is 1.9m AHD. This is consistent with a number of measured flood levels in the area from the 1934 flood. The survey data shown in Figure 5-3 shows that ground surface elevations of around 2.4m AHD along the bank of the Yarra River adjacent to site. Upstream of the site the bank is a little lower than 2.4m AHD for a short section adjacent to the end of Southbank Boulevard. These bank levels are, however, well above the 1.9m AHD 1% AEP river flood level.

Further, backflow prevention devices have been fitted to the stormwater outlets in the area to minimise the likelihood of river flood water flowing back up the stormwater drainage system.

As such, I have concluded that the Hotel is not currently susceptible to direct flooding from the Yarra River under current sea level conditions. (The effects of sea level rise are considered in Section 6.2.2, below.)

The Hotel will, however, be susceptible to the combination of riverine flooding and high storm tide levels in Port Phillip Bay, as described in Section 6.2.1.

6.2 Storm Tide Flooding

The Flood Level Information for the Hotel provided by Melbourne Water in May 2016 states that: "*The estimated flood level for this property is 1.6 metres to Australian Height Datum (AHD) for existing conditions, based on a 100 year Average Recurrence Interval (ARI) storm*" (i.e., the 1% AEP storm event). I understand that Melbourne Water's Flood Level advice is based on storm tide levels in the Yarra River. These in turn are

2010366_R01v01

based on a 1% AEP storm tide level at Williamstown of 1.33m AHD (Adams, 1987) with a 0.3m allowance for wave effects.

I have previously expressed the opinion that the Hotel is not currently affected by flooding by storm tides from Port Phillip Bay (Water Technology, 2017). I based this opinion on the fact that the riverbank adjacent to the site was at a level of around 2.2m to 2.4m AHD and, as such, was much higher than the storm tide elevation in the river.

I have since learnt that Melbourne Water's storm tide flooding of Queens Bridge Street does not originate from local overtopping of the riverbank, but from flooding of lower areas farther downstream, adjacent to Spencer Street. This can be seen in the SES 1% AEP Flood Map for Southbank, part of which is presented in Figure 6-1. This shows the areas that would be expected to be flooded by a 1% AEP storm tide elevation of 1.6m AHD in the Yarra River (with the flooded areas shaded purple).

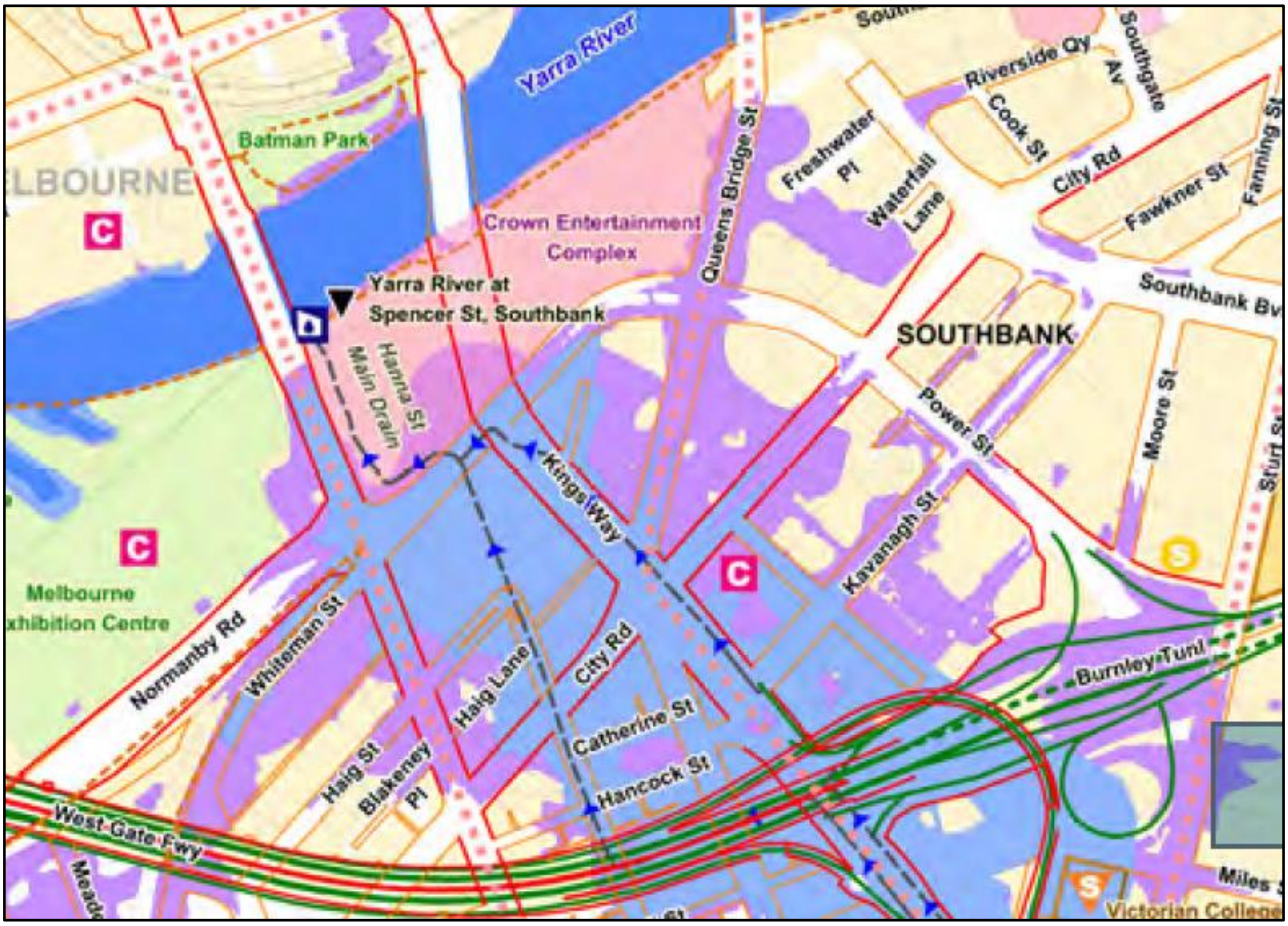


Figure 6-1 Part of Southbank 1 in 100 year (1% AEP) Flood Map (SES, 2016)
(1% AEP Storm Surge, 1.6m AHD, extent shaded purple)

More details of the likely effects of a storm tide flood level of 1.6m AHD are presented in Figure 6-2. This figure has been generated by superimposing a flood level of 1.6m AHD on DELPW's 2017 LiDAR data (as shown in Figure 5-3). It shows that much of Southbank and South Melbourne would be expected to be flooded during a 1% AEP storm tide event. Flood depths in much of Queens Bridge Street would be in excess of 0.3m, the upper depth limit for vehicle safety. Flood depths outside the Hotel would be expected to range from 0.1m to 0.4m

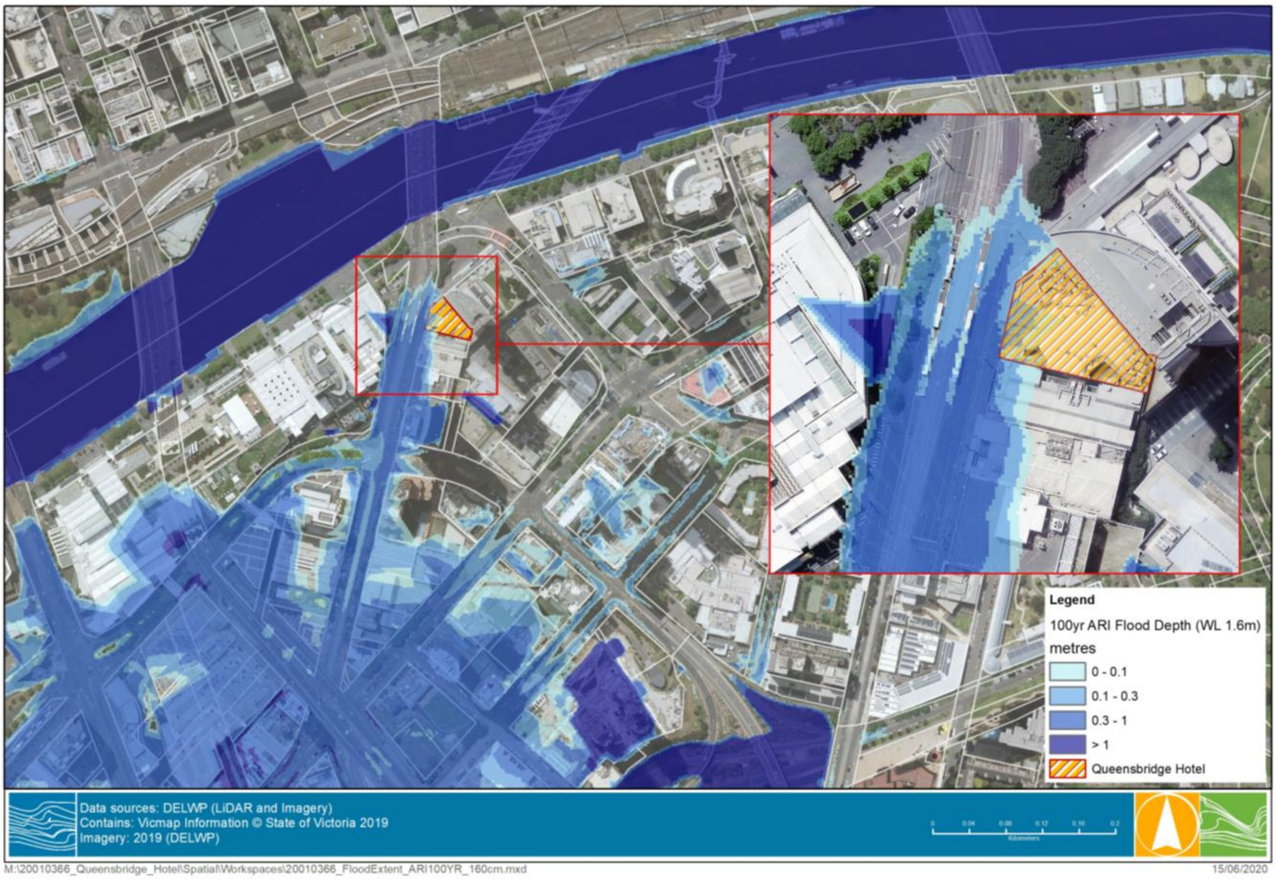


Figure 6-2 1% AEP Storm Tide (1.6m AHD) Depth and Extent

6.2.1 Combined River Flooding and Storm Tide

The 1934 flood also coincided with the highest storm tide level ever recorded at Williamstown (Adams, 1987). Although the peak storm tide level occurred approximately 24 hours before the river flow peak, there was sufficient overlap between the two phenomena such that the peak water levels in the lower Yarra River were due to a combination of both storm tide and river flood flow (Water Technology, 2017).

Further, the peak water level at the Spencer Street Gauge during the 1934 flood was 1.61m AHD (SES, 2012). This is marginally higher than Melbourne Water's 1% AEP storm tide elevation at the same location that was considered in the preceding section. As such, I conclude that a repeat of the 1934 flood would be expected to result in flooding extents similar to those shown in Figure 6-2, for storm tide alone.

6.2.2 Effects of Sea Level Rise

The Victorian Coastal Strategy (VCS, Victorian Coastal Council, 2014) requires planning to include the effects of a *"possible sea level rise of not less than 0.8 metres by 2100"*. Under this scenario, Melbourne Water now requires new developments in Southbank to allow for a 1% AEP storm tide elevation of 2.4m AHD. With the inclusion of a freeboard allowance of 600 mm, new developments in the area are now required to have ground floor levels of 3.0m AHD.

Storm Tide Effects

The likely effects of a storm tide flood level of 2.4m AHD are presented in Figure 6-3. This shows that most of Southbank and South Melbourne would be expected to be flooded during a 1% AEP storm tide event in 2100.

Southbank Promenade would be expected to be over-topped in places and flood depths in much of Queens Bridge Street and throughout much of South Melbourne would be in excess of 1.0m. Flood depths outside the Hotel would be expected to range from 0.9m to 1.2m.

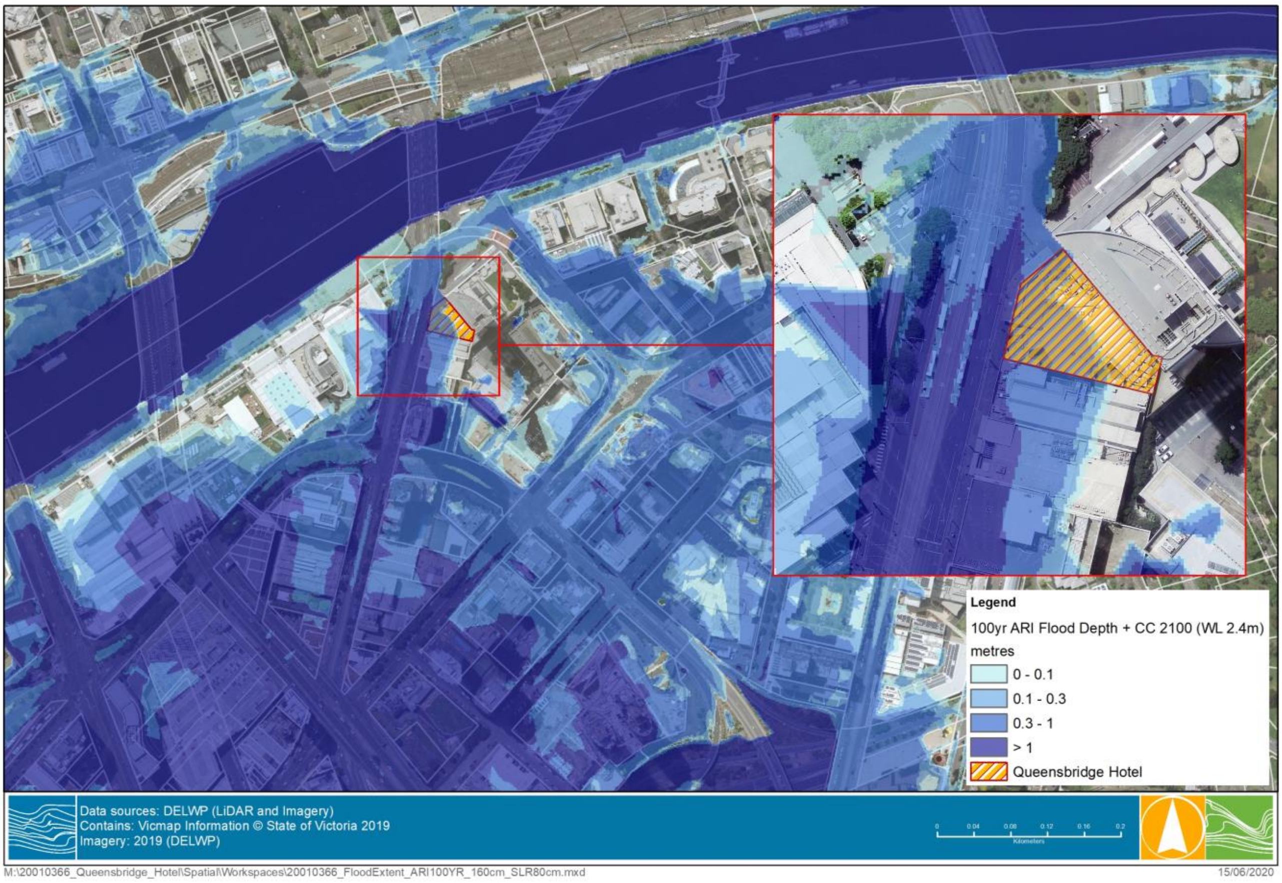


Figure 6-3 1% AEP Storm Tide by 2100 (2.4m AHD) Depth and Extent

Combined Storm Tide and River Flooding

With an increase in sea level of 0.8m by 2100, a repeat of the 1934 flood in 2100 would be expected to result in a similar increase in flood levels. The 1934 flood level of 1.9m AHD in the Yarra River adjacent to Queens Bridge Street would increase to the point where Southbank Promenade would be over-topped, and the Hotel would be flooded directly. Further, under the combined effects of storm tide and river flood flow, the flood level at Spencer Street would be expected to increase from 1.6m AHD (as occurred in 1934) to 2.4m AHD. As a result, much of Southbank, including the Hotel, would be expected to be flooded to a level of 2.4m AHD or more. As such, I conclude that a repeat of the 1934 flood in 2100 would be expected to result in flooding extents similar to those shown in Figure 6-3, for storm tide alone.

More Frequent Storm Tide Events

The storm tide elevation at Williamstown that would currently be exceeded on average once a year is 0.9m AHD. This event would be expected to have a probability of occurrence of 63% in any given year (i.e., 63% AEP). Allowing for 0.8m of sea level rise, this level would increase to 1.7m AHD by 2100. That is, by 2100, the Hotel would be expected to be flooded on average, once a year to a level of 1.7m AHD. This level is higher than the current 1% AEP storm tide level, and combined storm tide and river flooding level of 1.6m AHD.

The likely effects of a storm tide flood level of 1.7m AHD are presented in Figure 6-4. This figure shows similar results to those for the 1% AEP storm tide level under existing conditions (in Figure 6-2). The only difference being the flood depths and extents have increased slightly. Flood depths outside the Hotel would now be expected to range from 0.2m to 0.5m. That is, by 2100, the storm tide flooding of the Hotel that would be expected to occur, on average, once a year would be 0.1m higher than that which would be expected to occur, on average, once every 100 years under current conditions.

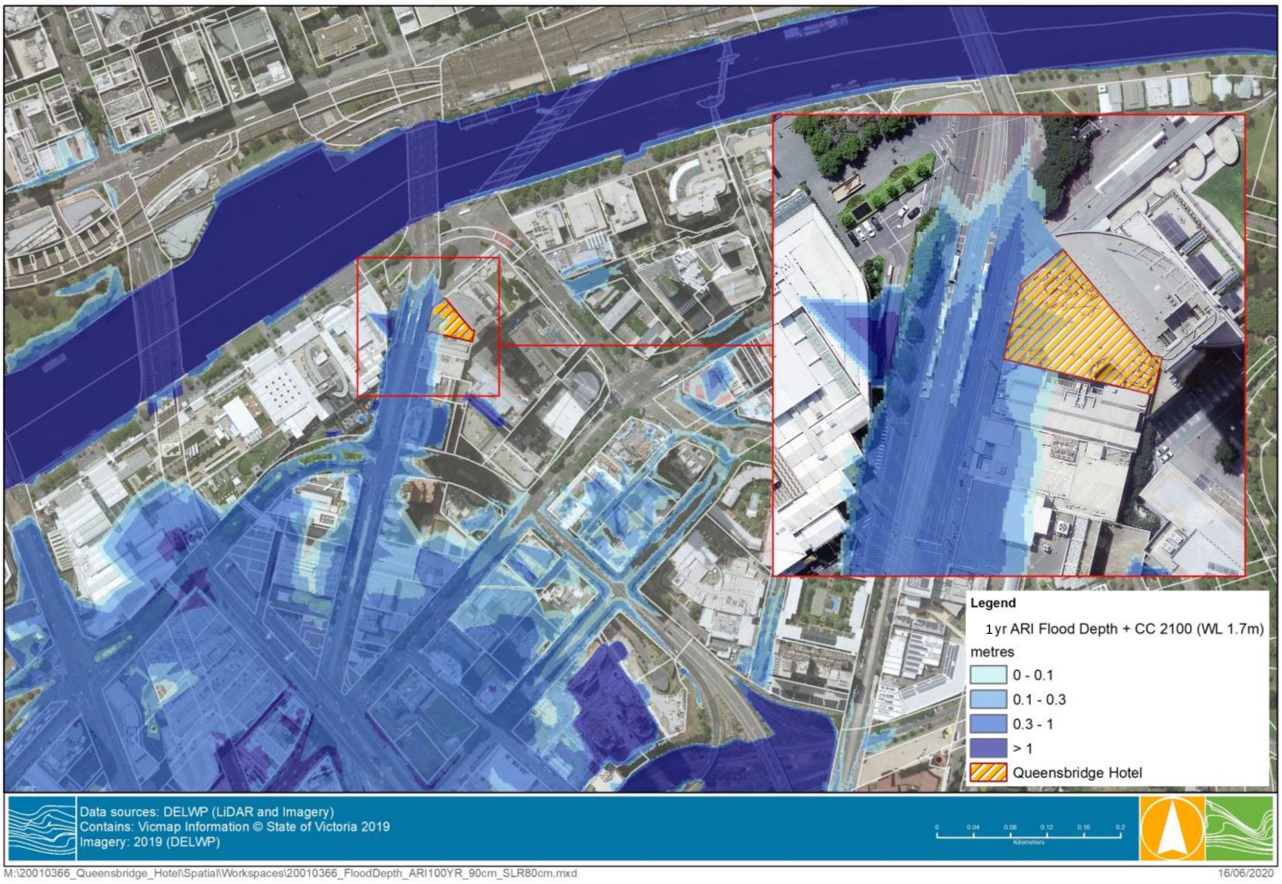


Figure 6-4 63% AEP Storm Tide by 2100 (1.7m AHD) Depth and Extent

6.3 Stormwater Flooding

Stormwater flooding in the area is caused by runoff from rainfall over the local catchment. As noted in Section 5.3, Queens Bridge Street has no overland flow path for surface water flows to the Yarra River. As such, the area is entirely reliant on the underground pipe network for drainage of locally generated stormwater. Further, the pipe network does not have the capacity to drain all the stormwater generated by intense rainfall events. Due to the low-lying nature of the land the drainage capacity of the pipe network can be further reduced by high storm tide and/or flood levels in the Yarra.

When the capacity of the pipe network is exceeded, excess stormwater runoff will accumulate at the ground surface, flooding Queens Bridge Street and other low-lying areas. This type of flooding occurs irregularly every few years in Queens Bridge Street.

24 June 2014 Storm

Figure 6-5 shows a photograph of stormwater flooding in Queens Bridge Street following a significant storm on 24 June 2014. The photograph was taken from the east side of Queens Bridge Street, looking south from just south of the Hotel. It shows extensive flooding across the street and over the footpath.

Figure 6-5 Stormwater Flooding in Queens Bridge Street, 24 June 2014 (Crown Resorts)

The Bureau of Meteorology report on this storm notes that it was generated by a deep low pressure system that *"passed near the south of Port Phillip Bay producing significant rainfall and strong, gusty winds"*, and that the passage of the low *"coincided with high tides, with flooding experienced in much of the coastal Melbourne area and along the Yarra River"*. The corresponding storm tide level at Williamstown was 1.115m AHD. This is close to the estimated level of the water in the photograph and meant that there would have little or no natural drainage through the pipe network at that time.

Modelling by Cardno

Cardno (2017) carried out an assessment of flooding for the proposed One Queensbridge development (refer to Section 8). This included an assessment of stormwater flooding in Queens Bridge Street. Modelling was used to estimate the 1% AEP stormwater flood levels corresponding to a range of different rainfall scenarios. The resulting flood levels ranged from 1.31m to 1.52m AHD under existing conditions and increased up to 1.63m AHD under an increased rainfall intensity "Climate Change" scenario for 2100.

Cardno's modelling was carried out under two contrasting assumptions. The first was that elevated water levels in the Yarra River would prevent natural drainage to the river over the duration of the rainfall. This would potentially result in an over-estimate of the flood levels. The second was that flooding would extend throughout the area unimpeded by buildings and other structures. This would result in in an under-estimate of the flood levels.

Modelling by Water Technology

Preliminary modelling by Water Technology (2017) has also provided estimates of flood levels in the area. This was carried out over a range of different storm durations having annual exceedance probabilities ranging from about 20% through to a 1% AEP. The results are presented in Table 6-1. As for Cardno, Water

Technology assumed that the water level in the Yarra River was sufficiently high to prevent natural drainage through the pipe network to the river. Unlike Cardno, Water Technology only included flooding of open spaces, and did not include flooding of buildings or other structures. In this respect, I consider that this may have resulted in an over-estimate of the flood levels.

Table 6-1 Stormwater Flood Levels in Queens Bridge Street

AEP EVENT	FLOOD LEVEL (m AHD)
20%	1.23
10%	1.28
2%	1.46
1%	1.71

Taking both sets of modelling into account, I consider that a 1% AEP flood level of 1.6m AHD is an appropriate level for assessing the effects of stormwater flooding at the Hotel. With increased rainfall intensity associated with Climate Change, this could be expected to increase to about 1.7m AHD by 2100. The likely flood depths and extents for these two scenarios are the same as those presented in Figure 6-2 and Figure 6-4, respectively.

7 FLOOD RISK FOR THE HOTEL

From the above, I consider that the Hotel is currently subject to the flooding from storm tides in the Yarra River, from a combination of storm tide and Yarra River flood flows, and from stormwater from the local catchment. At an annual exceedance probability of 1%, the flood level for each of these mechanisms is 1.6m AHD.

Allowing for the effects of Climate Change, the 1% AEP flood levels at the Hotel would be expected to increase to 2.4m AHD by 2100 for storm tides, and for the combination of storm tide and flood flows. For local stormwater flooding, the 1% AEP flood level at the Hotel would be expected to increase by a smaller amount, to about 1.7m AHD.

The main areas of the Hotel that are susceptible to flooding are considered below. They include:

- The footpath outside the Hotel (for safe access/egress);
- The ground floor;
- The basement car park: and
- The cellar.

In assessing the risks associated with flooding, I have taken into account the “thresholds for safety” provided in DELWP’s (2019) *“Guidelines for Development in Flood Affected Areas”*. For low flow velocities, as will be the case in Queens Bridge Street, these give a maximum water depth for safe pedestrian access of 0.5m. This is given as the limiting water depth through which *“children (but not infants) are able to safely wade”*.

7.1 The Footpath

The level of the footpath in front of the Hotel ranges from around 1.5m AHD along the northwest face of the Hotel down to just under 1.2m AHD at the southern end. This would result in flood depths ranging from 0.1m to 0.4m during a 1% AEP flood. These depths would be considered safe for pedestrians and would provide safe pedestrian egress to higher ground along Southbank Promenade.

To the south of the Hotel, the footpath becomes gradually lower. The levels in front of 17 Queens Bridge Street are around 1.0m AHD, and there is a low point of about 0.9m AHD in front of 25 Queens Bridge Street. This area would be unsafe for pedestrians during a 1% AEP flood.

Effects of Climate Change

The increase in sea level by 2100 would be expected to increase the storm tide levels in the lower Yarra River. This in turn would be expected to increase the frequency of the flooding of the footpath. Flooding similar to that which would only currently occur in a 1% AEP flood would be expected to occur, on average, once or more a year. Further, the increase in the 1% AEP flood level to 2.4m AHD would result in flood depths of 0.9m to 1.2m along the footpath in front of the Hotel. This would make the area unsafe for pedestrian access.

7.2 The Ground Floor

A plan view of the existing ground floor of the Hotel is presented in Figure 7-1. A cross-section through the Hotel (cross-section 1 on Figure 7-1) is presented in Figure 7-2. These show that the main features of the ground floor include:

- A floor level of 1.52m AHD in the Cafe/Bistro area, in the toilet area, and at the entrances along Queens Bridge Street.
- A floor level of 1.45m AHD in the Service Yard in the north corner of the Hotel.
- An elevated timber floor in the main “Entertainment Room” with a level of 1.87m AHD.

- A low section of floor with a level of 1.17m AHD under the timber Entertainment Room floor.

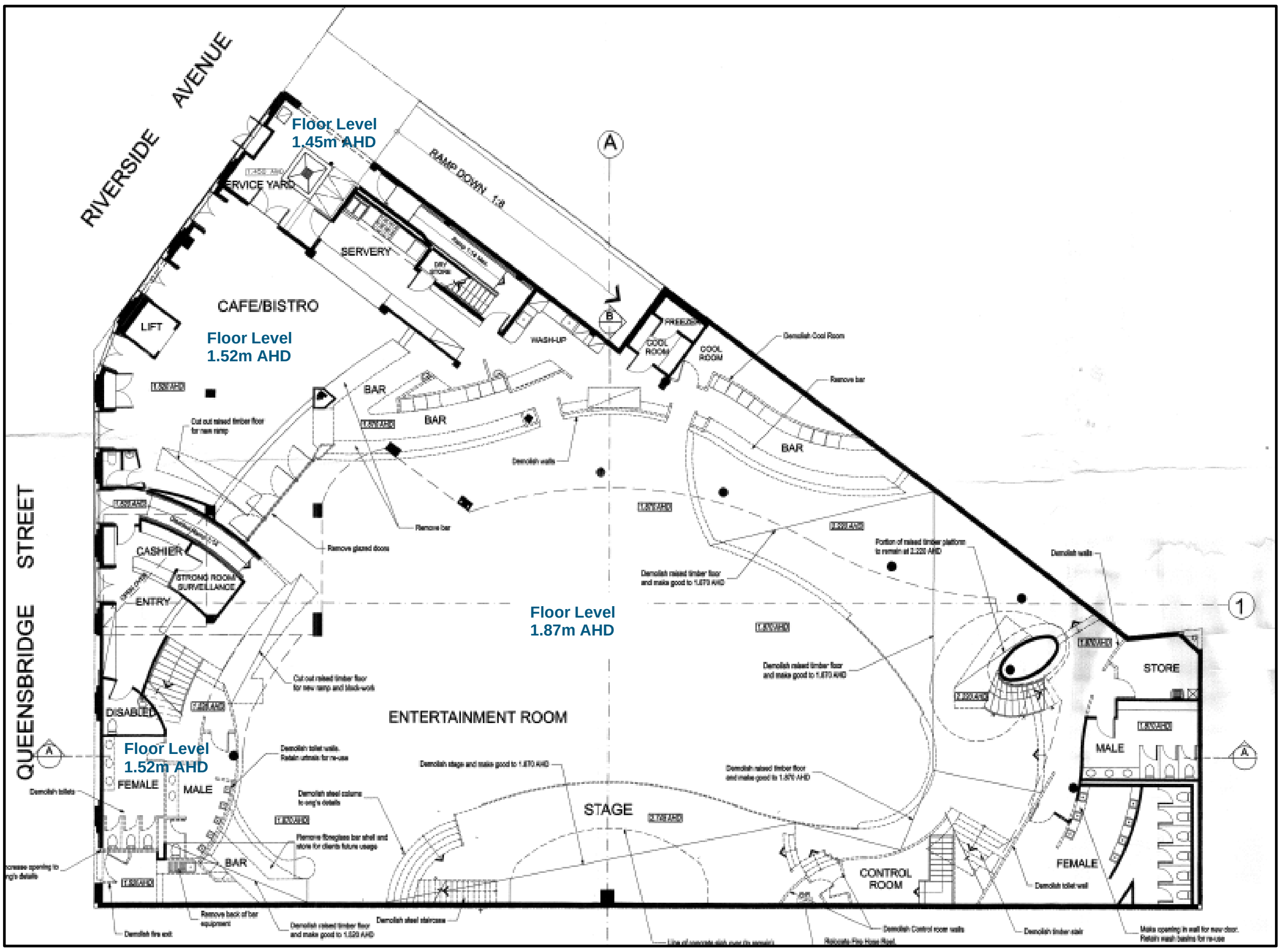


Figure 7-1 Ground Floor Plan of the Hotel – Cross-Section (Enth Degree Architects, 2005)

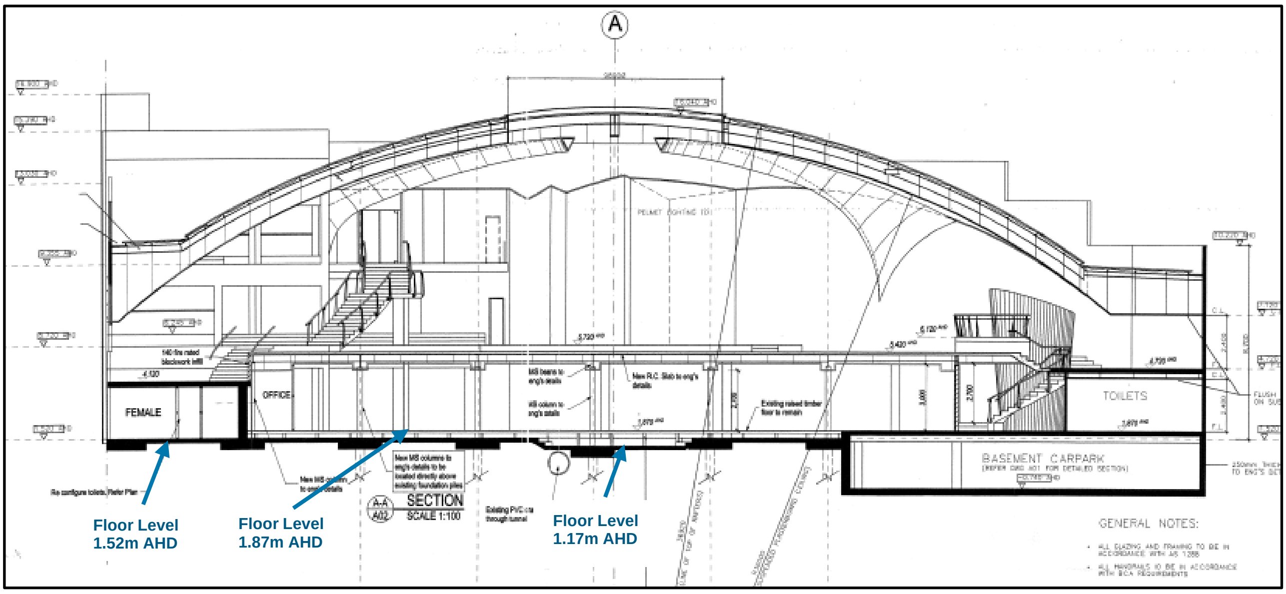


Figure 7-2 Cross-Section through the Hotel – Cross-Section (Enth Degree Architects, 2005)

2010366_R01v01

With a flood level of 1.6m AHD, all but the elevated floor of the Entertainment Room would be flooded in an 1% AEP flood. The depth of flooding to accessible areas of the ground flood would be 0.08 to 0.15m. This would allow safe access to all of the ground floor.

The maximum depth of flooding would be 0.43m over the lower section of floor under the Entertainment Room. In this respect, I note that flood water can only access this area by flowing over the door sills and the 1.52m floor levels adjacent to the Queens Bridge Street entrances. (see Figure 7-3). This means that this section of the ground floor is only likely to become inundated when the flood level exceeds 1.52m AHD. This is only likely to occur in a flood having an annual exceedance probability close to that of the 1% AEP event.

Figure 7-3 The Hotel – Looking South along Queens Bridge Street

Effects of Climate Change

By 2100, the increase in storm tide levels in the lower Yarra River would be expected to result in the ground floor becoming flooded, on average, once or more a year. Further, in a 1% AEP flood, the increase in flood level to 2.4m AHD would result in the entire ground floor becoming flooded. The depth of flooding would be greater than 0.50m and, as such, all of the ground floor would be unsafe for pedestrian access.

7.3 The Basement Carpark

A plan view of the existing basement level of the Hotel is presented in Figure 7-4. This shows that the basement carpark has a floor level of -0.74m AHD. Access to the car park is via a driveway off Queens Bridge Street, as shown in Figure 5-2 and Figure 7-5. Behind the gates at the end of the driveway, a ramp slopes downwards into the carpark. There is a low point at the entrance to the carpark, at the base of the ramp with a level of -0.89m AHD.

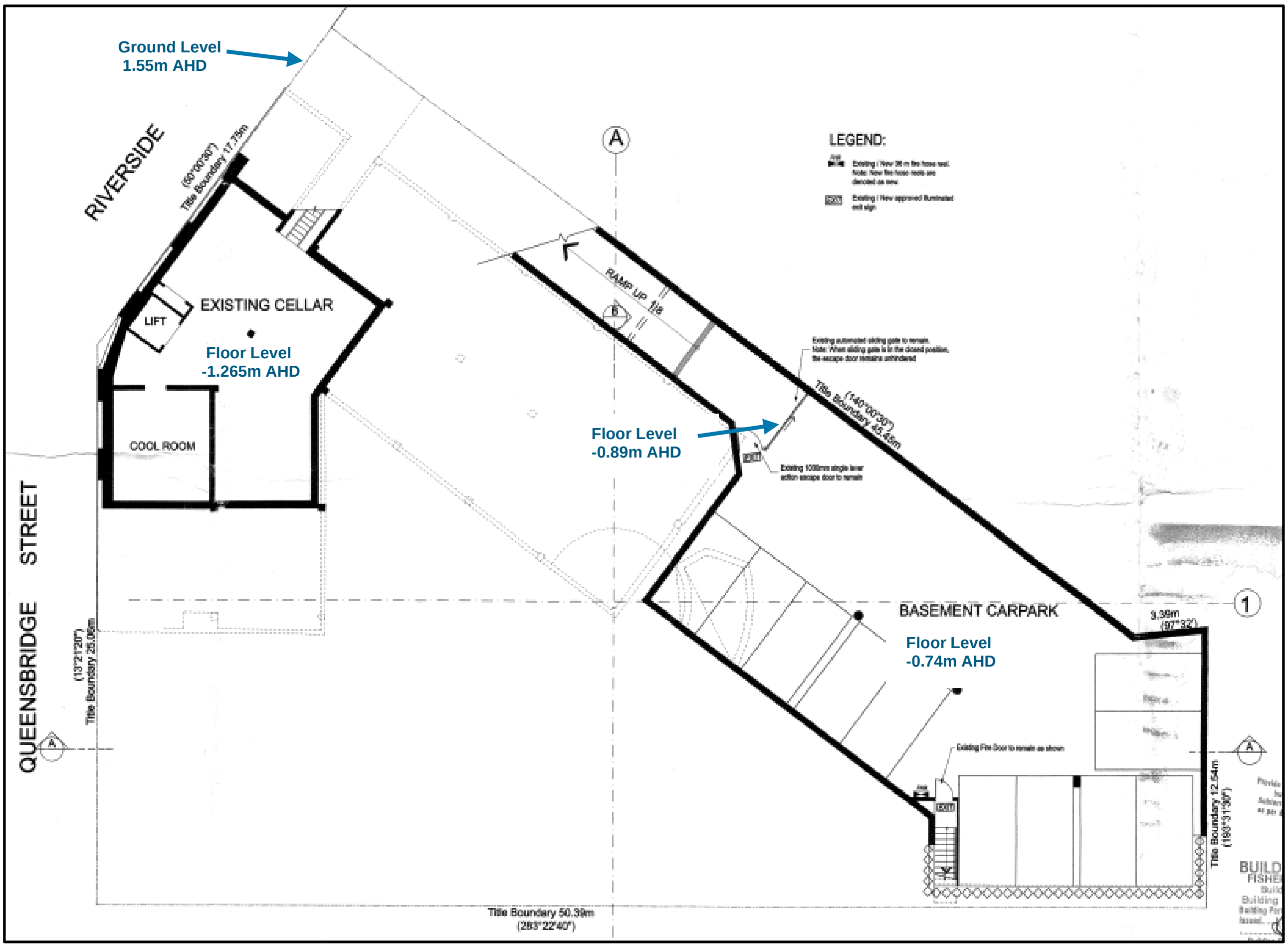


Figure 7-4 Basement Level of the Hotel – Cross-Section (Enth Degree Architects, 2005)

Flood water can only access the carpark directly via the driveway and access ramp, or indirectly via an internal staircase once the ground floor of the Hotel has become flooded. The top of the driveway has an elevation of about 1.55m AHD, just before the start of the down ramp (i.e., at the gate shown in Figure 7-5). As a result, direct flooding of the carpark will only begin when the flood water gets to this level. However, once this level is exceeded, the basement would be expected to fill quite rapidly to a depth of almost 2.5m at the base of the ramp. The basement carpark would be unsafe during a 1% AEP flood and would be expected to become unsafe quite rapidly, once the flood level exceeded that of the top of the ramp.

As for the ground floor, flooding of the basement carpark is only likely to occur in a flood having an annual exceedance probability close to that of the 1% AEP event.

Nuisance Flooding

The basement carpark is also currently affected by nuisance flooding. Monjon (2020) have reported that *"this occurs after every major downpour"*. Further, Crown Resorts (2020) have reported that the carpark has had to be pumped out twice in the last 12 months, and that the carpark is *"usually a couple of feet under water to up to a 1m"*. In this respect, I note the carpark floor level is up to 0.9m below mean sea level in the Yarra River which is only about 100m away. As a result, there can be no natural drainage of the carpark. Any water entering the carpark must be artificially pumped out.

I consider that the flooding reported by Monjon is due to a combination of: the direct effects of rainfall on the ramp leading down to the carpark; groundwater intrusion, and faulty drainage infrastructure including pumps. Remedial work will be required to prevent this nuisance flooding continuing.

Effects of Climate Change

By 2100, the basement carpark would be expected to be flooded, on average, once or more a year. Further, in a 1% AEP flood, the depth of flooding at the base of the ramp would be expected to increase to almost 3.3m.

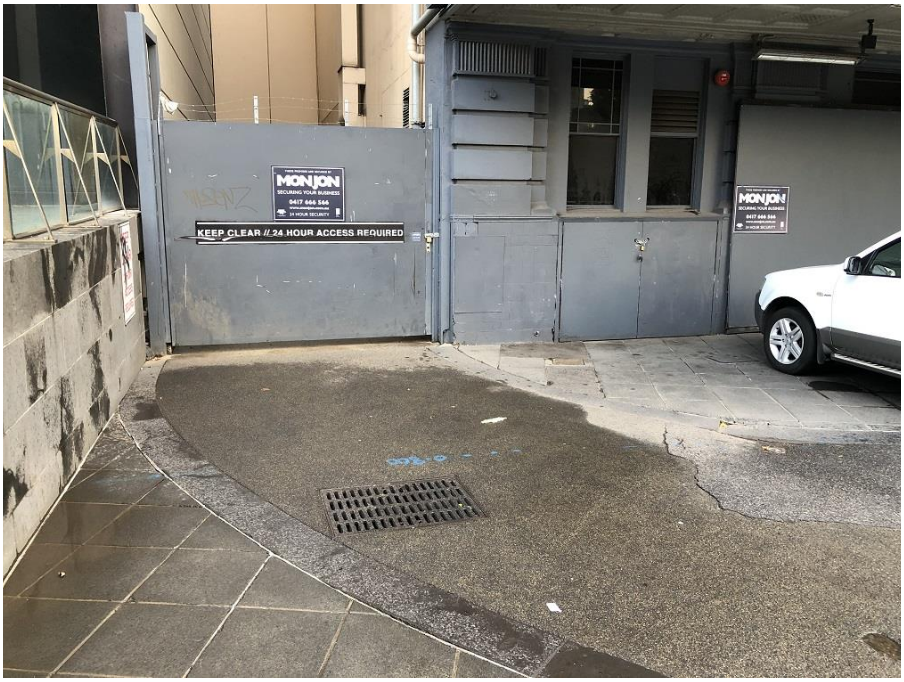


Figure 7-5 Driveway and Gate Leading to the Basement Carpark

7.4 The Cellar

The cellar has a floor level of -1.265m AHD (see Figure 7-4). Access to the cellar is via a service yard in the northeast corner of the ground floor. This service yard has a floor level of 1.45m AHD and is accessed by doors opening onto the footpath (see Figure 7-5). The footpath in front of the service yard doors has levels of around 1.48m AHD. As such, the cellar is only likely to become inundated when the flood water gets to this level. However, once this level is exceeded, the cellar would be expected to fill quite rapidly to a depth of more than 2.8m. As a result, the cellar would be unsafe during a 1% AEP flood and would be expected to become unsafe quite rapidly, once the flood level exceeded that of the footpath outside the service yard doors

As for the ground floor and the basement carpark, flooding of the cellar is only likely to occur in a flood having an annual exceedance probability close to that of the 1% AEP event.

Effects of Climate Change

By 2100, the cellar would be expected to be flooded, on average, once or more a year. Further, in a 1% AEP flood, the depth of flooding of the cellar would be expected to increase to more than 3.6m.

2010366_R01v01

7.5 Overview

To put flooding at the Hotel in perspective, the current and future (2100) 1% AEP flood levels have been super-imposed on a western elevation of the Hotel in Figure 7-6. This figure also shows the approximate levels of the footpath in front of the Hotel, as well as a level of 3.0m AHD. This last level is the minimum floor level that Melbourne Water requires for any new buildings in the area.

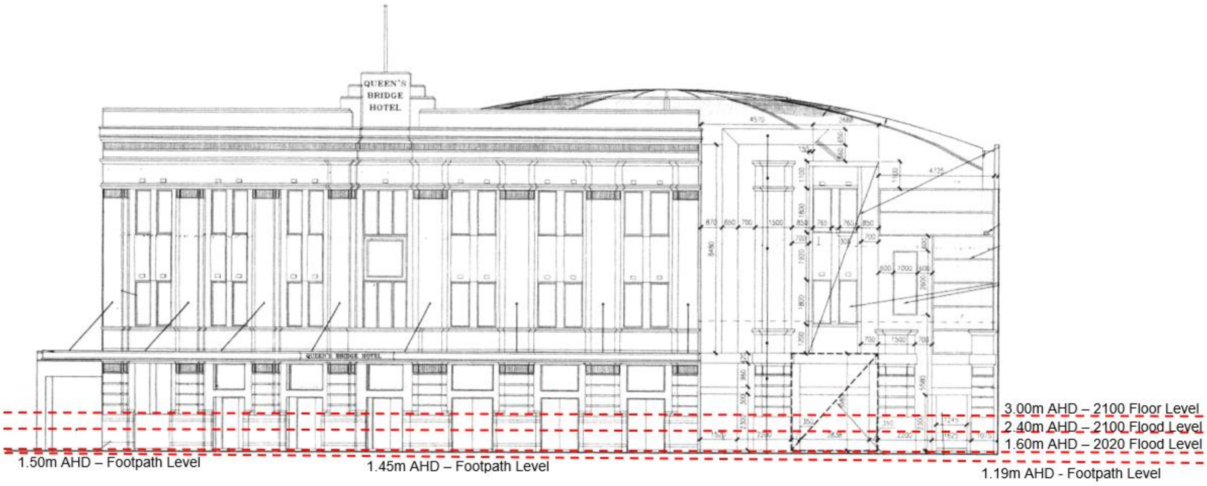


Figure 7-6 Flood Levels super-imposed on a Western Elevation of the Hotel

The Hotel is presently at risk of flooding in a 1% AEP flood. The frequency and depth of flooding will increase with sea level rise such that by 2100, the depth of flooding would result in all of the ground floor and the surrounding footpath becoming unsafe for pedestrian access. Further, flooding similar to that which would only currently occur in a 1% AEP flood would be expected to occur, on average, once or more a year.

2010366_R01v01

8 THE PROPOSED ONE QUEENSBRIDGE DEVELOPMENT

One Queensbridge was a proposed new hotel development that was to be constructed at 1 to 29 Queens Bridge Street, Southbank. The works required as part of this development were described in an Incorporated Document under the Melbourne Planning Scheme. From a flooding perspective, this included "Public Realm Improvements", as well as specific requirements related to the Hotel complex.

8.1 Public Real Improvements

The Public Realm Improvements Plan included a series of works aim ed at alleviating the effects of flooding along Queens Bridge Street. These included:

- Raising and regrading the footpath along the Queens Bridge Street frontage.
- Raising and regrading the road paving to alleviate water ponding / flooding at tram stop crossings.
- Upgrading the stormwater collection system, including the installation of a new pipe between the project site and the Yarra River.

These works would have been expected to alleviate the more frequent "nuisance" flooding of Queens Bridge Street that currently occurs as a result of heavy rainfall on the local catchment. They would have also improved the safety of pedestrian access along the footpath during a 1% AEP flood under current climate conditions. They would, however, have little impact on the actual water levels that would occur during such a flood, and would have little effect on the increased frequency and depth of flooding that is expected to occur by 2100.

8.2 The Hotel Complex

Works required to "flood-proof" the hotel complex included:

- A minimum ground floor level of 3.0m AHD (i.e., the 1% AEP flood level for 2100 plus a 0.6m freeboard) in all but the retail tenancies.
- A minimum ground floor level in the retail tenancies of 2.4m AHD (i.e., the 1% AEP flood level for 2100).
- All entries to the basement are to be set to a minimum of 3.0m AHD.

These requirements would have ensured that the hotel complex was immune to flooding in events up to the 1% AEP flood for 2100. Queens Bridge Street would have remained unsafe for pedestrian access during such an event. Safe pedestrian access was, however, to be provided via an internal arcade connecting to higher ground in Freshwater Place to the east, and via an overhead pedestrian bridge connecting the hotel to the existing Crown Complex to the west.

8.3 Overview

The works associated with development of the site similar to that which was proposed for One Queensbridge would be expected to alleviate the more frequent "nuisance" flooding of Queens Bridge Street, and improve the safety of pedestrian access along the footpath during a 1% AEP flood. With increased flood levels by 2100, Queens Bridge Street would become unsafe for pedestrian access during a 1% AEP flood, but the development itself would be immune to flooding and would provide safe pedestrian access to higher ground away from the site.

9 CONCLUSIONS

The main findings of my investigations can be summarised as follows:

- The Queens Bridge Hotel (the Hotel) is located at 1 to 7 Queens Bridge Street, Southbank and comprises three floors, as well as a basement carpark and a cellar.
- The area is low-lying and the road and footpath levels in Queens Bridge Street between Power Street and Southbank Promenade are typically in the range of 0.8m to 1.5m AHD.
- Ground levels increase at the northern end of Queens Bridge Street and there is no natural overland flow path for surface water flows from Queens Bridge Street northwards to the Yarra River.
- The Hotel is currently subject to flooding from:
  - Storm tides in the Yarra River.
  - A combination of storm tide levels and Yarra River flood flows; and
  - Stormwater generated by rainfall over the local catchment.
- At an annual exceedance probability of 1%, the flood level for each of these mechanisms is estimated to be 1.6m AHD.
- Allowing for the effects of Climate Change, the 1% AEP flood levels at the Hotel would be expected to increase to:
  - 2.4m AHD for both storm tides, and the combination of storm tides and flood flows; and
  - 1.7m AHD for local stormwater flooding.
- With an increase in mean sea level of 0.8m AHD, the frequency of flooding would increase such that the Hotel would be expected to be flooded to a level of 1.7m AHD, on average once a year.
- Under current climate conditions, the effects of a 1% AEP flood on the Hotel would be as follows:
  - The footpath adjacent to the Hotel would be flooded to depths ranging from 0.1m to 0.4m. These depths would be safe for pedestrians and would provide safe pedestrian access to higher ground along Southbank Promenade.
  - The footpath in front of 17 and 25 Queens Bridge Street to the south of the hotel would be flooded to depths of 0.6 to 0.7m, which would be unsafe for pedestrians.
  - Parts of the ground floor would be flooded to depths of up to 0.15m, but would remain safe for pedestrian access.
  - The basement carpark would be filled to a depth of almost 2.5m at the base of the ramp. It would be unsafe, and would be expected to become unsafe quite rapidly once it began filling.
  - The cellar would be filled to a depth of more than 2.8m. It would be unsafe, and would be expected to become unsafe quite rapidly once it began filling.
- The basement carpark is also subject to more frequent nuisance flooding and will require remedial work if this is to be prevented from continuing.
- By 2100, the effects of Climate Change and sea level rise will result in an increase in both the frequency and severity of flooding, such that:
  - All of the Hotel and its surroundings would become unsafe in a 1% AEP flood; and
  - Flooding that currently only has a 1% probability of occurring in any given year (described above) could be expected to occur, on average, once or more a year.
- Public Realm Improvements proposed as part of the One Queensbridge development would have:

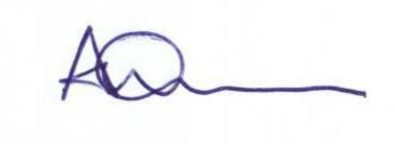
2010366_R01v01

- Helped alleviate the more frequent “nuisance” flooding of Queens Bridge Street; and
- Improved the safety of pedestrian access along the footpath under current climate conditions.

- Access to Queens Bridge Street would have remained unsafe in a 1% AEP flood by 2100.
- The proposed hotel complex would have been effectively flood-proofed to 2100 by:
  - All ground floor levels and any basement entries being constructed at, or above the 2100 1% AEP flood level; and
  - Providing safe pedestrian access to high ground via an internal arcade connecting to Freshwater Place, and an overhead pedestrian bridge connecting the hotel to the existing Crown Complex.

10 DECLARATION

I declare that I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.



Dr Andrew McCowan

30 June 2020

Melbourne

15 Business Park Drive
Notting Hill VIC 3168
Telephone (03) 8526 0800
Fax (03) 9558 9365

Brisbane

Level 3, 43 Peel Street
South Brisbane QLD 4101
Telephone (07) 3105 1460
Fax (07) 3846 5144

Adelaide

1/198 Greenhill Road
Eastwood SA 5063
Telephone (08) 8378 8000
Fax (08) 8357 8988

Perth

Ground Floor
430 Roberts Road
Subiaco WA 6008
Telephone 0438 347 968

Geelong

PO Box 436
Geelong VIC 3220
Telephone 0458 015 664

Gippsland

154 Macleod Street
Bairnsdale VIC 3875
Telephone (03) 5152 5833

Wangaratta

First Floor, 40 Rowan Street
Wangaratta VIC 3677
Telephone (03) 5721 2650

Wimmera

PO Box 584
Stawell VIC 3380
Telephone 0438 510 240

www.watertech.com.au

info@watertech.com.au