AECOM

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Defence Breach Modelling

Technical Note

November 2017

Prepared for Bristol City Council

Issue	Date	Details	Prepared by	Checked by	Approved by
1	21/07/2017	Draft for client review	**Richard Moore** Flood Risk Consultant	**Mark Davin** Principal Engineer	**David Dales** Technical Reviewer
2	21/11/2017	Final issue	**Richard Moore** Flood Risk Consultant	**Mark Davin** Principal Engineer	**David Dales** Technical Reviewer

Scott House
Alencon Link
Basingstoke
Hampshire
RG21 7PP

Limitations

AECOM Infrastructure & Environment UK Limited ("AECOM") has prepared this Report for the sole use of Bristol City Council ("Client") in accordance with the Agreement under which our services were performed **River Avon Tidal Flood Risk Management Strategy RESP1007626 (23/10/15) and Response to Tender Submission Clarifications (03/11/15) (the "Agreement")**. The report takes into account the particular instructions and requirements of the Client in accordance with the provisions of the Agreement. It is not intended for and cannot be relied upon by any third party. No liability is accepted by AECOM and no responsibility is undertaken to any third party.

Information obtained by AECOM has not been independently verified by AECOM, unless otherwise stated in the Report.

The methodology adopted and the sources of information used by AECOM in providing its services are outlined in this Report. The work described in this Report was undertaken between September 2016 and July 2017 and is based on the conditions encountered and the information available during this period. The scope of this Report and the services are therefore factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

Copyright

TABLE OF CONTENTS

1 INTRODUCTION

Following a review of the Preferred Option defence alignments and a meeting with Bristol City Council (BCC) on 22nd May 2017, AECOM Infrastructure & Environment UK Limited (AECOM) have been commissioned to undertake additional breach modelling to assist with the development of the Preferred Option to support the Bristol Tidal Flood Risk Management Strategy (TFRMS).

The additional modelling involves assessing residual risk as a result of a breach in the proposed defences along the River Avon. It was agreed with BCC that the 1 in 200 year tidal event (combined with a 1 in 2 year fluvial event) would be simulated for the 2115 epoch, with the Preferred Option in place. For the 2115 epoch this consists of high defence measures which comprise linear defences (walls and embankments) to provide a high standard of protection. This includes the additional mitigation at Bower Ashton and Netham which have been proposed following the detriment modelling undertaken as part of the modelling undertaken in January 2017 (see Additional Hydraulic Modelling Technical Note, AECOM 2017). Ten different scenarios would then be simulated, each representing a different breach in the Preferred Option defences.

The agreed location and length of each breach are discussed in more detail throughout Section 2. There are a number of gate and structural breaches/failures, all of which have been selected based on low-lying vulnerable area and confirmed with BCC. For more information regarding the defences that are being implemented, please refer to Appendix A and for all locations specified in each section, refer to flood maps within Appendix B alongside the location figures within the report.

To represent the breach in each location, ground/banks levels from the Do Nothing modelling were reviewed and used as the level that the breach should be lowered. It should be noted that this modelling exercise looks at the residual risk immediately landward of the breach. In many of the breach locations, it is possible that water can flow overland from the River Avon to the Floating Harbour via the breach and as a result the water level in the Floating Harbour could potentially increase. As a consequence of this, there is potential for other localised areas of inundation around the harbour that would otherwise be protected. The impact is likely to be exacerbated due to the fact that water leaving the Floating Harbour is restricted by the raised defences at the Entrance Lock and Netham Lock.

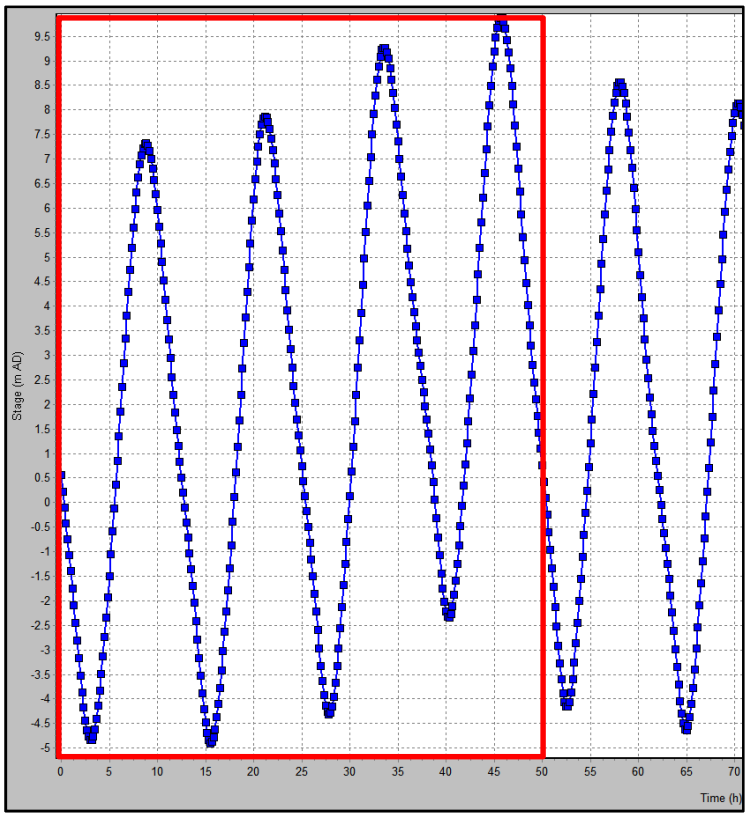


Figure 1: Modelled Tidal Cycles (shown in red)

It should be noted that for breach simulations, the run time of each model has been changed from 70 hours to 50 hours in an attempt to reduce the overall computational run time (shown in red within Figure 1). The initial conditions of the model and tidal representation have been adjusted to suit this new period of the tidal cycle, ensuring that the main peak of the tidal event is simulated, but reducing the total number of tidal cycles.

As mentioned in the preceding modelling reports, the modelling approach incorporated the adoption and updating of the existing BCC CAFRA WS3 model. For consistency purposes, this approach was used as part of the Options Phase modelling (testing linear flood defences) and has therefore been taken forward for the additional modelling which forms this phase of works. Aspects regarding the modelling methodology and hydrological approach have not been discussed within this document, but can be found within Section 2 of the Hydraulic Modelling Report: Short Listing Phase (AECOM, 2016).

2 FLOOD GATE FAILURE - BREACH LOCATIONS

2.1 Breach Location 1 - Cumberland Road Reach 1-20

The first breach simulation represents a failure of the manually operated floodgate that is located across the railway adjacent to Cumberland Road. The gate itself is approximately 5m in width. To be appropriately represented within the model, it was a technical requirement to increase the breach dimension length to 10m which also involves the ramped defence which ties-in with the MetroBus floodwall alignment. This is shown in Figure 2.

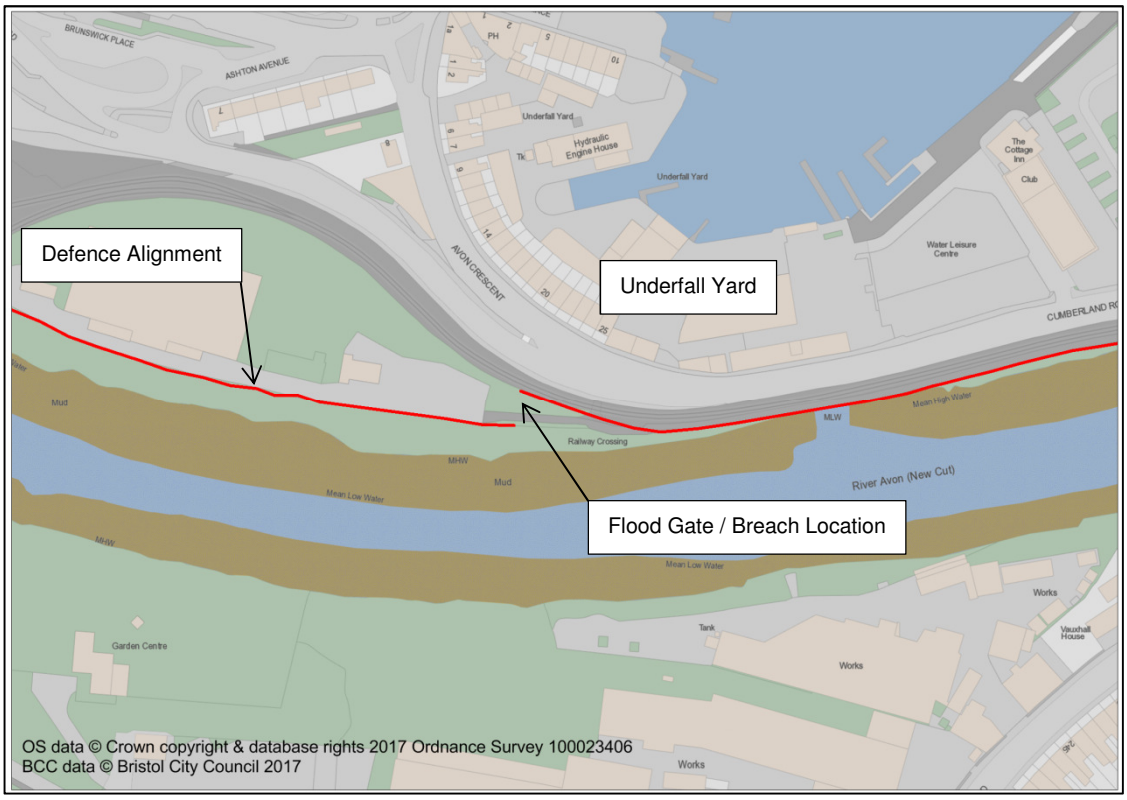


Figure 2: Breach Location 1 - Cumberland Road (Reach 1-20)

The modelling results have shown that water flows through the open flood gate in the defences during the third and fourth tidal cycles, where the fourth tidal cycle includes for the peak of the simulated event. Water first flows through the breach approximately 32.45 hours into the simulation (during the third tidal cycle) with water propagating west behind the raised defence and also east across Cumberland Road and Avon Crescent. Water flows overland into Underfall Yard, contributing to a slight increase in water level within the Floating Harbour.

During the fourth tidal cycle, water flows through the flood gate in the defence 44.45 hours into the simulation. Similarly, water propagates west behind the defence alignment but, in addition to the previous tidal cycle, water flows beneath McAdam Way, north across Smeaton Road and Brunel Lock Road and into the Cumberland Basin (Figure 1A, Appendix B). To the east, water flows across Cumberland Road and Avon Crescent and into the Floating Harbour. This also leads to the inundation of properties and businesses located around Underfall Yard, Avon Crescent and Nova Scotia Place with depths reaching approximately 0.60m.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 1 can be found within Appendix B (Figure 1A, 1B and 1C).

2.2 Breach Location 2 - Cumberland Road Reach 3-1

This breach simulation represents a failure of the floodgates that are situated across the heritage railway that is located beneath the Cumberland Road Bridge. Similar to the breach scenario at Breach Location 1 (Section 2.1), Breach Location 2 was extended to 10m in width to ensure it is appropriately represented within the model. According to the defence alignment plan (Appendix A) the footpath adjacent to the railway will be raised to act as a flood defence. For this breach simulation, this was removed with the footpath remaining at its current level (i.e. during the Do Nothing scenario). The location of where the gate beneath Cumberland Road Bridge is proposed is shown by the dashed line in Figure 3. It should be noted that there are no other proposed defences in this area, hence why these are not shown on the figure.

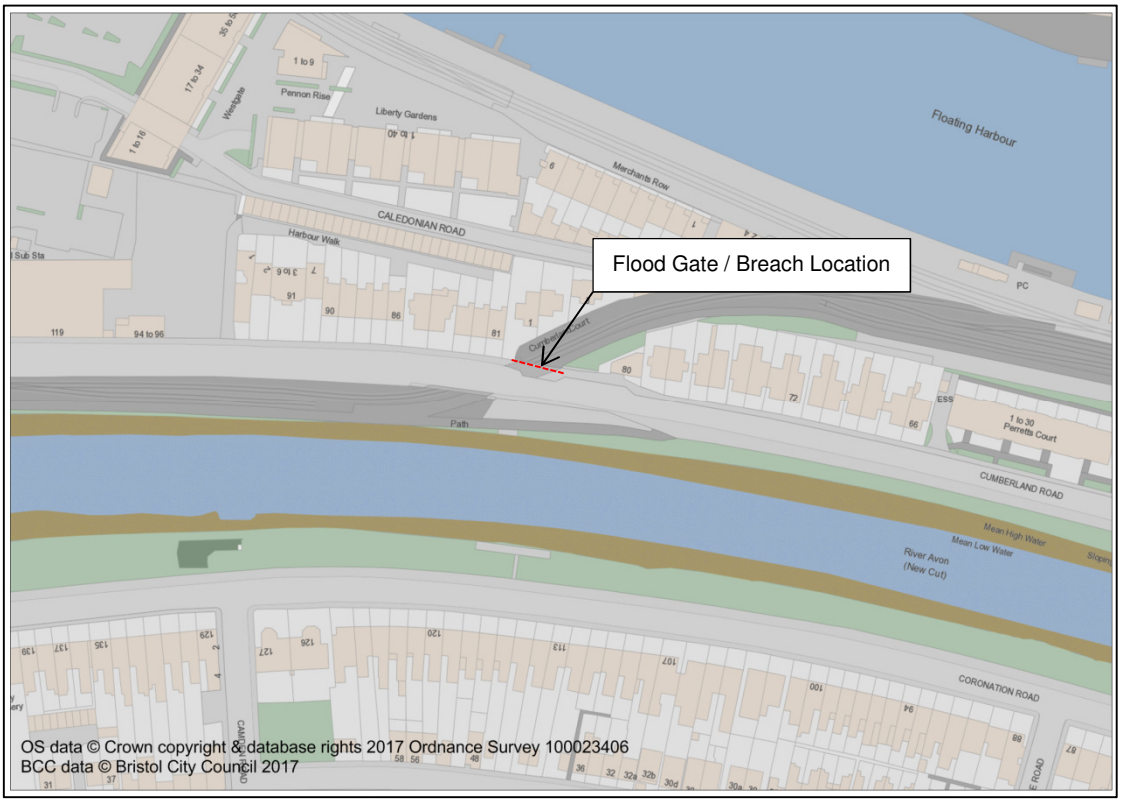


Figure 3: Breach Location 2 - Cumberland Road (Reach 3-1)

During the third tidal cycle water overtops the right bank defences of the River Avon (approximately 33.00 hours into the simulation) with water flowing beneath Cumberland Road before making its way into the Floating Harbour. During this tidal peak, water also flows west once under the bridge, inundating properties along Caledonian Road / Merchants Row to depths of between 0.10m – 0.30m.

During the fourth tidal cycle water overtops the right bank of the River Avon approximately 44.45 hours into the simulation. Water propagates as it does during the third tidal cycle, however more water flows west along Caledonian Road inundating the waterside properties. Water also propagates east but remains largely within the undeveloped areas with only a few of the commercial units becoming inundated. Depths of approximately 1.10m are recorded along Caledonian Road during this tidal cycle, with depths rising to approximately 1.50m around the immediate location of the breach where the footpath adjacent to Cumberland Road is at a lower level than the main road.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 2 can be found within Appendix B (Figure 2A, 2B and 2C).

2.3 Breach Location 3 - St Phillips Reach 7-13

The final breach simulation which represents gate failure is located along the right bank of the River Avon at St. Phillips Reach where a 0.40m high and 6m wide floodgate is being proposed behind Ferry Steps Industrial Estate. With floodwalls located either side of this floodgate, this defence will help protect some of the industrial and commercial properties that are located along Albert Road in St Phillips. This is shown in Figure 4.

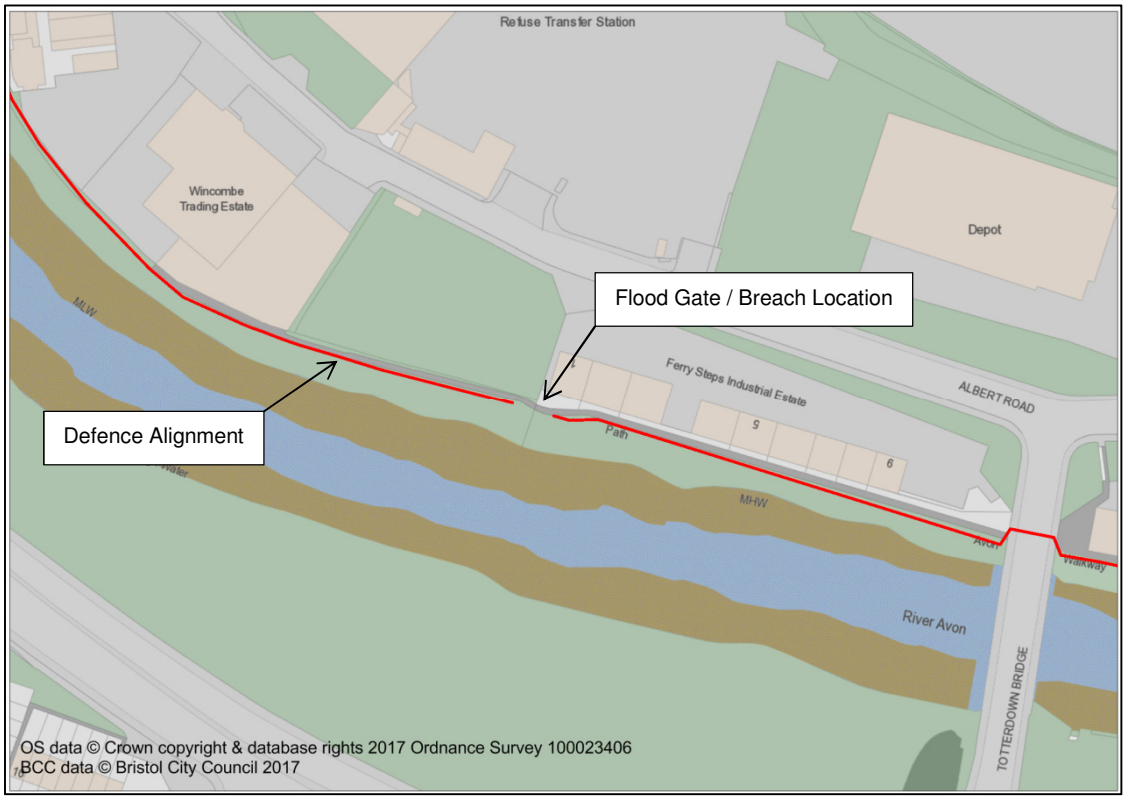


Figure 4: Breach Location 3 - St Phillips (Reach 7-13)

During the third tidal cycle water flows through the flood gate along the right bank of the River Avon (approximately 33.30 hours into the simulation) with water flowing north and then west along Albert Road. During this tidal cycle, water inundates the majority of the commercial and industrial properties either side of Albert Road, to depths of up to 0.70m. This is shown in detail within Figure 3A in Appendix B.

During the fourth tidal cycle water propagates through the flood gate approximately 45.15 hours into the simulation. Water flows quickly through the flood gate in the defence and by 46.30 hours; floodwater has inundated all developments along Albert Road, with water starting to flow east along Stanhope Street, Victoria Road and Chapel Street. Floodwater also begins to flow into Feeder Canal to the north. During this tidal cycle flood depths of approximately 1.80m are recorded along Albert Road.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 3 can be found within Appendix B (Figure 3A, 3B and 3C).

3 STRUCTURAL FAILURE – BREACH LOCATIONS

3.1 Breach Location 4 - Cumberland Road 2-1 (10m)

This breach location is located along Cumberland Road where a 10m wide breach was represented and modelled. The location of the 10m breach was located opposite to the road which leads to the British Sailing School / Harbour Masters office. In this location a flood defence has already been constructed as part of the MetroBus development and it is proposed to construct a new contiguous piled wall with a reinforced concrete wall on the same alignment. The defence height for 2115 following construction will be 1.80m. Figure 5 shows this location.

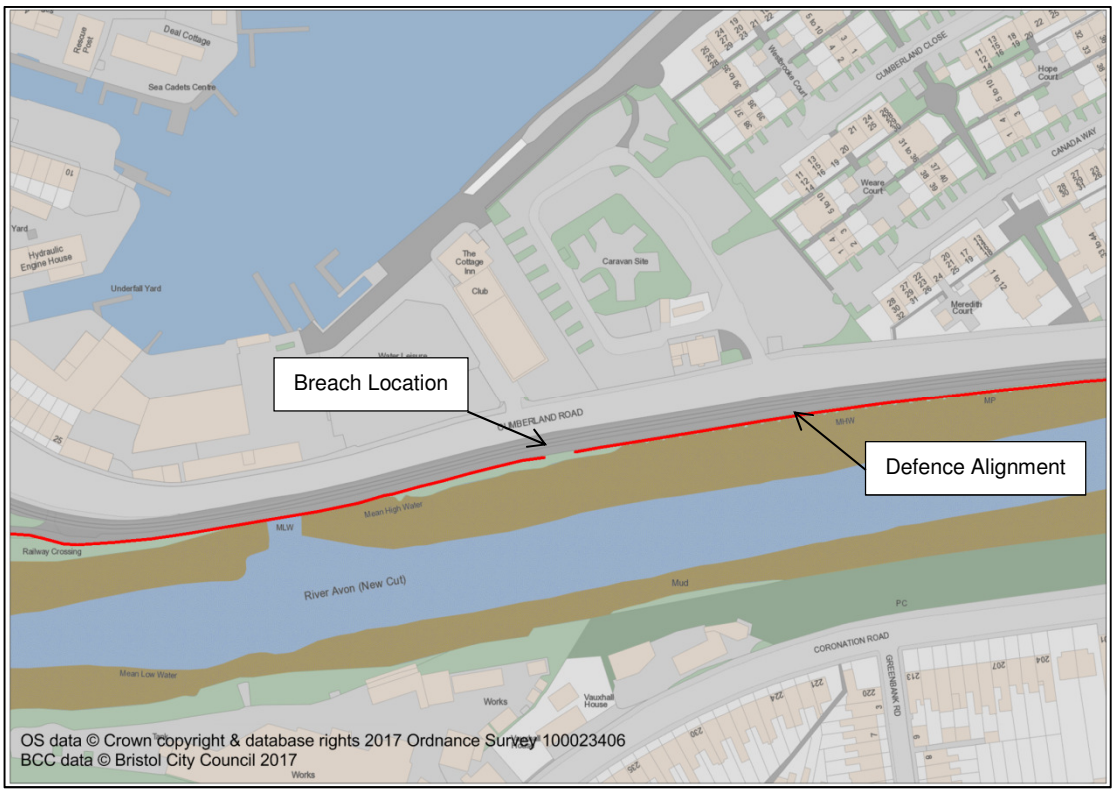


Figure 5: Breach Location 4 - Cumberland Road (Reach 2-1)

At approximately 33.00 hours into the simulation (third tidal cycle) water flows through the breach location on the right bank and onto the footpath that runs parallel to Cumberland Road. At 33.15 hours, water flows through the breach and propagates both east and west along Cumberland Road. To the west, water flows to the junction with Avon Crescent before flowing north and into the Floating Harbour. To the east, the Baltic Wharf Caravan Park and Bristol Sailing School become fully inundated by 33.30 hours. Properties along Mardyke Ferry Road, Cumberland Close and Canada Way also become inundated with depths rising to approximately 0.60m.

During the fourth tidal cycle water flows through this breach location at approximately 45.00 hour into the simulation with water inundating the entire western extent of Spike Island with depths around the residential properties rising to approximately 0.70m. It is considered that the direct flow route from the River Avon into the Floating Harbour prevents flood depths from reaching any higher. The maximum flood depth within the area is around Underfall Yard where depths reach 1.50m. This is an example of how the Floating Harbour levels are increasing as a result of the breach (combined with the other watercourses which outfall into the harbour), leading to inundation of low lying areas.

The figures within Appendix B (Figure 4A, 4B and 4C) show the maximum flood depth, velocity and hazard for Breach Location 4 immediately behind the breach location.

3.2 Breach Location 5 - Cumberland Road 2-1 (20m)

The location of this breach is exactly the same as the breach in the above simulation (Section 3.1) the only exception is that the width has been extended to 20m. This was simulated to see how the flood extents and depths changed as a result of a larger breach in the flood defence. The location of the breach is shown in Figure 6.

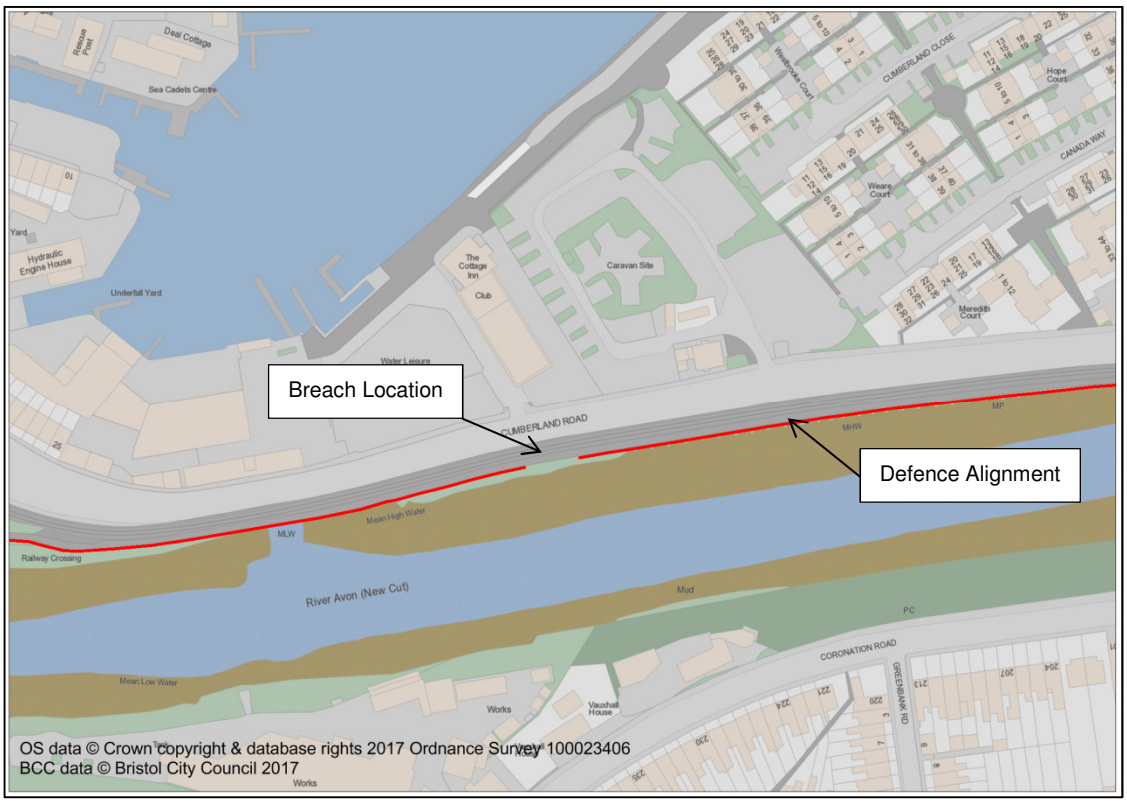


Figure 6: Breach Location 5 - Cumberland Road (Reach 2-1)

Results from this breach simulation are very similar to those experienced in the previous simulation (Section 3.1). During the third tidal cycle flood depths and extents are very similar, with water propagating across the area in exactly the same way. It is only during the fourth tidal cycle where there are slight differences. With a larger breach in the defence, a greater volume of water can effectively flow into the area behind the defences. Although the flood extent is largely similar to the 10m scenario, there are greater flood depths.

During the third tidal cycle there is only a small period where water levels in the River Avon are high enough to flow through the breach, therefore flood depths between the 10m breach simulation and 20m breach simulation are very similar. During the fourth tidal cycle there is much greater period where the water level in the River Avon is greater than the level of the breach therefore more volume of water can flow through. As a result, flood depths during this cycle increase to approximately 0.75m (an increase of 0.05m when compared with the 10m breach) along Mardyke Ferry Road which is caused by the larger breach in the flood defence.

The figures within Appendix B (Figure 5A, 5B and 5C) show the maximum flood depth, velocity and hazard for Breach Location 5 immediately behind the breach location.

3.3 Breach Location 6 - Bathurst Dam Reach 4-1

The next structural breach simulation represents a defence failure at Bathurst Dam. The Preferred Option involves raising the concrete dam to 2m (high defences) above the existing crest level which currently stands at 8.30m AOD. This breach simulation involves lowering that defence back down to the existing crest level (as it was represented during the Do Nothing scenario), while keeping all raised defences along the River Avon. Bathurst Basin is represented by the red dashed line in Figure 7, while all other defences within the location (which remain raised) are shown as a solid red line.

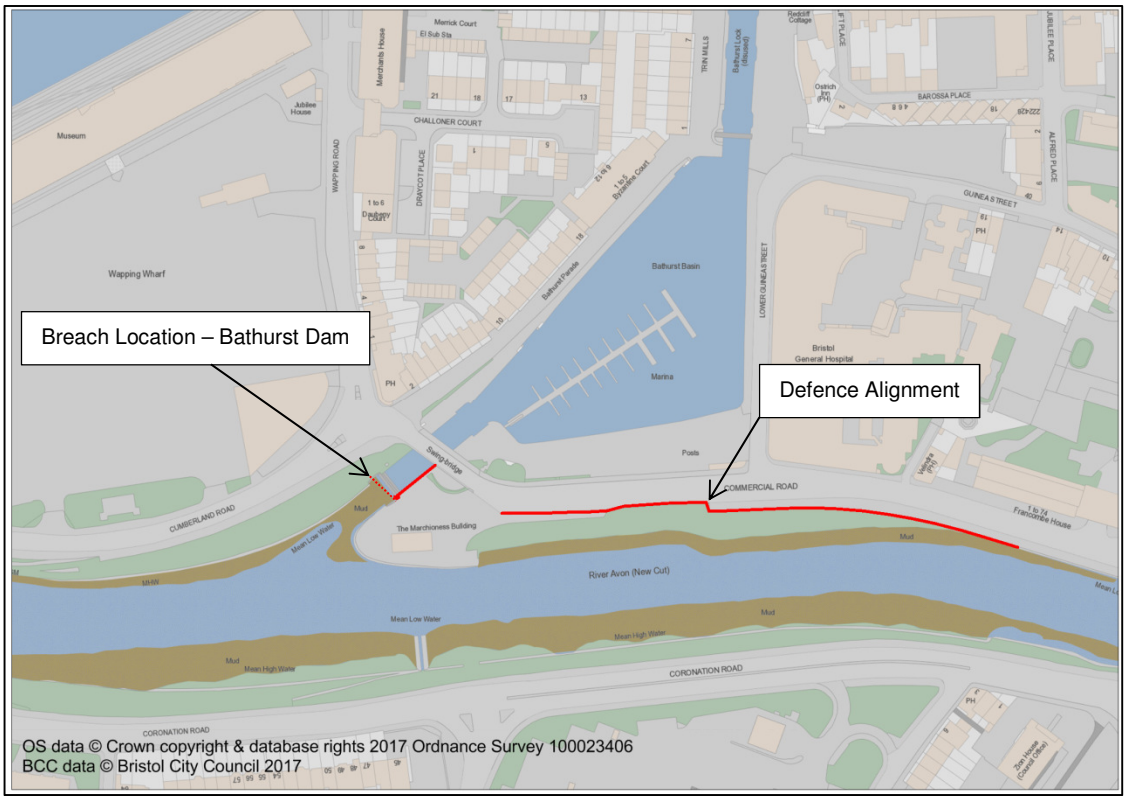


Figure 7: Breach Location 6 - Bathurst Dam (Reach 4-1)

Results from this breach simulation show that during the third tidal cycle, the water level within the River Avon rises to approximately 9.60m AOD at the Bathurst Dam. As a function of this water level exceeding 8.30m AOD, water overtops into the Bathurst Basin. During this tidal cycle, the level in the Floating Harbour rises from 6.20m AOD to 6.96m AOD. While the breach of Bathurst Dam contributes to this elevated water level, it should be noted that there are other sources (i.e. a section of the River Frome) which also discharge into the Floating Harbour.

During the fourth tidal cycle, water levels within the River Avon rise to approximately 10.07m AOD. This small breach therefore allows water to freely flow into the Floating Harbour for over 2 hours causing the water level to rise from 6.20m AOD to 8.11m AOD. With the amount of storage that the Floating Harbour provides, this small breach in the defence does not cause significant flooding as in the majority of central Bristol; water is retained within the Floating Harbour. This is why no flooding is shown around Bathurst Dam. It is likely however, that by raising the water level within the Floating Harbour to 8.11m AOD, there could potentially be localised areas (i.e. low lying) around the harbour that may experience flooding as a result of this breach.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 6 can be found within Appendix B (Figure 6A, 6B and 6C).

3.4 Breach Location 7 - Clarence Road Reach 5-3

Along Clarence Road a contiguous piled floodwall, set 1m - 2m into the river channel, is proposed as part of the Preferred Option. When considering 'high defences' i.e. for 2115, this floodwall will be raised 2.30m above existing ground levels. Following a review of the LiDAR data, it was determined that a breach should be positioned in the Clarence Road defence between Somerset Street and Chatterton Street, where ground levels are particularly low. This is shown in Figure 8.

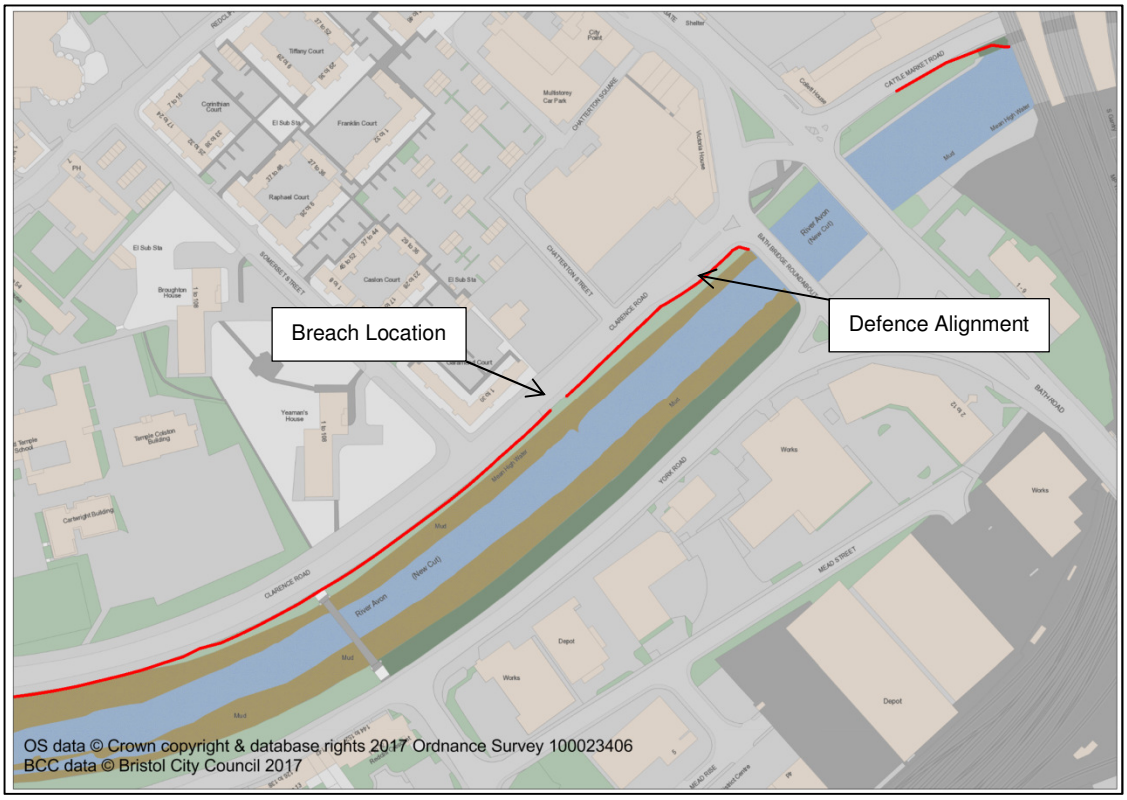


Figure 8: Breach Location 7 - Clarence Road (Reach 5-3)

Results from this breach show that water overtops the right bank of the River Avon at the breach location 33.00 hours into the simulation which coincides with the third tidal cycle. Water propagates west along Clarence Road down to Ship Lane but the main flow route is north along Chatterton Street and onto Temple Gate where ground levels are notably lower. Residential properties within this area along with the car garage are inundated during this cycle as a result of the breach.

During the fourth tidal peak, water flows through the breach at approximately 45.00 hours into the simulation. Water propagates quickly to the north along Temple Gate and Victoria Street and by 46.30 hours, water has reached the Floating Harbour which is located approximately 890m from the breach location. Large areas to the east and west become inundated including Redcliff Street, St Thomas Street and Temple Street. The maximum flood depths recorded in this area are approximately 1.60m along Chatterton Street and Clarence Road which are located close to the breach location.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 7 can be found within Appendix B (Figure 7A, 7B and 7C).

3.5 Breach Location 8 - St Phillips Reach 7-6

For this structural breach a sheet piled flood wall was removed along the right bank of the River Avon where the railway line crosses over from the Totterdown area into St Phillips. The location of this breach is shown in Figure 9.

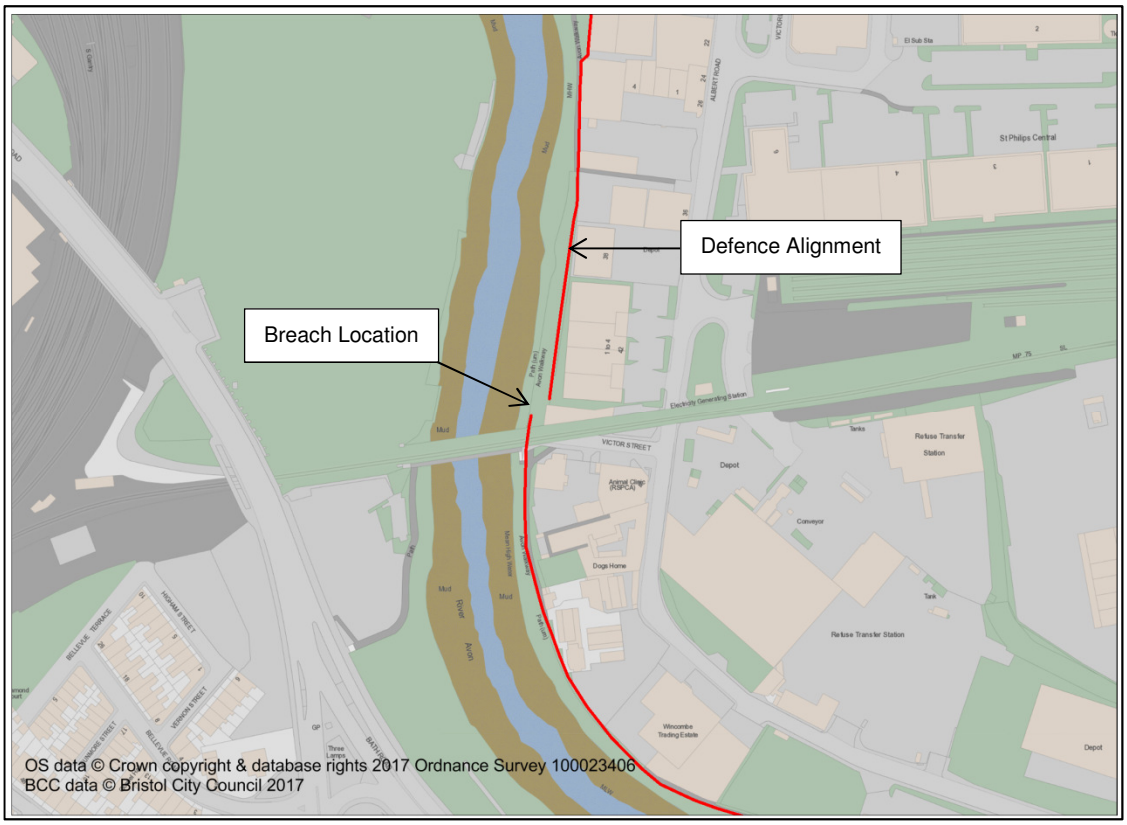


Figure 9: Breach Location 8 - St Phillips (Reach 7-6)

Water overtops the right bank of the River Avon and through the breach in defence, 33.00 hours into the simulation which again coincides with the third tidal cycle. Water propagates north and south along Albert Road in a similar way to the breach event experienced in Section 2.3. The trading estate to the east of Albert Road / Stanhope Street is fully inundated as are all commercial and industrial properties that exist along the bank of the River Avon. Water continues to propagate north before flowing into Feeder Canal.

During the fourth tidal cycle water follows the low lying land as it does during the third tidal cycle. The only difference is water flows further east along Chapel Street inundating trading estates off Albert Crescent which are located approximately 800m to the north-east of the breach location. Water also flows south and then east along Albert Road. The maximum flood depth recorded during the third tidal cycle is approximately 1.70m, located along Albert Road in close proximity to the breach location. During the fourth cycle, the maximum flood depth increases to 2.10m in the same location.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 8 can be found within Appendix B (Figure 8A, 8B and 8C).

3.6 Breach Location 9 - St Phillips Reach 7-27

This structural breach is located along the right bank of the River Avon behind the St Phillips Trade Park adjacent to Albert Road. It is proposed to construct a new sheet piled defence in this location which will be installed during future redevelopment of the site. The location of the breach is shown in Figure 10, and was chosen based on areas with low ground levels in behind the defence.

Figure 10: Breach location 9 - St Phillips (Reach 7-27)

Water overtops the right bank of the River Avon through the breach in defence 33.00 hours into the simulation, which coincides with the third tidal cycle. Water propagates through St Phillips Trade Park before flowing west and east along Albert Road, as well as north along Albert Crescent. The commercial / industrial estates either side of the breach become fully inundated with depths reaching approximately 1.30m. Water also flows north beneath the railway bridge all the way to Feeder Canal (approximately 650m to the north) inundating the trading estates in St Philip's Marsh.

During the fourth tidal cycle, where water flows through the breach approximately 44.45 hours into the simulation, a large area of St Philip's Marsh becomes inundated. Water initially flows west and propagates in a similar way as it does during the gate breach in Section 2.3. Water follows Albert Road all the way to Feeder Canal, inundating the majority of the commercial and industrial properties located either side of the road. Water also propagates north along Albert Crescent, under the railway bridge, inundating the trading estates immediately to the east which are located in areas of low lying ground. Other roads that become flooded include Chapel Street, Victoria Street, Lewis Street, Philip Street and Meriton Street. The greatest flood depths are experienced along Albert Road, immediately to the north of the breach location, where they reach 1.30m during the third tidal cycle and 1.90m during the fourth tidal cycle.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 9 can be found within Appendix B (Figure 9A, 9B and 9C).

3.7 Breach Location 10 - Netham Reach 8-2

This structural breach is located in Netham, slightly downstream from Netham Lock. In this area there is contiguous bored pile wall being proposed which will protect the industrial areas along the right bank of the River Avon. Figure 11 shows this location.

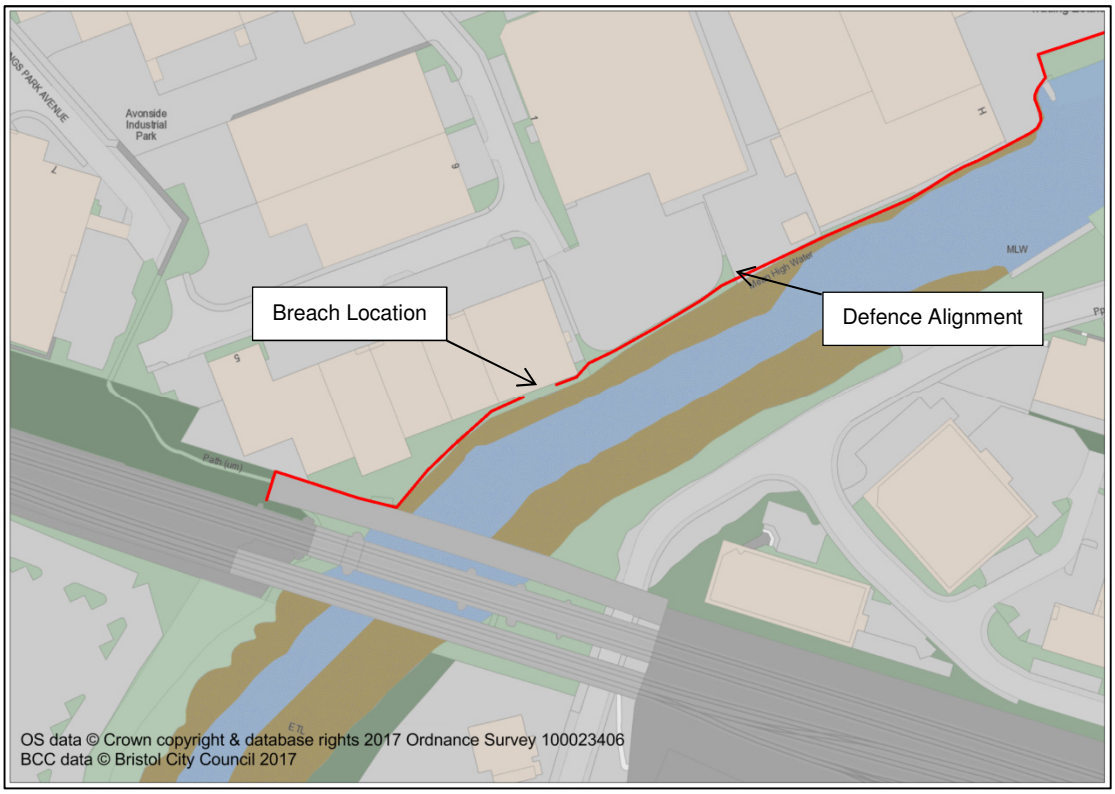


Figure 11: Breach Location 10 - Netham (Reach 8-2)

The first sign of flow through the breach occurs during the third tidal cycle, approximately 33.30 hours into the simulation. Water flows north onto Avonside Road before flowing north-west, following the low points in the area. Water flows through the Avonside Industrial Estate before flowing into Feeder Canal which is located approximately 340m to the north of the breach location.

During the fourth tidal cycle, water follows the same route as above, but this time the entire industrial estate is inundated along with Kings Park Avenue and Tamar Road. The maximum flood depth recorded during this event is 0.70m, located along Kings Park Avenue which provides access to the industrial estate. In contrast, the majority of St Vincents Trading Estate which is located to the east of Avonside Road remains dry given that it is located on slightly higher ground.

Figures showing the maximum flood depth, velocity and hazard for Breach Location 10 can be found within Appendix B (Figure 10A, 10B and 10C).

4 SUMMARY OF BREACH RESULTS

Breach Location	Time of breach (third tidal cycle) (hours)	Time of breach (fourth tidal cycle) (hours)	Key Areas Inundated	Flood Depth (m)	Maximum Flood Depth (m)[1]
Gate Failure					
Breach Location 1 Cumberland Road 1-20	32.45	44.45	Underfall Yard / Avon Crescent	0.60m	1.60m
			Nova Scotia Place	0.20m	
Breach Location 2 Cumberland Road 3-1	33.00	44.45	Caledonian Road	1.10m	1.50m
Breach Location 3 St Phillips 7-13	33.30	45.15	Albert Road	1.80m	1.80m
			Chapel Street Trading Estate	0.70m	
Structural Failure					
Breach Location 4 Cumberland Road 2-1 (10m)	33.15	45.00	Underfall Yard	1.50m	1.60m
			Baltic Wharf Caravan Site	0.60m	
			Mardyke Ferry Road	0.70m	
Breach Location 5 Cumberland Road 2-1 (20m)	33.15	45.00	Underfall Yard	1.50m	1.50m
			Baltic Wharf Caravan Site	0.70m	
			Mardyke Ferry Road	0.75m	
Breach Location 6 Bathurst Dam 4-1	33.00	44.45	n/a	n/a	n/a
Breach Location 7 Clarence Road 5-3	33.00	45.00	Clarence Road	1.60m	1.60m
			Chatterton Square	1.60m	
			Temple Gate	1.00m	
			Victoria Street	0.60m	
Breach Location 8 St Phillips 7-6	33.00	45.00	Albert Road	2.10m	2.10m
			Chapel Street Trading Estate	1.00m	

[1] Maximum flood depth resembles greatest depth behind the breach location. This is often in the area immediately behind the breach which doesn't coincide with a 'key' feature.

Breach Location 9 St Phillips 7-27	33.00	44.45	Albert Road (east) / Albert Crescent	1.90m	1.90m
			Chapel Street Trading Estate	0.50m	
			St Philips's Marsh	1.00m	
Breach Location 10 Netham 8-2	33.30	45.15	Avonside Industrial Estate	0.70m	0.70m

5 SINGLE SOURCE WORST CASE RESIDUAL RISK

In addition to the breach modelling described in this report, a range of model runs have previously been undertaken to inform the assessment of residual risk from different breach sources. These included breach runs for the proposed new flood/lock gates at Entrance Lock and Netham which are part of the preferred option.

For any given site within the flood plain, the worst case flood scenario will vary depending on the location and the nature of the event (for instance, a location may have a greater risk from either a defence breach adjacent to the location or a breach of Entrance Lock or Netham gates).

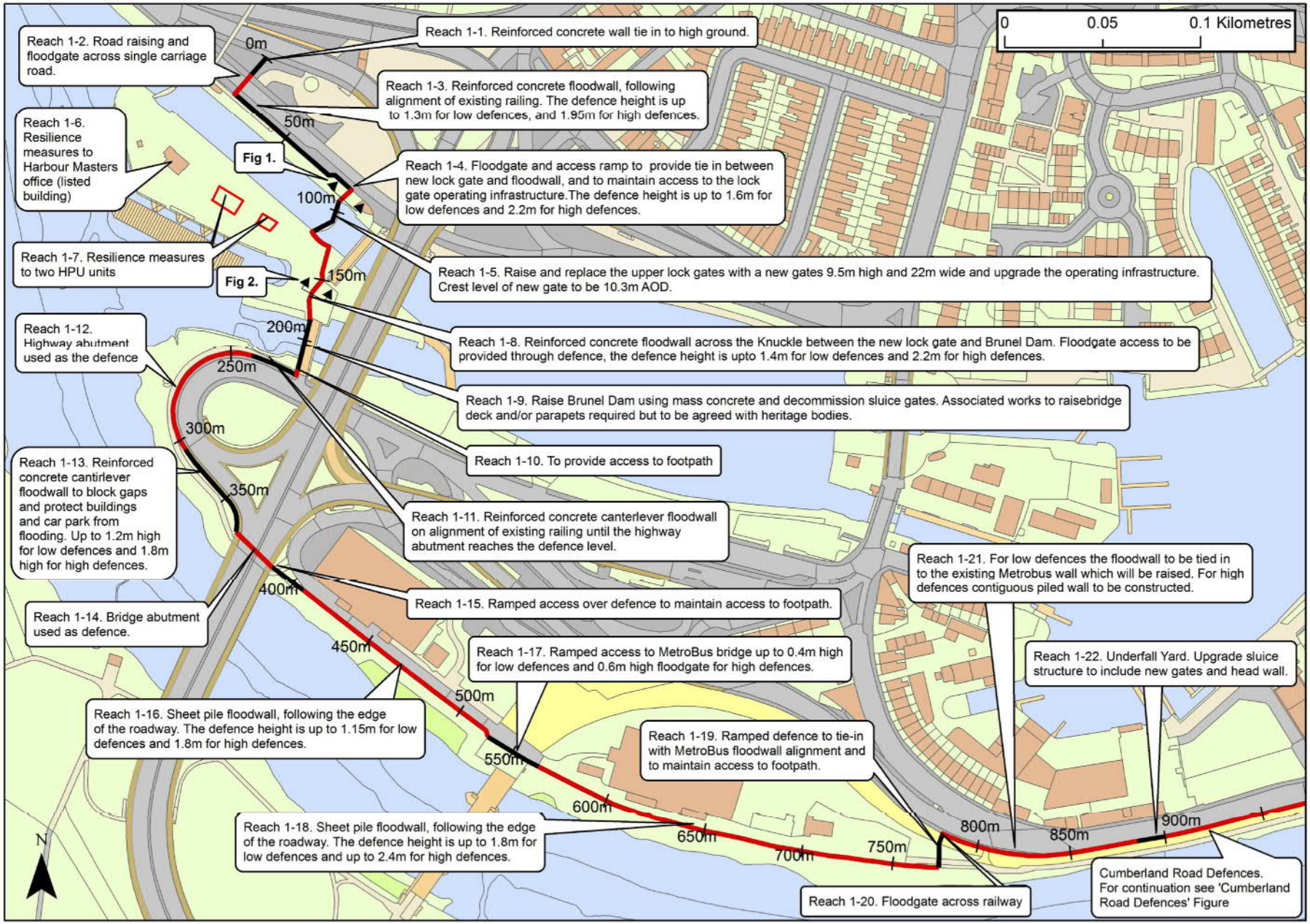
In order to provide one coherent single source of truth dataset as a reference for considering the potential outcome from any one of the breach scenarios occurring, the outputs from all the breach modelling results have been merged in GIS to provide maximum depth, maximum velocity and maximum hazard mapping layers. Each map takes the worst case data from any of the runs for a particular location and includes it in the output to display the parameter of interest. The merged datasets include all the breach modelling results described in this report (structural failures and gate failures), the breaching of the proposed gates at Entrance Lock, and breaching of the proposed gates at Netham. The return period for all the model runs is a 1:200 year tidal event in 2115.

The mapping provides a quick reference to review the likely worst case potential outcome in the unlikely event that breaching were to occur, between Entrance Lock and Netham, in terms of residual flood risk depth, velocity and hazard associated with breaching. It is important to note that these outputs do not provide a 'real' or time referenced snapshot of flooding but simply report the worst case that could be experienced from any of the breach scenarios modelled. To understand the magnitude of each separate breach the reader should view the maps in Appendix B.

The single source breach mapping is provided in Appendix C.

For reference, the separate breach results showing the breaches at Entrance Lock and Netham gates can be found in the Residual Risk technical note.

APPENDIX A – DEFENCE ALIGNMENTS



AECOM

AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.65m

- Design level for high defences (including 200mm freeboard) = 10.30m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

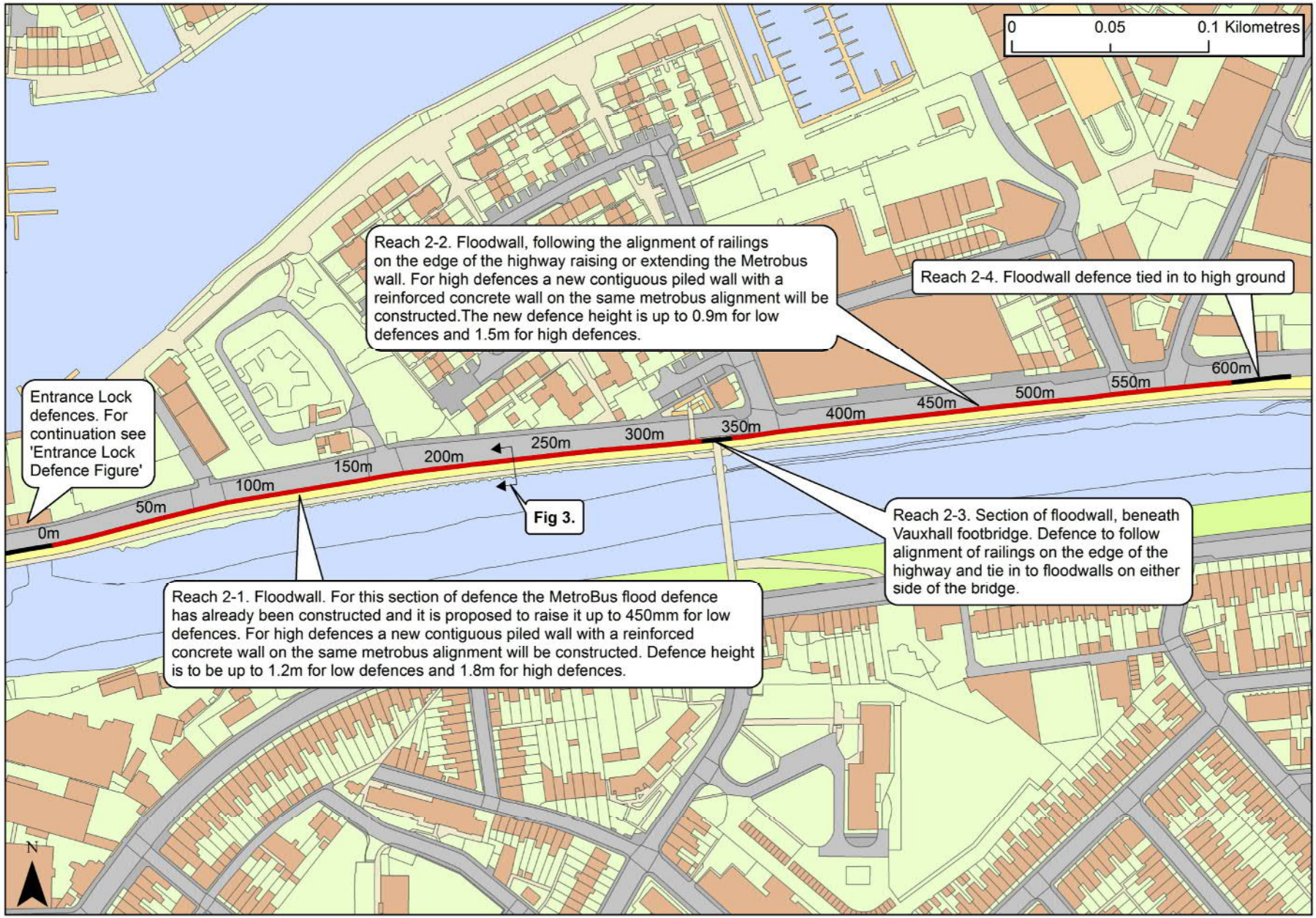
ENTRANCE LOCK DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Entrance Lock template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.65m

- Design level for high defences (including 200mm freeboard) = 10.30m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

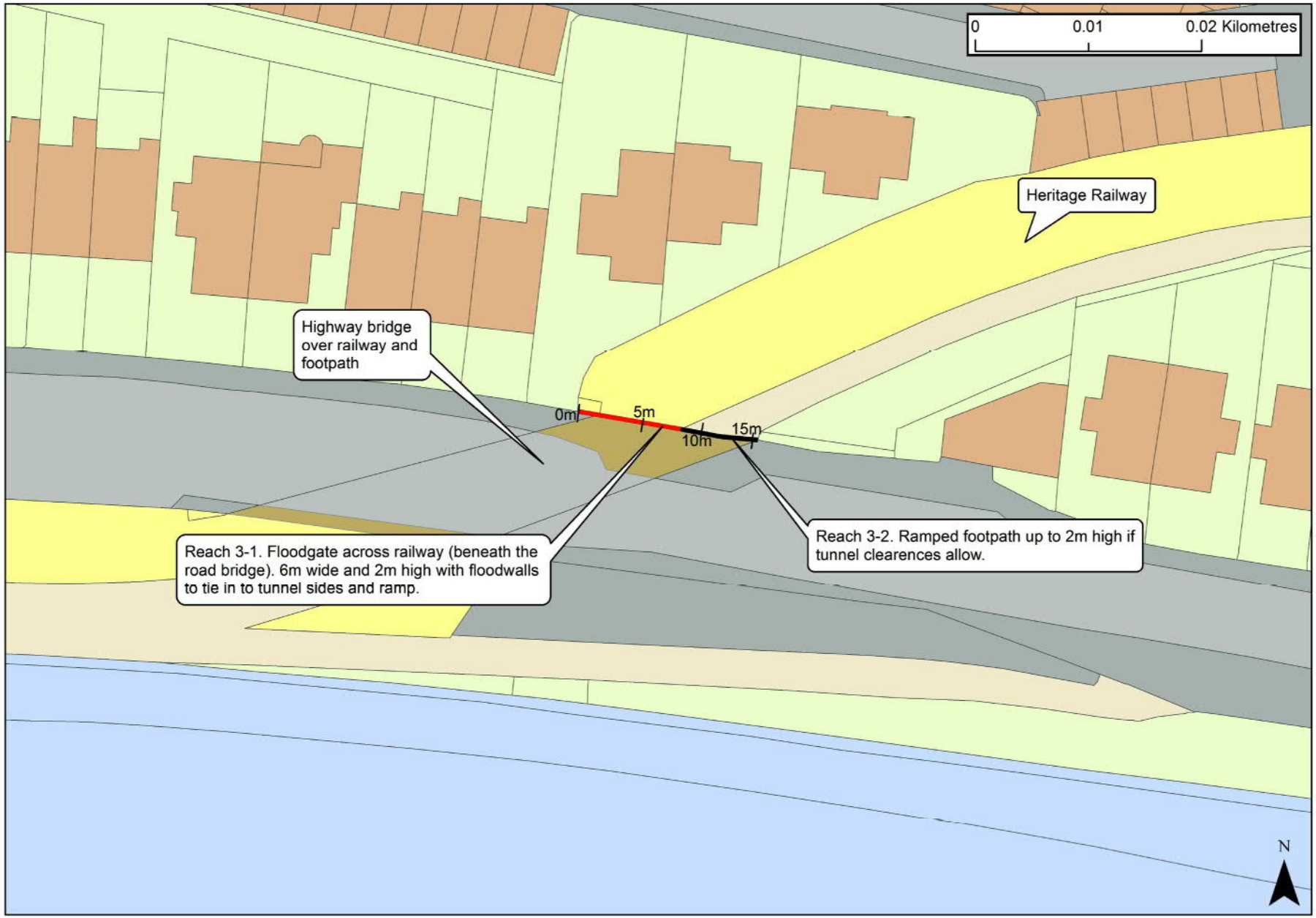
CUMBERLAND ROAD DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Cumberland Road template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.65m

- Design level for high defences (including 200mm freeboard) = 10.30m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

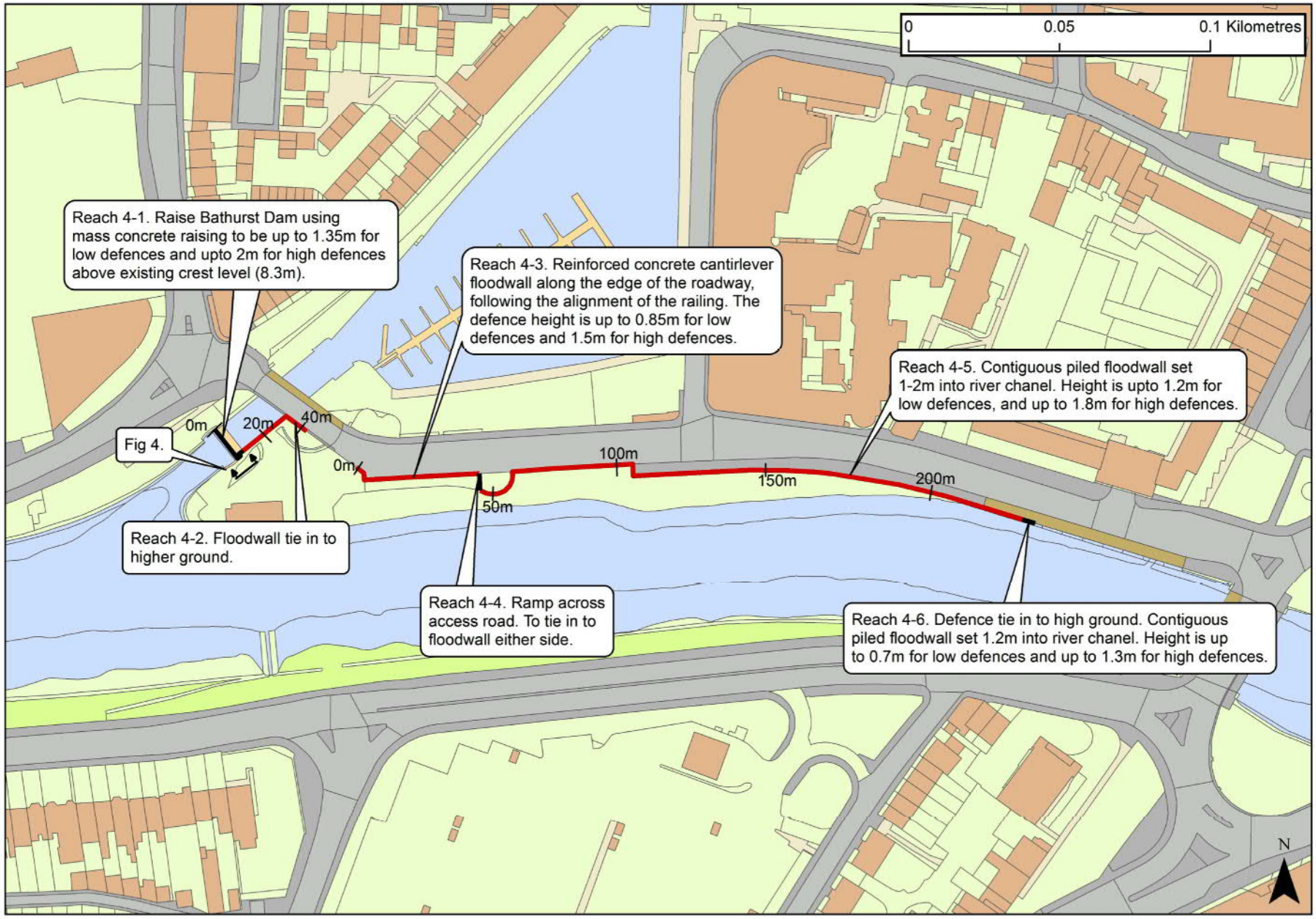
CUMBERLAND ROAD EAST DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Cumberland Road East template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.65m

- Design level for high defences (including 200mm freeboard) = 10.30m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

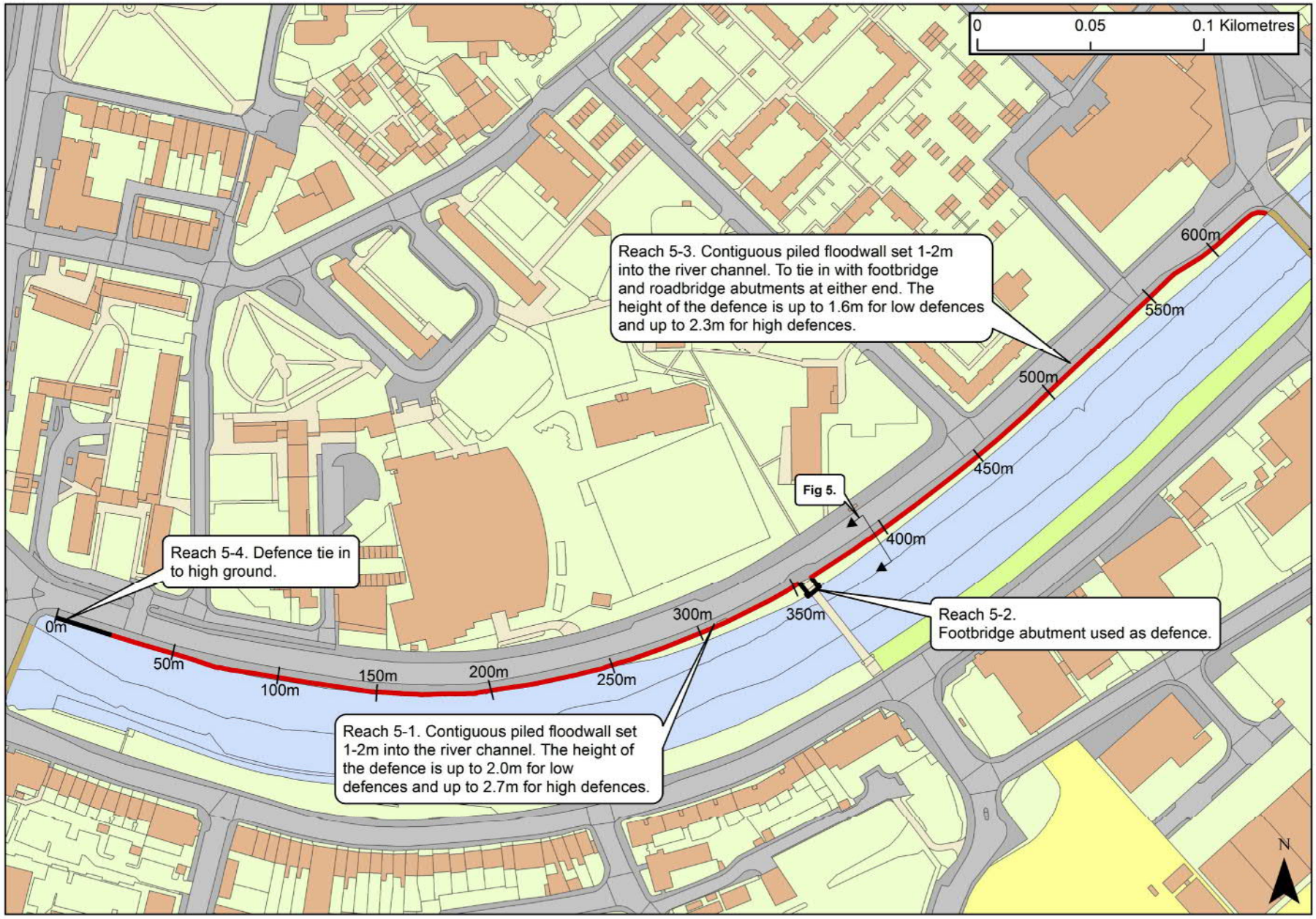
COMMERCIAL ROAD DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Commercial Road template.mxd



AECOM

AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.65m

- Design level for high defences (including 200mm freeboard) = 10.30m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

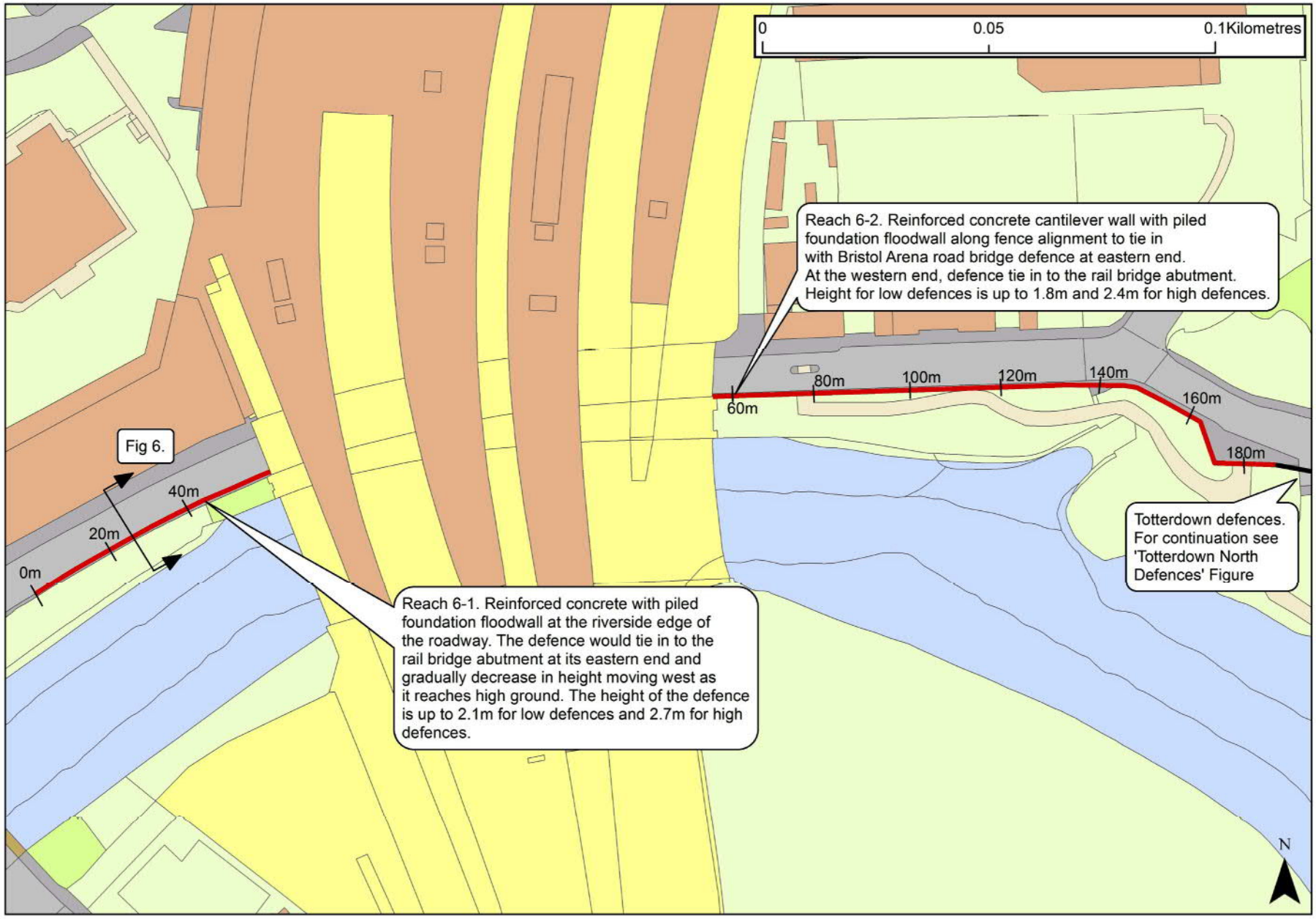
CLARENCE ROAD DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Clarence Road template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.80m

- Design level for high defences (including 200mm freeboard) = 10.40m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:
60478613

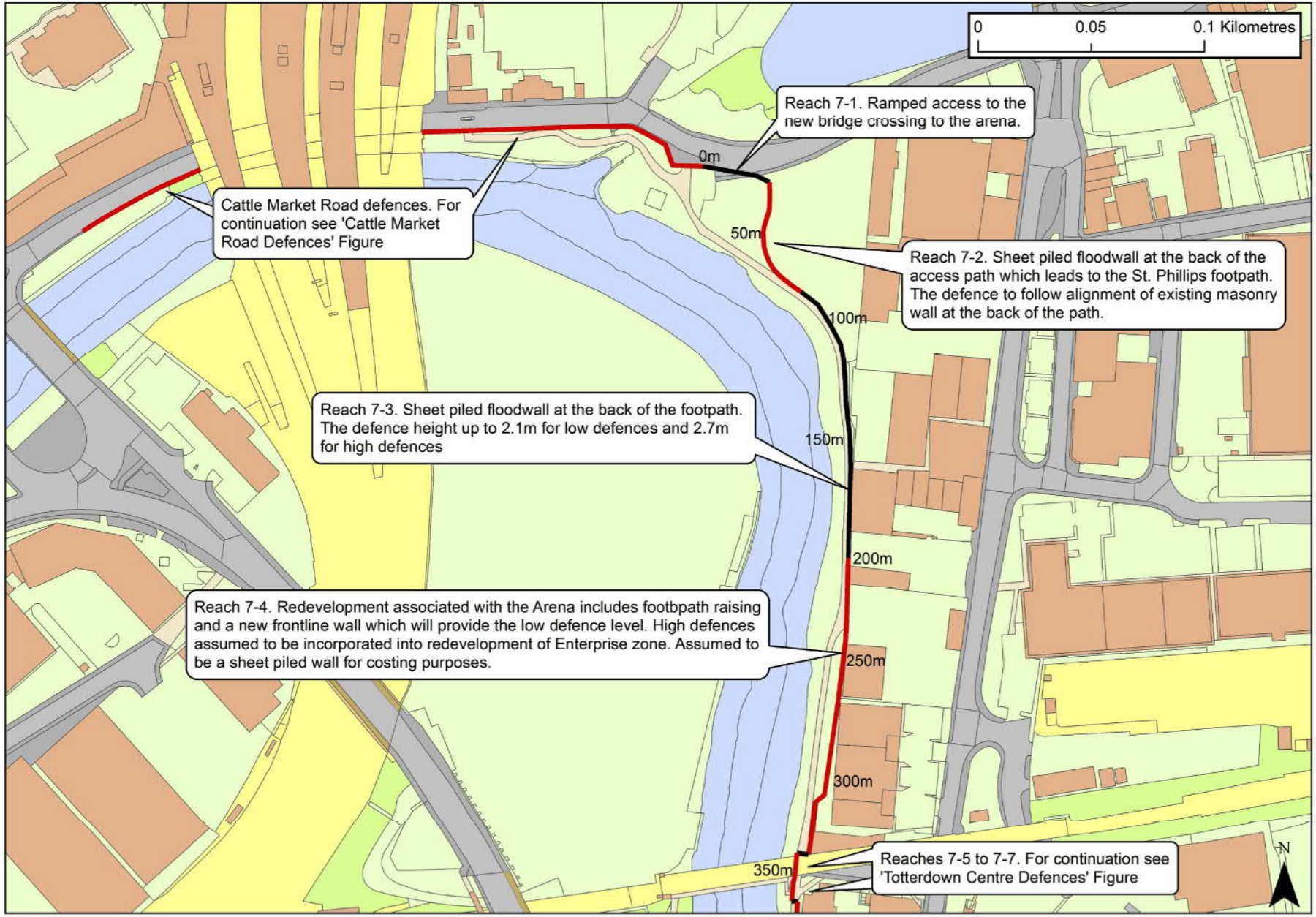
Drawing Title:
CATTLE MARKET ROAD DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Cattle Market Road template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.80m

- Design level for high defences (including 200mm freeboard) = 10.40m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

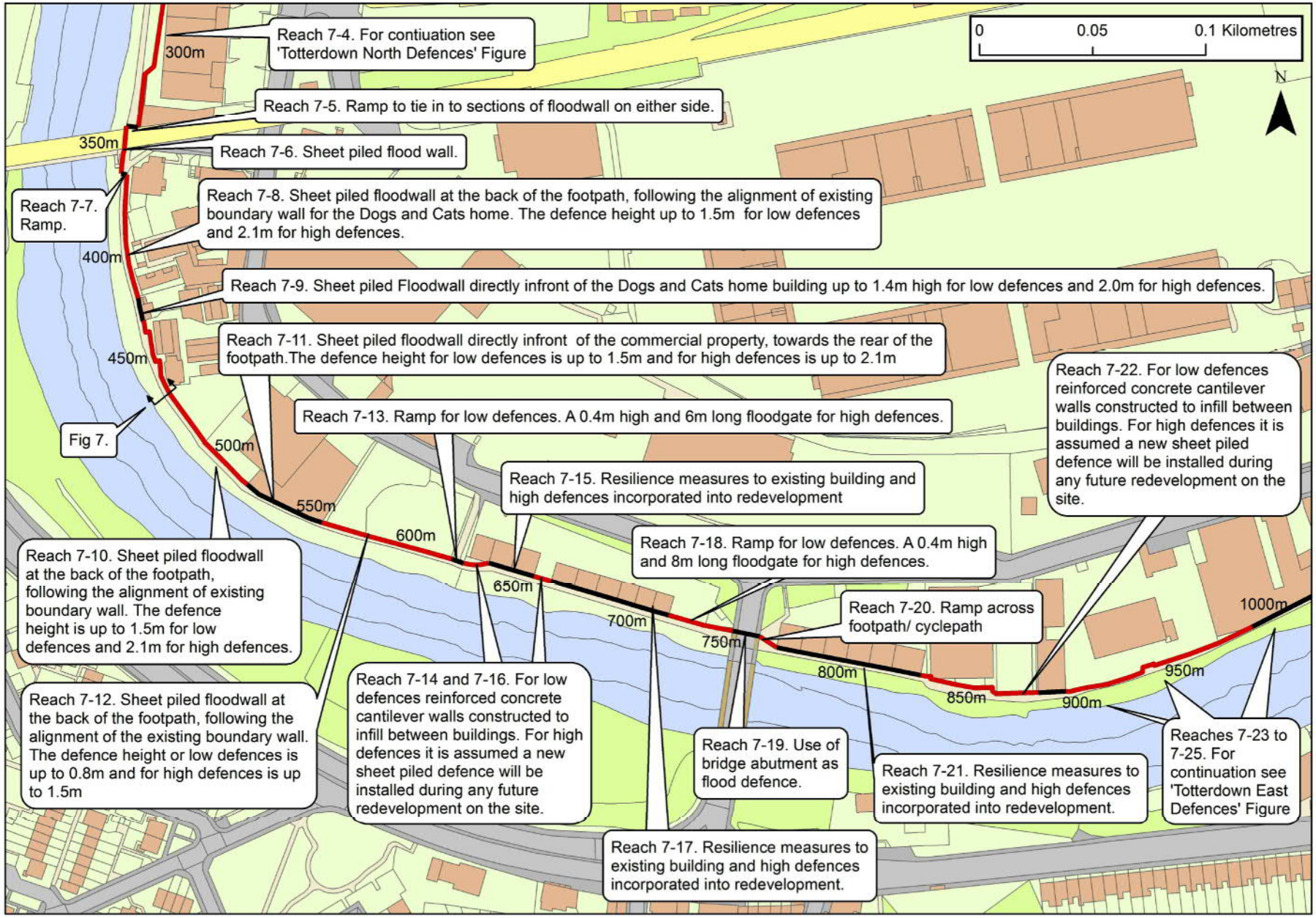
TOTTERDOWN NORTH DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Totterdown N template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.80m

- Design level for high defences (including 200mm freeboard) = 10.40m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:
60478613

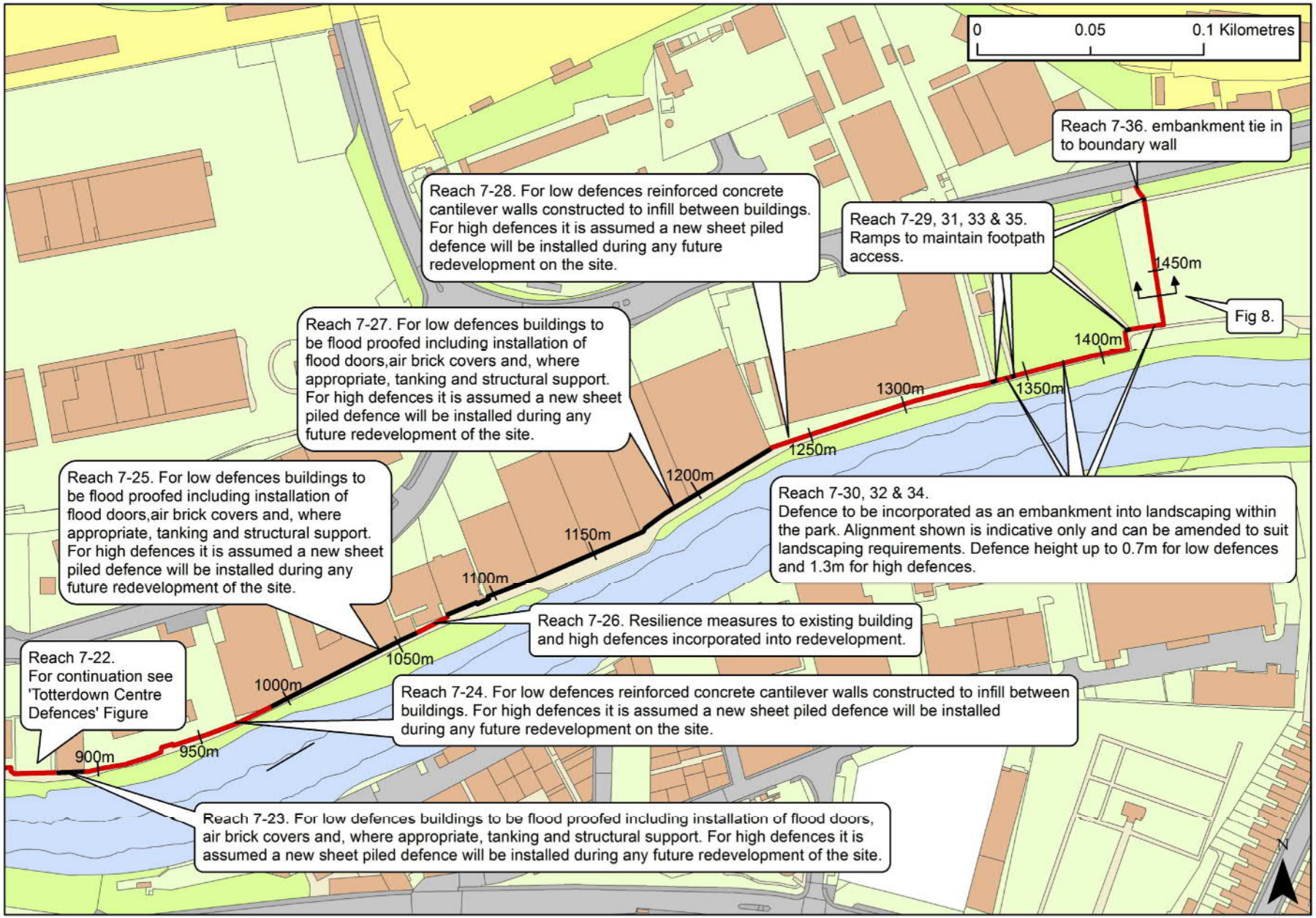
Drawing Title:
TOTTERDOWN CENTRE DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Totterdown C template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.80m

- Design level for high defences (including 200mm freeboard) = 10.40m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

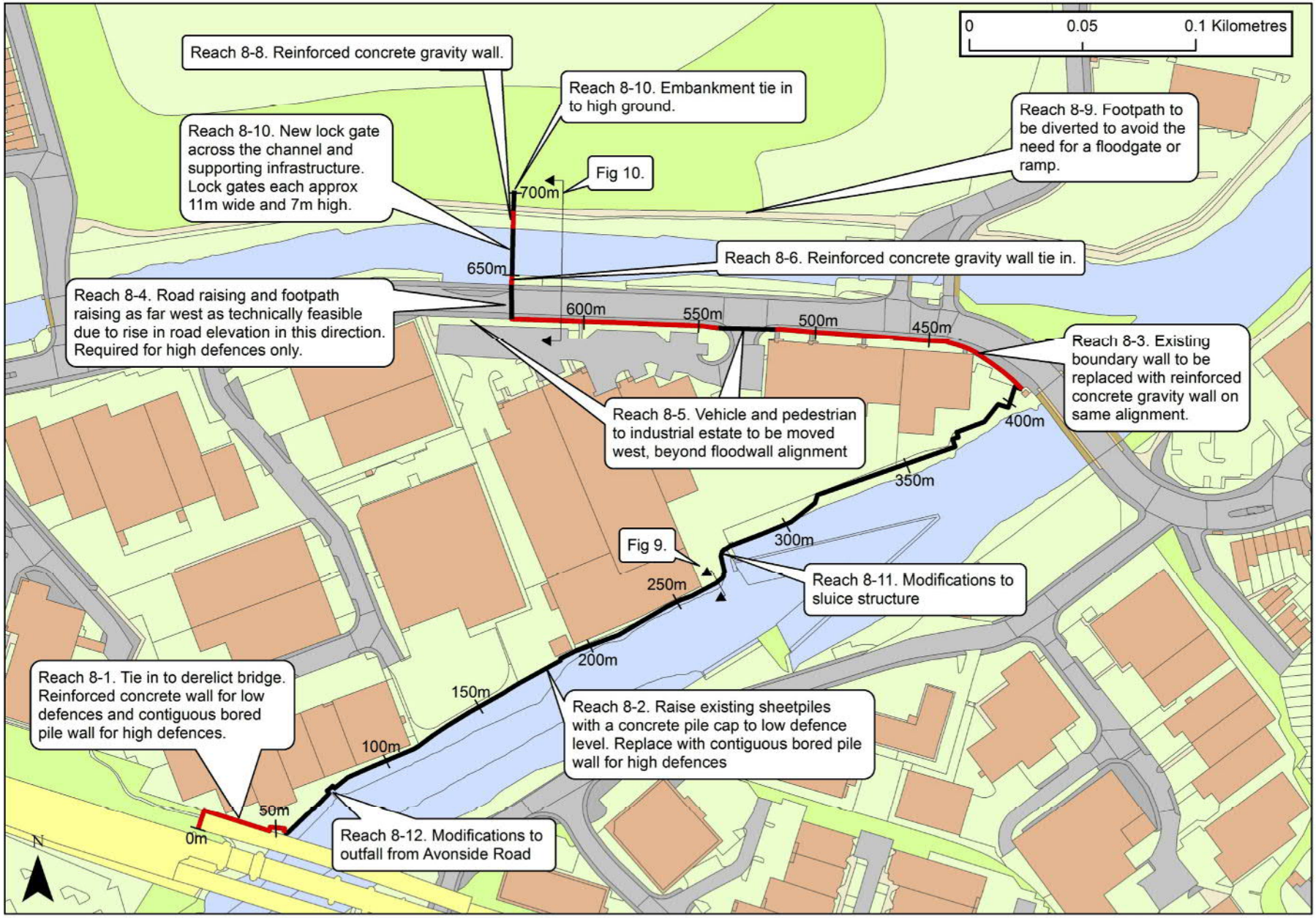
TOTTERDOWN EAST DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Totterdown E template.mxd



AECOM

AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

- Alignments and defence heights are indicative only and will need to be confirmed during detailed design.

- Defence heights quoted are above existing adjacent ground level.

- Design level for low defences (including 200mm freeboard) = 9.80m

- Design level for high defences (including 200mm freeboard) = 10.40m

- Structure references relate to the contents of the associted table

- Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:
60478613

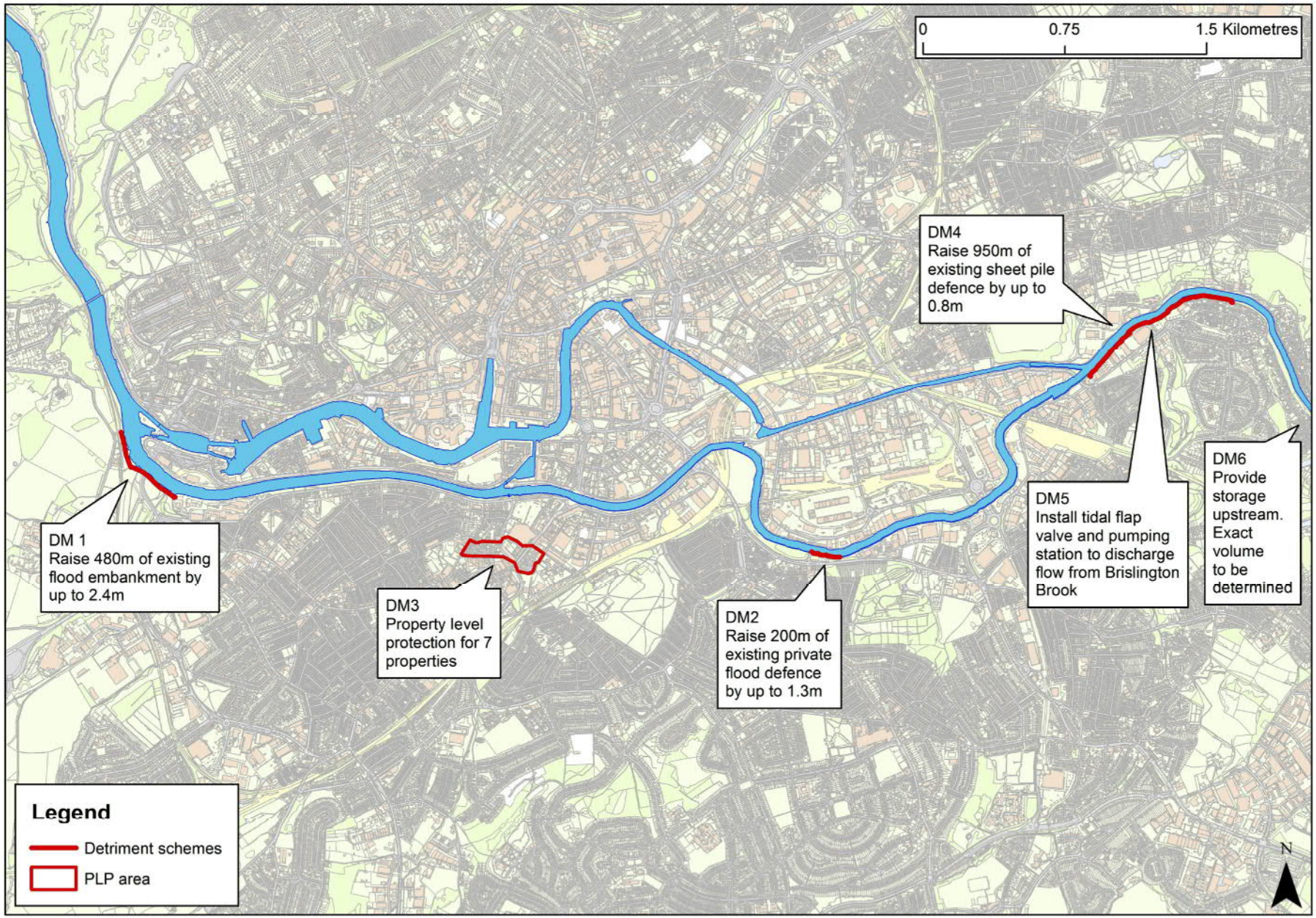
Drawing Title:
NETHAM DEFENCES

Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Outline Design Alignments\Figures\BT version 5\Netham template.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

Detriment mitigation works are indicative only at this stage. Additional modelling and design work is required to confirm the extents, heights and other aspects of the proposals.
It has been assumed that where defence raising is proposed it will be to the same level as the adjacent strategy works (i.e. high defence level).

Under no circumstances must this drawing be used for construction

Issue/Revision:

	25/01/17	V1

AECOM Internal Project No:
60478613

Drawing Title:
DETRIMENT DEFENCES

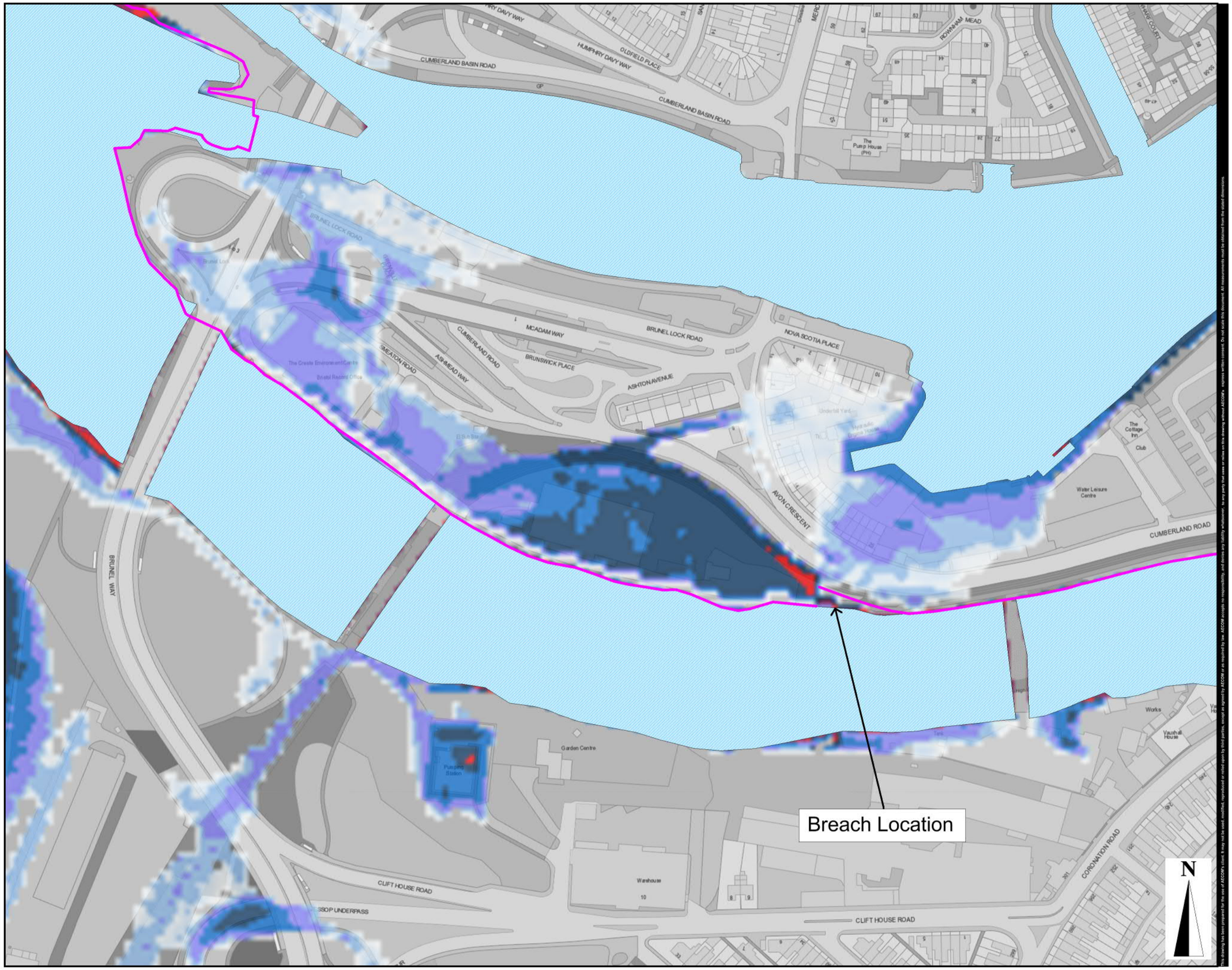
Scale at A3: 1:17,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	NC	DD	25/01/16

Filename: \\BA-WIP-003\4700 - Water\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Detriment volumes\Detriment all approach template.mxd

APPENDIX B – FLOOD MAPS



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_1_20

Copyright:

AECOM Internal Project No:

60478613

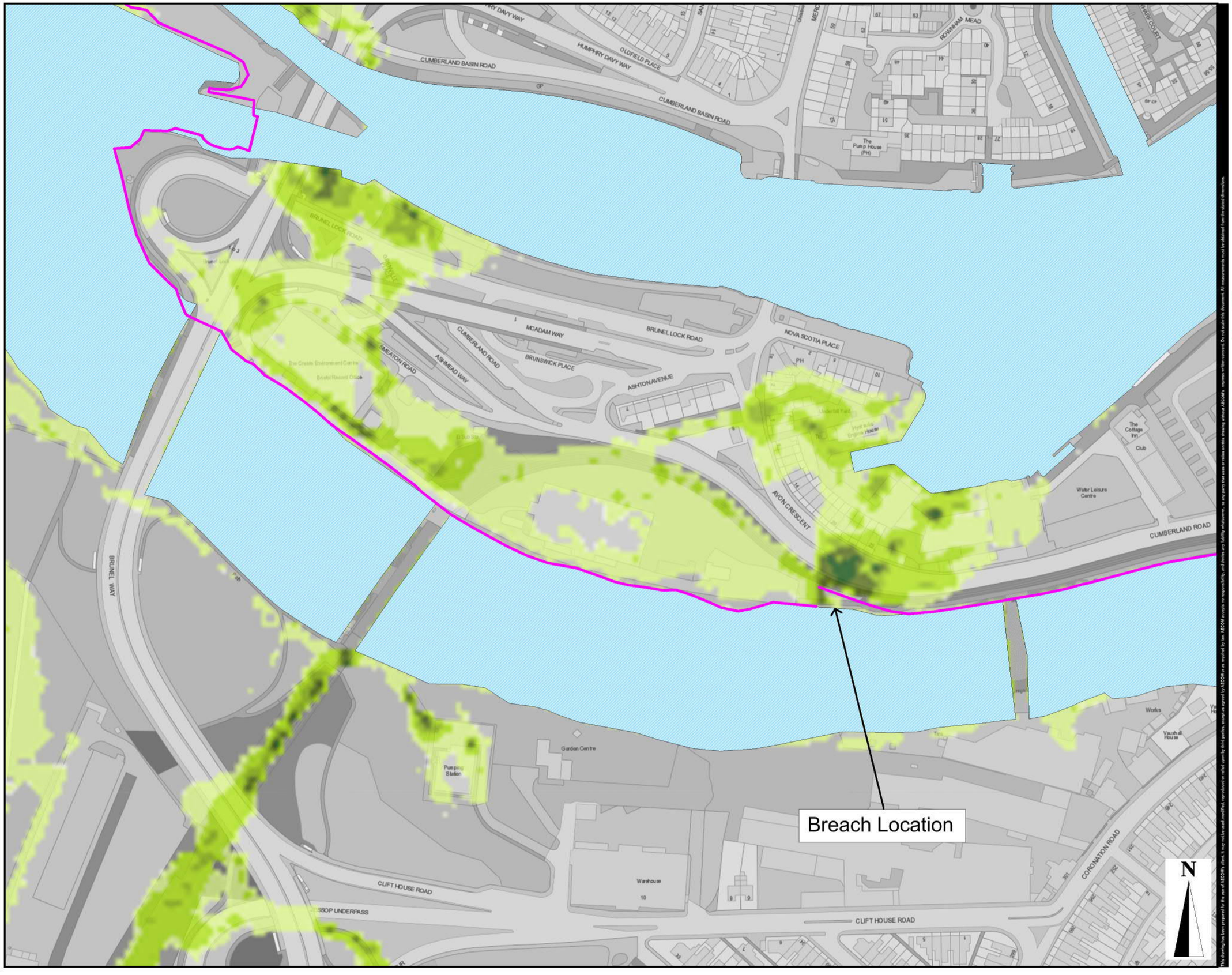
Drawing Title:

BR1 - CUMBERLAND ROAD
GATE BREACH 1-20
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 2,000

Drawing No:	Rev:
FIGURE 1A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_1_20

AECOM Internal Project No:

60478613

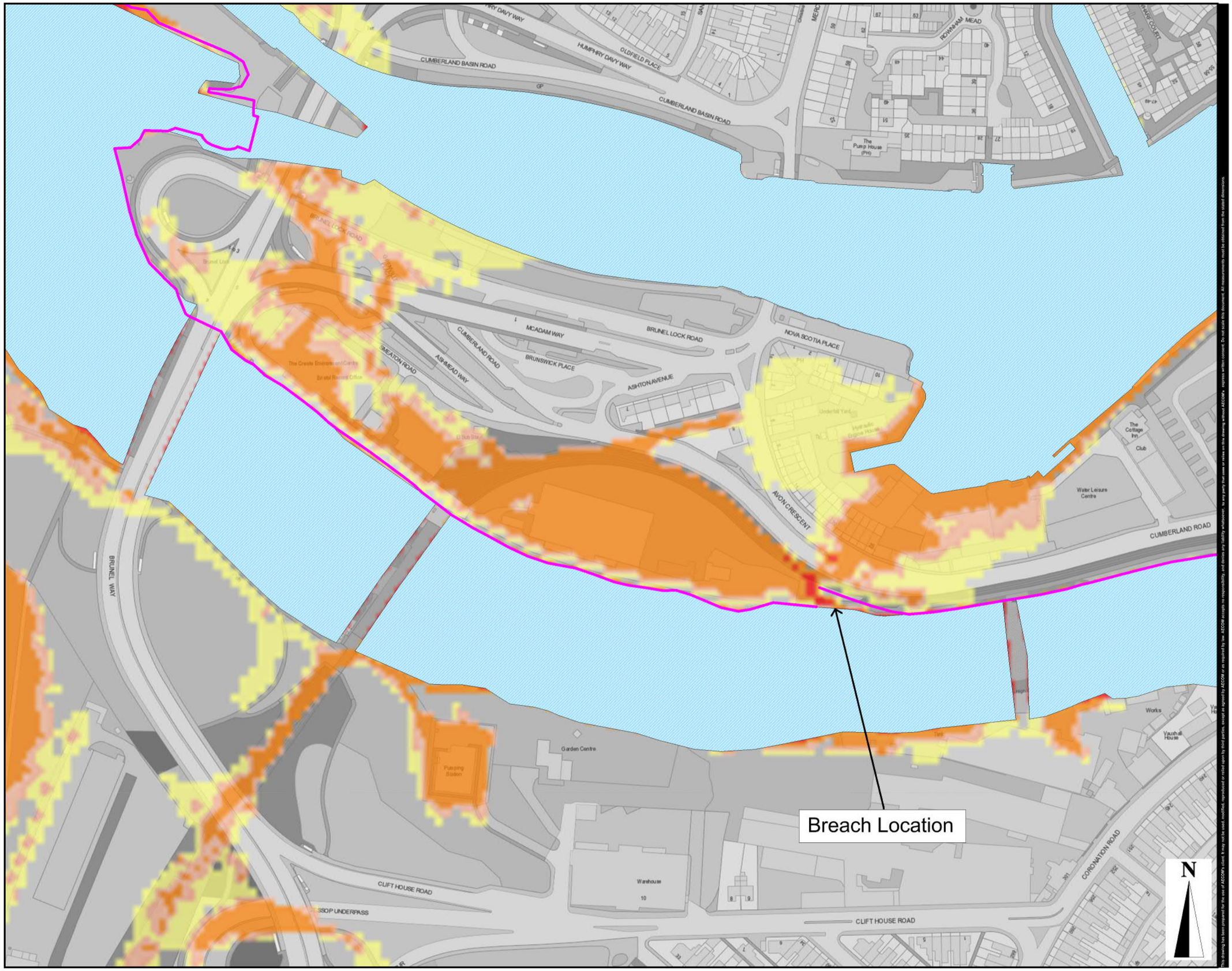
Drawing Title:

BR1 - CUMBERLAND ROAD
GATE BREACH 1-20
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 2,000

Drawing No:	Rev:
FIGURE 1B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_1_20

Copyright:

AECOM Internal Project No:

60478613

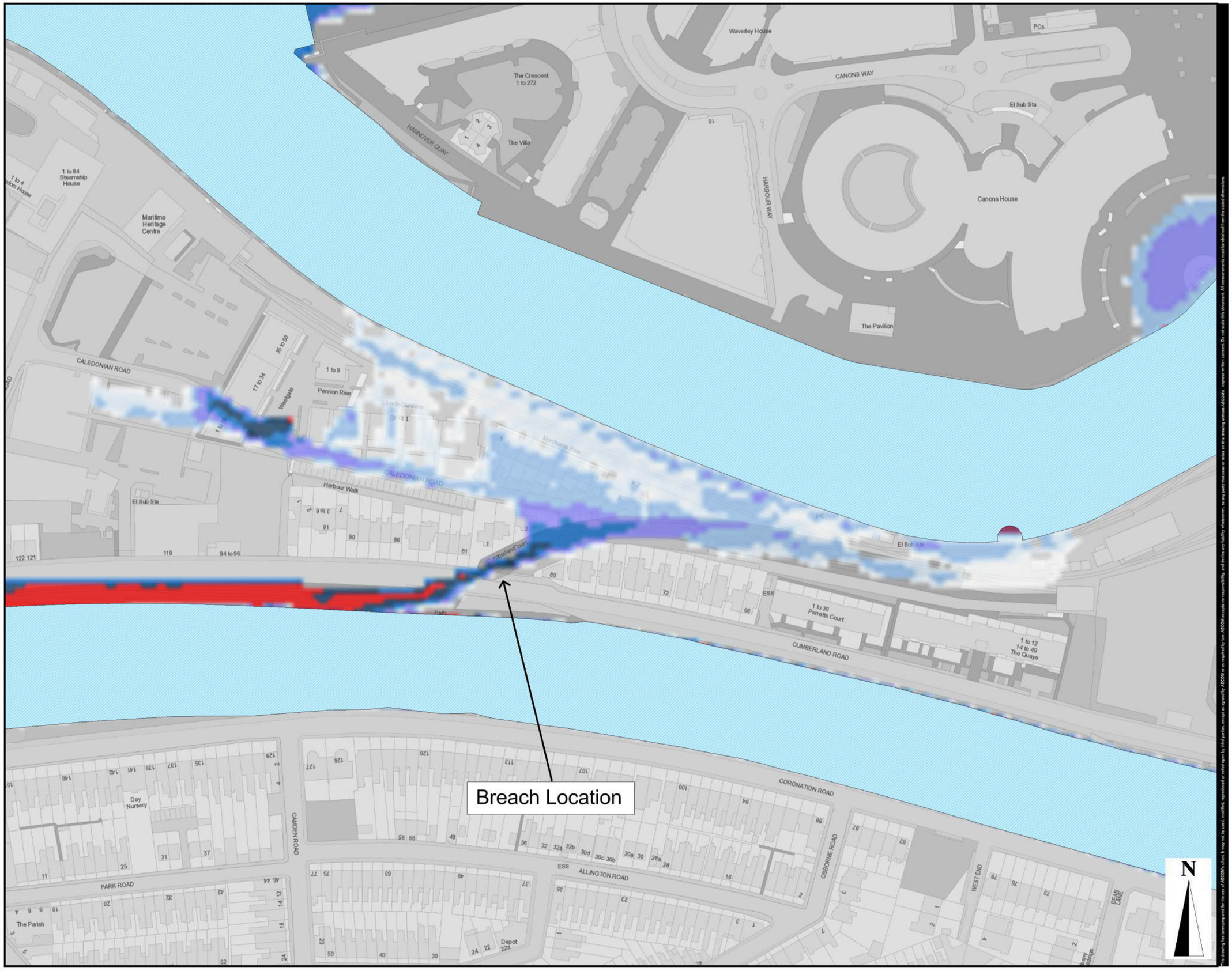
Drawing Title:

BR1 - CUMBERLAND ROAD
GATE BREACH 1-20
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 2,000

Drawing No:	Rev:
FIGURE 1C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_3_1

AECOM Internal Project No:

60478613

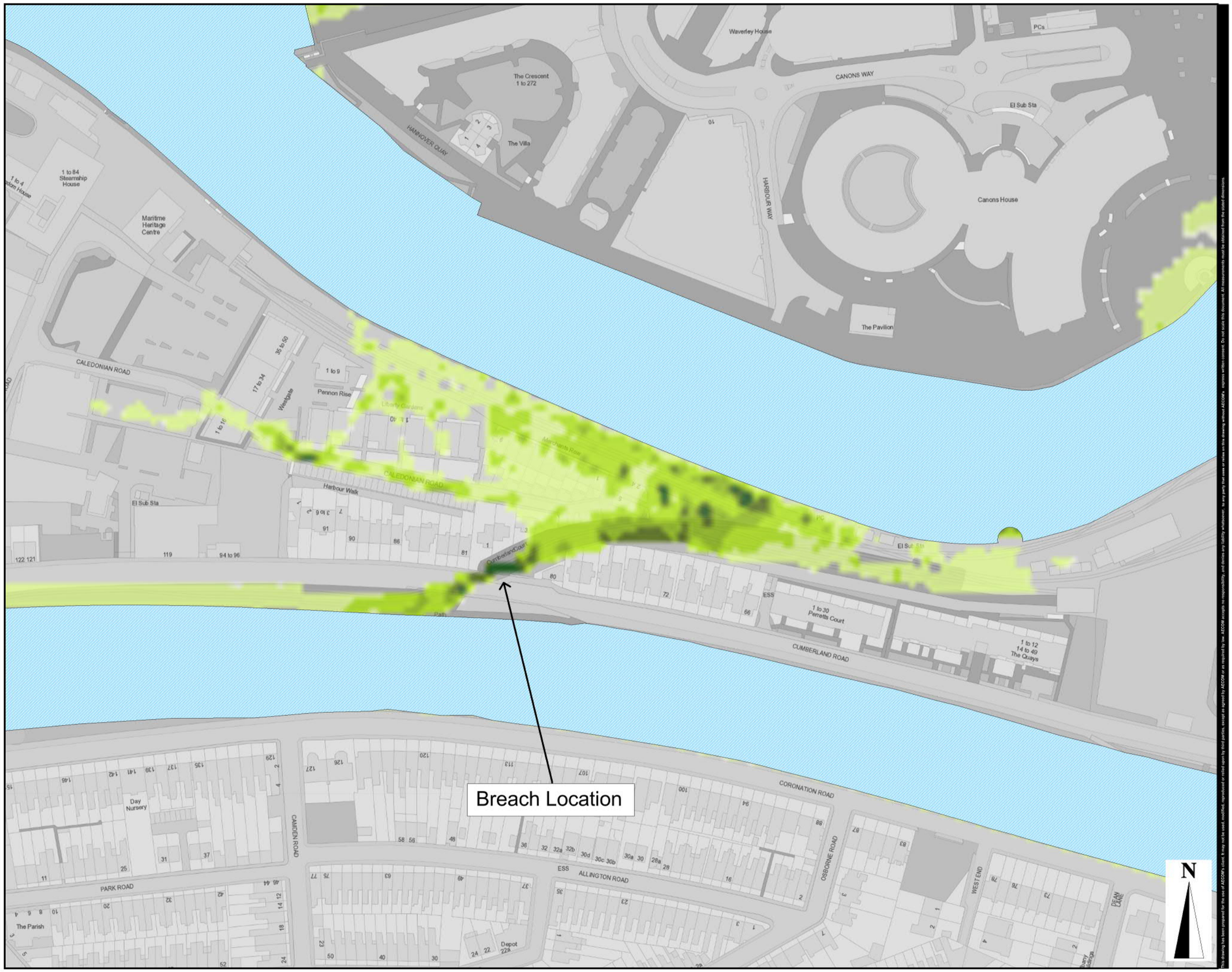
Drawing Title:

BR2 - CUMBERLAND ROAD
GATE BREACH 3-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 1,750

Drawing No:	Rev:
FIGURE 2A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_3_1

AECOM Internal Project No:

60478613

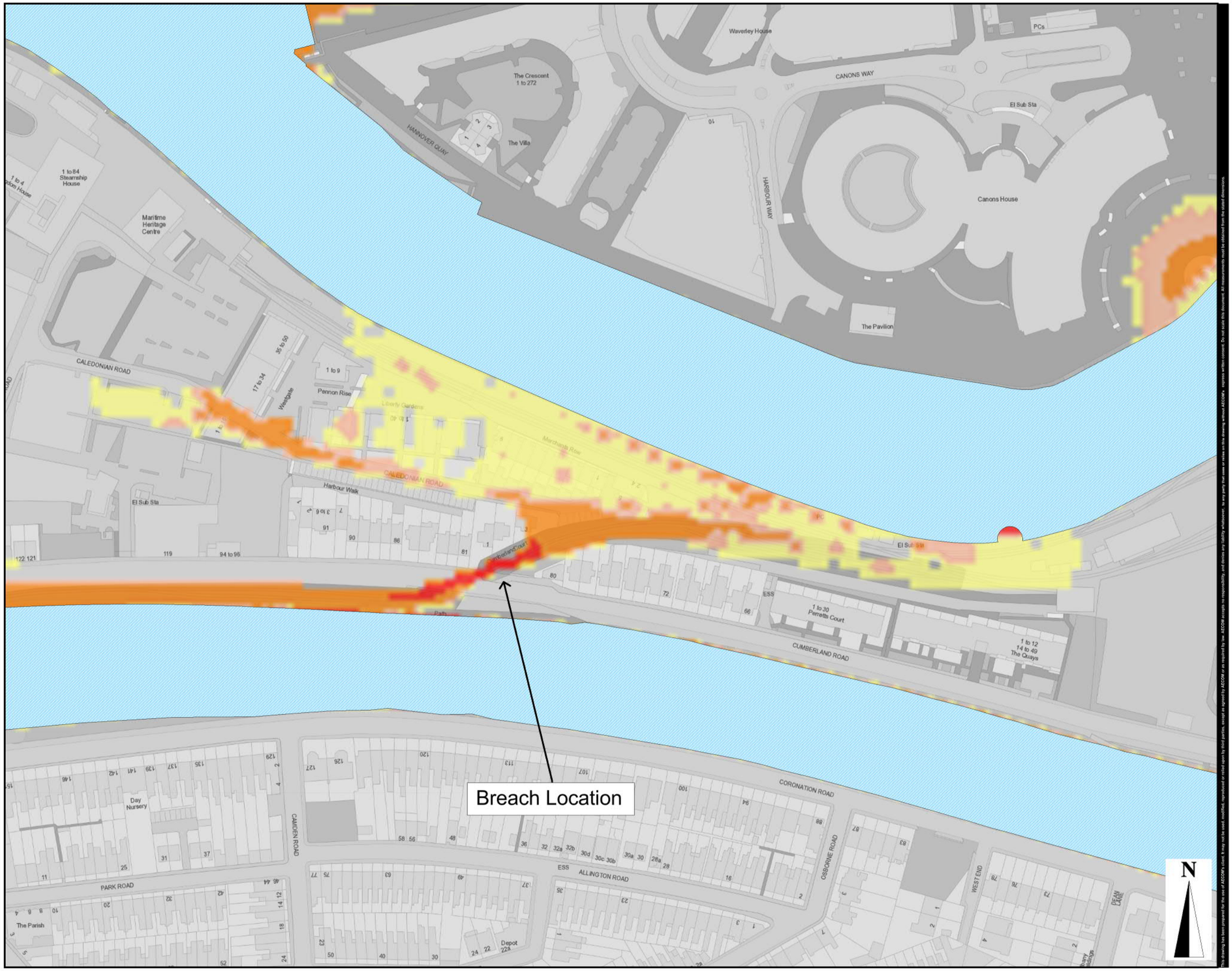
Drawing Title:

BR2 - CUMBERLAND ROAD
GATE BREACH 3-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 1,750

Drawing No:	Rev:
FIGURE 2B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_3_1

Copyright:

AECOM Internal Project No:

60478613

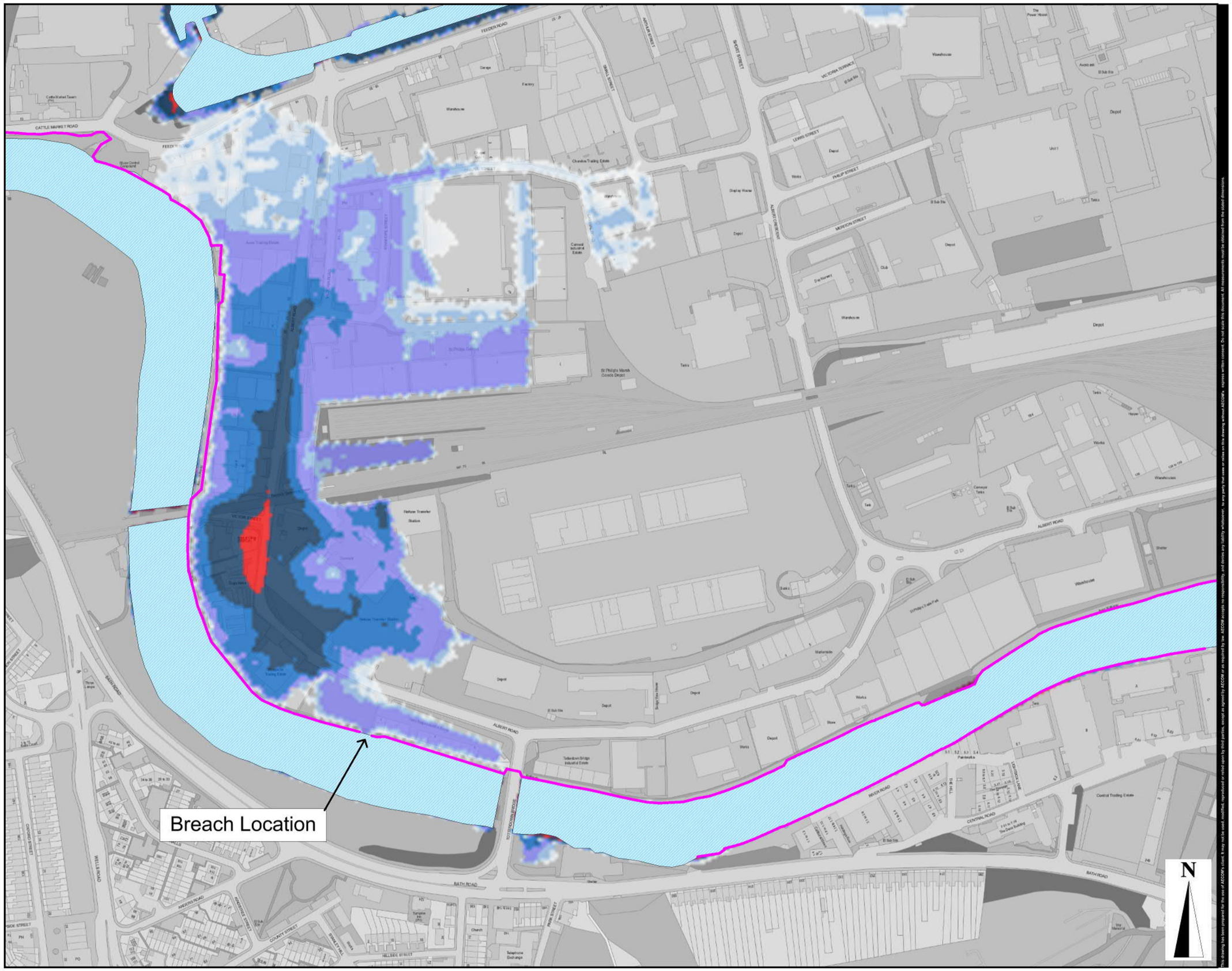
Drawing Title:

BR2 - CUMBERLAND ROAD
GATE BREACH 3-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 1,750

Drawing No:	Rev:
FIGURE 2C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_13

Copyright:

AECOM Internal Project No:

60478613

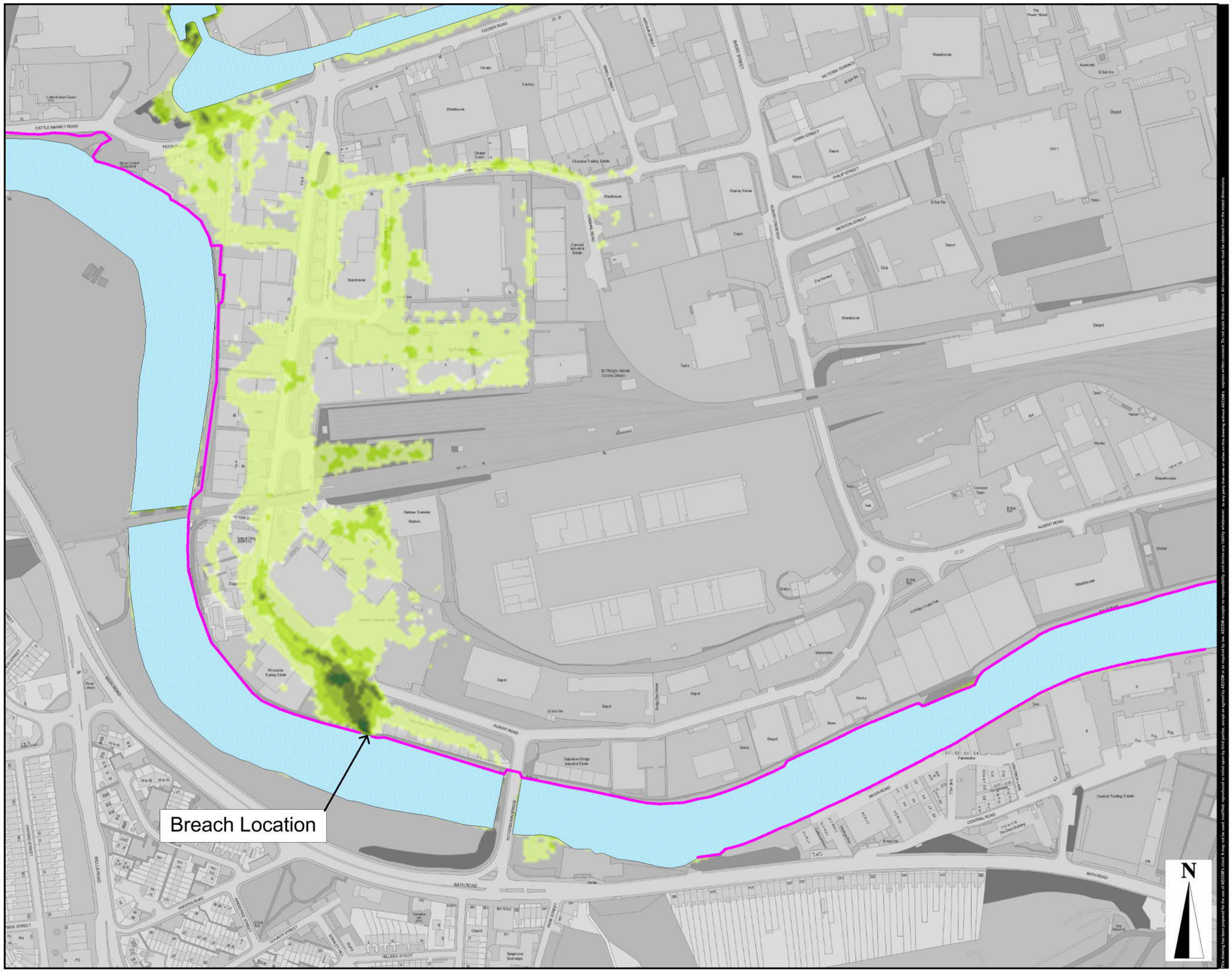
Drawing Title:

BR3 - TOTTERDOWN CENTRE GATE BREACH 7-13
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 3,000

Drawing No:	Rev:
FIGURE 3A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_13

Copyright:

AECOM Internal Project No:

60478613

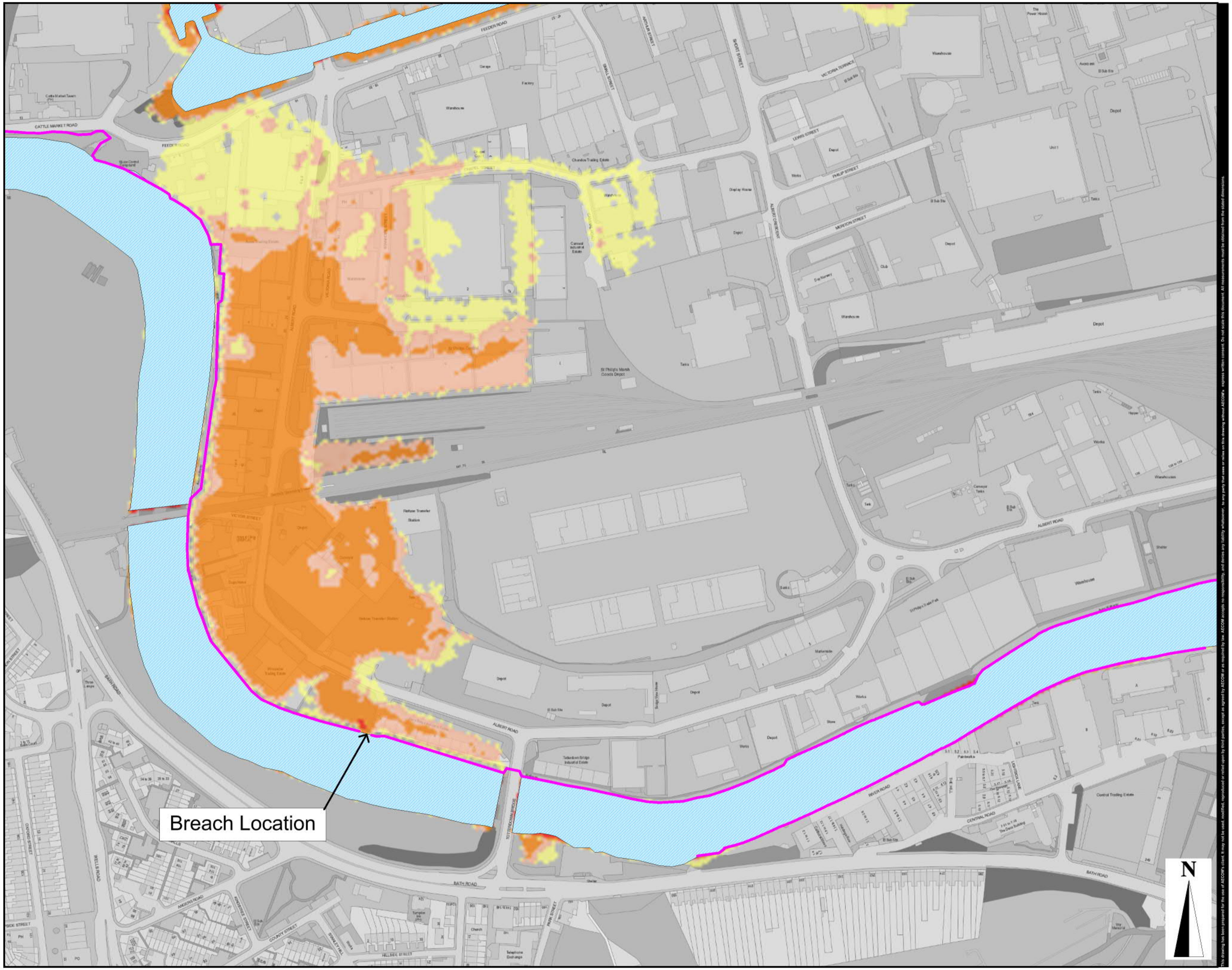
Drawing Title:

BR3 - TOTTERDOWN CENTRE GATE BREACH 7-13
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 3,000

Drawing No:	Rev:
FIGURE 3B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:
CAFRA_139_200yr_F002_T200_2115_Breach_7_13

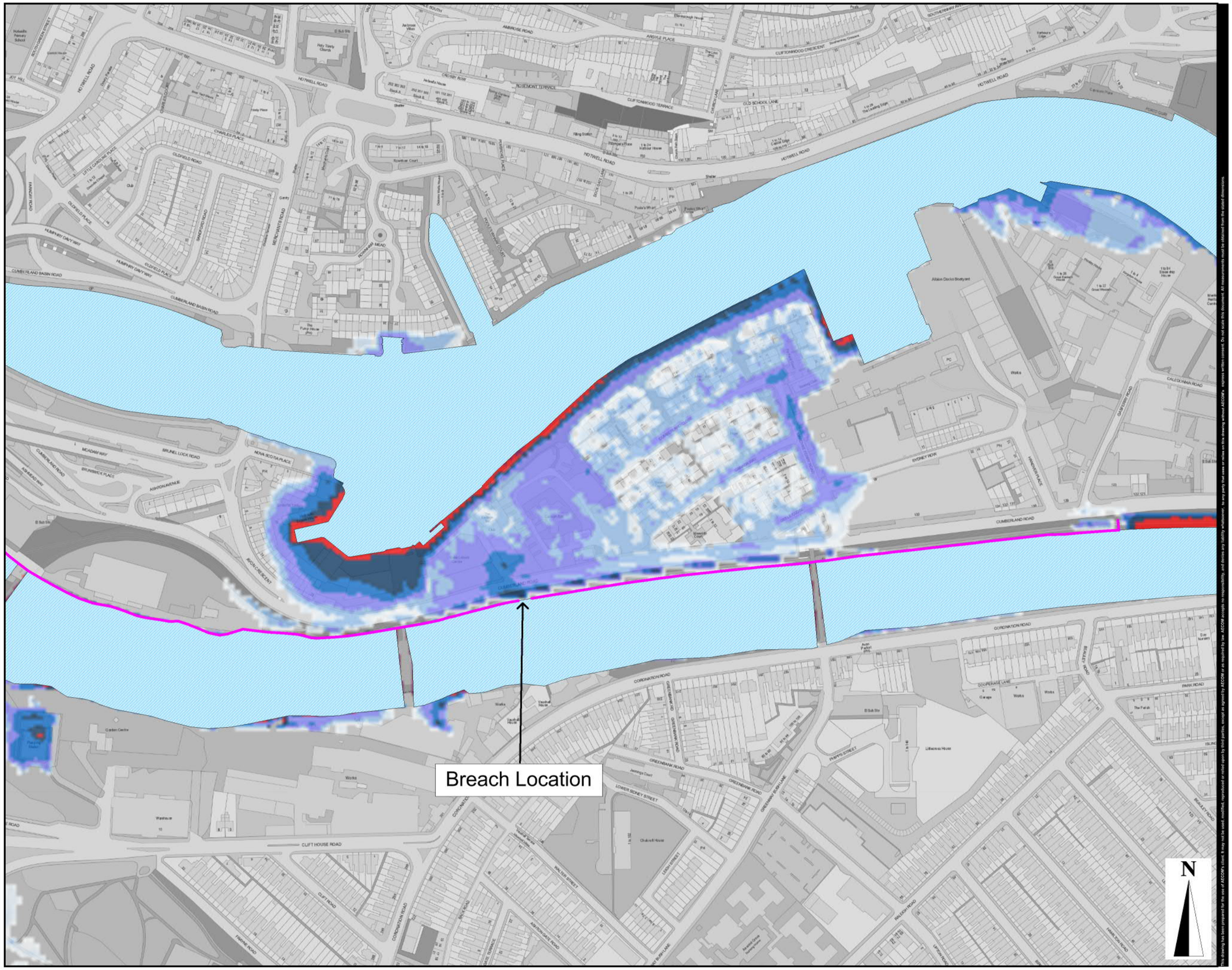
Copyright:

AECOM Internal Project No:
60478613

Drawing Title:
BR3 - TOTTERDOWN CENTRE GATE BREACH 7-13
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 3,000

Drawing No:			Rev:
FIGURE 3C			1
Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_2_1

AECOM Internal Project No:

60478613

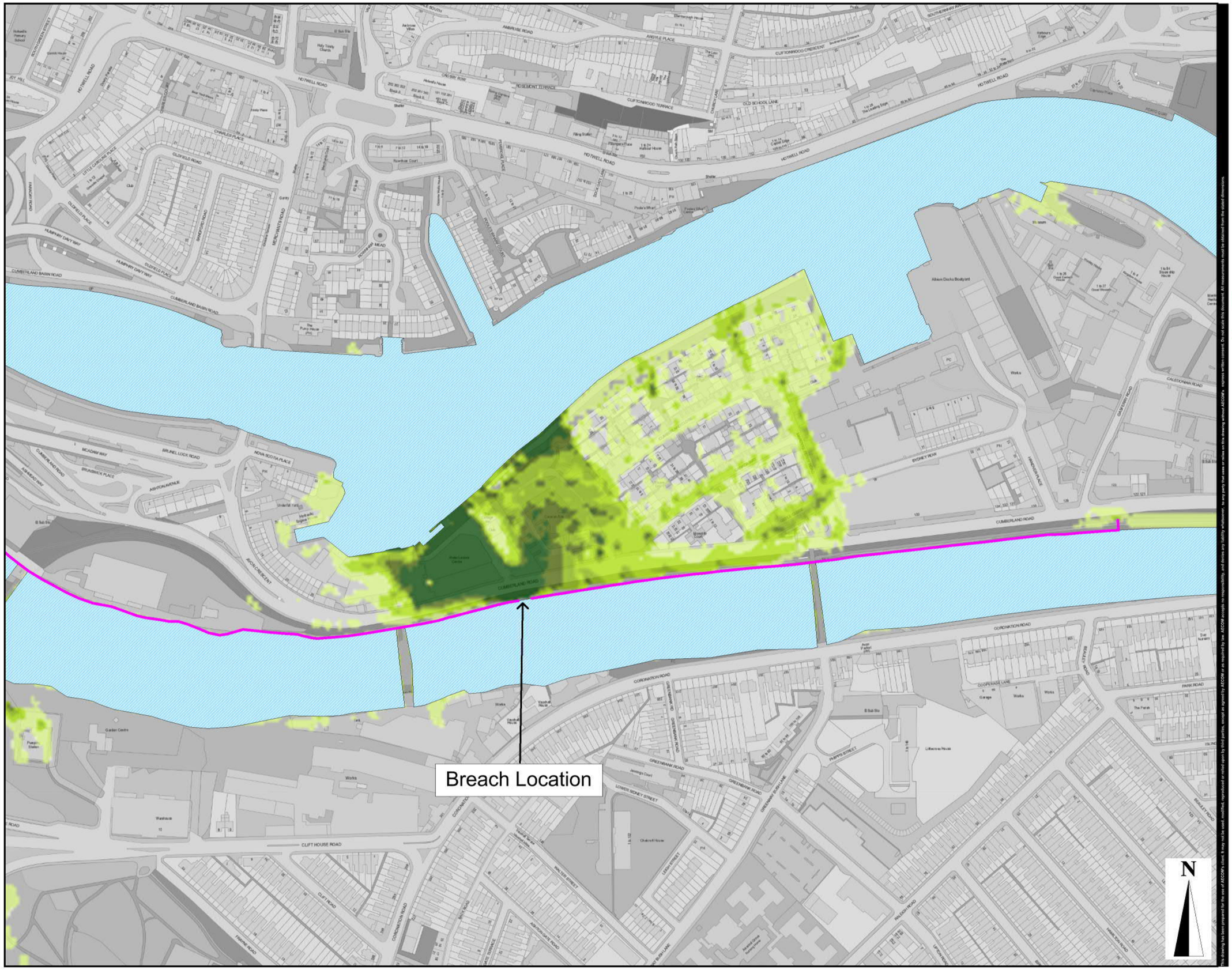
Drawing Title:

BR4 - CUMBERLAND ROAD
10m STRUCTURE BREACH 2-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 3,000

Drawing No:	Rev:
FIGURE 4A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_2_1

AECOM Internal Project No:

60478613

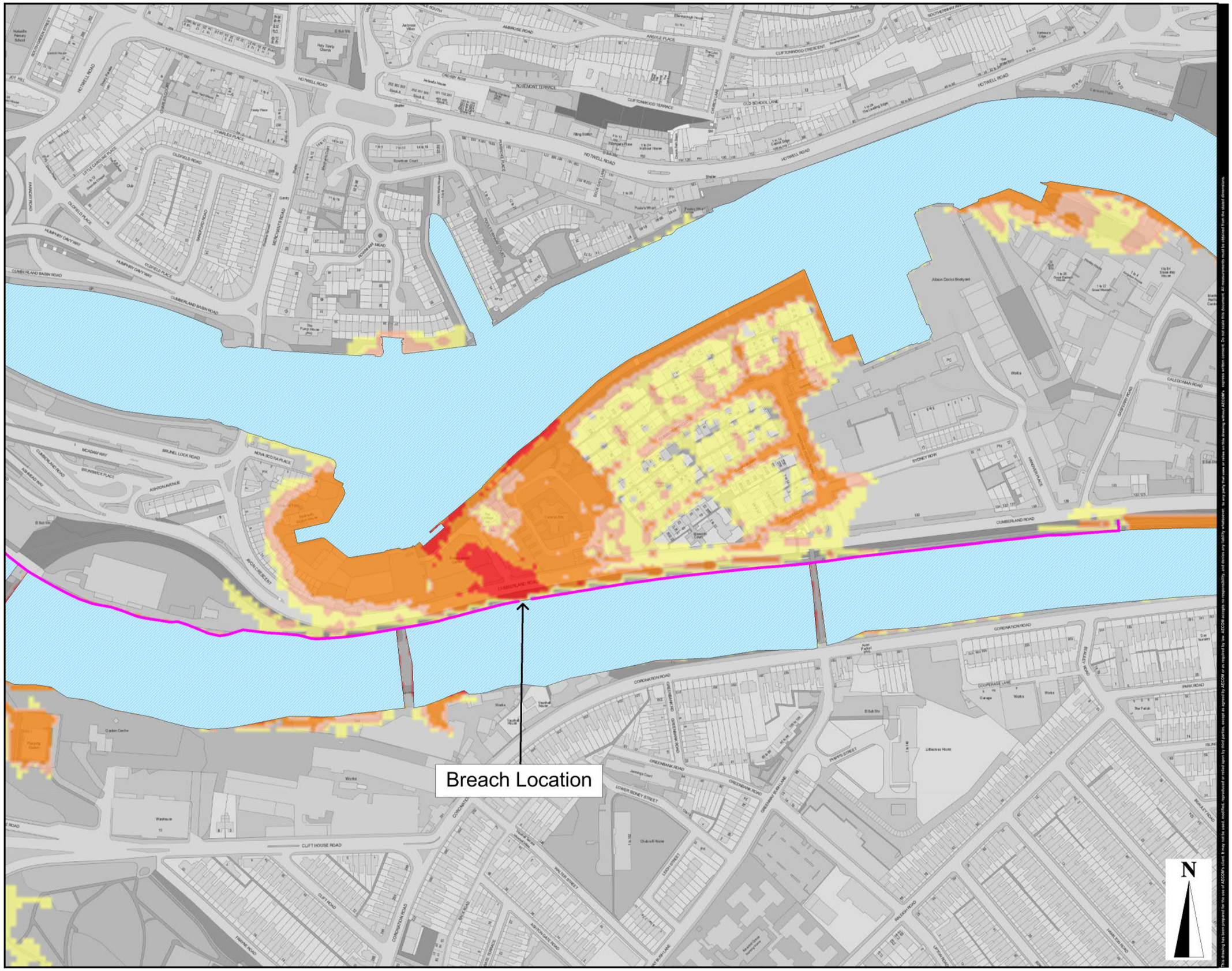
Drawing Title:

BR4 - CUMBERLAND ROAD
STRUCTURE BREACH 2-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 3,000

Drawing No:	Rev:
FIGURE 4B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_2_1

AECOM Internal Project No:

60478613

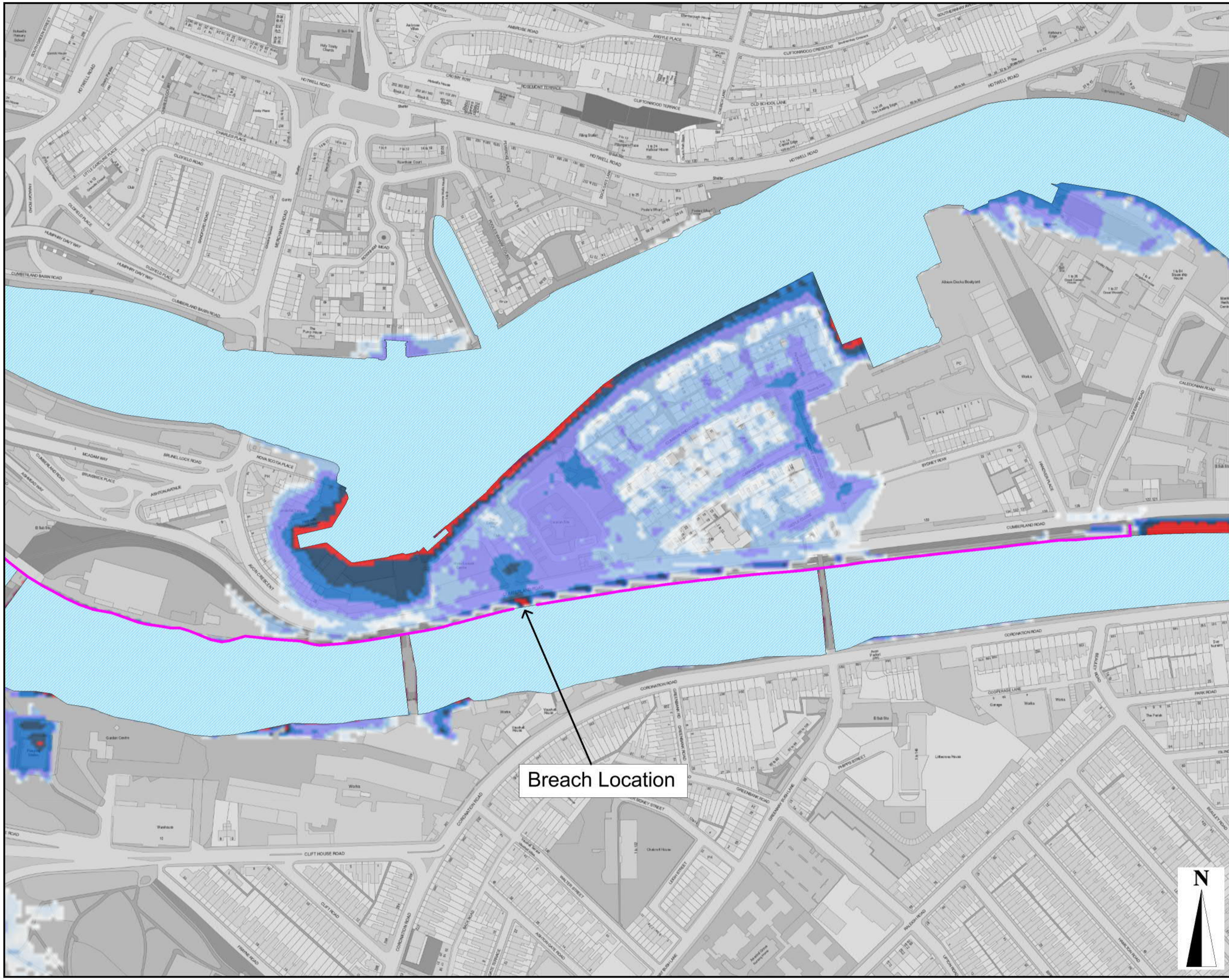
Drawing Title:

BR4 - CUMBERLAND ROAD STRUCTURE BREACH 2-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 3,000

Drawing No:	Rev:
FIGURE 4C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

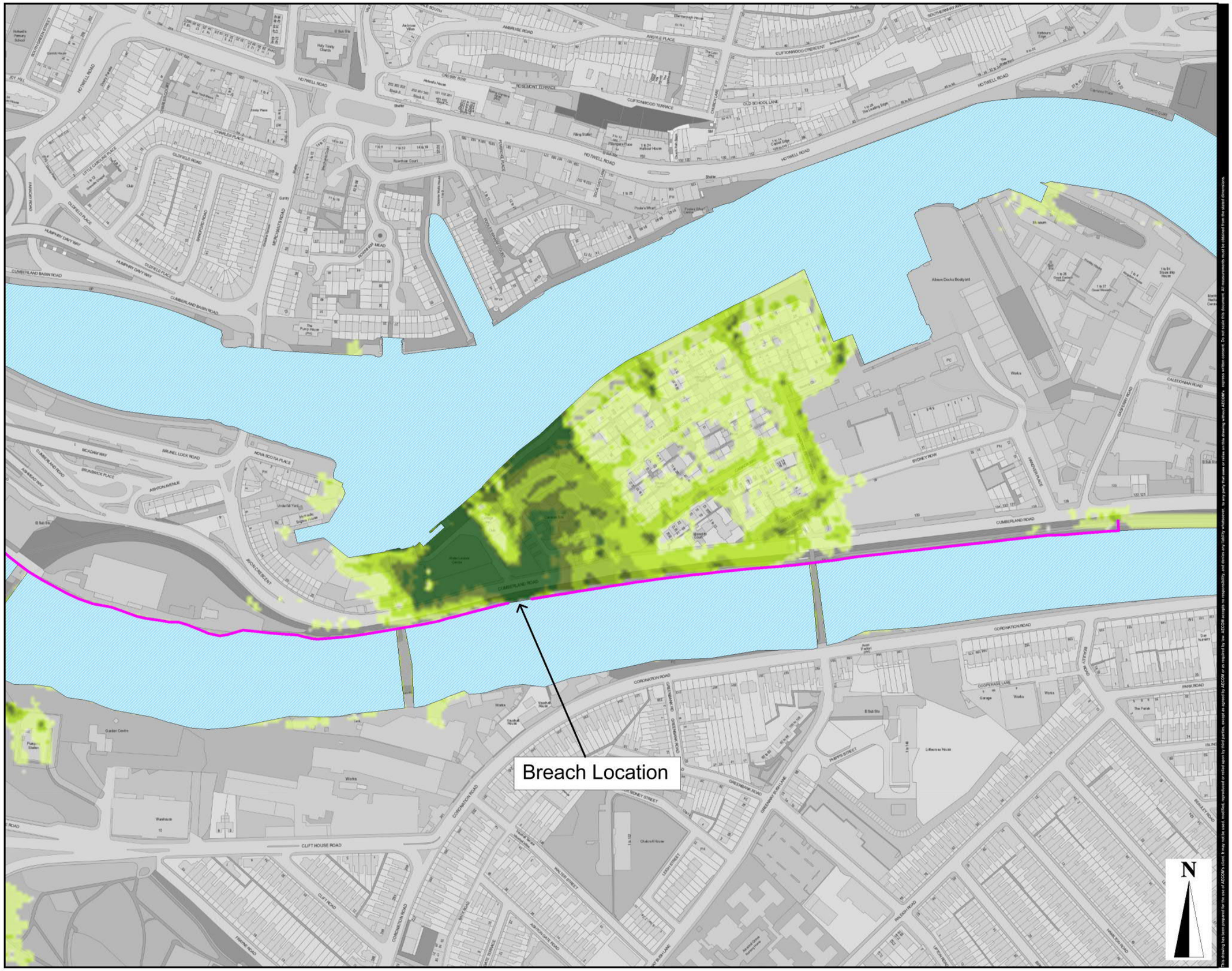
Model Reference:
CAFRA_139_200yr_F002_T200_2115_Breach_20m

AECOM Internal Project No:
60478613

Drawing Title:
BR5 - CUMBERLAND ROAD
20m STRUCTURE BREACH 2-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 3,000

Drawing No:			Rev:
FIGURE 5A			1
Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_20m

AECOM Internal Project No:

60478613

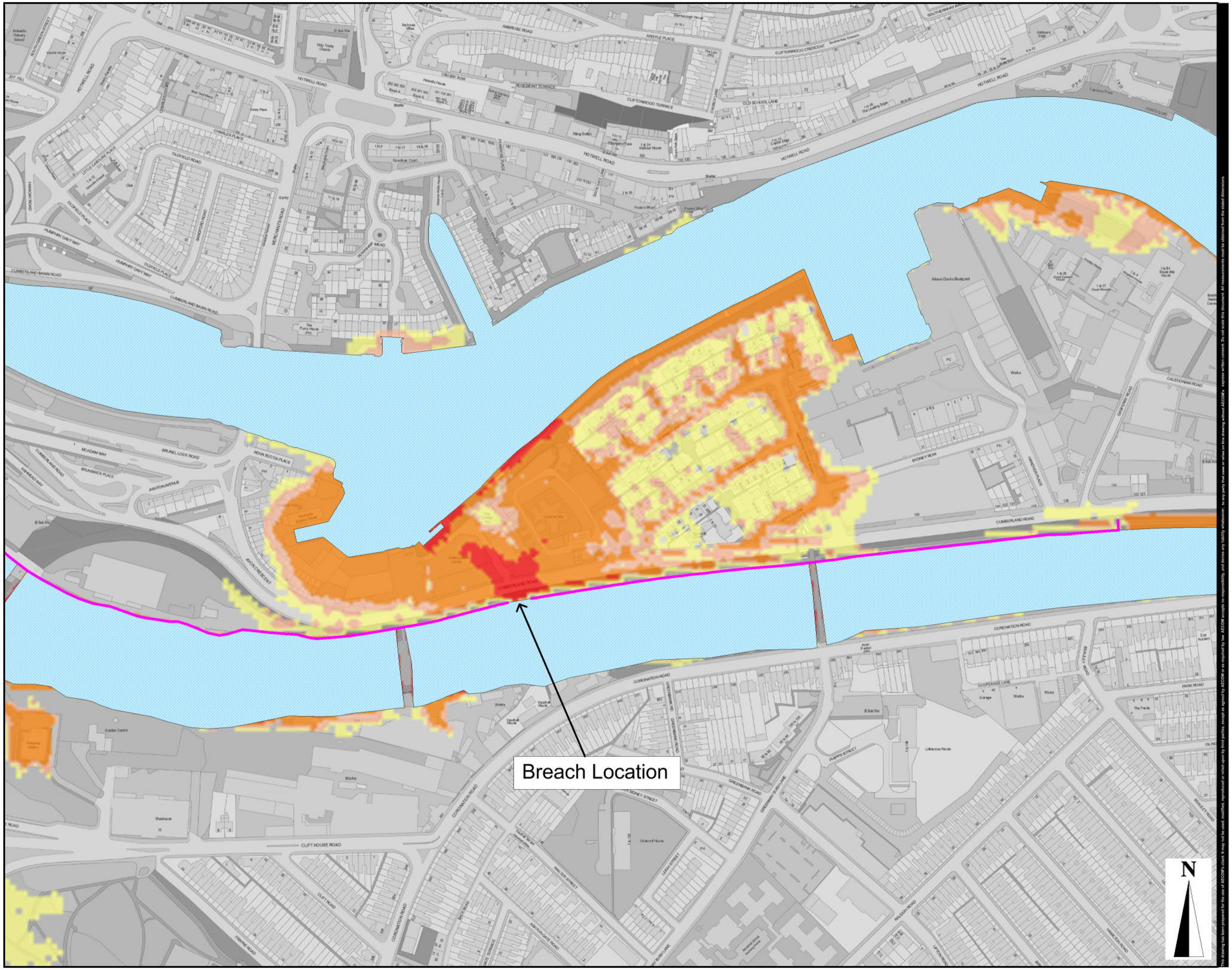
Drawing Title:

BR5 - CUMBERLAND ROAD
20m STRUCTURE BREACH 2-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 3,500

Drawing No:	Rev:
FIGURE 5B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_20m

Copyright:

AECOM Internal Project No:

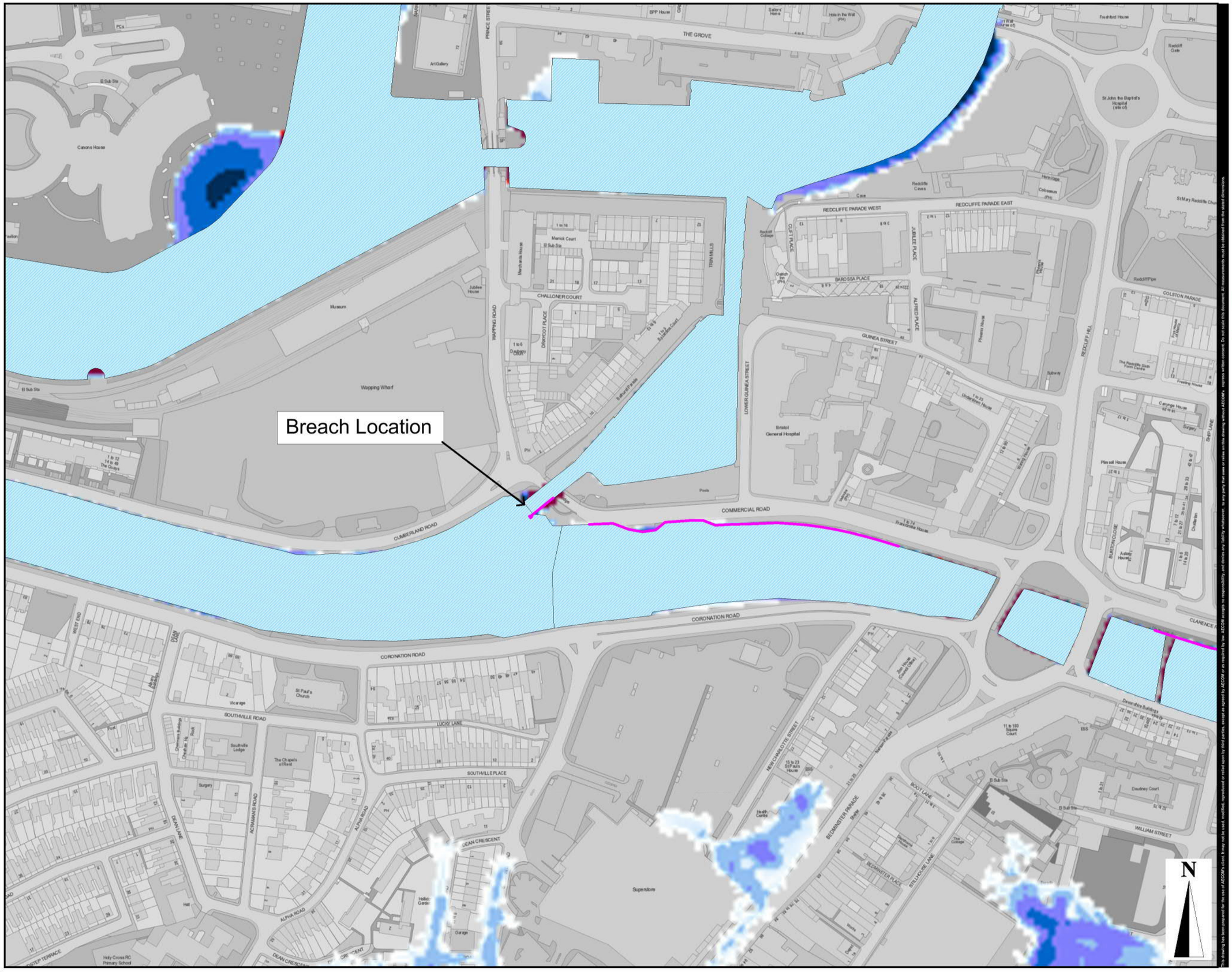
60478613

Drawing Title:

BR5 - CUMBERLAND ROAD
20m STRUCTURE BREACH 2-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 3,500

Drawing No:			Rev:
FIGURE 5C			1
Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_4_1

Copyright:

AECOM Internal Project No:

60478613

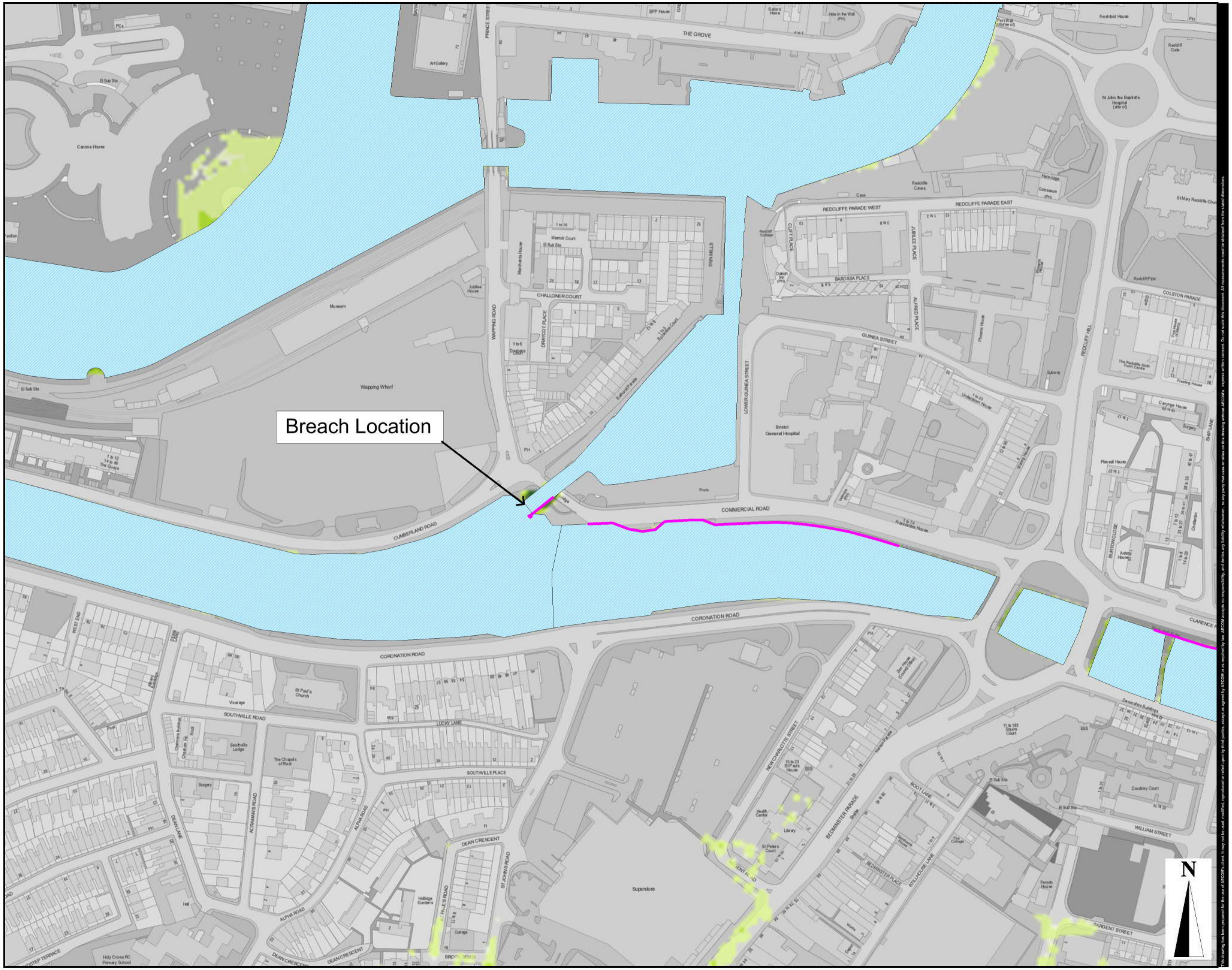
Drawing Title:

BR6 - COMMERCIAL ROAD GATE BREACH 4-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 2,500

Drawing No:	Rev:
FIGURE 6A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM

AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:
CAFRA_139_200yr_F002_T200_2115_Breach_4_1

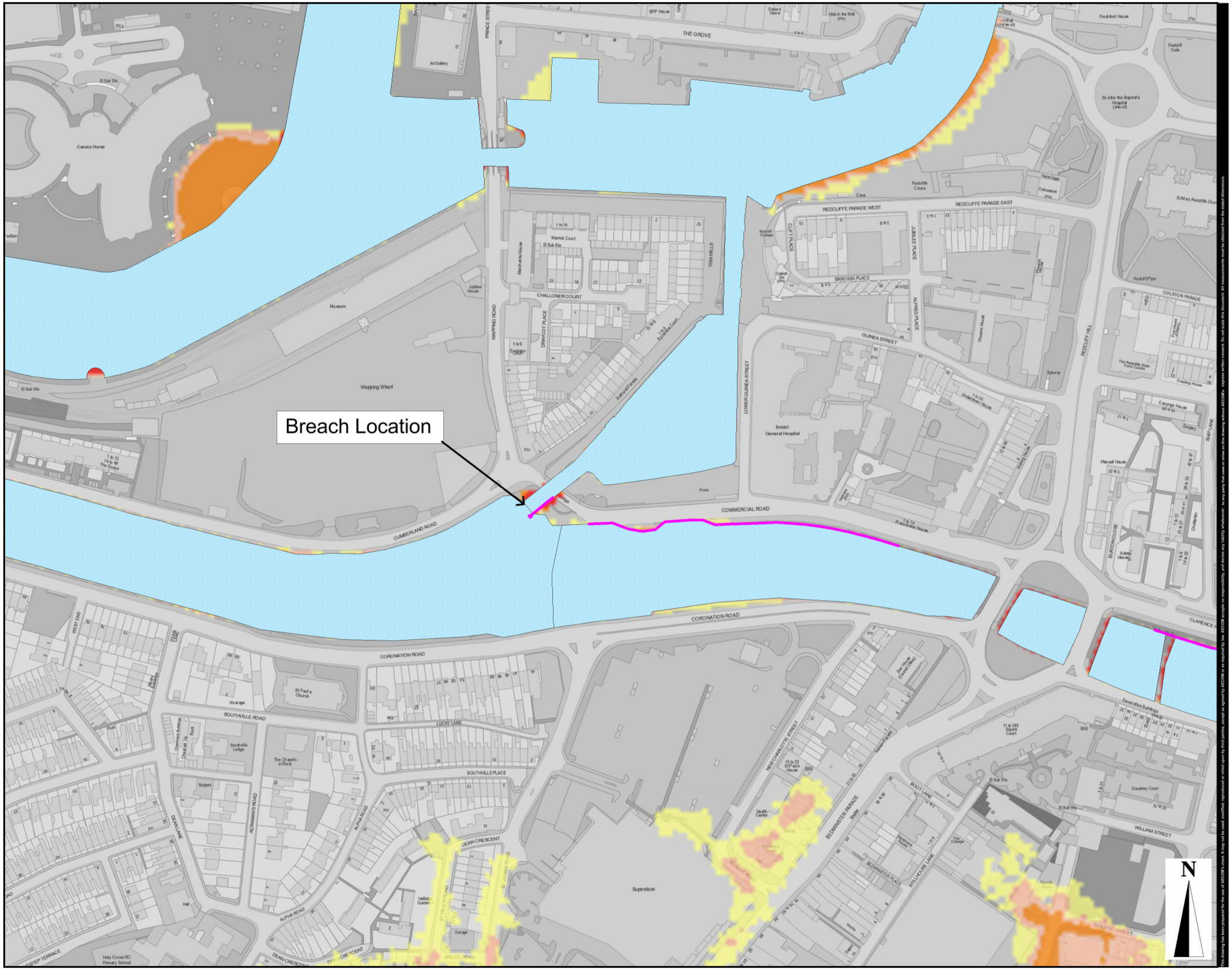
AECOM Internal Project No:
60478613

Drawing Title:
BR6 - COMMERCIAL ROAD GATE BREACH 4-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 2,500

Drawing No:	Rev:
FIGURE 6B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

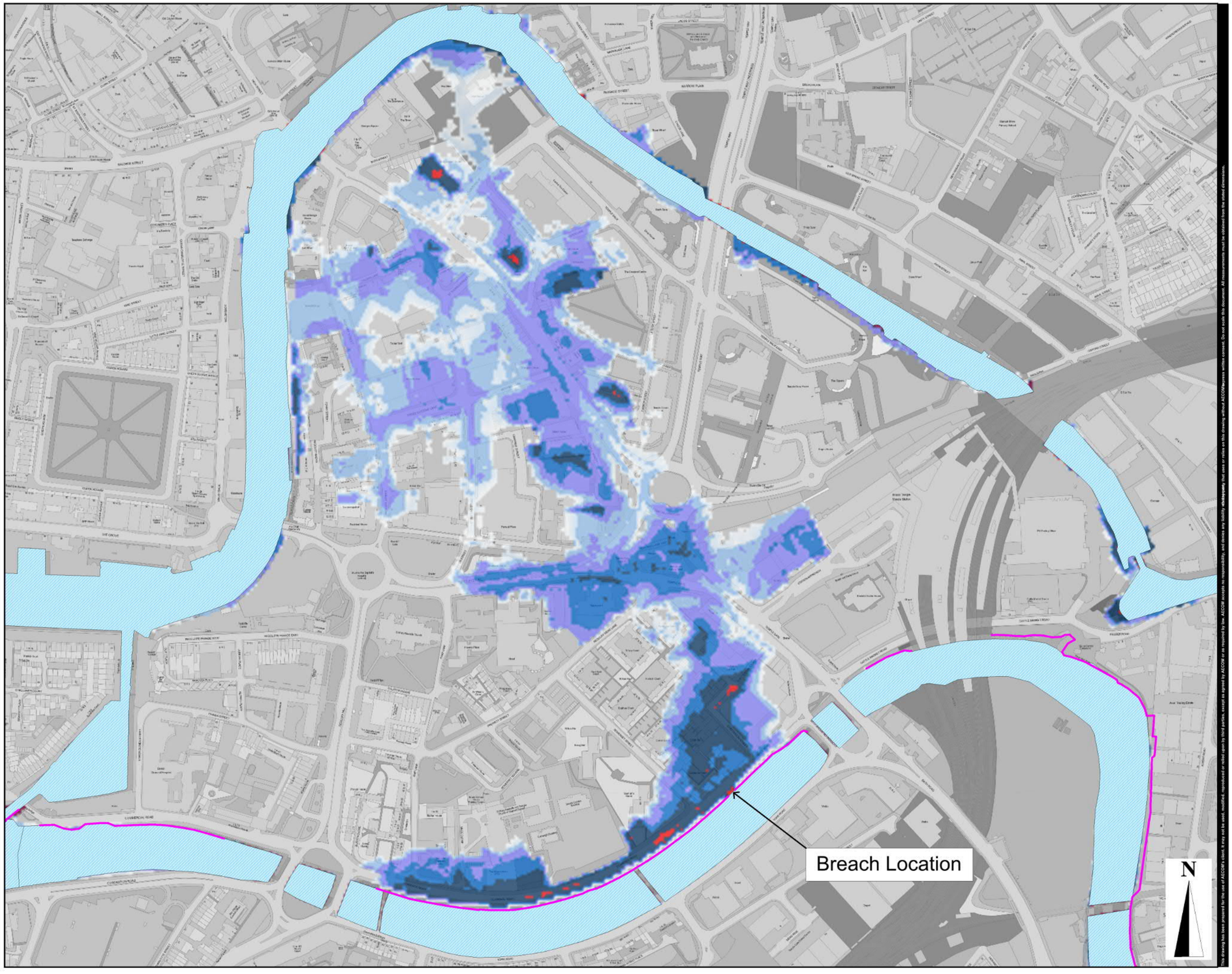
Model Reference:
CAFRA_139_200yr_F002_T200_2115_Breach_4_1

AECOM Internal Project No:
60478613

Drawing Title:
BR6 - COMMERCIAL ROAD GATE BREACH 4-1
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 2,500

Drawing No:			Rev:
FIGURE 6C			1
Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_5_3

AECOM Internal Project No:

60478613

Drawing Title:

BR7 - CLARENCE ROAD STRUCTURE BREACH 5-3
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 4,500

Drawing No:	Rev:
FIGURE 7A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017

AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Breach Location

N

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_5_3

AECOM Internal Project No:

60478613

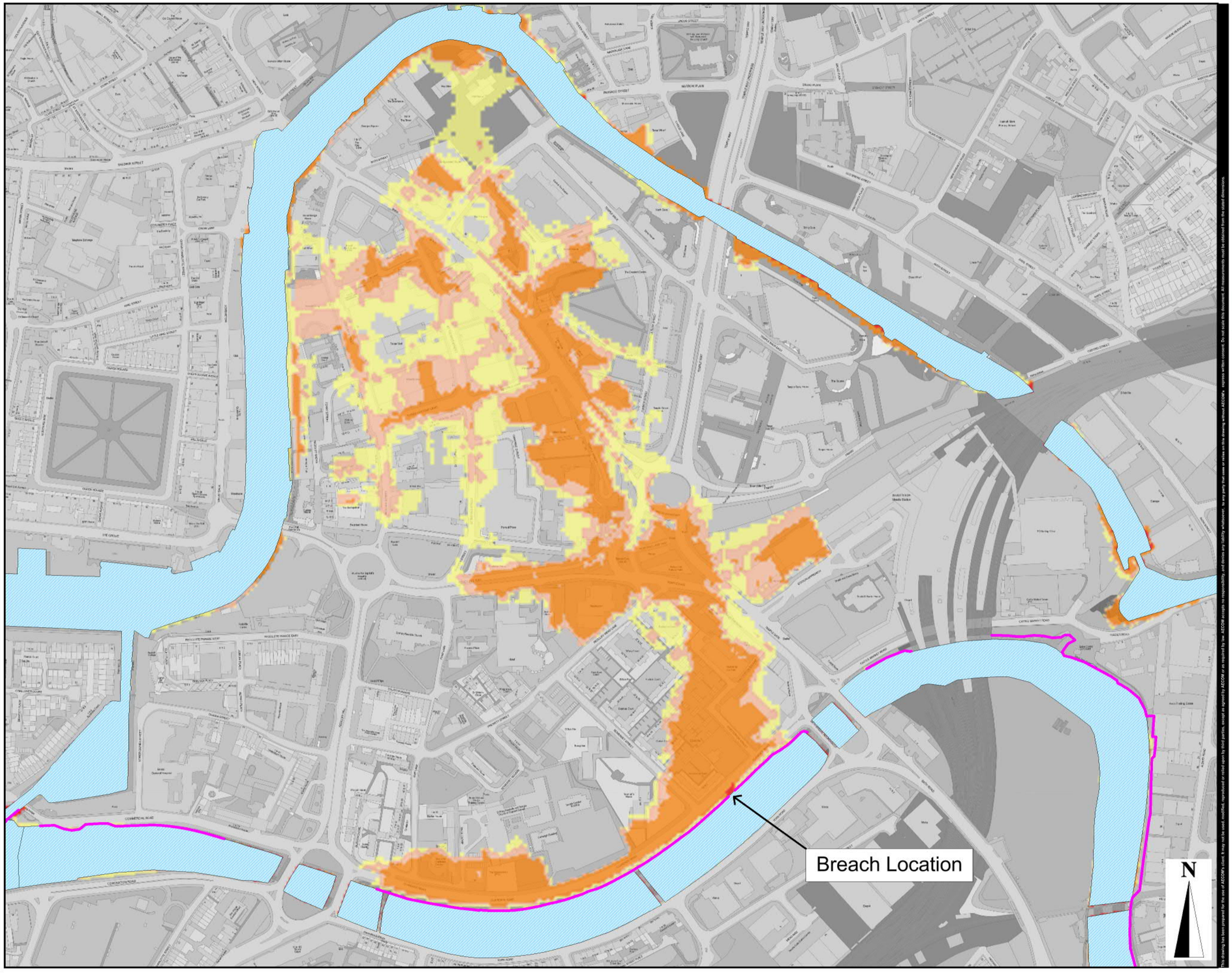
Drawing Title:

BR7 - CLARENCE ROAD
STRUCTURE BREACH 5-3
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 4,500

Drawing No:	Rev:
FIGURE 7B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_5_3

AECOM Internal Project No:

60478613

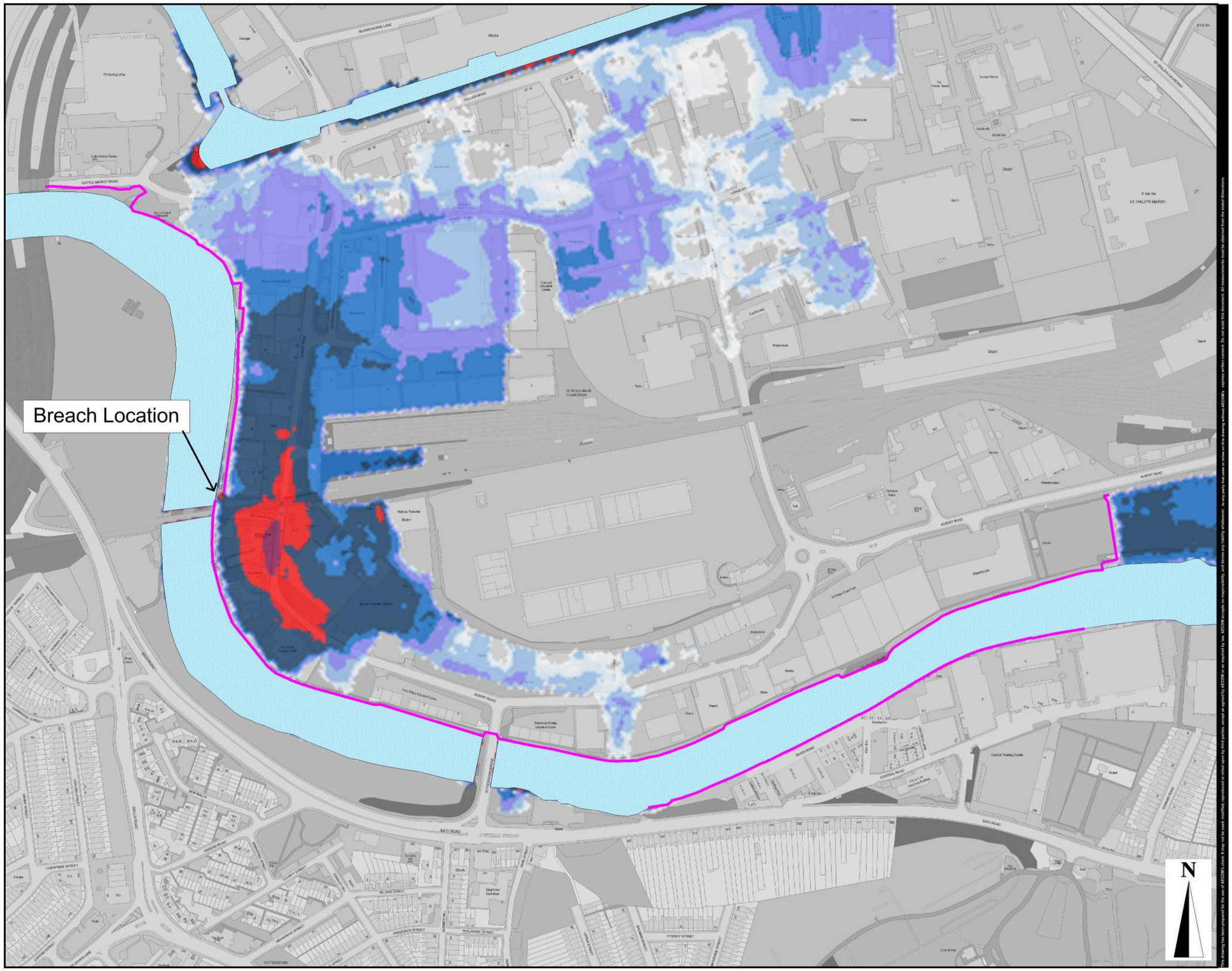
Drawing Title:

BR7 - CLARENCE ROAD
STRUCTURE BREACH 5-3
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 4,500

Drawing No:	Rev:
FIGURE 7C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_6

AECOM Internal Project No:

60478613

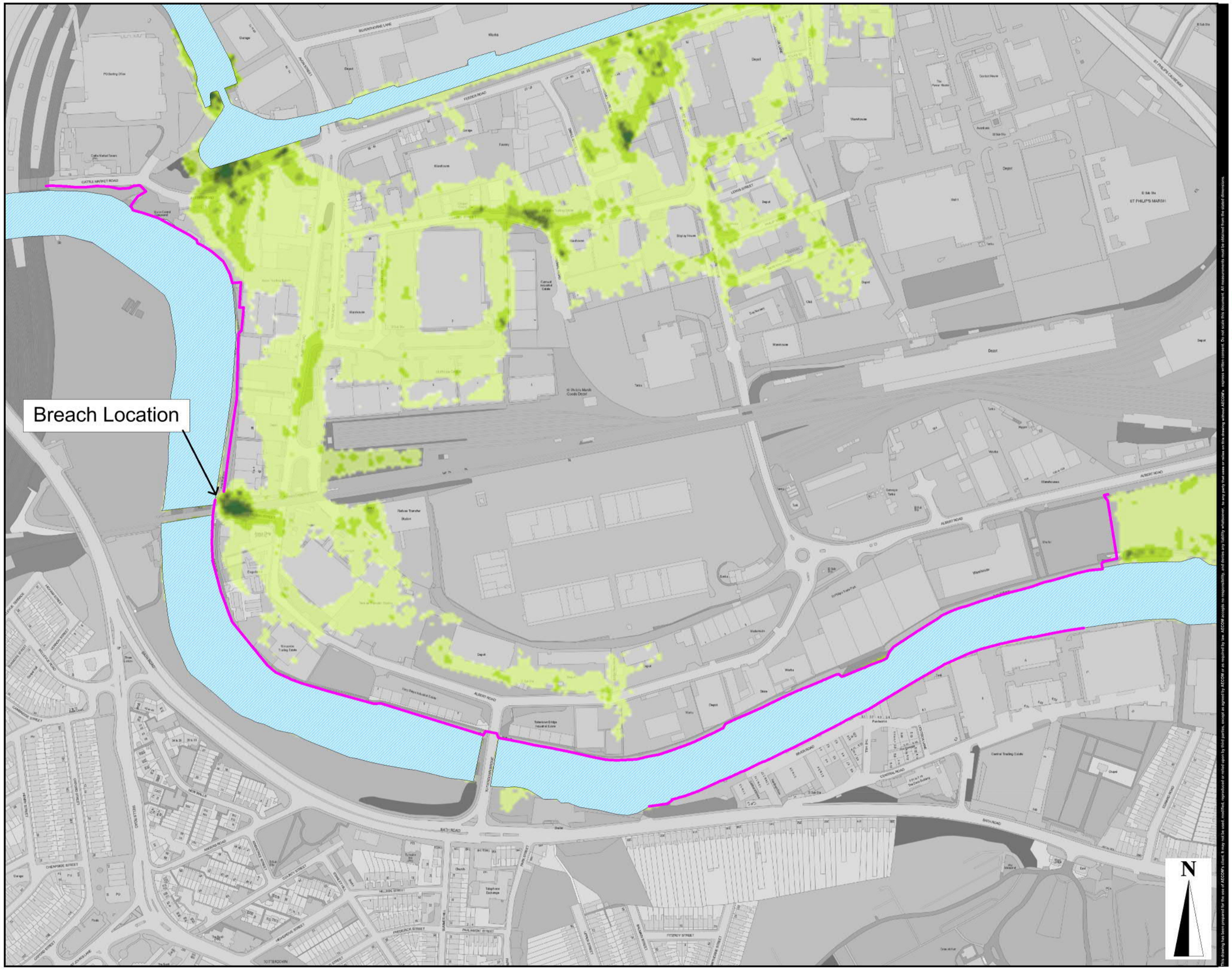
Drawing Title:

BR8 - TOTTERDOWN CENTRE
STRUCTURE BREACH 7-6
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 3,500

Drawing No:	Rev:
FIGURE 8A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_6

AECOM Internal Project No:

60478613

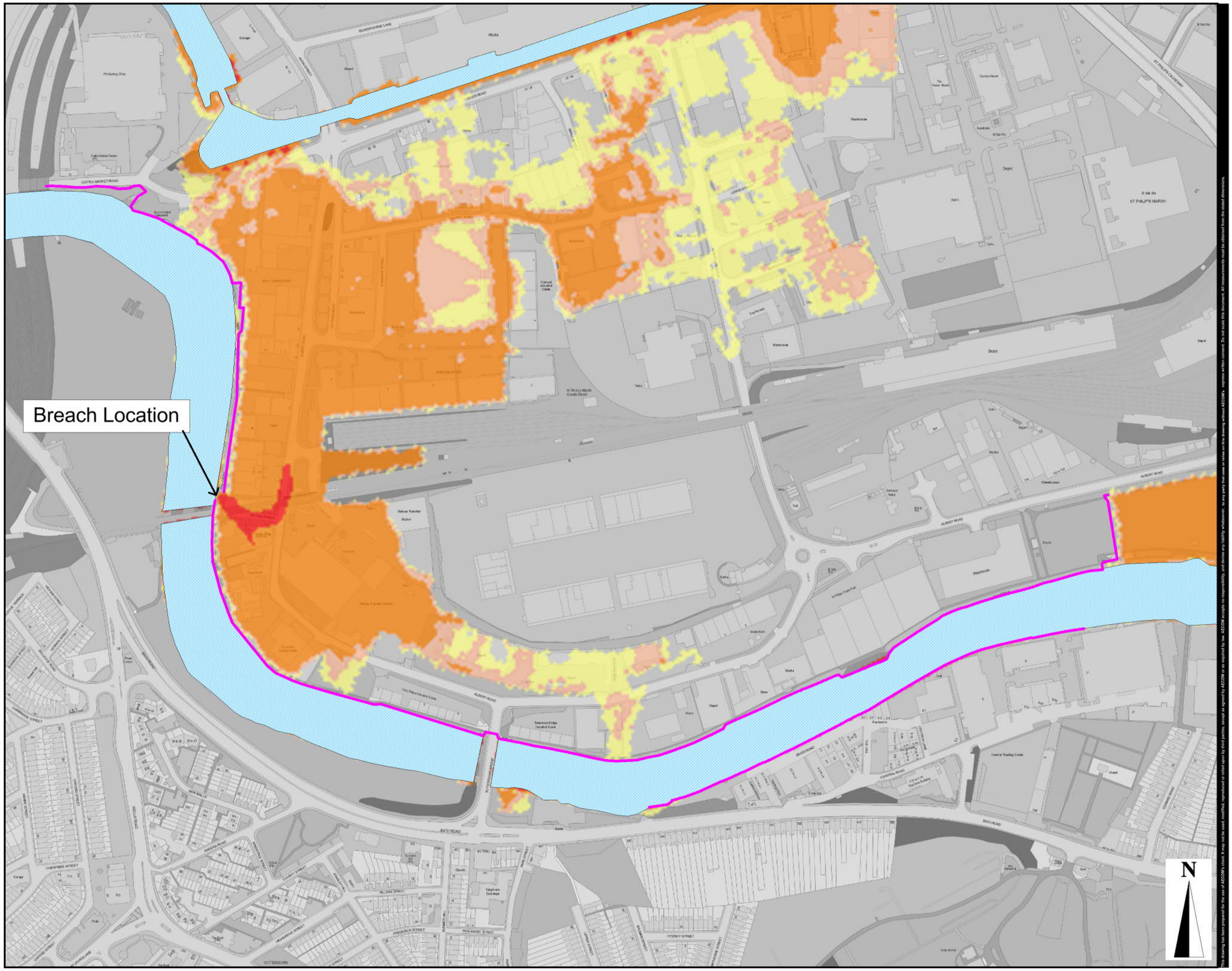
Drawing Title:

BR8 - TOTTERDOWN CENTRE
STRUCTURE BREACH 7-6
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 3,500

Drawing No:	Rev:
FIGURE 8B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_6

AECOM Internal Project No:

60478613

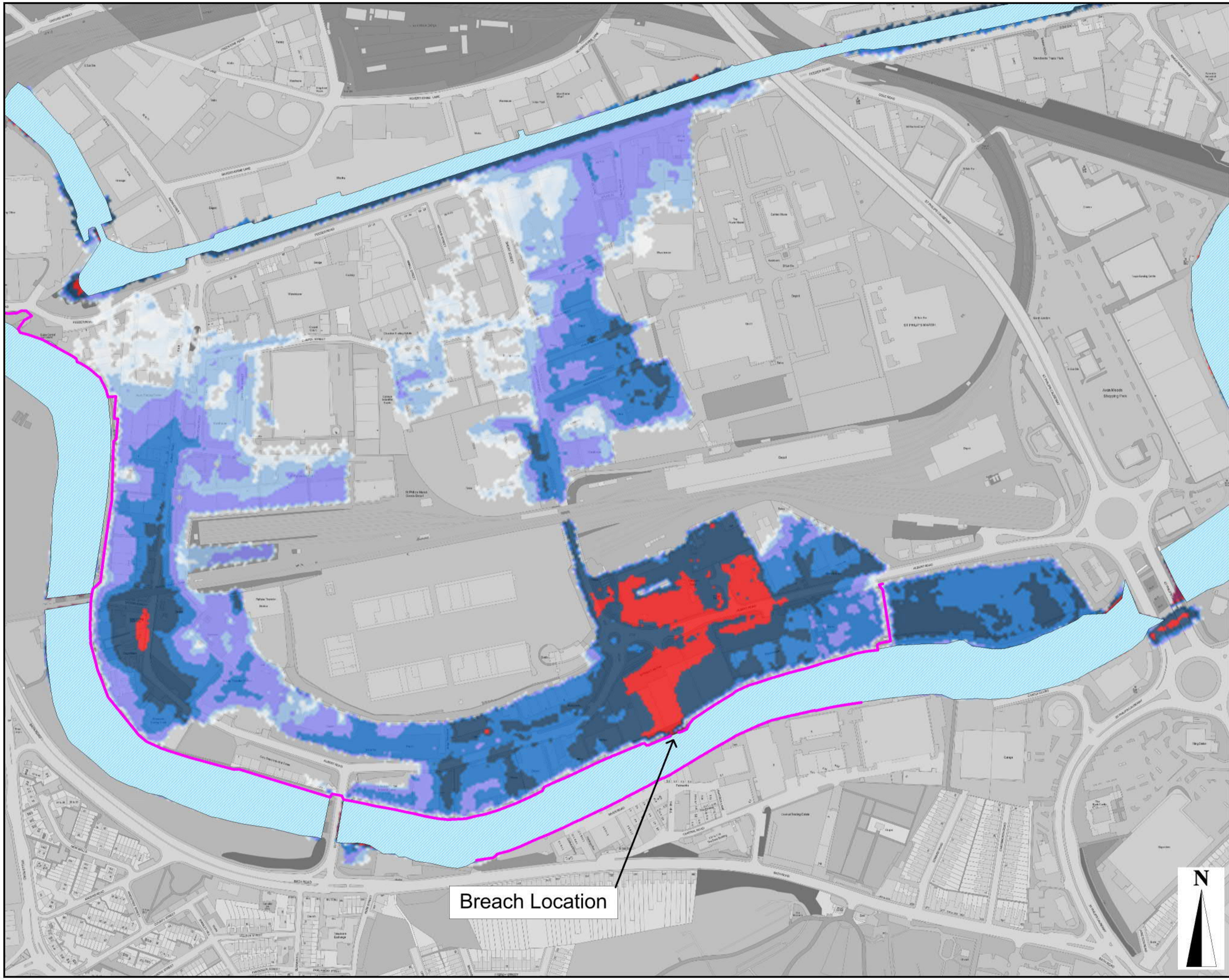
Drawing Title:

BR8 - TOTTERDOWN CENTRE
STRUCTURE BREACH 7-6
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 3,500

Drawing No:	Rev:
FIGURE 8C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_27

Copyright:

AECOM Internal Project No:

60478613

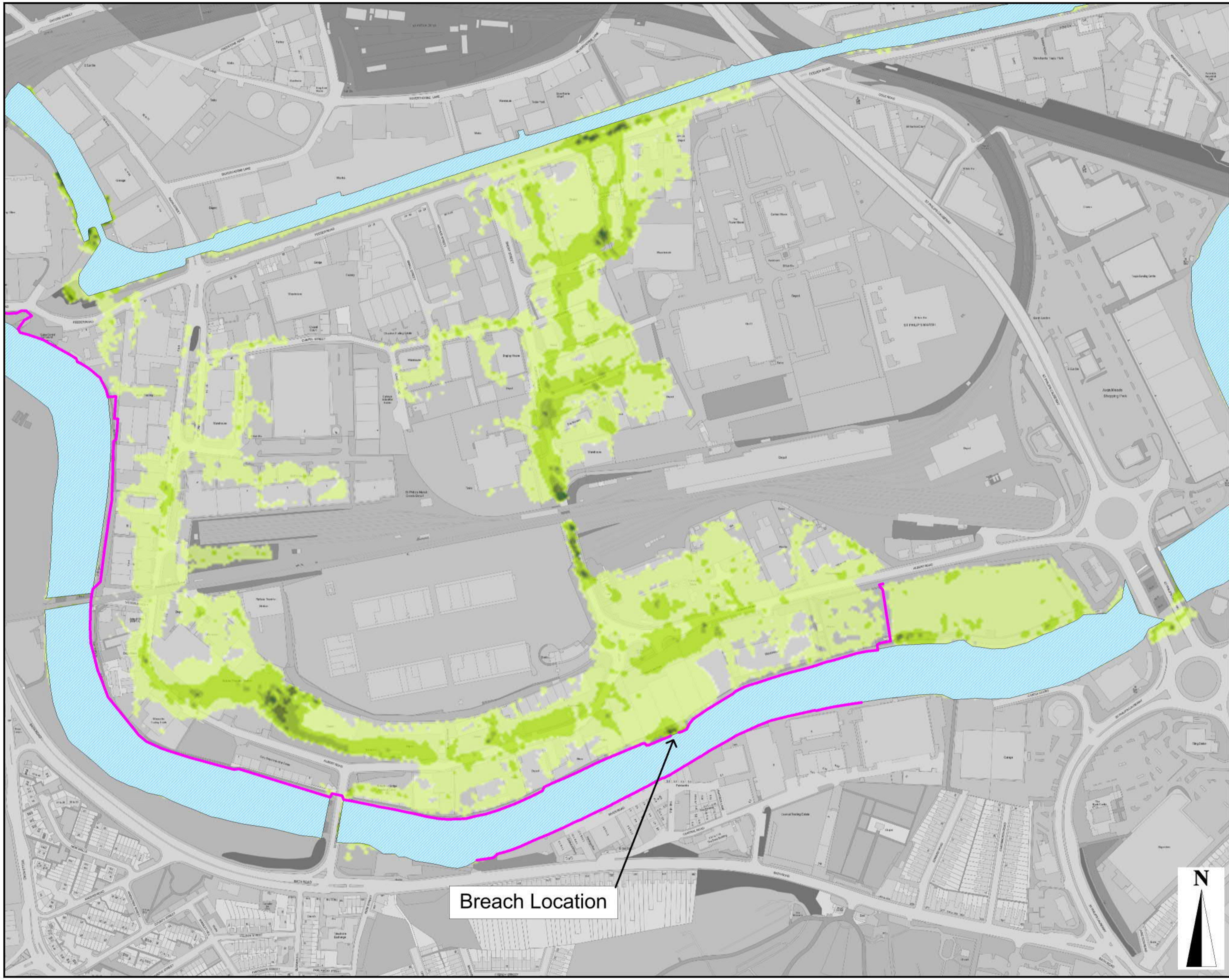
Drawing Title:

BR9 - TOTTERDOWN EAST STRUCTURE BREACH 7-27
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 4,000

Drawing No:	Rev:
FIGURE 9A	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:
RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:
BRISTOL CITY COUNCIL

LEGEND

River Avon / Floating Harbour

Defence Alignment

Maximum Flood Velocity

0.1m/s to 0.5m/s

0.5m/s to 1.0m/s

1.0m/s to 1.5m/s

1.5m/s to 2.0m/s

>2.0m/s

Model Reference:
CAFRA_139_200yr_F002_T200_2115_Breach_7_27

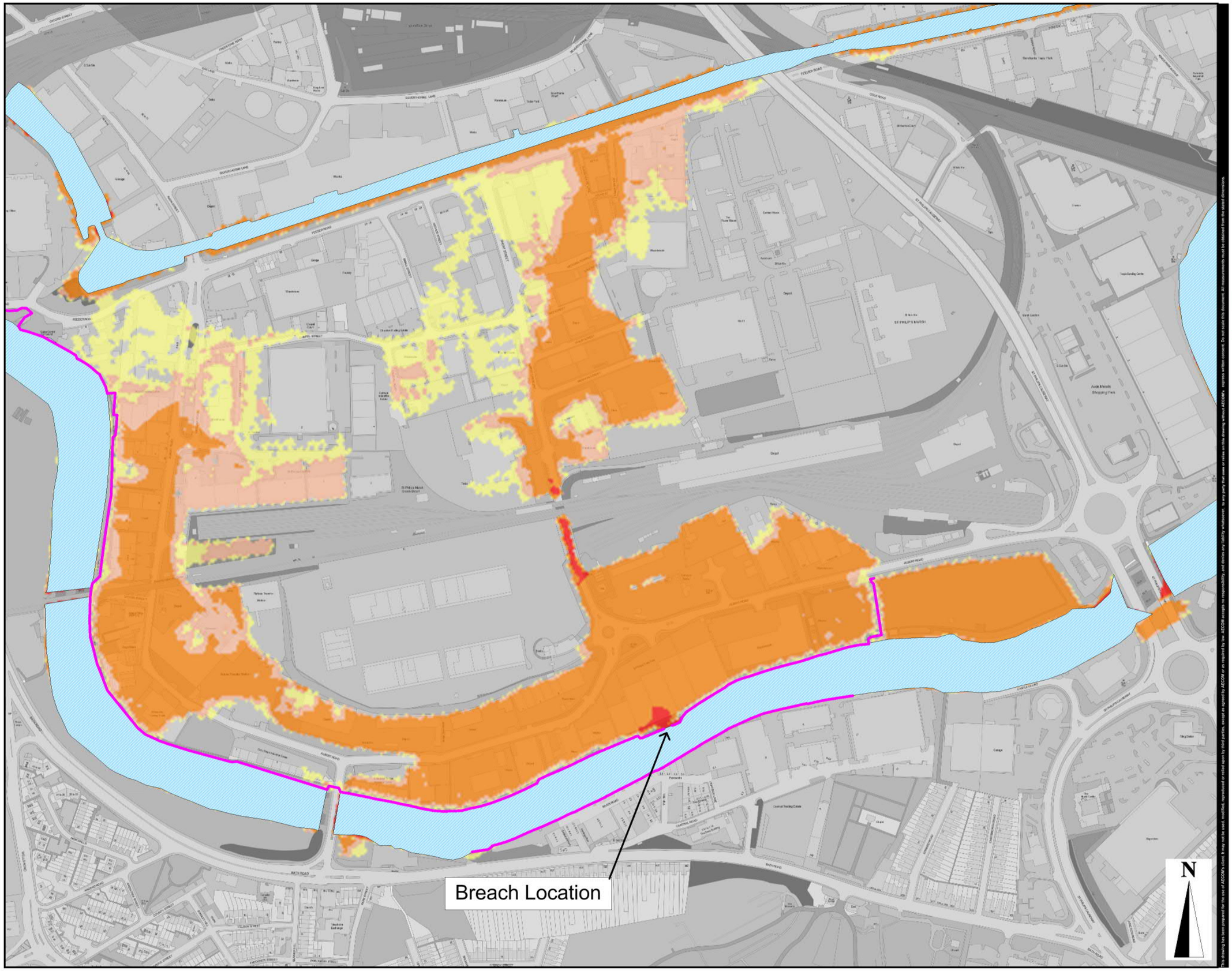
AECOM Internal Project No:
60478613

Drawing Title:
BR9 - TOTTERDOWN EAST STRUCTURE BREACH 7-27 200 YR RETURN PERIOD 2115 MAXIMUM FLOOD VELOCITY

Scale at A3: 4,000

Drawing No:	Rev:
FIGURE 9B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_7_27

AECOM Internal Project No:

60478613

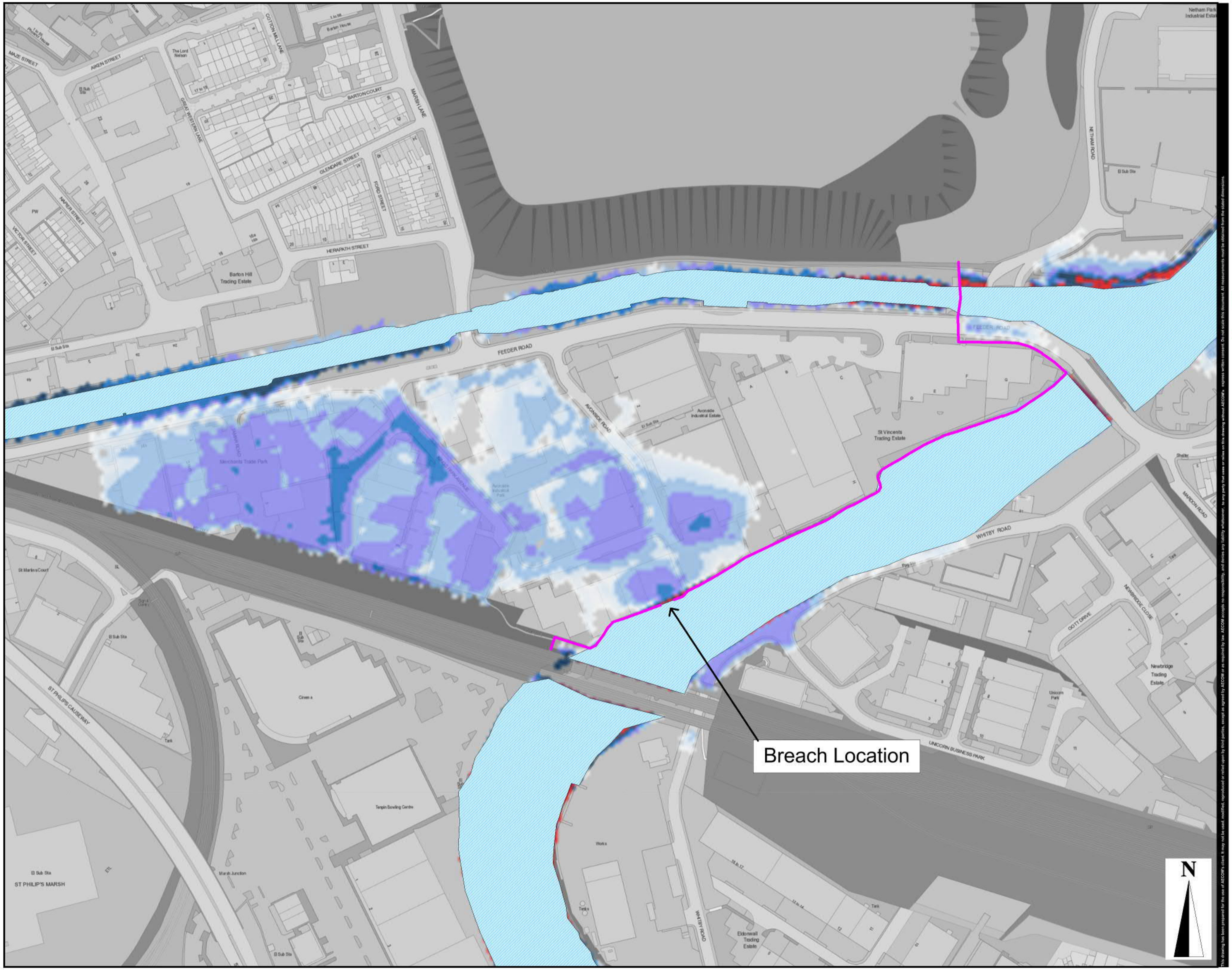
Drawing Title:

BR9 - TOTTERDOWN EAST
STRUCTURE BREACH 7-27
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 4,000

Drawing No:	Rev:
FIGURE 9C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Depth

- 0.00m to 0.15m
- 0.15m to 0.30m
- 0.30m to 0.60m
- 0.60m to 0.90m
- 0.90m to 1.50m
- 1.50m to 2.00m
- >2.00m

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_8_2

Copyright:

AECOM Internal Project No:

60478613

Drawing Title:

BR10 - NETHAM STRUCTURE BREACH 8-2
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD DEPTH

Scale at A3: 2,500

Drawing No:			Rev:
FIGURE 10A			1
Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017

AECOM
AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Velocity

- 0.1m/s to 0.5m/s
- 0.5m/s to 1.0m/s
- 1.0m/s to 1.5m/s
- 1.5m/s to 2.0m/s
- >2.0m/s

Breach Location

N

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_8_2

AECOM Internal Project No:

60478613

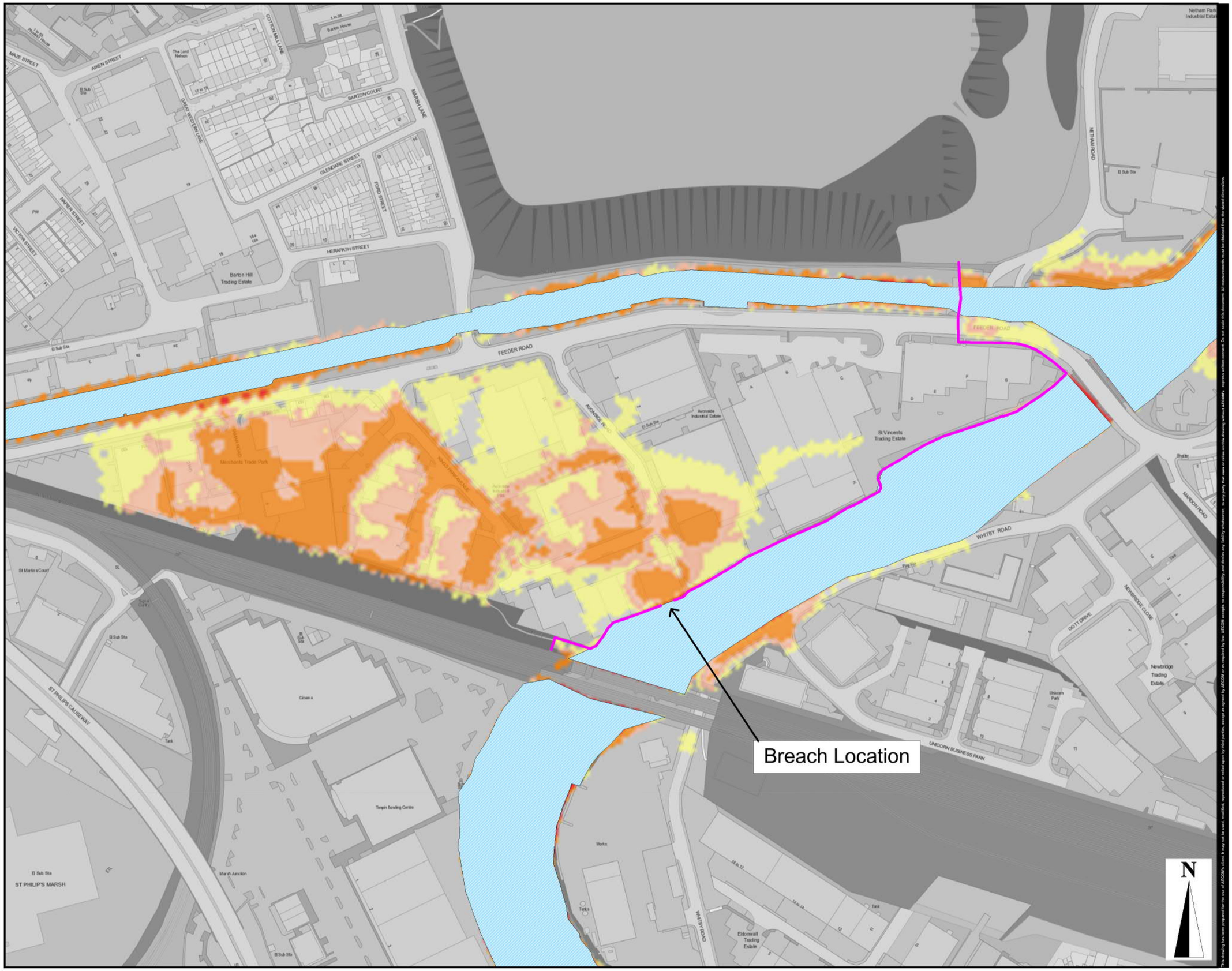
Drawing Title:

BR10 - NETHAM
STRUCTURE BREACH 8-2
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD VELOCITY

Scale at A3: 2,500

Drawing No:	Rev:
FIGURE 10B	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017



AECOM
The Crescent Centre
Bristol, BS1 6EZ
+44 (0)117 917 1200
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

LEGEND

- River Avon / Floating Harbour
- Defence Alignment

Maximum Flood Hazard

- Caution
- Danger for Some
- Danger for Most
- Danger for All

Model Reference:

CAFRA_139_200yr_F002_T200_2115_Breach_8_2

AECOM Internal Project No:

60478613

Drawing Title:

BR10 - NETHAM
STRUCTURE BREACH 8-2
200 YR RETURN PERIOD
2115
MAXIMUM FLOOD HAZARD

Scale at A3: 2,500

Drawing No:	Rev:
FIGURE 10C	1

Drawn:	Chk'd:	App'd:	Date:
RM	MD	JD	June 2017

APPENDIX C – SINGLE SOURCE BREACH RISK MAPPING

Entrance Lock gates

Netham gates

Structural failure 8-2

Manual floodgate failure 1-20

Structural failure2-1

Manual flood gate failure 3-1

Structural failure 4-1

Structural failure 5-3

Structural failure 7-6

Manual flood gate failure 7-13

Structural failure 7-27

AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

Maximum depth (m)

- < 0.15
- 0.15 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.5
- 1.5 - 2.0
- > 2.0
- Channel
- Defence alignments

Issue/Revision:

	06/07/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

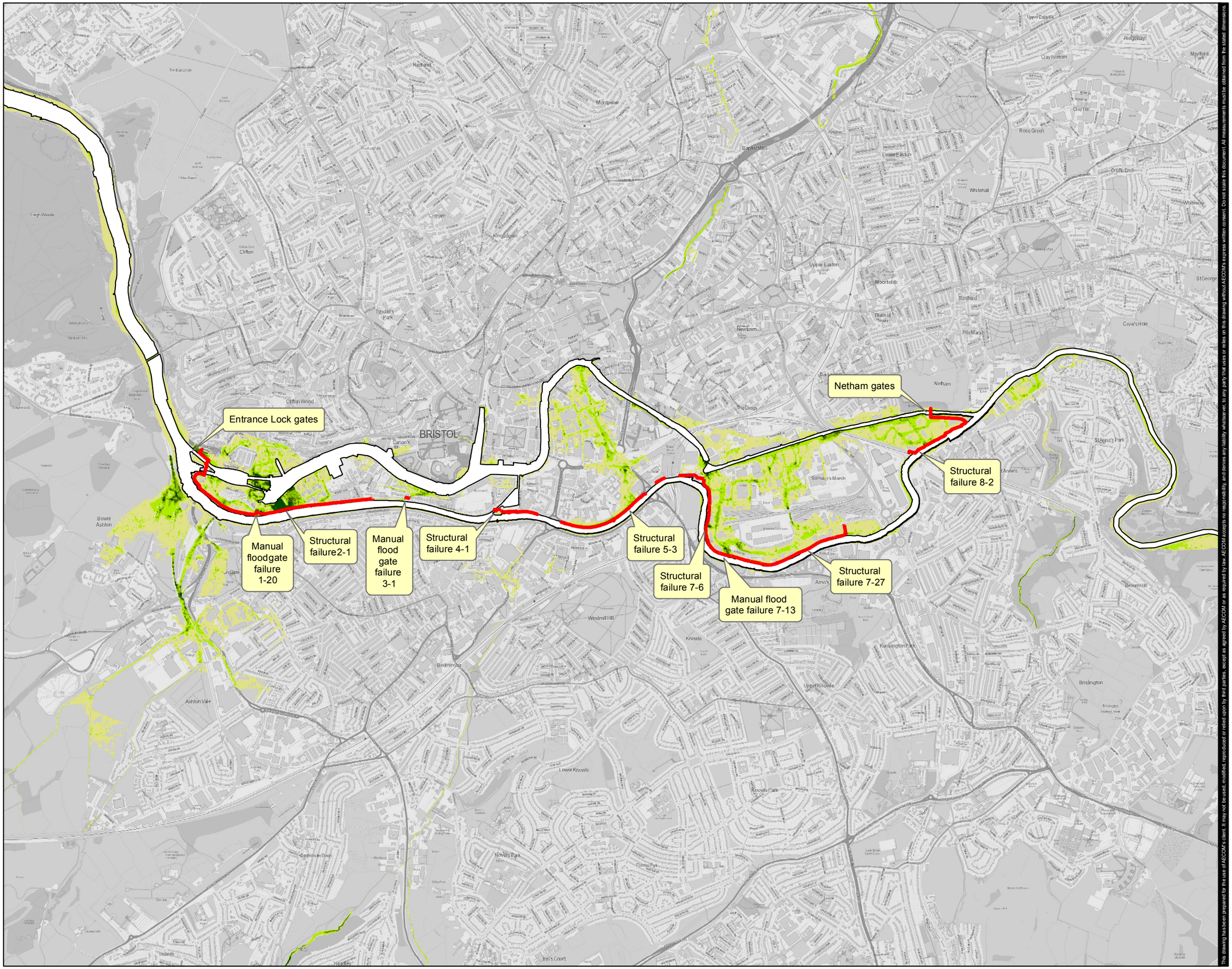
SINGLE SOURCE WORST CASE RESIDUAL RISK MAPPING.
ALL BREACHES; STRUCTURAL FAILURE, FLOOD GATE FAILURE, ENTRANCE LOCK GATE FAILURE, NETHAM LOCK GATE FAILURE

Scale at A3: 1:22,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT		JD	06/07/17

Filename: L:\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Max depth figure - breach and gates.mxd



Channel

Defence alignments

Velocity (m/s)

- < 0.1
- 0.1 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

Issue/Revision:

	06/07/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

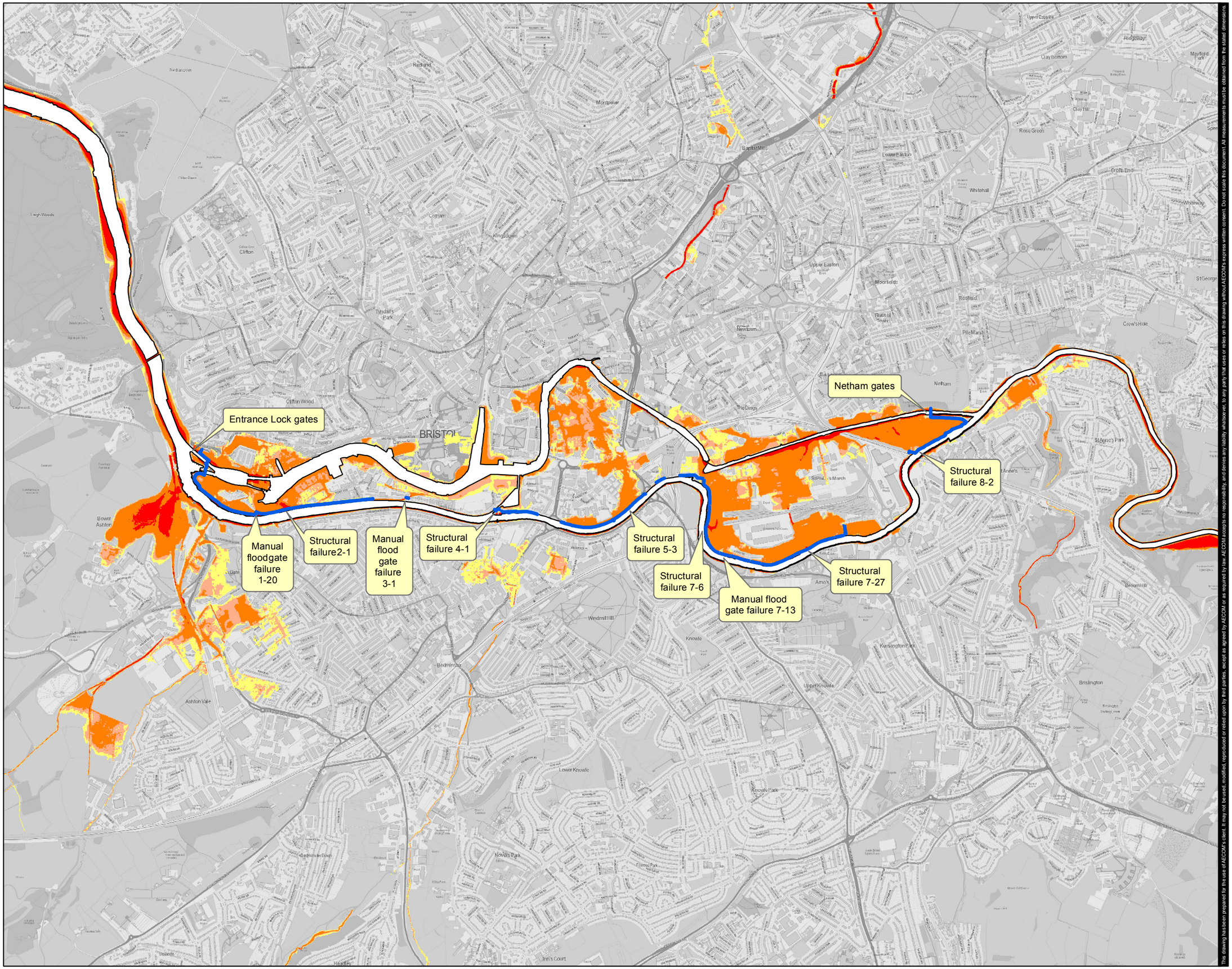
SINGLE SOURCE WORST CASE RESIDUAL RISK MAPPING.
ALL BREACHES; STRUCTURAL FAILURE, FLOOD GATE FAILURE, ENTRANCE LOCK GATE FAILURE, NETHAM LOCK GATE FAILURE

Scale at A3: 1:22,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT		JD	06/07/17

Filename: L:\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Max velocity figure - breach and gates.mxd



AECOM Limited
Midpoint
Basingstoke, RG21 7AQ
+44 (0)1256-310200 tel
www.aecom.com

Project Title:

RIVER AVON TIDAL FLOOD RISK MANAGEMENT STRATEGY

Client:

BRISTOL CITY COUNCIL

Max Hazard Rating

- < 0.75
- 0.75 - 1.25
- 1.25 - 2.5
- > 2.5
- Channel
- Defence alignments

Issue/Revision:

	06/07/17	V1

AECOM Internal Project No:

60478613

Drawing Title:

SINGLE SOURCE WORST CASE RESIDUAL RISK MAPPING.
ALL BREACHES; STRUCTURAL FAILURE, FLOOD GATE FAILURE, ENTRANCE LOCK GATE FAILURE, NETHAM LOCK GATE FAILURE

Scale at A3: 1:22,000

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT		JD	06/07/17

Filename: L:\Water\Projects & Jobs\River Avon TFRMS\20 CAD_GIS\GIS Workspace\Max hazard figure - breach and gates.mxd