

Appendix F

Flood Modelling Technical Note

P01158 Ageas Bowl, Southampton

Flood Modelling Study

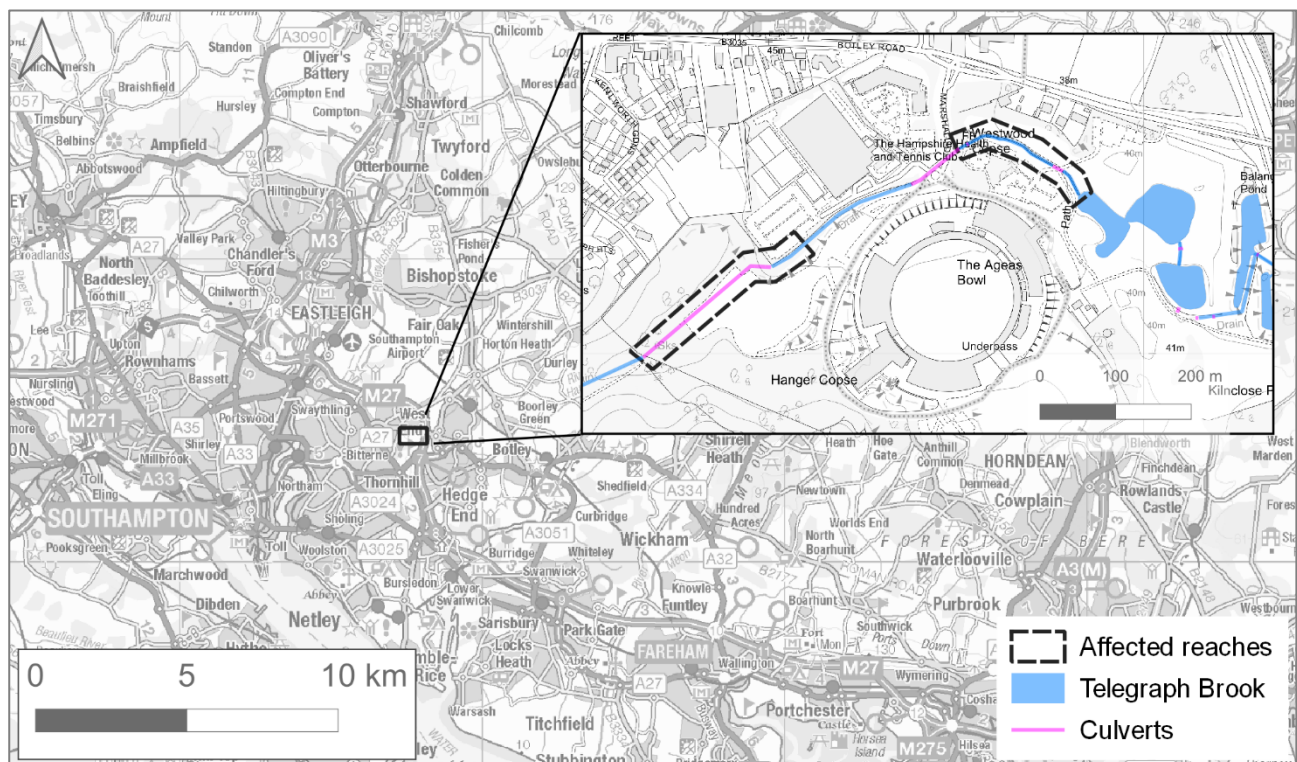
Baseline Model Technical Note

Prepared by	Matthew Shallcross BEng
Reviewed by	Simon Jepps BSc MSc
Status	FINAL
Version	1-0
Date	24 th January 2022

1 INTRODUCTION

The Ageas Bowl is home to Hampshire County Cricket Club as well as various sport and leisure facilities that are available to the public. The site includes the cricket ground and stadium, a hotel and a golf course. It is located in West End, Hampshire, east of the city of Southampton. **Figure 1** below shows the site location and approximate extent of Telegraph Brook affected by the proposed development.

Figure 1. Site location and approximate extent of Telegraph Brook affected by the proposed development



A minor watercourse named Telegraph Brook flows west to east from Telegraph Woods through a 200 m long culvert under the gravel car park on the western side of the site. The culvert discharges into an open channel after passing under the car park then follows the northern site boundary until it reaches another culvert at Marshall Drive. This culvert then discharges into an open channel that flows along the edge of the golf course. It continues flowing south-east and enters a series of three ponds situated on the golf course. The final pond discharges via a short open channel (labelled as a drain on the Ordnance Survey map) to a balancing pond adjacent to the M27 motorway on the eastern boundary of the site. The balancing pond discharges into a culvert which travels south-east under the motorway and away from the site.

The inlet to the 200 m long culvert which exits Telegraph Woods cannot be located and is thought to be completely buried.

There are proposals to develop two areas of the Ageas Bowl site. One development to the west of the cricket ground, the other to the east. The proposed development would replace and realign the culverted section of the watercourse in the western part of the site, presenting the opportunity to improve the inlet from Telegraph Wood. On-site the realigned culvert will be partially daylighted within the setting of a housing development. Downstream of Marshall Drive, proposals include the realignment of the watercourse in the reach upstream of the first pond.

To understand the baseline flood risk to the site and assess the potential change in flood risk due to the proposed developments, Thomas Mackay Ltd has been instructed to undertake a flood modelling study (FMS) of Telegraph Brook. The outcomes of this modelling study will also be used to inform the Flood Risk Assessment (FRA) being carried out by Andy Clay Consulting.

This technical note is to provide a brief overview of the modelling approach taken to build the baseline hydraulic model and to present the preliminary baseline results. A modelling report with full details of the hydrological assessment and hydraulic model build process will be completed alongside assessment of the modelled proposed design scenario. The final report and model files will be submitted for review by the Environment Agency once complete.



2 BASELINE MODEL

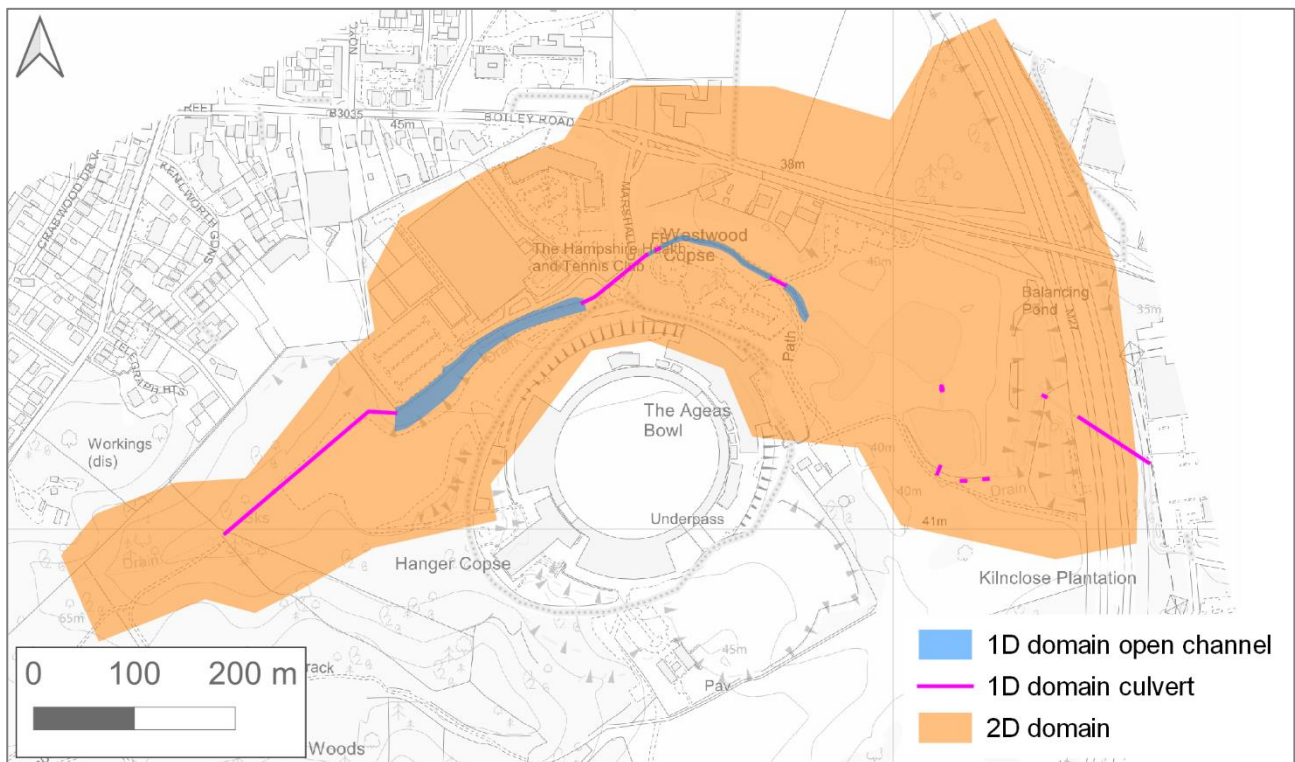
2.1 MODELLING APPROACH

A 1D-2D linked model has been constructed of Telegraph Brook from Telegraph Woods to the M27 motorway. The modelling software used for this study is BMT's TUFLOW Classic with their ESTRY solver used for the 1D components. The build version of the software is "2020-10-AB-iDP-w64".

The watercourse and in-line structures (i.e. culverts and weirs) have been represented in the 1D domain. The floodplain and ponds have been represented in the 2D domain. Both domains are linked to allow interaction between the channel, floodplain and ponds. **Figure 2** below shows the extent of the 1D and 2D model domains.

The software and approach used for this study are commensurate with Environment Agency guidance and industry best-practice.

Figure 2. Model domains



3 MODELLLED SCENARIOS & RESULTS

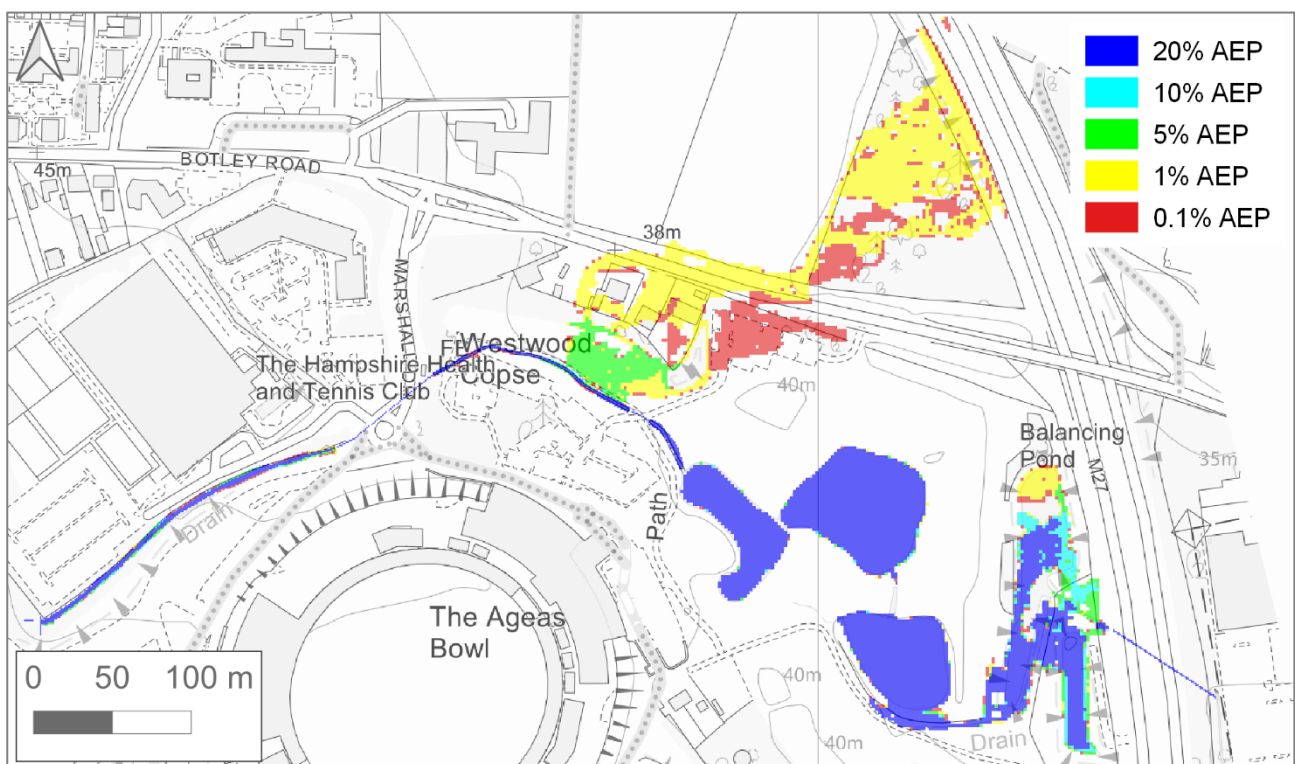
The modelled maximum flood depths for the baseline scenario have been mapped. These maps are presented in **Appendix A** for the following range of annual exceedance probabilities (AEPs) / return periods (RPs), labelled as Figures A1 to A6 respectively:

- 20% AEP (1 in 5 year RP)
- 10% AEP (1 in 10 year RP)
- 5% AEP (1 in 20 year RP)
- 1% AEP (1 in 100 year RP)
- 0.1% AEP (1 in 1000 year RP)

The maps indicate that there is no water entering the floodplain in the 10% AEP (1 in 10 year RP) event in the modelled baseline scenario. In the 5% AEP (1 in 20 year RP) and more extreme events, the model results show water overtopping the left bank in the reach upstream of the culvert under the golf course track. In the 5% AEP event, the modelled flood extent stays with-in the golf course. In the 1% and 0.1% AEP events the modelled flood extent continues north-east to the bungalows on Botley Road and reaches the western side of the M27 motorway.

Figure 3 below presents a summary of the flood extents from the modelled baseline scenario events. The extents have been overlayed in order, with the least extreme event on top and the most extreme event on the bottom. Therefore, this figure shows the increase in flood extent as events become more extreme. For example, the 0.1% AEP events flood extent includes the red extent labelled 0.1% AEP plus all of the less extreme events, i.e. 1% (yellow) to 20% (dark blue) AEP extents.

Figure 3. Overlayed flood extents showing the increase in extent with more extreme events



4 NEXT STEPS

Following completion of the engineering design work for the post-development watercourse and drainage network, a proposed scenario model will be completed. The following design events will be simulated and the results compared to the baseline scenario to assess any potential changes to flood risk off-site and to understand the potential on-site flood risk:

- 5% AEP (1 in 20 year RP)
- 1% AEP (1 in 100 year RP)
- 0.1% AEP (1 in 1000 year RP)

In addition, appropriate climate change scenarios based on current Environment Agency guidance will be undertaken for the 1 % AEP event.

Additional scenarios will be simulated using the 1% AEP event to investigate the sensitivity of the model results to the following:

- Choice of roughness coefficient
- Implementation of the downstream boundary
- Magnitude of the hydrological inflows

Finally, scenarios will be modelled in order to understand the residual risk to properties, should a blockage occur in key locations during a flood event. The blockage locations will be chosen following review of the proposed scenario model and will be based on the following:

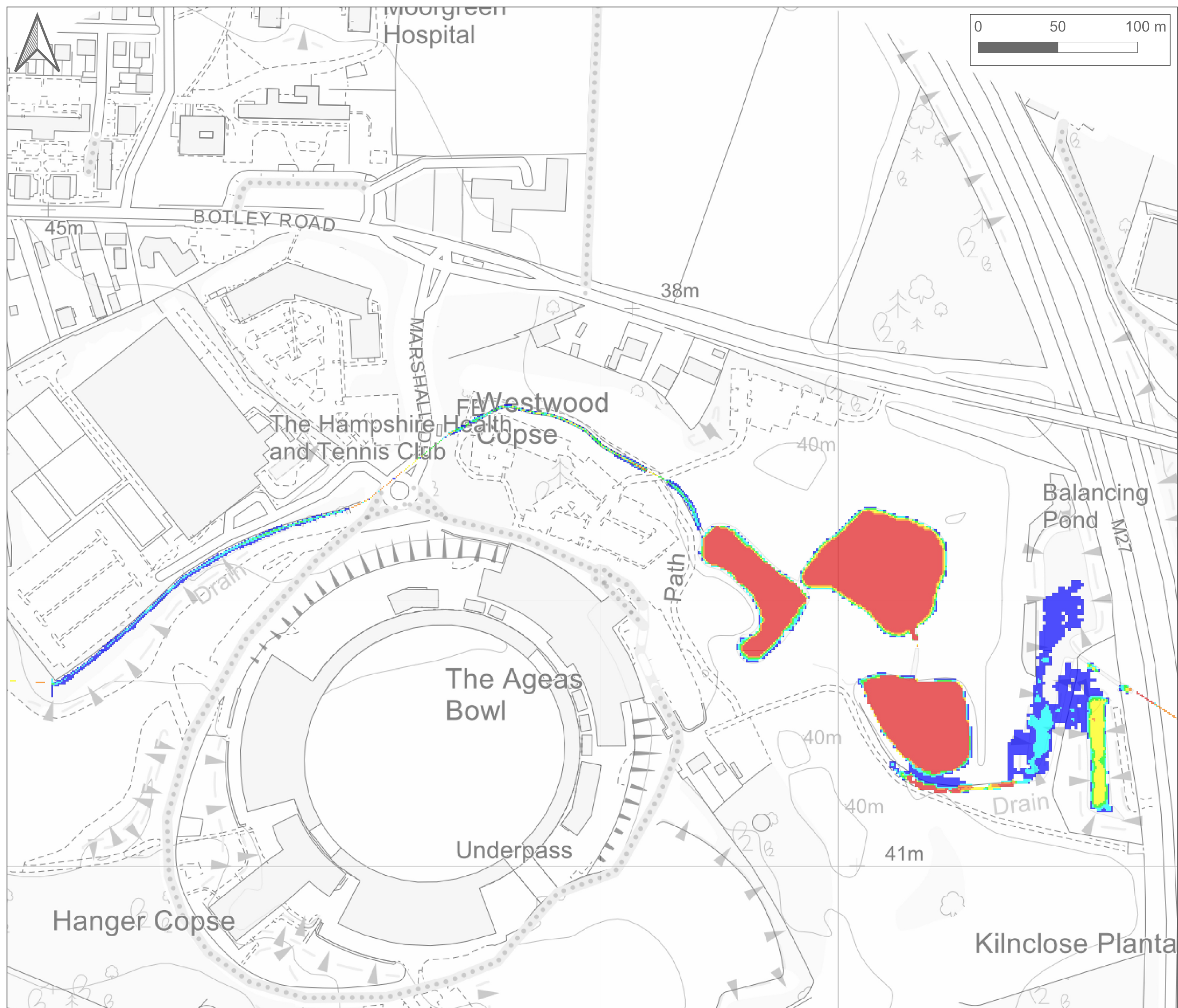
- The perceived likelihood of a blockage occurring at a given structure
- The impact on flood risk if a blockage occurs at a given structure

It is likely two blockage scenarios will be presented which will represent the two “worse-case” scenarios following the above assessment. If considered appropriate, additional blockage scenarios could be presented.

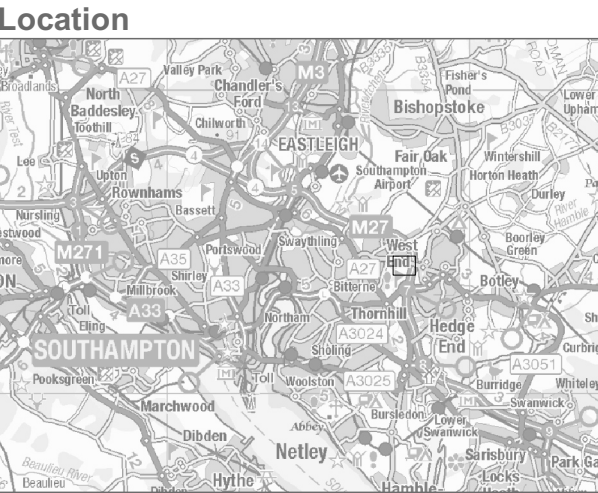
On completion of the modelling process, a Final Modelling Report will be completed and submitted as an addendum to the FRA submitted by Andy Clay Consulting. This report will include mapped and tabular outputs and will be suitable for review by the Environment Agency, alongside the model files.

APPENDIX A





Legend



P01158 Ageas Bowl, Southampton

**Flood Modelling Study
Baseline Model Technical Note**

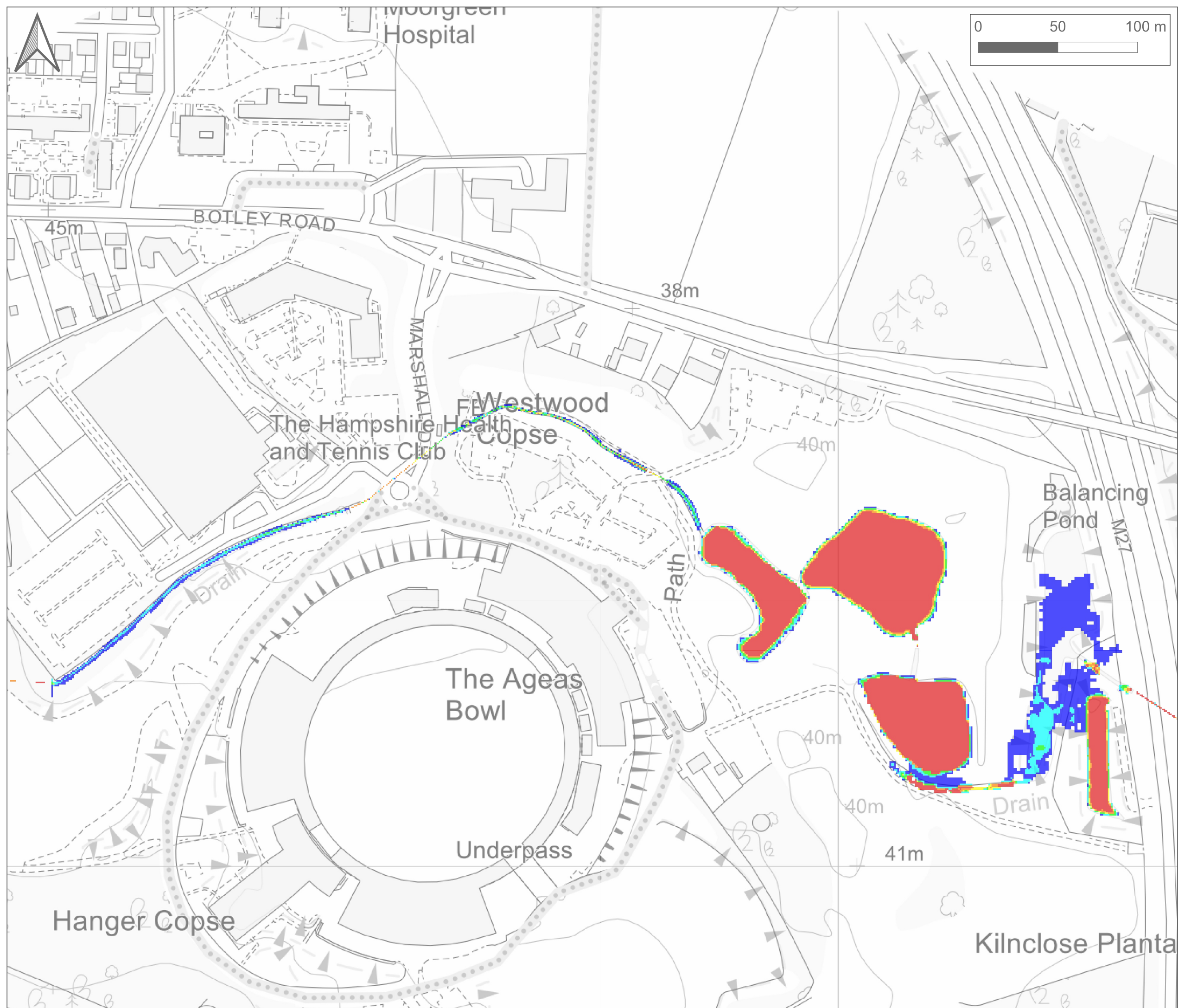
Figure A1
Maximum Flood Depth
Baseline Scenario
20% AEP (1 in 5 year)

Modelled	Drawn	Checked	Approved	Date	Version
MJS	MJS	SJ	JJ	24/01/22	v0-2

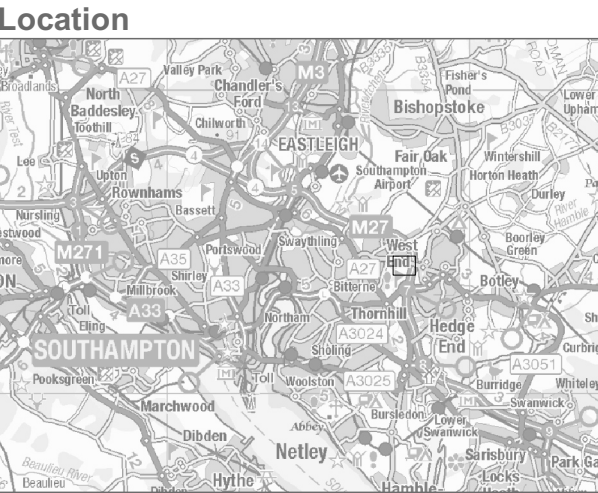
Source:
AgeasBowl_BUILD_003_20%AEP-2hrU.xmdf

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Legend



P01158 Ageas Bowl, Southampton

**Flood Modelling Study
Baseline Model Technical Note**

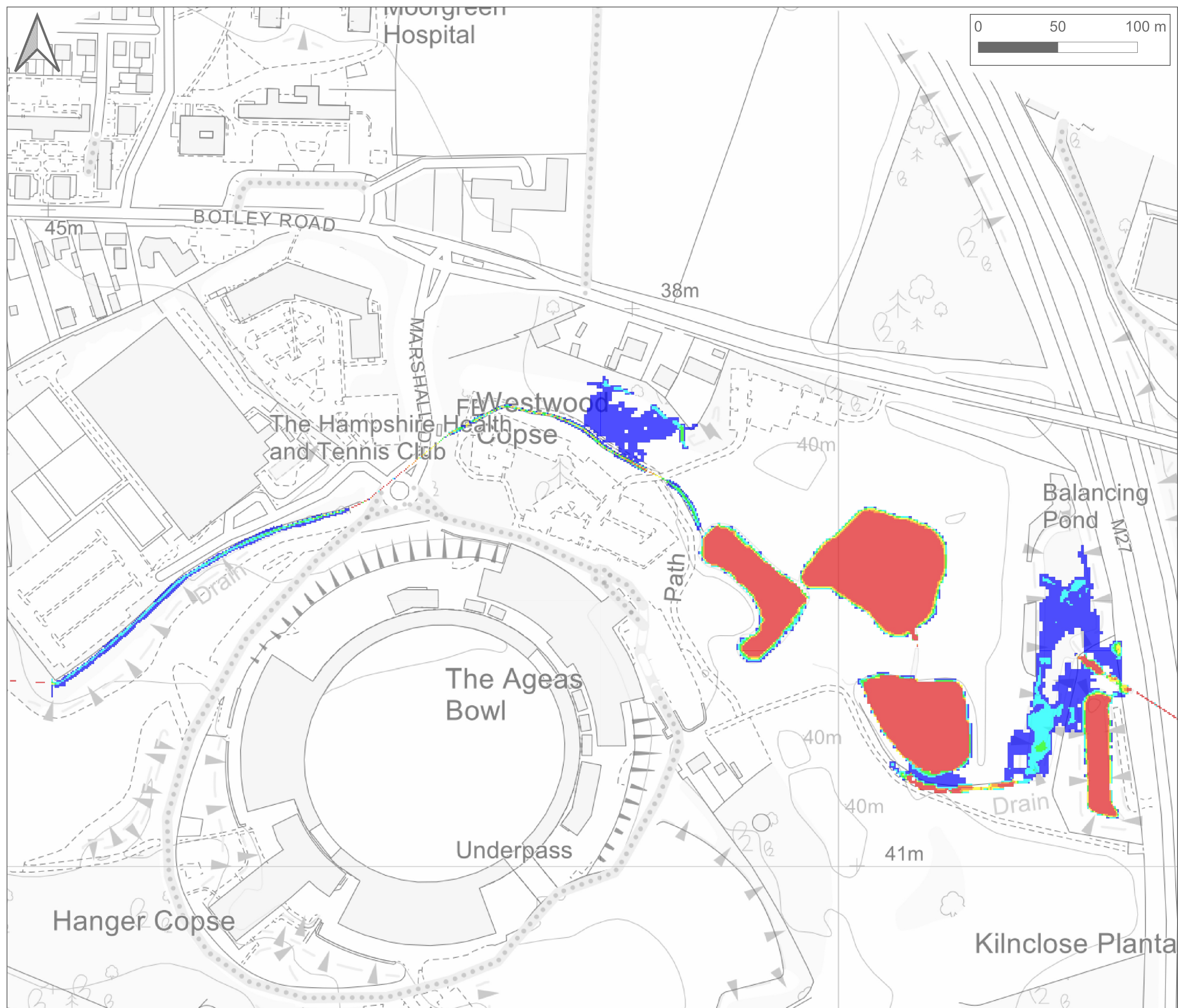
Figure A2
Maximum Flood Depth
Baseline Scenario
10% AEP (1 in 10 year)

Modelled	Drawn	Checked	Approved	Date	Version
MJS	MJS	SJ	JJ	24/01/22	v0-2

Source:
AgeasBowl_BUILD_003_10%AEP-2hrU.xmdf

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Legend

Location



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Flood Modelling Study
Baseline Model Technical Note

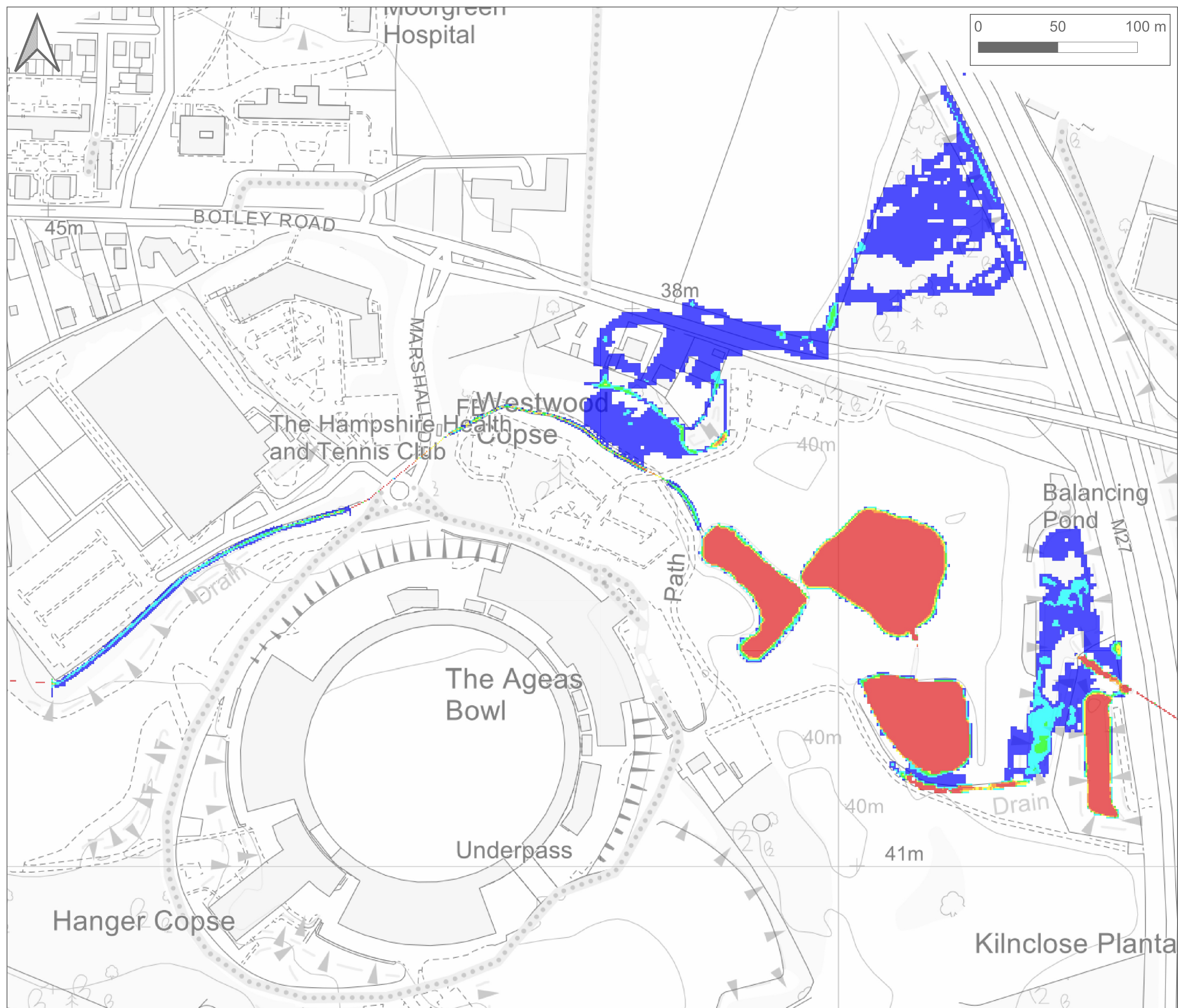
Figure A3
Maximum Flood Depth
Baseline Scenario
5% AEP (1 in 20 year)

Modelled	Drawn	Checked	Approved	Date	Version
MJS	MJS	SJ	JJ	24/01/22	v0-2

Source:
AgeasBowl_BUILD_003_5% AEP-2hrU.xmdf

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Legend

Location



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Flood Modelling Study
Baseline Model Technical Note

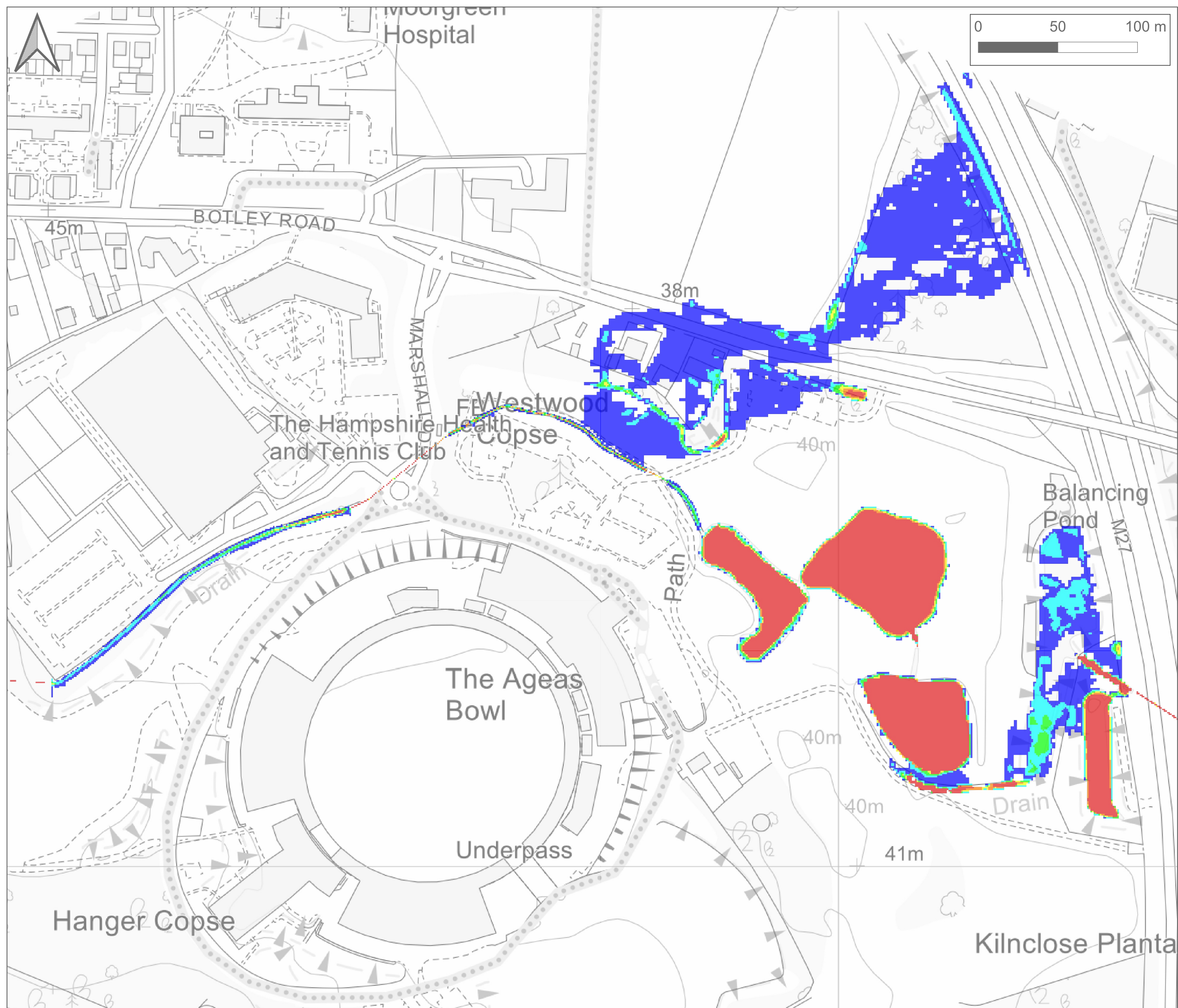
Figure A4
Maximum Flood Depth
Baseline Scenario
1% AEP (1 in 100 year)

Modelled	Drawn	Checked	Approved	Date	Version
MJS	MJS	SJ	JJ	24/01/22	v0-2

Source:
AgeasBowl_BUILD_003_1%AEP-2hrU.xmdf

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Legend

Location



P01158 Ageas Bowl, Southampton

Flood Modelling Study
Baseline Model Technical Note

Figure A5
Maximum Flood Depth
Baseline Scenario
0.1% AEP (1 in 1,000 year)

Modelled	Drawn	Checked	Approved	Date	Version
MJS	MJS	SJ	JJ	24/01/22	v0-2

Source:
AgeasBowl_BUILD_003_0.1%AEP-2hrU.xmdf

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Ageas Bowl Flood Modelling Study Glasswalled Scenario Draft Results

Prepared by	Matthew Shallcross BEng
Reviewed by	John Jepps BA MSc
Approved by	Simon Jepps BSc MSc
Status	FINAL
Version	v0-2
Date	13/07/2023

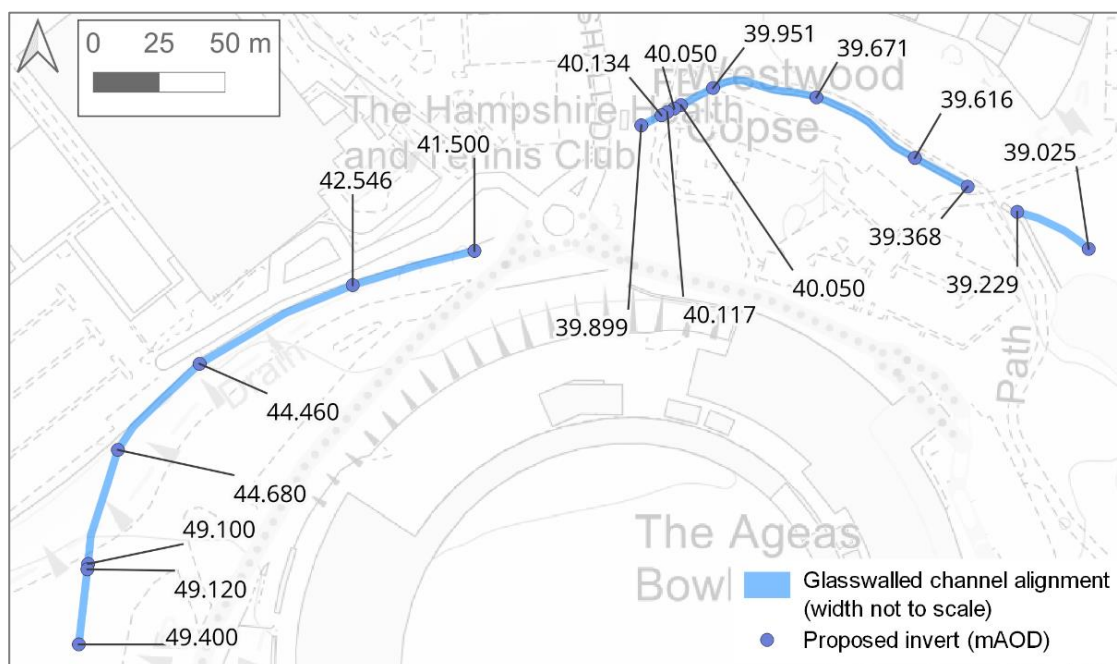
1 INTRODUCTION

In order to understand the required design elevations of the banktops in the proposed Ageas Bowl development, a “glasswalled” scenario was assessed within the existing flood model of the reach, developed by Thomas Mackay Ltd and reported on in a previous technical note¹. The modelling included a proposed new culvert alignment and daylighted section of the watercourse at the western part of the site, as well as partial realignment of the watercourse at the eastern part of the site. A two-stage channel geometry is proposed in two reaches as discussed below.

2 HYDRAULIC MODEL

Glasswalling of the model was achieved by unlinking the watercourse (represented in the 1D domain from Telegraph brook to the first pond) from the 2D domain. This ensured that water was kept within the footprint of the channel allowing model results to inform the required banktop design elevations in this reach for a given event. The alignment and invert of the channel was taken from design drawings, as shown below in **Figure 1**.

Figure 1. Proposed channel alignment and inverts



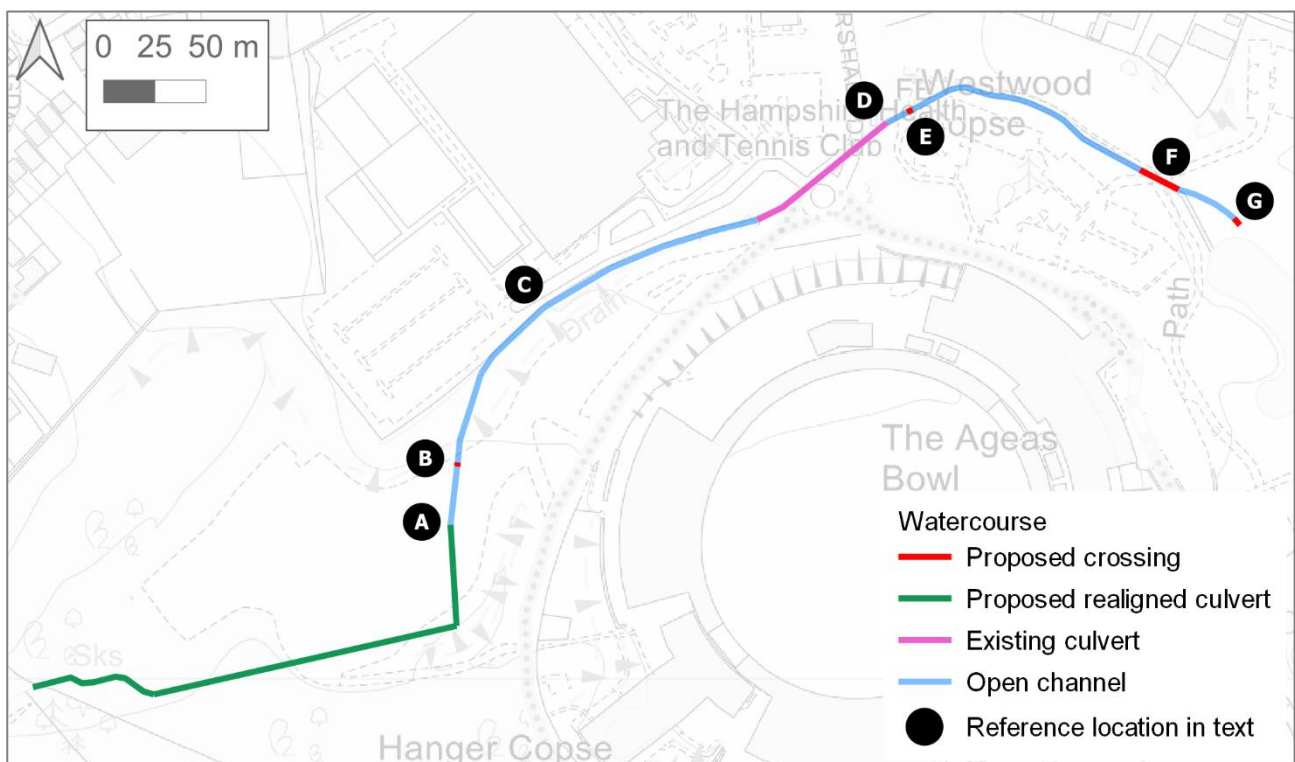
¹ P01158 Ageas Bowl, Southampton Flood Modelling Study Baseline Model Technical Note, Jan 2022

The channel geometry was based on drawings provided in the drainage design for the western part of the development (file 'X_Drainage.dwg'). At the eastern part of the watercourse, the geometry was based on drawings provided in landscape drawings (file 'D31A Two Stage Channel Section.pdf').

The channel geometry was represented as follows for the locations presented in **Figure 2**:

- A to B – Two-stage Trapezoidal channel (0.2 m deep low-flow channel)
- B to C – Trapezoidal channel
- C to D – Existing watercourse and culvert
- D to G – Two-stage Trapezoidal channel (0.5 m deep low-flow channel)

Figure 2. Proposed crossing and reference locations used in the text



The proposed crossings are also shown in to **Figure 2** above. These were represented in the model as summarised below in **Table 1** using judgment based on the provided design drawings.

Table 1. Proposed design crossings and model representation in “glasswalled” scenario

Ref	Comments	Model representation
B	Footbridge crossing Represented as a structure that will span the channel without altering the cross-section geometry and not be surcharged in any of the modelled events. Upstream of structure is proposed two-stage channel, downstream is trapezoidal channel.	Rectangular conduit with a width consistent with the channel width at that location (taken from plan drawings), i.e. 6 m. Opening height sufficiently large to ensure that conduit would not surcharge, i.e. 3 m.

Ref	Comments	Model representation
E	Footbridge crossing Represented as a structure that will span the channel without altering the cross-section geometry and not be surcharged in any of the modelled events. Upstream and downstream is proposed two-stage channel.	Two-stage open channel (consistent with upstream and downstream channel geometry).
F	Vehicle crossing Assumption that this is unlikely to be a structure that fully spans the channel due to use and width of channel.	Circular conduit with diameter 0.8 m.
G	Footbridge crossing Represented as a structure that will span the channel without altering the cross-section geometry and not be surcharged in any of the modelled events. Upstream of structure is proposed two-stage channel, downstream is outfall into pond 1	Rectangular conduit with a width consistent with the channel width at that location (taken from plan drawings), i.e. 3 m. Opening height sufficiently large to ensure that they would not surcharge, i.e. 1 m.

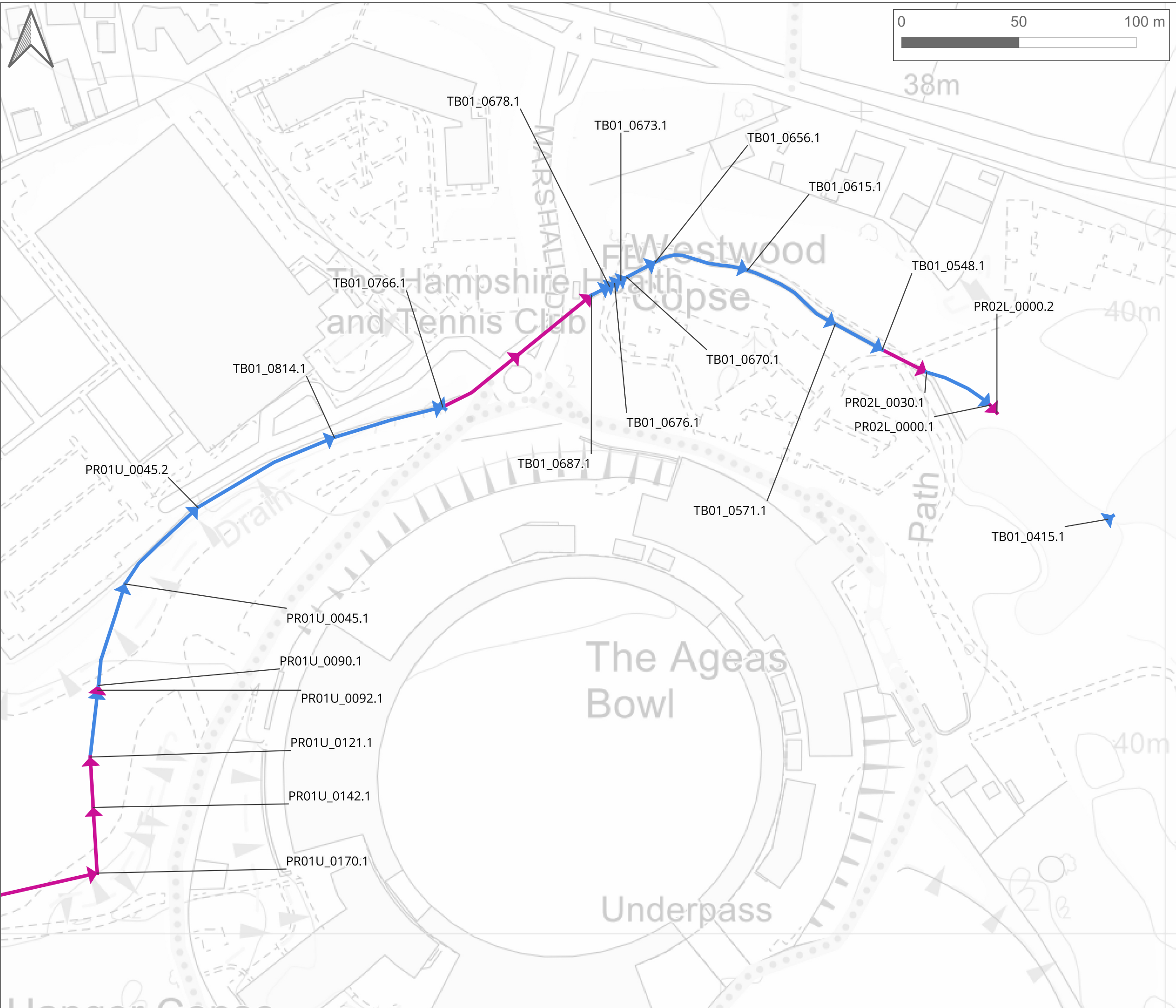
3 RESULTS

The modelled peak in-channel water elevations for a range of design events are provided in the table presented in **Appendix A1** of this note. In addition, the peak in-channel depths for the realigned or re-landscaped reaches of the proposed design are also included in **Appendix A2**. The locations of the nodes included in the tabular results are shown in **Appendix B1**.

These can be used to guide elevations for the banktops and crossings in the proposed design. These elevations do not include an allowance for freeboard; an appropriate freeboard allowance will need to be added to the peak water elevation provided where required.

A further iteration of modelling will need to be undertaken when the development design is completed if there is any requirement to assess the following:

- on-site flood risk
- off-site impacts
- residual risk (for example exceedance events or blockage scenarios)
- sensitivity to storm duration
- sensitivity to modelling choices

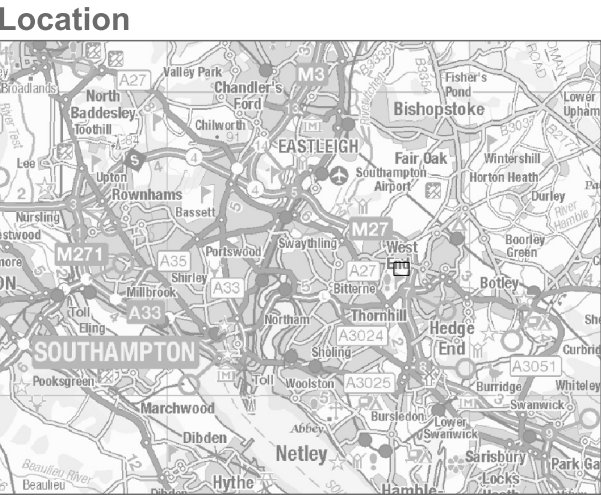


Legend

Watercourse

Open channel

Culverted channel



P01158 Ageas Bowl, Southampton

Flood Modelling Study
Addendum

Appendix B1

Node Locations
Proposed Sceario (PR02)

Modelled	Drawn	Checked	Approved	Date	Version
MJS	MJS	SJ	JJ	13/07/23	v0-1

Source:
AgeasBowl_PR02(GLW)_004_0.1% AEP-
2hrU_nwk_N_check_P



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Appendix A1

Proposed GLASSWALLED Scenario PR02(GLW) - Model v004

Draft Peak Flood Elevation in mAOD

Further modelling to be undertaken, when development design completed, to assess:

- on-site flood risk
- off-site impacts
- residual risk
- sensitivity to storm duration
- sensitivity to modelling choices

Model node	Location	20% AEP	10% AEP	5% AEP	1% AEP	1% AEP	1% AEP
		2 hour storm	2 hour storm	2 hour storm	2 hour storm	CC 37% 2 hour storm	CC 51% 2 hour storm
PR01U_0385.1		54.88	54.98	55.09	55.38	55.66	55.82
PR01U_0322.1		53.67	53.75	53.83	54.05	54.27	54.39
PR01U_0248.1		52.28	52.32	52.38	52.52	52.66	52.74
PR01U_0170.1		50.84	50.86	50.88	50.94	51.00	51.04
PR01U_0142.1		50.22	50.23	50.24	50.26	50.29	50.30
PR01U_0121.1	DS of long culvert	49.81	49.81	49.81	49.81	49.81	49.81
PR01U_0092.1		49.23	49.23	49.24	49.25	49.26	49.27
PR01U_0090.1		49.22	49.23	49.24	49.25	49.26	49.27
PR01U_0045.1		44.91	44.92	44.92	44.94	44.95	44.96
PR01U_0045.2	Start of existing channel	44.61	44.61	44.62	44.63	44.64	44.65
TB01_0814.1		42.79	42.79	42.79	42.79	42.80	42.84
TB01_0766.1	Culvert under roundabout	41.91	41.93	41.96	42.03	42.11	42.17
TB01_0726.1	Culvert under roundabout	41.27	41.29	41.32	41.38	41.47	41.52
TB01_0687.1	Start of Area 1	40.41	40.43	40.45	40.50	40.58	40.60
TB01_0678.1		40.40	40.42	40.44	40.48	40.55	40.58
TB01_0676.1	Footbridge (US face)	40.37	40.39	40.41	40.46	40.53	40.56
TB01_0673.1	Footbridge (DS face)	40.35	40.37	40.39	40.44	40.52	40.55
TB01_0670.1		40.33	40.36	40.38	40.43	40.50	40.53
TB01_0656.1		40.23	40.26	40.28	40.34	40.43	40.46
TB01_0615.1		40.08	40.10	40.12	40.18	40.28	40.30
TB01_0571.1		39.89	39.91	39.93	39.99	40.08	40.11
TB01_0548.1	Car park crossing (US face)	39.81	39.83	39.84	39.90	39.97	40.02
PR02L_0030.1	Car park crossing (DS face)	39.58	39.61	39.64	39.67	39.72	39.76
PR02L_0000.1		39.17	39.17	39.18	39.24	39.28	39.30
PR02L_0000.2		38.99	38.99	38.99	38.99	38.99	38.99
TB01_0415.1	Pond 1	38.80	38.81	38.81	38.83	38.85	38.86
TB01_0415.2	Pond 2	38.65	38.65	38.65	38.65	38.65	38.65
TB01_0319B.2		37.80	37.81	37.83	37.87	37.93	37.96
TB01_0319Aw.2		37.61	37.61	37.61	37.61	37.61	37.61
TB01_0319A.1		37.80	37.82	37.84	37.89	37.95	37.99
TB01_0319A.2		37.80	37.81	37.83	37.88	37.93	37.96
TB01_0238.1	Pond 3	34.94	34.94	34.95	34.96	34.97	34.98
TB01_0238.2		34.93	34.93	34.93	34.94	34.94	34.94
TB01_0203.1		34.15	34.18	34.21	34.23	34.32	34.37
TB01_0203.2		34.12	34.14	34.15	34.16	34.18	34.20
TB01_0181.1		33.71	33.73	33.74	33.77	33.82	33.84
TB01_0181.2		33.70	33.71	33.72	33.73	33.78	33.79
TB01_0042.1		30.70	30.70	30.70	31.19	31.19	31.19
TB01_0042.2		30.70	30.70	30.70	31.19	31.20	31.19
MwayCulvert.1	Motorway culvert	30.00	30.06	30.10	30.34	30.57	30.70
MwayCulvert.2		29.67	29.69	29.71	29.83	29.92	29.97

Appendix A2

Proposed GLASSWALLED Scenario PR02(GLW) - Model v004

Draft Peak Flood Depth in m

Further modelling to be undertaken, when development design completed, to assess:

- on-site flood risk
- off-site impacts
- residual risk
- sensitivity to storm duration
- sensitivity to modelling choices

Model node	Invert (mAOD)	Location	20% AEP 2 hour storm	10% AEP 2 hour storm	5% AEP 2 hour storm	1% AEP 2 hour storm	1% AEP CC 37% 2 hour storm	1% AEP CC 51% 2 hour storm	0.1% AEP 2 hour storm
PR01U_0385.1	53.70								
PR01U_0322.1	52.67								
PR01U_0248.1	51.46								
PR01U_0170.1	50.21								
PR01U_0142.1	49.75								
PR01U_0121.1	49.40	DS of long culvert	0.41	0.41	0.41	0.41	0.41	0.41	0.41
PR01U_0092.1	49.12		0.11	0.11	0.12	0.13	0.14	0.15	0.15
PR01U_0090.1	49.10		0.12	0.13	0.14	0.15	0.16	0.17	0.17
PR01U_0045.1	44.68		0.23	0.24	0.24	0.26	0.27	0.28	0.28
PR01U_0045.2	44.46	Start of existing channel	0.14	0.15	0.16	0.17	0.18	0.19	0.19
TB01_0814.1	42.55		0.25	0.25	0.25	0.24	0.25	0.28	0.29
TB01_0766.1	41.50	Culvert under roundabout							
TB01_0726.1	40.87	Culvert under roundabout							
TB01_0687.1	39.90	Start of Area 1	0.51	0.53	0.56	0.60	0.68	0.69	0.70
TB01_0678.1	40.13		0.26	0.28	0.30	0.35	0.42	0.44	0.45
TB01_0676.1	40.12	Footbridge (US face)	0.26	0.28	0.30	0.35	0.42	0.44	0.45
TB01_0673.1	40.05	Footbridge (DS face)	0.30	0.32	0.34	0.39	0.47	0.48	0.50
TB01_0670.1	40.05		0.28	0.31	0.33	0.38	0.45	0.47	0.48
TB01_0656.1	39.95		0.28	0.31	0.33	0.39	0.48	0.49	0.50
TB01_0615.1	39.67		0.41	0.43	0.45	0.51	0.60	0.62	0.63
TB01_0571.1	39.62		0.27	0.30	0.31	0.38	0.46	0.48	0.49
TB01_0548.1	39.37	Car park crossing (US face)	0.44	0.46	0.47	0.53	0.60	0.63	0.65
PR02L_0030.1	39.23	Car park crossing (DS face)	0.36	0.38	0.41	0.44	0.49	0.51	0.53
PR02L_0000.1	39.03		0.14	0.15	0.15	0.22	0.26	0.27	0.28
PR02L_0000.2	38.99								
TB01_0415.1	38.66	Pond 1							
TB01_0415.2	38.66	Pond 2							
TB01_0319B.2	37.35								
TB01_0319Aw.2	37.61								
TB01_0319A.1	37.21								
TB01_0319A.2	37.32								
TB01_0238.1	34.51	Pond 3							
TB01_0238.2	34.56								
TB01_0203.1	33.60								
TB01_0203.2	33.56								
TB01_0181.1	33.43								
TB01_0181.2	33.43								
TB01_0042.1	30.70								
TB01_0042.2	30.70								
MwayCulvert.1	29.46	Motorway culvert							
MwayCulvert.2	29.35								