

ENVIRONMENT

Richborough
Brascote Lane, Newbold Verdon
Leicestershire
Flood Risk Assessment

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Flood Risk Assessment

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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. It has been produced on behalf of Richborough in respect of a planning application for proposed residential development off Brascote Lane, Newbold Verdon (approximate grid reference: SK 4468 0320).

This report demonstrates that the proposed development is not at significant flood risk, subject to the recommended flood mitigation strategies being implemented.

Following review of the Environment Agency (EA) Flood Map for Planning, the site is shown to be located wholly in Flood Zone 1. At the location of the site, no Flood Zones are associated with the length of the Thurlaston Brook that flows parallel to the northern boundary of the site from east to west. This is believed to be due to the national flood mapping tool being limited to representing watercourses with a catchment above 3km². Subsequently, a bespoke detailed hydraulic modelling study has been undertaken to inform this FRA and provide a robust understanding of the fluvial flood risk posed from the nearby local watercourse network.

Following review of the illustrative masterplan, all residential units are shown to be located outside of all modelled flood extents. This includes larger simulated return periods such as the 1 in 100-year +28%CC and 1 in 1000-year events. As such, the proposed development can be considered safe for its lifetime without displacing flood water and increasing flood risk elsewhere. The proposed residential development is also shown to be raised above the modelled flood levels.

The risk of surface water flooding has also been assessed following a review of available data. The surface water flood extents show similar patterns to the modelled fluvial extents with flows largely contained to the Thurlaston Brook channel. A review of the illustrative masterplan demonstrates that all proposed residential plots are located outside of the 1 in 30-year, 1 in 100-year and 1 in 1000-year surface water flood extents.

The site is located atop of mudstone bedrock with superficial deposits present that are comprised of diamicton, sand and gravel. Third party data sources identify the site as located within a region that is considered to be susceptible to groundwater flooding. This risk is typically negated by the raising of finished floor levels relative to adjacent ground levels. It is subsequently recommended that Finished Floor Levels are set a minimum of 150mm above the surrounding ground level. Further recommendations have been made in relation to encountering groundwater during the construction phase, such as appropriate dewatering.

The FRA also demonstrates that the site is at a low level of risk from other sources: canals, reservoirs, and sewers.

In compliance with the requirements of NPPF, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area subject to suitable management of surface water runoff discharging from the site. A separate Sustainable Drainage Statement (SDS) (Ref: **BLN-BWB-ZZ-XX-RP-YE-0001_SDS**) has been provided to demonstrate this.

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1. INTRODUCTION

- 1.1 This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. The FRA has been produced on behalf of Richborough Estates Limited in respect of a planning application for a proposed residential development off Brascote Lane, Newbold Verdon.
- 1.2 This FRA is intended to support an outline planning application and as such the level of detail included is commensurate and subject to the nature of the proposals. Summary information is included as **Table 1.1**.

Table 1.1: Site Summary

Site Name	Brascote Lane
Location	Newbold Verdon
NGR (approx.)	SK 4468 0320
Application Site Area (ha)	14.2 (approx.)
Development Type	Residential
Flood Zone Classification	Flood Zone 1
NPPF Vulnerability	More Vulnerable
Environment Agency Office	East Midlands
Lead Local Flood Authority	Leicestershire County Council
Local Planning Authority	Hinckley and Bosworth Borough Council

Sources of Data

- i. Hydraulic Modelling Study of the Thurlaston Brook by BWB Consulting (Ref: **BLN-BWB-ZZ-XX-RP-YE-0004**)
- ii. Topographical Survey by BWB Consulting (Ref: **BLN-BWB-00-ZZ-M3-G-001**)
- iii. OS Explorer Series mapping
- iv. Environment Agency (EA) consultation
- v. Leicestershire County Council (LLFA) Consultation
- vi. Hinckley and Bosworth Borough Council Level 1 and Level 2 Strategic Flood Risk Assessments
- vii. Leicestershire and Leicester City Level 1 Strategic Flood Risk Assessment
- viii. Leicestershire County Council Preliminary Flood Risk Assessment

- ix. Hinckley and Bosworth Borough Council Local Plan
- x. Severn Trent Sewer Records
- xi. Sustainable Drainage Statement completed by BWB Consulting (Ref: **BLN-BWB-ZZ-XX-RP-CD-0001**)
- xii. British Geological Survey (BGS) Drift & Geology Maps

Existing Site

- 1.3 The site is located off Brascote Lane, immediately south of the residential setting of Newbold Verdon. Leicester city centre is located approximately 1.5km east of the site and the village of Newbold Verdon. Brascote Lane forms the western and southern boundaries of the site. The northern site boundary is bordered by the Thurlaston Brook which flows from east to west. The east of the site is surrounded by farmland. The site's location is illustrated within **Figure 1.1**.
- 1.4 The site is currently comprised of an agricultural field and is therefore considered to be greenfield land.
- 1.5 The primary points of existing access to the application site are via Brascote Lane to the west and south.

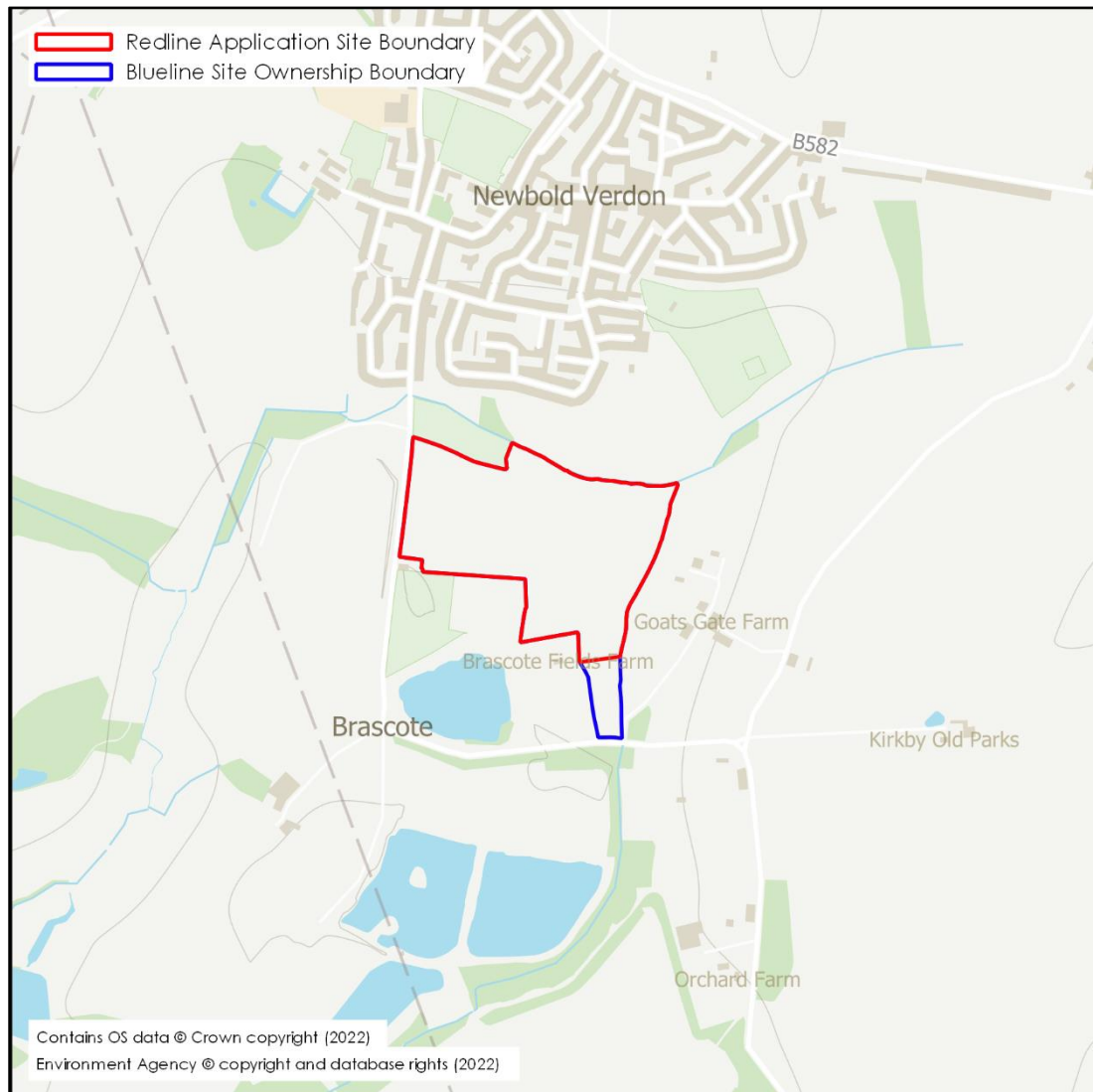


Figure 1.1: Site Location Map

- 1.6 According to the topographical survey presented within **Appendix 1**, ground levels generally fall from south to north. Levels across the southern perimeter of the site boundary range between 128m Above Ordnance Datum (AOD) and 130mAOD. The levels then fall towards the Thurlaston Brook which forms the northern perimeter of the site boundary. Levels along the northern boundary generally range between 123mAOD and 125mAOD. In the wider area, levels to the north are also seen to drain towards the Thurlaston Brook. The site contours are shown in **Figure 1.2**.

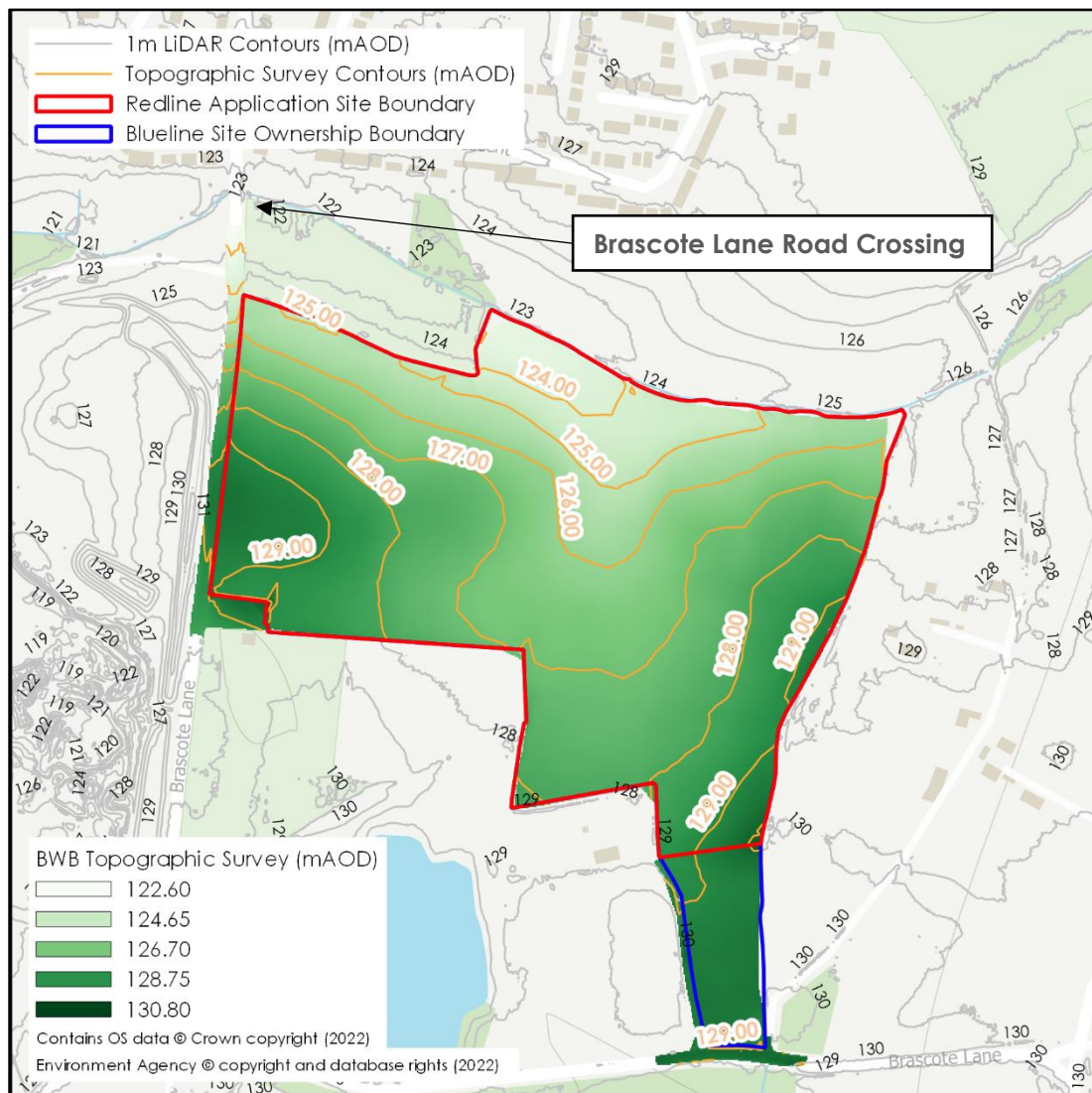


Figure 1.2: Topography Across the Site and Wider Area

Local Watercourses

- 1.7 The Thurlaston Brook is a tributary of the River Soar with a total catchment area of approximately 37.5km². The proposed development site is located at the very upstream limit of the catchment. The watercourse has a catchment area of approximately 2.1km² upstream of the Brascote Lane road crossing.
- 1.8 The watercourse flows from east to west parallel to the northern extent of the site boundary. **Figure 1.3** shows the local watercourse network.

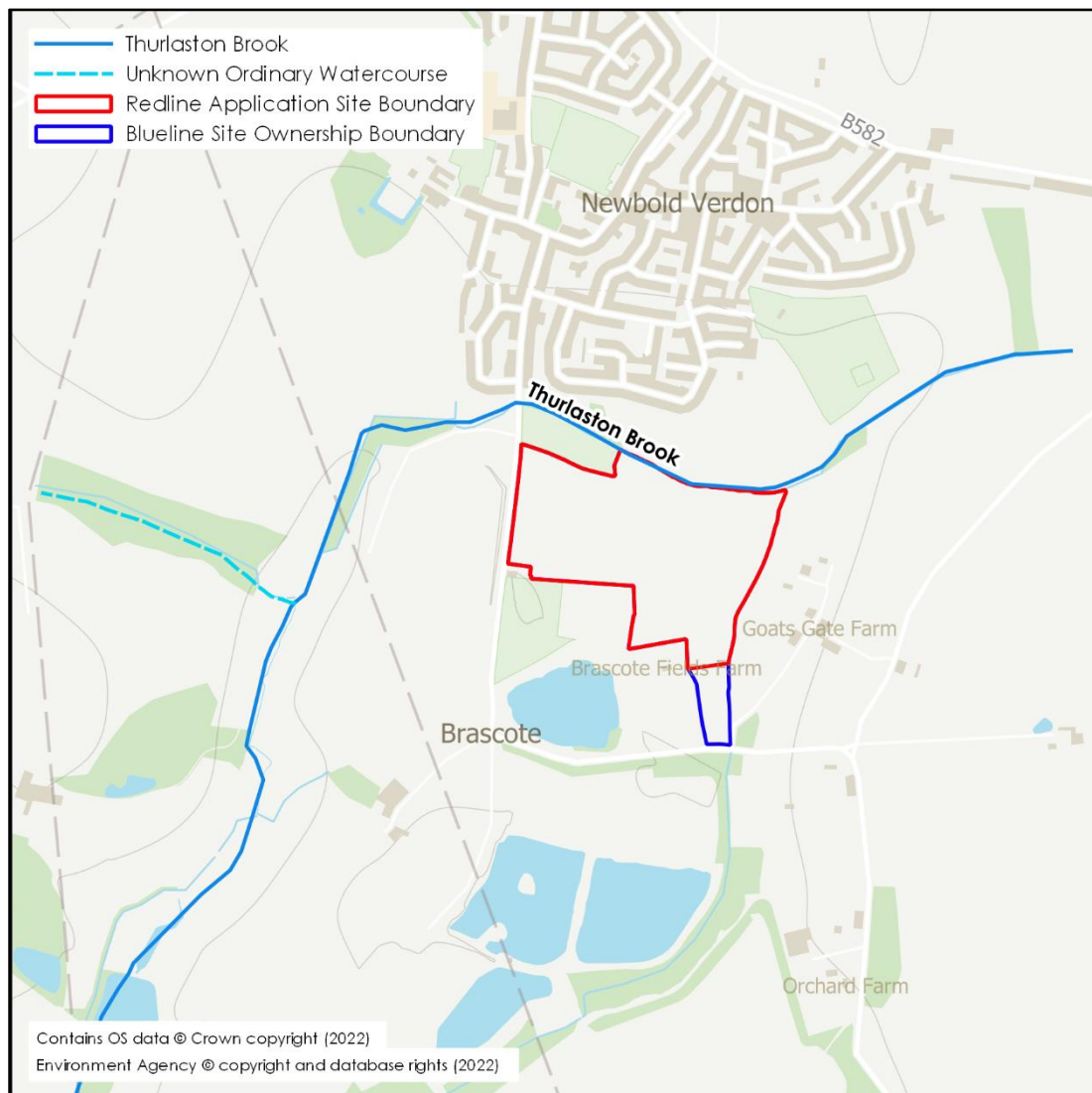


Figure 1.3: Local Watercourse Network

Proposed Development

- 1.9 The proposed development is predominantly comprised of residential development. The illustrative masterplan, which can be found in **Appendix 2**, also includes a country park.
- 1.10 Access to the site is to be taken from the western boundary via Brascote Lane.

2. FLOOD RISK PLANNING POLICY

National Planning Policy Framework

- 2.1 The NPPF¹ sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. Planning Practice Guidance is also available online².
- 2.2 The Planning Practice Guidance sets out the vulnerability to flooding of different land uses. It encourages development to be located in areas of lower flood risk where possible and stresses the importance of preventing increases in flood risk off site to the wider catchment area.
- 2.3 The Planning Practice Guidance also states that alternative sources of flooding, other than fluvial (river flooding), should be considered when preparing an FRA.
- 2.4 The Planning Practice Guidance includes a series of tables that define Flood Zones (Table 1), the flood risk vulnerability classification of development land uses (Table 2) and 'compatibility' of development within the defined Flood Zones (Table 3).
- 2.5 This FRA is written in accordance with the NPPF and the Planning Practice Guidance.

Flood Map for Planning

- 2.6 With particular reference to planning and development, the Flood Map for Planning identifies Flood Zones in accordance with Table 1 of the Planning Practice Guidance. Further details on the Flood Zone classifications are outlined in **Table 2.1**.

Table 2.1: Flood Zone Classifications

Flood Zone	Description
Flood Zone 1 (Low Probability)	Land having less than a 1 in 1000 annual probability of river or sea flooding (<0.1% Annual Exceedance Probability).
Flood Zone 2 (Medium Probability)	Land having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1% AEP); or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1% AEP).
Flood Zone 3a (High Probability)	Land having a 1 in 100 or greater annual probability of river flooding (>1% AEP); or land having a 1 in 200 or greater annual probability of flooding from the sea (>0.5% AEP). This is represented by "Flood Zone 3" on the Flood Map for Planning.
Flood Zone 3b (The Functional Floodplain)	Flood Zone 3b (The Functional Floodplain) is defined as land where water must flow or be stored in times of flood. This is not identified or separately distinguished from Zone 3a on the Flood Map for Planning.

¹ Revised National Planning Policy Framework, Ministry of Housing, Communities & Local Government, amended 2021

² Planning Practice Guidance: <https://www.gov.uk/government/collections/planning-practice-guidance>

- 2.7 The site is shown to be located wholly within Flood Zone 1, as shown in **Figure 2.1**. This is believed to be due to the national flood mapping tool being limited to representing watercourses with a catchment above 3km².
- 2.8 The Thurlaston Brook is not defined as a Main River. There are no formal spatial flood defences at the site or in the wider area and subsequently no areas are identified as benefitting from the presence of defences.

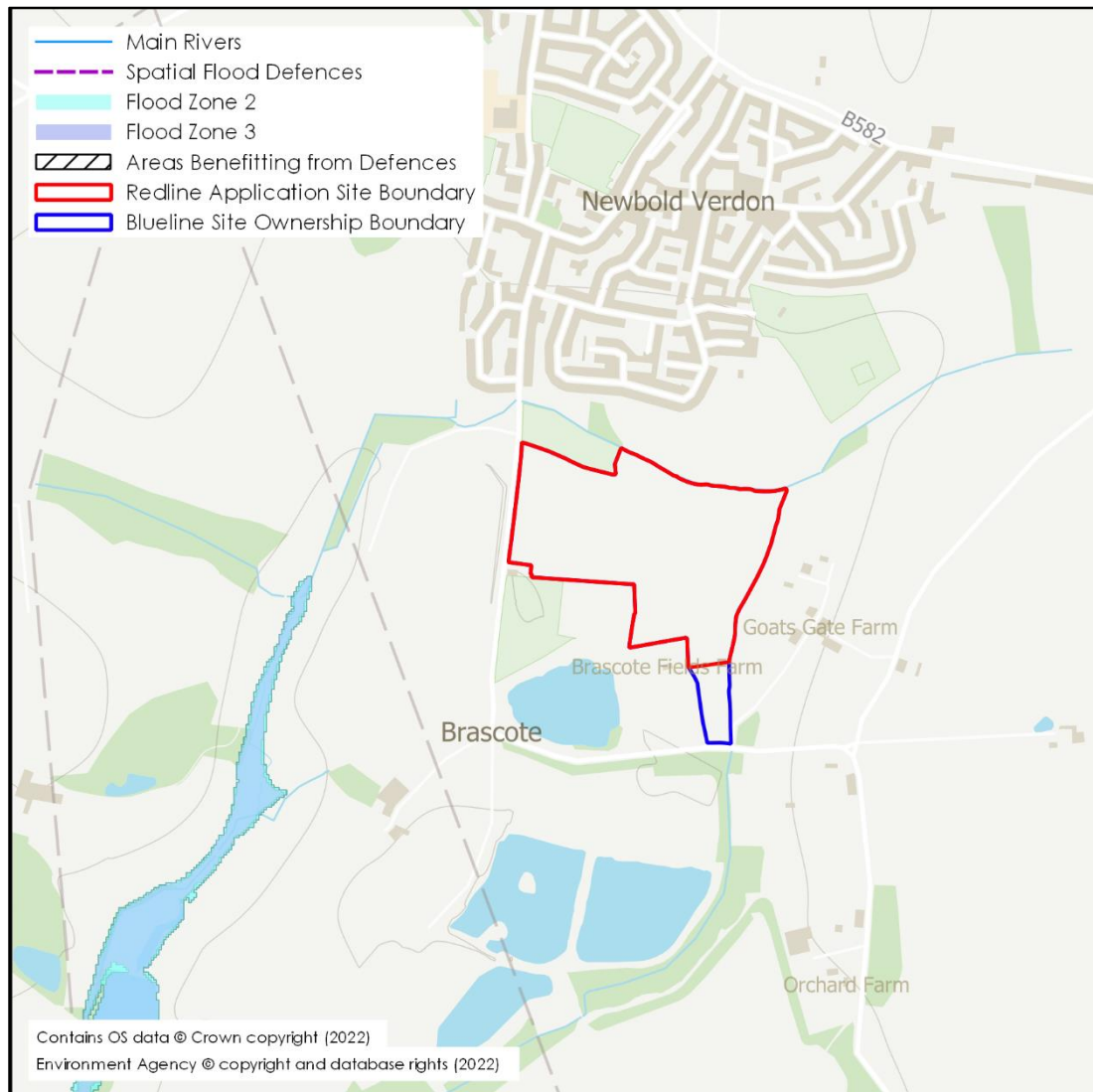


Figure 2.1: Flood Map for Planning

The Design Flood

- 2.9 The Planning Practice Guidance identifies that new developments should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime.
- 2.10 This is a flood event of a given annual flood probability, which is generally taken as fluvial (river) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year),

against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Climate Change

- 2.11 Predicted future changes in peak river flows caused by climate change are provided by the EA³, with a range of projections applied to regionalised 'River Basin Districts', which are further subdivided into 'Management Catchments'.
- 2.12 The site falls within the Soar Management Catchment of the Humber River Basin District. **Table 2.2** identifies the relevant peak river flow allowances from this Management Catchment.

Table 2.2: Peak River Flow Allowance for the Soar Management Catchment within the Humber River Basin District

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper End	28%	35%	60%
Higher Central	18%	21%	37%
Central	14%	16%	28%

- 2.13 When determining the appropriate allowance for use in a FRA the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of the development should be considered. **Table 2.3** provides a matrix summarising the EA's guidance on determining the appropriate allowance(s).

Table 2.3: Application of the Appropriate Climate Change Allowance

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
1	Use the central allowance where a location may fall within Flood Zone 2 or 3 in the future.				
2	Use the higher central allowance	Use the central allowance			
3a	Use the higher central allowance	Development should not be permitted	Use the central allowance		

³ Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1>

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
3b	Use the higher central allowance	Development should not be permitted			Use the central allowance
If development is considered appropriate by the local authority when not in accordance with Flood Zone vulnerability categories, then it would be appropriate to use the higher central allowance.					

- 2.14 The site is located entirely within Flood Zone 1; however, the Thurlaston Brook forms the northern boundary of the site. No Flood Zones have been defined for this reach of the watercourse due to their small catchment size. The proposed development is for a residential-led scheme and would therefore likely be classified as 'More Vulnerable'. Residential development has an anticipated lifespan of at least 100 years. Therefore, the central allowance for the '2080s' epoch will be considered.
- 2.15 Therefore, to ensure the development is designed adequately for its lifetime an allowance of 28% will be applied to the design flood to identify minimum development levels.
- 2.16 The higher central and upper end allowances have also been simulated as an informative.

Strategic Flood Risk Assessment

- 2.17 An SFRA is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future.
- 2.18 The Leicestershire and Leicester City Level 1 SFRA⁴ has been reviewed in the production of this FRA. Furthermore, the Hinckley and Bosworth Borough Council Level 1 SFRA⁵ has also been assessed. The SFRAs provide information specific to the site location in the form of fluvial, surface water and groundwater flood risk mapping, as well as records of historical flooding. Information from these sources will be referenced within **Section 3** where applicable.
- 2.19 The Hinckley and Bosworth Borough Council Level 2 SFRA⁶ was produced to facilitate the application of Sequential and Exception Tests to screen allocated development sites. The proposed application site is not referenced within the Level 2 SFRA. Information from the Level 2 SFRA will be referenced within **Section 3** where applicable.

Preliminary Flood Risk Assessment

- 2.20 A Preliminary Flood Risk Assessment (PFRA) is an assessment of floods that have taken place in the past and floods that could take place in the future. It generally considers

⁴ Level 1 Strategic Flood Risk Assessment (JBA Consulting, October 2017)

⁵ Level 1 Strategic Flood Risk Assessment (JBA Consulting, July 2019)

⁶ Level 1 2 Strategic Flood Risk Assessment (JBA Consulting, May 2020)

flooding from surface water runoff, groundwater and ordinary watercourses, and is prepared by the Lead Local Flood Authorities.

- 2.21 The Leicestershire County Council PFRA⁷ considers flooding from surface water runoff, groundwater, ordinary watercourses and canals. It also references historical river flooding within the wider county. No records are reported at the site or in Newbold Verdon. Information from the PFRA will be referenced within this report where applicable.

Local Flood Risk Management Strategy

- 2.22 A Local Flood Risk Management Strategy (LFRMS) is prepared by a Lead Local Flood Authority to help understand and manage flood risk at a local level.
- 2.23 The LFRMS aims to ensure that the knowledge of local flood risk issues is communicated effectively so that they can be better managed. The LFRMS also aims to promote sustainable development and environmental protection.
- 2.24 The Leicestershire County Council LFRMS⁸ has been reviewed and will be referenced within this report where applicable.

Local Plan

- 2.25 The Hinckley and Bosworth Local Plan 2006 to 2026 is made up of a series of documents. *Policy DM7 – Preventing Pollution and Flooding* outlined within the Site Allocations and Development Management Policies⁹ notes that development proposals should demonstrate that development doesn't create or exacerbate flooding by being located away from areas of flood risk unless adequately mitigated against in line with National Policy.
- 2.26 It should be noted that a new Local Plan is being undertaken which will set out land allocations and planning policies for the period 2020 to 2041. The Draft Local Plan¹⁰ sets out *Policy CC02 Flood Risk* which notes all planning applications for development proposals that require a Flood Risk Assessment will be required to address the actual and residual risk from all forms of flooding and the impact of climate change.

⁷ Preliminary Flood Risk Assessment (Leicestershire County Council, June 2011)

⁸ Leicestershire County Council Local Flood Risk Management Strategy (2015)

⁹ Site Allocations and Development Management Policies DPD. Local Plan 2006 – 2026 (Hinckley and Bosworth Borough Council, Adopted July 2016)

¹⁰ Consultation Draft Plan Regulation 18 (Hinckley and Bosworth Borough Council, June 2021)

Other Relevant Policy and Guidance

Flood Risk to People and New Developments

- 2.27 The Flood Risk to People (FD2321/TR1)¹¹ document was prepared as a research project considering flood hazard and factors that affect it.
- 2.28 Flood Risk Assessment Guidance for New Development (FD2320/TR2)¹² provides a framework and guidance for assessing and managing flood risks for new developments and sets flood hazard thresholds.
- 2.29 Hazard ratings are derived using the following equation in line with the above:

$$\text{Hazard Rating} = D * (V+0.5) + DF$$

Where:

D = depth

V = velocity

DF = debris factor

- 2.30 A supplementary note¹³ provides clarification of the hazard rating thresholds which should be used for development planning and control use. **Table 2.4** identifies the thresholds of the flood hazard categories.

Table 2.4: Hazard to People¹⁴

Threshold for Flood Hazard Rating	Degree of Flood Hazard	Description
< 0.75	Low	Caution "Flood zone with shallow flowing water or deep standing water"
0.75 - 1.25	Moderate	Danger for some (i.e.: children, the elderly and the infirm) "Danger: Flood Zone with deep or fast flowing water"
1.25 - 2.0	Significant	Danger for most (includes the general public) "Danger: Flood Zone with deep fast flowing water"
> 2.0	Extreme	Danger for all (includes the emergency services) "Extreme Danger: Flood Zone with deep fast flowing water"

¹¹ Flood Risk to People Methodology (FD2321/TR1), Defra/Environment Agency, 2006

¹² Flood Risk Assessment Guidance for New Development (FD2320/TR2), Defra/Environment Agency, 2005

¹³ Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1. (http://randd.defra.gov.uk/Document.aspx?Document=FD2321_7400_PR.pdf)

¹⁴ 2008, DEFRA, Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purposes.

3. POTENTIAL SOURCES OF FLOOD RISK

- 3.1 Flooding can occur from a variety of sources, or combination of sources, which may be natural or artificial. **Table 3.1** below identifies the potential sources of flood risk to the site in its current condition, and the impacts which the development could have in the wider catchment, prior to mitigation. These are discussed in greater detail in the forthcoming section. The mitigation measures proposed to address flood risk issues and ensure the development is appropriate for its location are discussed within **Section 4**.

Table 3.1: Pre-Mitigation Sources of Flood Risk

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Fluvial			X		The site is located in Flood Zone 1.
			X		Hydraulic modelling, undertaken by BWB, has confirmed that all proposed residential units are located outside of all modelled flood extents.
Canals				X	The Ashby-de-la-Zouch canal is located approximately 5.3km west of the site. Levels at the canal are set approximately 30m below the site.
Groundwater		X			SFRA mapping reports the site as being located across several grid tiles, whereby 50-75% of the area is considered to be susceptible to groundwater flooding.
Reservoirs and waterbodies			X		The site is shown to fall outside of the area at risk of reservoir failure. There are nearby waterbodies, such as Brascote Carp Fishery that could pose a residual risk to the site if breached.
Pluvial runoff			X		The surrounding area generally falls to the Thurlaston Brook. The site remains unaffected for the 1 in 30-year and 1 in 100-year rainfall events. A small proportion of the site is affected during the 1 in 1000-year event, however the illustrative masterplan shows there to be no properties located in these areas.

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Sewers			X		Severn Trent records do not display any sewer networks along the immediate southern or western boundary of the site. Ground levels at the site drain towards the Thurlaston Brook and therefore any surcharged water would be directed away from the proposed development.
Effect of Development on Wider Catchment			X		The proposed development will not result in impedance or loss of the Thurlaston Brook channel capacity. Furthermore, there will be no loss of floodplain storage. The proposed development would not be expected to displace flood water.
	X				The development will increase the area of impermeable surfaces at the site. Without the consideration of Sustainable Drainage Systems, this could lead to a potential increase in surface water runoff rates.

Fluvial Flood Risk

- 3.2 Flooding from watercourses occurs when flows exceed the capacity of the channel, or where a restrictive structure is encountered, which leads to water overtopping the banks into the floodplain. This process can be exacerbated when debris is mobilised by high flows and accumulates at structures.
- 3.3 The Thurlaston Brook is an ordinary watercourse and flows from east to west parallel to the northern site boundary. Approximately 17km downstream of the site, the Thurlaston Brook outfalls to the River Soar, which is classified as an EA main river.
- 3.4 At the site's location, the Thurlaston Brook has not been represented on the EA Flood Map for Planning, due to its small catchment. The national flood mapping tool is limited to representing watercourses with a catchment above 3km². The Thurlaston Brook catchment east of Brascote Lane road crossing is 2.1km².

Site Specific Hydraulic Modelling

- 3.5 To provide a detailed understanding of fluvial flooding at the site, BWB Consulting completed a hydraulic modelling study and associated hydrological assessment in August – September 2021. Further details with regards to the schematisation and the

data used within the hydraulic model is provided in **Appendix 3**, along with detailed floodplain maps.

- 3.6 The hydraulic model was simulated for several key return periods to inform the production of an FRA. Assessed return periods included the 1 in 20-year (5% AEP), 1 in 100-year (1% AEP) and 1 in 1000-year (0.1% AEP) events.
- 3.7 In accordance with the July 2021 climate change guidance, BWB Consulting also produced model outputs for the 1 in 100-year +28%CC ('central' allowance), 1 in 100-year +37%CC ('higher central' allowance) and the 1 in 100-year +60%CC ('upper end' allowance). The modelled flood outlines are presented in **Figure 3.1**.

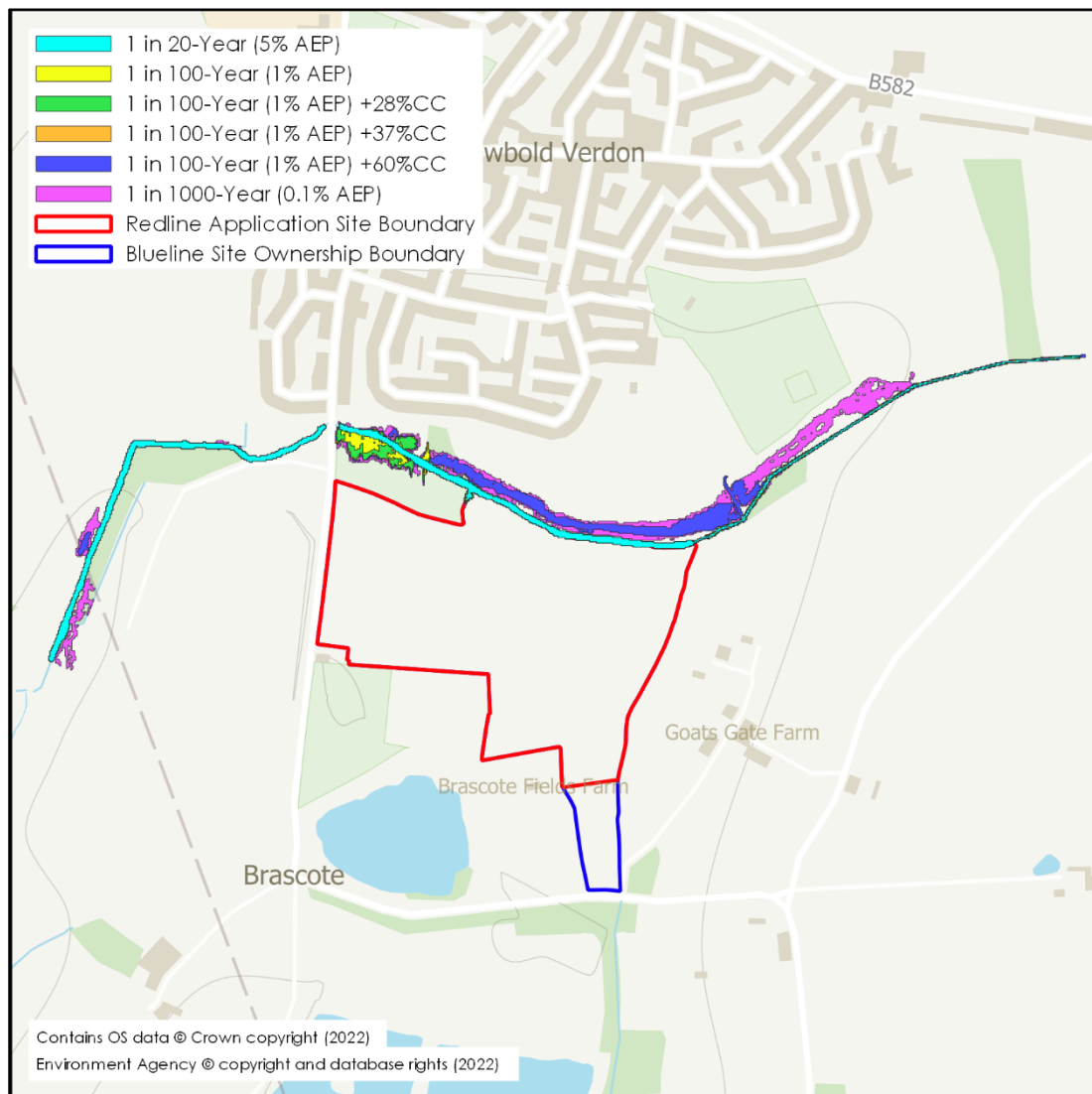


Figure 3.1: Modelled Fluvial Flood Extents

- 3.8 The illustrative masterplan has been overlaid onto the site boundary, as shown in **Figure 3.2**. The proposed plots are shown to remain wholly unaffected during all modelled events.

- 3.9 Several 2D nodes have been added to the map along the Thurlaston Brook and its modelled flood extent. Maximum flood levels for the modelled return periods are reported at these locations in **Table 3.2**.

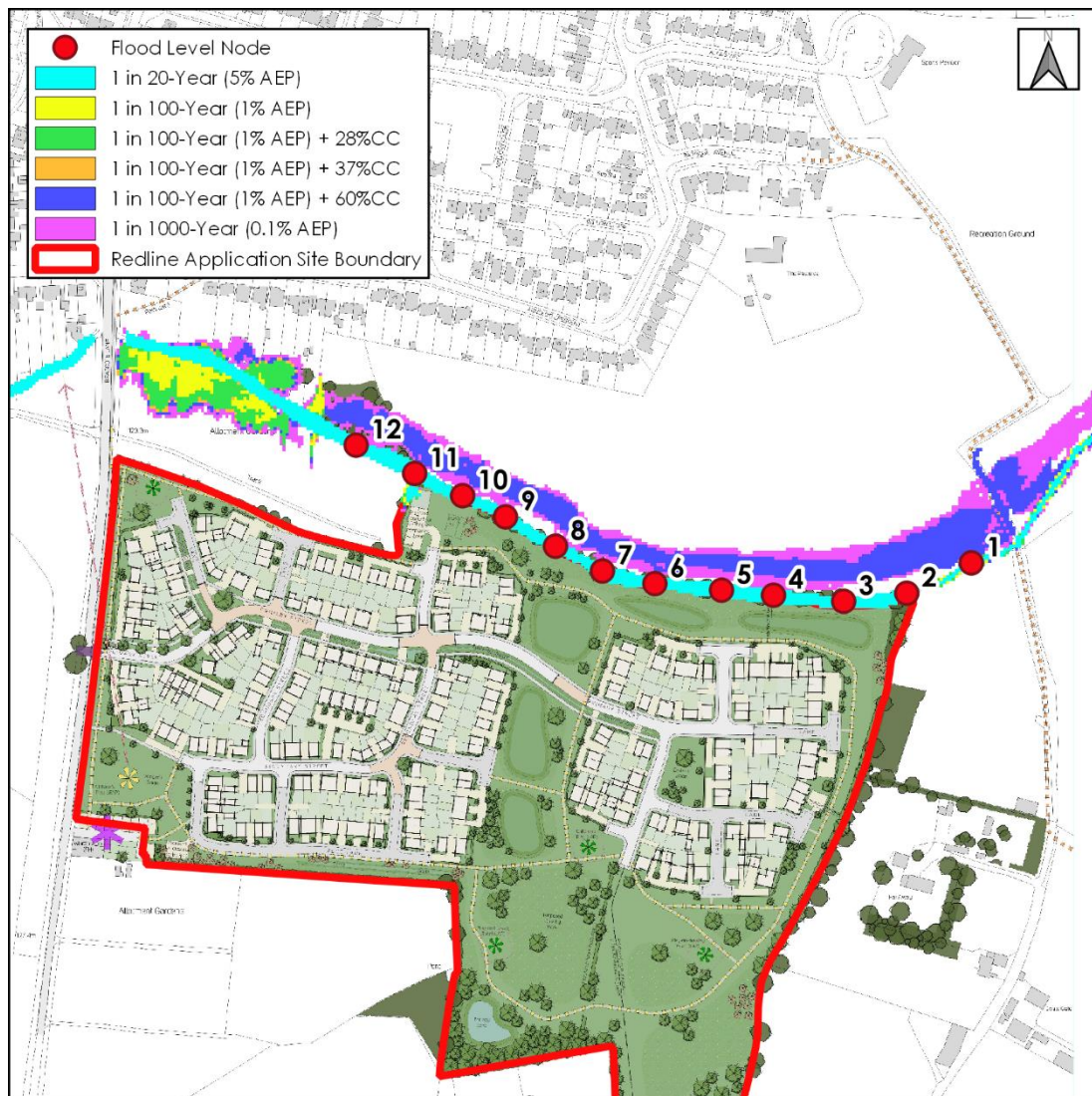


Figure 3.2: Proposed Development Relative to Modelled Flood Extents

Table 3.2: Maximum Modelled Flood Levels

Node	Maximum Modelled Flood Level (mAOD)					
	5% AEP	1% AEP	1% AEP +28%CC	1% AEP +37%CC	1% AEP +60%CC	0.1% AEP
1	125.95	126.08	126.13	126.13	126.16	126.16
2	125.12	125.20	125.29	125.31	125.43	125.43
3	124.82	124.92	124.99	125.01	125.04	125.04
4	124.55	124.66	124.72	124.74	124.77	124.77

5	124.32	124.43	124.49	124.50	124.53	124.53
6	123.97	124.07	124.12	124.16	124.18	124.18
7	123.70	123.80	123.86	123.88	123.90	123.91
8	123.46	123.55	123.60	123.62	123.64	123.64
9	123.14	123.33	123.28	123.30	123.32	123.32
10	122.86	122.95	123.02	123.03	123.05	123.06
11	122.66	122.76	122.81	122.82	122.84	122.85
12	122.44	122.56	122.60	122.60	122.60	122.63

3.10 Subsequently, the site has been split into four areas for analysis (**Figure 3.3**).

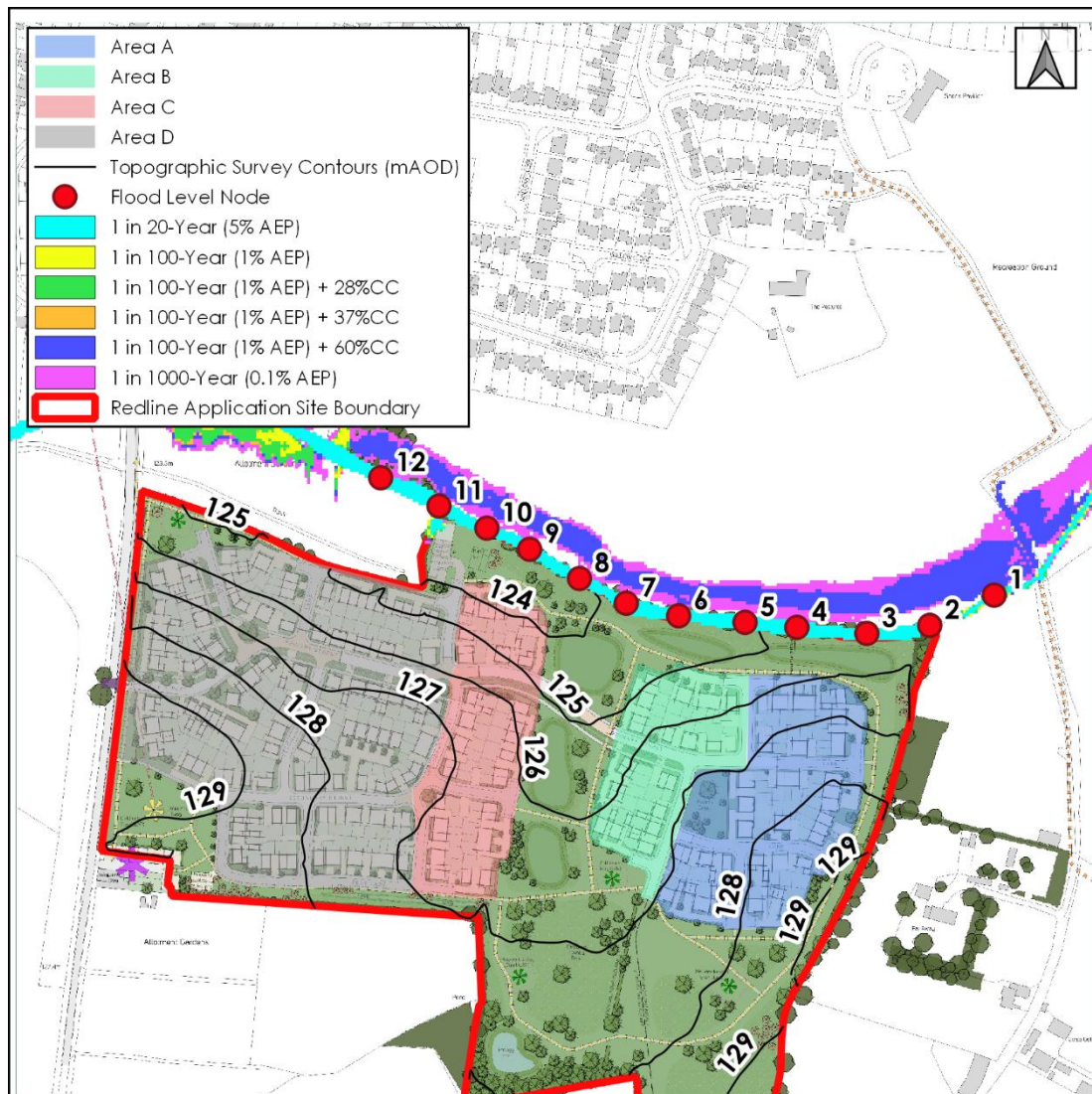


Figure 3.3: Proposed Development Divided into Assessment Areas

Area A

- 3.11 Flood level node 3 is the closest upstream node to properties within Area A. It is therefore considered to be the most representative node of fluvial flood risk.
- 3.12 The 1 in 100-year +28%CC flood level is 124.99mAOD at this location.
- 3.13 As per **Figure 3.3**, all plots are shown to be located above the surveyed level of 126.00mAOD. As such, a minimum freeboard of 1.01m will be provided during this event.

Area B

- 3.14 Flood level node 5 is the closest upstream node to properties within Area B.
- 3.15 The 1 in 100-year +28%CC flood level is 124.49mAOD at this location.
- 3.16 As per **Figure 3.3**, all plots are shown to be located above the surveyed level of 125.00mAOD. As such, a minimum freeboard of 0.51m will be provided during this event.

Area C

- 3.17 Flood level node 8 is the closest upstream node to properties within Area C.
- 3.18 The 1 in 100-year +28%CC flood level is 123.60mAOD at this location.
- 3.19 As per **Figure 3.3**, all plots are shown to be located above the surveyed level of 124.00mAOD. As such, a minimum freeboard of 0.40m will be provided during this event.

Area D

- 3.20 Flood level node 10 is the closest upstream node to properties within Area D.
- 3.21 The 1 in 100-year +28%CC flood level is 123.02mAOD at this location.
- 3.22 As per **Figure 3.3**, all plots are shown to be located above the surveyed level of 124.00mAOD. As such, a minimum freeboard of 0.98m will be provided during this event.

Summary of Whole Site

- 3.23 All properties across Areas A, B, C and D are shown to remain unaffected during all modelled events, including the 1 in 100-year +37%CC (higher central) and +60%CC (upper end) events. As such, the proposed development could be considered safe for its lifetime.
- 3.24 The proposed access route onto Brascote Lane remains wholly unaffected during all events.
- 3.25 As part of the hydraulic modelling exercise, blockage scenarios were simulated for three hydraulic structures (including the culvert beneath Brascote Lane). To test a worst-case

scenario, the structures were represented as 100% blocked. The site continued to remain unaffected during these scenarios. The results for which can be found in **Appendix 3**.

- 3.26 Neither the EA or Hinckley and Bosworth Borough Council have provided any evidence to suggest that the site has historically flooded from fluvial sources. The nearest recorded EA fluvial flood extent is located approximately 6km northeast and is associated with the Rothley Brook at Ratby.
- 3.27 Based off the illustrative masterplan provided, the proposed development is considered to be at low risk of fluvial flooding. Suitable freeboard above the assessed modelled flood levels is provided due to existing topography. Therefore, no additional measures would be required to mitigate against the risk of fluvial flooding.

Flood Risk from Canals

- 3.28 The Canal and River Trust (CRT) generally maintains canal levels using reservoirs, feeders and boreholes and manages water levels by transferring it within the canal system.
- 3.29 Water in a canal is typically maintained at predetermined levels by control weirs. When rainfall or other water enters the canal, the water level rises and flows out over the weir. If the level continues rising it will reach the level of the storm weirs. The control weirs and storm weirs are normally designed to take the water that legally enters the canal under normal conditions. However, it is possible for unexpected water to enter the canal or for the weirs to become obstructed. In such instances the increased water levels could result in water overtopping the towpath and flowing onto the surrounding land.
- 3.30 Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails.
- 3.31 The nearest canal is the Ashby-de-la-Zouch canal which is approximately 5.3km west of the site. Levels at the canal at this located are set approximately 30m lower than the site at 95mAOD. Therefore, the risk of flooding from canals is considered negligible.

Groundwater Flood Risk

- 3.32 Groundwater flooding occurs when the water table rises above ground elevations. It is most likely to happen in low lying areas underlain by permeable geology. This may be regional scale chalk or sandstone aquifers, or localised deposits of sands and gravels underlain by less permeable strata such as that in a river valley.
- 3.33 Following review of the BGS mapping, the bedrock geology across the entire site is made up of the Gunthorpe Member, which is comprised of Mudstone. With reference to the Defra Magic Maps, this is defined as a 'Secondary B' aquifer. These are typically lower permeability layers which may store and yield limited amounts of groundwater through localised features such as fissures and thin cracks.
- 3.34 The BGS mapping also identifies a mix of Superficial Deposits across the site. These include Glaciofluvial deposits (Sand and Gravel), Oadby Member deposits (Diamicton) and Alluvium deposits (Clay, Silt, Sand and Gravel) in immediate proximity to the

Thurlaston Brook. These are largely considered to be 'Secondary A' aquifers at the site which are comprised of permeable layers that are capable of supporting local water supplies and may form an important source of base flows to some rivers.

- 3.35 No historic borehole records are available at the site. Soils data suggests that there are loamy soils with naturally high groundwater at the site. Soils that are considered to be 'naturally wet' are typically associated with either low-lying areas or areas with high groundwater that has drained from the surrounding landscape.
- 3.36 The Hinckley and Bosworth Borough Council SFRA includes mapping of the BGS's Areas Susceptible to Groundwater Flooding (ASStGWf) dataset. The site is shown to be located across several grid tiles, whereby 50-75% of the area is considered as being susceptible to groundwater flooding.
- 3.37 The site is shown to be located outside of all EA designated Groundwater Source Protection Zones.
- 3.38 Neither the EA nor Hinckley and Bosworth Borough Council have provided any evidence to suggest that the site has historically been affected by groundwater flooding.
- 3.39 Overall, the risk of flooding posed by groundwater is moderate and mitigation measures are discussed in **Section 4**.

Flood Risk from Reservoirs & Large Waterbodies

- 3.40 Flooding can occur from large waterbodies or reservoirs if they are impounded above the surrounding ground levels or are used to retain water in times of flood. Although unlikely, reservoirs and large waterbodies could overtop or breach leading to rapid inundation of the downstream floodplain.
- 3.41 To help identify this risk, reservoir failure flood risk mapping has been prepared by the EA. This shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. The map displays a worst-case scenario and is only intended as a guide. An extract of the mapping is provided within **Figure 3.4**. Two scenarios are presented: a 'dry day' scenario occurs when rivers are at normal level, and a 'wet day' scenario occurs when rivers are in flood.
- 3.42 The site is located outside of all reservoir flood extents (for both scenarios). The nearest extent to the site is approximately 2.5km northeast of the site.
- 3.43 There are several large waterbodies to the southwest of the site, which can be seen in **Figure 3.4**. Two of which are located approximately 300-500m south of the site boundary. The road, Brascote Lane, spans from west to east between the site and these waterbodies. The road acts as a high point, set at approximately 130mAOD, with ground levels falling away towards these waterbodies. Ground levels at these lakes are set approximately 2m below the road levels at approximately 128mAOD. Ground levels continue to fall south of the waterbodies and subsequently, should a failure event occur, the study site would not be at risk of flooding from this specific source.

- 3.44 Closer to the site lies a lake associated with Brascote Carp Fishery. This is immediately southeast of the site boundary, located north of Brascote Lane road. The waterbody is bound by a steep embankment that reaches heights of 130mAOD. Levels fall from the top of the embankment towards the site, however, and subsequently there would be a residual risk of flooding to the site in the unlikely event that this embankment fails or overtops. Due to the maintenance responsibilities associated with the ownership of waterbodies, the probability of such an event occurring is considered low. Therefore, the overall risk from this waterbody is considered low.

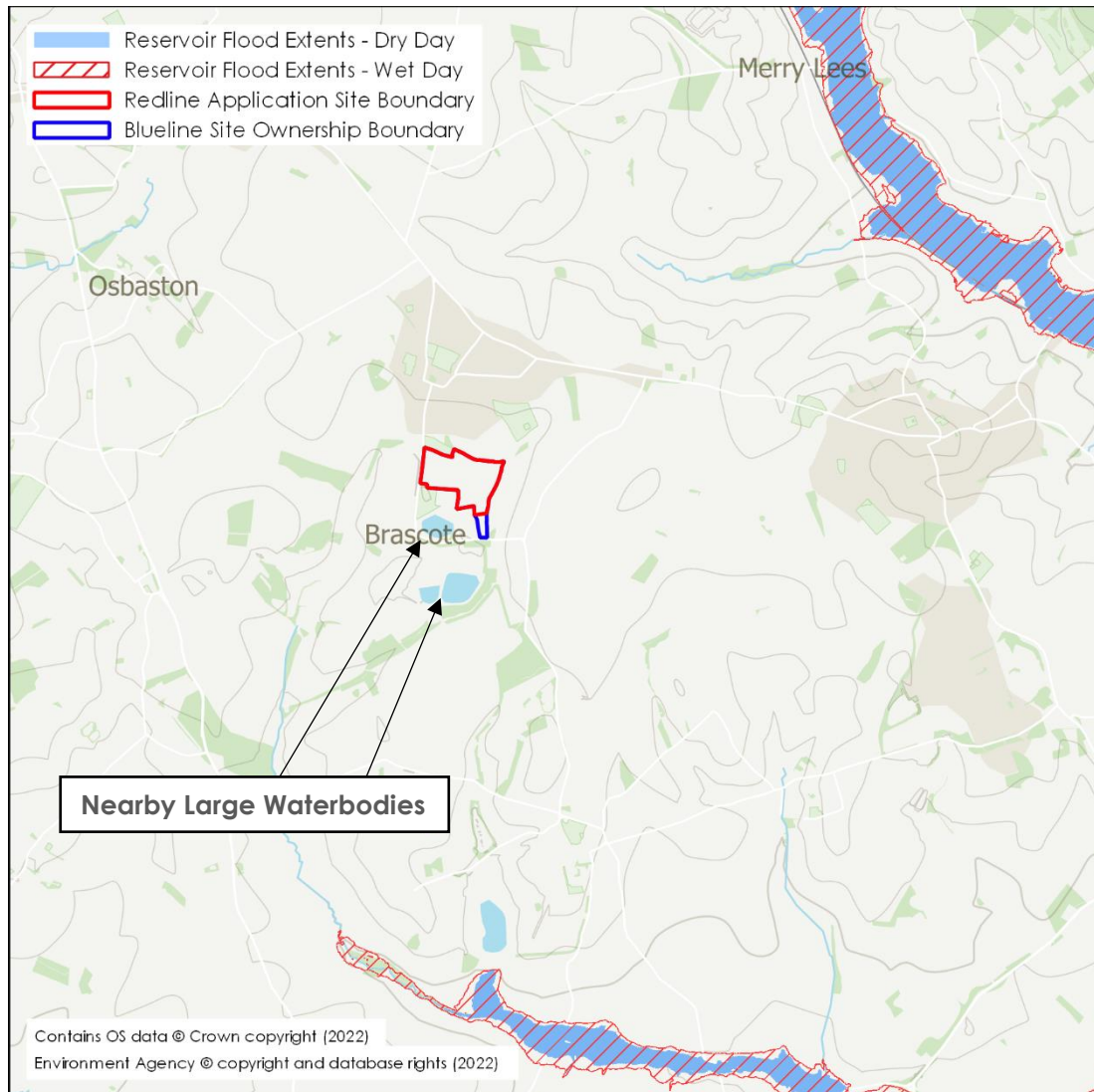


Figure 3.4: Reservoir Failure Flood Risk Map

Pluvial Flood Risk

- 3.45 Pluvial flooding can occur during prolonged or intense storm events when the infiltration potential of soils, or the capacity of drainage infrastructure is overwhelmed leading to the accumulation of surface water and the generation of overland flow routes.
- 3.46 Risk of flooding from surface water mapping has been prepared. This shows the potential flooding that could occur when rainwater does not drain away through the

normal drainage systems or soak into the ground, but lies on or flows over the ground instead. An extract from the mapping is included as **Figure 3.5**.

- 3.47 The pluvial flood mapping shows the 1 in 30-year and 1 in 100-year extents to be contained to the Thurlaston Brook channel.

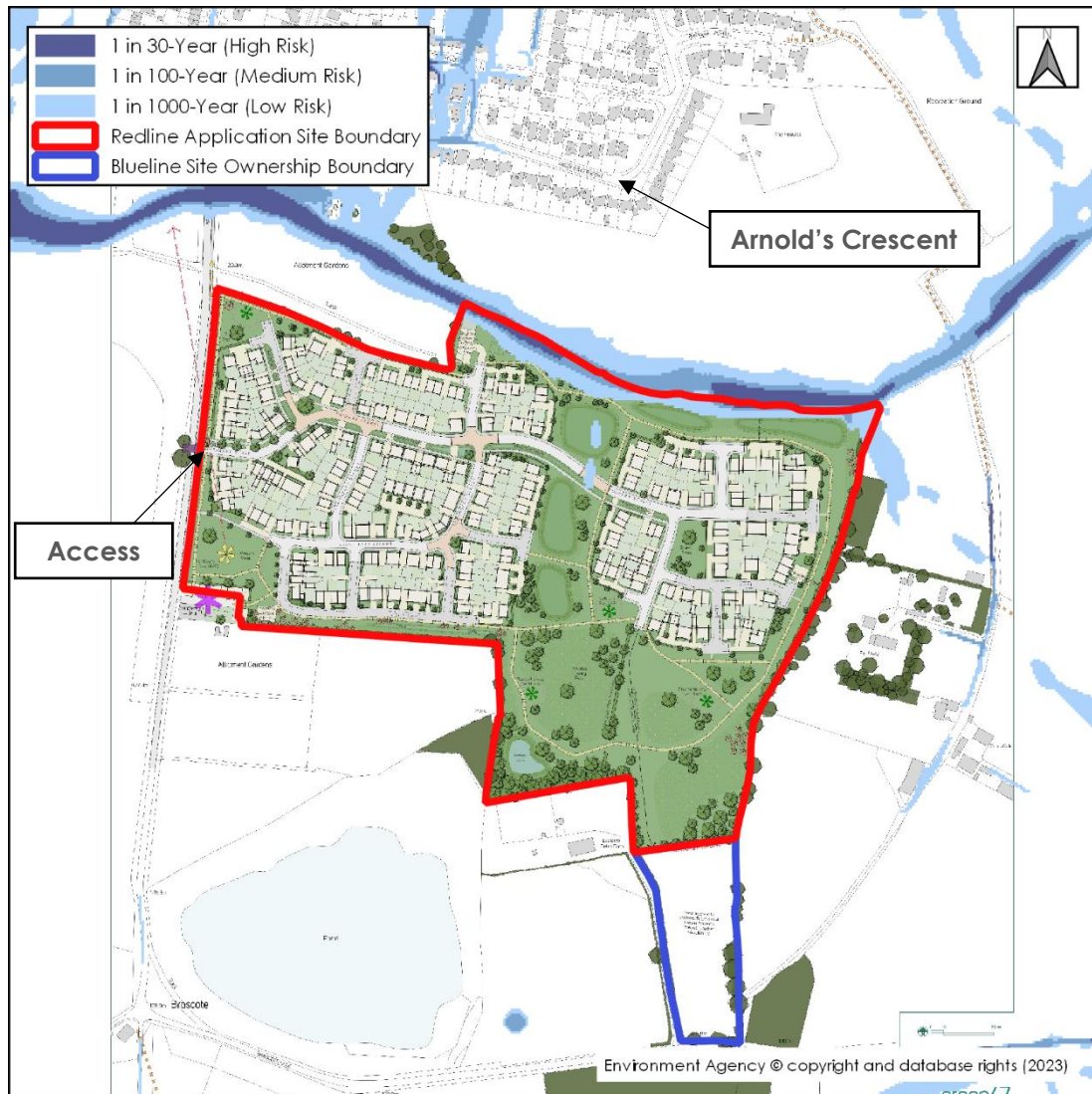


Figure 3.5: Surface Water Flood Map

- 3.48 The site boundary is shown to be partly affected during the 1 in 1000-year rainfall event with depths of less than 300mm predicted along the northern limit of the site boundary.
- 3.49 There are also two small areas of localised ponding in the northern centre and in the north east corner of the site boundary. Depths in these areas are predicted to remain below 300mm. As per the illustrative masterplan, no development is proposed in these locations. All residential plots are shown to remain unaffected for all surface water events.

- 3.50 The access location is labelled on **Figure 3.5**. Brascote Lane is shown to be unaffected during all rainfall events and safe vehicular access and egress can subsequently be maintained during all pluvial events.
- 3.51 Neither the EA nor Hinckley and Bosworth Borough Council have provided any evidence to suggest that the site specifically has historically been affected by surface water flooding.
- 3.52 Following consultation with the LLFA, Leicestershire County Council, it has been reported that there are two records of flooding incidents within close proximity to the site. Specifically, these are referred to as:
- March 2016: Arnolds Crescent (labelled on **Figure 3.5**) Here, driveways were flooded from the highway. The source was not identified, but as this location is removed from the watercourse it is most likely associated with surface water flooding, as illustrated by the flood patterns north of the Thurlaston Brook.
 - September 2019: The corner of Brascote Lane and Luburnum Avenue. This incident was limited to the highway and was believed to be caused by localised surface water ponding due to the highway topography.
- 3.53 The risk of pluvial flooding to the proposed development is subsequently considered to be low.

Flood Risk from Sewers

- 3.54 Sewer flooding can occur when the capacity of the infrastructure is exceeded by excessive flows, or as a result of a reduction in capacity due to collapse or blockage, or if the downstream system becomes surcharged. This can lead to the sewers flooding onto the surrounding ground via manholes and gullies, which can generate overland flows.
- 3.55 Severn Trent records, included as **Appendix 4**, do not illustrate the presence of any public sewer networks within the site or along Brascote Lane to the west or south of the site. Subsequently, there is a low risk of a surcharged sewer exceedance event being directed onto the site.
- 3.56 Should such an event occur, the topography of the site naturally drains towards the Thurlaston Brook and subsequently flows would be directed away from the proposed development and towards the Thurlaston Brook.

Effect of Development on Wider Catchment

Displacement of Floodplain

- 3.57 The proposed development is shown to be located outside of all modelled fluvial flood extents. As such there would be no displacement of fluvial flood water as a result of the proposed development.

- 3.58 All proposed plots are also shown to be located outside of existing surface water extents at the site.

Impedance of Flood Flows

- 3.59 Given that the proposed development is located outside of all modelled fluvial and pluvial flood extents, no overland flow routes will be impeded or re-directed as a result of the development.

Development Land Use/Drainage Considerations

- 3.60 The proposed development is to result in an increase in impermeable surfaces at the site. This increase in hardstanding area will subsequently result in greater surface water runoff rates leaving the site and entering the nearby watercourses.
- 3.61 A separate Sustainable Drainage Statement (SDS) (Ref: **BLN-BWB-ZZ-XX-RP-CD-0001_SDS**) has been provided to demonstrate how surface water runoff rates can be attenuated on site and discharged at an appropriate rate, in accordance with the relevant local policy.

4. FLOOD RISK MITIGATION

- 4.1 **Section 3** has identified the sources of flooding which could potentially pose a risk to the site and the proposed development. This section of the FRA sets out the mitigation measures which are to be incorporated within the proposed development to address and reduce the risk of flooding to within acceptable levels.

Sequential Arrangement

- 4.2 The illustrative masterplan shows all residential plots are sequentially located outside of all modelled areas at risk of fluvial flooding.

Development Levels

- 4.3 Finished floor levels of “More Vulnerable” development should be set at a minimum of 600mm above maximum flood levels during the design event. In this case, this is taken as the 1 in 100-year +28% allowance for climate change (central allowance).
- 4.4 An assessment was conducted in **Section 3** whereby topographic levels at the development site were compared against the most representative 1 in 100-year +28%CC modelled flood levels and extents for that location. All residential plots are shown to located above the 1 in 100-year +28%CC flood level and outside of the 1 in 100-year +28%CC flood extents.
- 4.5 Plots in Area A and Area D will already be set a minimum of 1.01m and 0.98m above the 1 in 100-year +28CC flood level at the closest and most representative 1D in-channel node. Proposed plots within Areas B and C will be 0.51m and 0.40m above the 1 in 100-year +28CC flood level for their respective in-channel representative nodes.
- 4.6 To ensure that plots in Areas B and C can be deemed safe for their lifetime, it is recommended that finished floor levels are set no lower than 125.09mAOD (Area B) and 124.20mAOD (Area C), respectively.
- 4.7 As part of the hydraulic modelling exercise, blockage testing was simulated of three hydraulic structures. To test a worst-case scenario, the structures were represented as 100% blocked. The site continued to remain unaffected during these extents.
- 4.8 Third party data sources identify the site as located within a region that is considered to be susceptible to groundwater flooding. This risk is typically negated by the raising of finished floor levels relative to adjacent ground levels. It is subsequently recommended that Finished Floor Levels are set a minimum of 150mm above the surrounding ground level. This would also mitigate against the potential risk of a sewer exceedance event.

Groundwater and Construction

- 4.9 Groundwater has been highlighted as a risk to the site, particularly during the construction phase.

- 4.10 If groundwater is struck during excavations, any necessary dewatering should be carried out to ensure stable soil conditions on site. A groundwater specialist should be consulted.

Safe Access and Egress

- 4.11 Proposed access is located outside of all modelled fluvial flood extents, including an allowance for climate change, and is shown to remain wholly unaffected during all surface water events.
- 4.12 Subsequently, safe access and egress will be achievable for the lifetime of the proposed development.

Flood Contingency Plan and Evacuation Procedures

Flood Warning and Evacuation

- 4.13 Due to the low risk of flooding to the site, the site is not located within an EA Flood Alert or Flood Warning service area.

Safe Refuge

- 4.14 In the unlikely event that a flood event was to affect the site, residents could seek safe refuge at upper floor levels of the proposed properties.
- 4.15 Alternatively, safe refuge could be sought by travelling to the proposed community hall, which is located at higher ground in the southwest corner of the site.

Surface Water Drainage

- 4.16 To mitigate the development's impact on the current runoff regime, it is proposed to incorporate surface water attenuation as part of the development proposals.
- 4.17 Further information on the drainage approach is provided within the accompanying Sustainable Drainage Statement (Ref: **BLN-BWB-ZZ-XX-RP-YE-0001_SDS**).
- 4.18 In brief, the development will continue to infiltrate into the ground or discharge surface water to the Thurlaston Brook at the greenfield QBAR rate. Attenuated surface water storage will be provided in the form of SuDS detention basins with capacity for the 1 in 100-year storm with an allowance for climate change.

Foul Water Drainage

- 4.19 It is proposed to drain foul water from the development separately to surface water.
- 4.20 Further information can be found within the accompanying Sustainable Drainage Statement, (Ref: **BLN-BWB-ZZ-XX-RP-YE-0001_SDS**).

5. CONCLUSIONS AND RECOMMENDATIONS

- 5.1 This FRA has been prepared in accordance with requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance. The FRA has been produced on behalf of Richborough in respect of a planning application for a proposed residential development off Brascote Lane, Newbold Verdon.
- 5.2 This FRA is intended to support an outline planning application and as such the level of detail included is commensurate and subject to the nature of the proposals.
- 5.3 This report demonstrates that the proposed development is not at significant flood risk, subject to the recommended flood mitigation strategies being implemented. The identified risks and mitigation measures are summarised within **Table 5.1**:

Table 5.1: Summary of Flood Risk Assessment

Flood Source	Risk & Proposed Mitigation Measures
Fluvial	A bespoke hydraulic modelling exercise has been completed to determine representative fluvial flood extents for the upper catchment of the Thurlaston Brook. The proposed development is shown to be sequentially arranged to be located outside of all modelled flood events including the 1 in 100-year +28%CC, 1 in 100-year +37%CC and 1 in 100-year +60%CC events. As part of the hydraulic modelling exercise, blockage testing was simulated of three hydraulic structures. To test a worst-case scenario, the structures were represented as 100% blocked. The site continued to remain unaffected during these extents. Following review of the illustrative masterplan, all residential plots are shown to be located on surveyed topographic levels that are set suitably above the maximum modelled design flood level with climate change (+28%). It is proposed that all plots are set a minimum of 600mm above the 1 in 100-year +28%CC climate change flood level reported within their closest respective in-channel node. Access to the site is shown to remain unaffected during all modelled events. Subsequently, safe access and egress will remain achievable for the lifetime of the proposed development.
Groundwater	Third party data sources identify the site as located within a region that is considered to be susceptible to groundwater flooding. Finished floor levels should be raised a minimum of 150mm above surrounding ground. Any groundwater that is struck during excavations should be appropriately dewatered.
Reservoirs and waterbodies	The EA reservoir failure flood extent does not cover the site, with the nearest extent being located approximately 2.5km northeast. There is a waterbody located immediately south of the site which is set above the proposed

	development. In the unlikely event that the structure of this waterbody was to fail, the site could be at residual risk of flooding.
Pluvial runoff	The pluvial risk across the majority of the site is very low. The 1 in 30-year and 1 in 100-year events are contained to the channel. There are two areas of isolated ponding predicted on site during the 1 in 1000-year event. Depths of below 300mm are predicted in these areas. All proposed plots are shown to be located outside of all surface water extents including the 1 in 1000-year event.
Impact of the Development	The site has been located so as to not encroach or displace any floodplain. Surface water runoff from the development will be controlled appropriately and infiltrate into the ground or discharge to the local watercourse at the equivalent greenfield QBAR rate. The foul water from the development will be drained separately to clean water.
This summary should be read in conjunction with BWB's full report. It reflects an assessment of the Site based on information received by BWB at the time of production.	

- 5.4 In compliance with the requirements of NPPF, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area subject to suitable management of surface water runoff discharging from the site.

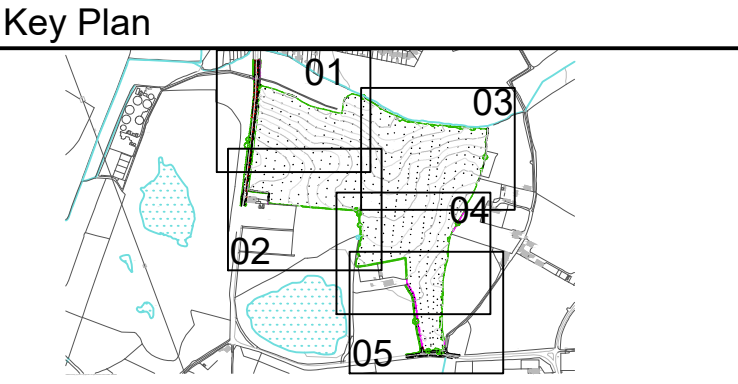
APPENDICES

Appendix 1: Topographic Survey



Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
BWB01	444426.770	303328.244	122.988
BWB02	444421.393	303216.789	127.180
BWB03	444415.262	303163.558	128.736

- Notes**
- Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
 - This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 - All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
 - Any discrepancies noted on site are to be reported to the engineer immediately.
 - No scale factor has been applied to this survey, therefore the os coordinates are to be treated as arbitrary. Please refer to survey station information below for on site control establishment.
 - All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via OS smart net.
 - All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
 - OS license number: 100022432



- Legend**
- OS Buildings
 - Surveyed Buildings
 - Building
 - Wall
 - Kerb Channel Line
 - Top of Kerb
 - Edge of Surface
 - Top of Bank
 - Bottom of Bank
 - Canopy / Overhang
 - Line Marking
 - Centre Line
 - Watercourse
 - Centre Line
 - Barrier
 - Fence
 - Gate
 - Overhead Powerline
 - Overhead Utilities
 - Contour Lines
 - Inspection Chamber
 - Flow direction and pipe diameter
 - Station and Name
 - Monitoring Borehole
 - Tree / Bush / Sapling
 - Area of Vegetation/ Extent of Tree Canopy
 - Hedge
 - Body of Water
 - Body of Water from OS
 - Spot Level
 - Assumed Surface
 - Water Drainage Line
 - Surface Water Drainage Line

- AP Anchor Point
- BG Back Gully
- BO Bollard
- BS Bus Stop
- BT British Telecom
- C Crest
- CL Cover Level
- CMP Cable Marker
- Post
- CCTVSecurity Camera
- CTV Cable TV
- DC Drainage Channel
- DK Drop Kerb
- DP Down Pipe
- Elec Electric
- EP Electricity Post
- ER Earth Rod
- FH Fire Hydrant
- FL Floodlight
- FBW Fence Barbed Wire
- FCB Fence Closed Board
- FCL Fence Chain Link
- FEL Fence Electric
- FMP Fence Metal Panel
- FMB Fence Metal Railing
- FOB Fence Open Board
- FPW Fence Post & Wire
- FSP Fence Steel Palisade
- FWM Fence Wire Mesh
- FFL Finished Floor Level
- FP Flagpole
- GV Gas Valve
- GY Gully
- Ht Height
- IC Inspection Chamber
- IFL Internal Floor Level
- IL Invert Level (as a reduced level)
- LB Litter Bin
- LP Lamp Post
- MH Manhole
- Mkr Service Marker
- PB Post Box
- PT Post
- RE Rodding Eye
- SP Sign Post
- ST Stop Tap
- SV Stop Valve
- TCB Telephone Call Box
- THL Threshold Level
- TL Traffic Light
- TP Telegraph Post
- TS Traffic Signal
- UTS Unable to Survey
- WL Water Level
- WM Water Meter
- WO Wash Out

P2	08.07.21	First Issue	SDS	Ds
Rev	Date	Details of issue / revision	Drw	Rev

Issues & Revisions

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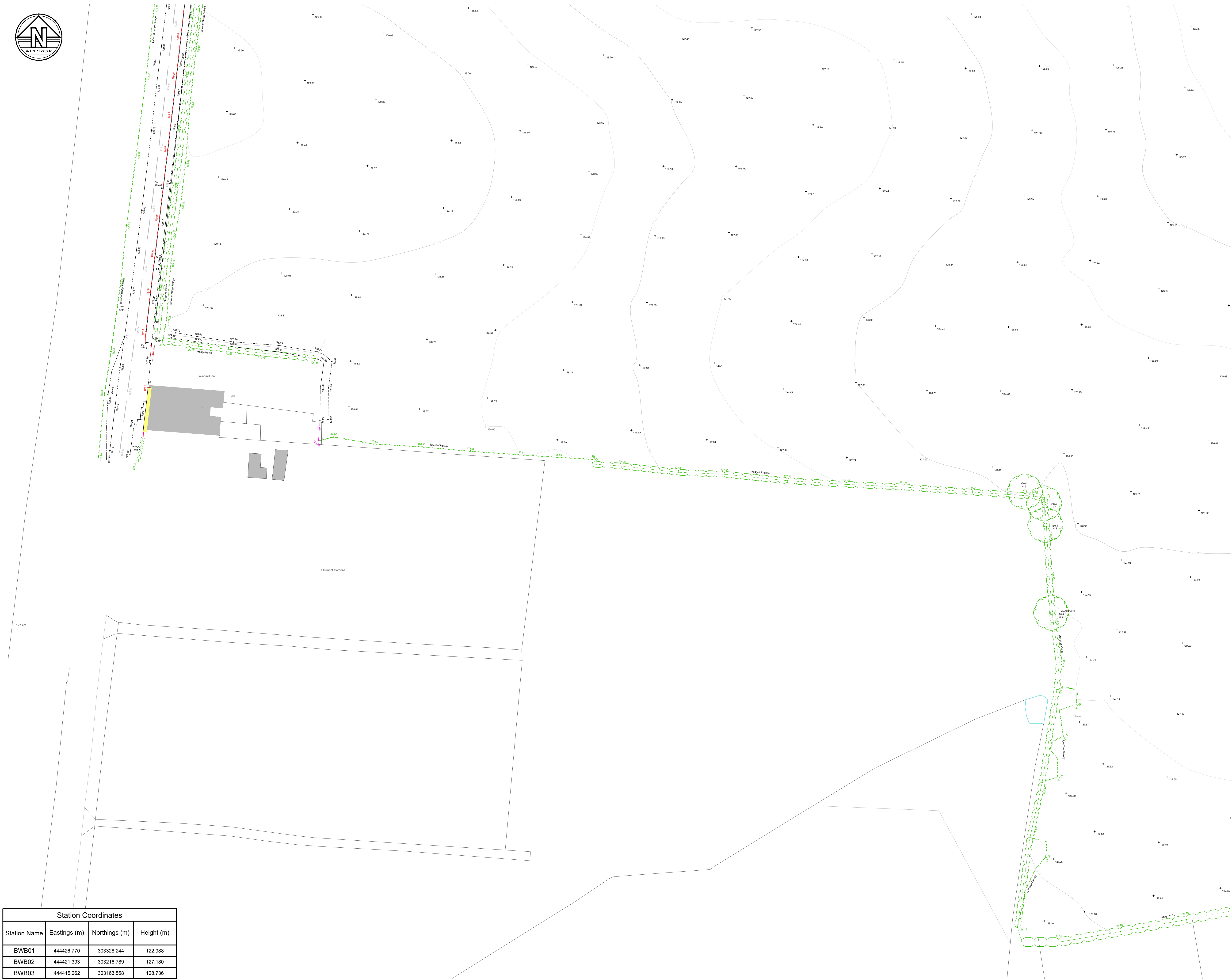
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□ London | 020 7407 3879
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□ Nottingham | 0115 924 1100
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Client
Richborough Estates Ltd

Project Title
**Brascote Lane
Newbold Verdon**

Drawing Title
**Existing Site 2D Plan
Sheet 1 of 5**

Drawn:	S.D.Shreeves	Reviewed:	D.Smith
BWB Ref:	BMW3175	Date:	08.07.21
Scale@A1:	1:500		
Drawing Status PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number		Status	Rev
BLN-BWB-00-01-DR-G-001		S2	P1

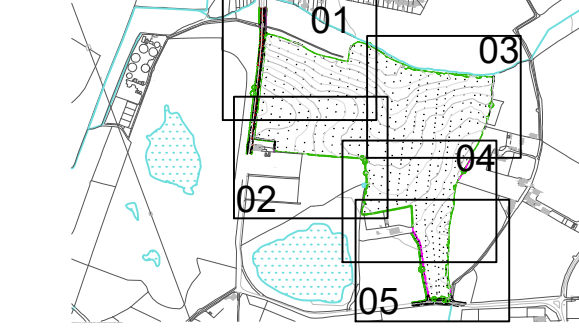


Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
BWB01	444426.770	303328.244	122.988
BWB02	444421.393	303216.789	127.180
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Key Plan



Legend

- | | |
|--------------------|---|
| OS Buildings | Contour Lines |
| Surveyed Buildings | Inspection Chamber |
| Building | Flow direction and pipe diameter |
| Wall | Station and Name |
| Kerb Channel Line | Monitoring Borehole |
| Top of Kerb | Tree / Bush / Sapling |
| Edge of Surface | Area of Vegetation/ Extent of Tree Canopy |
| Top of Bank | Hedge |
| Bottom of Bank | Body of Water |
| Canopy / Overhang | Body of Water from OS |
| Line Marking | Spot Level |
| Centre Line | Assumed Surface |
| Watercourse | Water Drainage Line |
| Barrier | |
| Fence | |
| Gate | |
| Overhead Powerline | |
| Overhead Utilities | |
-
- | | | |
|---------------------|--------------------------|----------------------|
| AP Anchor Point | FBW Fence Barbed Wire | LB Litter Bin |
| BG Back Gully | FCB Fence Closed Board | LP Lamp Post |
| BO Bollard | FCL Fence Chain Link | MH Manhole |
| BS Bus Stop | FEL Fence Electric | Mkr Service Marker |
| BT British Telecom | FMP Fence Metal Panel | PB Post Box |
| C Crest | FMR Fence Metal Railing | PT Post |
| CL Cover Level | FOB Fence Open Board | RE Rodding Eye |
| CMP Cable Marker | FPW Fence Post & Wire | SP Sign Post |
| Post | FSP Fence Steel Palisade | ST Stop Tap |
| CCTVSecurity Camera | FWM Fence Wire Mesh | SV Stop Valve |
| CTV Cable TV | FFL Finished Floor Level | TCB Telephone |
| DC Drainage | FP Flagpole | Call Box |
| Channel | Gas | THL Threshold Level |
| DK Drop Kerb | GV Gas Valve | TL Traffic Light |
| DP Down Pipe | GY Gully | TP Telegraph Post |
| Elec Electric | Ht Height | TS Traffic Signal |
| EP Electricity Post | IC Inspection Chamber | UTS Unable to Survey |
| ER Earth Rod | IFL Internal Floor Level | WL Water Level |
| FH Fire Hydrant | IL Invert Level | WM Water Meter |
| FL Floodlight | (as a reduced level) | WO Wash Out |

P2	08.07.21	First Issue	SDS	Ds
Rev	Date	Details of issue / revision	Drw	Rev

Issues & Revisions

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■ Birmingham | 0121 233 3322

□ Leeds | 0113 233 8000

□ London | 020 7407 3879

□ Manchester | 0161 233 4260

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Client

Richborough Estates Ltd

Project Title

Brascote Lane
Newbold Verdon

Drawing Title

Existing Site 2D Plan
Sheet 2 of 5

Drawn:	S.D.Shreeves	Reviewed:	D.Smith
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BWB Ref:	BMW3175	Date:	08.07.21	Scale@A1:	1:500
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Drawing Status

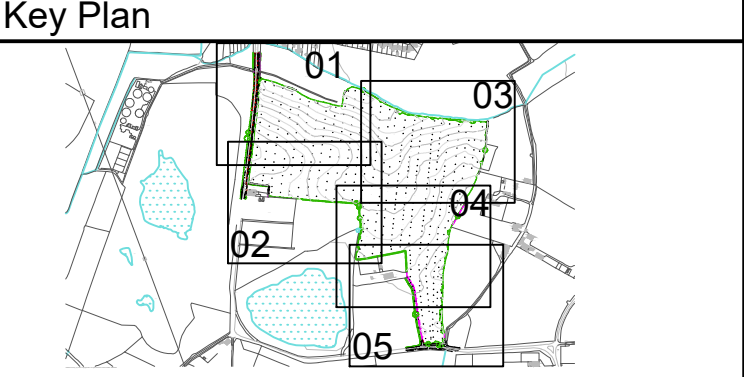
PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-00-02-DR-G-001	S2	P1



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 - OS license number: 100022432



- Legend**
- OS Buildings
 - Surveyed Buildings
 - Building
 - Wall
 - Kerb Channel Line
 - Top of Kerb
 - Edge of Surface
 - Top of Bank
 - Bottom of Bank
 - Canopy / Overhang
 - Line Marking
 - Centre Line
 - Watercourse
 - Centre Line
 - Barrier
 - Fence
 - Gate
 - Overhead Powerline
 - Overhead Utilities
 - Contour Lines
 - Inspection Chamber
 - Flow direction and pipe diameter
 - Station and Name
 - Monitoring Borehole
 - Tree / Bush / Sapling
 - Area of Vegetation/ Extent of Tree Canopy
 - Hedge
 - Body of Water
 - Body of Water from OS
 - Spot Level
 - Assumed Surface
 - Water Drainage Line
 - Surface Water Drainage Line

- AP Anchor Point
- BG Back Gully
- BO Bollard
- BS Bus Stop
- BT British Telecom
- C Crest
- CL Cover Level
- CMP Cable Marker
- Post
- CCTV Security Camera
- CTV Cable TV
- DC Drainage Channel
- DK Drop Kerb
- DP Down Pipe
- Elec Electric
- EP Electricity Post
- ER Earth Rod
- FH Fire Hydrant
- FL Floodlight
- FBW Fence Barbed Wire
- FCB Fence Closed Board
- FCL Fence Chain Link
- FEL Fence Electric
- FMP Fence Metal Panel
- FMB Fence Metal Railing
- FOB Fence Open Board
- FPW Fence Post & Wire
- FSP Fence Steel Palisade
- FWM Fence Wire Mesh
- FFL Finished Floor Level
- FP Flagpole
- GV Gas Valve
- GY Gully
- Ht Height
- IC Inspection Chamber
- IFL Internal Floor Level
- IL Invert Level (as a reduced level)
- LB Litter Bin
- LP Lamp Post
- MH Manhole
- Mkr Service Marker
- PB Post Box
- PT Post
- RE Rodding Eye
- SP Sign Post
- ST Stop Tap
- SV Stop Valve
- TCB Telephone Call Box
- THL Threshold Level
- TL Traffic Light
- TP Telegraph Post
- TS Traffic Signal
- UTS Unable to Survey
- WL Water Level
- WM Water Meter
- WO Wash Out

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Client

Richborough Estates Ltd

Project Title

**Brascote Lane
Newbold Verdon**

Drawing Title

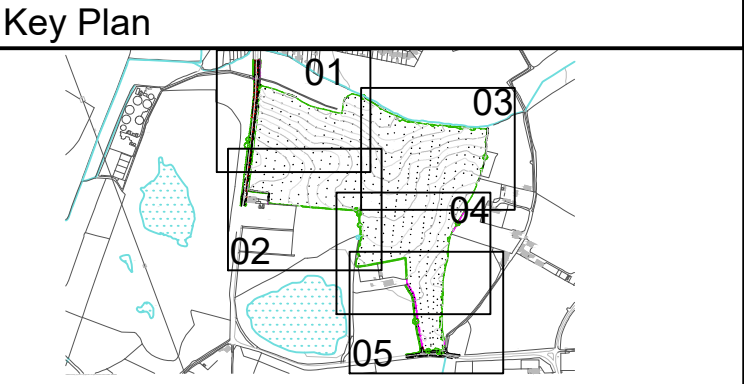
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Sheet 3 of 5**

Drawn:	S.D.Shreeves	Reviewed:	D.Smith
BWB Ref:	BMW3175	Date:	08.07.21
Scale@A1:	1:500		
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			Status Rev
BLN-BWB-00-03-DR-G-001			S2 P1



Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
BWB01	444426.770	303328.244	122.988
BWB02	444421.393	303216.789	127.180
BWB03	444415.262	303163.558	128.736

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- Legend**
- | | |
|--------------------|---|
| OS Buildings | Contour Lines |
| Surveyed Buildings | Inspection Chamber |
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| Kerb Channel Line | Monitoring Borehole |
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UTS Unable to Survey
WL Water Level
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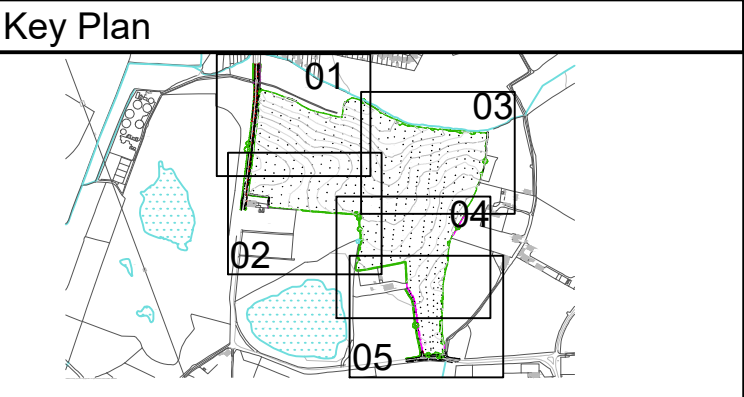
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Station Coordinates			
Station Name	Eastings (m)	Northings (m)	Height (m)
BWB01	444426.770	303328.244	122.988
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Legend

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Surveyed Buildings	Inspection Chamber
Building	Flow direction and pipe diameter
Wall	Station and Name
Kerb Channel Line	Monitoring Borehole
Top of Kerb	Tree / Bush / Sapling
Edge of Surface	Area of Vegetation/ Extent of Tree Canopy
Top of Bank	Hedge
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S2 P1			

Appendix 2: Illustrative Masterplan



Key

- Application site boundary
- Other land under control of applicant
- Existing (retained) trees & hedgerow
- Proposed tree/hedge removal

- Indicative proposed planting
- Potential for fruit-tree planting
- Areas of new publicly-accessible open space
- Potential for equipped area of children's play (with min 20m development offset shown)

- Potential for children's play ar and/or event along a trim-trail (with min 5m development offset shown)
- Indicative marginal wildflower and grassland planting
- Indicative surface water attenuation basin

- Existing Public Right of Way
- Proposed pedestrian/cycle routes
- Proposed vehicular access from Brascote Lane

- Visual link with the spire of The Church of St. James
- Potential for improvements at Windmill pub
- Indicative dwellings (and associated garages)

01050m

Richborough Estates

CHARTERED TOWN PLANNERS & URBAN DESIGNERS

Project

Brascote Lane, Newbold Verdon

Drawing Title

Illustrative Layout

Project Code

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Drawing No

006

Rev

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Date

10.08.2022

Drawing Scale

1:1,250 @ A1

Appendix 3: Hydraulic Modelling Study

ENVIRONMENT

Richborough Estates Limited
Brascote Lane, Newbold Verdon
Leicestershire
Hydraulic Model Report

ENVIRONMENT

Richborough Estates Limited
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Leicestershire
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September 2021

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Notice

All comments and proposals contained in this report, including any conclusions, are based on information available to BWB Consulting during investigations. The conclusions drawn by BWB Consulting could therefore differ if the information is found to be inaccurate or misleading. BWB Consulting accepts no liability should this be the case, nor if additional information exists or becomes available with respect to this scheme.

Except as otherwise requested by the client, BWB Consulting is not obliged to and disclaims any obligation to update the report for events taking place after: -

- (i) The date on which this assessment was undertaken, and
- (ii) The date on which the final report is delivered

BWB Consulting makes no representation whatsoever concerning the legal significance of its findings or the legal matters referred to in the following report.

All Environment Agency mapping data used under special license. Data is current as of September 2021 and is subject to change.

The information presented, and conclusions drawn, are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

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GLOSSARY & NOTATION

1D – one-dimensional hydraulic model, good for representing the hydraulics of a definitive channel or flow pathway and hydraulic structure.

2D – two-dimensional hydraulic model, good for representing complex flow routing present within the floodplain.

Annual Exceedance Probability (AEP) - the probability (%) of a flood event occurring in any year.

Catchment - the land area that drains (normally naturally) to a given point on a river, drainage system or body of water.

Design flood event - magnitude of the flood adopted for the design of the whole or part of a development, usually defined in relation to the severity of the flood in terms of its return period. Typically, the 1 in 100-year return period event including an allowance for future climate change for fluvial flood events.

DTM – Digital Terrain Model

EA – Environment Agency

ESTRY - a 1D hydraulic modelling software package published by BMT.

Flood Estimation Handbook (FEH) – industry standard guidance on rainfall and river flood frequency estimation across the UK.

Floodplain - any area of land over which water flows or is stored during a flood event.

FRA – Flood Risk Assessment

Freeboard - the height of the top of a bank, floodwall or other flood defence structure, above the design water level. Freeboard can be seen as a safety margin that makes allowance for uncertainty associated with the potentially damaging effects of flood rise or wave action.

Hydraulic model - a mathematical (generally computer based) model of a water/sewer/storm system which is used to analyse the system's hydraulic behaviour.

LiDAR – Light Detection and Ranging aerial survey data

LLFA – Lead Local Flood Authority

mAOD – metres above Ordnance Datum

mBGL – metres below ground level

Main River - a statutory type of watercourse in England and Wales, usually larger streams and rivers. The EA can carry out maintenance, improvement or construction work on main rivers to manage flood risk as part of its duties and powers.

NRFA – National River Flow Archive

OS – Ordnance Survey

Preliminary Flood Risk Assessment (PFRA) - an assessment of floods that have taken place in the past and floods that could take place in the future. It generally considers flooding from surface water runoff, groundwater and ordinary watercourses, and is prepared by the Lead Local Flood Authority.

ReFH – Revitalised Flood Hydrograph rainfall-runoff hydrological model

Return period - a statistical term defining the probability of occurrence of a flood event. Thus a 1 in 50-year flood is one likely to be equalled or exceeded on average only once in a 50-year period: a flood with a 2.0% annual probability exceedance (AEP).

Strategic Flood Risk Assessment (SFRA) - a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future.

TUFLOW – a 2D fixed grid hydraulic modelling software package published by BMT.

UOW – Unnamed Ordinary Watercourse

Watercourse – a natural or man-made open channel for the conveyance of water.

Z-line – a break line layer in TUFLOW which can be used to reinforce linear features in the 2D model domain such as a riverbank, flood defence, or channel bed.

Z-shape – a layer in TUFLOW which can be used to manipulate the 2D model geometry.

1. INTRODUCTION

- 1.1 BWB Consulting Ltd has been commissioned by Richborough Estates Limited (the client) to undertake a site-specific hydraulic modelling exercise of the Thurlaston Brook to provide a detailed understanding of potential flood risk to the proposed development site at land off Brascote Lane, Newbold Verdon (NGR: SK 4468 0320).

Aims and Objectives.

- 1.2 The aim of the modelling exercise is to identify peak flood levels and floodplain extents within the vicinity of the site to help inform the flood risk management strategy of a proposed development. The model will be used to assess the potential impact of climate change on the floodplain, as well as assess residual risks associated with the watercourse, such as a blockage of the downstream bridge.
- 1.3 This modelling exercise will be used to inform a FRA in support of the proposed development.

Approach

- 1.4 In order to achieve the aim, a new 1D/2D ESTRY-TUFLOW model was constructed, based on a watercourse survey completed by BWB Consulting in July 2021 (see **Appendix 1**).
- 1.5 The model has been simulated for a series of design storm events. These modelled events include the 1 in 20-year, 1 in 100-year and 1 in 1000-year events that are typically used by the Environment Agency (EA) to define Flood Zones 3b, 3a and 2 respectively for planning purposes.
- 1.6 Furthermore, simulations have been run to account for the impacts of climate change in accordance with the recent allowances that were released by the EA in July 2021. This is necessary to demonstrate within the FRA that the proposed development can be deemed safe for its lifetime.
- 1.7 Sensitivity testing has also been undertaken to understand what impacts changes to roughness, downstream boundary and storm duration has upon the model outputs. Blockage testing has also been conducted at 3 locations to understand the potential impacts to the site, should such a scenario occur.
- 1.8 The modelled flood extents and levels from this study have been assessed in the associated FRA (REF: **BLN-BWB-ZZ-XX-RP-YE-0002_FRA**). Following an assessment of how the development proposals correspond to the model outputs, appropriate development levels and mitigation measures have been recommended as part of the FRA.

Site Description

- 1.9 The site is located off Brascote Lane, immediately south of the residential setting of Newbold Verdon. Leicester city centre is located approximately 1.5km east of the site and the village of Newbold Verdon.
- 1.10 Brascote Lane forms the western and southern boundaries of the site. The northern limit of the redline site boundary is bordered by the Thurlaston Brook which flows from east to west. The east of the site is surrounded by farmland.
- 1.11 The site itself is wholly comprised of farmland, bordered by hedgerows and tree lines. A site location plan is shown in **Figure 1.1**.

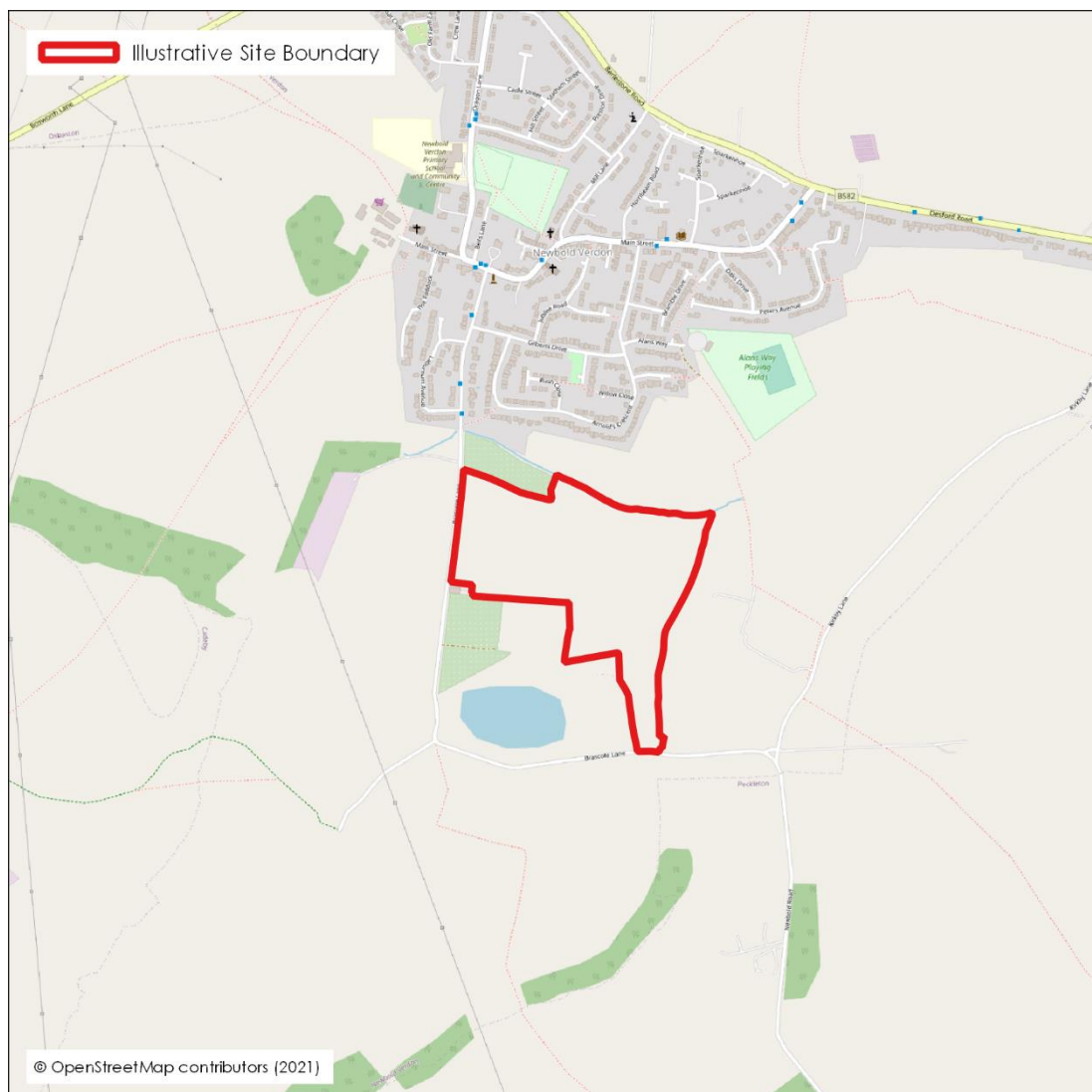


Figure 1.1: Site Location Plan

Local Watercourse Network and Catchment

- 1.12 The Thurlaston Brook flows alongside the northern boundary of the site in a westerly direction. The source of this watercourse is located approximately 700m upstream of

the site. An UOW flows into the Thurlaston Brook approximately 700m downstream of the Brascote Lane road crossing. The Thurlaston Brook later becomes a tributary to the River Soar, approximately 17km downstream of the site.

- 1.13 **Figure 1.2** shows the local watercourse network. The watercourse labels shown will be used throughout this report.

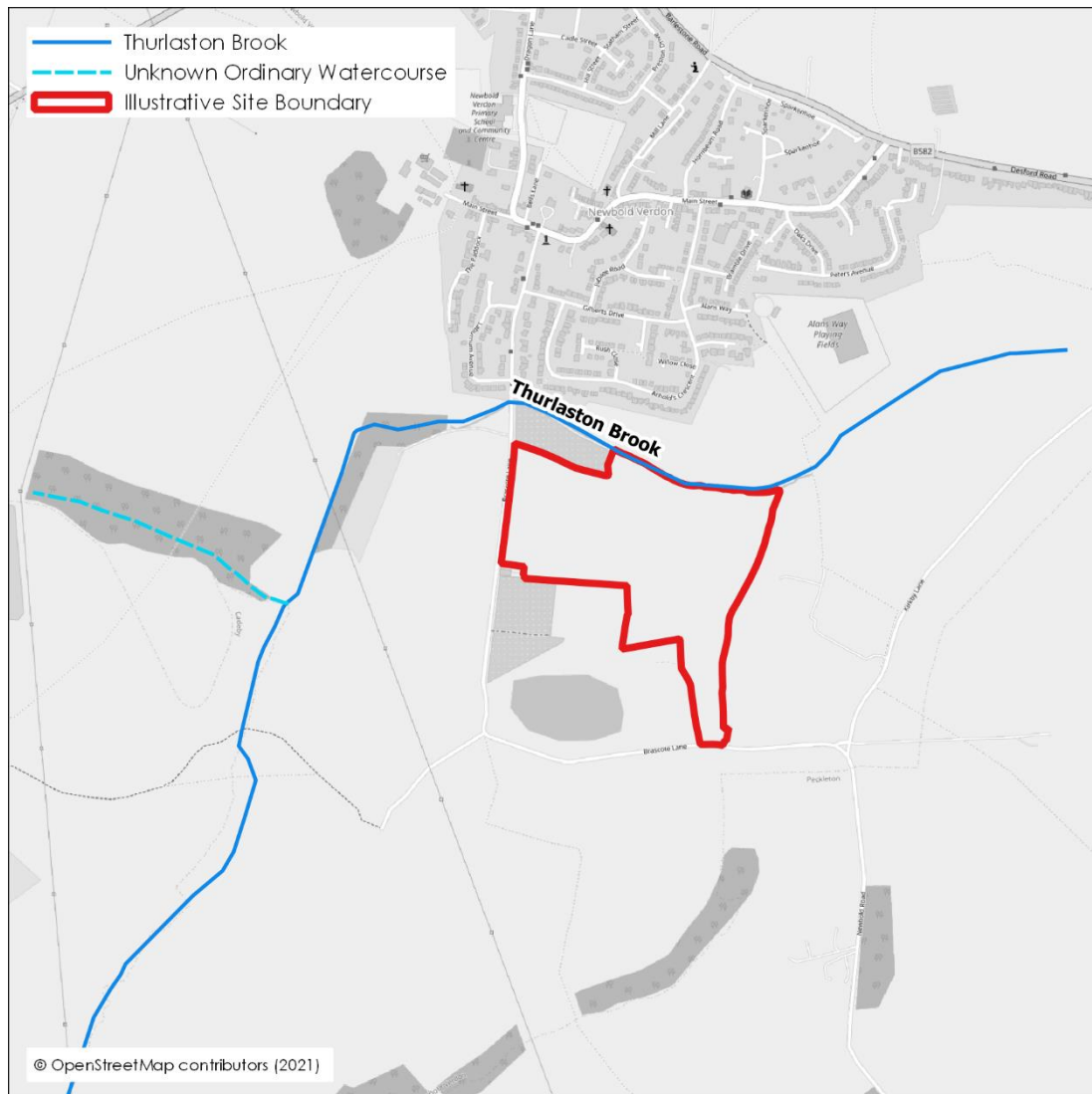


Figure 1.2: Watercourse Network

- 1.14 The Thurlaston Brook is a tributary of the River Soar with a total catchment area of approximately 37.52km². The proposed development site is located at the very upstream limit of the catchment. The watercourse has a catchment area of 1.74km² upstream of the Brascote Lane road crossing.
- 1.15 The catchment area associated with this study is illustrated within **Figure 1.3**. Also displayed is EA 1m LiDAR data which provides a general illustration of the topography in the area.

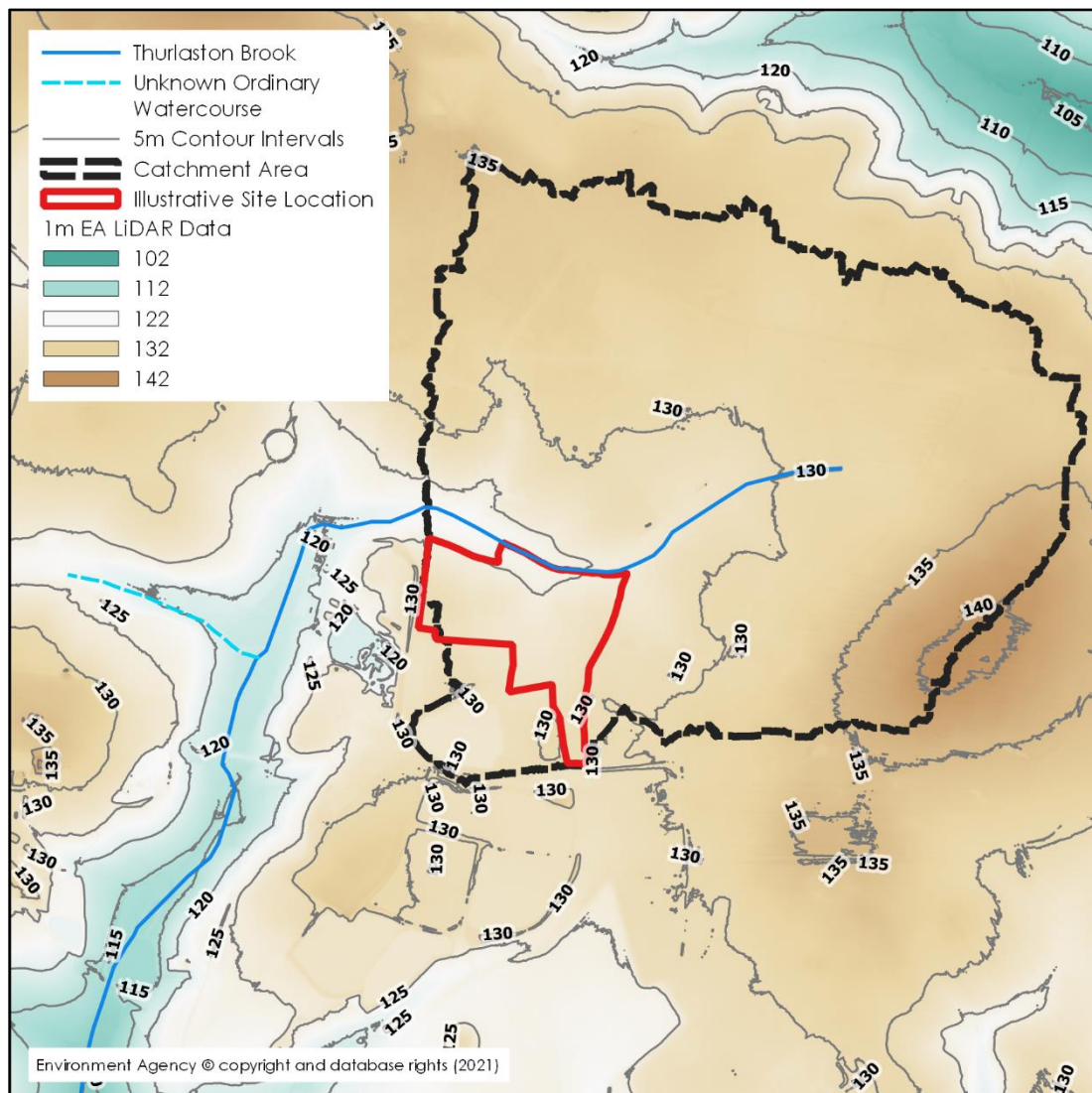


Figure 1.3: Site Topography

Previous Studies & Available Data

EA Recorded Flood Outlines

- 1.16 A review of the 2019 Hinckley and Bosworth Strategic Flood Risk Assessment (SFRA), the 2011 Leicestershire County Council Preliminary Flood Risk Assessment (PFRA), EA recorded flood data, and local news outlets did not return any reports of flooding within the site or further upstream.
- 1.17 Following liaison with Leicestershire County Council, acting as the Lead Local Flood Authority (LLFA), it has been reported that there are two records of flooding incidents within close proximity to the site. Specifically, these are referred to as:
 - March 2016 = Arnolds Crescent. Here, driveways were flooded from the highway. The source was not identified, but as this location is removed from the watercourse it is most likely associated with surface water flooding. The pluvial mapping displayed in **Figure 1.5** estimates flooding at this location.

- September 2019 = The corner of Brascote Lane and Luburnum Avenue. This incident was limited to the highway and was believed to be caused by localised surface water ponding due to the highway topography.

1.18 There have subsequently been no records of historic flooding provided at the site specifically.

Hydraulic Model(s)

1.19 BWB Consulting contacted the EA and Leicestershire County Council (LLFA) to request for any hydraulic model data/ files that were held at the site. Both authorities confirmed that they held no such information at this location. The EA specifically stated that:

"This location is within flood zone 1. As such we do not hold any modelled information (no heights, or products 5, 6 & 7) for this site."

1.20 Leicestershire County Council commented stating:

"The County Council has [not] commissioned flood modelling studies in Newbold Verdon at this time. As such, no sensitive receptors or critical areas have been identified."

Environment Agency Flood Maps

1.21 The EA Flood Map for Planning confirms that the site lies wholly in Flood Zone 1. The EA have confirmed that there is not any modelled data available for this location as existing. This is because no detailed modelling exercise has been completed to date.

1.22 The JFLOW national mapping programme does recognise the Thurlaston Brook catchment and, accordingly, flood extents have been produced for this watercourse. However, these extents do not include the stretch of the Thurlaston Brook immediately adjacent to the site (or upstream) and are only available further downstream. This confirms the need for explicit hydraulic modelling to inform the associated Flood Risk Assessment.

1.23 The Flood Map for Planning is displayed in **Figure 1.4**.

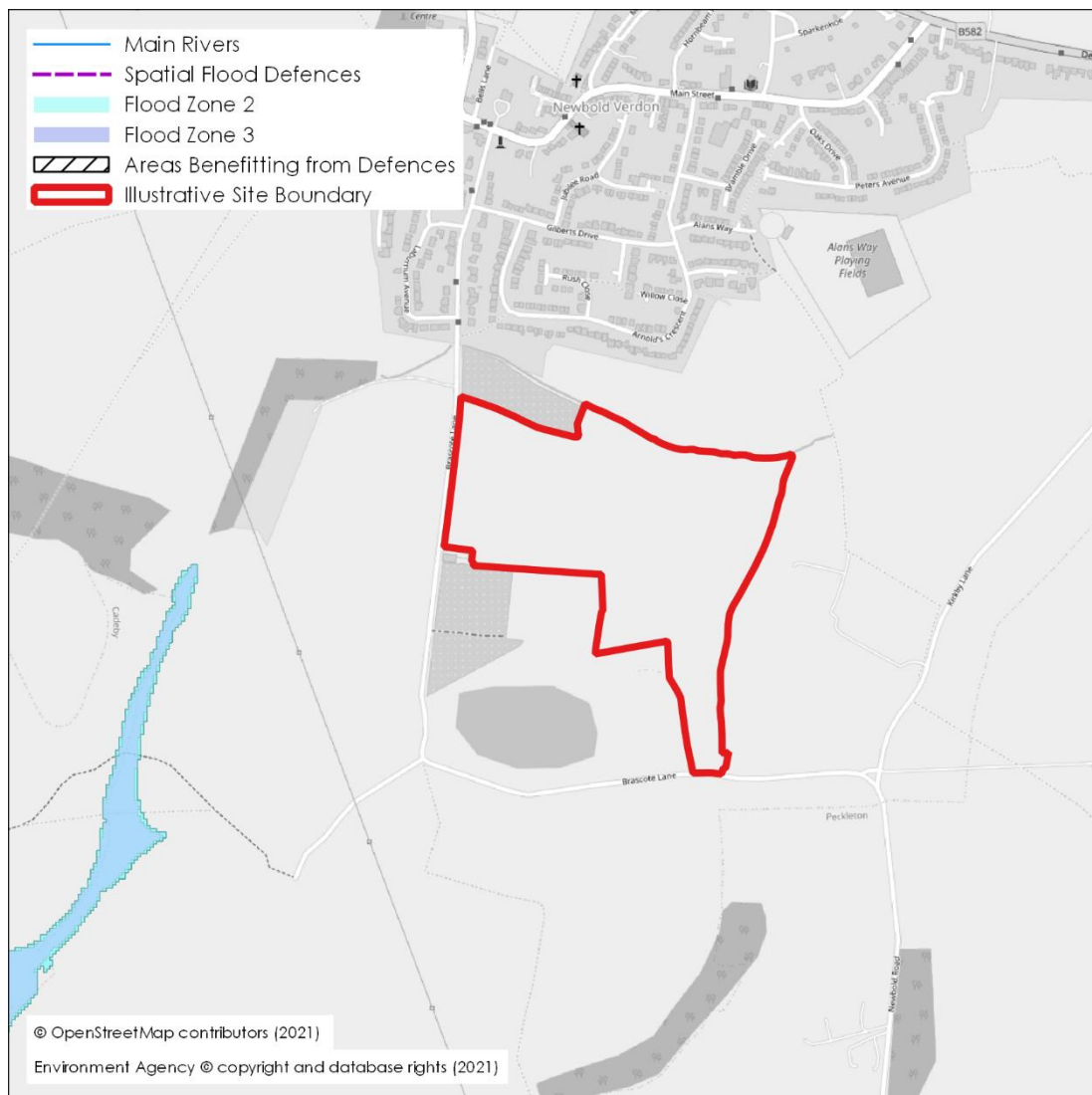


Figure 1.4: EA Flood Map for Planning

Risk of Flooding from Surface Water

- 1.24 EA surface water flood risk maps identify the potential areas at risk of flooding if rainwater does not enter the drainage system or infiltrate into the ground. While not strictly a fluvial source, this mapping can provide an indication of the potential flood risk associated with minor watercourses excluded from the Flood Maps for Planning.
- 1.25 The surface water maps suggest that the potential floodplain associated within the watercourses is relatively constrained and remains close to the channels. The site boundary is shown to remain largely unaffected.
- 1.26 An extract of the Surface Water Flood Risk maps is illustrated within **Figure 1.5**.

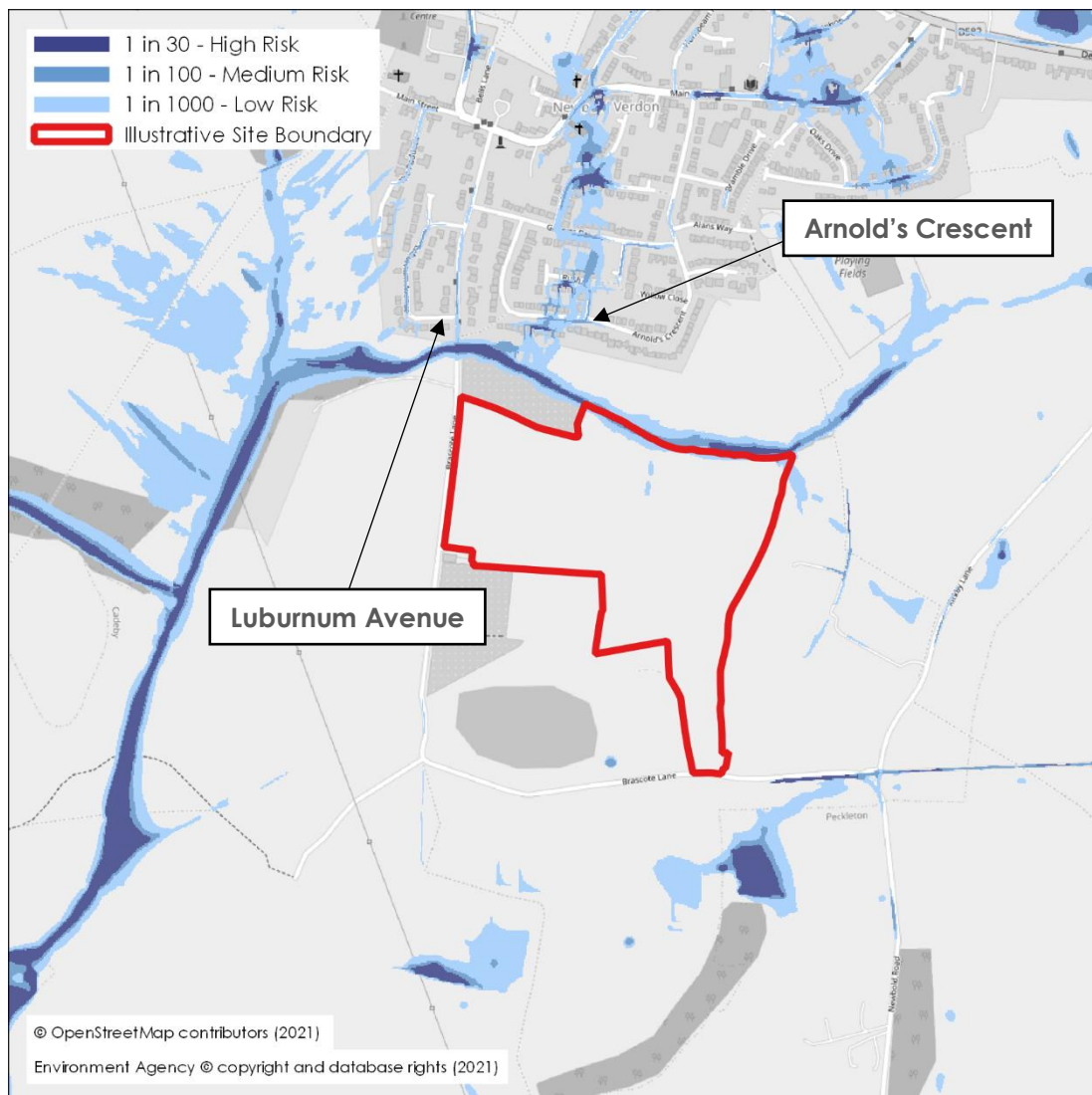


Figure 1.5: Risk of Flooding from Surface Water Map

Other Sources of Data

1.27 The following additional datasets were used within the hydraulic modelling exercise:

- EA LiDAR aerial survey. 1m resolution composite Digital Terrain Model (DTM).
- Topographic survey of the study site, undertaken in July 2021.
- Cross-sectional Watercourse Survey, undertaken in July 2021 (included as **Appendix 1**).
- Photographs and observations from site visit undertaken in July 2021 by BWB Consulting.
- A hydrological assessment of Flood Flows undertaken by BWB Consulting (included as **Appendix 2**).

Assumptions and Limitations

1.28 Several assumptions were made during the study which may lead to implications on the modelled results. However, the study has been based on the data available at the time of writing. The key assumptions and limitations are as follows:

- The modelling exercise has made use of the available data at the time of construction and simulation. The model represents the floodplain and channel conditions at the time of survey.
- The modelling exercise has made use of the latest hydrological and hydraulic modelling software versions at the time of analysis and completion (the hydrological assessment was completed in August 2021 with the hydraulic modelling completed between August and September 2021).
- The model contains no formal representation of the conveyance within minor watercourses or ditches other than that captured by the model grid and within the 1D model domain.
- The 2m resolution of the model may negate any small-scale topographic features, although all the significant features are believed to have been captured.
- Outside of the site boundary (where topographic survey is available), floodplain levels are derived from LiDAR which has limited accuracy (+/- 0.15m). however, this is considered to be sufficient for the purpose of this study.
- The bare earth DTM does not include for the presence of walls, buildings or other structures. Buildings have been modelled at ground level with an elevated roughness in line with best practice.
- The modelling exercise has been undertaken to produce a good representation of flood risk mechanisms in and around the study site. It has not been designed to accurately map flooding in the wider catchment.
- Due to the size of the catchment area modelled (2.14km²), flows have been applied to the model as a lumped inflow at the upstream limit of modelled watercourse. This is considered to be a conservative approach as 100% of the calculated flows for each event are being conveyed through the model at the upstream limit of the site.
- Due to access limitations, it was not possible to survey an informal farm access track that crosses the Thurlaston Brook immediately upstream of the site as well as an additional structure downstream of Brascote Lane road crossing. Subsequently, these hydraulic structures were excluded from the baseline model. Sensitivity testing was undertaken whereby the channel was represented as 100% blocked at these locations to understand a worst-case scenario.

2. HYDROLOGY

Flood Flow Estimation

- 2.1 A hydrological review of the catchment was undertaken using Flood Estimation Handbook (FEH) methodologies to estimate peak flood flows and derive an appropriate hydrograph shape. This was undertaken in relation to the EA's latest guidance¹. This assessment is documented within **Appendix 2**.
- 2.2 In summary, there were no hydrometric data available in the area to inform the hydrological analysis. Therefore, the industry standard FEH statistical method and Revitalised Flood Hydrograph (ReFH2.3) rainfall-runoff model were both reviewed, and a comparative analysis undertaken.
- 2.3 The industry standard FEH statistical method and ReFH2.3 rainfall-runoff model were both reviewed, and the ReFH2 method was determined to be the most suitable for a site-specific hydraulic model as it produced the more conservative flow estimates.
- 2.4 While conservative estimates are not necessarily the 'correct' estimates, given the exercise will be supporting an assessment of flood risk, and given the lack of site-specific flow information, a precautionary approach was considered appropriate.
- 2.5 The flow estimates were made at the downstream extent of the site, and therefore represent runoff generated upstream and from within the site.
- 2.6 The catchment area was updated using a watershed analysis to improve its accuracy. The catchment was compared against public sewer records which showed that no cross-catchment transfers are present – the sewer networks generally follow the topographical catchment.
- 2.7 Flood flow estimates were derived for a range of return period events, the adopted peak flow estimates are provided within **Table 2.1**.

Table 2.1: Adopted Peak Flood Flows

Return Period Event (Yrs)	Annual Exceedance Probability	Catchment Peak Flow (m ³ /s)
1 in 2	50%	0.45
1 in 5	20%	0.60
1 in 10	10%	0.71
1 in 30	3.3%	0.84
1 in 50	2.0%	1.06
1 in 75	1.3%	1.18

¹ Flood Estimation Guidelines 197_08 (Environment Agency, June 2020)

Return Period Event (Yrs)	Annual Exceedance Probability	Catchment Peak Flow (m ³ /s)
1 in 100	1.0%	1.29
1 in 200	0.5%	1.59
1 in 1000	0.1%	2.42

- 2.8 Flows have been applied to the model as a lumped point inflow at the upstream extent of the hydraulic model.
- 2.9 Given the size of the catchment area (2.14km²) and the length of watercourse modelled (approximately 1.8km), this approach was considered to be appropriate. Using a lumped inflow at the upstream extent of the catchment subsequently allows for a conservative volume of flow being conveyed through the model at the upstream limit of the site. **Figure 2.1** demonstrates how the flows were applied to the model.

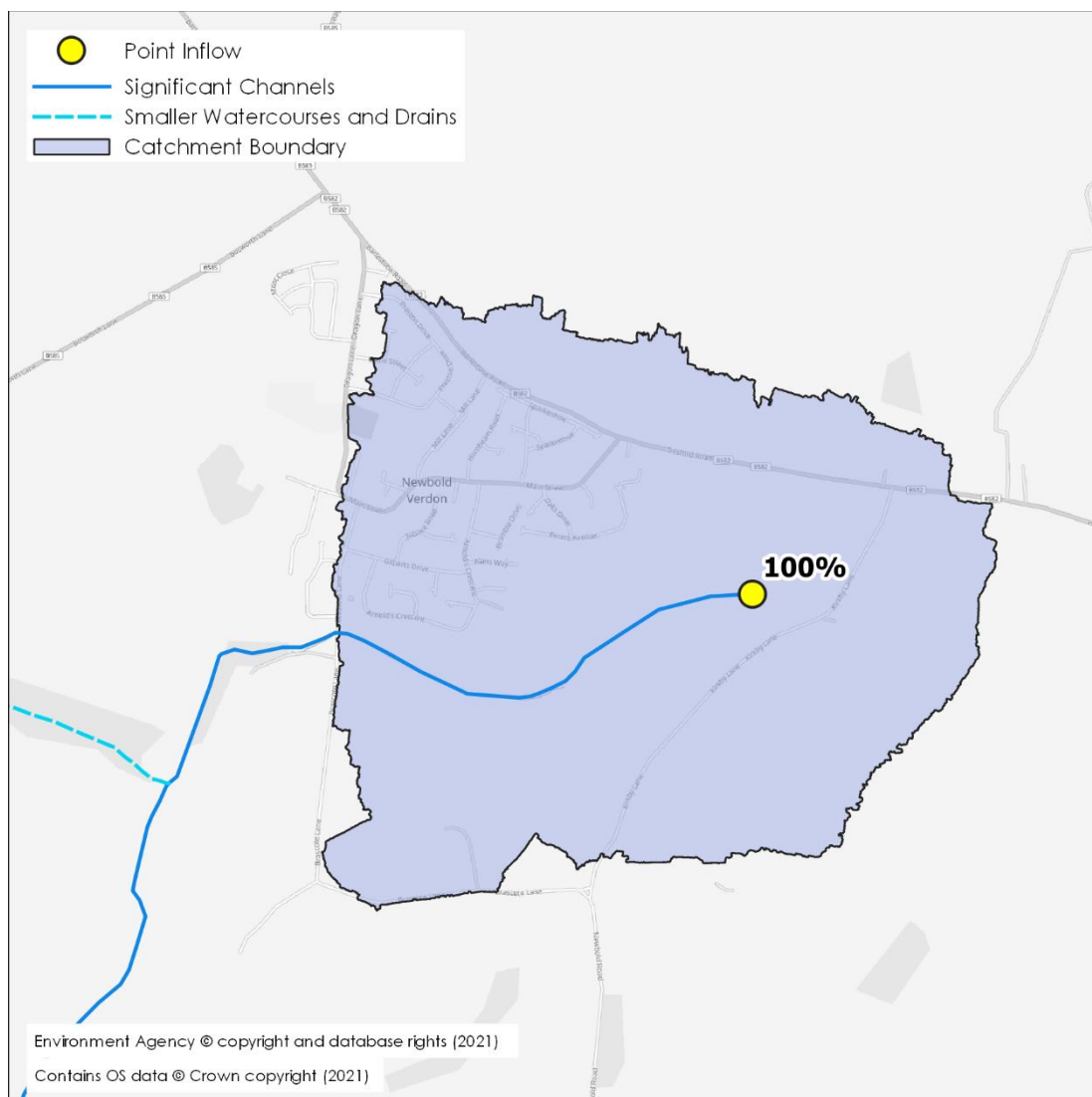


Figure 2.1: Distribution of Model Inflows

Climate Change

- 2.10 Predicted future change in peak river flows caused by climate change are provided by the EA within their online guidance², with a range of projections applied to regionalised 'River Basin Districts'. These districts are further split into 'Management Catchments'. The Thurlaston Brook falls within the Soar Management Catchment. **Table 2.2** identifies the relevant peak river flow allowances.

Table 2.2: Peak River Flow Allowance for the Soar Management Catchment

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2125)
Upper End	28%	35%	60%
Higher Central	18%	21%	35%
Central	14%	16%	28%

- 2.11 To estimate the potential future design floodplain under a range of scenarios, the Central, Higher Central and Upper End climate change allowance for the 2080s will be applied to the 1.0% AEP flood flows.
- 2.12 The proposed development is for residential use which would be classified as a 'More Vulnerable' development with reference to the Planning Practice Guidance (PPG). EA climate change guidance states that the central allowance should be used to assess whether a 'More Vulnerable' proposed development can be deemed safe for its lifetime in Flood Zones 2 and 3a. Given that the site borders the Thurlaston Brook and will be in close proximity to the fluvial flood extents (even if they remain in-channel), the central allowance has subsequently been simulated and will be assessed in detail as part of the FRA.
- 2.13 The higher central and upper end allowances have also been simulated to provide additional information on floodplain extents and depths, although they are not specifically required under the EA climate change guidance .

² Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1>

3. THE HYDRAULIC MODEL

Software and Solver

- 3.1 TUFLOW version 2020-10-AA was used for all model runs. TUFLOW's Classic solver was used.
- 3.2 TUFLOW's built in 1D component, ESTRY, was used to model the 1D domain/channel.

The 1D Domain

Extent

- 3.3 The 1D domain begins at the upstream extent of the illustrative site boundary. The remainder of the modelled Thurlaston Brook channel is represented within the 1D domain until the downstream boundary. The extent can be seen in **Figure 3.1**.

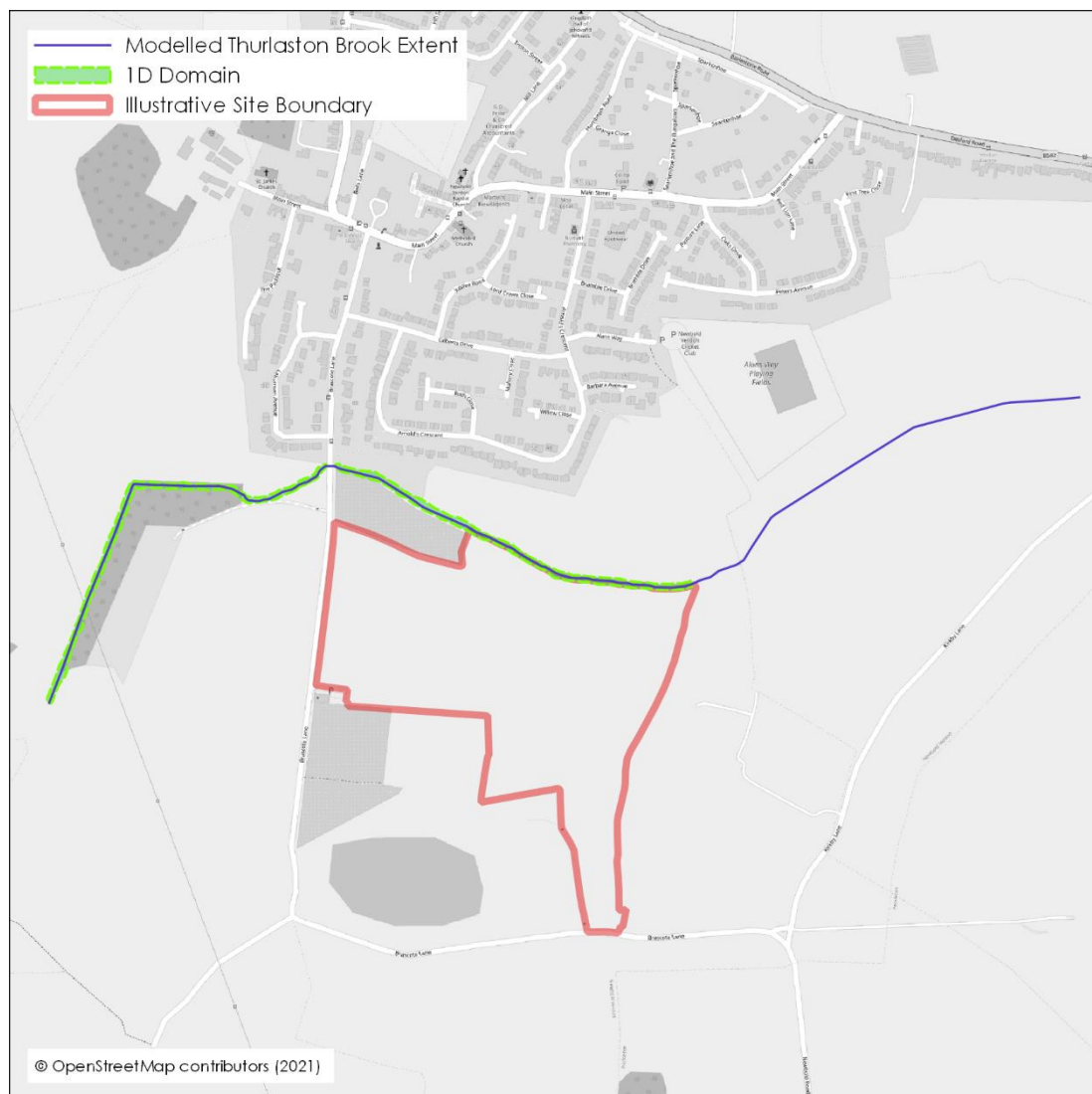


Figure 3.1: Modelled Thurlaston Brook and 1D Domain Extents

Channel Geometry

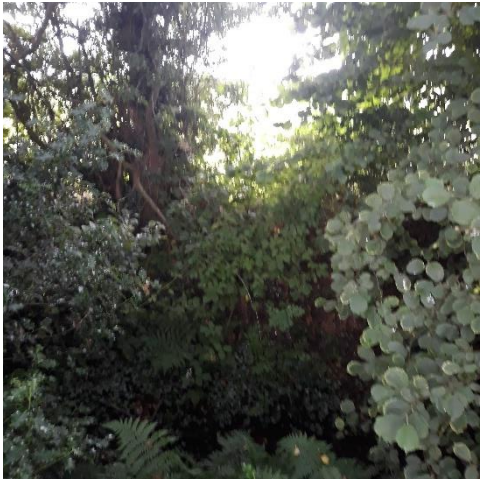
- 3.4 The river channel geometry is based on a new watercourse survey carried out by BWB Consulting in July 2021. The survey also captured the culvert at Brascote Lane road crossing. This hydraulic structure is of significant interest given its location at the downstream boundary of the site boundary.
- 3.5 Due to access constraints, the maximum distance between surveyed cross sections is 189m. However, sections are more generally spaced approximately 50m apart. The river channel survey is available as **Appendix 1**.
- 3.6 The channel sections were truncated at top-of-bank from survey data, at what would be the interface with the 2D domain.

Hydraulic Roughness

- 3.7 Hydraulic roughness has been represented using the Manning's n coefficient. The values applied are based on those stipulated in the literature, using Chow (1959)³. This study documents appropriate values based on channel bed material, sinuosity and presence of vegetation.
- 3.8 The guideline values are chosen using engineering judgement, based on photographs of the channel condition taken at the time of survey. Each cross section has a Manning's roughness value applied in the same way as the channel geometry and is read into TUFLOW within a CSV file.
- 3.9 The Thurlaston Brook was observed to be free flowing. The channel was considered to be relatively straight with few rifts or deep pools. Some stones and weeds could be seen within the channel. As such, a Manning's n coefficient of 0.035 was deemed suitable to represent in-channel roughness. The banks and top of bank were in some instances lined with long grass and in other instances bordered by woodland. Values of 0.035 and 0.080 was used to represent the long grass and woodland conditions respectively. Some examples are highlighted in **Table 3.1**.

³ http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm

Table 3.1: Manning's n Examples

Model ID	Values chosen and description	Photograph
THURL_0279	0.035 1. Main Channels b. clean, straight, full stage, no rifts or deep pools, some stones and weeds.	
THURL_1004	0.035 3. Floodplains a. Pasture, no brush 2. high grass.	
THURL_1079	0.080 3. Floodplains d. Trees 4. heavy stand of timber, a few down trees, little undergrowth, flood stage below branches.	

Hydraulic Structures

- 3.10 A single hydraulic structure at the Brascote Lane road crossing was represented in the 1D domain, the data for which was collected during the watercourse survey.
- 3.11 The structure was represented as a culvert with two 750mm diameter pipes. Please view **Appendix 3** for details on the modelled structure.
- 3.12 Due to access constraints, it was not possible to survey two additional structures in the study area. The first of which is an access track crossing located approximately 100m upstream of the site boundary (NGR: SK 4502 0321). The second missing structure is believed to be a culvert located approximately 150m downstream of the Brascote Lane road crossing (NGR: SK 4429 0332).
- 3.13 The baseline model has subsequently been built without consideration of these structures, adopting an open channel approach at these locations. Sensitivity testing was later undertaken whereby the channel was represented as 100% blocked at these locations to understand a worst-case scenario and what implications this could have at the site. Of these two structures, the missing culvert downstream of the site (NGR: SK 4429 0332) was added to the model in the 1D domain as a 100% blocked 0.8m x 0.8m box culvert. This scenario was 'Blockage Location 3'.

Boundary Conditions

- 3.14 Boundary conditions were applied to the 1D domain to allow flow in and out of the model.
- 3.15 A HT (water level vs time) boundary was applied at the downstream limit of the 1D domain. This was set to 116.83mAOD which is the top of bank surveyed level at the downstream cross-section (THURL_0000).
- 3.16 Model inflows were applied to the 2D domain further upstream and are discussed later in **Section 3**. The upstream limit of the Thurlaston Brook 1D domain has been linked to the Thurlaston Brook represented in the 2D domain through a "HX" link. This transfers the calculated water level from between the 2D domain and the 1D cross sections.

Initial Conditions

- 3.17 Initial conditions were applied by defining each cross-section with the surveyed water level. At interpolated cross-sections, the surveyed water level was also interpolated between upstream and downstream cross-sections accordingly. This provides a baseflow throughout the model.

1D/2D Links

- 3.18 The 1D channel was linked to the floodplain and the upstream extent of the Thurlaston Brook (represented within the 2D domain) using "HX" links. These transfer the calculated water level from the 1D cross sections into the 2D floodplain, and vice versa. Water levels will be transferred from the 1D domain to the 2D domain, providing that

the in-channel water level is above the level of the cell that the HX link is located in. Therefore, HX links are typically found to be digitised along the top of bank of the watercourse visible in LiDAR data or along the crest of any embankments if present.

- 3.19 The average modelled width of the channel was approximately 6-8m.

The 2D Model Domain

Extent and Active Area

- 3.20 The main influence on the 2D domain extent is generally the expected width of the floodplain, meaning that it should be large enough to allow for flows to be routed through the floodplain where necessary and so that no “glass walling” occurs.
- 3.21 The river channel was deactivated to ensure that it was only represented in the 1D domain. This deactivated area may appear fragmented in places where the deck of a structure is modelled in the 2D domain. The active area is displayed in **Figure 3.2**.

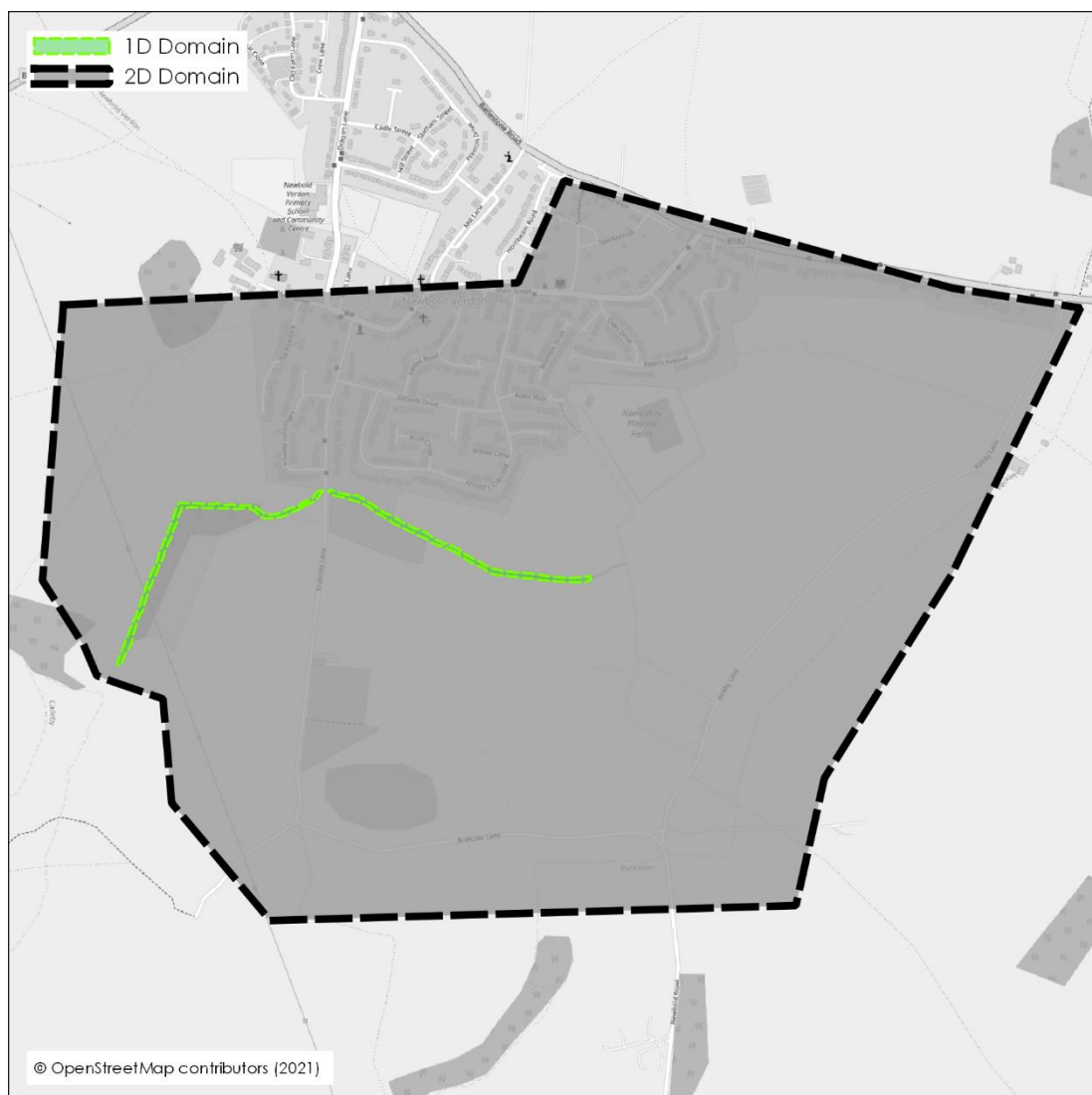


Figure 3.2: 2D Active Area

Grid Size and Orientation

- 3.22 The grid cell size should be chosen in order to sufficiently represent the average width of the modelled channel and its ability to capture key floodplain topographic features.
- 3.23 The selected grid size of 2m provides a high enough resolution to capture the capacity of the channel where it needs to be represented in the 2D domain (6m width = 3 number of 2m cells) as well as provide appropriate representation of key floodplain features.
- 3.24 The orientation of the grid is important for flow routing as flow cannot pass to the neighbouring cell via its corner, only via the cell sides. Therefore, the location line (2d_loc) was drawn to orientate the grid in the predominant direction of flow adjacent to the site (east to west).

Simulation Parameters

- 3.25 A timestep of 0.5 seconds was adopted for the 2D TUFLOW domain, this is representative of 1/4 of the adopted grid size and is therefore within the typical range.
- 3.26 A timestep of 0.25 second was adopted for the 1D ESTRY domain, this is an equal interval of the 2D timestep and is therefore in line with best practise.
- 3.27 All TUFLOW and ESTRY parameters were retained as default.
- 3.28 Flood events were simulated for 20 hours, to allow the flood flows generated by the 5.5-hour storm duration events to flow through the site and start to recede.

Floodplain Roughness

- 3.29 Floodplain roughness is defined by the Manning's n coefficient, as per the 1D domain. However, the method in which it is applied differs.
- 3.30 A global roughness value is set based on the predominant land use (long grass) in the catchment. This is then supplemented by a series of polygons, based on spatial variation in land use, which applies values where appropriate from a variety of sources such as OS MasterMap data (where available), OS Zoomstack and aerial imagery. These are linked to a coefficient listed in a TUFLOW Materials File (TMF).
- 3.31 The values applied for different land use types are listed in **Table 3.2**.

Table 3.2: Floodplain Roughness Values

Land Use Type	Manning's n Coefficient
Long grass	0.035
Urban areas	0.025
Roads	0.015

Land Use Type	Manning's n Coefficient
Water	0.035
Woodland	0.080
Buildings	0.500

Floodplain Topography and Amendments

- 3.32 The general floodplain topography is based on the latest available LiDAR data, which was downloaded from the DEFRA Open Survey website at a 1m resolution.
- 3.33 The following amendments to the base topography were made:
- The July 2021 topographic survey was exported as a Digital Elevation Model (DEM). This surface was stamped atop of the LiDAR data to provide more accurate levels across the site boundary.
 - River bank levels were reinforced through the use of a 'THICK' Z-line. Bank elevations were provided at 5m intervals along the Z-line. These are informed by surveyed cross-section data where available. Bank levels on the left bank immediately north of the site have been informed by the topographic survey. LiDAR data has been used to inform elevations elsewhere, where survey data is unavailable.
 - The representation of the Thurlaston Brook in the 2D domain was reinforced through the use of a 2m wide Z-shape which was assigned the 'GULLY' command. This therefore only changes a Zpt elevation if the Z-shape elevation at the specified Zpt is lower.

Floodplain Structures

- 3.34 There were no floodplain structures within the baseline model. The Brascote Lane road crossing was hence represented in the 1D domain.
- 3.35 As previously mentioned, a hydraulic structure located approximately 100m upstream of the site boundary could not be surveyed due to access constraints. Subsequently, this was excluded from the baseline model. A sensitivity test was conducted, referred to as Blockage Location 1, whereby the access track crossing was added to the model as a floodplain structure (100% blocked). This was achieved by using a Z-shape to raise Zpts in the 2D channel to a consistent level. The level was determined by reviewing 1m LiDAR data along the access road at bank top level.

Boundary Conditions

- 3.36 A QT (flow vs time) boundary was used to represent the fluvial inflows (**Section 2**) as hydrographs. This consisted of a point inflow which was added to the upstream extent of the 2D Thurlaston Brook channel. **Figure 2.1: Distribution** shows where this boundary unit was applied.
- 3.37 Boundary conditions within the 2D domain are often used to prevent "glass walling" at the downstream end of the model through use of a "HQ" boundary. This is a flow vs

stage relationship automatically defined in TUFLOW when the user inputs a slope value, to allow water to flow out of the model.

- 3.38 Slope in the “HQ” boundary was calculated by assessing the fall in floodplain levels on both banks over the distance of approximately 350m. The fall in levels was divided by the distance measured over to determine a slope value.

Calibration

- 3.39 A lack of hydrometric flow or level gauge data for the catchment meant that there was limited opportunity to calibrate the model.
- 3.40 Due to the lack of documentation on previous historical instances of flooding, the model cannot be verified against historic events. A conservative approach adopted to the model build mitigates this.

Stability, Warnings and Messages

- 3.41 TUFLOW has a number of indicators available to assess the stability of a model. These differ slightly between the Classic and HPC solver. The following indicators were checked to ensure the model was performing as expected:
- **Stage and flow time series** – A number of spot checks should be completed to ensure that conveyance through the channel is as expected and that both the stage and flow time series are reasonably smooth, particularly around the study area.
 - **1D negative depths** – Significant negative depths indicate that instabilities are present.
 - **Cumulative Mass Error** – A value of +/-1% is considered acceptable.
 - **Velocities** – Unusually high velocities or circulating vectors are usually a sign of instabilities.
- 3.42 No 1D or 2D negative depths were reported.
- 3.43 The remaining values highlighted above were considered acceptable.
- 3.44 Following review of all baseline model runs, the cumulative mass error stayed below +/- 0.5% for all simulations, and so was within the accepted tolerance levels. This is illustrated for within **Figure 3.3** as an example.

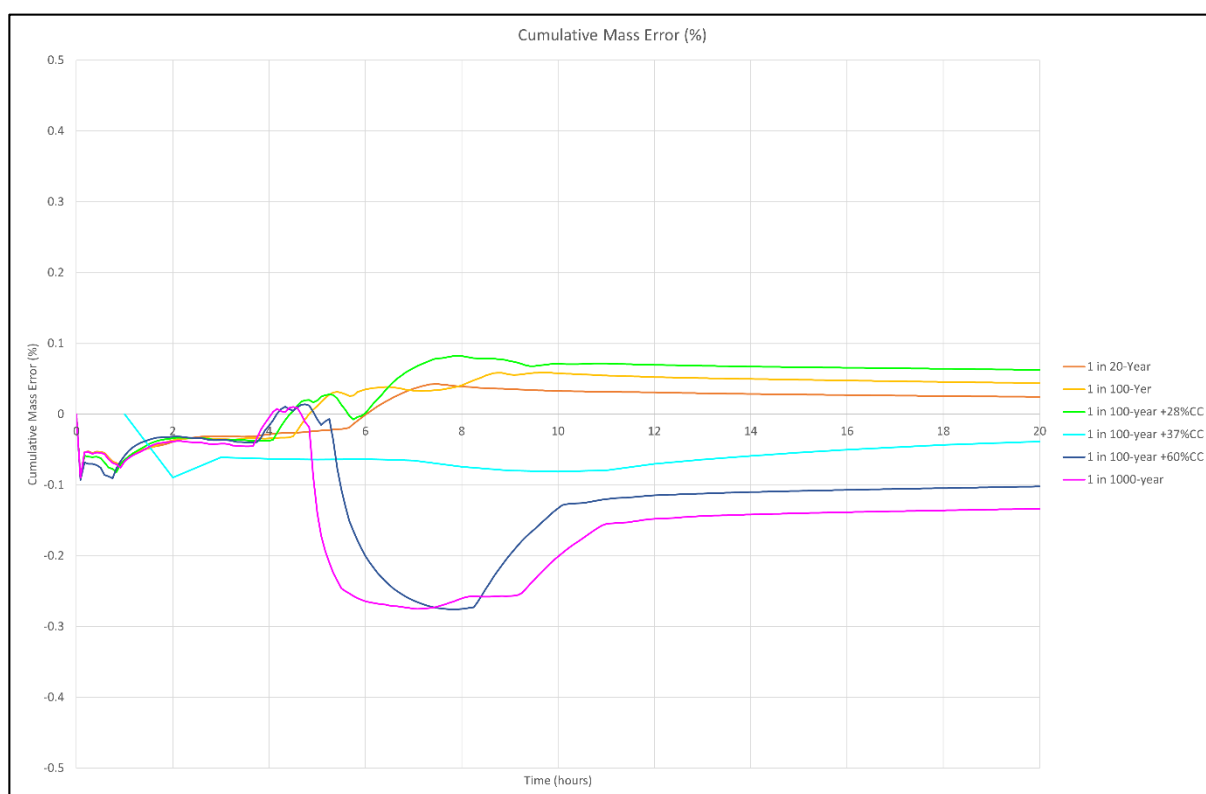


Figure 3.3: Cumulative Mass Error Time Series Plots

Model Runs

3.45 In order to achieve the study objectives, the simulations summarised in **Table 3.3** were completed.

Table 3.3: Model Runs

Model Geometry	Return Periods	Comments
Baseline	1 in 20-Year 1 in 100-Year 1 in 1000-Year 1 in 100-Year +28%CC 1 in 100-Year +37%CC 1 in 100-Year +60%CC	Representative of "as surveyed" conditions.
Roughness +20%	1 in 100-Year	Floodplain, channel and structure roughness increased by 20%
Roughness -20%	1 in 100-Year	Floodplain, channel and structure roughness decreased by 20%
DSBDY +20%	1 in 100-Year	1D HT downstream boundary unit was decreased by 150mm. The 2D HQ slope value was increased by 20%.

Model Geometry	Return Periods	Comments
DSBDY -20%	1 in 100-Year	1D HT downstream boundary unit was increased by 150mm. The 2D HQ slope value was decreased by 20%.
3-hour Storm Duration	1 in 100-Year	The 1 in 100-year was simulated for the 3-hour storm duration using a 20-minute time interval over a duration of 15 hours.
11-hour Storm Duration	1 in 100-Year	The 1 in 100-year was simulated for the 3-hour storm duration using a 1-hour time interval over a duration of 25 hours.
Blockage Location 1	1 in 100-Year	The missing access track crossing upstream of the site boundary was represented as 100% blocked in the 2D domain through using a Z-shape.
Blockage Location 2	1 in 100-Year	The two 750mm diameter pipes that are culverted beneath Brascote Lane were represented as 100% blocked in the 1D domain.
Blockage Location 3	1 in 100-Year	The missing structure downstream of Brascote Lane was added to the 1D domain as a 100% blocked 0.8m x 0.8m box culvert for this scenario.

4. BASELINE RESULTS

- 4.1 The results from the existing conditions model are mapped within **Appendix 4** and are summarised below. The flood mechanisms are discussed further within the forthcoming section.
- 4.2 The floodplain extents at the site have been summarised and are in **Figure 4.1**.

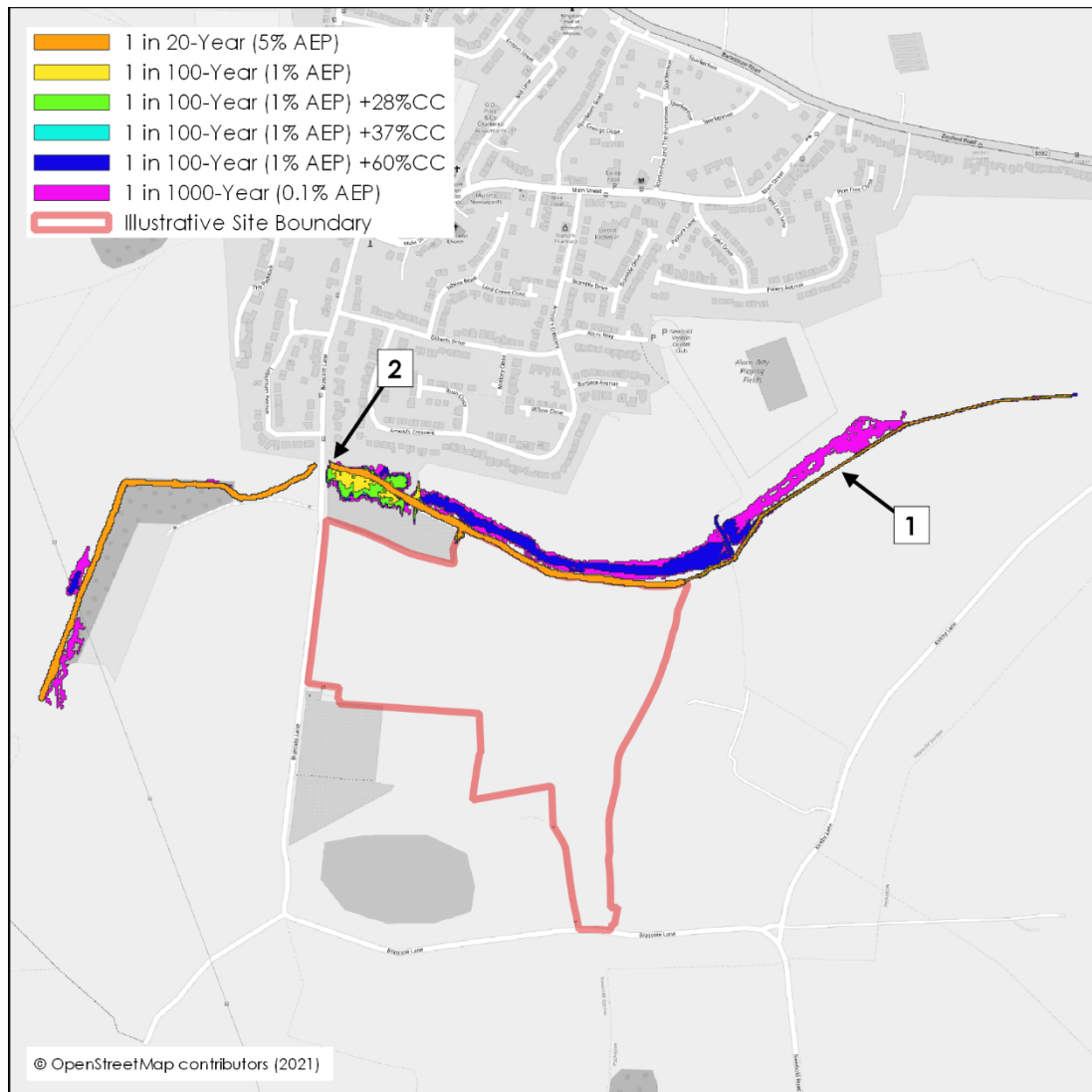


Figure 4.1: Fluvial Floodplain Extents

1. Thurlaston Brook 2D Channel

- 4.3 The floodplain extents are shown to be contained to the 2D Thurlaston Brook channel for all events excluding the 1 in 100-year +60%CC and 1 in 1000-year events.
- 4.4 During the 1 in 100-year +60%CC event, in-channel levels exceed the channel capacity approximately 150m upstream of the site boundary. Bank levels are lower on the right back of the watercourse at this location and subsequently, flood waters spill into the floodplain north of the channel. These are shown to be conveyed in the

floodplain for approximately 550m before entering back into the floodplain upstream of Brascote Lane road crossing.

- 4.5 Similar flow patterns are displayed in **Figure 4.1** for the 1 in 1000-year event. However, during this event, in-channel water levels exceed the channel capacity further upstream, again overtopping the right bank crest level and, in turn, spilling into the floodplain. This is displayed by the pink flood extent.

2. Brascote Lane Road Crossing

- 4.6 The smallest modelled return period was the 1 in 20-year event. The flood extent is shown to remain largely in-channel for the duration of the simulation. There is a small corner of the site boundary immediately upstream of the allotments which is shown to be partly affected by the 1 in 20-year floodplain extent. Water levels during the 1 in 20-year event remain in-channel immediately upstream and downstream of the Brascote Lane road crossing.
- 4.7 Similar flood patterns can be seen during the 1 in 100-year event, with the same area immediately upstream of the allotments being shown to be affected with a marginally larger area. The key difference between the 1 in 20-year and 1 in 100-year extent is that the 1 in 100-year extent is shown to spill into both sides of the floodplain immediately upstream of the Brascote Lane road crossing. This therefore suggests that the hydraulic structure has an insufficient capacity to convey flows for the 1 in 100-year event, which is confirmed by the long-section plot displayed in **Figure 4.2**. Downstream of this structure, the flood extent is shown to be contained within the Thurlaston Brook channel.

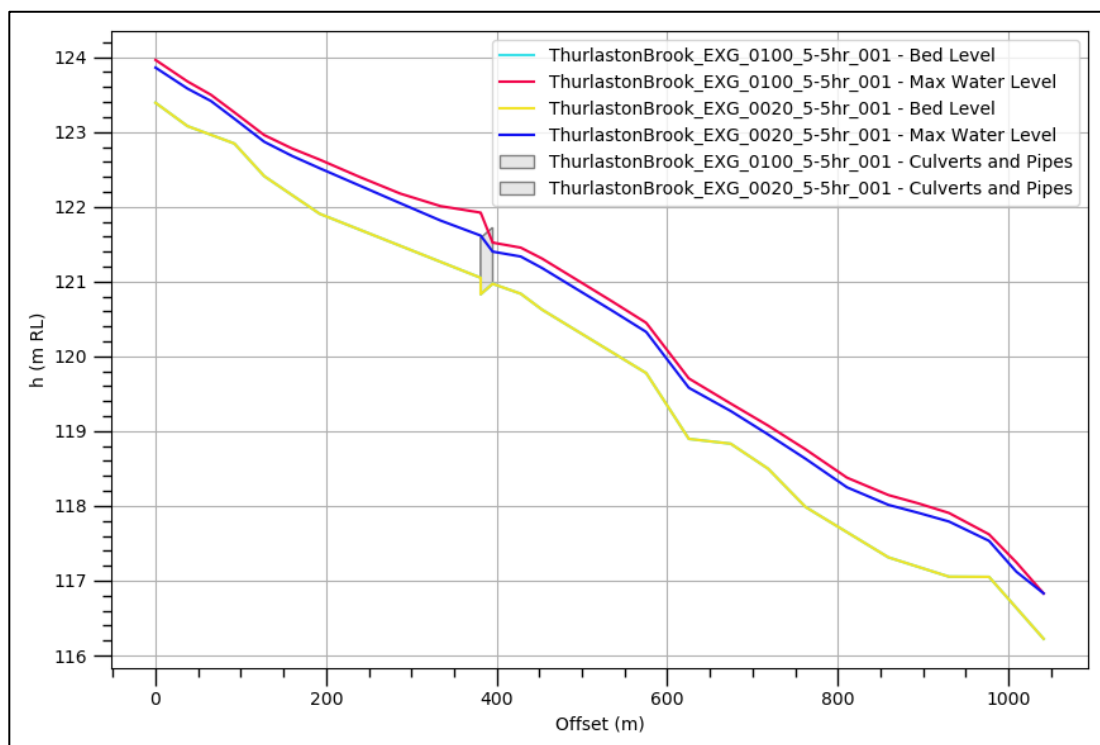


Figure 4.2: Long Section Plot Demonstrating Maximum Water Levels for 5% and 1% AEP Events

- 4.8 The 1 in 100-year +28%CC and 1 in 100 year +37%CC extents are similar to that of the 1 in 100-year extent except that they are associated with larger flood extents on the floodplain immediately upstream of the Brascote Lane road crossing. This is to be expected given the larger flows that are associated with these events.
- 4.9 As expected, the 1 in 100-year +60%CC and 1 in 1000-year flood extents are also associated with larger floodplain extents immediately upstream of the road crossing. The 1 in 1000-year extent also affects a small area of floodplain immediately downstream of Brascote Lane. Closer to the downstream boundary, both the 1 in 100-year +60%CC and 1 in 1000-year flood extents spill into the right bank, resulting in a small localised area of ponding. At the very downstream limit of the model, the 1 in 1000-year extent is also shown to be out-of-bank after exceeding the left bank crest level.

5. SENSITIVITY TESTING

- 5.1 To account for seasonal variations in vegetation and to ensure the robustness of boundary conditions, a series of sensitivity tests were conducted using the 1 in 100-year flood return period event. The difference in peak water level and floodplain extent between the sensitivity test scenarios and the 1 in 100-year baseline event are mapped in **Appendix 5**.
- 5.2 Robust sensitivity analysis also provides improved confidence in the model outputs, particularly in absence of calibration data.

Flow Estimates

- 5.3 As a climate change allowance has been assessed, it was not considered necessary to test variations on the predicted flood flows.

Storm Duration

- 5.4 The adopted recommended storm duration (5.5-hours) was derived in ReFH2.3 from the total study catchment area.
- 5.5 To assess how sensitive the model is to changes in storm duration, 3-hour and 11-hour storm durations were also simulated for the 1 in 100-year event. The results were compared against the 5.5-hour 1 in 100-year flood event to identify the extent of changes in water levels.
- 5.6 The comparison identified that for both the 3-hour and 11-hour storm durations, in-channel peak water levels were lower than for the 5.5-hour storm. The difference between flood levels for the 11-hour storm and the 5.5-hour storm were fairly minor and were generally shown to be no greater than 0.05m.
- 5.7 A much greater difference in model outputs can be seen between the 5.5-hour 1 in 100-year event and the 3-hour 1 in 100-year event. The flood extent can be seen to be notably smaller for the 3-hour storm duration with a relatively large area of floodplain immediately upstream of the Brascote Lane road crossing in the allotments identified as a "Former wet area now dry". More specifically, the peak difference in 1D water levels is reported as 0.167m. On the floodplain, the maximum difference is 0.157m.

Roughness

- 5.8 Sensitivity testing has shown that a 20% reduction in channel and floodplain roughness (representative of winter seasonal conditions or channel conditions following maintenance) results in a general decrease of in-channel flood levels.
- 5.9 There was a notable difference to how in-channel levels differed between the reach of the Thurlaston Brook modelled in the 1D domain, and the reach represented in the 2D domain. Within the 1D ETRY component, the 20% reduction scenario resulted in a negligible increase in water levels of <0.01m. This is contrary to expectations as a

reduction to the frictional drag effects imposed by rougher surfaces would typically increase the conveyance of the channels and culverts.

- 5.10 The increase within the 1D domain can be explained by the larger differences that can be seen between maximum water levels across the upper stretch of the Thurlaston Brook, that is represented in the 2D domain only. More considerable differences of between +0.082m to -0.213m are noted in the 2D domain. There is generally a reduction in levels in the watercourse (where represented in the 2D domain), which would be as a result of the improved channel conveyance in this reach. This perhaps subsequently explains why levels marginally increase in the 1D channel further downstream, although the differences could be described as insignificant (< 0.01m).
- 5.11 The impact on floodplain extents was shown to be negligible, with a small reduction in floodplain extent visible at the allotments, immediately upstream of Brascote Lane.
- 5.12 In contrast, a sensitivity test was also conducted whereby a 20% increase in Manning's 'n' (representative of summer seasonal conditions or a period without maintenance) was applied to the 1D and 2D domains of the hydraulic model. The model outputs are shown to result in a general increase of in-channel flood levels.
- 5.13 Again, there was a negligible difference in peak water levels shown in the 1D domain with levels increasing by <0.01m. Levels in the 2D reach of the Thurlaston Brook were shown to be up to 0.164m greater.
- 5.14 The impact on floodplain extents on the site are shown to be negligible with a very minor increase in extent (of 2 cells) in the allotments immediately upstream of Brascote Lane. This is to be expected given that an increase in roughness values across the floodplain would be associated with greater frictional forces against the flow of water as it looks to drain back into the channel. Subsequently, more flood water would likely be retained on the floodplain during these conditions.

Downstream Boundary

- 5.15 The downstream boundary is located approximately 700m downstream of the Brascote Land road crossing. It consists of a 1D head-time (HT) unit and a 2D head-flow (HQ) unit. The HT boundary has a set water level for the length of the simulation, whilst the HQ unit has an applied gradient derived from a terrain profile measured over the downstream 350m of floodplain.
- 5.16 As per the roughness tests, two sensitivity tests were conducted with the downstream boundary. Firstly, a decrease in gradient of 20% was applied to the 2D HQ boundary unit to represent a shallower slope. In combination with this, the 1D HT level was increased by 150mm. This therefore represented a scenario where in-channel levels were higher at the end of the system and there was a reduced impact of gravity on conveying flows out of the system.
- 5.17 In contrast, the alternative test increased the 2D HQ gradient by +20% to represent a steeper topography in the floodplain. The 1D HT boundary unit was decreased by 150mm. This scenario represented in an increase in gravity-driven conveyance of flow out of the model domain.

- 5.18 The model outputs reported localised impacts at the downstream limit of the model. The impacts on flood levels downstream of Brascote Lane road crossing were shown to be minimal and no differences are reported within the channel adjacent to the site.

Blockage Scenarios

- 5.19 Blockage scenarios were undertaken at locations of all surveyed hydraulic structures and known missed structures. These are identified within **Figure 5.1**.
- 5.20 A conservative worst-case scenario approach has been adopted whereby each hydraulic structure has been represented as 100% blocked. This is largely due to a lack of information on the structure opening areas at two of the blockage locations where surveyors were unable to access the watercourse.

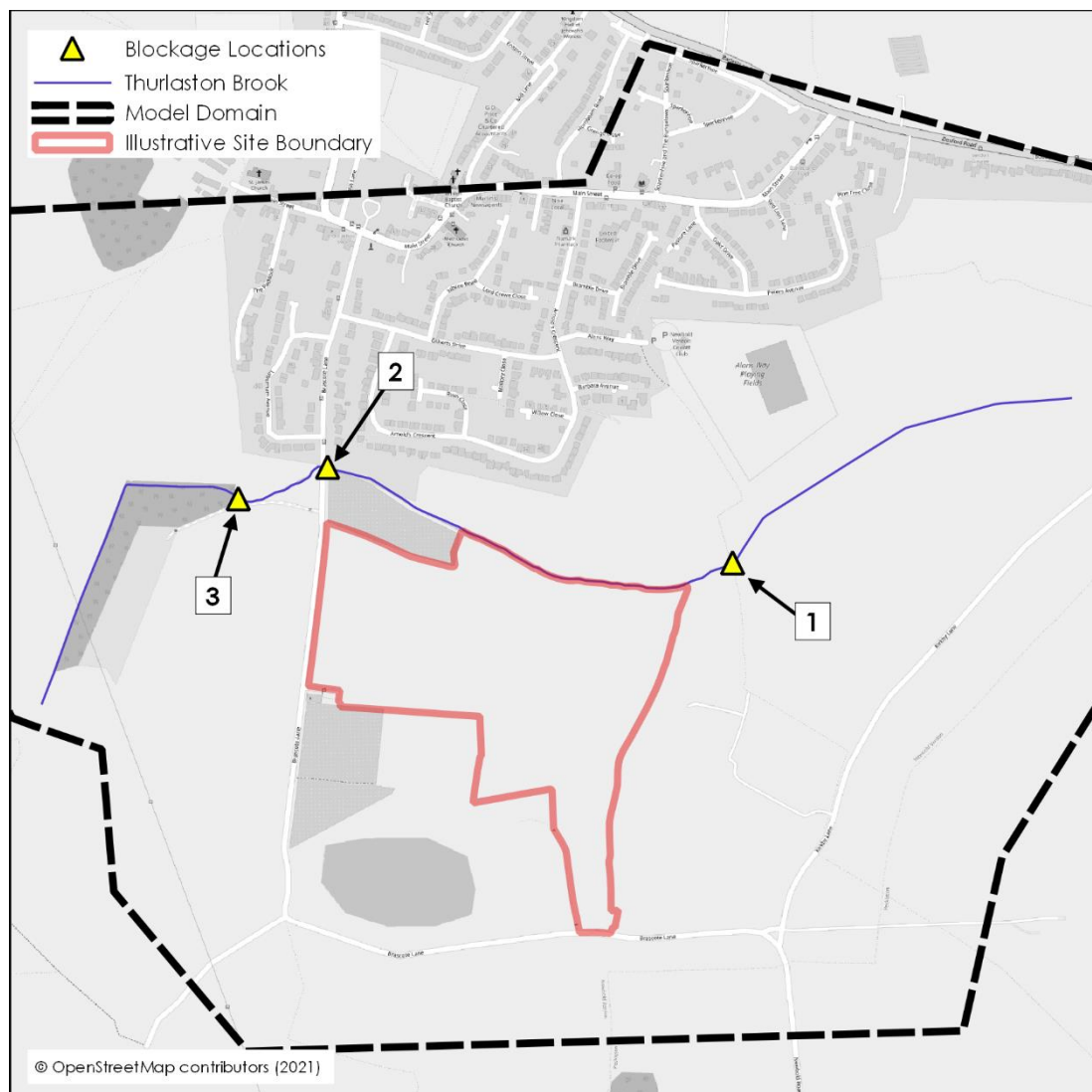


Figure 5.1: Blockage Locations

- 5.21 Blockage Location 1 (BLK1) was undertaken at an access track crossing that can be seen via satellite imagery. It was not possible for the surveyors to access this structure due to the watercourse being completely overgrown. At this location, the Thurlaston

Brook is represented in the baseline model as part of the 2D domain. Subsequently, a Z-shape was used to raise the cells over the deck of the road to the height of the access road. This was therefore considered as representing the channel as 100% blocked.

- 5.22 The BLK1 test has significant impacts on floodplain extents and flood levels in the channel. The blockage results in an increase in water levels in-channel immediately upstream which is to be expected as the obstruction prevents the conveyance of flows downstream of this location within the channel. As a result, levels continue to rise in-channel upstream of the blockage location until the right bank crest level is exceeded. Flows subsequently are shown to spill into the floodplain, resulting in a large area of floodplain north of the channel being shown as wet in a former dry area. Due to the volume of flow that has been directed to the floodplain, in-channel water levels immediately downstream of BLK1 are up to 0.496m lower than in the 1 in 100-year baseline scenario.
- 5.23 Blockage Location 2 (BLK2) was undertaken to the two surveyed 0.75m diameter circular culverts beneath the Brascote Lane road crossing. A 100% blockage percentage was applied to the ESTRY 1d_nwk unit.
- 5.24 In-channel water levels immediately upstream of the culvert increased by up to 1.083m. As a result of in-channel levels rising so dramatically, the capacity of the Thurlaston Brook becomes exceeded and water levels exceed the embankment and spill over the road crossing, returning back into the watercourse. Due to the slower conveyance of flows caused by the blockage, downstream levels in-channel are reported as being approximately -0.050m to -0.09m lower than the baseline 1 in 100-year levels.
- 5.25 Finally, Blockage Location 3 (BLK3) was modelled downstream of Brascote Lane at a location identified by OS Master Mapping as being crossed by a structure. The watercourse surveyors were also unable to access the river at this location due to thick vegetation. Given that the Thurlaston Brook at this location is represented within the 1D domain, a different approach was adopted to BLK1. For the purpose of the sensitivity test, a 'dummy' 0.8m x 0.8m box culvert was added to the model, and a 100% blockage was applied to it. Flow was allowed to leave the blocked channel through HX links following a break in the 1D domain.
- 5.26 The model outputs show in-channel flood levels increase immediately upstream of the blocked structure by up to 0.695m. Subsequently, the channel capacity is shown to become exceeded with floodwater spilling out the right bank and into the floodplain to the north. Flood waters return to the channel further downstream after bypassing the structure. Flood levels are reported as up to 0.238m lower immediately downstream of the blocked structure. The higher water level downstream of the Brascote Lane road crossing also results in a reduction in flood levels immediately upstream of this culvert. This is likely to be due to the downstream invert level of the circular culverts being surveyed and modelled as 0.14m higher than the upstream invert levels.
- 5.27 None of the three blockage scenarios are subsequently shown to result in an increased flood risk to the site and the proposed development.

6. SUMMARY & RECOMMENDATIONS

- 6.1 The conclusion should be read in conjunction with the study limitations and assumptions in **Section 1**.
- 6.2 The primary aim of this exercise was to establish a provide a detailed understanding of potential flood risk to the proposed development site at land off Brascote Lane, Newbold Verdon (NGR: SK 4468 0320). This was achieved through the creation of a site specific 1D-2D hydraulic model to better understand flood risk associated with the Thurlaston Brook.
- 6.3 The hydraulic assessment was informed by a hydrology assessment of the likely flood flows. This was undertaken using the industry standard FEH methodologies, as there was no gauged data available within the study area.
- 6.4 The baseline modelling has shown that the site boundary remains largely unaffected during all modelled flood events. Fluvial flood extents are shown adjacent to the north of the site due to the Thurlaston Brook forming the northern border of the site.
- 6.5 A number of sensitivity tests have been undertaken within the model on key assumptions. These tests have identified that the model results for the watercourses are sensitive to changes in roughness, flow, and blockages of key structures. The sensitivity tests confirmed that the most conservative storm duration has been adopted.
- 6.6 Whilst the model is shown to be appropriately sensitive to the tested parameter changes and blocked structures, the assessed differences are not shown to result in an increase in flood risk to the proposed development site.

APPENDICES

Appendix 1: River Channel Survey

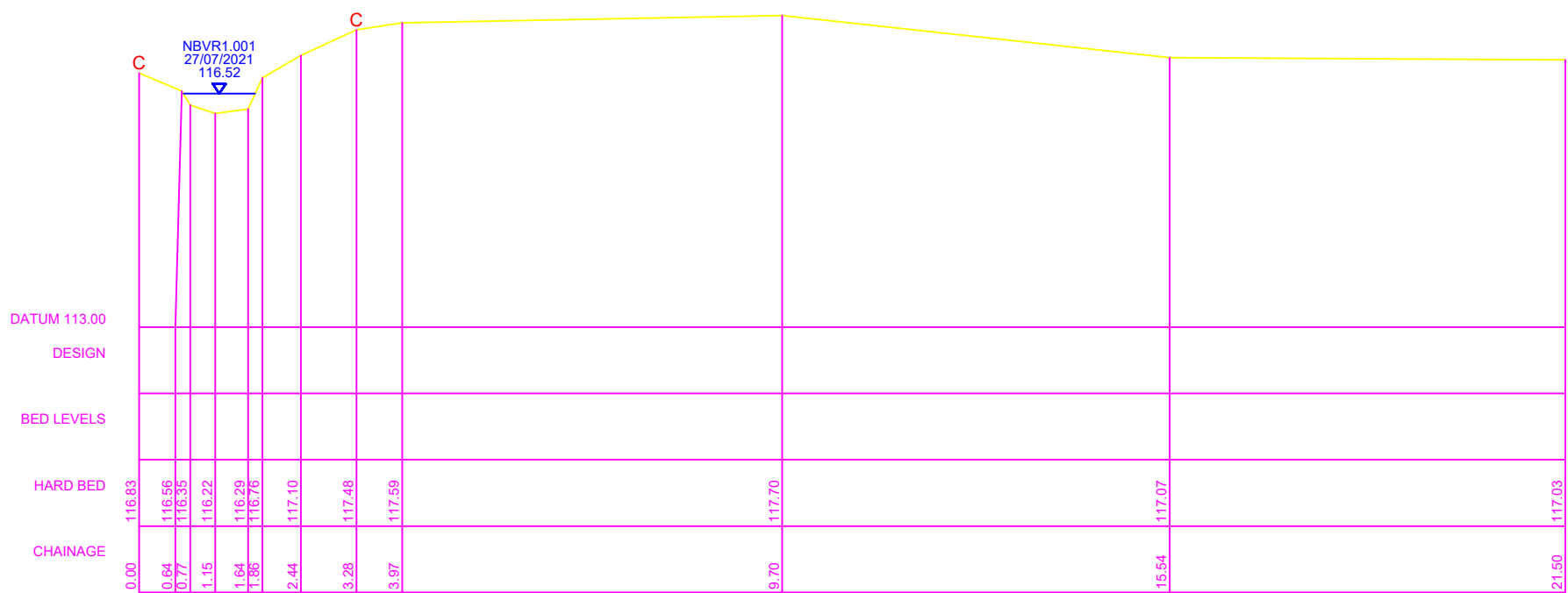
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 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. No scale factor has been applied to this survey, therefore the OS coordinates are to be treated as arbitrary. Please refer to survey station information below for on site control establishment.
 6. All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via OS smart net.
 7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
 8. OS license number: 100022432

Key Plan

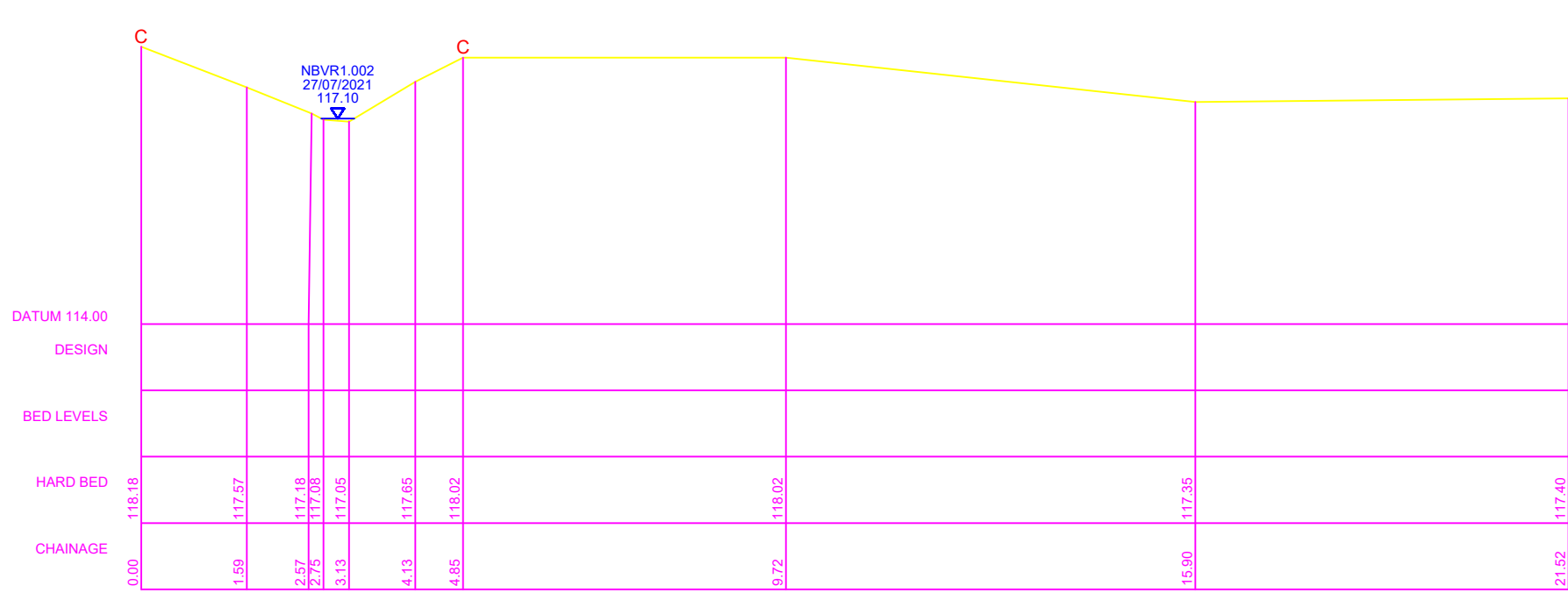


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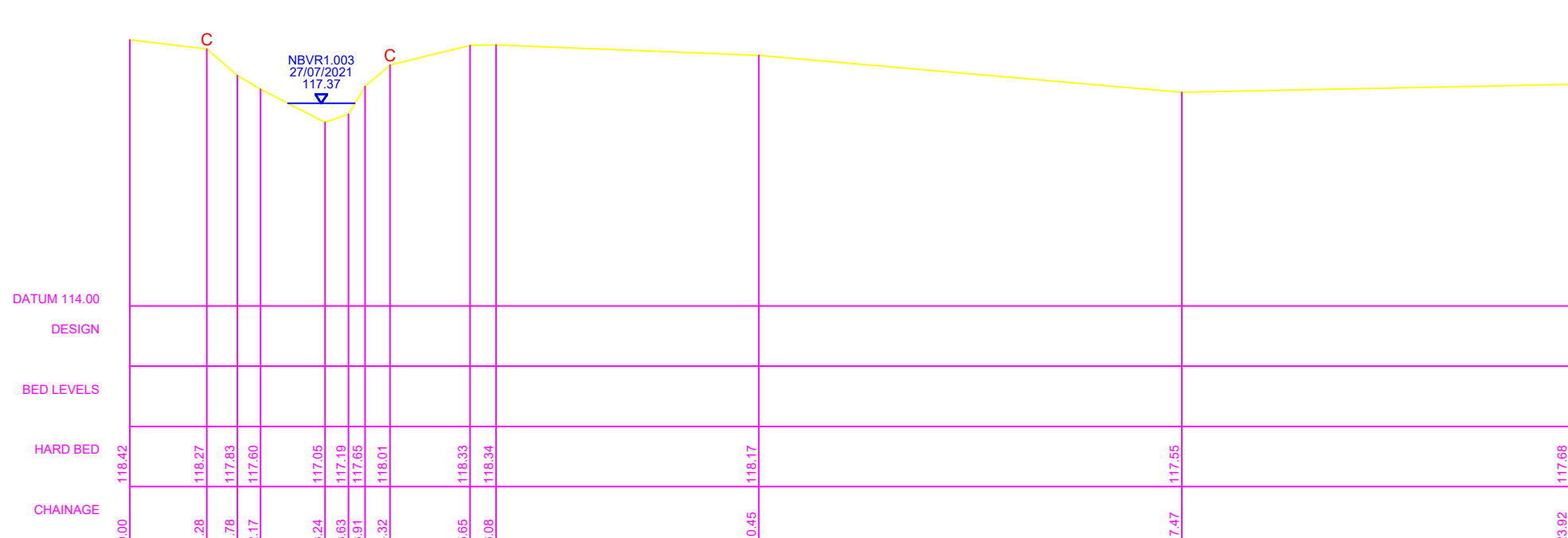
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| Surveyed Buildings | Inspection Chamber |
| Building | Flow direction and pipe diameter |
| Wall | Station and Name |
| Kerb Channel Line | Monitoring Borehole |
| Top of Kerb | Tree / Bush / Sapling |
| Edge of Surface | Area of Vegetation/ Extent of Tree Canopy |
| Top of Bank | Hedge |
| Bottom of Bank | Body of Water |
| Canopy / Overhang | Body of Water from OS |
| Line Marking | Spot Level |
| Centre Line | Assumed Surface |
| Watercourse | Water Drainage Line |
| Centre Line | Surface Water Drainage Line |
| Barrier | |
| Fence | |
| Gate | |
| Overhead Powerline | |
| Overhead Utilities | |
-
- | | | |
|----------------------|--------------------------|----------------------|
| AP Anchor Point | FBW Fence Barbed Wire | LB Litter Bin |
| BO Back Gully | FOB Fence Closed Board | LP Lamp Post |
| BOB Bollard | FCL Fence Chain Link | MH Manhole |
| BS Bus Stop | FEL Fence Electric | MV Service Marker |
| BT British Telecom | FMP Fence Metal Panel | PS Post Box |
| C Crest | FMF Fence Metal Rolling | PT Post |
| CL Cover Level | FOB Fence Open Board | RE Roadside Eye |
| CMP Cable Marker | FPW Fence Post & Wire | SP Sign Post |
| Post | FSP Fence Steel Pipeline | ST Stop Sign |
| CCTV/Security Camera | FVM Fence Wire Mesh | SV Stop Valve |
| CIV Cable TV | FPL Finished Floor Level | TGS Telephone |
| DK Drainage | FP Flagpole | THL Threshold Level |
| Channel | Gas Gas | TL Traffic Light |
| DK Drain Kerb | GV Gas Valve | TS Telegraph Post |
| DP Down Pipe | GY Gully | TS Traffic Signal |
| Elec Electric | HS Height | UTS Unable to Survey |
| EP Electricity Post | IC Inspection Chamber | VL Water Level |
| ER Earth Road | IFL Internal Floor Level | WM Water Meter |
| FI Fire Hydrant | IL Invert Level | WO Wash Out |
| FL Floodlight | (as a reduced level) | |



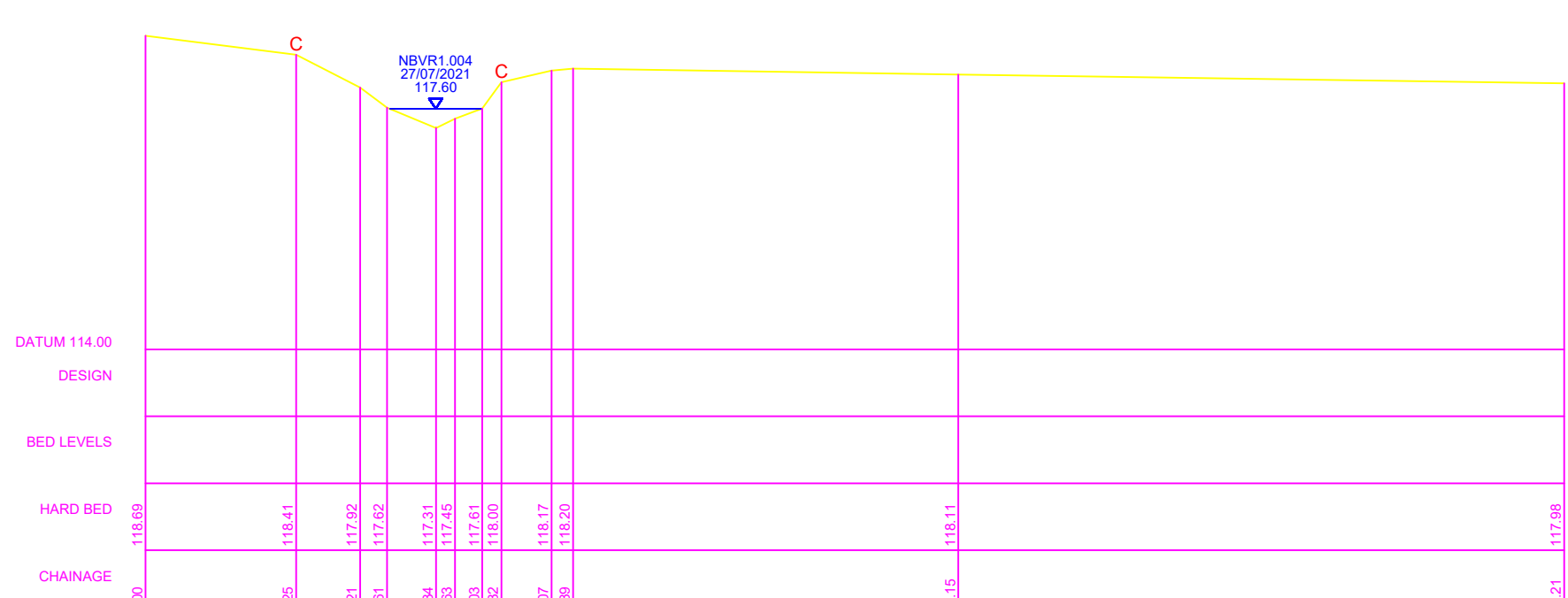
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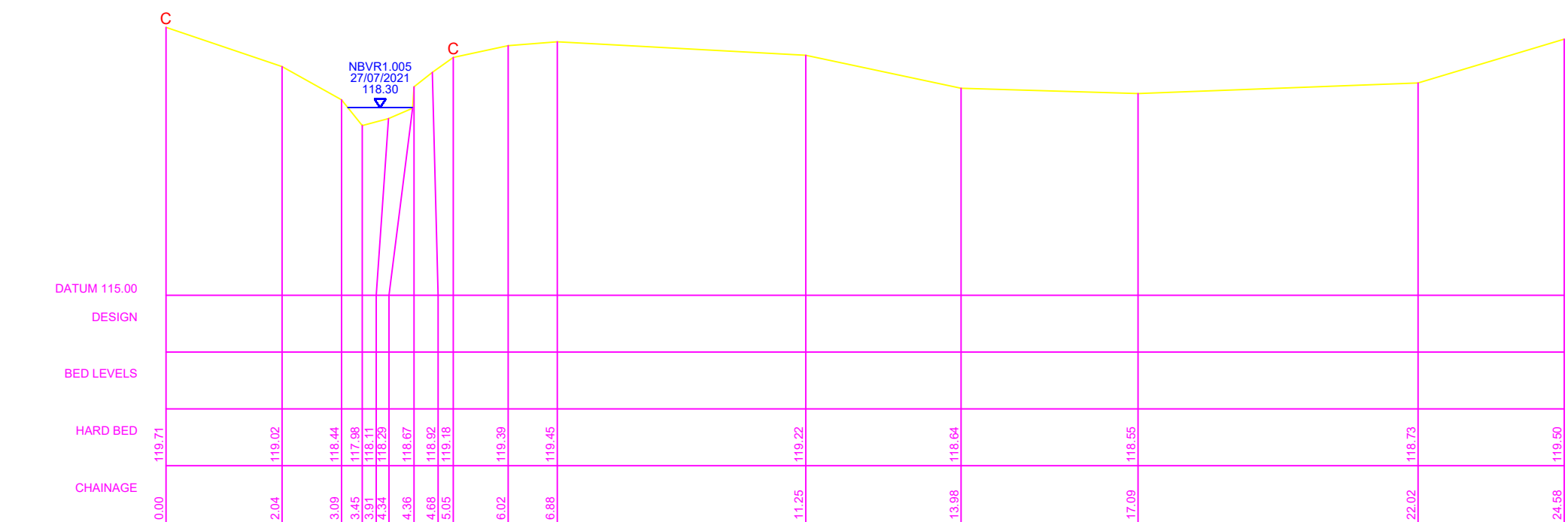
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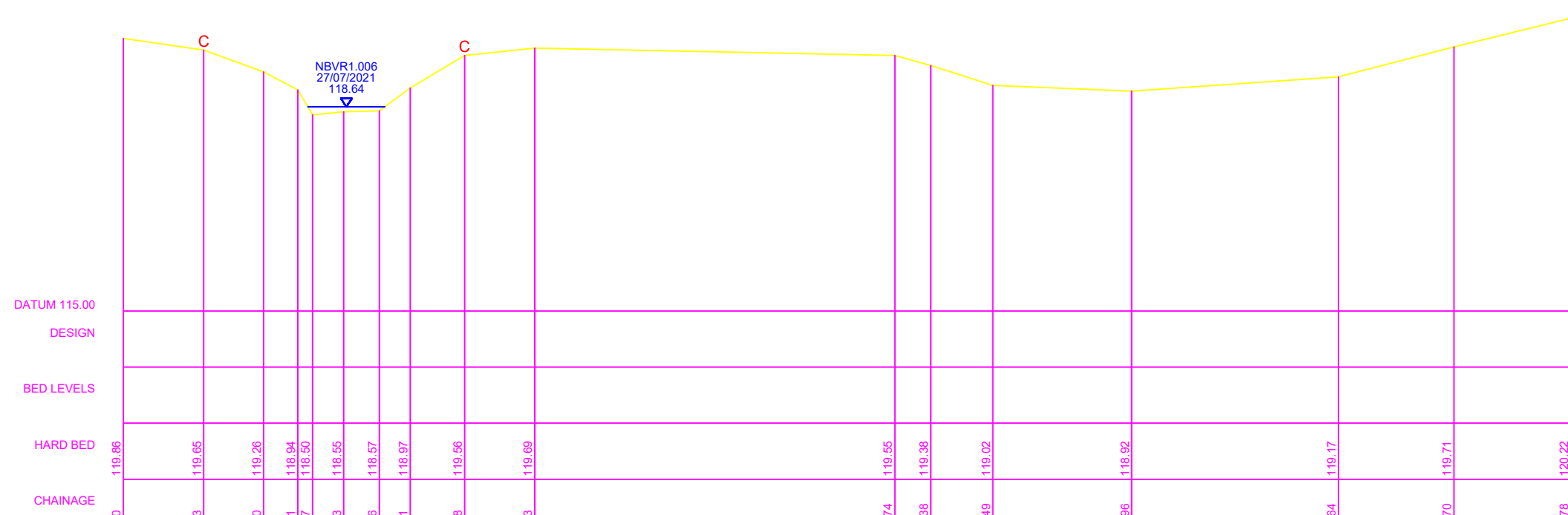
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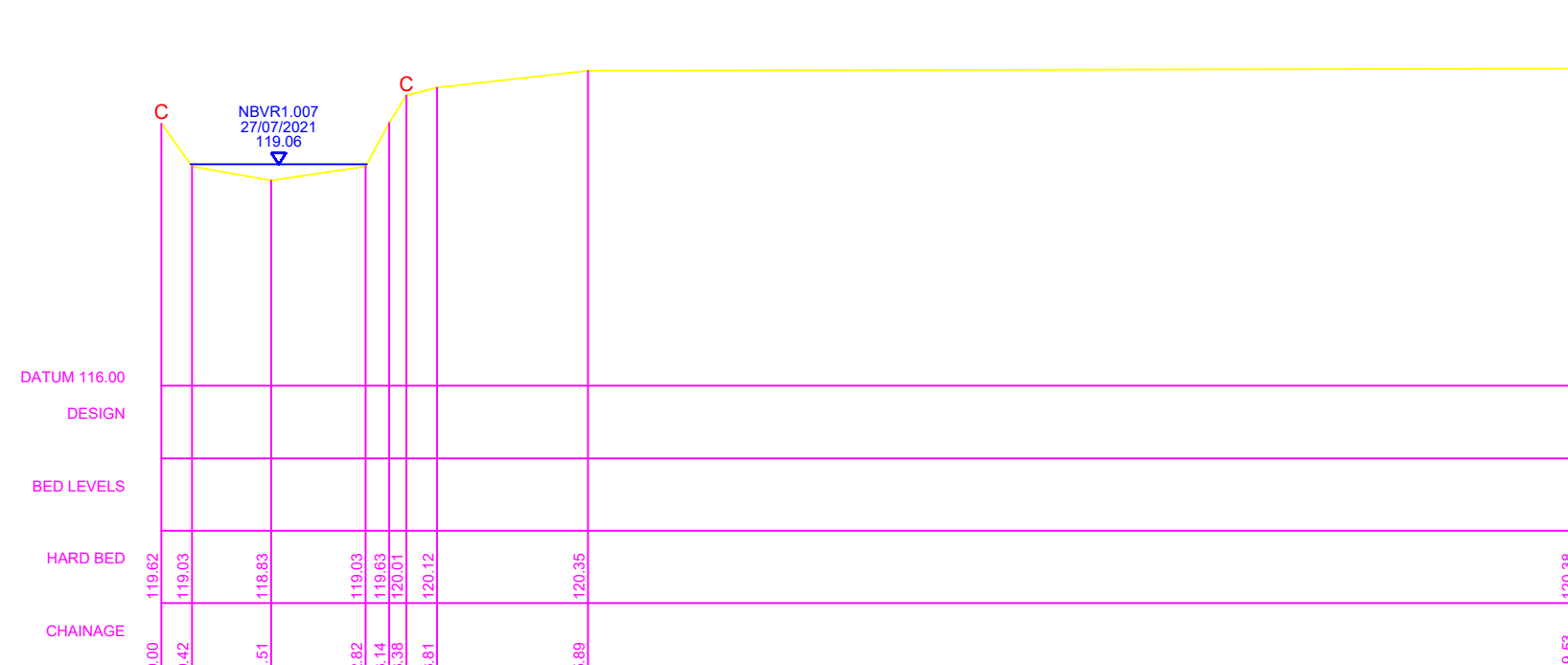
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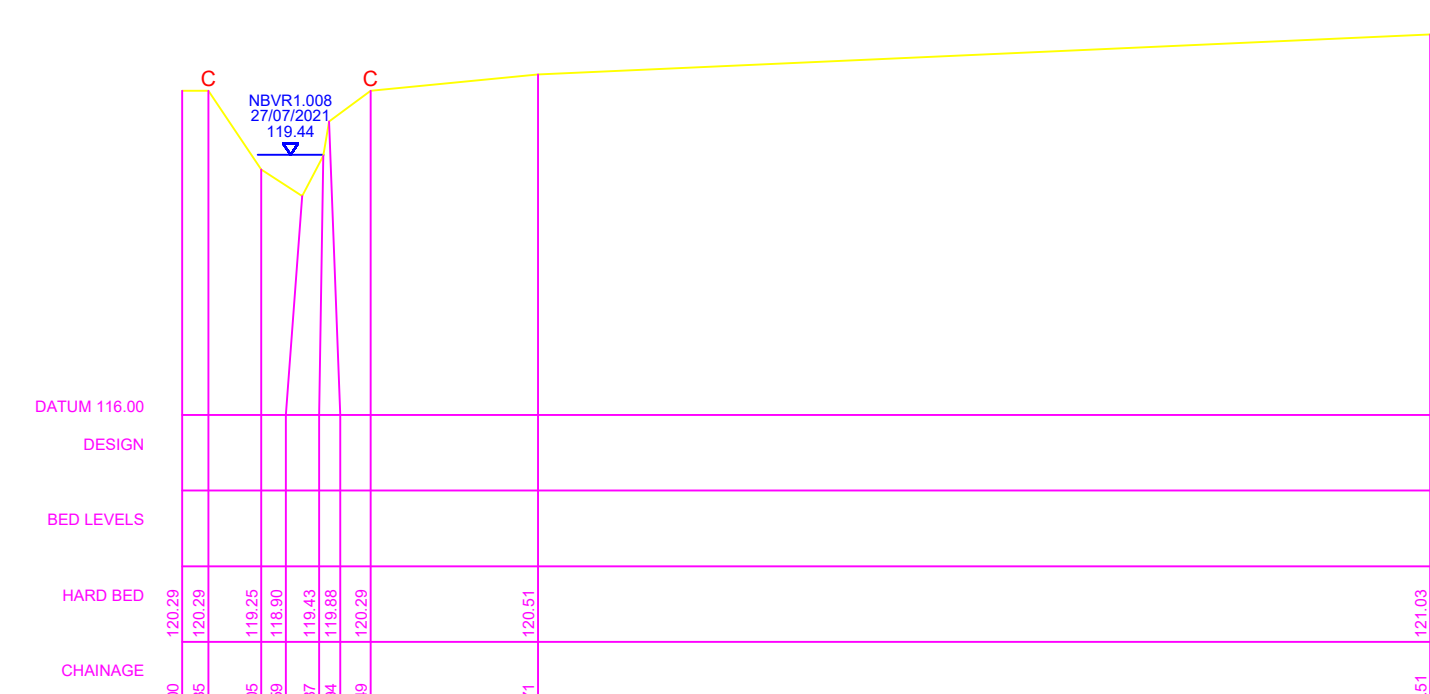
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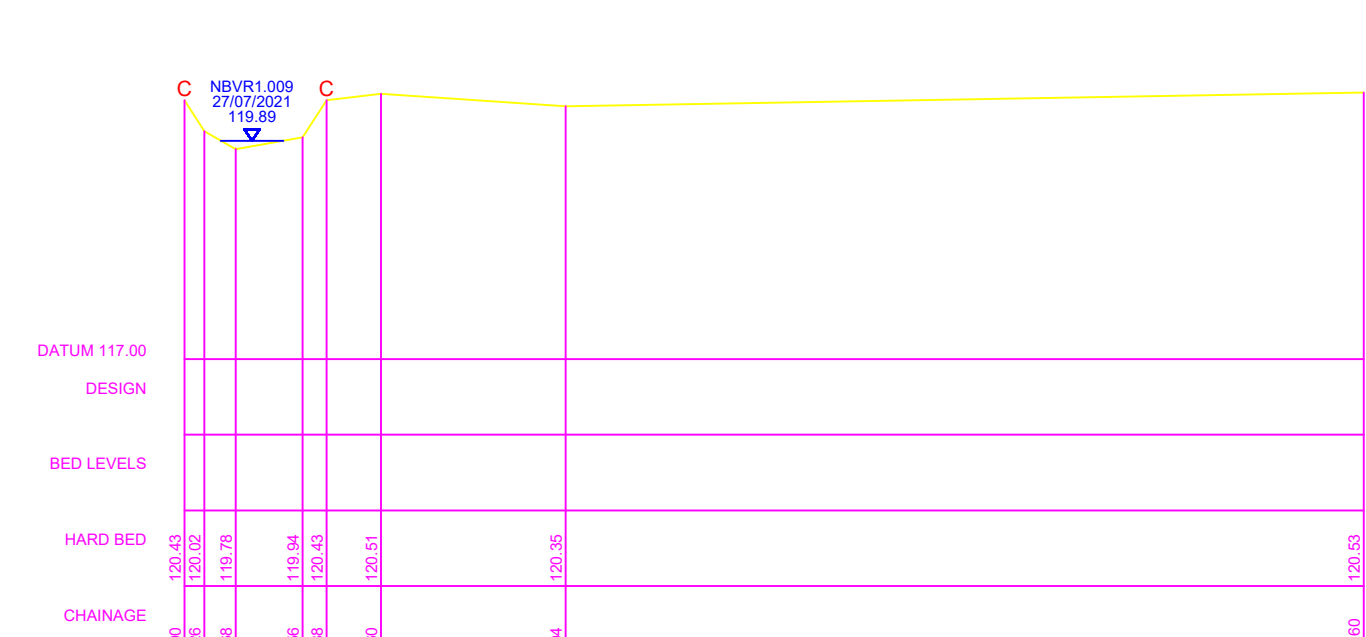
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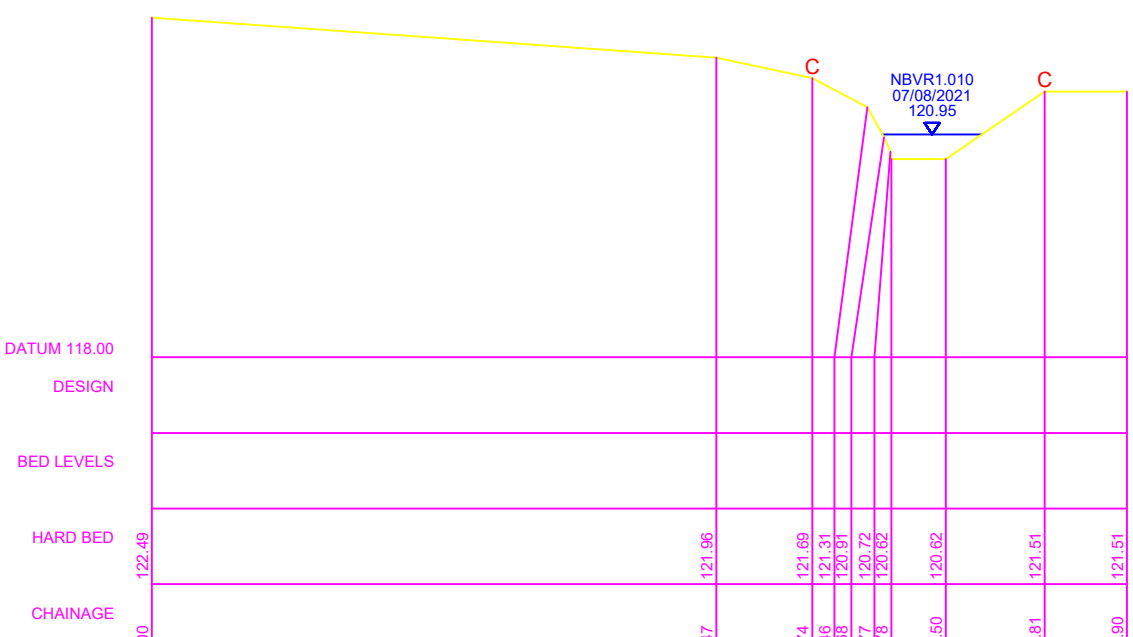
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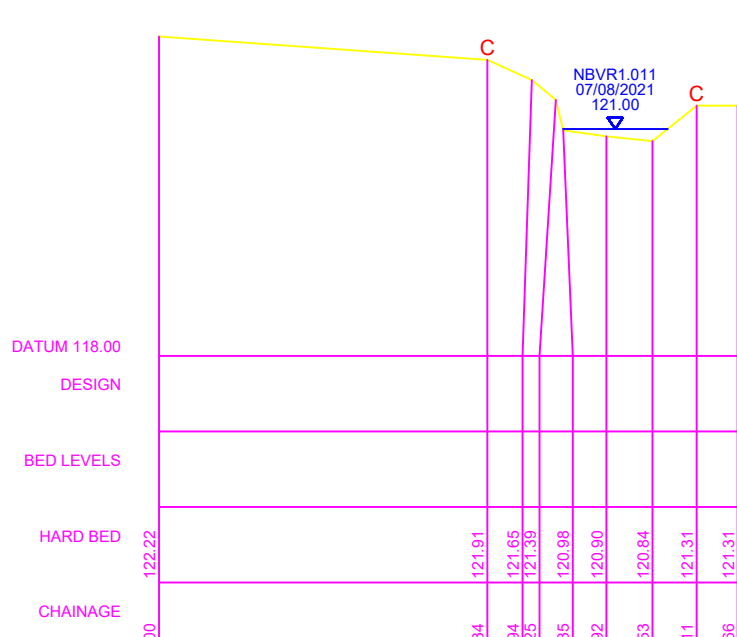
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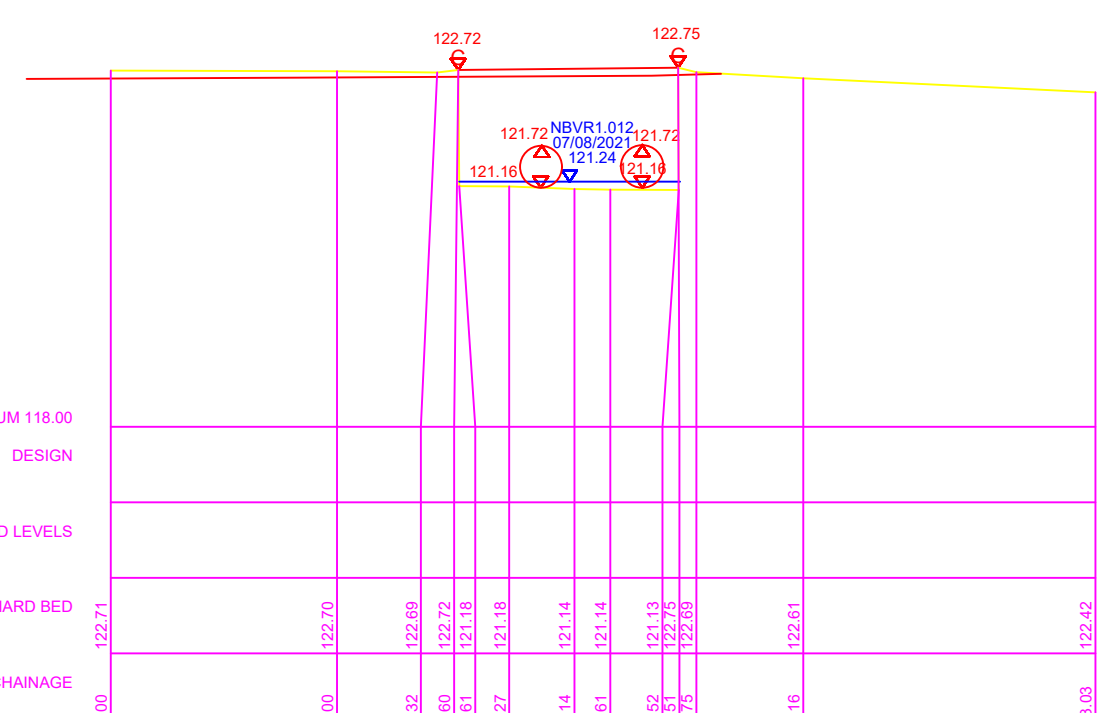
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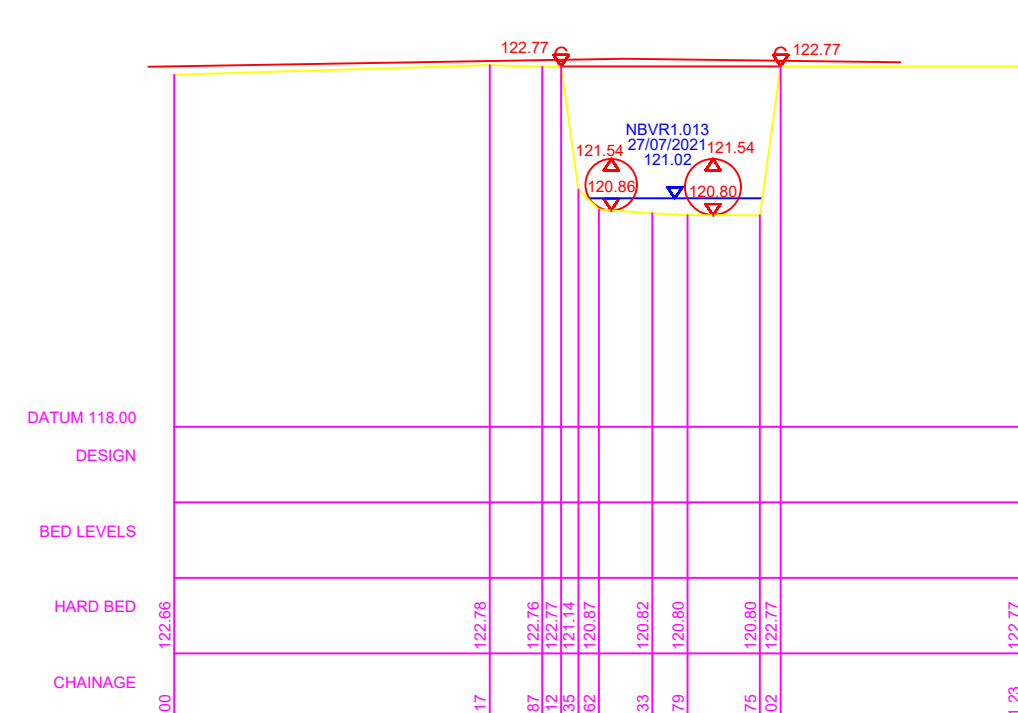
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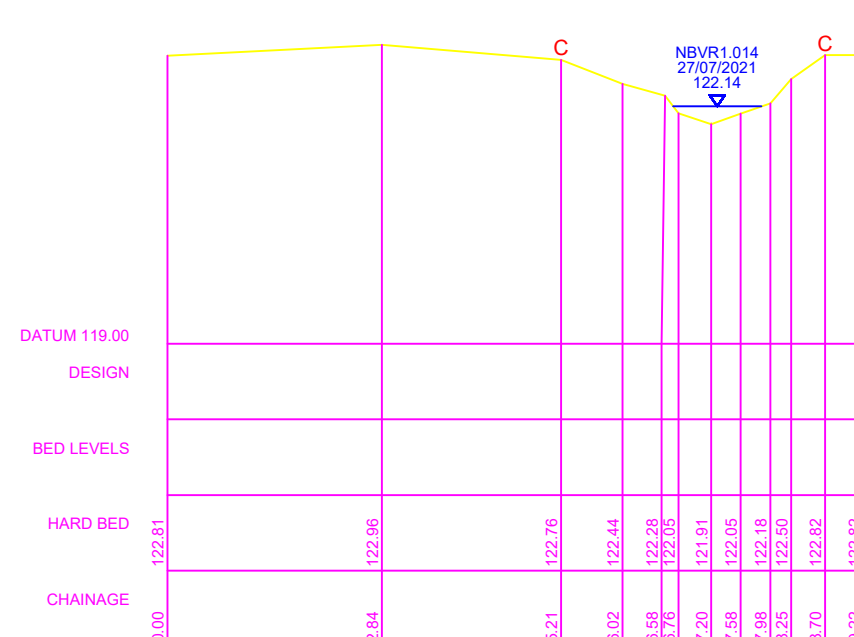
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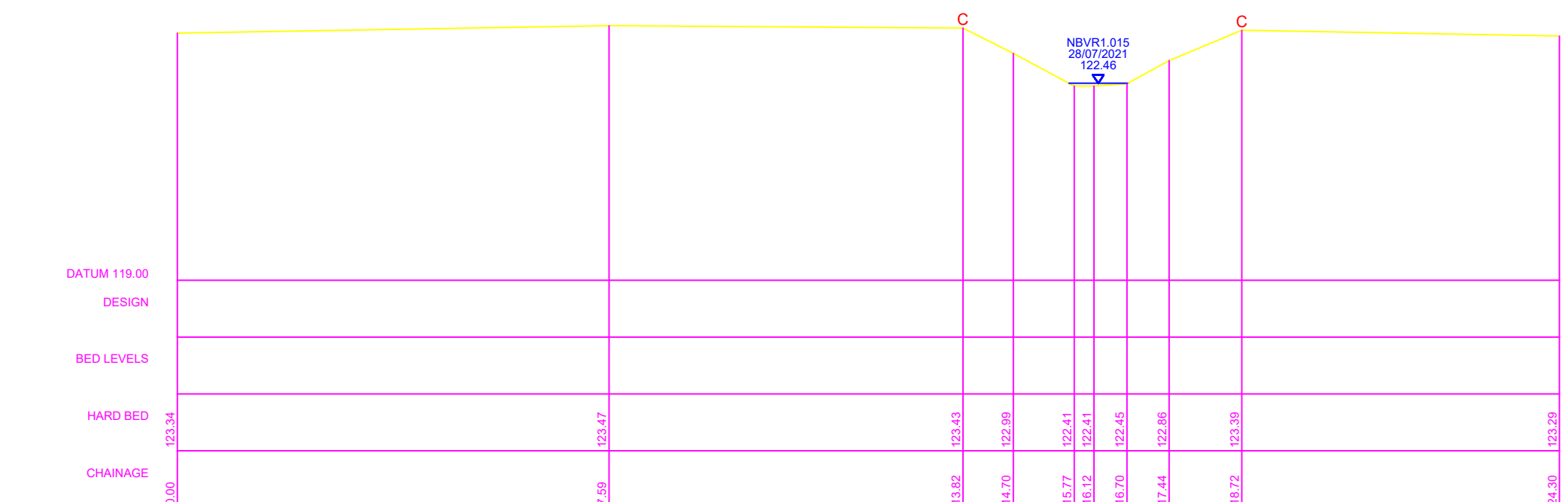
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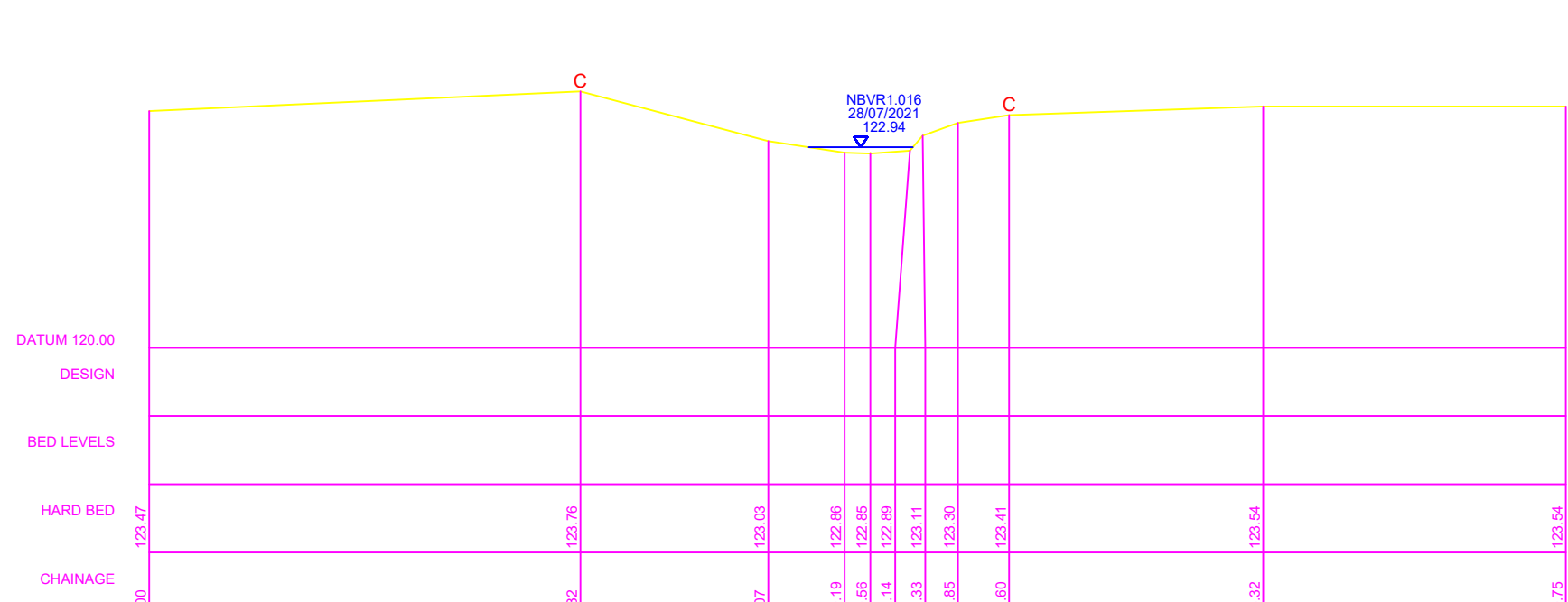
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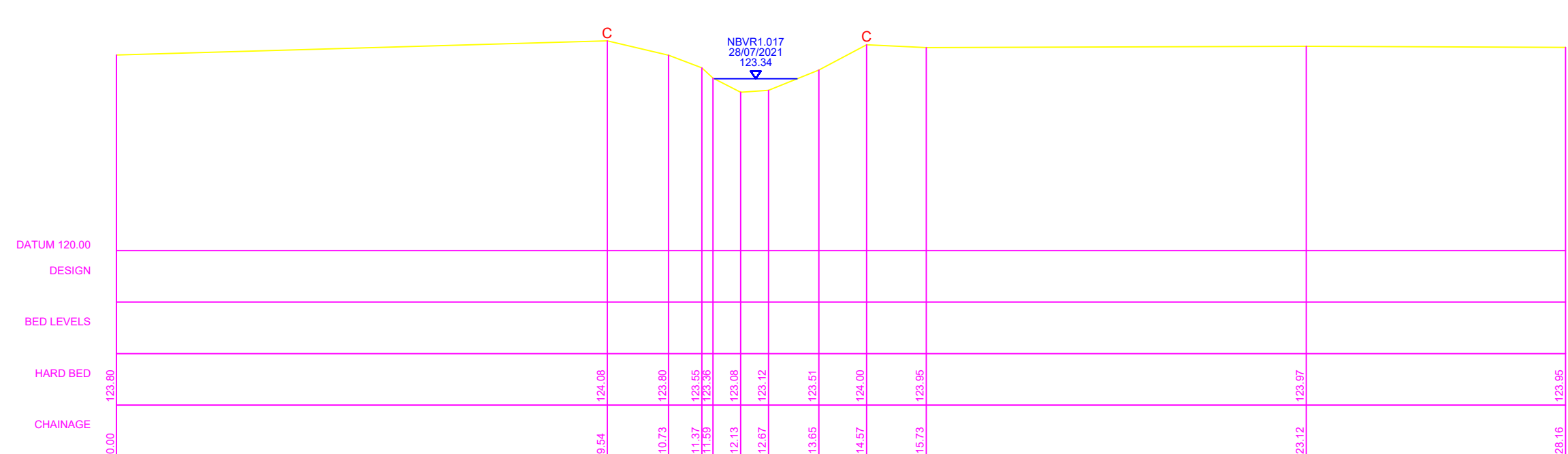
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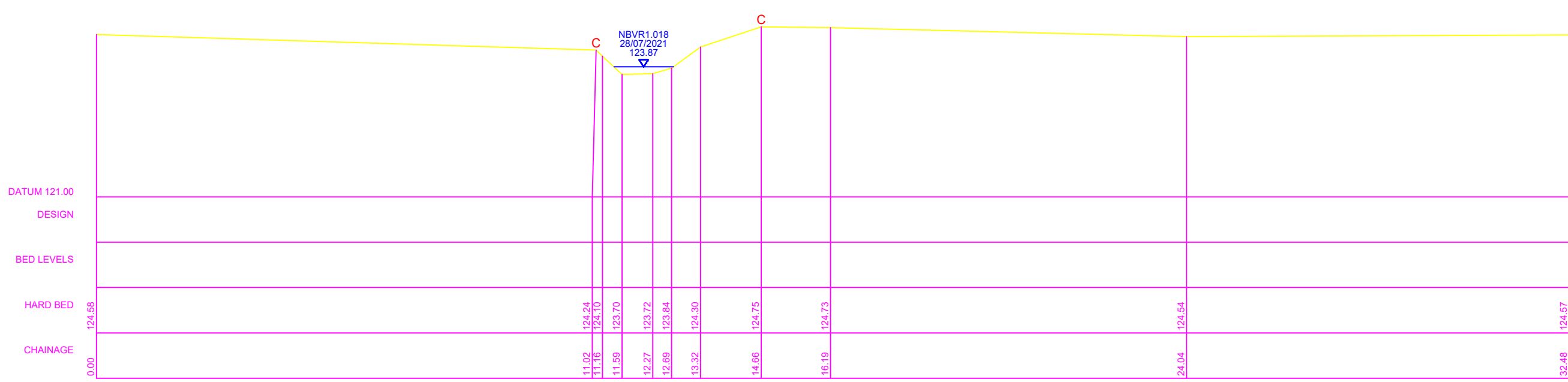
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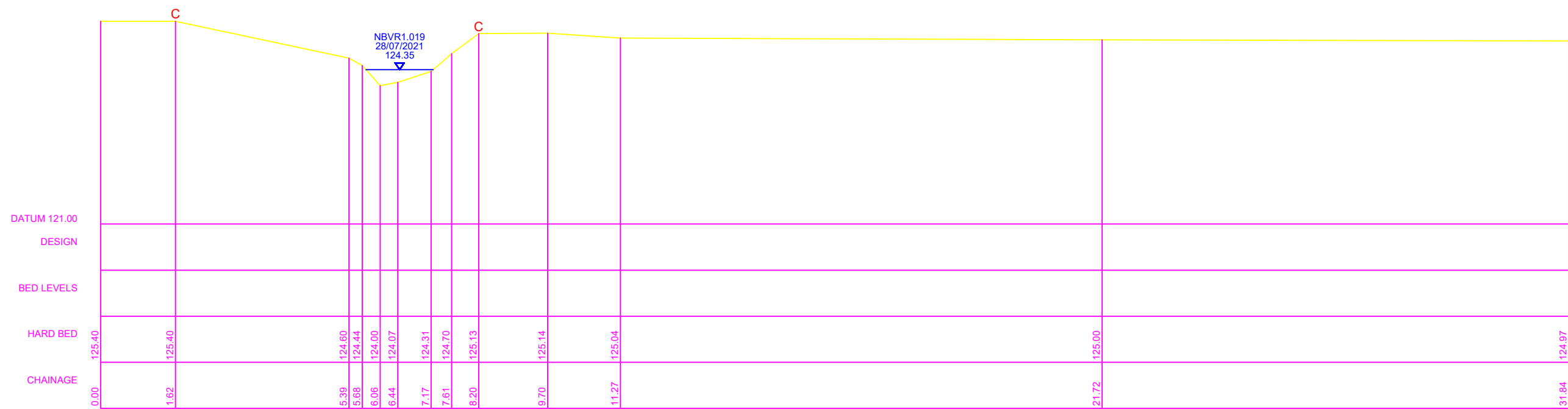
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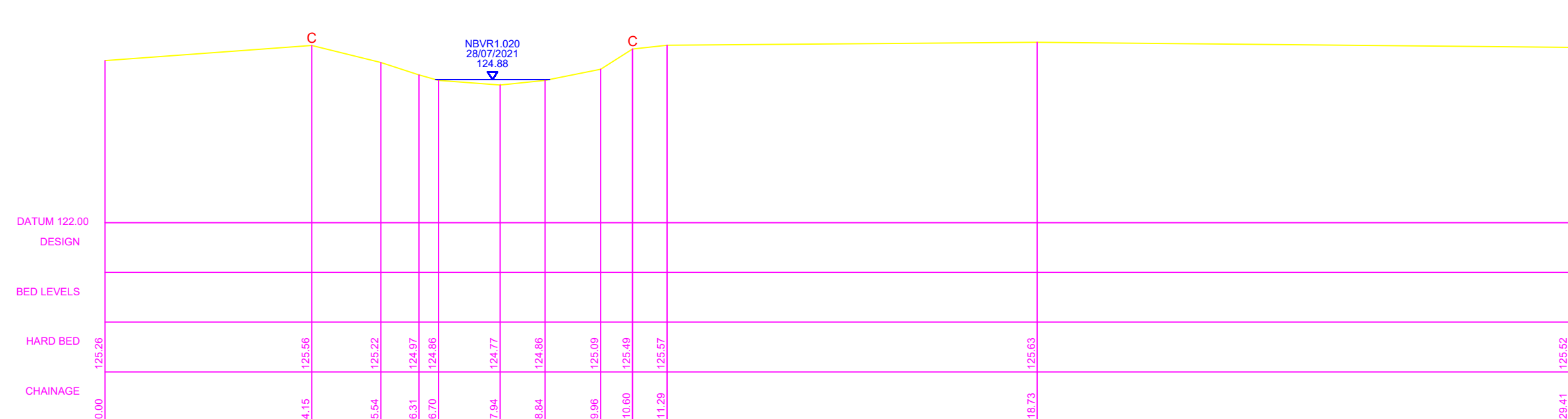
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Rev	Date	Details of issue / revision	Dw	Rev

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Client

Richborough Estates Ltd

Project Title

**Brascote Lane
Newbold Verdon**

Drawing Title

**Watercourse Survey
Reach 1 Sections 1 - 20
Sheet 1 Of 2**

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Project - Originator - Zone - Level - Type - Role - Number	BLN-BWB-00-ZZ-M2-G-0060		
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 7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
 8. OS license number: 10002422

Key Plan



Legend

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| Surveyed Buildings | Flow direction and pie-diameter | Station and Name |
| Building | Monitoring Borehole | |
| Wall | Tree / Bush / Sapling | |
| Kerb Channel Line | Area of Vegetation/ Extent of Tree Canopy | |
| Top of Surface | Hedge | |
| Top of Bank | Body of Water | |
| Edge of Surface | Body of Water from OS | |
| Bottom of Bank | Spot Level | |
| Canopy / Overhang | Assumed Surface | |
| Line Marking | Water Drainage Line | |
| Centre Line | Surface Water Drainage Line | |
| Watercourse | | |
| Centre Line | | |
| Barrier | | |
| Fence | | |
| Gate | | |
| Overhead Powerline | | |
| Overhead Utilities | | |
- | | | | | | |
|------|------------------|-----|-----------------------|-----|--------------------|
| AP | Anchor Point | FBW | Fence Barbed Wire | LB | Litter Bin |
| BO | Back Gully | FOB | Fence Chain Board | LP | Lamp Post |
| BO | Bollard | PCL | Fence Chain Link | MH | Manhole |
| BS | Bus Stop | FEL | Fence Electric | MV | Service Marker |
| BT | British Telecom | FMP | Fence Metal Panel | PS | Post Box |
| C | Crest | FMR | Fence Metal Rolling | PT | Post |
| CL | Cover Level | FOB | Fence Open Board | RE | Roadside Eye |
| CMP | Cable Marker | FPW | Fence Post & Wire | SP | Sign Post |
| CCTV | Cable TV | FSP | Fence Steel Pile/sole | ST | Stop Sign |
| CCTV | Security Camera | FVM | Fence Wire Mesh | SV | Stop Valve |
| CIV | Cable TV | FVL | Fence Floor Level | TGB | Telephone Call Box |
| DC | Drainage | FP | Flagpole | THL | Threshold Level |
| DK | Drop Kerb | OV | Gas Valve | TL | Traffic Light |
| DP | Down Pipe | GY | Gully | TP | Telegraph Post |
| ELC | Electric | HS | Height | TS | Traffic Signal |
| EP | Electricity Post | IC | Inspection Chamber | UTS | Unable to Survey |
| ER | Earth Road | IFL | Internal Floor Level | VL | Water Level |
| FH | Fire Hydrant | IL | Invert Level | WM | Water Meter |
| FL | Floodlight | | | WO | Wash Out |

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BWB Ref: BMW 3175 Date: 29.07.21 Scale: A0: 1:1000				
Drawing Status				
INFORMATION				
Project - Originator - Zone - Level - Type - Role - Number				
BLN-BWB-00-ZZ-M2-G-0060				
Status Rev				
S2 P1				



Appendix 2: Hydrological Assessment

ENVIRONMENT

Richborough Estates Limited
Brascote Lane, Newbold Verdon
Leicestershire
Flow Estimation Record

ENVIRONMENT

Richborough Estates Limited
Brascote Lane, Newbold Verdon
Leicestershire
Flow Estimation Record

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August 2021

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The information presented, and conclusions drawn, are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

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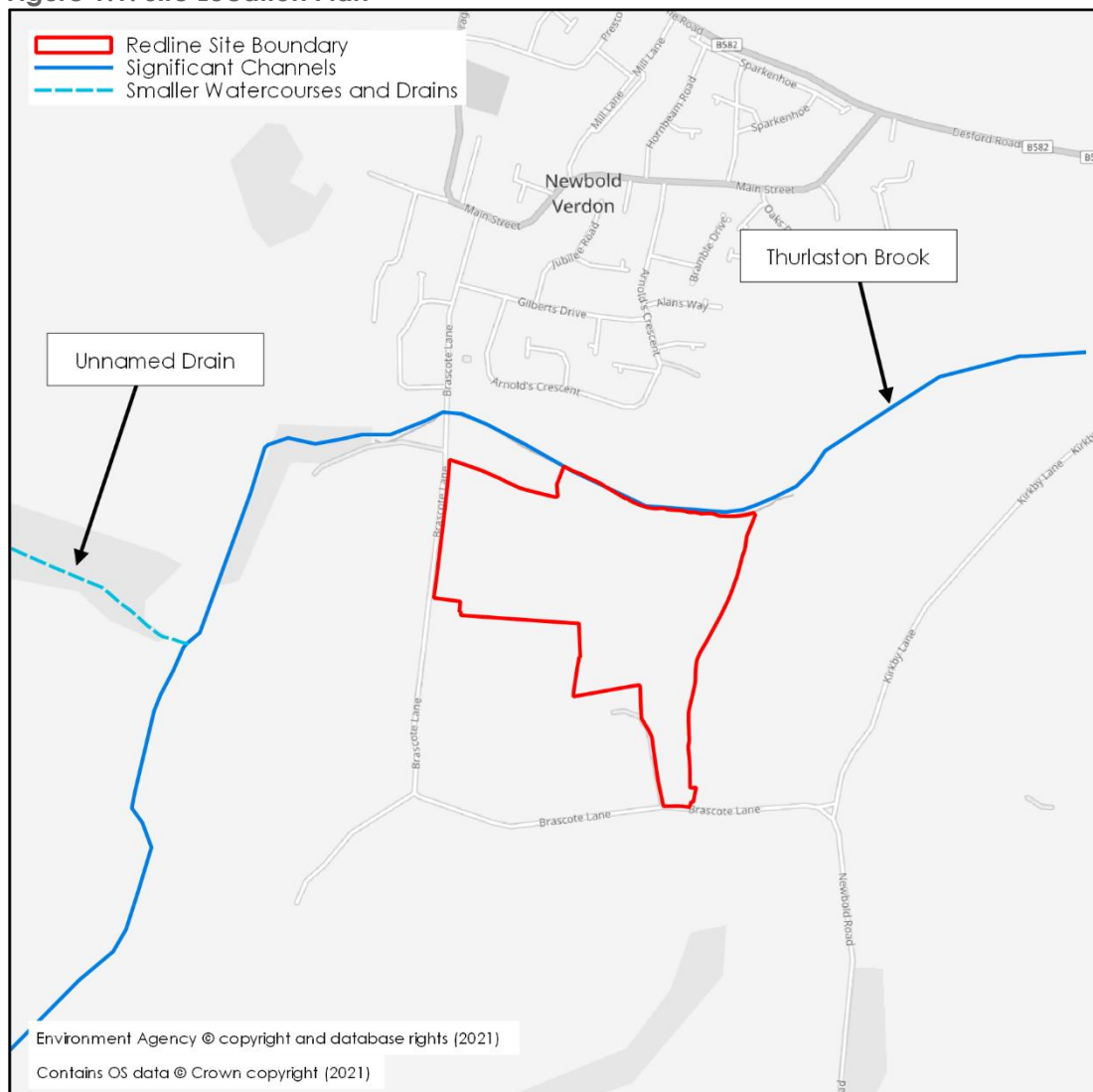
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1. METHOD STATEMENT

Overview of requirements

- 1.1 Flow estimates are required for input into a hydraulic model of the Thurlaston Brook, to support the planning application for a residential development at the land off Brascote Lane, Newbold Verdon, Leicestershire.
- 1.2 The location of the site of interest and the watercourses to be modelled are provided in **Figure 1.1**. The site is located immediately downstream of the source of the Thurlaston Brook, which is a tributary to the River Soar.

Figure 1.1: Site Location Plan



- 1.3 Return periods to be assessed include: 2, 5, 10, 20, 50, 75, 100, 200 and 1000-years. To inform the design event and potential future floodplain, the 1 in 100-year event with a range of climate change allowances applied will also be simulated. Hydrographs are required as well as peak flows.

- 1.4 The hydrological assessment was undertaken in August 2021.

Climate change

- 1.5 Predicted future change in peak river flows caused by climate change are provided by the Environment Agency (EA), with a range of projections applied to 'Management Catchments', which are sub-catchments of regionalised 'River Basin Districts'.
- 1.6 The site falls within the 'Soar' Management Catchment which is located within the 'Humber' River Basin District. **Table 1.1** identifies the relevant peak river flow allowances for the Soar Management Catchment.

Table 1.1: Peak River Flow Allowance for the Soar Management Catchment

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2125)
Soar Management Catchment			
Upper End	28%	35%	60%
Higher Central	18%	21%	37%
Central	14%	16%	28%

- 1.7 When determining the appropriate allowance, the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of a future development should be considered.
- 1.8 **Table 1.2** provides a matrix summarising the EA's guidance on determining the appropriate allowances.

Table 1.2: Application of the Appropriate Climate Change Allowance

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
1	Use the central allowance where a location may fall within Flood Zone 2 or 3 in the future.				
2	Use the higher central allowance	Use the central allowance			
3a	Use the higher central allowance	Development should not be permitted	Use the central allowance		
3b	Use the higher central allowance	Development should not be permitted			Use the central allowance

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
If development is considered appropriate by the local authority when not in accordance with Flood Zone vulnerability categories, then it would be appropriate to use the higher central allowance.					

Available hydrometric data

- 1.9 There are no hydrometric gauges within the study catchment. Therefore, there are no current hydrometric records of river flows or levels for the watercourse on which a hydrological assessment of flood flows can be made.
- 1.10 Following review of the National River Flow Archive (NRFA), the closest gauging station to the site is located on the River Soar at Littlethorpe. This is located approximately 20km downstream of the site.
- 1.11 The Littlethorpe gauge is located on a different watercourse to the study watercourse. As such, whilst the gauge can be used as part of the Statistical analysis for donor adjustment of QMED, its use for calibration and verification is limited.
- 1.12 **Table 1.3** and **Table 1.4** provide details on the Littlethorpe gauge. A detailed review of the data quality at the Littlethorpe gauge, beyond a review of the information on the NRFA website, was outside the scope of this assessment.

Table 1.3: Hydrometric gauges within the Study Catchment

Watercourse	Station Name	NRFA number	Grid Reference	Catchment Area (km ²)	Type	Period of Record
River Soar	Littlethorpe	28082	SP542973	183.9	Cross-correlation	08/1971 - present

Table 1.4: Gauging Station Data Availability and Quality

Station Name	Period of data in Peak Flow dataset	Suitable for QMED?	Suitable for Pooling?	Comments on station and data quality
Littlethorpe	1981 - 2019	Yes	Yes	Flood relief channel joins on the right bank just upstream. Bypassed at high flows above 2.4 mASD. During electromagnetic data, a rating was used to derive flows above 2.3m when instrumentation underestimated. Prone to weed growth.

- 1.13 The NRFA Peak Flow Dataset Version 9 (most up to date version available at the time of this assessment) will also be utilised in this assessment for the purposes of identifying any potential donor stations and for the development of pooling groups.

Initial choice of approach

Table 1.5: Method statement

Is FEH appropriate?	Yes. The study catchment is greater than 0.5km ² , is not considered to be highly permeable (BFIHOST is less than 0.75), and there is no significant reservoir attenuation (FARL>0.9). Catchment is considered to be moderately urbanised (URBEXT2000>0.060).
Initial choice of method(s) and reason	Both the FEH Statistical and the ReFH2 methods will be used. Both methods are suitable for the catchments and using both will enable comparison between the two flow estimation methods before choosing the final method.
Software to be used	WINFAP v4 and ReFH2 version 2.3

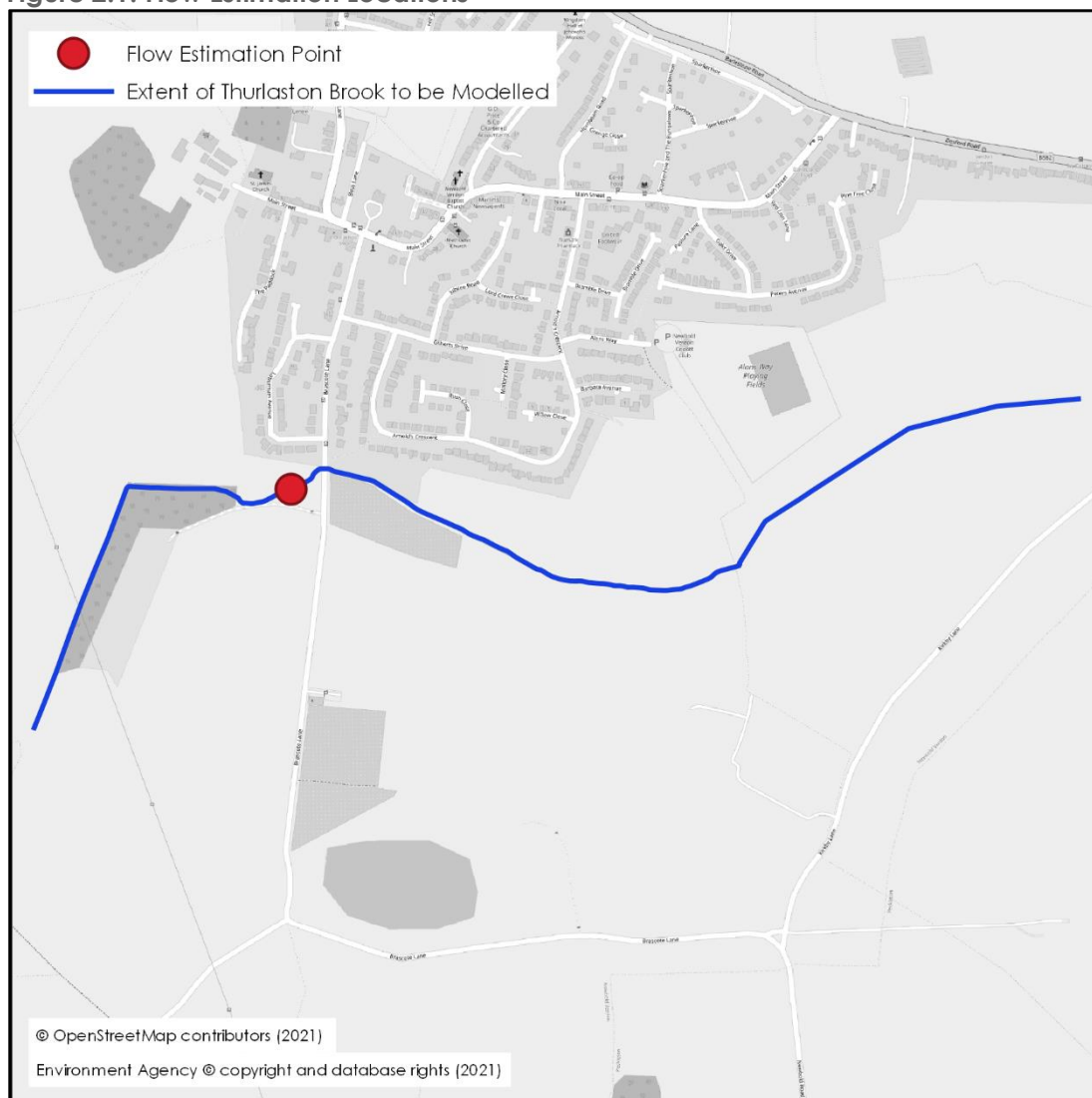
2. LOCATIONS WHERE FLOOD ESTIMATES ARE REQUIRED

Location of Flow Estimates

Table 2.1: Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	Area on FEH Webservice	Revised area (if altered)
Thurlaston	Thurlaston Brook	Brascote Lane	444400	303300	1.74	2.14
Reasons for choosing locations		A single flow estimation point was extracted immediately downstream of the structure at Brascote Lane. This was considered suitable to capture all flows draining to the Thurlaston Brook, whilst also being located downstream of the study site.				

Figure 2.1: Flow Estimation Locations



Checking Catchment Descriptors

Table 2.2: Catchment Descriptor Checks

Record how catchment boundary was checked and describe any changes.	The catchment boundary for the flow estimation point was identified by the FEH Web Service. The boundary was reviewed using EA LIDAR. A watershed analysis was undertaken using the LIDAR and the results compared to the FEH boundary. Results were also compared to sewers records; the sewer catchment follows the topographical catchment as expected. Following a review of the watershed analysis, the catchment boundary was updated to reflect the results. The original and amended catchment boundary is shown in Figure 2.2.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	British Geological Survey (BGS) mapping¹ indicates that the catchment is predominately underlain by the Gunthorpe Member (mudstone), with superficial deposits largely consisting of Glaciofluvial Deposits (sand and gravel, Oadby Member (diamicton) and Alluvium (clay, silt, sand and gravel). According to the Soilscales website², the catchment is predominantly underlain by loamy soils with naturally high groundwater. The underlying geology and soils suggest the BFIHOST and SPRHOST values of the FEH catchment descriptors are appropriate for the catchments. DPLBAR has been updated using the standard equation for DPLBAR, given in the FEH Volume 5. Following the change in AREA, a review of the urban coverage of the amended catchment boundary was undertaken against satellite imagery. URBEXT₂₀₀₀ was subsequently determined using the URBAN50k method. The FARL value was also reviewed following updates made to the AREA value. This value was retained as no online storage areas have been identified within the amended catchment boundary.
Source of URBEXT	URBEXT ₂₀₀₀
Method for updating of URBEXT to present day.	Values of URBEXT₂₀₀₀ were recalculated following the amendments to the catchment boundary using formula 5.4 from 2006 CEH report on URBEXT₂₀₀₀, which allows URBEXT₂₀₀₀ to be calculated from the present day urban area of the catchment.

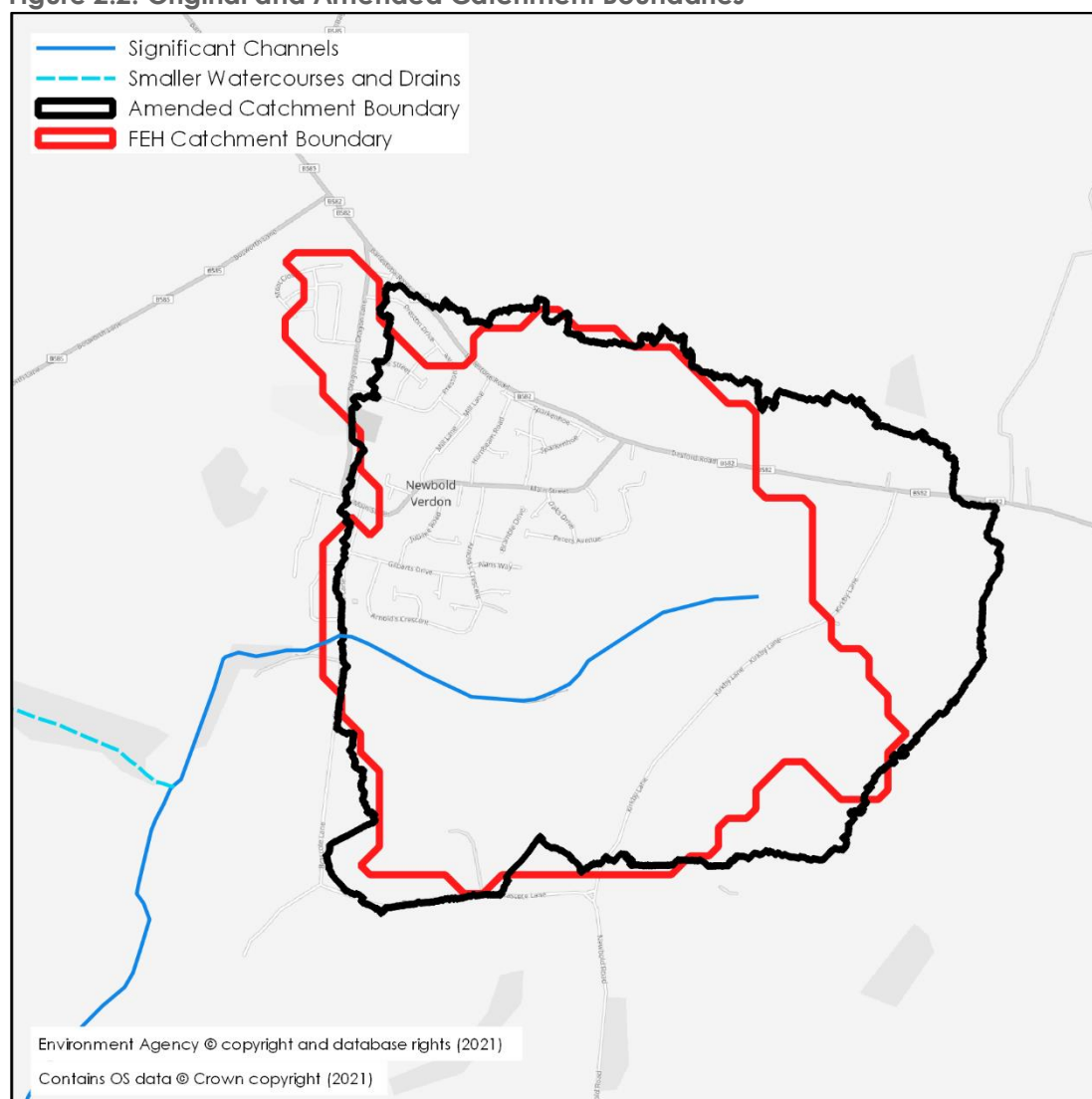
¹ <https://mapapps.bgs.ac.uk/geologyofbritain/home.html>

² <http://www.landis.org.uk/soilscales/>

Table 2.3: Important catchment descriptors at each subject (changes made are highlighted in red)

Site Code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR	SPRHOST	URBEXT 2000	FPEXT
Thurlaston	1.00	0.30	0.589	1.17	17.8	650	40.16	0.1474	0.1191

Figure 2.2: Original and Amended Catchment Boundaries



3. STATISTICAL METHOD

- 3.1 WINFAP version 4 was utilised to undertake a statistical analysis of the catchment using a hydrometric record of gauged catchments with similar characteristics. The latest version of the NRFA Peak Flow dataset (v9) was used to provide an up-to-date hydrometric record.

QMED Development

- 3.2 Catchment descriptors were originally used to estimate the rural QMED of the study site using the revised equation from Science Report (SC050050). The FEH states that flood frequency is best estimated by gauged data and estimation of key variables from catchment descriptors alone should be a method of last resort. As such, a search was undertaken to identify any potential donor sites that could be used to adjust QMED.
- 3.3 The research underlying the revised data transfer method (SC050050) found that identification of potential donor catchments should be based on geographical closeness rather than on hydrological similarity, as defined by catchment descriptors. More recent research on small catchments (SC090031) has supported the findings of SC050050, again recommending that donors are selected purely based on proximity. The EA FEH Guidelines advises similarity in catchment descriptors is not essential for donors. However, in view of the sometimes-uncertain relationship between BFIHOST and runoff, similarity in geology or soil type may be relevant. The guidelines also advise considering more than one donor.
- 3.4 With the guidance in mind, a search was undertaken within WINFAP 4 for suitable donor stations for QMED data transfer. Whilst the FEH recommends avoiding urbanised donors, the Littlethorpe gauge is approximately 20km downstream of the site and only just over the 0.03 threshold for URBEXT₂₀₀₀. WINFAP allows the use of urban donors, applying the urban adjustment factor in reverse to attempt to remove the urban influence. As such, the search for donors was extended to donors with URBEXT > 0.046 to allow WINFAP to include Littlethorpe as a donor.
- 3.5 The six nearest donors were reviewed based on similarity in BFIHOST to the subject site and data quality. Of the recommended donors, station 54111, was rejected due to concerns over data quality, particularly with early flow estimates.
- 3.6 Details for the donor stations are provided in **Table 3.1**.

Table 3.1: Donor Station Details

Station Number	QMED from Observed Data (A)	QMED from Catchment Descriptors (B)	Adjustment Ratio (A/B)
28082	15.472*	19.528	0.792
28086	21.807*	18.886	1.155
54019	27.319*	34.588	0.790
54102	12.313	13.242	0.930

Station Number	QMED from Observed Data (A)	QMED from Catchment Descriptors (B)	Adjustment Ratio (A/B)
28024	34.45	37.726	0.913

* As URBEXT2000 is greater than 0.03, QMED from observed data has been deurbanised.

Table 3.2: Overview of estimation of QMED at each subject site

Site Code	Method	Initial Estimate of QMED (m ³ /s) (Rural)	Data Transfer				Final estimate of QMED (m ³ /s) (URBAN)
			Donor site NRFA no	Distance between centroids d _j (km)	Weight	Final Adjustment Factor	
Thurlaston	Data Transfer	0.31	28082	10.23	0.379	0.944	0.35
			28086	20.99	0.302		
			54019	26.45	0.271		
			54102	29.94	0.253		
			280024	34.15	0.232		
Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?			QMED is consistent with the size and characteristics of the catchment.				
Which version of the urban adjustment was used for QMED?			Urban adjustment was applied using Kjeldsen (2010), as applied in WINFAP4.				

Derivation of Pooling Groups

- 3.7 A pooled group of hydrologically similar gauged sites was generated by the WINFAP software for the subject sites using the 'OK for Pooling' dataset.
- 3.8 The pooling group was reviewed to identify sites which may be inappropriate due to being significantly hydrologically dissimilar to the study site, or if they have any inaccuracies, uncertainties, or limitations in their data record.
- 3.9 The growth curve derived from the pooling group was also adjusted to reflect the urban influence using the methods adopted in WINFAP3 which is based on those published by Kjeldsen 2010⁴.
- 3.10 Further detail on pooling group composition is provided in **Section 6**.

³ Wallingford HydroSolutions (2016), WINFAP 4 Urban adjustment procedures, Wallingford HydroSolutions Ltd 2016.

⁴ Kjeldsen, T.K., 2010. Modelling the impact of urbanization on flood frequency relationships in the UK. Hydrology Research, volume 41, issue 5, pp391-405

Table 3.3: Derivation of pooling groups

Name of group	Site code from whose descriptors the group was derived	Subject site treated as gauged? (enhanced single site analysis)	Change made to default pooling group with reasons, including any sites investigated but retaining in the group	Weighted average L-moments L-CV and L-skew (before urban adjustment)
Thurlaston_PG	Thurlaston	No	Stations Removed: 27073 and 26016 – highly permeable compared to subject site. 49005 – high discordancy caused by negative and comparatively low L-kurtosis compared to rest of the sites. The station is also an outlier with regards to seasonality and has a relatively short record of 9 years of data. 106002 and 206006 – removed due to being located in geographically dissimilar locations that are subject to different rainfall patterns and meteorological conditions. 106002 in particular was an outlier with regards to seasonality. Stations Added: 54022 and 36010 – added to ensure the pooling group exceeded the recommended minimum record length of 500 years. Comments: Final pooling group is acceptably homogeneous and a review of the pooling group is not required.	L-CV: 0.231 L-Skew: 0.280

Table 3.4: Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS)	If P, ESS or J, name of pooling group	Distribution used and reason for choice	Note any urban or permeable adjustment	Parameters of distribution (location, scale and shape) after urban adjustment	Growth factor for 1% AEP event
Thurlaston	Pooled	Thurlaston_PG	Generalised logistic provided an acceptable fit and is regarded as the best fit for	Urban adjustment using methods adopted in WINFAP which is	Location: 1.000 Scale: 0.201 Shape: -0.307	3.034

Site code	Method (SS, P, ESS)	If P, ESS or J, name of pooling group)	Distribution used and reason for choice	Note any urban or permeable adjustment	Parameters of distribution (location, scale and shape) after urban adjustment	Growth factor for 1% AEP event
			most UK catchments	based on those published by Kjeldsen 2010		

Table 3.5: Flood estimates from the Statistical method

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
Thurlaston	0.35	0.47	0.57	0.69	0.88	0.98	1.06	1.29	2.04

4. REVITALISED FLOOD HYDROGRAPH (REFH) METHOD

4.1 The ReFH2 Revitalised Flood Hydrograph Modelling Tool (Version 2.3) was used to undertake an estimation of the peak flows for the subject sites.

Table 4.1: Overview of parameters for ReFH2 method

Site code	Method OPT: Optimisation BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer	T _p (hours) Time to peak	C _{max} (mm) Maximum storage capacity	BL (hours) Baseflow lag	BR Baseflow recharge
Thurlaston	CD	3.313	508.274	39.729	2.41*
Description of flood event analysis carried out			No flood event analysis was undertaken due to a lack of gauging station in the study catchment.		

* Baseflow recharge reported for the 1 in 100 year return period.

Table 4.2: Critical storm durations

Site code	Season of design event	Storm duration	Selected interval
Thurlaston	Winter	5hrs 30 mins	30 mins
Comments	The recommended storm duration for the upper catchment of the Thurlaston Brook is 5.5 hours. As such the model will be run with a 5.5 hour storm duration using a winter storm profile. However, sensitivity analysis will also be undertaken using 3 hr and 11 hr storm durations to assess the sensitivity of the model to differing storm durations.		

Table 4.3: Flood estimates from the ReFH method (based on critical duration for individual catchments)

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
Thurlaston	0.45	0.60	0.71	0.84	1.06	1.18	1.29	1.59	2.42

5. DISCUSSION AND SUMMARY OF RESULTS

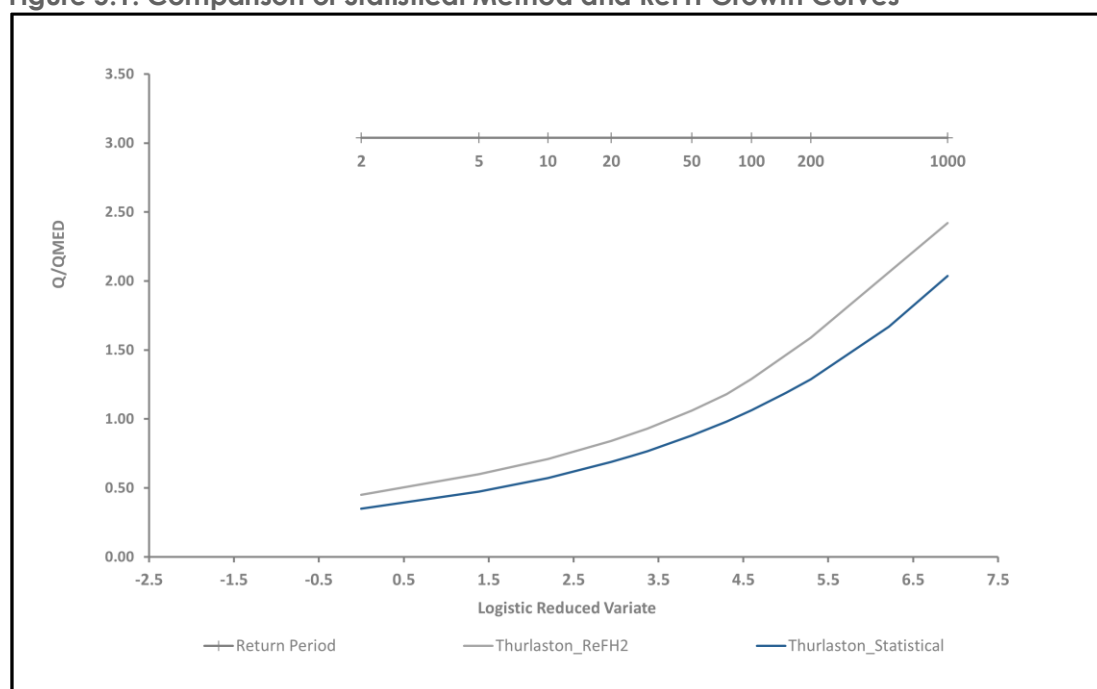
Comparison of method

- 5.1 A comparison of the peak flow results for the different estimation methods for the 1 in 2-year and 1 in 100-year events is provided in **Table 5.1**. Comparisons of the growth curves for both methods are shown in **Figure 5.1**.
- 5.2 The ReFH method gave the highest peak flows for the Thurlaston Brook flow estimation point. Both the Statistical and ReFH methods share a fairly similar steepness to their growth curves.

Table 5.1: Comparison of results

Site code	1 in 2-year peak flows			1 in 100-year peak flows		
	Statistical	ReFH	Ratio	Statistical	ReFH	Ratio
Thurlaston	0.35	0.45	1.29	1.06	1.29	1.22

Figure 5.1: Comparison of Statistical Method and ReFH Growth Curves



Final method and flows

Table 5.2: Final choice of method

Choice of method and justification	Whilst, both Statistical and ReFH2 methods are considered suitable for the catchments, the final choice of peak flows for input into the model is the ReFH2 method. Although the Statistical method incorporates local data from the Littlethorpe gauge, the Littlethorpe gauge is located on the River Soar not the Thurlaston Brook. As such, due to the lack of gauged data on the Thurlaston Brook itself, with which to verify flows, the more conservative ReFH2 flows will be applied to the hydraulic model.
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Table 5.3: Final Peak Flows from Chosen Method (ReFH)

Site Code	Flood peak (m ³ /s) for the following return periods								
	2	5	10	20	50	75	100	200	1000
Thurlaston	0.45	0.60	0.71	0.84	1.06	1.18	1.29	1.59	2.42

Table 5.4: Assumptions, limitations and uncertainty

List the main assumptions made	- The pooling group is representative of the catchment. - The River Soar at Littlethorpe gauge is suitable for use as a donor for QMED. - The ReFH2 hydrograph shape is representative of catchment response. - Tp and storm duration is representative of the catchment response. - The characteristics of the catchment do not change significantly between the up and downstream extents of the model.
Discuss any limitations e.g. applying methods outside the range of catchment types or return periods for which they were developed	- The FEH Statistical and ReFH2 methods are believed to be suitable up to the 1 in 200-year event. Estimates of flow beyond these events are extrapolations and, therefore, have a higher level of uncertainty. - There are only a small number of small gauged sites in the UK. As such the representation in the pooling is not ideal given the relatively small size of the study catchment. - There is no observed flow data within the catchment with which to calibrate or verify the flow estimates.
Give what information you can on uncertainty in the results	According to Table 4 of the EA FEH Guidelines, confidence intervals for the 1 in 100 year for a rural site when calculated from catchment descriptors are quoted as 0.45-2.23 (for the 95% confidence interval). Confidence is considered to be improved when using observed data from a donor site.

	It is more difficult to quantify uncertainty in design flows estimated from the ReFH rainfall-runoff model. However, evidence ⁵ suggests the factorial standard errors from ReFH2 are comparable to those observed for the FEH pooled Statistical method when the catchment is treated as ungauged.
Comment on the suitability of the results for future studies	The design flow estimates have been derived for the purpose of providing flow hydrographs into a hydraulic model to support planning decisions for a site near Newbold Verdon. Users for different studies should, as a minimum, review results to assess suitability for the purpose of the study.
Give any other comments on the study	While the installation of temporary flow gauges would provide local data with which to better inform the design peak flows, this would not align with the timescales of this project.

Table 5.5: Checks

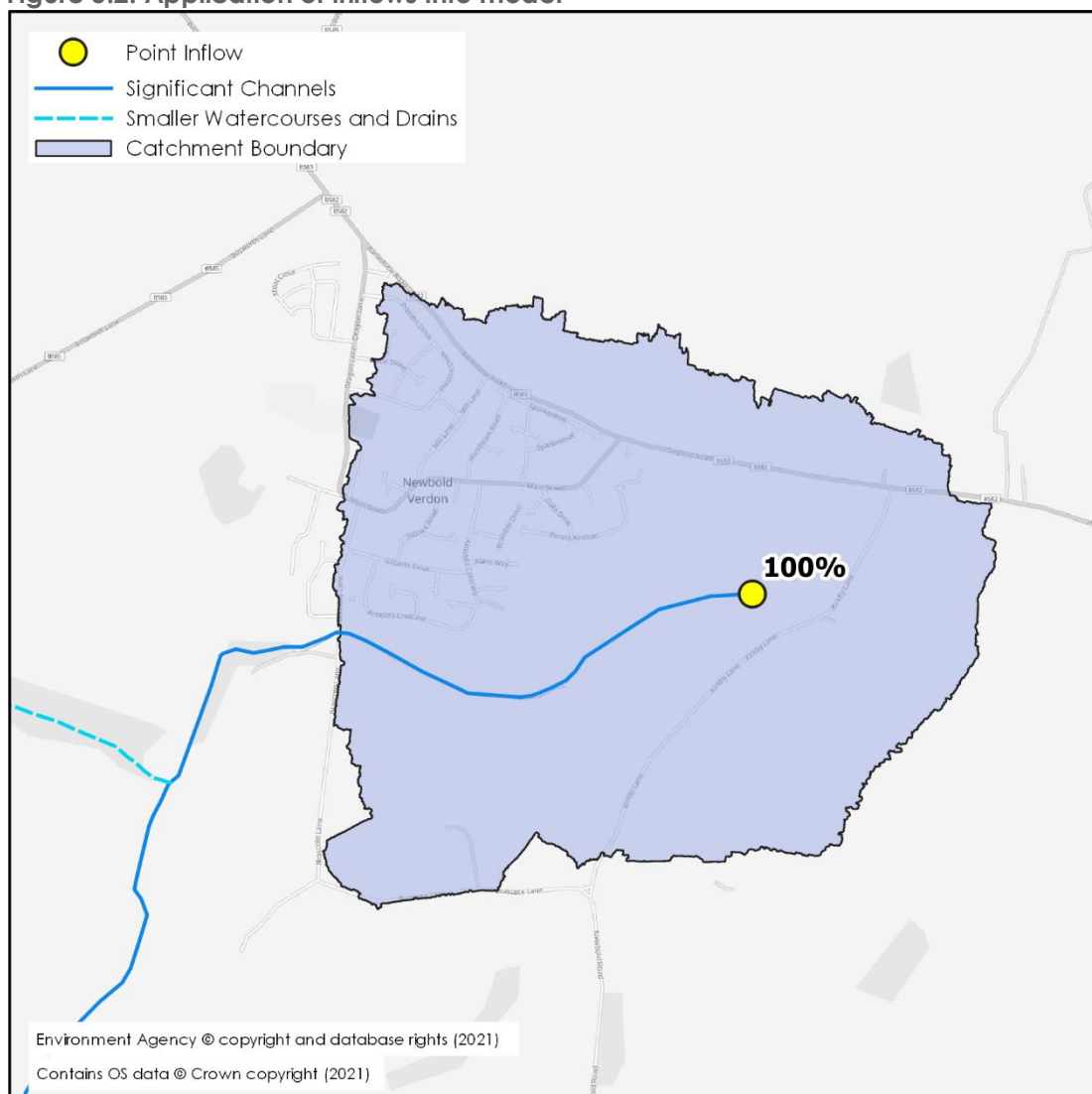
Are the results consistent?	Peak flows are consistent with the size and characteristics of the catchment.
What do the results imply regarding the return periods of floods during the period of record?	It is not possible to imply return periods of floods due to the lack of gauged data within the study catchment.
What is the 1 in 100-year growth factor? (the guidance suggests a typical range or 2.1 to 4.0)	• Statistical Method: 3.03 • ReFH2 Method: 2.87 These all fall within the typical range.
If 1 in 1000-year flows have been derived, what is the range of ratios for 1 in 1000-year flow over 1 in 100-year flow?	• Statistical Method: 1.92 • ReFH2 Method: 1.88
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred	There are no previous detailed studies on the Thurlaston Brook with which to make a comparison.
Are the results consistent with the longer-term flood history?	It is not possible to compare the results with the longer-term flood history due to the lack of gauged data within the study catchment.
Describe any other checks on the results	Sensitivity checks of modelled outlines will be undertaken at the modelling stage.

⁵ Wallingford Hydrosolutions (2019) ReFH2 Science Report: Evaluation of the Rural Design Event Model.

Application of flows to model

- 5.3 Flows will be applied to the model as a lumped point inflow at the upstream extent of the hydraulic model.
- 5.4 Given the size of the catchment area (2.14km²) and the length of watercourse modelled (approximately 1.8km), this approach was considered to be appropriate. Using a lumped inflow at the upstream extent of the catchment subsequently allows for a conservative volume of flow being conveyed through the model at the upstream limit of the site.
- 5.5 **Figure 5.2** demonstrates how the flows will be applied to the model.

Figure 5.2: Application of inflows into model



6. SUPPORTING INFORMATION

Flood history

- 6.1 A flood history review for the area has been undertaken using Environment Agency recorded flood outlines, Strategic Flood Risk Assessments⁶, Leicestershire County Council Flood Investigation Reports, the British Chronology of Hydrological Events and online newspaper reports. No record of flooding to the proposed development site has been found during the search of the sources.
- 6.2 Leicestershire County Council have reported two records of flooding incidents within close proximity:
- March 2016: Driveways were flooded from the highway along Arnolds Crescent
 - September 2019: Surface water ponding as a result of the highway topography occurred at the corner of Brascote Lane and Luburnum Avenue.
- 6.3 Nether of the above reports have affected the redline application site.

Detailed pooling group information

- 6.4 The default pooling group generated by WINFAP is provided in **Table 6.1** and the final pooling group following review is provided in **Table 6.2**.

Table 6.1: Default pooling group: Thurlaston_PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
76011 (Coal Burn @ Coalburn)	1.183	42	1.84	0.163	0.301	0.646
27051 (Crimple @ Burn Bridge)	2.277	47	4.524	0.218	0.156	0.209
27073 (Brompton Beck @ Snainton Ings)	2.286	39	0.812	0.215	0.035	1.267
45816 (Haddeo @ Upton)	2.342	26	3.456	0.3	0.406	0.868
28033 (Dove @ Hollinsclough)	2.616	44	4.177	0.228	0.371	0.599
26016 (Gypsy Race @ Kirby Grindalythe)	2.985	22	0.1	0.321	0.266	1.116
25019 (Leven @ Easby)	2.987	41	5.09	0.342	0.386	1.469
49005 (Bolingey Stream @ Bolingey Cocks Bridge)	3.152	9	5.777	0.271	0.151	2.793
47022 (Tory Brook @ Newnham Park)	3.169	25	6.176	0.257	0.191	0.507
25011 (Langdon Beck @ Langdon)	3.175	33	15.647	0.232	0.328	0.647
25003 (Trout Beck @ Moor House)	3.234	46	15.142	0.168	0.29	0.513
71003 (Croasdale Beck @ Croasdale Flume)	3.244	37	10.9	0.212	0.323	0.266
91802 (Allt Leachdach @ Intake)	3.312	34	6.35	0.153	0.257	0.645
106002 (Laxdale @ Laxdale)	3.356	12	17.449	0.103	0.132	1.258
206006 (Annalong @ Recorder)	3.419	48	15.33	0.189	0.052	2.196

⁶ Strategic Flood Risk Assessment for Hinckley and Bosworth Borough Council: Final Report, Hinckley and Bosworth Council (July 2019)

Total		505			
Weighted Means				0.224	0.248
H2 value	2.2481				
Goodness of Fit	Generalised Logistic		General Extreme Value		
	0.3807		-1.0599		

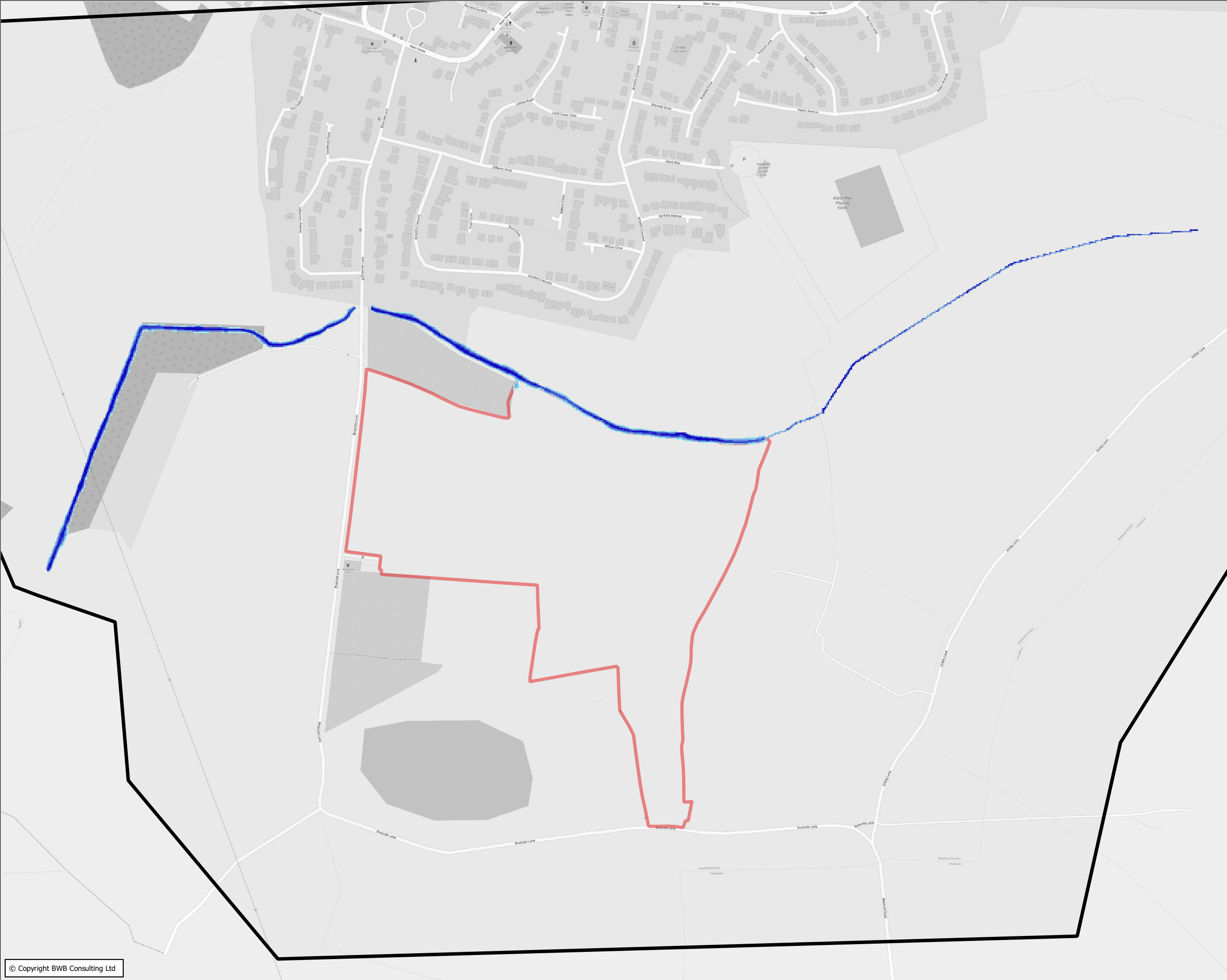
Table 6.2: Final pooling group: Thurlaston PG

Station	Distance	Years of Data	QMED AM	L-CV	L-Skew	Discordancy
76011 (Coal Burn @ Coalburn)	1.183	42	1.84	0.163	0.301	0.57
27051 (Crimple @ Burn Bridge)	2.277	47	4.524	0.218	0.156	0.892
45816 (Haddeo @ Upton)	2.342	26	3.456	0.3	0.406	0.978
28033 (Dove @ Hollinsclough)	2.616	44	4.177	0.228	0.371	0.66
25019 (Leven @ Easby)	2.987	41	5.09	0.342	0.386	1.237
47022 (Tory Brook @ Newnham Park)	3.169	25	6.176	0.257	0.191	1.71
25011 (Langdon Beck @ Langdon)	3.175	33	15.647	0.232	0.328	1.21
25003 (Trout Beck @ Moor House)	3.234	46	15.142	0.168	0.29	0.339
71003 (Croasdale Beck @ Croasdale Flume)	3.244	37	10.9	0.212	0.323	0.17
91802 (Allt Leachdach @ Intake)	3.312	34	6.35	0.153	0.257	0.564
27010 (Hodge Beck @ Bransdale Weir)	3.374	41	9.42	0.224	0.293	0.047
54022 (Severn @ Plynlimon Flume)	3.453	38	14.988	0.156	0.171	1.895
36010 (Bumpstead Brook @ Broad Green)	3.675	52	7.395	0.382	0.181	2.728
Total		506				
Weighted Means				0.231	0.280	
H2 value	0.7046					
Goodness of Fit	Generalised Logistic		General Extreme Value			
	0.1133		-1.1292			

Appendix 3: Table of Hydraulic Structures

Network ID, Cross Section ID	Model Details	Photograph/Survey Section
THURL_0660	Description: Brascote Lane road culvert NGR: 444424, 303358 Domain: 1D ESTRY Unit Type: Circular conduit Dimensions: 2 x 0.75m diameter Upstream Invert Level: 120.83mAOD Downstream Invert Level: 120.97mAOD (downstream and upstream faces surveyed) Length: 14m Manning's N: 0.025 Blockage: Represented as 100% blocked in BLK2 sensitivity test Spill/Bypass: Modelled in 2D domain	

Appendix 4: Floodplain Maps



- Notes**
1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. OpenStreetMap data have been reproduced under the terms of the Open Data Commons Open Database License. © OpenStreetMap contributors.

Key

 Illustrative Site Boundary

 Model Domain

Peak Flood Depth (m)

-  <= 0.1
-  0.1 - 0.2
-  0.2 - 0.3
-  0.3 - 0.4
-  > 0.4

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Richborough Estates

Project Title

Brascote Lane, Newbold Verdon

Drawing Title

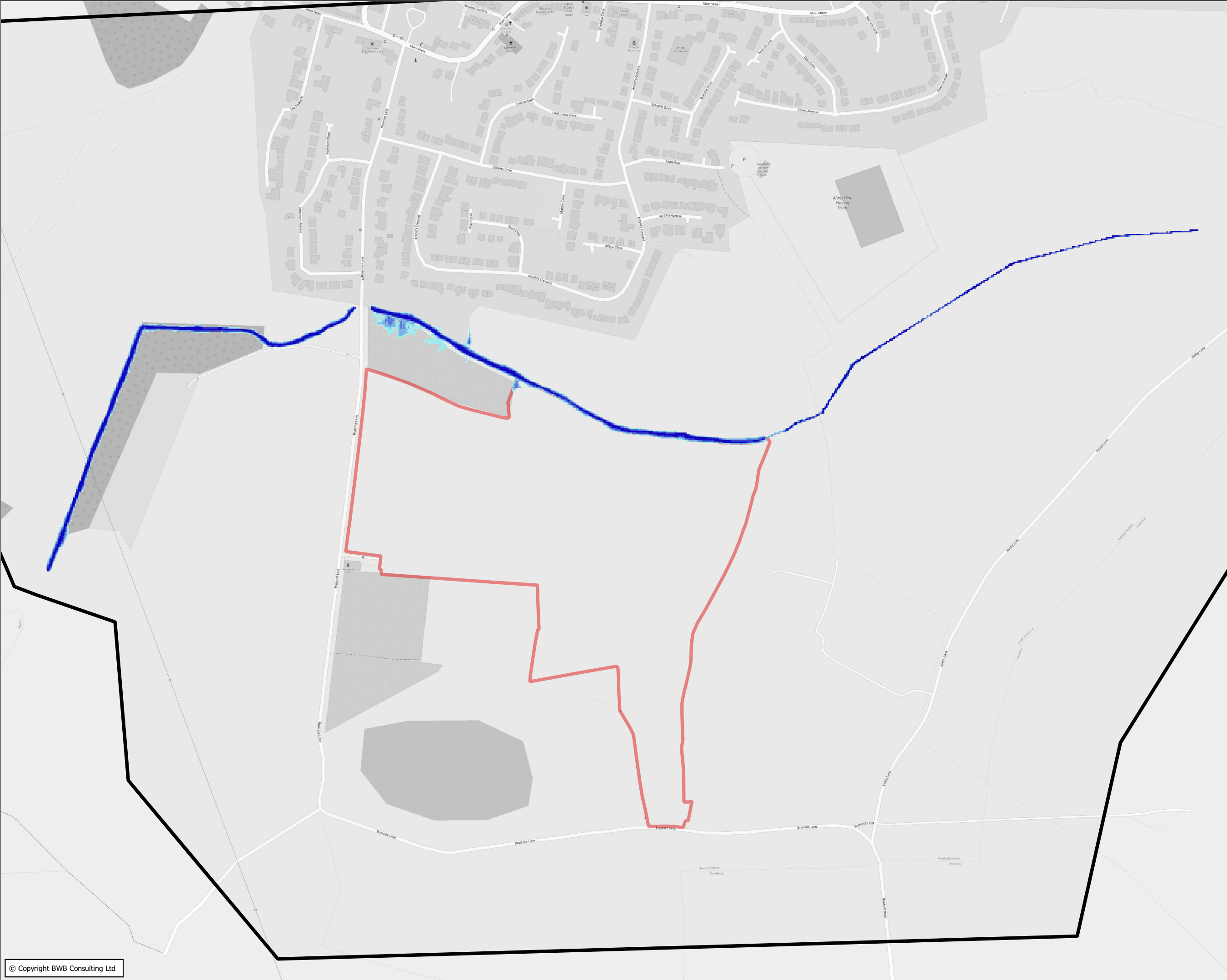
**Thurlaston Brook Flood Depths:
1 in 20-Year (5% AEP)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0002	S2	P01



- Notes**
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P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Project Title

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Drawing Title

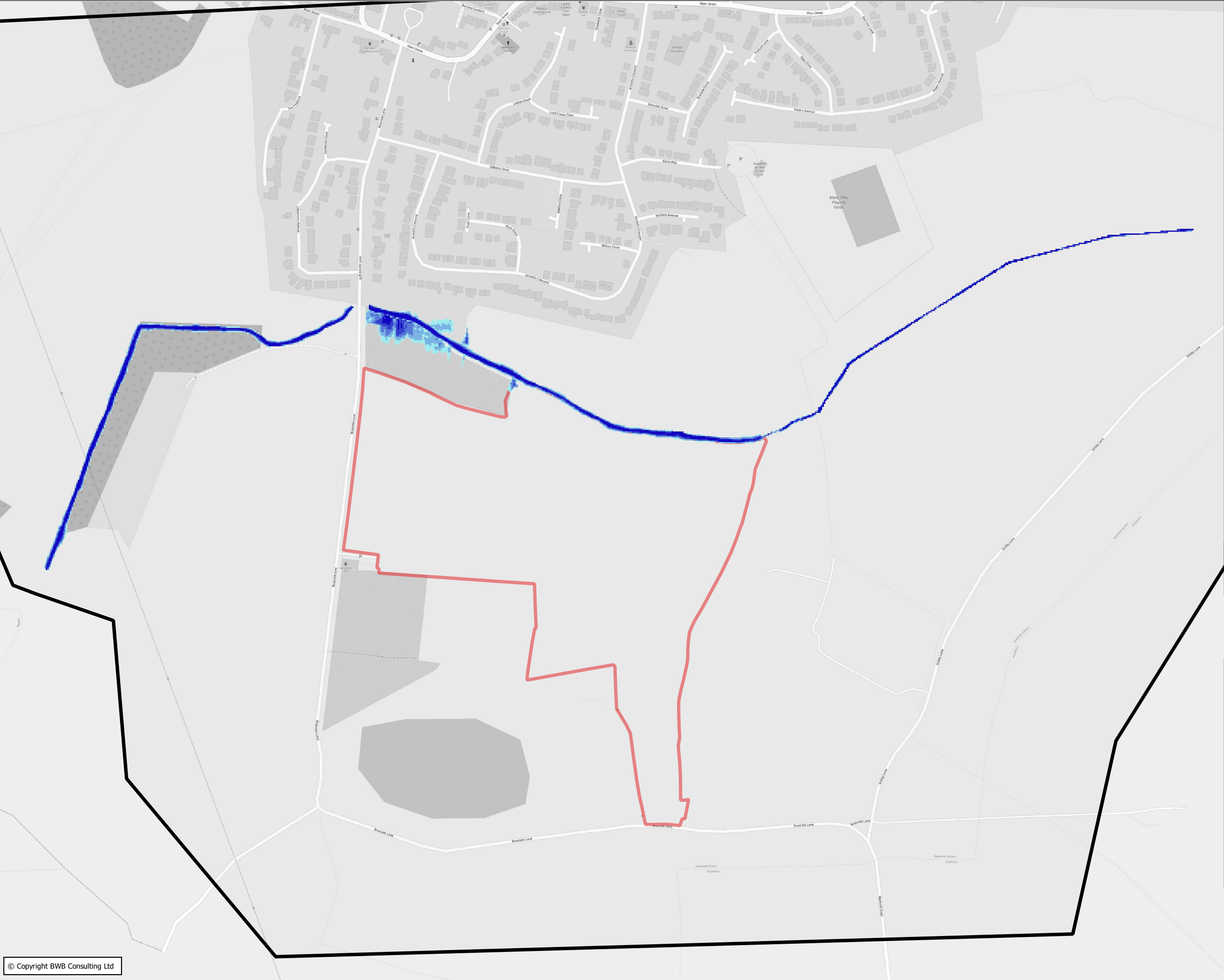
**Thurlaston Brook Flood Depths:
1 in 100-Year (1% AEP)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0003	S2	P01



- Notes**
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Key

 Illustrative Site Boundary

 Model Domain

Peak Flood Depth (m)

-  <= 0.1
-  0.1 - 0.2
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-  0.3 - 0.4
-  > 0.4

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Client

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Brascote Lane, Newbold Verdon

Drawing Title

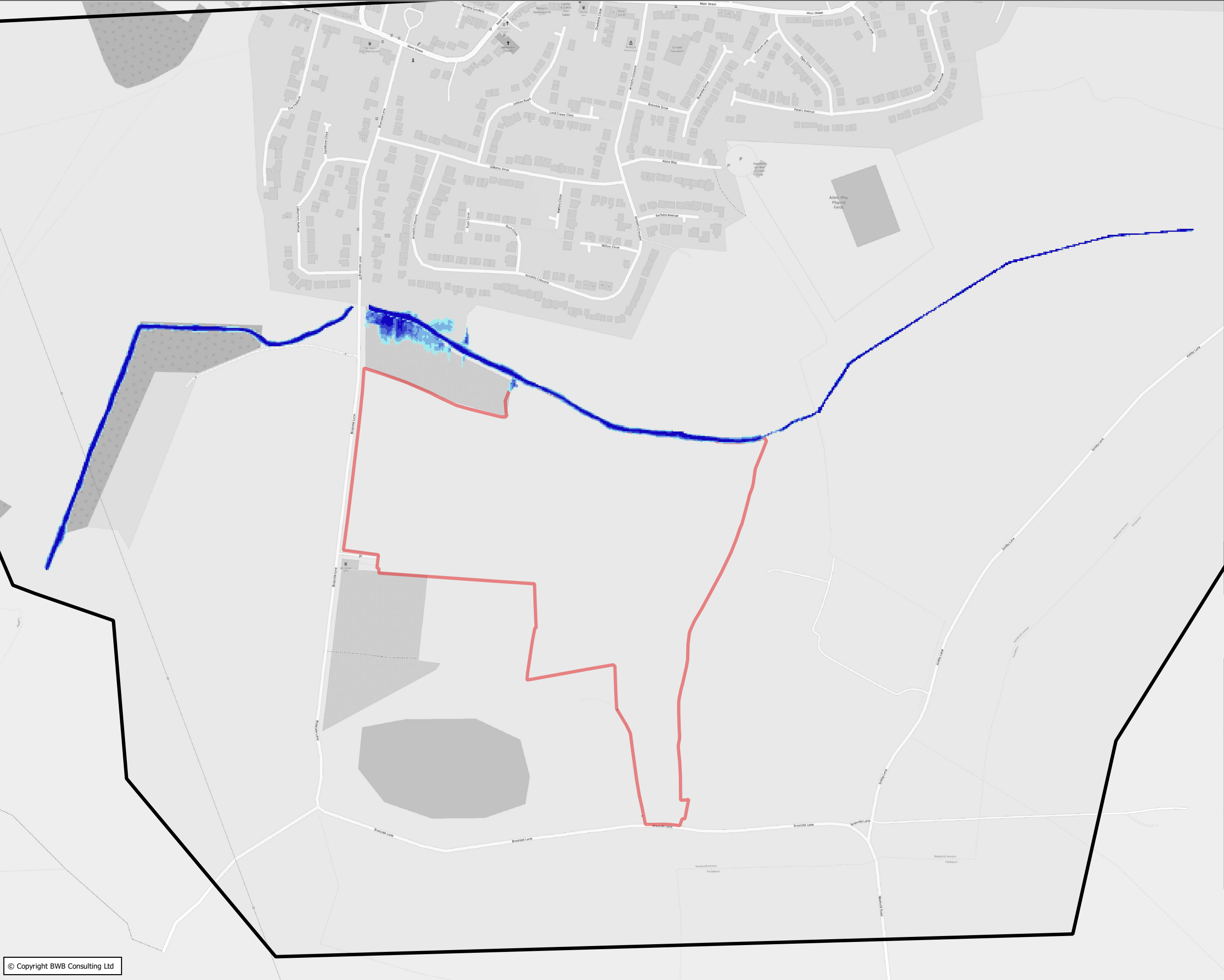
**Thurlaston Brook Flood Depths:
1 in 100-Year (1% AEP)
+28%CC**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0004	S2	P01



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Key

 Illustrative Site Boundary

 Model Domain

Peak Flood Depth (m)

-  <= 0.1
-  0.1 - 0.2
-  0.2 - 0.3
-  0.3 - 0.4
-  > 0.4

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Client

Richborough Estates

Project Title

Brascote Lane, Newbold Verdon

Drawing Title

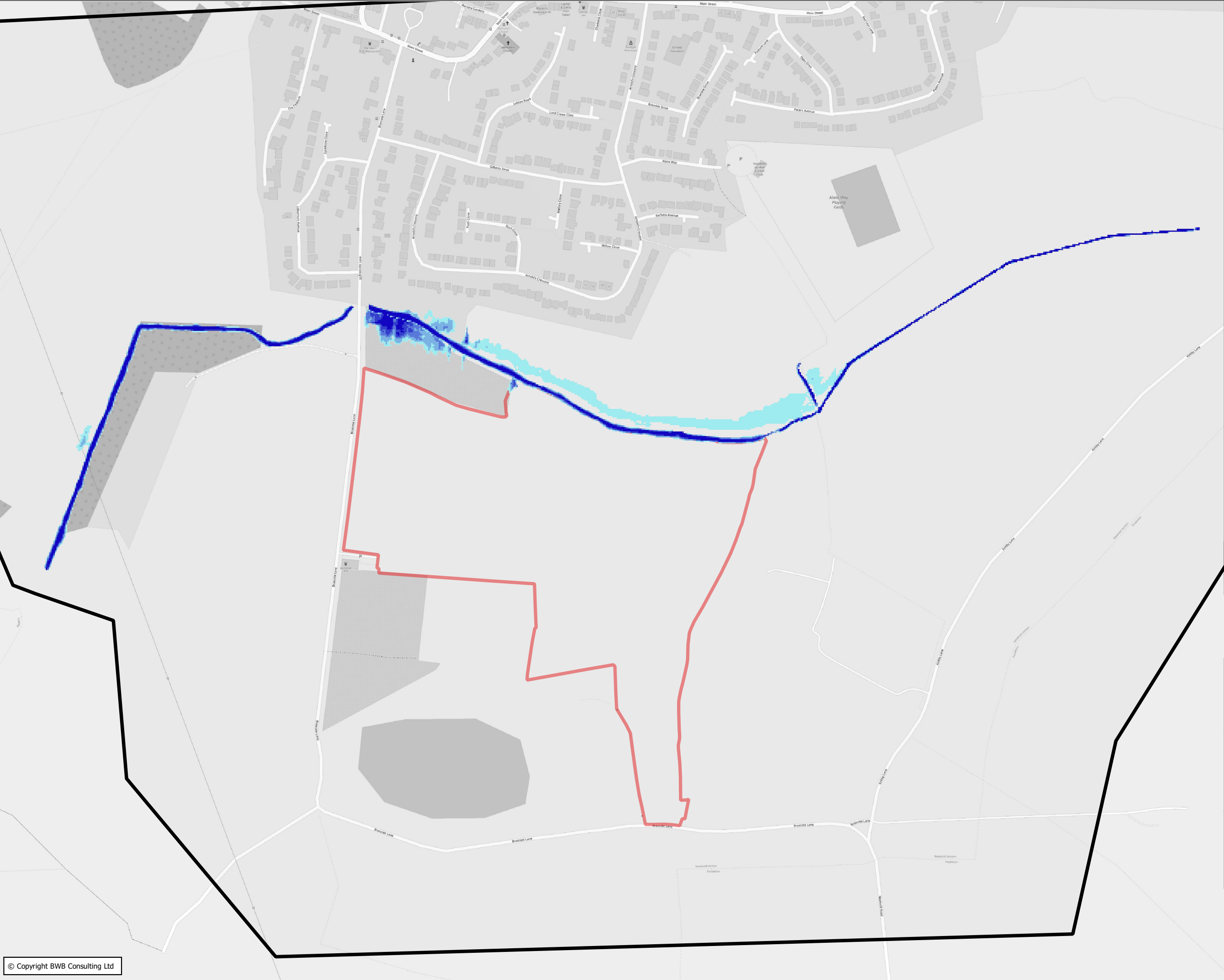
**Thurlaston Brook Flood Depths:
1 in 100-Year (1% AEP)
+37%CC**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0005	S2	P01



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Key

 Illustrative Site Boundary

 Model Domain

Peak Flood Depth (m)

-  <= 0.1
-  0.1 - 0.2
-  0.2 - 0.3
-  0.3 - 0.4
-  > 0.4

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Project Title

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Drawing Title

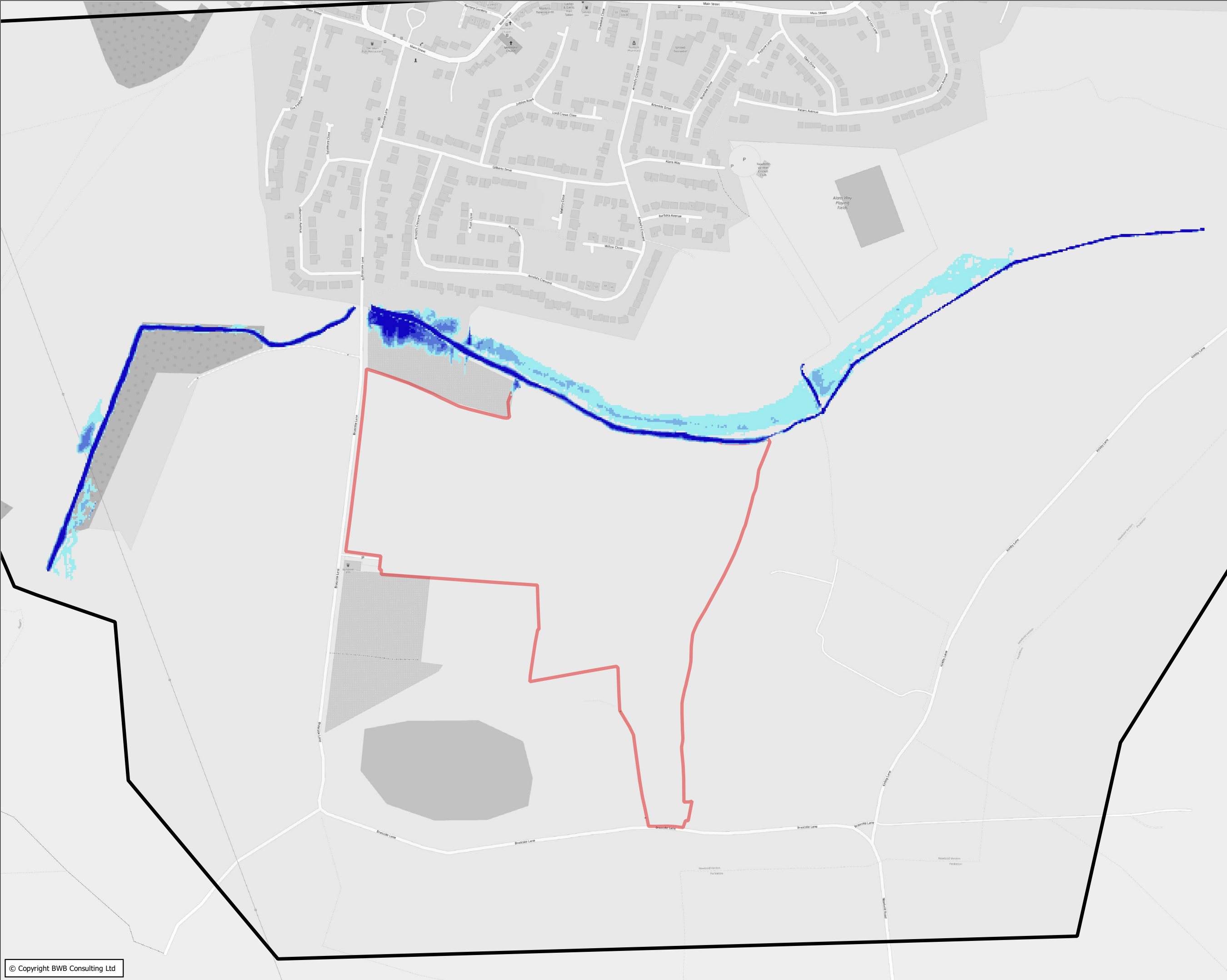
**Thurlaston Brook Flood Depths:
1 in 100-Year (1% AEP)
+60%CC**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0006	S2	P01



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Key

Illustrative Site Boundary

Model Domain

Peak Flood Depth (m)

- <= 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- > 0.4

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
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Client

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Project Title

Brascote Lane, Newbold Verdon

Drawing Title

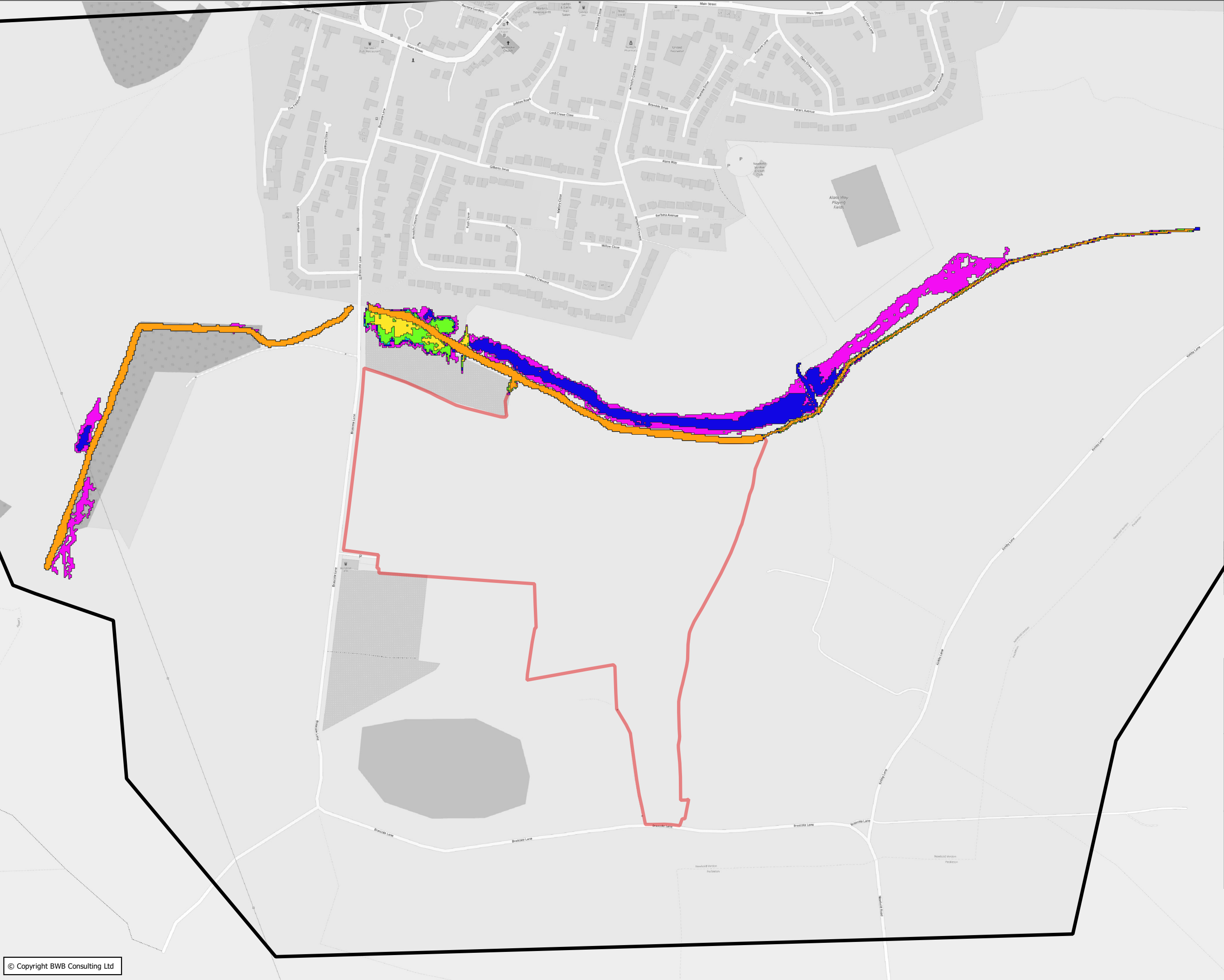
**Thurlaston Brook Flood Depths:
1 in 1000-Year (0.1% AEP)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0007	S2	P01



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- Key
- Illustrative Site Boundary
 - Model Domain
 - 1 in 20-Year (5% AEP)
 - 1 in 100-Year (1% AEP)
 - 1 in 100-Year (1% AEP) +28%CC
 - 1 in 100-Year (1% AEP) +37%CC
 - 1 in 100-Year (1% AEP) +60%CC
 - 1 in 1000-Year (0.1% AEP)

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
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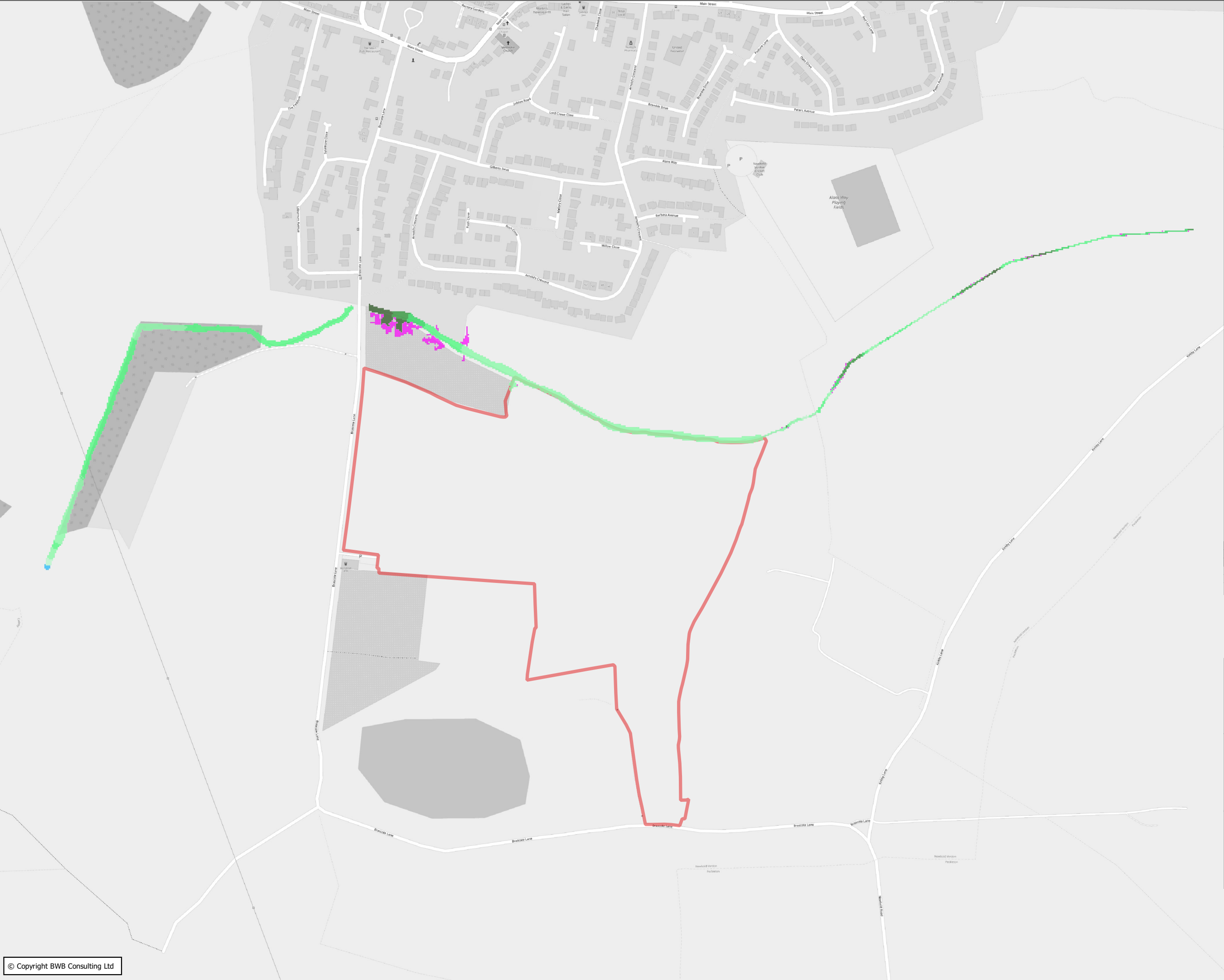
Project Title
**Brascote Lane, Newbold
Verdon**

Drawing Title
**Thurlaston Brook Floodplain
Extents**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status				
PRELIMINARY				
Project - Originator - Zone - Level - Type - Role - Number	Status	Rev		
BLN-BWB-ZZ-XX-SK-YE-0008	S2	P01		

Appendix 5 – Sensitivity Maps



- Notes**
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Key

 Illustrative Site Boundary

 Model Domain

Change in Flood Level (m)

-  <= -0.125
-  -0.125 - -0.100
-  -0.100 - -0.075
-  -0.075 - -0.050
-  -0.050 - -0.025
-  -0.025 - -0.01
-  -0.01 - 0.01 (No Change)
-  0.01 - 0.025
-  0.025 - 0.050
-  0.050 - 0.075
-  0.075 - 0.100
-  0.100 - 0.125
-  > 0.125

Change in Floodplain Extent

-  Former Wet Areas Now Dry
-  Former Dry Areas Now Wet

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
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Project Title

Brascote Lane, Newbold Verdon

Drawing Title

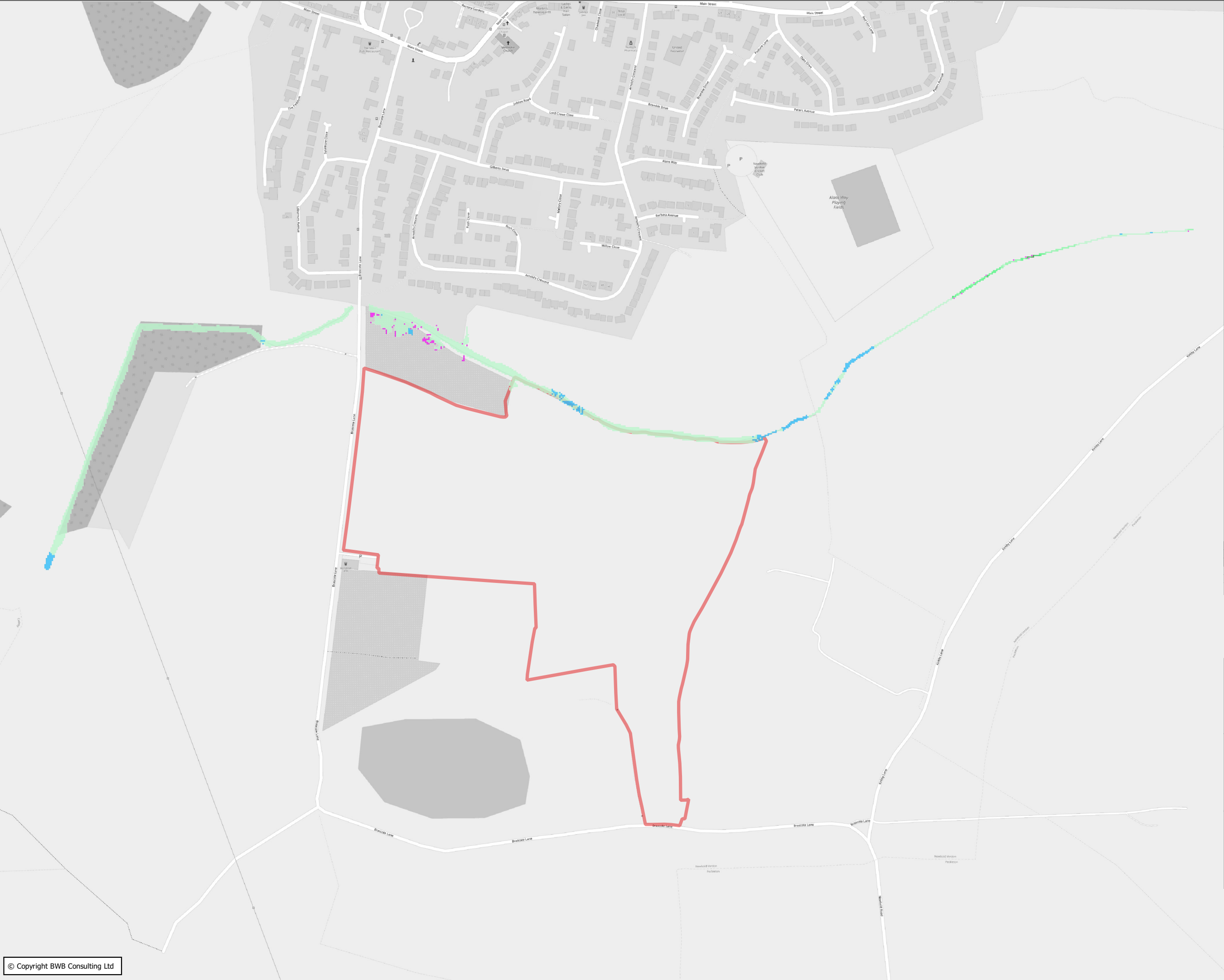
**Sensitivity Tests:
1 in 100-Year (1% AEP) 5.5hr
Storm Compared to 3hr
Storm**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
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Key

Illustrative Site Boundary

Model Domain

Change in Flood Level (m)

- <= -0.125
- 0.125 - -0.100
- 0.100 - -0.075
- 0.075 - -0.050
- 0.050 - -0.025
- 0.025 - -0.01
- 0.01 - 0.01 (No Change)
- 0.01 - 0.025
- 0.025 - 0.050
- 0.050 - 0.075
- 0.075 - 0.100
- 0.100 - 0.125
- > 0.125

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P01	15.09.21	PRELIMINARY ISSUE			MB RG
Rev	Date	Details of issues/ revision			Drw Rev

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Client

Richborough Estates

Project Title

Brascote Lane, Newbold Verdon

Drawing Title

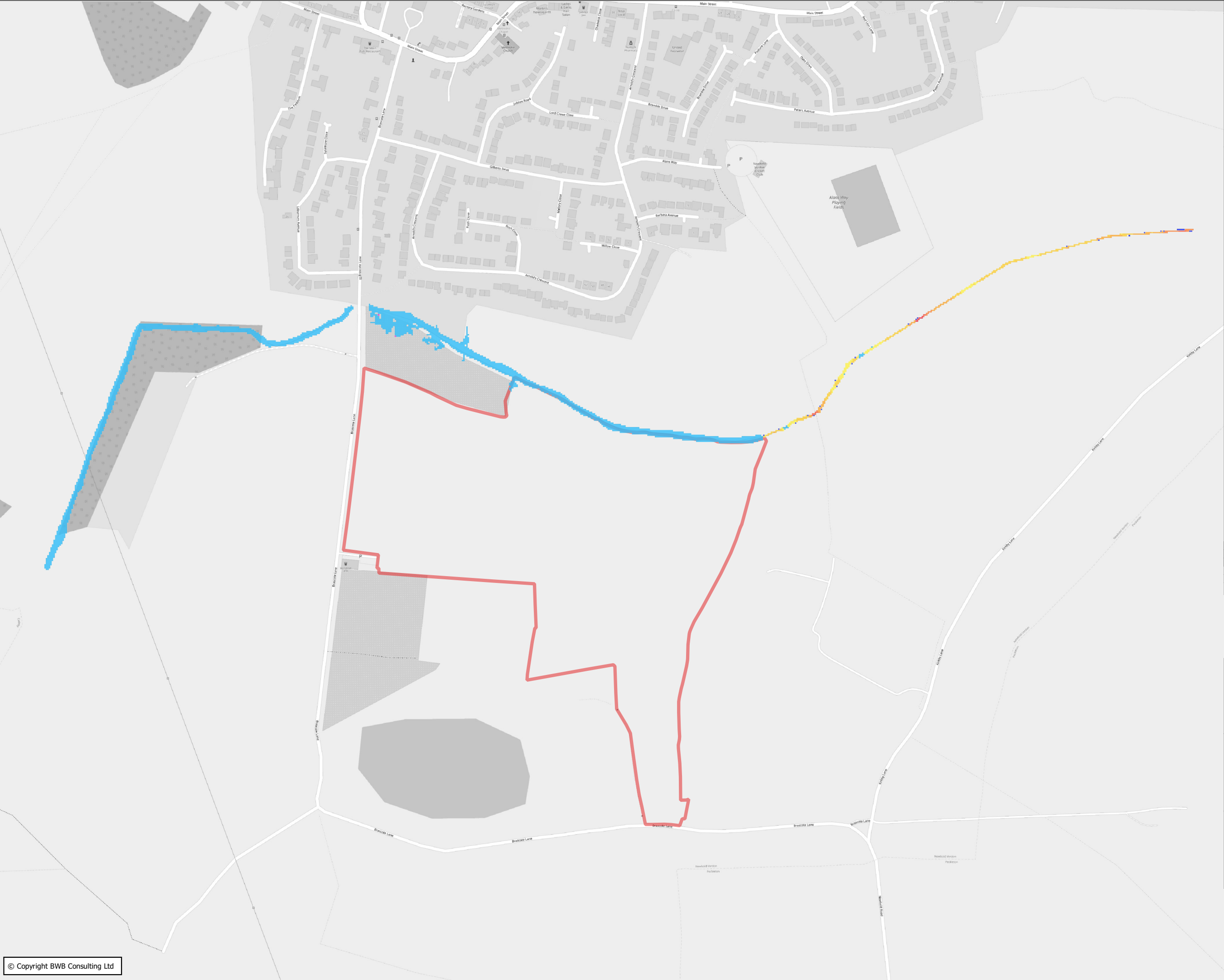
**Sensitivity Tests:
1 in 100-Year (1% AEP) 5.5hr
Storm Compared to 11hr
Storm**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	15/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0010	S2	P01



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Key

 Illustrative Site Boundary

 Model Domain

Change in Flood Level (m)

-  <= -0.125
-  -0.125 - -0.100
-  -0.100 - -0.075
-  -0.075 - -0.050
-  -0.050 - -0.025
-  -0.025 - -0.01
-  -0.01 - 0.01 (No Change)
-  0.01 - 0.025
-  0.025 - 0.050
-  0.050 - 0.075
-  0.075 - 0.100
-  0.100 - 0.125
-  > 0.125

Change in Floodplain Extent

-  Former Wet Areas Now Dry
-  Former Dry Areas Now Wet

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Project Title

Brascote Lane, Newbold Verdon

Drawing Title

**Sensitivity Tests:
1 in 100-Year (1% AEP)
Increased Roughness (+20%)**

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BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500
Drawing Status			
PRELIMINARY			
Project - Originator - Zone - Level - Type - Role - Number			
BLN-BWB-ZZ-XX-SK-YE-0011			
Status	S2	Rev	P01



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Key

Illustrative Site Boundary

Model Domain

Change in Flood Level (m)

- <= -0.125
- 0.125 - -0.100
- 0.100 - -0.075
- 0.075 - -0.050
- 0.050 - -0.025
- 0.025 - -0.01
- 0.01 - 0.01 (No Change)
- 0.01 - 0.025
- 0.025 - 0.050
- 0.050 - 0.075
- 0.075 - 0.100
- 0.100 - 0.125
- > 0.125

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
Rev	Date	Details of issues/ revision		Drw	Rev

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Project Title

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Drawing Title

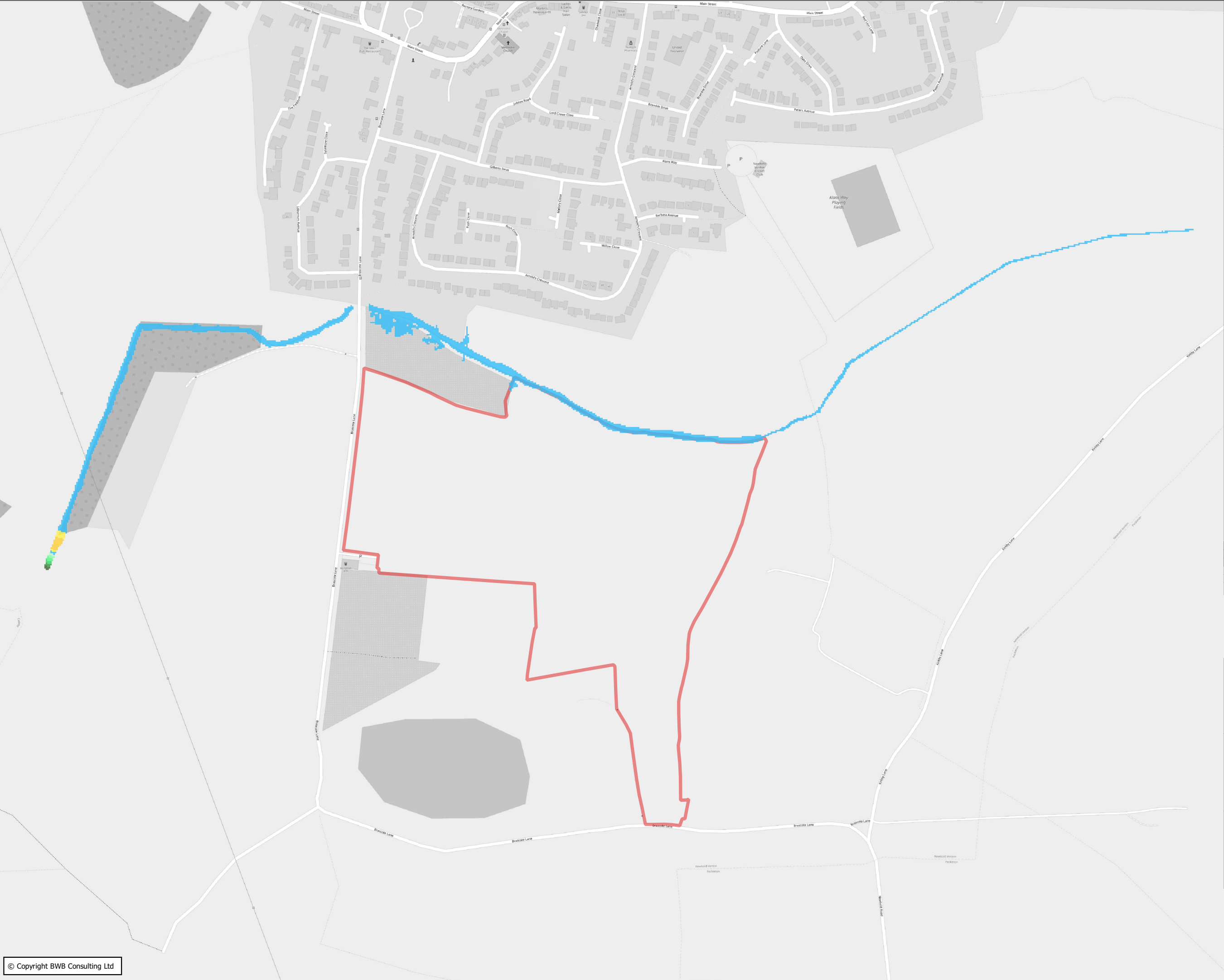
**Sensitivity Tests:
1 in 100-Year (1% AEP)
Decreased Roughness
(-20%)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0012	S2	P01



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Key

Illustrative Site Boundary

Model Domain

Change in Flood Level (m)

- <= -0.125
- 0.125 - -0.100
- 0.100 - -0.075
- 0.075 - -0.050
- 0.050 - -0.025
- 0.025 - -0.01
- 0.01 - 0.01 (No Change)
- 0.01 - 0.025
- 0.025 - 0.050
- 0.050 - 0.075
- 0.075 - 0.100
- 0.100 - 0.125
- > 0.125

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P01	15.09.21	PRELIMINARY ISSUE			MB RG
Rev	Date	Details of issues/ revision			Drw Rev

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Project Title

Brascote Lane, Newbold Verdon

Drawing Title

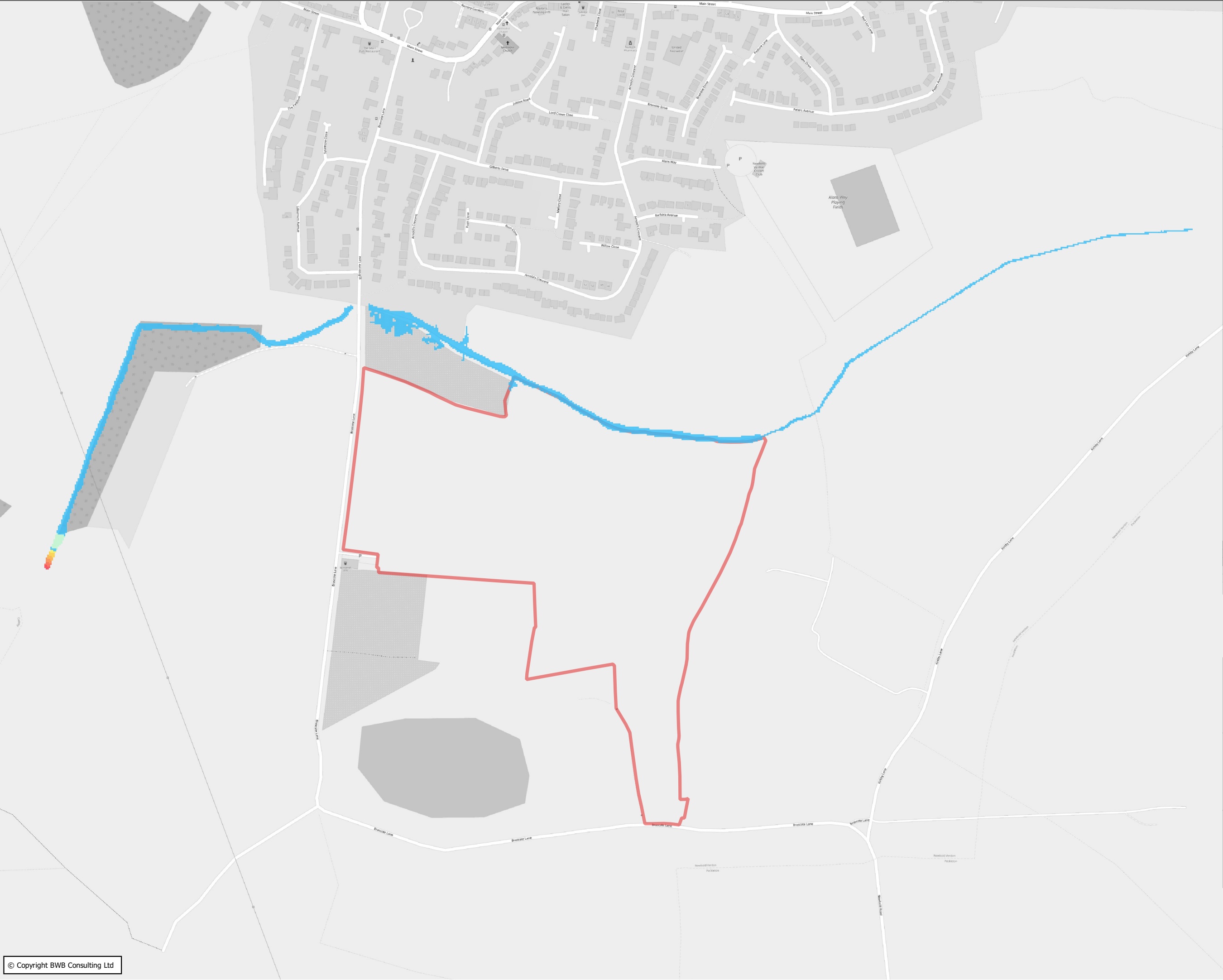
**Sensitivity Tests:
1 in 100-Year (1% AEP)
Downstream Boundary
Gradient (+20%)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	15/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0014	S2	P01



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Key

Illustrative Site Boundary

Model Domain

Change in Flood Level (m)

- <= -0.125
- 0.125 - -0.100
- 0.100 - -0.075
- 0.075 - -0.050
- 0.050 - -0.025
- 0.025 - -0.01
- 0.01 - 0.01 (No Change)
- 0.01 - 0.025
- 0.025 - 0.050
- 0.050 - 0.075
- 0.075 - 0.100
- 0.100 - 0.125
- > 0.125

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P01	15.09.21	PRELIMINARY ISSUE			MB RG
Rev	Date	Details of issues/ revision			Drw Rev

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Project Title

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Drawing Title

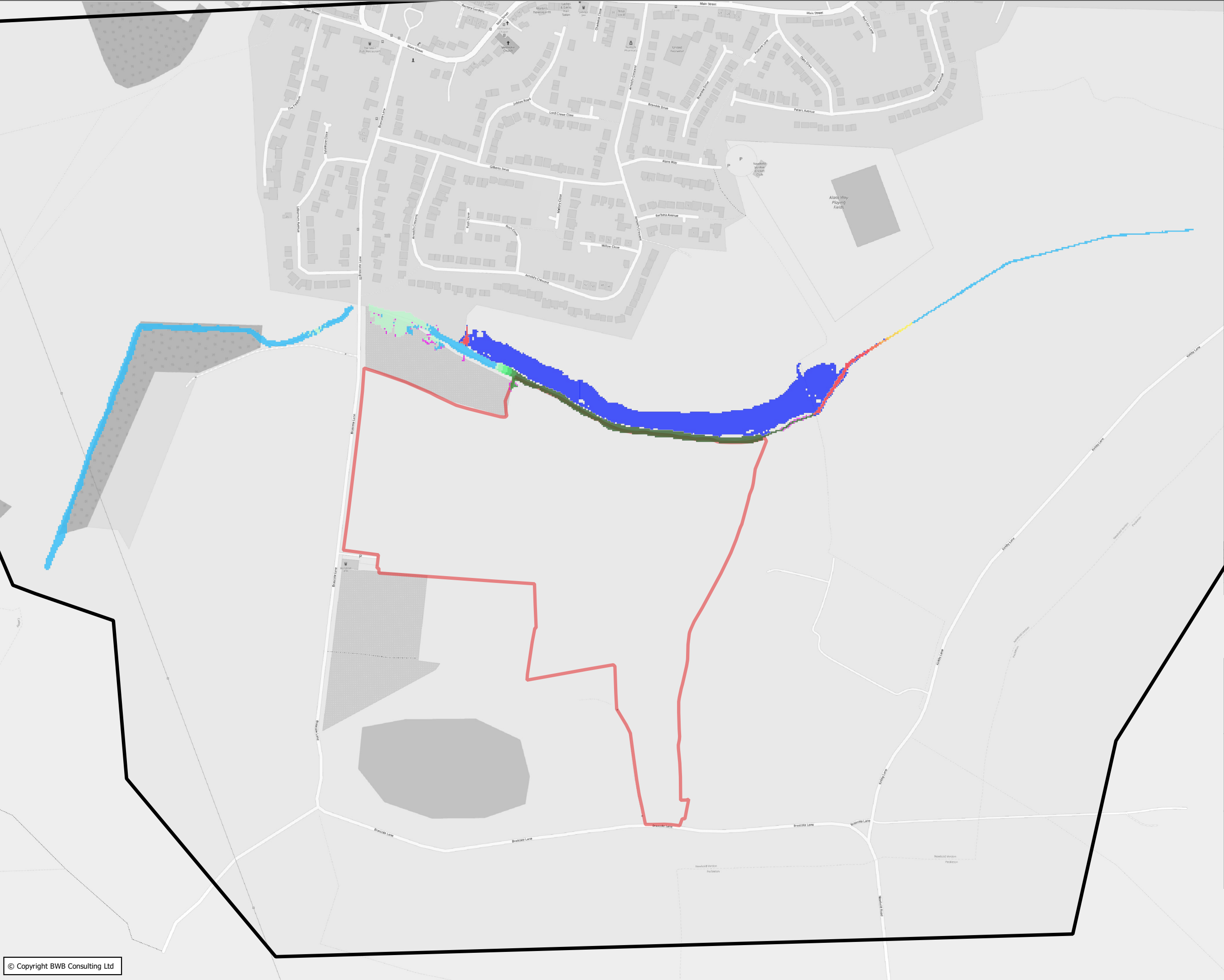
**Sensitivity Tests:
1 in 100-Year (1% AEP)
Downstream Boundary
Gradient (-20%)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	15/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0014	S2	P01



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Key

 Illustrative Site Boundary

 Model Domain

Change in Flood Level (m)

-  <= -0.125
-  -0.125 - -0.100
-  -0.100 - -0.075
-  -0.075 - -0.050
-  -0.050 - -0.025
-  -0.025 - -0.01
-  -0.01 - 0.01 (No Change)
-  0.01 - 0.025
-  0.025 - 0.050
-  0.050 - 0.075
-  0.075 - 0.100
-  0.100 - 0.125
-  > 0.125

Change in Floodplain Extent

-  Former Wet Areas Now Dry
-  Former Dry Areas Now Wet

P01	14.09.21	PRELIMINARY ISSUE			MB RG
Rev	Date	Details of issues/ revision			Drw Rev

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Project Title

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Drawing Title

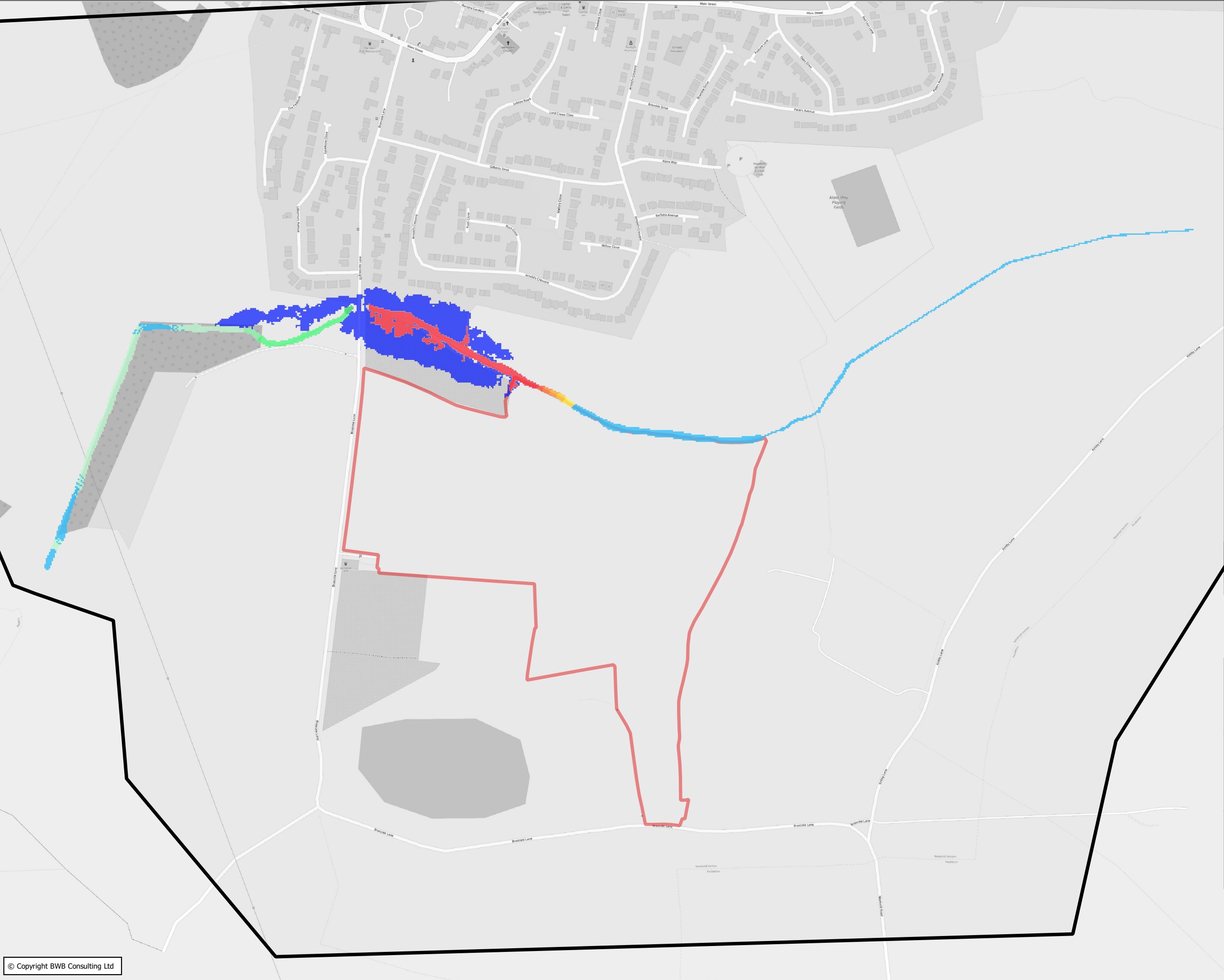
**Sensitivity Tests:
1 in 100-Year (1% AEP)
Blockage Test Location 1
(100%)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0015	S2	P01



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Key

Illustrative Site Boundary

Model Domain

Change in Flood Level (m)

- <= -0.125
- 0.125 - -0.100
- 0.100 - -0.075
- 0.075 - -0.050
- 0.050 - -0.025
- 0.025 - -0.01
- 0.01 - 0.01 (No Change)
- 0.01 - 0.025
- 0.025 - 0.050
- 0.050 - 0.075
- 0.075 - 0.100
- 0.100 - 0.125
- > 0.125

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P01	14.09.21	PRELIMINARY ISSUE		MB	RG
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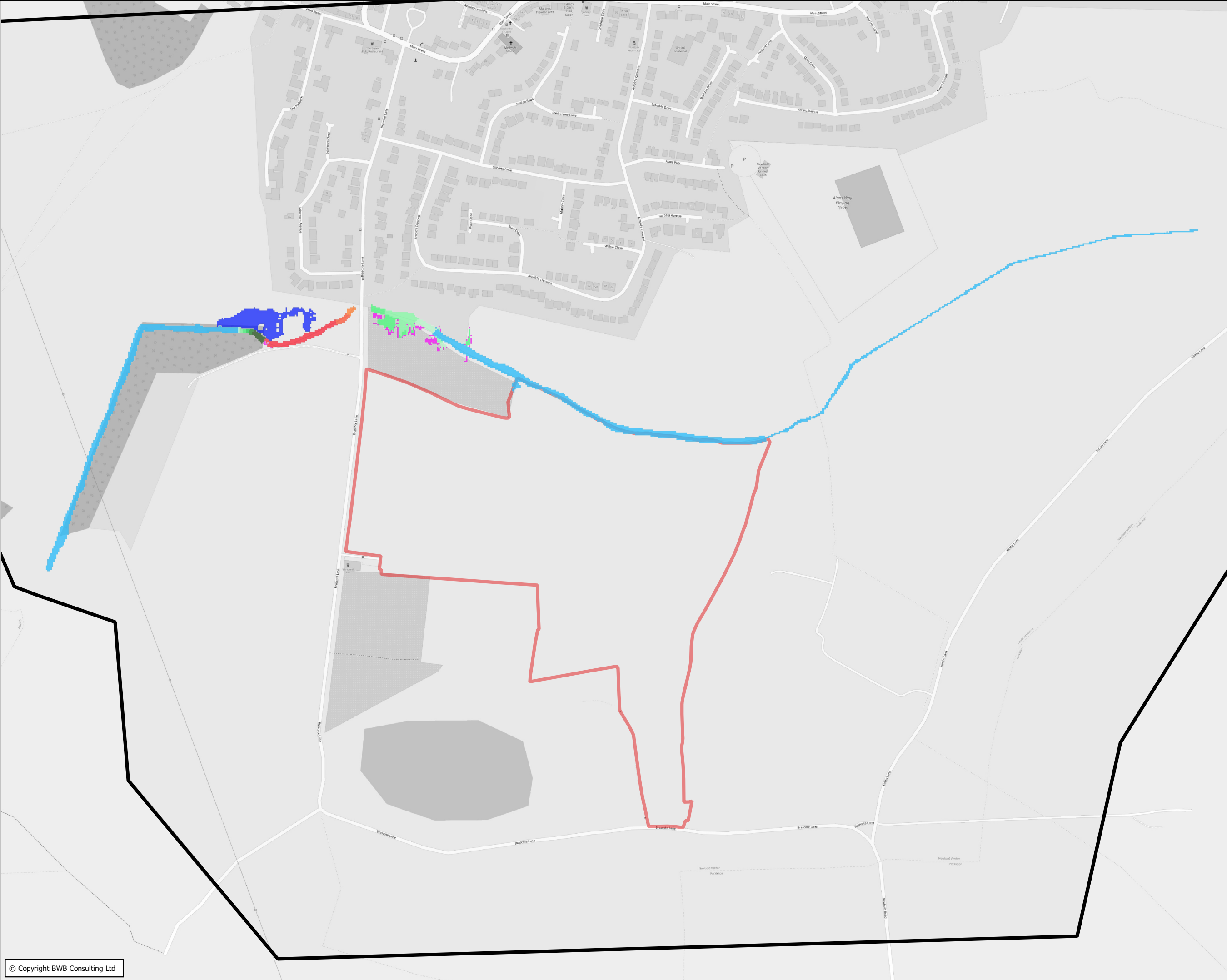
Project Title
Brascote Lane, Newbold Verdon

Drawing Title
**Sensitivity Tests:
1 in 100-Year (1% AEP)
Blockage Test Location 2
(100%)**

Drawn:	M. Brambani	Reviewed:	R. Green
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		Scale@A3:	1:4,500

Drawing Status
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 3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. OpenStreetMap data have been reproduced under the terms of the Open Data Commons Open Database License. © OpenStreetMap contributors.

Key

Illustrative Site Boundary

Model Domain

Change in Flood Level (m)

- <= -0.125
- 0.125 - -0.100
- 0.100 - -0.075
- 0.075 - -0.050
- 0.050 - -0.025
- 0.025 - -0.01
- 0.01 - 0.01 (No Change)
- 0.01 - 0.025
- 0.025 - 0.050
- 0.050 - 0.075
- 0.075 - 0.100
- 0.100 - 0.125
- > 0.125

Change in Floodplain Extent

- Former Wet Areas Now Dry
- Former Dry Areas Now Wet

P01	14.09.21	PRELIMINARY ISSUE			MB RG
Rev	Date	Details of issues/ revision			Drw Rev

Issues & Revisions

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Client

Richborough Estates

Project Title

Brascote Lane, Newbold Verdon

Drawing Title

**Sensitivity Tests:
1 in 100-Year (1% AEP)
Blockage Test Location 3
(100%)**

Drawn:	M. Brambani	Reviewed:	R. Green
BWB Ref:	BMV 3175	Date:	14/09/21
		Scale@A3:	1:4,500

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
BLN-BWB-ZZ-XX-SK-YE-0017	S2	P01

Appendix 6 – Model Schematic



1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. The Ordnance Survey material used in this map has been used with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office Crown copyright. Licence No 100022432, (2020).

- 2D Inflow Location (QT)
- 1D Downstream Boundary (HT)
- 2D Downstream Boundary (HQ)
- 2D Thurlaston Brook Channel
- 1D Thurlaston Brook Channel
- 1D Hydraulic Structures
- Blockage Locations
- 1D-2D Boundary (HX)
- 1D Domain
- 2D Domain
- Illustrative Site Boundary

P01	08.09.21	Preliminary Issue	MB	RG
Rev	Date	Details of issue / revision	Drw	Rev

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Project Title

Brascote Lane, Newbold Verdon

Hydraulic Model Schematic

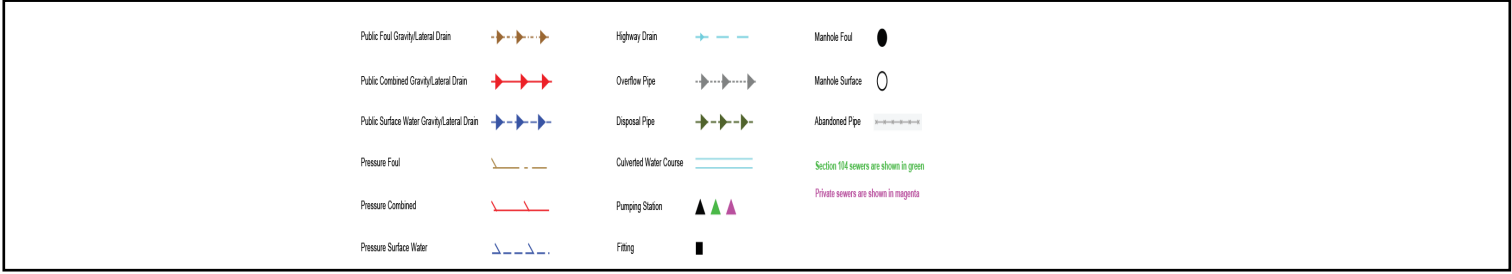
Drawn:	M. Brambani		Reviewed:	R. Green	
BWB Ref:	BMW 3175	Date:	08/09/21	Scale@A1:	1:3,000

Drawing Status

PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
RI N-BWB-77-XY-SK-YE-0001	S2	P01

Appendix 4: Severn Trent Sewer Records



GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on: 0800 753 4444 (24 hours)

- a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt), mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.
- b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.
- c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.
- d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.
- e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).
- f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).
3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.
4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.
6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.
9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.
10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.
11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.
12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.
13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants,
14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.
16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.
17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014
18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.
19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

