Former Merseyside Dogs Home

East Halewood

Hydraulic Modelling Report

November 2022

Waterco

Assessment | Modelling | Design

Scheme Information	
Scheme:	Former Merseyside Dogs Home, East Halewood
Report Title:	Hydraulic Modelling Report
Client:	BBE Developments Ltd
Instruction:	The instruction to undertake this modelling was received from Mr Nabeil Nasr of BBE Developments Ltd.
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Approval Record	
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Document History		
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This report will remain valid for a period of twelve months (from the date of last issue) after which the source data should be reviewed in order to reassess the findings and conclusions on the basis of latest available information

Contents

Introduction 1

Hydraulic Model Build 3

Model Simulation Setup 8

Model Limitations 10

Model Results 13

Recommendations 15

Tables

Table 1: Glossary of Technical Terms iv

Table 2: Modelling Short Codes v

Table 3: Site Overview 1

Table 4: Site Flood Risk 2

Table 5: General model overview 3

Table 6: Data sources 4

Table 7: 1D Model Information 5

Table 8: 2D model details 6

Table 9: 1D/2D Linking Details 7

Table 10: Primary simulations under normal conditions (NC) 8

Table 11: Structure blockage details 9

Table 12: Sources of uncertainty and assumptions 10

Table 13: Sensitivity test details 11

Table 14: Existing Maximum In Channel Water Levels 13

Table 15: Proposed Development Maximum In Channel Water Levels 14

Table 16: Existing and Proposed Development Maximum In Channel Water Levels 14

Appendices

Appendix A Location Plan, Aerial Image and Photographs

Appendix B Survey Data

Appendix C Proposed Development Plans

Appendix D EA Correspondence and Flood Maps

Appendix E Model Extent

Appendix F Hydrology - Flood Estimation Calculation (FEC) Record

Appendix G Cross Section Comparisons

Appendix H Simulated Flood Maps

Appendix I 2D Model Water Level Map

Glossary and Modelling Short Codes

Table 1: Glossary of Technical Terms

Term / Acronym	Definition
1D (model)	One dimensional – A type of model typically built using watercourse cross-section survey data to represent the watercourse and adjacent floodplain
2D (model)	Two dimensional – A type of hydraulic model typically built using LiDAR and site-specific topographic data to represent the wider floodplain
1D-2D (model)	A combination of 1D and 2D modelling (i.e. typically a representation of the watercourse and floodplain respectively)
AEP	Annual Exceedance Probability – the probability that a storm event will occur in any given year
Defra	Department for Environment, Food and Rural Affairs
DfI	Department for Infrastructure – one of nine departments in Northern Ireland responsible for regional strategic planning and development policy
EA	Environment Agency – non-departmental public body responsible for the protection and enhancement of the environment in England
ESTRY	Industry standard flood modelling software (1D engine built into TUFLOW)
FCA	Flood Consequence Assessment
FRA	Flood Risk Assessment
FFL	Finished Floor Level
Flood risk	The product of the frequency or likelihood of a flood event and the consequences (such as loss, damage, harm, distress and disruption)
FMP	Flood Modeller Pro – industry standard flood modelling software
HMR	Hydraulic Modelling Report
IDB	Internal Drainage Board
LA	Local authority
LiDAR	Light Detection and Ranging (i.e. Ground elevation data)
LLFA	Lead Local Flood Authority
Main river	A watercourse on which the relevant regulatory body (e.g. EA/NRW/SEPA/DfI) has permissive powers, but not a duty, to carry out maintenance, improvement, or construction work.
MIKE (11/21/FLOOD)	Industry standard flood modelling software

Term / Acronym	Definition
NGR	National Grid Reference
NRW	Natural Resources Wales – Welsh Government sponsored body responsible for managing the environment and natural resources of Wales
Ordinary watercourse	A river, stream, ditch, cut, sluice, dyke or non-public sewer that is not a designated main river, and for which the LA has flood risk management responsibilities and powers.
SEPA	Scottish Environment Protection Agency – non-departmental public body responsible for the protection and enhancement of the environment in Scotland
TN	Technical Note
TUFLOW	Industry standard flood modelling software

Short codes are used in the naming and referencing of model files, events and scenarios to ensure a consistent, high-quality naming convention is followed and to simplify communication of model results.

Table 2: Modelling Short Codes

Model Short Code	Definition
ABC	Model identifier
BL[*x*]-[*y*]	A *y*% blockage at location *x* (e.g. BL1-67 – 67% blockage at location "1")
BR[*x*]-[*y*]	A *y* metre wide breach scenario at location *x* (e.g. BR2-50 – 50m wide breach at location "2")
CC	Climate change
DEV	Post-development site layout
EXG	Existing (pre-development) site layout
MIT	Flood mitigation option
NC	"Normal conditions" A model setup representative of present channel and floodplain conditions throughout the study area – no additional structure blockages, defence breaches or pump failures
OPT	Development option
Q[*x*]	1 / *x* % AEP fluvial event
R[*x*]	1 / *x* % AEP pluvial event
ST[*x*]	Sensitivity test *x* (e.g. ST1 – channel and floodplain roughness +20%)
T[*x*]	1 / *x* % AEP tidal event

Introduction

Waterco has been commissioned to undertake a detailed hydraulic modelling study in support of the FRA being prepared for the development.

The main objective of this hydraulic modelling study is to quantify existing flood risk at the site and the change in flood risk elsewhere (if any) as a result of the development. To enable this, an existing EA linked 1D/2D[1] hydraulic model has been utilised. The purpose of this report is to summarise the hydraulic modelling works completed.

Site Description and Proposed Development

A full description of the existing site layout, flood risk and the proposed development site layout can be found within the associated FRA. Table 3 provides an overview of the existing site. A location plan and an aerial photograph of the site are included in Appendix A .

Table 3: Site Overview

Site Overview	
Site Address	Former Merseyside Dogs Home, Greensbridge Lane, Halewood, Tarbock Green, Liverpool, L35 1QH
NGR (located at centre of site)	345615, 386610
Topographic Survey	A topographical survey of the site was undertaken by Ian Strachan Ltd in January 2022 and is provided in Appendix B for information.
Current Site Use	Former Merseyside Dogs Home
Regulatory body	EA

The finished floor level (FFL) of the proposed development platform is yet to be finalised and will be based on the outputs of the hydraulic modelling study. To ensure the development platform is flood-free during all fluvial events the development platform will be entirely raised out of the floodplain.

Initial concept development plans are included in Appendix C.

The outputs of this hydraulic modelling study provide a detailed, up-to-date assessment of the existing fluvial flood risk at the site and quantify the change in flood risk elsewhere as a result of the proposed development (if any).

Flood Risk & History

Table 4 provides a brief overview of the flood risk pertaining to the site.

[1] A 1D/2D hydrodynamic model is comprised of a 1-Dimensional (1D) river network model (based on surveyed river cross-sections) coupled with a 2-Dimensional (2D) Digital Terrain Model (DTM) of the potential floodplain (created from LiDAR).

Table 4: Site Flood Risk

Site Flood Risk	
Type of Flood Risk	Fluvial
Primary Source of Flood Risk	Watercourse Netherley Brook
EA Flood Map for Planning (November 2022)	The flood map is included in Appendix D . Flood Zone 1 – an area considered to be at low risk of fluvial flooding with an annual probability of the flooding lower than 0.1%. Flood Zone 2 - an area considered to be at moderate risk of fluvial and/or tidal flooding with an annual probability of flooding from rivers of between 1% and 0.1% and from the sea of between 0.5% and 0.1%. Flood Zone 3 - an area considered to be at high risk of fluvial flooding with an annual probability of the flooding greater than 1%.
Available Model Data	The EA currently hold a detailed hydraulic model of the area (Model Ref: Netherley, Halewood and Woodend), which has been sourced for this project.

The EA historical flood map, included in Appendix D, shows that there are no records of flooding recorded at the site. A review of publicly available information online revealed no evidence of historical flooding at or near to the site.

Hydraulic Model Build

The information provided in this section details the modelling works carried out as part of this scheme. The model log[2] provided with the model files should be consulted if further details are required. An explanation of the file, event and scenario naming convention used is provided in the model log.

Model Approach

A proposed hydraulic modelling and hydrological assessment methodology was sent to the EA for comment prior to commencing the model build. The EA's response includes comments and recommendation to the proposed methodology. This has been taken into consideration throughout the model build/model update process and where appropriate has been implemented. All correspondence with the EA regarding the modelling approach is included in Appendix D .

Table 5 provides a general overview of the model itself. The 1D/2D model extents are provided in Appendix E.

Table 5: General model overview

General Model Overview	
Brief Summary:	The current EA Netherley, Halewood and Woodend model has been used as a base for this scheme.
Model Type:	1D-2D
Software Builds:	FMP 6.0 / TUFLOW 2020-10-AE CLASSIC Single Precision (Latest build available at the start of the project)
Simulation Type:	Fluvial
EA Model Reference:	Netherley, Halewood and Woodend
Waterco Model Reference & Version:	14506-Item 25072-v15

[2] Doc ref: 14506-25072-Model_Log.xlsx

Data Sources

Table 6 details the data sources used within the model build process.

Table 6: Data sources

Data Source	Doc Ref	Provider	Date/Age	Comments
Current EA Netherley, Halewood and Woodend model	2011s5273 Final Report_13 April.pdf	EA	March 2012	Model files updated to create site-specific model for this study
Topographic Data				
Topographic survey	Greensbridge Topographical Survey 27.01.22.dwg	Ian Strachan Ltd in	January 2022	Full coverage of site
Post- development site layout plan	Greensbridge Lane_Feasibility_Rev A.pdf	Client	July 2022	Full coverage of site
EA LiDAR DTM (1m)	SJ48nw_DTM_1m.tif SJ48ne_DTM_1m.tif	EA	2020	Site and surrounding area
Other Data				
FEC Record	14506-25637-FEC-1.pdf	Waterco	Nov 2022	FEC Record provided in Appendix F which details inflow hydrographs used in the model
Site visit photos	-	Waterco	Sept 2020	Site and surrounding area

1D/2D Model Information

Tables 7, 8 and 9 summarise the details of the 1D/2D model, including the various parameters within the model, and how the proposed development is represented within the model.

Table 7: 1D Model Information

1D Model Information	
Extent:	A plan of the 1D/2D model extent is included in Appendix E.
Cross-Sections:	A comparison of the LiDAR and the modelled cross sections adjacent to the site (between model nodes NETH01_0416 and DITT01_4749d) found that that whilst the LiDAR bed levels were higher than those in the existing model the shape of the cross sections matched well. The comparisons are included in Appendix G. For cross sections NETH01_0291u and NETH01_0286d there appears to be two channels in the modelled cross sections, whilst only one in the Lidar. These cross sections are located at the culvert underneath Cartbridge Lane. A site visit confirmed there are multiple culverts beneath the road. Photo IMG_2784.JPEG, included in Appendix A, is looking upstream and shows that there is an overflow channel (dry) located higher than the main channel (water present). This is reflected in the modelled survey data. Cross sections are either dated from October 2011 survey, or 1997 survey. A comparison of the cross sections where the different datasets overlap show that the channel shape matches well between NETH01_0195 (Oct 2011) and DITT01_4924 (1997) and DITT01_4874 (1997) suggesting that the channel hasn't changed over the 14 years between the modelled survey data undertaken.
Cross-Section Spacing:	Generally 50m-200m Typically 50m adjacent to the site
Roughness Approach and Values ($s/m^{1/3}$):	Manning's n roughness coefficients in the existing EA cross-sections have been reviewed and were deemed acceptable.
Boundary Conditions:	QT boundaries applied to the most upstream node of each watercourse. Additional lateral inflows applied through urban areas using QT boundaries. Total 10no QT boundaries. A detailed hydrological assessment of the predicted flows in the watercourses has been completed by Waterco. The completed hydrological calculations, summarised in a Flood Estimation Calculation (FEC) Record are included in Appendix F, along with the final design hydrographs used. The downstream boundary is represented using a flow-head relationship based on local slope.
Structures:	A review of the existing EA structures was carried out and no modifications to structures within the existing model setup were undertaken.
Existing Flood Defences:	None
Post-Development Layout:	No changes were made to the 1D model for the proposed development scenario.
Timestep:	1s
Initial Conditions:	.iic files generated using steady state simulation
Non-Default Parameters:	EA parameters reviewed and were deemed acceptable. As per EA model set up Preissmann slot set to "on" for low flow stability

Table 8: 2D model details

2D Model Details	
Number of Domains and Extent:	1 domain. The model extent is shown in Appendix E.
DTM Data Sources:	Latest available EA LiDAR data has been used to update the base DTM in the model. The LiDAR levels at the site have been compared to the topographical survey of the site and found to be within +/- 150mm difference. As the LiDAR offers a higher resolution this dataset has been utilised in the model.
Cell Size:	4m – this resolution is adequate to represent the flow paths on site and within the wider floodplain whilst maintaining a reasonable run time.
Building Representation:	High roughness – 0.5s/m$^{1/3}$
Existing Flood Defences:	Existing flood defences located along Winster Drive, upstream of the site. Initial model runs during the 1% AEP event showed water levels at the site are not affected by the defences.
General Bank Levels (Non-Defence):	Bank levels have been enforced along the 1D-2D links using thick z-line features. The elevations within these z-lines are based on latest EA 1m LiDAR data.
Roughness Approach and Values (s/m$^{1/3}$):	Manning's n based on Chow (1959), survey, photographs, and aerial imagery. Land use has been updated based on the latest OS MasterMap data. 0.500 Buildings 0.035 Land (Multi Surface, step, structures) 0.030 Water 0.040 Land (Rail) 0.060 Land (Scrub, Rough grassland) 0.025 Roads Tracks And Paths 0.040 Structures 0.100 Structures (Pylon) 0.035 Land (Unclassified)
Boundary Conditions:	None
Structures:	None
Post-Development Layout:	A TUFLOW code layer has been used to represent the proposed development platform (entire site), by removing the platform from the model to simulate raising the platform completely out of the floodplain.
Other DTM Adjustments:	Mill Brook watercourse channel has been interpolated out due to negative depths when water backs up the watercourse. Given this is likely to force more flows downstream, it is considered a conservative approach to modelling flood risk at the subject site.
Timestep:	2s
Initial Conditions:	None

Non-Default Parameters:	None

Table 9: 1D/2D Linking Details

1D/2D Linking Details	
Link Types:	HX links used to link the 1D channel to the 2D floodplain.
Changes to Default Link Parameters:	None

Model Simulation Setup

The list of primary and blockage simulations modelled for this study are detailed in this section.

Primary Simulations

Primary simulations have been modelled for a range of fluvial design events and site scenarios and are summarised in Table 10.

Table 10: Primary simulations under normal conditions (NC)

Fluvial Design Event (AEP)	Climate Change Allowance	Site Layout
5%	-	Existing (EXG) / Proposed Development (DEV)
1%	-	
1%	+44%	
0.1%	-	

Blockage Simulations

Structure blockages have been assessed at two locations with respect to the 1% AEP +44% CC fluvial event, for both EXG and DEV site layout scenarios. Details of the studied blockages can be found in Table 11.

Blockage percentages were chosen based on a review of upstream land-use (e.g. woodland/vegetation), trash screen presence, channel slope and width, orifice shape and size and worst-case blockage estimate should the structure collapse.

Photographs of the structures are included in Appendix A.

Table 11: Structure blockage details

Blockage Location (Model Short Code)	Coordinates	Structure Details	Considerations	Blockage %	Fluvial Event (AEP)	Site Layout
BL1 (BL1-33)	345558, 386644	Cartbridge Lane. Large arch culvert upstream of site 4.29m wide x 2.1m high, with an additional overflow culvert 4m wide x 1.23m high.	Unlikely to significantly block given size and number of culverts.	33%	1% +44% CC	EXG/DEV
BL2 (BL2-33)	345726, 386428	Greensbridge Lane. Large culvert downstream of site 4.015m wide x 2.616m high, with springing height of 1.246m and height of crown 1.37m. Two additional overflow culverts, approx. dia. 3.02m and 1.81m.	Structures are unlikely to significantly block given the number and size of culverts. Further there is a bridge located approximately 300m upstream.			

Model Limitations

This section presents the steps taken throughout the modelling process to reduce uncertainty and improve confidence in the model outputs. Efforts have been made to assess and reduce the levels of uncertainty at each stage of the modelling process. The most appropriate available information has been used to construct the model to represent flooding mechanisms. The assumptions made are generally conservative for modelled water levels at the proposed scheme location and are therefore appropriate for the assessment of flood risk.

In the absence of available calibration data, sensitivity testing of four identified sources of uncertainty has been carried out along with model validation against a known flood event (if available) and a review of the model's performance rating. Table 12 lists and ranks identified sources of uncertainty and the assumptions made as part of the model build process.

Limitations and Assumptions

Table 12: Sources of uncertainty and assumptions

Rank	Source	Selected method	Assumptions
1	Friction parameters	Manning's n roughness coefficient based on available guidance (Chow 1959)	Channel and floodplain roughness utilised in the current EA model have been reviewed against aerial photographs and found to be appropriate for use in this study. The channel roughness values may vary over the year and the sensitivity tests have been carried out to quantify the impact.
2	Boundary conditions	Flow-head relationship	Sensitivity tests have been carried out to ensure that there is no impact to water levels at the site location.
3	Inflow hydrology	FEH Statistical	See FEC record for detail. In addition, sensitivity tests have been carried out to quantify the impact.
4	Minimum flow in FMP	Minimum flow in FMP nodes NETH01_4081, HAL3_0507i	Sensitivity tests have been carried out to ensure that there is no impact to water levels at the site location as a result of minimum flow included for inflows in the existing EA model.
5	Topography	DTM and survey data	Latest available 1m resolution LiDAR data has been used to represent the floodplain topography and watercourse bank levels. For the proposed scheme, the existing ground levels were modified within the proposed scheme footprint using code polygons.
6	Grid size	4m cell size	This is suitable to represent most of the floodplain features across the model extents to an appropriate level of detail.
7	Structures	Flood Modeller Pro defaults.	Hydraulic coefficients for structures have been applied using available guidance within the Flood Modeller software.
8	Change in climate condition	Predictions of anticipated change to watercourse flow	Climate change events selected based on NPPF guidance.

Sensitivity Tests

Sensitivity testing of the top three ranked sources of uncertainty (see Table 12) has been carried out. A total of eight sensitivity tests have been carried out (ST1-6) with respect to the 1% AEP +44% CC fluvial event. Details of these sensitivity tests can be found in Table 13.

Table 13: Sensitivity test details

Sensitivity Test Short Code	Varied Parameter	Adjustment	Fluvial Event (AEP)	Site Layout
ST1	Roughness coefficients	+20%	1% +44% CC	EXG
ST2	Roughness coefficients	-20%		
ST3	Downstream boundary level	+20%		
ST4	Downstream boundary level	-20%		
ST5	Inflow	+20%		
ST6	Inflow	-20%		
ST7	Minimum Flow in FMP nodes NETH01_4081, HAL3_0507i	+0.2		
ST8	Minimum Flow in FMP nodes NETH01_4081, HAL3_0507i	-0.1		

The results of sensitivity tests ST1 and ST2 show that a significant variation (+/-20%) in the Manning's 'n' coefficients used within the channel and floodplain affects the flood extent across the site during this event. A small increase/decrease in the flood extent across the site is observed during ST1 and ST2 scenarios respectively relative to the existing scenario. The maximum water levels in channel increases/decreases at the site are less than 150mm. The maximum water levels in channel increases/decreases throughout the model by typically less than 150mm, with a maximum of 264mm. Whilst this change in maximum levels can be deemed significant in places, the selected roughness coefficients used within the model are based on industry standard guidance (Chow 1959[3]) and are considered to be appropriate.

The results of sensitivity tests ST3 and ST4 show that significantly varying the slope value used at the downstream boundary by +/-20% has a negligible effect on the maximum water levels in-channel adjacent to the site (<10mm difference). There are negligible changes to flood depths or extents across the site when ST3 and ST4 are considered.

The results of sensitivity tests ST5 and ST6 show that significantly varying the inflows used at the most upstream nodes by +/-20% respectively causes an increase/decrease in maximum water levels and flood extents throughout the model as can be expected. Two differing flow estimation methods have been used to produce the final design hydrographs used in the model. Both flow estimation methods have been subject to scrutiny in accordance with EA guidance and detailed in the FEC Record (Appendix F) - the final design hydrographs are deemed reliable and robust. The FEC record (see Appendix F) section 7.3) provides an upper and lower flow limit with a 95% confidence on the QMED value used to generate the inflows for this study.

[3] Chow, V.T., 1959, Open-channel hydraulics: New York, McGraw-Hill

The results of sensitivity tests ST7 and ST8 show that varying the minimum flow in FMP nodes NETH01_4081, HAL3_0507i has negligible effects on flood depths and extents across the site. Given there is negligible impact in altering the minimum flow values, the values applied in the current EA model are deemed acceptable.

Model Validation

Comparison of model results against historical data was not possible as there are no available maps, flood extents or gauge data of past historical flooding at the site. Increased significance has therefore been placed on sensitivity testing to understand confidence in the model outputs.

A comparison of model results against EA 2012 modelled outputs for the 50% AEP, 1% AEP and 0.1% shows modelled flood extents to increase on site and within the surrounding areas. Maximum flood depths on site are shown to have increased in comparison to the EA 2012 modelled outputs.

1D Stability

A review of the 1D log files shows that there are no comments, warnings or errors warranting attention.

There are no non-convergent timesteps reported.

In channel water levels are stable at the site.

2D Stability

A review of the 2D log files shows that there are no comments, warnings or errors warranting attention.

Mass balance error statistics show the model to initially be high during the wetting of the model. However, the mass balance during peak water levels at the site is <+/-1%.

There are no negative depths reported.

Model Results

This section of the report documents the results obtained from the primary simulations, both EXG and DEV models and blockage scenarios.

Maximum flood depth, velocity and hazard mapping has been provided for each primary simulation in Appendix H. Flood hazard ratings have been calculated in accordance with DEFRA document 'FD2320: Flood Risks to People' and EA guidance document 'Supplementary Note on Flood Hazard Ratings and Thresholds'.

Maximum water level mapping for the 1% AEP +44% CC and 0.1% AEP fluvial events are provided in Appendix I.

Existing Site Layout Simulations

The results of the hydraulic modelling show the entire development site to remain dry during and up to the 5% AEP event. During the 1% AEP event and above flooding along the western boundary of the site occurs.

During the 1% AEP event and above, floodwater is shown to exceed channel capacity upstream of Cartbridge Lane and flow in a southerly direction across the site. From here flood water flows through the site and either re-joins the watercourse along the low spots in the banks or flows over Greensbridge Lane. Floodwaters are also shown to exceed channel capacity at the southernmost point of the site during the 1% AEP + 44% CC and above.

Maximum water levels in channel at the site are shown in Table 14. FMP Nodes are shown on the model extent in Appendix E.

Table 14: Existing Maximum In Channel Water Levels

	Maximum In Channel Water Level (m AOD)			
FMP Node	5% AEP	1% AEP	1% AEP +44% CC	0.1% AEP
NETH01_0286d	7.74	7.99	8.32	8.49
NETH01_0195	7.63	7.86	8.17	8.35
DITT01_4924	7.62	7.84	8.14	8.31
DITT01_4874	7.59	7.81	8.10	8.26
DITT01_4824	7.56	7.77	8.08	8.25
DITT01_4776	7.50	7.69	8.00	8.21
DITT01_4770u	7.52	7.72	8.00	8.20

DEV Simulations - Post-Development Site Layout

When the development levels are considered, the entire development site is shown to remain flood free up to the 0.1% AEP event.

During the simulated flood events, floodwater is shown to exceed channel capacity upstream of Cartbridge Lane and flow in a southerly direction. From here floodwater is prevented from flowing onto site as a result of raising the development platform out of the flood zone.

Maximum water levels in channel at the site are shown in Table 15. FMP Nodes are shown on the model extent in Appendix E.

Table 15: Proposed Development Maximum In Channel Water Levels

	Maximum In Channel Water Level (m AOD)			
FMP Node	5% AEP	1% AEP	1% AEP +44% CC	0.1% AEP
NETH01_0286d	7.74	7.99	8.32	8.50
NETH01_0195	7.63	7.86	8.17	8.35
DITT01_4924	7.62	7.84	8.14	8.31
DITT01_4874	7.59	7.81	8.10	8.26
DITT01_4824	7.56	7.77	8.08	8.25
DITT01_4776	7.50	7.69	8.00	8.21
DITT01_4770u	7.52	7.72	8.00	8.20

Flood Risk Impact Off Site

The potential impact of the proposed development on flood risk elsewhere has been quantified by comparing the equivalent EXG and DEV simulation results. To provide a detailed assessment of the relative changes in flood depths throughout the floodplain, a series of maximum flood depth difference maps have been created and are included in Appendix H.

Blockages

Maximum flood depth, velocity and hazard mapping has been provided for each blockage simulation in Appendix H.

Maximum water levels in channel at the site are shown in Table 16. FMP Nodes are shown on the model extent in Appendix E.

Table 16: Existing and Proposed Development Maximum In Channel Water Levels

	Maximum In Channel Water Level (m AOD) During 1% AEP +44% CC			
FMP Node	BL1		BL2	
	EXG	DEV	EXG	DEV
NETH01_0286d	8.33	8.34	8.50	8.51
NETH01_0195	8.18	8.18	8.41	8.43
DITT01_4924	8.15	8.14	8.40	8.41
DITT01_4874	8.11	8.10	8.37	8.38
DITT01_4824	8.08	8.08	8.36	8.38
DITT01_4776	8.00	8.00	8.35	8.36
DITT01_4770u	8.00	8.00	8.36	8.37

Recommendations

The proposed development platform should be set to a minimum of 8.74m AOD to remain dry during the 0.1% AEP event.

The updated EA hydraulic model and this associated report should be submitted to the EA for review and approval as a reasonable representation of the fluvial flood risk at the site from Netherley Brook when both the existing and proposed development levels / arrangements are considered.

The outputs of this modelling study should be used to inform the site layout design and support the Flood Risk Assessment.

Appendix A Location Plan, Aerial Image and Photographs

Photograph 1: Cartbridge Lane Structure IMG_2784.JPEG. Photo looking upstream shows that there is an overflow channel (dry) located higher than the main channel (water present). This is reflected in the modelled survey data.

Photograph 2: Cartbridge Lane Structure IMG_2772.JPEG. Photo looking upstream

Photograph 3: Cartbridge Lane Structure IMG_2776.JPEG. Photo looking upstream

Photograph 4: Greensbridge Lane Structure IMG_2745.JPEG. Photo looking downstream

Photograph 5: Greensbridge Lane Structure IMG_2752.JPEG. Photo looking downstream

Photograph 6: Greensbridge Lane Structure IMG_2754.JPEG. Photo looking downstream

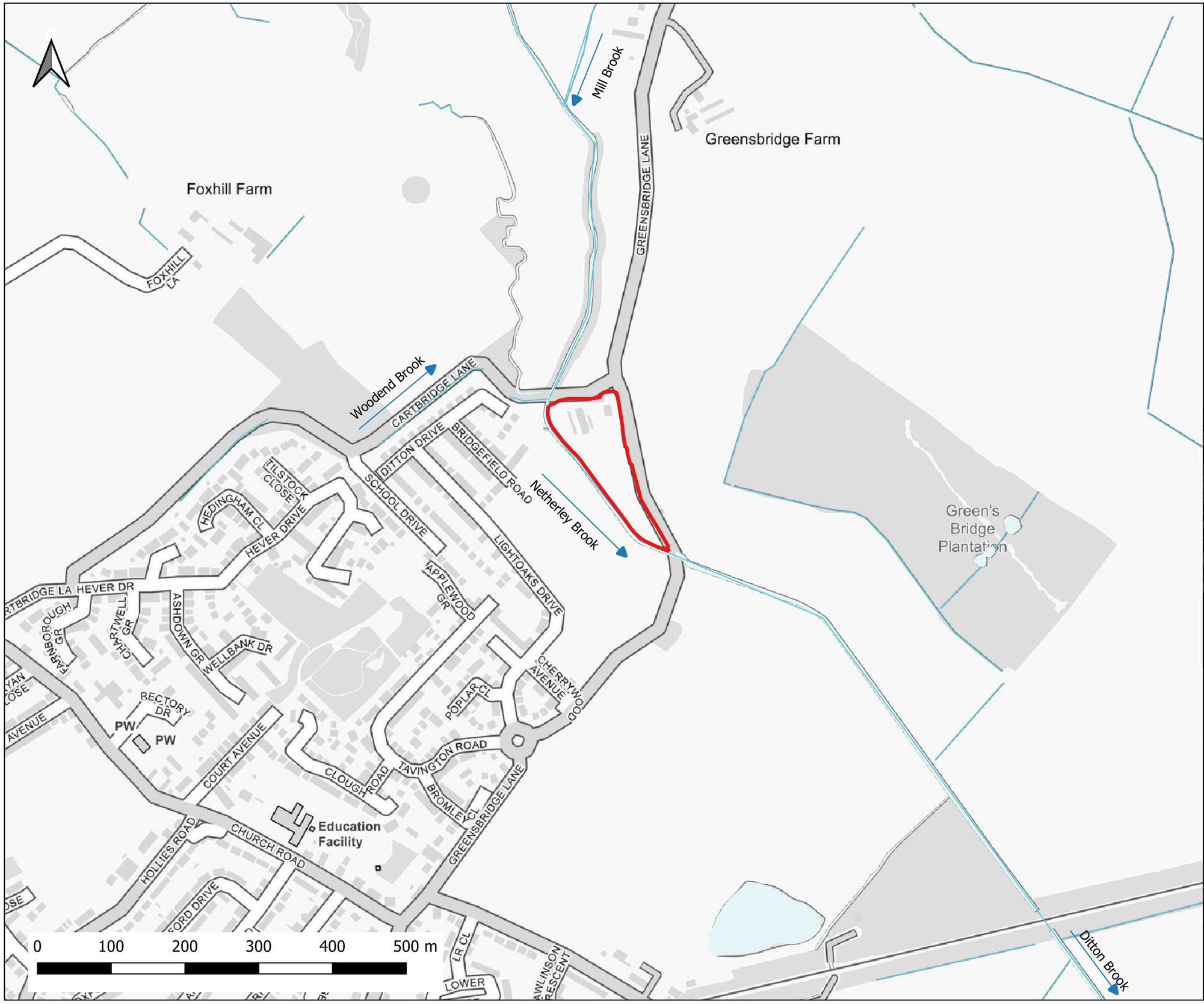
Photograph 7: Greensbridge Lane Structure IMG_2764.JPEG. Photo looking upstream

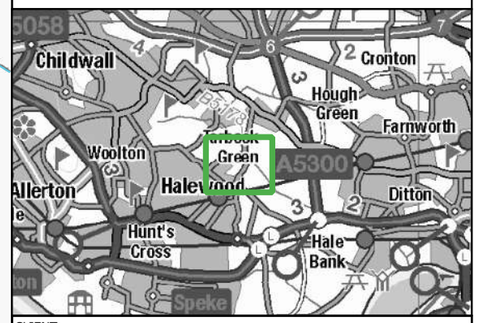
Photograph 8: Greensbridge Lane Structure IMG_2769.JPEG. Photo looking upstream

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Water Bodies
- Watercourses





CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Location Plan

PLOT STATUS:			DATE:
FINAL			16-11-2022
DRAWN: LW	CHECKED: AP	APPROVED: APR	PLOT SCALE AT A3: 1:5000
PLOT NAME: 14506_Location_Plan			REVISION: -

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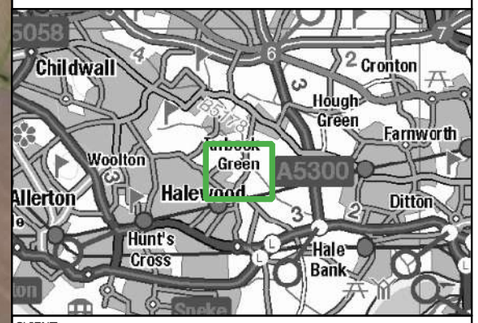
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

Site Boundary



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SCHEME:

Former Merseyside Dogs Home, East Halewood

PLOT TITLE:

Aerial Plan

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
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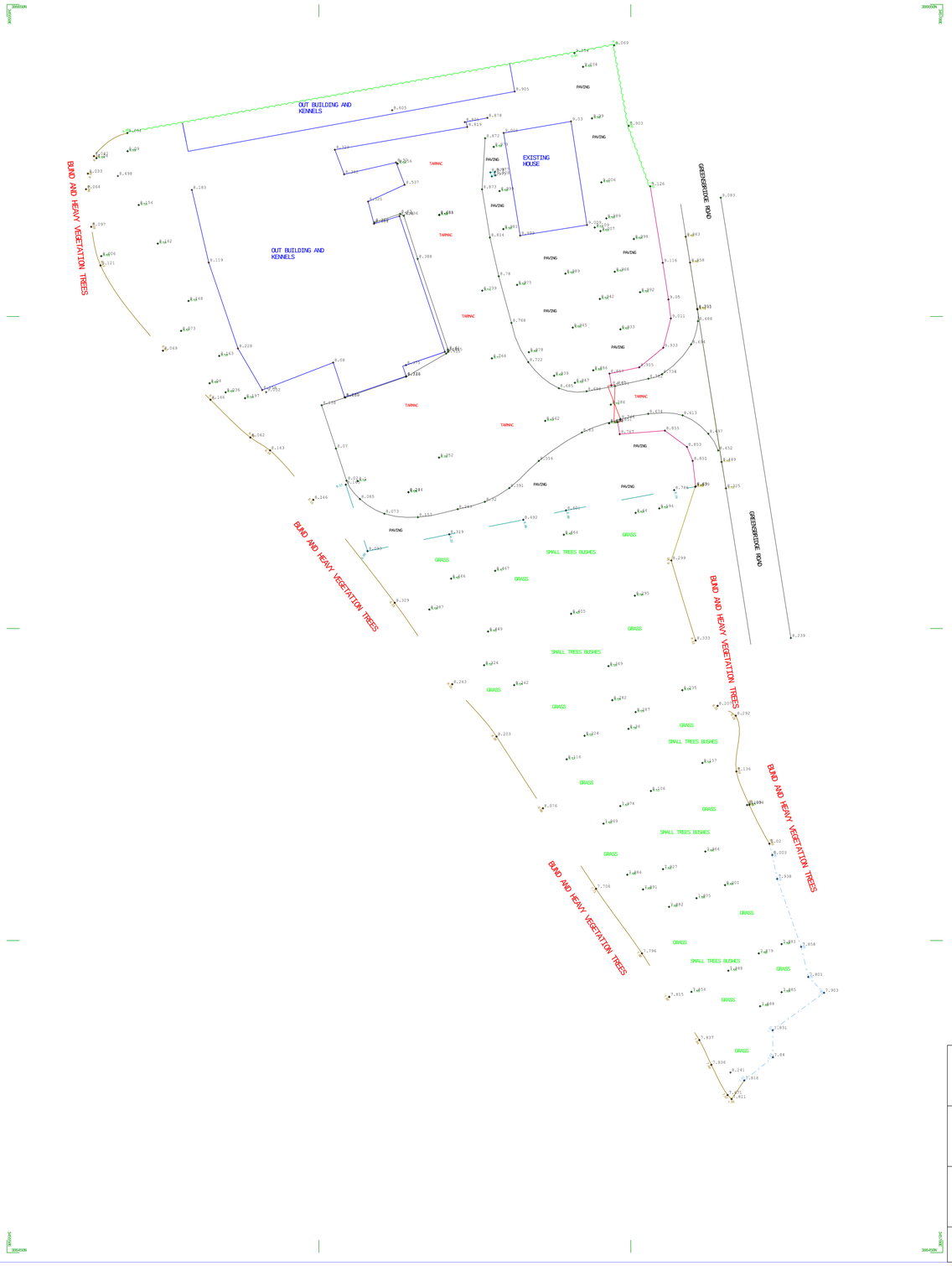
Appendix B Survey Data



IAN STRACHAN LTD

GREENSBRIDGE LANE
TOPOGRAPHICAL SURVEY

Tel: 07946569971
Email strachan57@btinternet.com

Date: 27th January 2022

Appendix C Proposed Development Plans

Total

19 Three-Bed Semi-detached Houses
8 Two-Bed Terraced Houses
2 Two-Bed Apartments
6 One-Bed Apartments

35 Units

Phase 01
19 *Three-Bed Semi-detached Houses*
8 *Two-Bed Terraced Houses*

Phase 02
+ 2 *Two-Bed Apartments*
+ 6 *One-Bed Apartments*

Greensbridge Lane / 531

ARCHITECTURAL EMPORIUM Ltd
EMAIL: mail@architectural-emporium .co.uk
WEB: www.architectural-emporium .co.uk
ADDRESS: 13 Hope St, Liverpool, L1 9BQ
PHONE: +44 (0)151 363 0000

North Point

Low Flood Risk

Site Boundary

Bank Edge

For: **Feasibility**

Checked By: **LC** | Drawn By: **NH**

Scale: **1:1000**

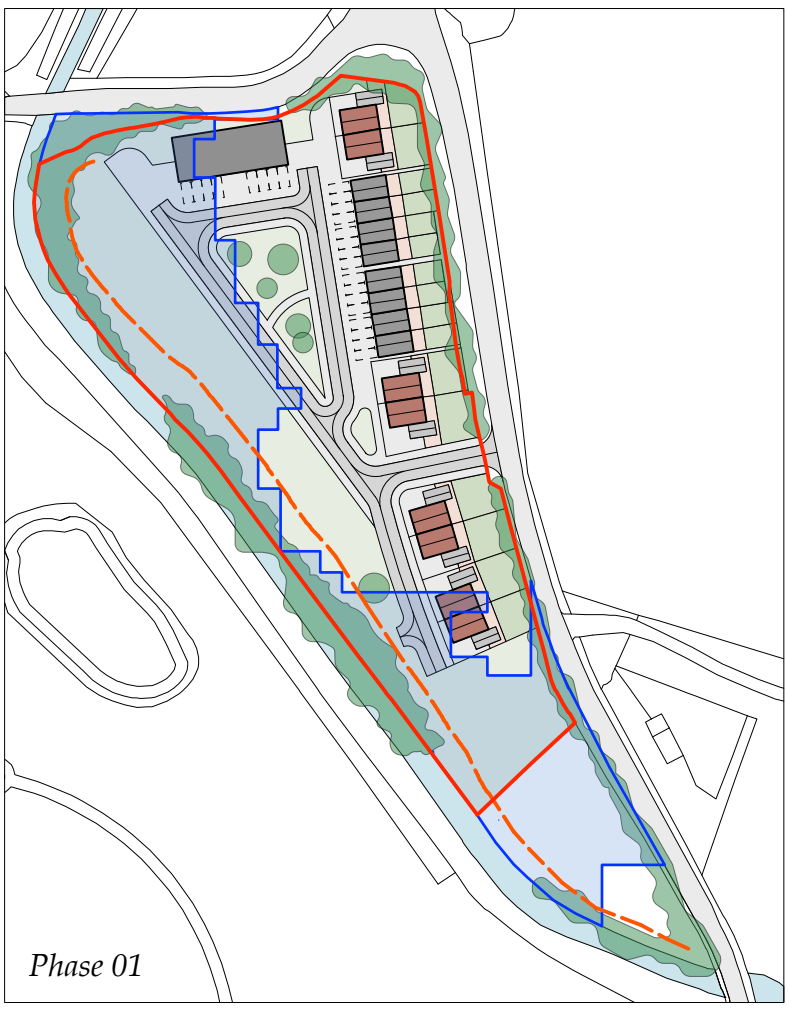
Paper Size: **A3**

Job: **Greensbridge Lane 531**

Option 01_Rev A

Rev A: 15/07/22 *First Issue: 08/07/22*

Proposed Site Layout 01



Total

24 Three-Bed Semi-detached Houses
8 Two-Bed Terraced Houses
2 Two-Bed Apartments
6 One-Bed Apartments

40 Units

Phase 01
8 Three-Bed Semi-detached Houses
8 Two-Bed Terraced Houses
2 Two-Bed Apartments
6 One-Bed Apartments

Phase 02
+ 16 Three-Bed Semi-detached Houses

Greensbridge Lane / 531

ARCHITECTURAL EMPORIUM Ltd
EMAIL: mail@architectural-emporium .co.uk
WEB: www.architectural-emporium .co.uk
ADDRESS: 13 Hope St, Liverpool, L1 9BQ
PHONE: +44 (0)151 363 0000

North Point

Low Flood Risk

Site Boundary

Bank Edge

Total

19 Three-Bed Semi-detached Houses
8 Two-Bed Terraced Houses
2 Two-Bed Apartments
6 One-Bed Apartments

35 Units

Phase 01
19 Three-Bed Semi-detached Houses
8 Two-Bed Terraced Houses

x

Phase 02
+ 2 Two-Bed Apartments
+ 6 One-Bed Apartments

For: **Feasibility**

Checked By: **LC** | Drawn By: **NH**

Scale: **1:1000**

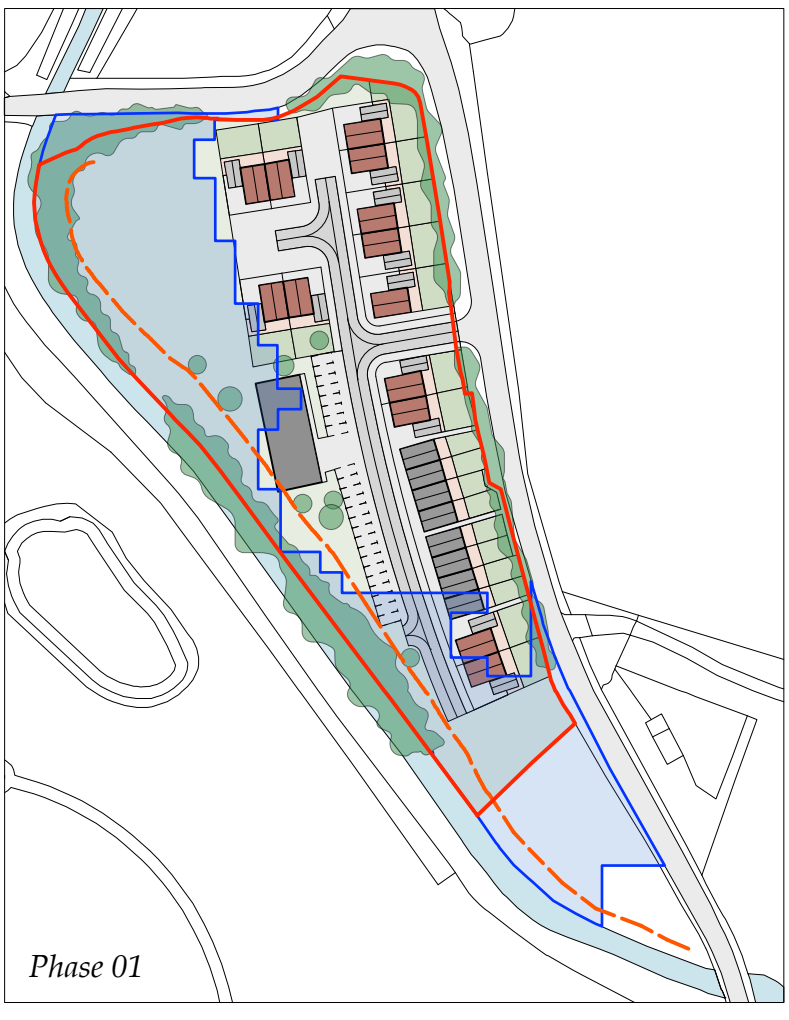
Paper Size: **A3**

Job: **Greensbridge Lane 531**

Option 02_Rev A

Rev A: 15/07/22 *First Issue: 08/07/22*

Proposed Site Layout 02



Total

23 Three-Bed Semi-detached Houses
8 Two-Bed Terraced Houses
2 Two-Bed Apartments
6 One-Bed Apartments

39 Units

Phase 01
13 *Three-Bed Semi-detached Houses*
8 *Two-Bed Terraced Houses*
2 *Two-Bed Apartments*
6 *One-Bed Apartments*

Phase 02
+ 10 *Three-Bed Semi-detached Houses*

Greensbridge Lane / 531

ARCHITECTURAL EMPORIUM Ltd
EMAIL: mail@architectural-emporium .co.uk
WEB: www.architectural-emporium .co.uk
ADDRESS: 13 Hope St, Liverpool, L1 9BQ
PHONE: +44 (0)151 363 0000

North Point

Low Flood Risk

Site Boundary

Bank Edge

For: **Feasibility**

Checked By: **LC** | Drawn By: **NH**

Scale: **1:1000**

Paper Size: **A3**

Job: **Greensbridge Lane 531**

Option 03_Rev A

Rev A: 15/07/22 *First Issue: 08/07/22*

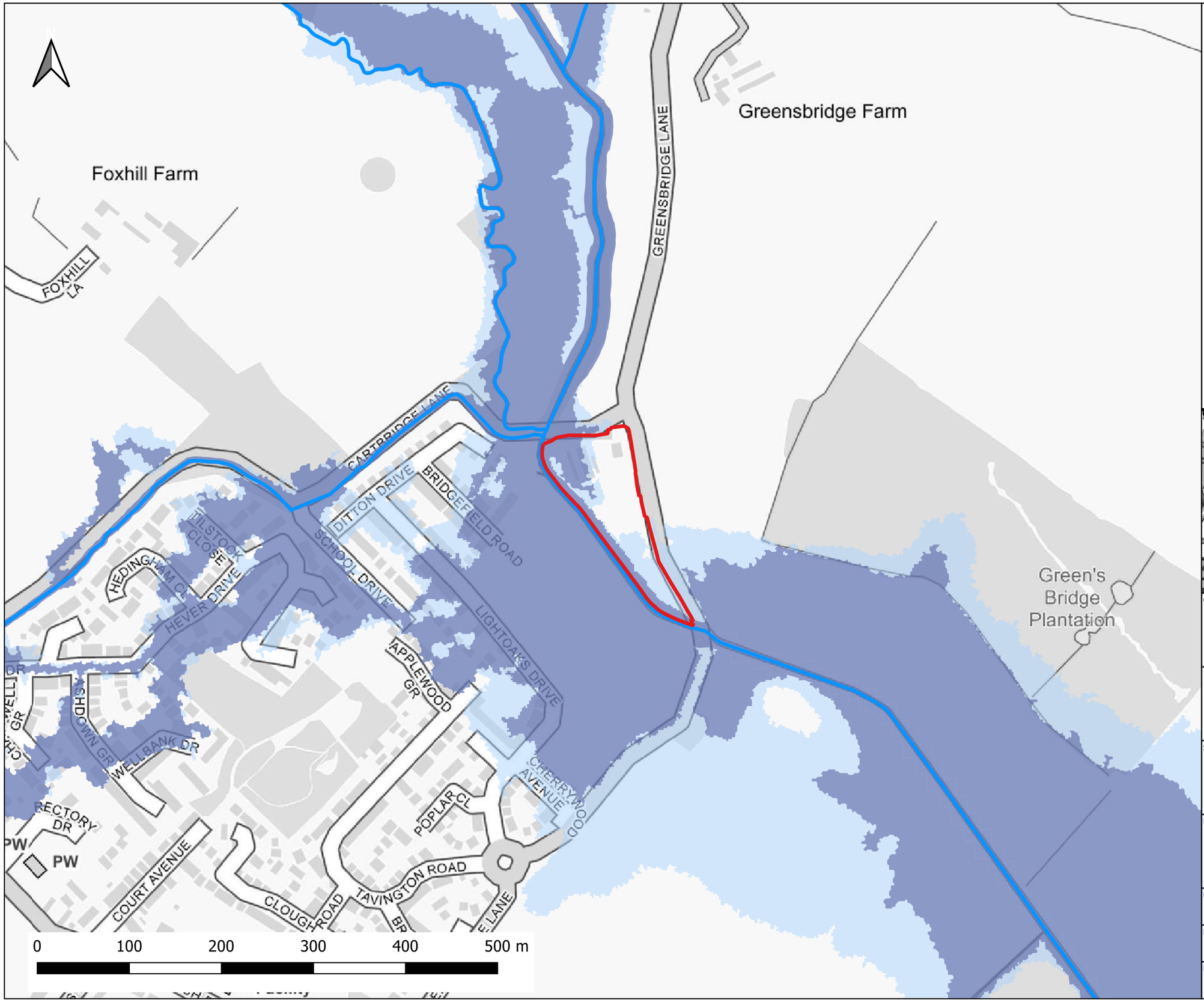
Proposed Site Layout 03

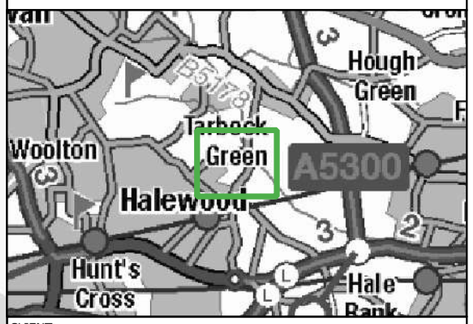
Appendix D EA Correspondence and Flood Maps

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Flood Zone 1
- Flood Zone 2
- Flood Zone 3
- Main Rivers





CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
EA Flood Map for Planning
Data accessed November 2022

PLOT STATUS:			DATE:
FINAL			16-11-2022
DRAWN: AQ	CHECKED: LW	APPROVED: AP	PLOT SCALE AT A3: 1:4000
PLOT NAME: 14506_EA_FMP			REVISION: -

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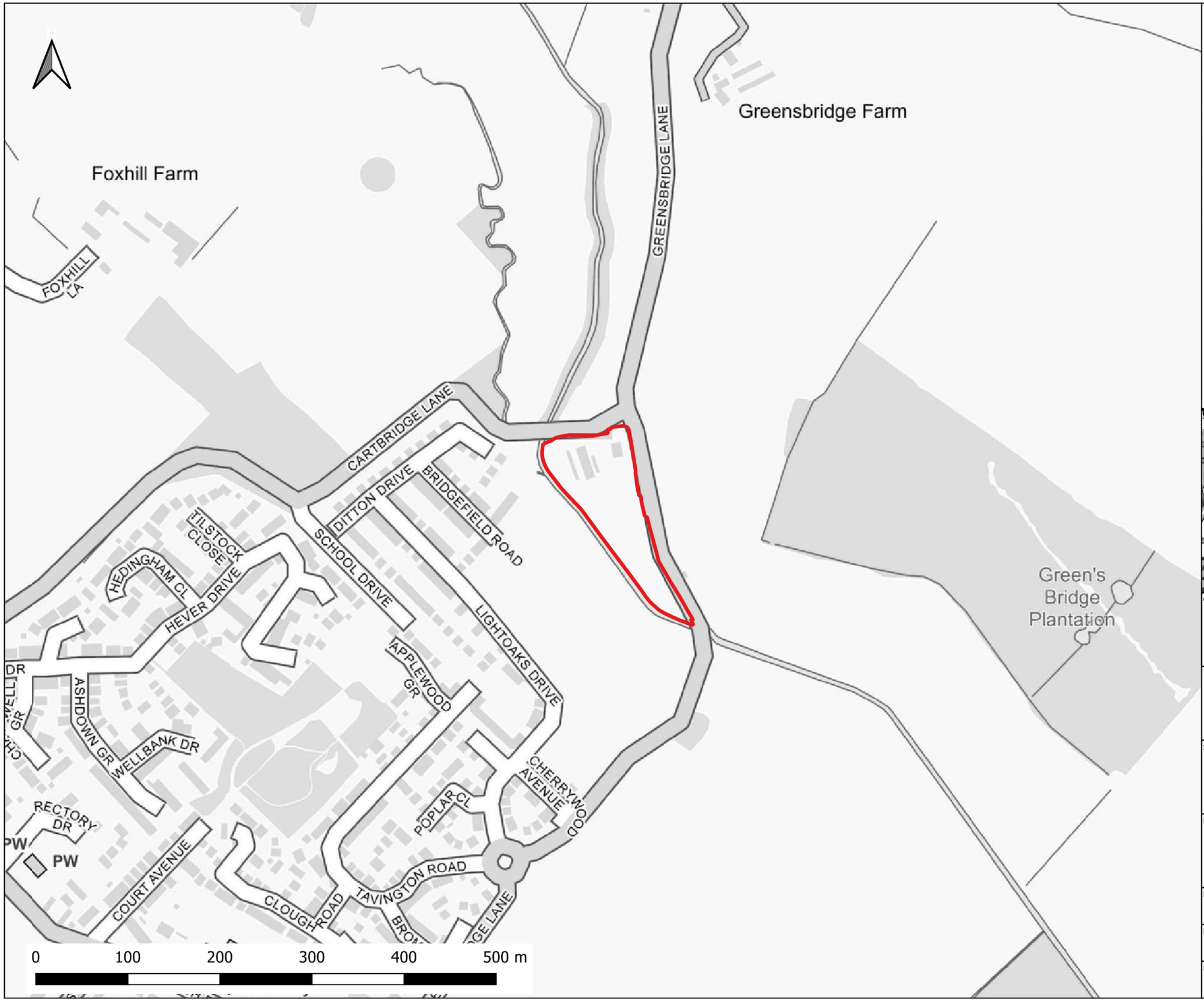

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise
2) The Historic Flood Map is a GIS layer showing the maximum extent of individual Recorded Flood Outlines from river, the sea and groundwater springs that meet a set criteria. It shows areas of land that have previously been subject to flooding in England. This excludes flooding from surface water, except in areas where it is impossible to determine whether the source is fluvial or surface water but the dominant source is fluvial.
3) If an area is not covered by the Historic Flood Map it does not mean that the area has never flooded, only that the EA do not currently have records of flooding in this area that meet the criteria for inclusion.
4) The Historic Flood Map takes into account the presence of defences, structures, and other infrastructure where they existed at the time of flooding. It will include flood extents that may have been affected by overtopping, breaches or blockages.

LEGEND

Site Boundary

Historic Flood Map

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
EA Historic Flood Risk
Data accessed November 2022

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:4000

PLOT NAME:	REVISION:
14506_EA_Historic_Flood_Risk	-

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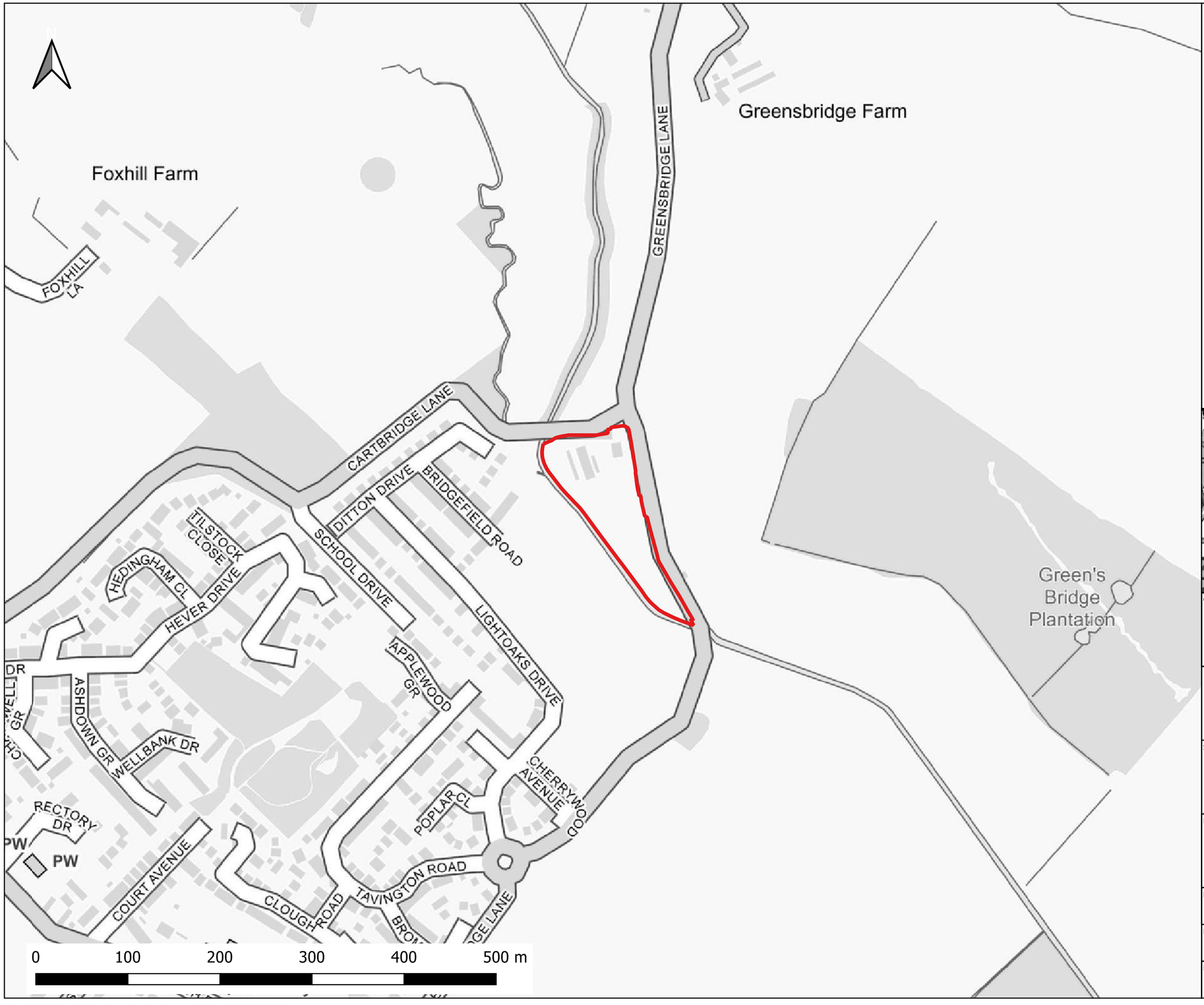

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise.
2) Recorded Flood Outlines is a GIS layer which shows all EA records of historic flooding from rivers, the sea, groundwater and surface water.
3) The absence of coverage by Recorded Flood Outlines for an area does not mean that the area has never flooded, only that the EA do not currently have records of flooding in this area.
4) The Recorded Flood Outlines take into account the presence of defences, structures, and other infrastructure where they existed at the time of flooding. It includes flood extents that may have been affected by overtopping, breaches or blockages.

LEGEND

- Site Boundary
- Recorded Flood Outlines

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
EA Recorded Flood Outlines
Data accessed November 2022

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:4000

PLOT NAME:	REVISION:
14506_EA_Recorded_Flood_Outlines	-

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14506-Former Merseyside Dogs Home, East Halewood
Proposed hydraulic modelling methodology for EA comment – Existing EA Model Build

May 2022

Background

We are currently undertaking hydraulic modelling of the Netherley Brook through Halewood to inform a Flood Risk Assessment for a proposed development at the former Merseyside Dogs Home, Tarbock Green, Prescot, L35 1QH (plan of site location attached). Prior to progressing works further, we are seeking your advice and comment with regard to our proposed modelling methodology. We find that discussing our approach with the Environment Agency (EA) at the early stage saves all parties involved time and ensures your team's site-specific requirements are fully accounted for. As such please find below our proposed methodology for your consideration. Your advice or comment would be very much appreciated.

Project Details & Requirements

We propose to utilise and update the current EA Netherley, Halewood and Woodend (2012) hydraulic model of the Netherley Brook and its tributaries to provide the required output data.

The 2D grid size of the model is 4m. A site-specific topographical survey will be used to update the model to provide an up-to-date, site-specific assessment of flood risk at the existing (EXG) site. The model will also be used to quantify the impact of the development on flood risk elsewhere (if any). Model outputs will then be used to support the Flood Risk Assessment being prepared for the development. The site is shown to be located within EA Flood Zone 1/2/3.

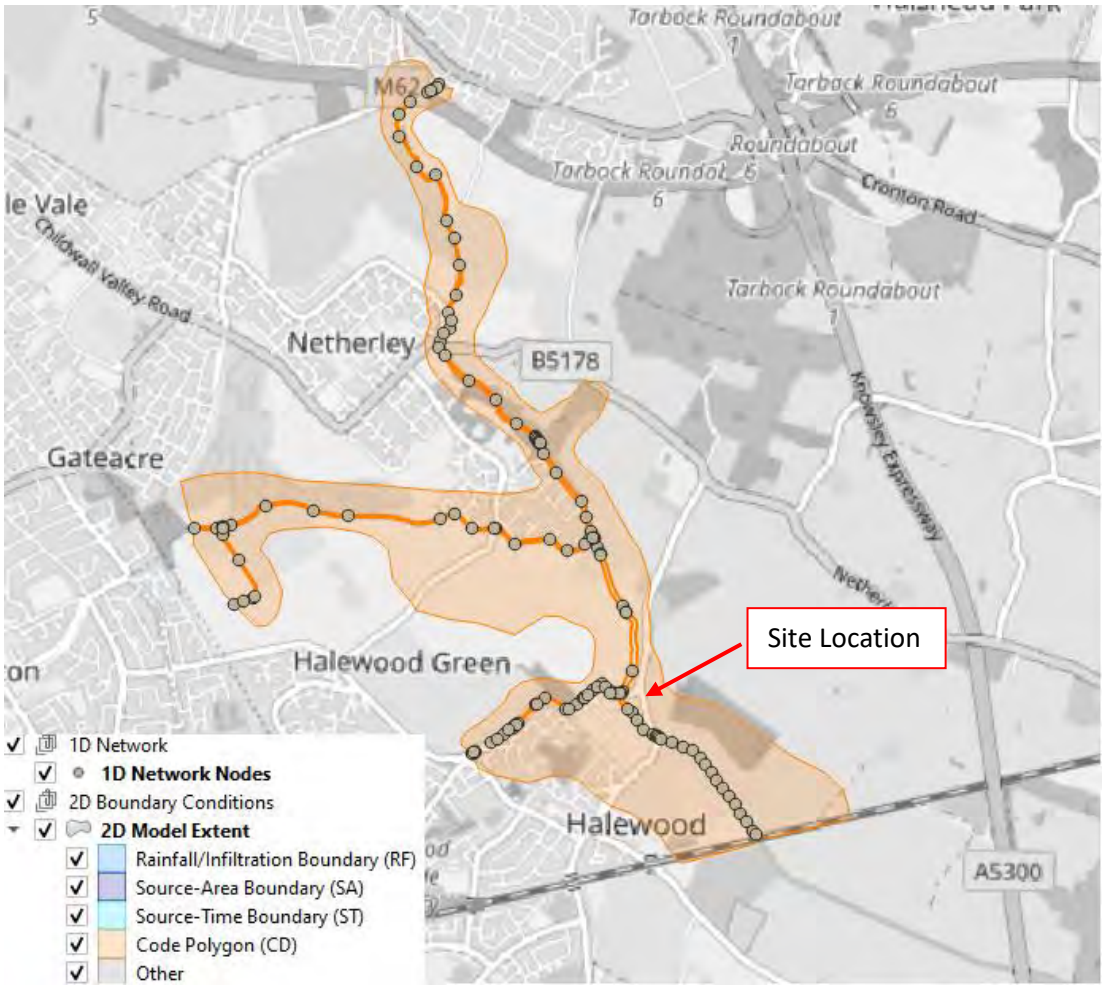
It is assumed the current model is fit-for-purpose and includes all required input data (LiDAR, boundary conditions etc). Please advise if you or your team are aware of any pre-existing issues with the model – any additional information at this stage is useful. Thank you.

The works will include preparation of a Hydraulic Modelling Report and Flood Mapping.

Model and Simulation Type

Software:	FMP-TUFLOW
Approach:	Fluvial only
Extent:	See model extent below
Time:	>1hrs- As per EA model

Model Extent



Hydrological Calculations

There will be four inflows into the hydraulic model; point inflows applied at the upstream extent of Netherly Brook and Halewood Brook as well as, lateral inflows applied to Mill Brook and Chidwell Brook.

We propose to carry out FEH Statistical (ungauged) and ReFH2 calculations for Netherly Brook. Details of the downstream catchment location at which the watercourse inflows will be calculated are provided below. If acceptable, we propose to use the FEH Statistical method to estimate peak flows and scale the ReFH2 hydrographs to match the FEH Statistical peaks. We will also apply the adjusted statistical method for the Q1000 peak flow.

Watercourse	Downstream Catchment Location (NGR)
Ditton Brook at the Manchester and Allerton Junction Rail line	346227, 385935

Where appropriate, catchment descriptors will be updated based on the latest available datasets (e.g AREA updated with LiDAR.

Events/ Scenarios Considered

Model study to simulate and compare the flood risk at the site for the existing (EXG) and proposed development (DEV) level. Table 1 provides a summary of the proposed events and scenarios.

Proposed Climate Change Allowance (CCA) for this site during the 1% AEP event is +44% in accordance with EA guidance (Site located in North West River Basin, Lower Mersey Management Catchment; development considered 'More Vulnerable' with predicted 100 year lifetime – 'central estimate' allowance category chosen):

A blockage scenario based on latest EA blockage guidance document will be carried out simulating a 33% blockage of the Greensbridge Lane bridge at approximately NGR 345727, 386423 during the 1% AEP CC1 event only.

Sensitivity Tests (ST) to be run:

- ST1 and ST2 - Roughness: +/-20% Manning's n roughness (channel & floodplain)
- ST3 and ST4 - Downstream Boundary Test: -20% slope
- ST5 and ST6 - Flow: +/-20% flow rate

Table 1*: Summary table of proposed model scenarios and events*

Event (AEP)	Scenario			
	Existing site layout and level (EXG)	Proposed site layout and levels (DEV)	Blockage	Sensitivity Tests (ST)
5%	✓	✓		
1%	✓	✓		
1% CC1	✓	✓	✓	✓
0.1%	✓	✓		

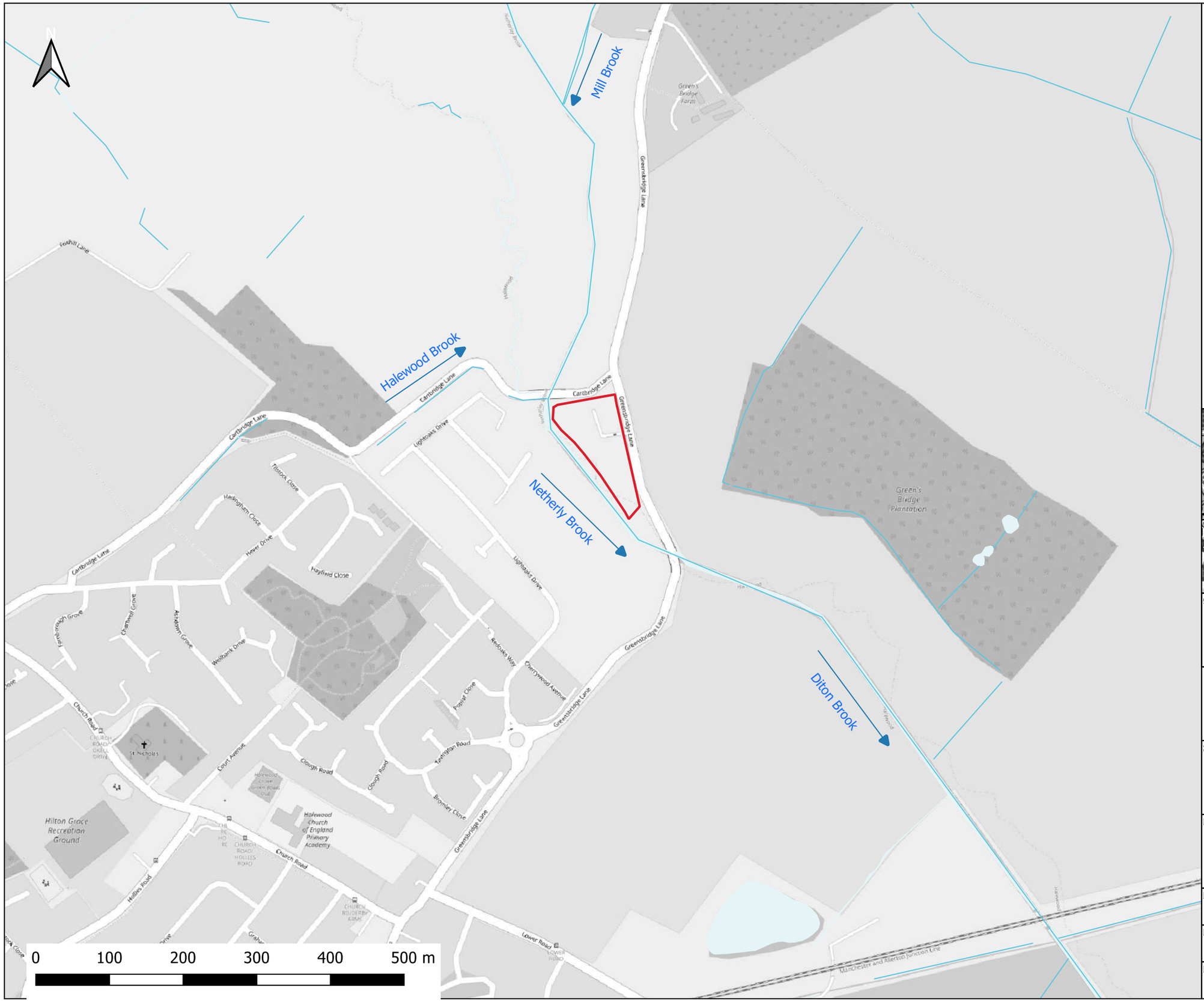
For Your Consideration

Please provide comment on our above methodology and whether you are in agreement with the approach outlined? Please also confirm if any hydrology updates are required?

Waterco Contact

Michael Farmer
01244 668128
Michael.farmer@waterco.co.uk

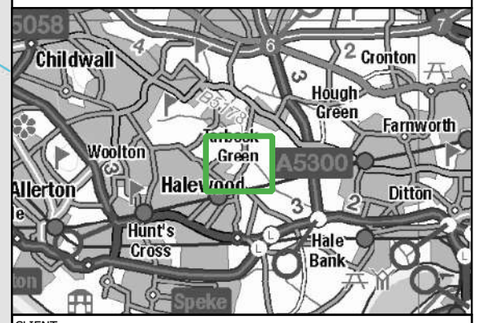
Site Location Plan



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Water Bodies
- Watercourses



CLIENT:
Mr. N Nasr

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Location Plan

PLOT STATUS:			DATE:
FINAL			27-05-2022
DRAWN: MF	CHECKED: LW	APPROVED:	PLOT SCALE AT A3: 1:5000
PLOT NAME: 14506_Location_Plan			REVISION: -

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Waterco Ltd
Eden Court Business Centre Lon Parcwr
Industrial Estate
Ruthin
Clwyd
LL15 1NJ

Our ref: SO/2022/122324/01-L01
Your ref: 220606/lk21 14506

Date: 03 August 2022

Dear Michael,

ENVPAC/1/GMC/00442 - EA / WATERCO - DOCUMENTATION REVIEW - PROPOSED HYDRAULIC MODELLING METHODOLOGY FOR EA COMMENT

FORMER MERSEYSIDE DOGS HOME, TARBOCK GREEN, PRESCOT, L35 1QH

Thank you for requesting a flood model methodology review by the Environment Agency relating to the potential development located at the Former Merseyside Dogs Home, Tarbock Green.

For the purpose of this request, the Environment Agency's Evidence & Risk (E&R) team have reviewed the following documents:

- Note – 14506-Former Merseyside Dogs Home, East Halewood - Proposed hydraulic modelling methodology for EA comment – Existing Model Build. File ref. 14506-220527-Former Dogs Home EA Modelling Methodology. Prepared by Waterco. Dated: May 2022.
- Location Plan – Former Merseyside Dogs Home, East Halewood. Plot Name: 14506_Location_Plan. Prepared by WaterCo. Dated: 27th May 2022.
- Aerial Plan – Aerial Plan. Former Merseyside Dogs Home, East Halewood. Plot Name: 14506_Aerial_Plan. Prepared by Waterco. Dated 27th May 2022.

Please note, in order to undertake a review of the above and provide this letter response, we have used 7 hours of established charge agreement ENVPAC/1/GMC/00442 (5 hours remaining).

Environment Agency E&R Commentary: Proposed Hydraulic Modelling Methodology

Our Flood Risk Modelling Advisor in the E&R team has reviewed the proposed hydraulic modelling methodology and provided the following commentary and advice detailed below:

<u>Model Approach</u>
We note the hydraulic modelling will be undertaken for a proposed development at the former Merseyside Dogs Home in Tarbock Green. To aid in determining the appropriateness of the flood model approach we require clarification on the type of development being proposed at this location.

We note the proposal includes updating the EA Netherley, Halewood and Woodend (2012) hydraulic model. We require further clarification as to why this approach was

chosen and whether changes need to be made to ensure it is suitable for this new use. We note that it is assumed the current model is fit-for-purpose. It is for you to review the model and make any changes needed to make it suitable for your intended use. As the model was originally built for another purpose, it may be fit for that purpose but will require changes in order to make it fit for your purpose.

If there are any pre-existing issues with the modelling, it should be mentioned in the model report for the model. When submitting a Flood Risk Assessment that uses a previous Environment Agency model, it is useful for the report of the previous model to be included or you ensure any information about the previous model is provided in your report. For instance, explaining why you have chosen (or kept) the roughness values, grid size, any changes to default parameters etc. This means from the first review we can understand why the model has been built that way, even if it has not changed from the previous model. If you have not received the model report for the previous 2012 model, we advise contacting inforequests.gmmc@environment-agency.gov.uk to request this information.

We understand the software that will be utilised is FMP-TUFLOW (1D/2D fluvial) model. We require further clarity as to why this approach has been chosen and, if it is the same as the previous model, whether other software was considered that may be more suited.

General Model Build

A model extent diagram has been included in the proposed hydraulic methodology note, however, there is no explanation as to why the upstream and downstream extents have been applied. We require further explanation as to why the upstream and downstream extents have been chosen. The downstream extent is at the railway bridge and it looks like there could be potential for some glass walling at this location. We advise establishing why this downstream extent is appropriate and how this potential issue will be overcome.

It is noted that a grid size of 4m is to be used. It has not been established what timesteps are intended to be utilised for this approach. Please note, we would typically see 2 seconds for 2D and 1 second for 1D with this grid size. We are unable to comment on whether a 4m grid size would be suitable at this stage but this will be checked when the model is reviewed to ensure that it is adequately representing flow pathways e.g. between buildings.

Model Input Data

We note a site specific topographical survey will be used to update the model. It is assumed at this time that this means there will be new survey for all of the 1D stretch of the model (please confirm). We require further clarification on what Lidar age and resolution will be used as it is assumed there is more up-to-date Lidar since the previous model from 2012.

We advise checking for any flood defence assets in the area that will need to be accounted for. A quick check of the Environment Agency's Asset Information Management System (AIMS) shows there are embankments and engineered high ground in the area.

Model Runs

The summary table indicates the 5%, 1%, 1% plus climate change and 0.1% design runs will be undertaken for the existing and proposed site. We can confirm that this seems appropriate at this time. We note the climate change allowance has been chosen

as the 'central estimate', however, it is unclear what the development proposals are. Therefore, we cannot comment on whether this is the correct category of climate change allowance to use. Please refer to the latest climate change allowances guidance to aid in determining whether the appropriate climate change allowance will be used.

We note the methodology proposes a blockage scenario for Greensbridge Lane bridge and outlines the sensitivity tests that will be run including roughness, downstream boundary and flow on the 1% plus climate change event. We require further information as to why the downstream boundary is only -20% slope and not 20% as well. Further information on how you calculated 33% blockage as an appropriate value would also be useful. We require further clarification as to why there is a proposed blockage scenario for the bridge at Greensbridge Lane and not for the bridge at Cartbridge Lane too.

Hydrology Review

We note the catchment is ungauged. We require clarification as to whether a review of all / any available river level / flow and rainfall gauges or other useful information will be undertaken, including a review of flood history for the catchment. Further to this, catchment descriptors will need to be checked against latest datasets (i.e. Lidar).

We note, FEH Statistical and ReFH2 calculations are to be conducted for the Netherley Brook. We require clarification as to why it has been provisionally decided to use FEH Statistical peaks that are scaled to ReFH2 hydrograph before a fair comparison of the two methods has taken place. There is no mention of how the calculations will be laid out, however, it is highly recommended to use the Food Estimation Calculation record format. This will ensure all information required for the review is included and minimise risk of it being rejected in the future.

Additional Guidance

In addition to the above, we would like to provide you with the following guidance, attached alongside our response, that will aid in the decision making and completion of your forthcoming hydrology and hydraulic model. This includes the following:

- LIT 18686 – NEC4 Minimum Technical Requirements for Modelling
- LIT 56326 – Fluvial Modelling Standards
- LIT 11832 – Flood Estimation Guidelines

--

We trust you will find the contents of this letter beneficial. However, should you have any queries or questions further to this response, or wish to request a further review with the Environment Agency, then please do not hesitate to contact us.

Yours faithfully

Ms Anne-Marie McLaughlin
Planning Advisor

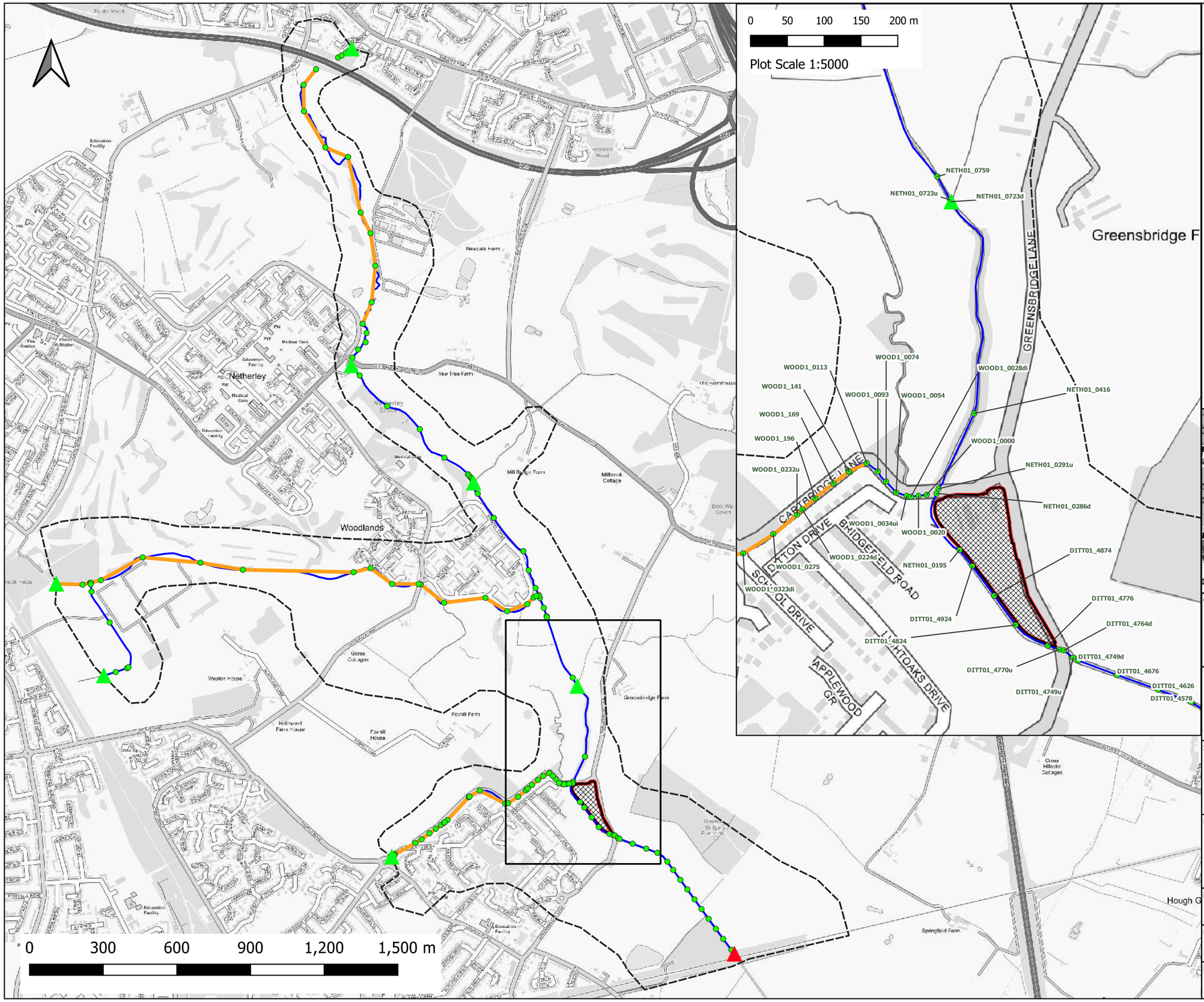
Direct e-mail anne-marie.mclaughlin@environment-agency.gov.uk

Disclaimer

Our opinion is based on the information available to us at the time of the enquiry. When the formal planning application is submitted, our position may change if there have been changes to environmental risk or evidence, and/or planning policy.

End

Appendix E Model Extent



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Model Extent
- Site Boundary
- 1D Cross Section Nodes
- 1D Watercourse Network
- 1D Lateral Inflow Locations
- 1D Point Inflow Locations
- 1D Downstream Boundary
- Development Platform

CLIENT: BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME: Former Merseyside Dogs Home, East Halewood

PLOT TITLE: Model Extent

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:15000

PLOT NAME:	REVISION:
14506_Model_Extent	-

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Appendix F Hydrology - Flood Estimation Calculation (FEC) Record

Flood estimation calculations record

Project	Former Merseyside Dogs Home
Job No	14506
Revision	1
Prepared by	Louise Wilcock BSc (Hons) MCIWEM
Checked by	Awel Roberts BSc (Hons) MCIWEM
Approved by	Adam Parkinson BSc (Hons) MCIWEM
Watercourse name:	Netherley Brook
Catchment NGR:	346150 386050

Date: 18/11/2022

River Basin District		
North West		
Allowance for CC1	Allowance for CC2	Time horizon
Central	Upper End	2080s

INTRODUCTION

This Flood Estimation Calculation (FEC) Record is based on the latest version of the EA's FEC Record templates (LIT 11833 Flood estimation report 2020 V2), supporting document to the Environment Agency's flood estimation guidelines. It provides a record of the calculations and decisions made during flood estimation.

The information given here should enable the work to be reproduced in the future.

CONTENTS

1 SUMMARY OF ASSESSMENT 2
2 METHOD STATEMENT 3
3 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED 7
4 STATISTICAL METHOD 7
5 REVITALISED FLOOD HYDROGRAPH (REFH) METHOD 11
6 REVITALISED FLOOD HYDROGRAPH 2 (REFH2) METHOD 11
7 DISCUSSION AND SUMMARY OF RESULTS 12
8 ANNEXES 16

ABBREVIATIONS

AEP	Annual Exceedance Probability	GEV	Generalised Extreme Value
AM	Annual Maximum	GL	Generalised Logistic
AOD	Above Ordnance Datum	HOST	Hydrology of Soil Types
AREA	Catchment area (km^2)	IGR	Irish Grid Reference
BFI	Base Flow Index	LiDAR	Light Detection And Ranging
BFIHOST	Base Flow Index derived using HOST soil classification	NGR	National Grid Reference
CC	Climate Change	NRFA	National River Flow Archive
CDs	Catchment Descriptors	NRW	Natural Resources Wales
CEH	Centre for Ecology and Hydrology	OS	Ordnance Survey
CFMP	Catchment Flood Management Plan	POT	Peaks Over a Threshold
CPRE	Council for the Protection of Rural England	PROPWET	Index of Proportion of time that soils are Wet
cumecs	m^3s^{-1}, m^3/s, or cubic meter per second	QMED	Median Annual Flood (with return period 2 years)
DDF	Depth-Duration-Frequency	$QMED_{CDS}$	Estimate of Median Annual Flood from Catchment Descriptors
DPLBAR	Mean drainage path length (km)	ReFH	Revitalised Flood Hydrograph method
DPSBAR	Mean drainage path slope (m/km)	SAAR	Standard Average Annual Rainfall (mm)
DTM	Digital Terrain Model	SEPA	Scottish Environment Protection Agency
EA	Environment Agency	SPR	Standard percentage runoff
ESS	Enhanced Single Site	SPRHOST	Standard percentage runoff derived using the HOST soil classification

FARL	FEH index of flood attenuation due to reservoirs and lakes	Tp(0)	Time to peak of the instantaneous unit hydrograph
EA	Environment Agency	UAF	Urban Adjustment Factor
FEH	Flood Estimation Handbook	URBAN	Flood Studies Report index of fractional urban extent
FPEXT	Floodplain Extent	$URBEXT_{1990}$	FEH index of fractional urban extent
FSE	Factorial Standard Error	$URBEXT_{2000}$	Revised index of urban extent, measured differently from $URBEXT_{1990}$
FSR	Flood Studies Report	WINFAP-FEH	Windows Frequency Analysis Package – used for FEH statistical method
GEV	Generalised Extreme Value		

1 SUMMARY OF ASSESSMENT

1.1 Summary

This table provides a summary of the key information contained within the detailed assessment in the following sections. The aim of the table is to enable quick and easy identification of the type of assessment undertaken. This should assist in identifying an appropriate reviewer and the ability to compare different studies more easily.

Catchment location and watercourse name	NGR: 346150, 386050	Netherley Brook		
Purpose of study and scope	Catchment analysis to provide peak flows for input into a hydraulic model of the Netherley Brook and its tributaries to support a planning application.		Scope	Simple
Key catchment features	Urban			
Flooding mechanisms	Fluvial			
Gauged / ungauged	Ungauged			
Final choice of method	FEH Statistical			
Key limitations / uncertainties in results	Standard uncertainties associated with such assessments (see Section 7 for more details)			

1.2 Note on flood frequencies

The frequency of a flood can be quoted in terms of a return period, which is defined as the average time between years with at least one larger flood, or as an annual exceedance probability (AEP), which is the inverse of the return period.

Return periods are output by the Flood Estimation Handbook (FEH) software and can be expressed more succinctly than AEP. However, AEP can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval. Results tables in this document contain both return period and AEP titles.

Annual exceedance probability (AEP) and related return period reference table

AEP (%)	50	20	10	5	4	3.33	2	1.33	1	0.5	0.2	0.1
Return period (yrs)	2	5	10	20	25	30	50	75	100	200	500	1,000

2 METHOD STATEMENT

2.1 Requirements for flood estimates

Item	Comments
Overview: • Purpose of study • Peak flows or hydrographs? • Design events for which flow estimates are to be made given as AEP (%) • Climate change allowances with reference to relevant guidance • Potential number of locations for flow estimation • The purpose of the document	The purpose of the study is to provide hydrographs for the catchment of Netherley Brook and its tributaries which flows adjacent to a proposed development site at the Former Merseyside Dogs Home, Greensbridge Lane, Halewood, Tarbock Green, Liverpool L35 1QH [NGR 345615, 386610]. A location plan is included in Annex 8.1. Hydrographs are required for the 5% (Q20), 1% (Q100), 1%+44%CCA (Q100CC1), and 0.1% (Q1000) AEP fluvial events to be used as inflow data for a hydraulic model of Netherley Brook. Model outputs will be used to provide an up-to-date assessment of flood risk in the area. A proposed hydraulic modelling and hydrology methodology was submitted to EA for review and comment on the 27/05/2022. Comments were received on the 03/08/2022 (see correspondence reported in Annex 8.2) and have been addressed in this report.
Project scope: What is the complexity of the study – simple, routine, moderate, difficult, very difficult? What analyses need to be included within the study, for example: • Review of existing studies? • Rating reviews / updates? • Simple / detailed flood history review? • ReFH model parameter estimation? • Joint probability?	The catchment appears standard. Review and re-definition of CDs will be undertaken as appropriate (see Section 3.3). Flood history will be reviewed in Section 2.7. Standard procedures for FEH Statistical and ReFH2 methods will be followed (see Sections 4 and 6).

2.2 The catchment

See Annex 8.1	
Description: Include topography, climate, geology, soils, land use and any unusual features (e.g. reservoirs, historic mining) that may affect the flood hydrology. In some cases, it may be useful to include reference to things such as amount of modelled reach that is culverted but remember that this is not a hydraulic modelling report and detail on hydraulic features, such as weir and culvert sizes, is not required. Think about what features are going to affect runoff from the contributing catchment reaching the watercourse.	The Netherley Brook catchment is located to the north of Halewood, west of Warrington and east of Liverpool. It drains in a southerly direction through Halewood before draining into the River Mersey. A hydrology location plan showing the catchment location and extent is provided in Annex 8.1. Catchment Descriptors (CDs) for the catchment have been purchased from the FEH Web Service and are included in Annex 8.1. A review of the British Geological Survey (BGS) 1:50,000 Geology Maps reveals that the catchment is underlain by multiple geology types. The predominate types of bedrock are the Chester formation comprising sandstone, the Wilmslow Sandstone formation comprising sandstone, and the Kinnerton Sandstone formation comprising sandstone. The predominate type of the superficial deposits is the Till Devensian comprising diamicton. The predominant soil types within the catchment are described as 'slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' (source: http://www.landis.org.uk/soilscapes). This soil configuration is compatible with the FEH BFIHOST19 value of 0.461. The SAAR value of the catchment is 853mm. There are a small number of lakes within the catchment. The FARL value of 0.988 is consistent with this value.

2.3 Source of flood peak data

Source	NRFA peak flows dataset, Version 11.0.0, released September 2022 (most recent dataset at start of the project). This contains data up to water year 2020/2021 for all the stations.

2.4 Gauging stations (flow or level)

(at the sites of flood estimates or nearby at potential donor sites)

Watercourse	Station Name	Gauging Authority Number	NRFA number (used in FEH)	Grid Reference	Catchment Area (km²)	BFIHOST	Type (rated / ultrasonic / level…)	Start and end of flow record
Netherley Brook	Winster Drive	694460	n/a	345162 387801	51	unknown	Level	February 2012, August 2022

2.5 Data available at each flow gauging station in Table 2.4

Station Name	Start and end of data on NRFA	Update for this study?	OK for QMED?	OK for pooling?	Data quality check needed?	**Other comments on station and flow data quality** – e.g. information from NRFA Peak Flows, trends in flood peaks, outliers. Give link/reference to any further data quality checks carried out
Winster Drive	Shoothill Gauge Map 2012-2022	No	No	No	No	River level data only available on the Shoothill Gauge Map and not NRFA website.
Tabulate any updated or revised flood peak series in the Annex and provide a link here.						No further checks performed

2.6 Rating equations

Station Name	Type of rating	Rating review needed?	Comments and link to any rating reviews
N/A			

2.7 Other data available and how it has been obtained

Type of data	Data relevant to this study?	Data available?	Source of data and licence reference if from EA	Date obtained	Details
Check flow gaugings (if planned to review ratings)	n/a				
Historic flood data – give link to historic review if carried out.	No	No	https://thefloodhub.co.uk/wp-content/uploads/2019/04/Case-study_-Egremont-Lawn-Woodlands-Estate-1.pdf	October 2022	Winster Drive is a residential road located on land at the confluence of Netherley Brook and Halewood Brook. The report notes that '*the area experienced considerable rainfall from around 18:00 on the 23rd September and continued overnight. The rain gauge at Fazakerley recorded over 82mm in 48 hours and nearly 90mm in 60 hours… The properties flooded initially from the front and later from the rear (Winster Drive) as a pond of water accumulated on the road and into the gardens of the properties.'* The report noted '*It is likely that the flooding was caused by the drainage system being exceeded, possibly due to partial blockage not helped by Netherley Brook being high and reducing the efficiency of discharge into the river from the surface water sewer. The initial flooding to the front of the properties may have been caused by the pavement drains not taking water due to the sewer system capacity having been exceeded or blocked. Surface water drainage systems are rarely designed to cope with a rainstorm of greater than a 30 year return period. It was initially thought the Brook overtopped its banks but it has been confirmed that this is not the case.'*
			https://www.knowsley.gov.uk/knowsleycouncil/media/Documents/kmbc-level-2-strategic-flood-risk-assessment-vol-1-and-2-dec-2016.pdf	October 2022	
Flow or level data for events	Yes	Yes	Email reference GMMC275772SPW	EA email received August 2022	Gauge data received from the EA of the Winster Drive gauge situated on the Netherley brook, in the Lower Mersey catchment. The data was supplied from the entire period of record digitally available to the EA i.e. February 2012, August 2022. No calculated return periods have been supplied for any of the flood events within the gauged history.
Rainfall data for events	n/a				
Potential evaporation data	n/a				

Results from previous studies	Yes	Yes	Flood estimation calculation record – Netherley Model. "EA FEH calculation record (v3)-Netherley.doc" Doc no. 197_08_SD01, 2009 by JBA Consulting	Email reference GMMC253222SPW dated March 2022	Both FEH statistical and ReFH methods have been considered. However, only the flood estimate for the QMED from the statistical method has been provided. The table below shows the summary of the subject site.

Site code	Watercourse	Easting	Northing	Site
Point 1	Netherley Beck & Tribs	344550	389700	Point inflow at u/s model limit of Netherley Brook
Lat 1	Netherley Beck & Tribs	344650	388400	Lateral inflows between Netherley u/s limit and Childwall Brook confluence
Point 2	Netherley Beck & Tribs	344600	388400	Childwall Brook
Point 4	Netherley Beck & Tribs	343700	387250	Halewood Brook
Lat 2	Netherley Beck & Tribs	345500	386700	Lateral inflows along Halewood Brook
Point 3	Netherley Beck & Tribs	345200	387950	Mill Brook
Point 5	Netherley Beck & Tribs	345600	387100	Tarbock Beck
Point 6	Netherley Beck & Tribs	344900	386400	Woodend Brook
Lat 3	Netherley Beck & Tribs	345450	386650	Lateral inflows along Woodend Brook

Table Extract 3.6 Flood estimates from the statistical method. Only QMED derived.

Site Code	Flood peak (m3/s) for the 2 year return period
Point 1	0.67
Lat 1	1.45
Point 2	6.57
Point 3	9.45
Point 4	0.29
Lat 2	1.45
Point 5	1.07
Point 6	0.35
Lat 3	0.54

Table Extract 4.3 Flood estimates from the ReFH method

	Flood peak (m3/s) for the following return periods (in years)				
Site Code	**5**	**10**	**50**	**100**	**1000**
Point 1	0.9	1.1	1.6	1.9	3.4
Lat 1	0.6	0.7	0.8	1.1	2
Point 2	8.3	10	14.2	16.6	29.7
Point 3	11.6	13.8	19.2	22.3	39
Point 4	0.5	0.6	0.8	1	1.9
Lat 2	2.5	3.1	4.4	5.1	9
Point 5	1.1	1.3	1.8	2.1	3.6
Point 6	0.5	0.6	0.8	0.9	1.7
Lat 3	0.4	0.4	0.6	0.7	1.2

The record states '*FEH Statistical methods only used to investigate QMED values. No suitable donor sites available and significant uncertainties considered in Stat method results. ReFH results have been used, however these should be deemed as being equally uncertain, particularly given the catchment size and the locally high levels of urbanisation. Hydrograph shape from ReFH.*'

The flows detailed in the FEC record will be compared to the flows derived in the present assessment. See section 7.4 for more details.

Other data or information (e.g. groundwater, tides, etc...)	n/a				

2.8 Hydrological understanding of catchment

Plots of flow data and interpretation	The Winster Drive gauge data is a level only recording station, as such flow data cannot be analysed.
Plots of flood peak data and interpretation	The AMAX data at Winster Drive gauge is included in Annex 8.4. The general trend in the data is that the recorded peak levels are predominantly shown to occur during the summer months (May-September), though there are water years which show the largest recorded events have occurred within the winter months (October – April, 2 instances in the 10 year history of recordings at the gauging station).

Conceptual model	The main site of interest is the proposed development site located on the left bank of the Netherley Brook to the north-east Halewood town. Water spilling from Netherley Brook is the primary sources of fluvial flood risk at the site. The site could be flooded if the local conveyance capacity of the Netherley Brook is exceeded. The site is situated at approximately 8m AOD and is not tidally influenced.
Unusual catchment features	The URBEXT2000 value is 0.3225 and therefore above 0.15 and classed as 'very heavily urbanised' and ReFH1 is likely to produce incorrect peak flow estimates. The catchment has extensive floodplain storage (FPEXT = 0.2199) and is not believed to be pumped. ReFH2 could overestimate. From a review of the 1:10,000 OS maps there are no springs present in the catchment.

2.9 Initial choice of approach

Is FEH appropriate?	The catchment is very heavily urbanised (URBEXT2000 is 0.3225) and corrections for urbanisation will be applied in-line with FEH guidelines. The other descriptors are within the standard range. FEH statistical method is appropriate.
Initial choice of method(s) and reasons	Initial flood estimates will be calculated using the FEH Statistical (Pooled method) and the ReFH2 rainfall-runoff method; the results from the two approaches will be compared. FEH single site analysis is not feasible for this ungauged catchment.
How will hydrograph shapes be derived if needed?	Hydrograph shapes will be extracted from the ReFH2 results.
Will the catchment be split into subcatchments? If so, how?	One analysis will be undertaken for the catchment as a whole and the design hydrographs scaled based on sub-catchment area to provide seven point inflows and three distributed sources for the hydraulic model (see Annex 8.1 for a map showing the sub-catchment extents and inflow locations). The respective scaling ratios are included in the following table. They have been derived from the adjusted catchment boundary and scaled to the FEH catchment area.

Code	Scaling Ratio	Area (km²)
NETH01_4081	0.023	1.19
NETH_LAT	0.015	0.80
CHILD	0.259	13.45
HAL1_2899	0.010	0.52
HALE_LAT	0.031	1.60
HAL3_0507i	0.016	0.82
MILL	0.474	24.61
TARBOCK	0.121	6.30
WOOD_1_0911	0.038	2.00
WOOD_LAT	0.013	0.66

Software to be used (with version numbers)	FEH Web Service / WINFAP 5 / ReFH2.3

3 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED

The table below lists the locations of subject sites. The site codes listed below are used in all subsequent tables to save space. Catchment maps are reported in Annexes 8.1.

3.1 Summary of subject sites

Site code	Type of estimate (L: lumped catchment S: Sub-catchment)	Watercourse	Name or description of site	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered (km^2)
S01	L	Netherley Brook and tributaries	Netherley Brook and tributaries flowing through town of Halewood.	346150	386050	51.94	-

3.2 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	AREA (km^2)	FARL	PROPWET	DPLBAR (km)	BFIHOST19	DPSBAR (m/km)	SAAR (mm)	SPRHOST	$URBEXT_{2000}$	FPEXT
S01	51.94	0.988	0.37	6.55	0.461	20.3	853	36.23	0.3225	0.2199

3.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	A watershed analysis has been carried out in GIS software based on 1m resolution LiDAR data. The results of the watershed analysis showed a similar catchment boundary to that provided by the FEH Web Service and therefore no alterations have been made to the catchment area.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	The BFIHOST value is compatible with the soil type and strata descriptions (see section 2.2 above) and has not been altered. SAAR has been checked using 1941-1970 Average Annual Rainfall maps; the FEH value of 853mm has been confirmed. FARL has been checked using OS maps and satellite images. The FARL value of 0.988 has been confirmed. URBEXT has been recalculated from 1:50,000 OS maps according to the watershed catchment boundary; the urbanised surface of the catchment appears to be equal to 26.63km^2 resulting in URBEXT values of URBEXT2000 = 0.3225 and URBEXT1990 = 0.2501.
Source of URBEXT	URBEXT2000 for FEH statistical and ReFH2.
Method for updating of URBEXT	CPRE formula from 2006 CEH report on URBEXT2000

4 STATISTICAL METHOD

4.1 Application of Statistical method

What is the purpose of applying this method?	Lumped estimate of peak flows downstream of proposed study area.

4.2 Overview of estimation of QMED at each subject site

Site code	QMED (rural) from CDs (m^3/s)	Final method	Data transfer							Urban adjust-ment factor UAF	Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites used (see 4.3)	Distance between centroids d_{ij} (km)	Power term, a	Adjustment ratio (A/B)	Moderated QMED adjustment factor, $(A/B)^a$	If more than one donor: Weight	If more than one donor: Weighted average adjustment		
S01	13.281	DT	69032	7.86	0.406	0.647	0.838	-	-	1.393	14.722
			69030	10.84	0.373	0.809	0.924	-	-		
			68010	16.91	0.328	0.805	0.931	-	-		
			68021	20.11	0.308	0.898	0.967	-	-		
			70002	22.14	0.295	1.127	1.036	-	-		
			68011	22.69	0.292	0.539	0.835	-	-		

Are the values of QMED spatially consistent?	n/a
Method used for urban adjustment for subject and donor sites	Urban adjustment applied within WINFAP v5

Parameters used for WINFAP v4 urban adjustment if applicable (these are 'standard' values and should be revised if alternative values have been applied)

Impervious fraction for built-up areas, IF	Percentage runoff for impervious surfaces, PR_{imp}	Method for calculating fractional urban cover, URBAN
0.3	70%	From updated URBEXT2000

Notes
Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer (with urban adjustment); CD – Catchment descriptors alone (with urban adjustment); BCW – Catchment descriptors and bankfull channel width (add details); LF – Low flow statistics (add details).
The QMED adjustment factor A/B for each donor site is moderated using the power term, a, which is a function of the distance between the centroids of the subject catchment and the donor catchment. The final estimate of QMED is (A/B)a times the initial (rural) estimate from catchment descriptors.
Important note on urban adjustment
The method used to adjust QMED for urbanisation published in Kjeldsen (2010)* in which PRUAF is calculated from BFIHOST is not correctly applied in WINFAP-FEH v3.0.003. Significant differences occur only on urban catchments that are highly permeable. This is discussed in Wallingford HydroSolutions (2016)**.

* Kjeldsen, T. R. (2010). Modelling the impact of urbanization on flood frequency relationships in the UK. Hydrol. Res. 41. 391-405.
** Wallingford HydroSolutions (2016). WINFAP 4 Urban adjustment procedures.

4.3 Search for donor sites for QMED (if applicable)

Note that donor catchments should usually be rural but may be urban provided the data is deurbanised prior to the adjustment process.

Comment on potential donor sites	WINFAP was used to generate a potential list of the closest 10 potential donor stations for this ungauged study site. Recent works (Doc. Ref. "Using Multiple Donor Sites for Enhanced Flood Estimation in Ungauged Catchments", Kjeldsen et al. 2014) recommend, the use of multiple donor sites for ungauged catchments, to improve estimation of the flood peak flows. Due to the hydrological similarities and centroid distances, stations 69032 Alt @ Kirkby, 69030 Sankey Brook @ Causey Bridges, 68010 Fender @ Ford Lane, 68021 Arrowe Brook @ Acton Lane, 70002 Douglas @ Wanes Blades Bridge and 68011 Arley Brook @ Gore Farm (individual details discussed in section 4.4) have been selected as suitable for donor transfer.

4.4 Donor sites chosen and QMED adjustment factors

NRFA no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjustment for climatic variation?	QMED from flow data - deurbanised (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
69032 Alt @ Kirkby	Chosen donor. Closest potential donor site (centroid distance of 7.86km). CDs are generally similar to those of subject catchment.	AM	No	12.959	20.043	0.647
69030 Sankey Brook @ Causey Bridges	Chosen donor. Second potential donor station (centroid distance of 10.84km). CDs are generally similar to those of subject catchment.	AM	No	23.852	29.471	0.809
68010 Fender @ Ford Lane	Chosen donor. Third potential donor station (centroid distance of 16.91km). CDs are generally similar to those of subject catchment.	AM	No	3.866	4.803	0.805
68021 Arrowe Brook @ Acton Lane	Chosen donor. 4th potential donor station (centroid distance of 20.11km). CDs are generally similar to those of subject catchment.	AM	No	3.313	3.69	0.898
70002 Douglas @ Wanes Blades Bridge	Chosen donor. 5th potential donor station (centroid distance of 22.14km). CDs are generally similar to those of subject catchment.	AM	No	38.471	34.147	1.127
68011 Arley Brook @ Gore Farm	Chosen donor. 6th potential donor station (centroid distance of 22.69km). CDs are generally similar to those of subject catchment.	AM	No	5.972	11.081	0.539

69005 Glaze Brook @ Little Woolden Hall	Rejected. 7th potential donor station (centroid distance of 24.37km).	AM	No	28.553	44.894	0.636
68020 Gowy @ Bridge Trafford	Rejected. 8th potential donor station. Centroid distance (25.76km) is too high. SAAR value is too low (729mm).	AM	No	15.141	17.819	0.850
70003 Douglas @ Wigan	Rejected. 9th potential donor station. Centroid distance (27.95km) is too high. FARL value is too low (0.778)	AM	No	16.465	12.727	1.294
70004 Yarrow @ Croston Mill	Rejected. 10th potential donor station. Centroid distance (30.03km) is too high.	AM	No	25.937	23.842	1.088

4.5 Derivation of pooling groups

The composition of the pooling groups is given in the Annex 8.4. Additional information on the WINFAP procedure are reported in Annex 8.5.

Name of group	**Site code from whose descriptors group was derived**	**Subject site treated as gauged?** (enhanced single site analysis)	**Changes made to default pooling group, with reasons** (if there are no changes just say "None", although it is helpful to provide details of stations which were investigated even if they were ultimately retained)	**Weighted average L-moments**, L-CV and L-skew, (before urban adjustment)
P01	S01	No	WINFAP was used to generate an initial pooling group (minimum 500 years of data) for this ungauged study site. A table showing the initial pooling group and catchment descriptors is included in Annex 8.4. All stations were reviewed for their hydrological similarity and suitability for pooling i.e. reliability of data. Four stations were removed from the pooling group (more details available in Annex 8.4). A short table detailing all stations (and their catchment descriptors) which were reviewed for inclusion within the pooling group is included in Annex 8.4. The final pooling group contains 319 years of data and is 'heterogenous' within WINFAP, with a standardised test value H1 (the most reliable, according to Hoskins and Wallace*) of 4.6841. A review of the pooling group is advised as 'desirable' by WINFAP. As mentioned in the Flood Estimation Guidelines '*the uncertainty associated with pooling does not increase much until the number of years drops below 300*', as such 319 years of data is acceptable. A table with the final pooling group (including CDs of all the stations) is included in Annex 8.4.	L-CV= 0.226 L-SKEW= 0.161

* Hoskings & Wallace (1997), Regional Frequency Analysis: An Approach Based on L-Moments; Cambridge University Press

Note: Pooling groups were derived using the procedures from Science Report SC050050 (2008).

4.6 Derivation of flood growth curves at subject sites

Site code	**Method (SS, P, ESS, J)**	**If P, ESS or J, name of pooling group**	**Distribution used and reason for choice**	**Note any urban adjustment or permeable adjustment**	**Parameters of distribution** (location, scale and shape) after adjustments	**Growth factor for 100-year return period**
S01	P	P01	GEV (best fit in WINFAP, equal to -0.3026)	Urban adjustment within WINFAP applied.	Location: 0.900 Scale: 0.270 Shape: -0.071 Bound: -2.892	2.37

Notes
Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis
Urban adjustments are all carried out using the method of Kjeldsen (2010).
Growth curves were derived using the procedures from Science Report SC050050 (2008).

4.7 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following return periods (in years)												
	1 in 2	1 in 5	1 in 20	1 in 100	1 in 100 (+CCA1)	1 in 1000							
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	20%	5%	1%	1%+44 %	0.1%							
S01	14.72	19.53	26.38	34.85	50.19	48.66							

5 REVITALISED FLOOD HYDROGRAPH (REFH or ReFH1) METHOD

5.1 Application of ReFH method

What is the purpose of applying this method?	ReFH1 method not used.

6 REVITALISED FLOOD HYDROGRAPH 2 (REFH2) METHOD

6.1 Application of ReFH2 method

What is the purpose of applying this method?	As per the FEH guidance, at least two methods should be investigated for deriving peak flows and hydrograph shape. Therefore, the ReFH2 peak flow estimates will be compared to those derived with the FEH statistical method.

6.2 Catchment sub-divisions for ReFH2 model

The paved areas were calculated by using the standard URBEXT equations.

6.3 Parameters for ReFH2 model

Site code	Method	Tp_{rural} (hours)	Tp_{urban} (hours)	C_{max} (mm)	PR_{imp} (% runoff for impermeable surfaces)	BL (hours)	BR
S01	CD	6.71	5.03	362.59	0.7	46.04	1.74-2.86
Brief description of any flood event analysis carried out (further details should be given in the annex)				n/a			
Methods: OPT: Optimisation, BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details)							

6.4 Design events for ReFH2 method: Lumped catchments

Site code	Urban or rural	**Season of design event** (summer or winter)	**Storm duration** (hours)
S01	Urban	Summer	13

6.5 Design events for ReFH2 method: Sub-catchments and intervening areas

Site code	**Season of design event** (summer or winter)	**Storm duration** (hours)	**Storm area for ARF** (if not catchment area)	**Reason for selecting storm**
n/a				
Results of storm duration testing	n/a			

6.6 Flood estimates from the ReFH2 method

The ReFH2 calculations are provided in Annex 8.6.

Site code	Flood peak (m^3/s) for the following return periods (in years)												
	1 in 2	1 in 5	1 in 20	1 in 100	1 in 100 (+CCA1)	1 in 1000							
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	20%	5%	1%	1%+44 %	0.1%							
S01	14.30	18.14	24.41	35.94	44.92	63.31							

7 DISCUSSION AND SUMMARY OF RESULTS

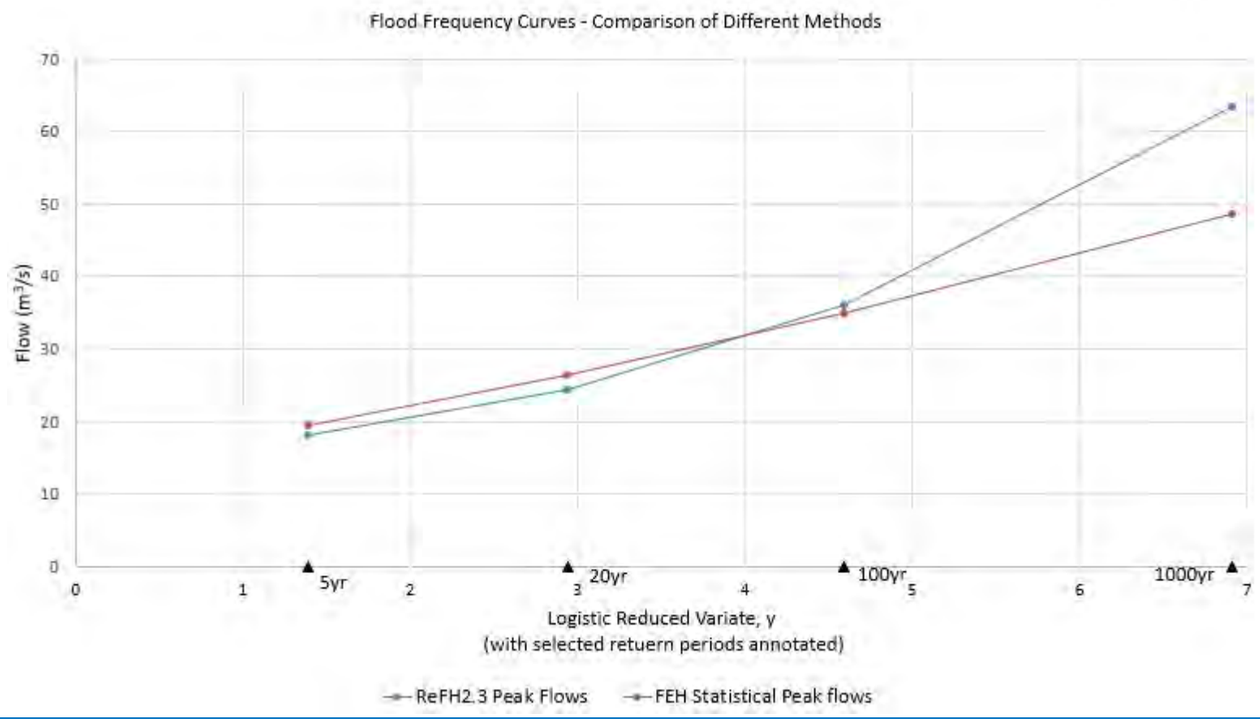
7.1 Comparison of results from different methods

This table compares peak flows from various methods with those from the FEH Statistical method at example sites for two key return periods / AEP events.

Site code	Ratio of peak flow to FEH Statistical peak					
	Return period 2 years / 50% AEP			Return period 100 years / 1% AEP		
	ReFH	ReFH2	Other method	ReFH	ReFH 2	Other method
S01	N/a	0.97	N/a	N/a	1.03	N/a

7.2 Final choice of method

Choice of method and reasons	As previously discussed, the ReFH2 and FEH Statistical methods have been investigated during this analysis. The following graph shows the growth curves of the two methods.



	As shown in the above graph, the FEH Statistical peak flows are higher for the lower return periods (approximately 8% for the 20% AEP and 5% AEP events) than the ReFH2 peaks. However, the ReFH2 peak flows are higher for the higher return periods (approximately 3% for the 1% AEP event and 30% for the 0.1% AEP event). The FEH Statistical method peak flows have been preferred as the method makes best use of local gauged data from hydrologically similar catchments which have short centroid distances. Furthermore, the latest software WINFAP5, which utilises improved procedures for the formation of the pooling group and for the application of donor catchments, was used for this assessment. Multiple donor sites have been used for the assessment further increasing the confidence in the FEH Statistical results. Further ReFH2 tends to overestimate flows on catchments where there are extensive floodplains, such as in this case as there is a high FPEXT value. The FEH Statistical method has been chosen as the preferred method for the design peak flows. The FEH Statistical method provides peak flows only; to prepare the required input hydrographs the ReFH2 design hydrographs have been scaled to match the FEH Statistical peaks for each design event (hybrid method). The FEH statistical method is not recommended for longer return periods (>0.67%AEP or Q150), the ratio method has been therefore adopted for the Q1000 return period. In line with FEH recommendations, the Q1000 peak flow estimate has been adjusted utilising the ReFH2 growth curve results, as follows: Q1000 = (Q1000ReFH2/Q100ReFH2) x Q100FEH Statistical = (63.309m^3/s / 35.938m^3/s) x 34.851m^3/s = 61.394m^3/s **Q1000 adjusted statistical peak = 61.39m^3/s**

How will the flows be applied to a hydraulic model?	Flows have been scaled to produce seven point inflows and three distributed sources (see section 2.9 and Annex 8.1 for more details) to be input into the model.

7.3 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	No significant or unusual assumptions have been made. The study catchment is treated as ungauged. The catchment boundary and descriptors have appropriately been re-defined.
Discuss any particular limitations	The 1000yr flows have been derived through the ratio method have a certain degree of uncertainty.
Provide information on the uncertainty in the design peak flow estimates and the methodology used	Confidence limits of 95% for the FEH Statistical derived QMED value of 14.722m3/s, based on the values reported in the EA report LIT 11832. Lower limit = 7.437m^3/s Upper limit = 29.142m^3/s Confidence Limits of 95% on ReFH2 derived QMED value of 14.297m^3/s, based on the EA Local Data Report SC13009/R Lower Limit = 6.527m^3/s Upper Limit = 31.317m^3/s
Comment on the suitability of the results for future studies	This hydrology assessment has utilised the most up-to-date flood estimation software and guidance and therefore, these results are applicable for future studies. However, it is recommended that future studies amend the hydrological assessment to incorporate any developments in methods/software and recent flow gauging data within the subject catchment.
Give any other comments on the study	No further comments.

7.4 Checks

Are the results consistent, for example at confluences?	No gauged flows available for checking consistency. The Winster Drive gauge data is a level only recording station, as such flow data cannot be analysed.
What do the results imply regarding the return periods / frequency of floods during the period of record?	N/A: ungauged catchment
What is the range of 100-year / 1% AEP growth factors? Is this realistic?	ReFH2 = 2.51 FEH-Statistical = 2.37 The growth factor is within the typical range for both result sets.

If 1000-year / 0.1% AEP flows have been derived, what is the range of ratios for 1000-year / 0.1% AEP flow over 100-year / 1% AEP flow?	ReFH2 = 1.76 FEH-Statistical = 1.40
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	The table below shows the summary of the subject sites from the JBA Consulting 2009 study in comparison to the catchments used in this study.

JBA Site code	Site	JBA Area (km²)	Waterco Code	Waterco Area (km²)
Point 1	Point inflow at u/s model limit of Netherley Brook	0.7	NETH01_4081	1.19
Lat 1	Lateral inflows between Netherley u/s limit and Childwall Brook confluence	1.2	NETH_LAT	0.80
Point 2	Childwall Brook	12.7	CHILD	13.45
Point 4	Halewood Brook	0.66	HAL1_2899	0.52
			HAL3_0507i	0.82
Lat 2	Lateral inflows along Halewood Brook	3.2	HALE_LAT	1.60
Point 3	Mill Brook	24	MILL	24.61
Point 5	Tarbock Beck	2	TARBOCK	6.30
Point 6	Woodend Brook	0.56	WOOD_1_0911	2.00
Lat 3	Lateral inflows along Woodend Brook	0.34	WOOD_LAT	0.66

A comparison of the flows is included in the table below for final flows.

	20% AEP Flood peak (m3/s)			1% AEP Flood peak (m3/s)			0.1% AEP Flood peak (m3/s)		
Waterco Code	JBA	Waterco	Difference	JBA	Waterco	Difference	JBA	Waterco	Difference
NETH01_4081	0.9	0.45	-0.45	1.9	0.80	-1.10	3.4	1.40	-2.00
NETH_LAT	0.6	0.30	-0.30	1.1	0.54	-0.56	2	0.95	-1.05
CHILD	8.3	5.06	-3.24	16.6	9.03	-7.57	29.7	15.90	-13.80
HAL1_2899	0.5	0.20	0.00	1	0.35	-0.10	1.9	0.61	-0.32
HAL3_0507i		0.31			0.55			0.97	
HALE_LAT	2.5	0.60	-1.90	5.1	1.08	-4.02	9	1.89	-7.11
MILL	11.6	9.25	-2.35	22.3	16.51	-5.79	39	29.09	-9.91
TARBOCK	1.1	2.37	1.27	2.1	4.22	2.12	3.6	7.44	3.84
WOOD_1_0911	0.5	0.75	0.25	0.9	1.34	0.44	1.7	2.36	0.66
WOOD_LAT	0.4	0.25	-0.15	0.7	0.44	-0.26	1.2	0.78	-0.42

A comparison of the JBA flows from the statistical method is included in the table below.

	50% AEP Flood peak (m3/s)		
Waterco Code	JBA	Waterco	Difference
NETH01_4081	0.67	0.34	-0.33
NETH_LAT	1.45	0.23	-1.22
CHILD	6.57	3.81	-2.76
HAL1_2899	0.29	0.15	0.09
HAL3_0507i		0.23	
HALE_LAT	1.45	0.45	-1.00
MILL	9.45	6.97	-2.48
TARBOCK	1.07	1.78	0.71
WOOD_1_0911	0.35	0.57	0.22
WOOD_LAT	0.54	0.19	-0.35

The tables above show that the results derived in this study are generally lower overall than those in the JBA assessment, however the Waterco flows are deemed to be more reliable as the latest software and guidance have been utilised to carry out the Assessment.

A key difference between the JBA and Waterco assessments is the chosen method. JBA chose ReFH1, whilst the Waterco assessment utilised the FEH Statistical method. The versions also are different. JBA used WINFAP-FEH v3 and the ReFH spreadsheet, whilst this assessment utilised WINFAP 5 and ReFH2.3.

	As mentioned in section 2.8 the URBEXT2000 value is 0.3225 and therefore above 0.15 and classed as 'very heavily urbanised' and ReFH1 is likely to produce incorrect peak flow estimates. Further the catchment has extensive floodplain storage (FPEXT = 0.2199) and is not believed to be pumped. ReFH2 could overestimate. As such the FEH Statistical method is deemed the most appropriate.
Are the results compatible with the longer-term flood history?	As discussed in the historical review, little is known about fluvial historical flood events at the subject site and no calculated return periods have been supplied for any of the flood events within the gauged history.
Describe any other checks on the results	No other checks performed.

7.5 Final results

Site code	Flood peak (m^3/s) for the following return periods (in years)												
	1 in 2	1 in 5	1 in 20	1 in 100	1 in 100 (+CCA1)	1 in 1000							
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	20%	5%	1%	1%+44 %	0.1%							
S01	14.72	19.53	26.38	34.85	50.19	61.39							
NETH01_4081	0.34	0.45	0.60	0.80	1.15	1.40							
NETH_LAT	0.23	0.30	0.41	0.54	0.77	0.95							
CHILD	3.81	5.06	6.83	9.03	13.00	15.90							
HAL1_2899	0.15	0.20	0.26	0.35	0.50	0.61							
HAL3_0507i	0.23	0.31	0.41	0.55	0.79	0.97							
HALE_LAT	0.45	0.60	0.81	1.08	1.55	1.89							
MILL	6.97	9.25	12.50	16.51	23.78	29.09							
TARBOCK	1.78	2.37	3.20	4.22	6.08	7.44							
WOOD_1_0911	0.57	0.75	1.01	1.34	1.93	2.36							
WOOD_LAT	0.19	0.25	0.34	0.44	0.64	0.78							

7.6 Uncertainty bounds

This table reports the flows derived from the uncertainty analysis detailed in Section 7.3. The 'true' value is more likely to be near the estimate reported in Section 7.5 than the bounds. However, it is possible that the 'true' value could still lie outside these bounds.

Site code	Flood peak (m^3/s) for the following return periods (in years)							
	1 in 2		1 in 20		1 in 100		1 in 1000	
	Flood peak (m^3/s) for the following AEP (%) events							
	50%		5%		1%		0.1%	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Na Confidence intervals for heavily urbanised catchments are not provided because there are not enough suitable catchments with flood peak data to provide reliable statistics. See section 7.3.								

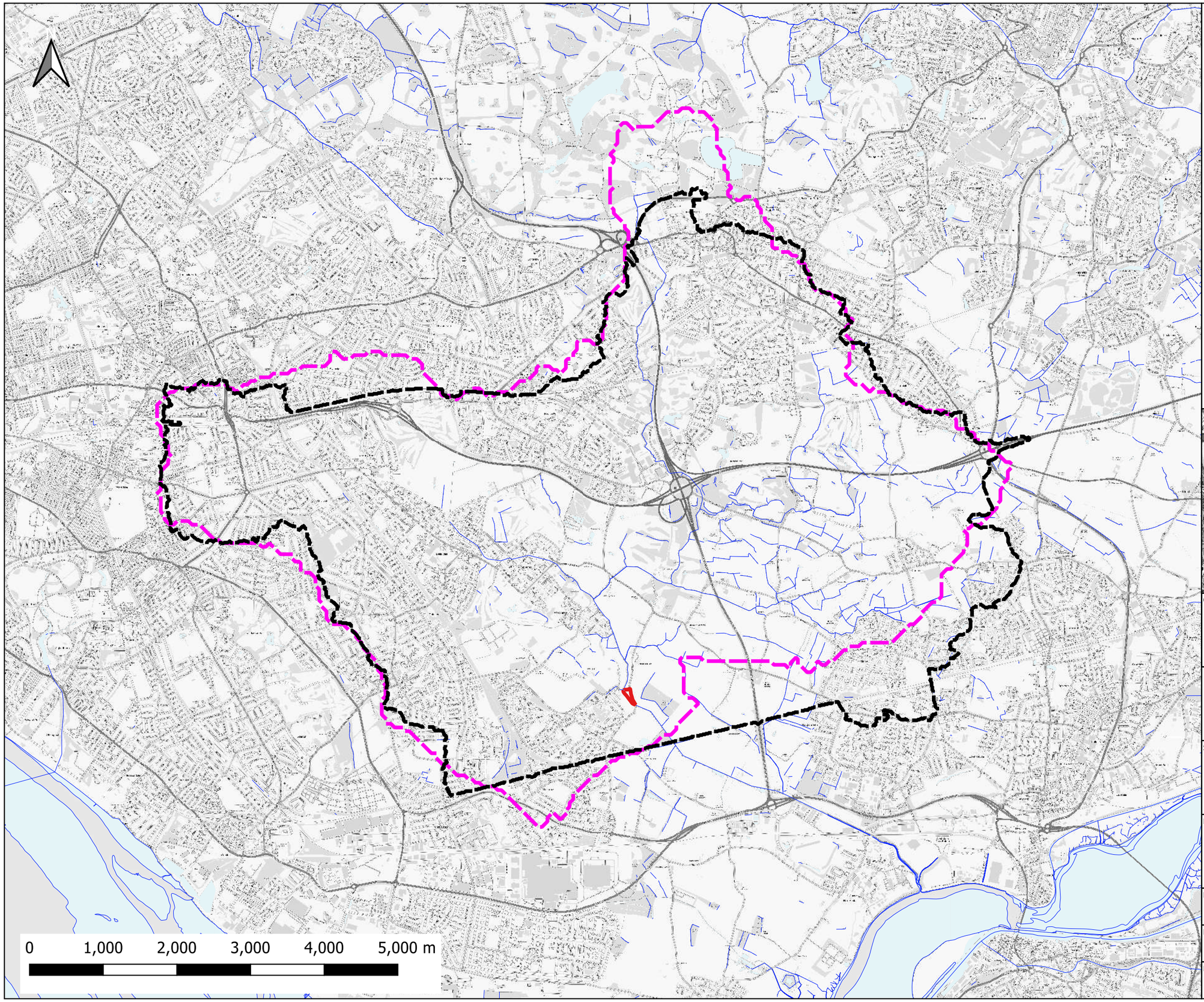
If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, hydraulic model, or reference to table below)	The design hydrographs are provided in Annex 8.7 and within the hydraulic model.

8 ANNEX - SUPPORTING INFORMATION

8.1 FEH Catchment Descriptors, Hydrological Location Plan

Catchment NGR: 346150 386050

Descriptor	FEH Original Value	Updated Value
AREA	51.9425	51.9425
ALTBAR	36	36
ASPBAR	164	164
ASPVAR	0.25	0.25
BFIHOST	0.427	0.427
BFIHOST19	0.461	0.461
DPLBAR	6.55	6.55
DPSBAR	20.3	20.3
FARL	0.988	0.988
FPEXT	0.2199	0.2199
FPDBAR	1.391	1.391
FPLOC	0.81	0.81
LDP	12.86	12.86
PROPWET	0.37	0.37
RMED-1H	11	11
RMED-1D	30.5	30.5
RMED-2D	42.1	42.1
SAAR	853	853
SAAR4170	875	875
SPRHOST	36.23	36.23
URBCONC1990	0.868	0.868
URBEXT1990	**0.2342**	**0.2501**
URBLOC1990	1.086	1.086
URBCONC2000	0.897	0.897
URBEXT2000	**0.2562**	**0.3225**
URBLOC2000	1.081	1.081
C	-0.02249	-0.02249
D1	0.30019	0.30019
D2	0.34194	0.34194
D3	0.3285	0.3285
E	0.28815	0.28815
F	2.50055	2.50055
C(1 km)	-0.023	-0.023
D1(1 km)	0.306	0.306
D2(1 km)	0.369	0.369
D3(1 km)	0.319	0.319
E(1 km)	0.287	0.287
F(1 km)	2.489	2.489



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- FEH Catchment Boundary
- Adjusted Catchment Boundary
- Watercourses
- Water Bodies

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Hydrological Location Plan

PLOT STATUS:	DATE:
FINAL	17-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
LW	AR	AP	1:50000

PLOT NAME:	REVISION:
14506_Hydrological_Location_Plan	-

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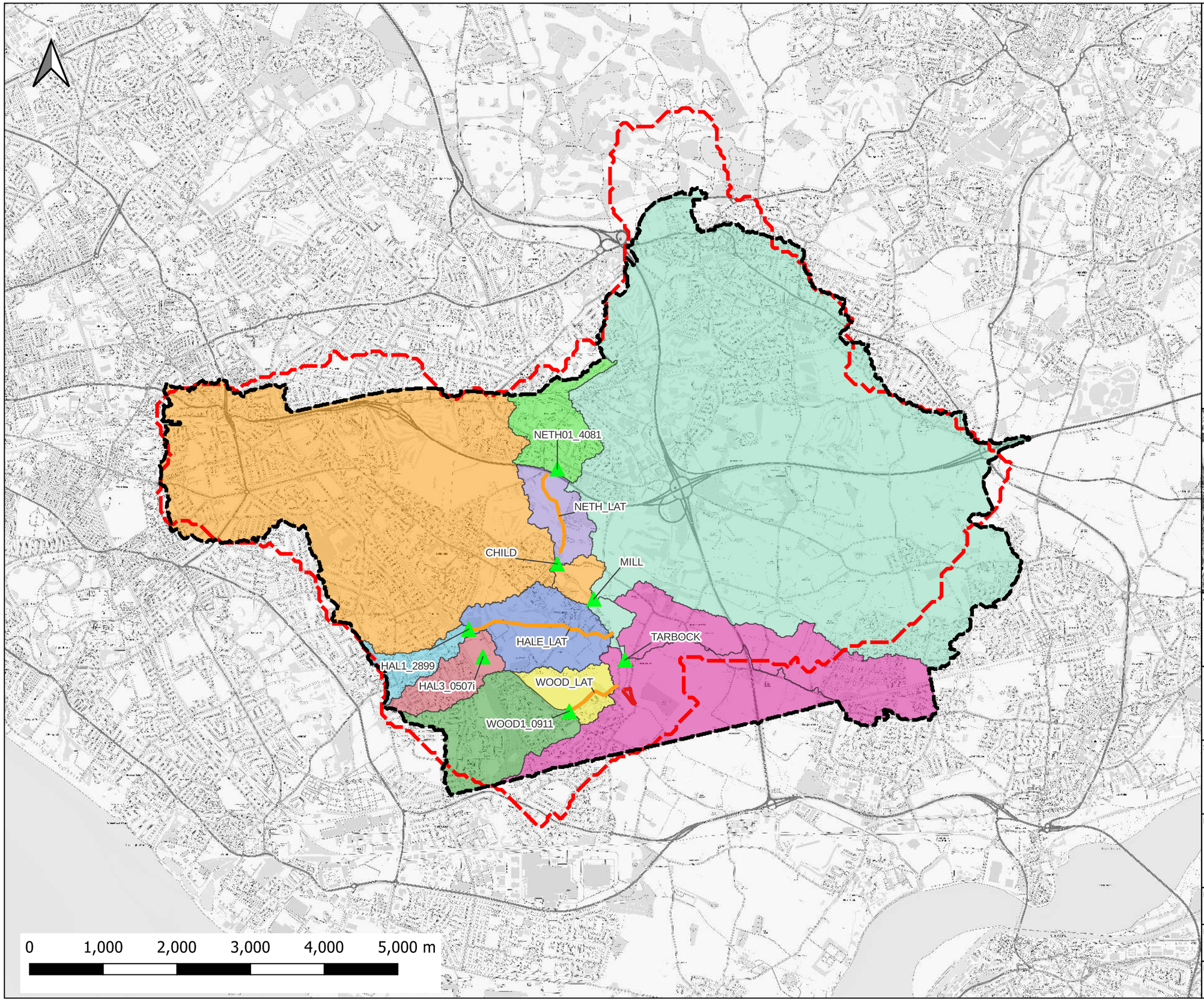


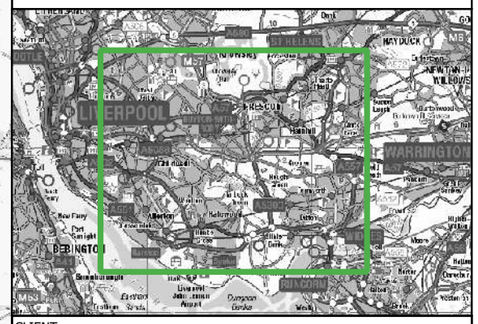
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- FEH Catchment Boundary
- Adjusted Catchment Boundary
- Lateral Inflow Locations
- Point Inflow Locations

Scaled Catchment Areas

- CHILD
- HALE_LAT
- HALE1_2899
- HALE3_0507i
- MILL
- NETH_LAT
- NETH01
- TARBOCK
- WOOD_LAT
- WOOD1_0911



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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Sub-Catchment & Inflow Location Plan

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
LW	AR	AP	1:50000

PLOT NAME:	REVISION:
14506_Sub-Catchment_&_Inflow_Location_Plan	-

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8.2 EA Correspondence

14506-Former Merseyside Dogs Home, East Halewood
Proposed hydraulic modelling methodology for EA comment – Existing EA Model Build

May 2022

Background

We are currently undertaking hydraulic modelling of the Netherley Brook through Halewood to inform a Flood Risk Assessment for a proposed development at the former Merseyside Dogs Home, Tarbock Green, Prescot, L35 1QH (plan of site location attached). Prior to progressing works further, we are seeking your advice and comment with regard to our proposed modelling methodology. We find that discussing our approach with the Environment Agency (EA) at the early stage saves all parties involved time and ensures your team's site-specific requirements are fully accounted for. As such please find below our proposed methodology for your consideration. Your advice or comment would be very much appreciated.

Project Details & Requirements

We propose to utilise and update the current EA Netherley, Halewood and Woodend (2012) hydraulic model of the Netherley Brook and its tributaries to provide the required output data.

The 2D grid size of the model is 4m. A site-specific topographical survey will be used to update the model to provide an up-to-date, site-specific assessment of flood risk at the existing (EXG) site. The model will also be used to quantify the impact of the development on flood risk elsewhere (if any). Model outputs will then be used to support the Flood Risk Assessment being prepared for the development. The site is shown to be located within EA Flood Zone 1/2/3.

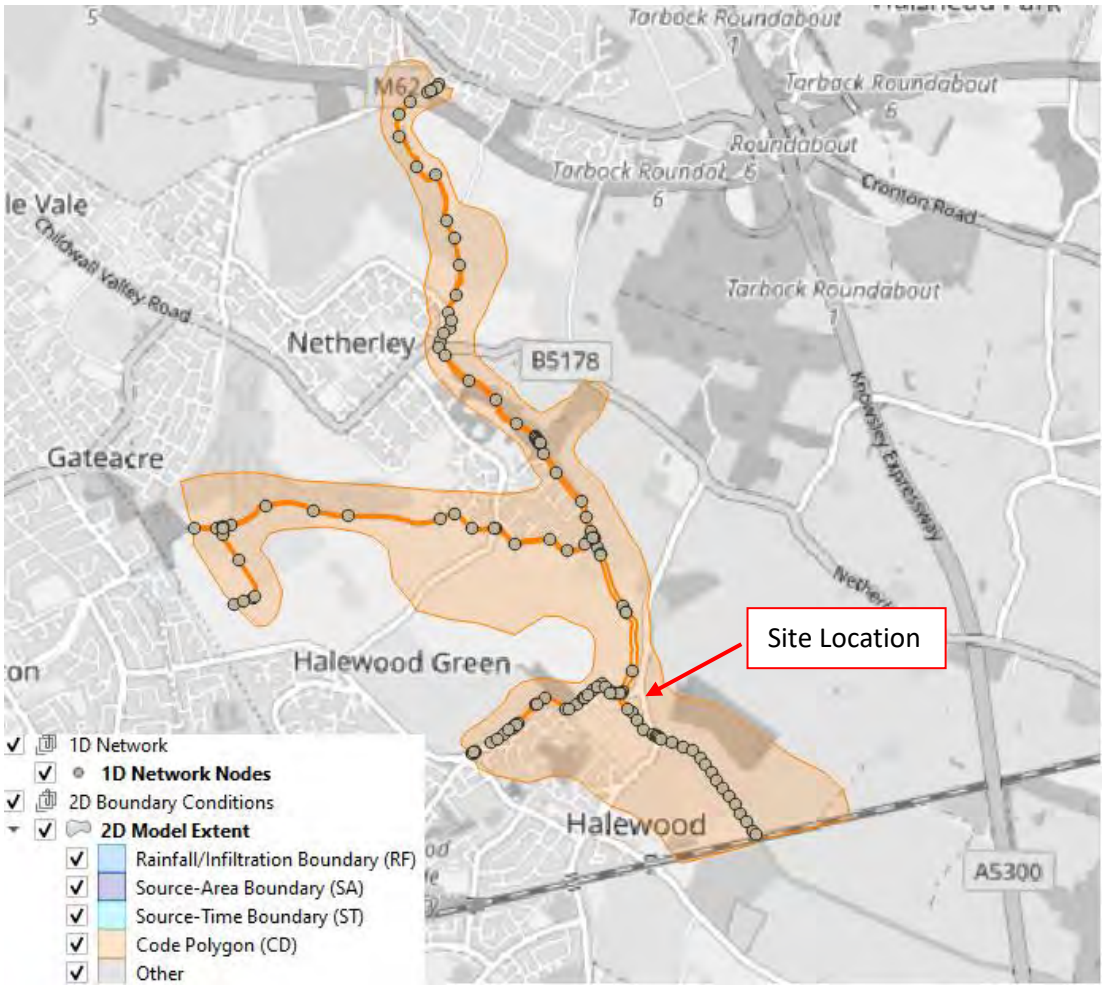
It is assumed the current model is fit-for-purpose and includes all required input data (LiDAR, boundary conditions etc). Please advise if you or your team are aware of any pre-existing issues with the model – any additional information at this stage is useful. Thank you.

The works will include preparation of a Hydraulic Modelling Report and Flood Mapping.

Model and Simulation Type

Software:	FMP-TUFLOW
Approach:	Fluvial only
Extent:	See model extent below
Time:	>1hrs- As per EA model

Model Extent



Hydrological Calculations

There will be four inflows into the hydraulic model; point inflows applied at the upstream extent of Netherly Brook and Halewood Brook as well as, lateral inflows applied to Mill Brook and Chidwell Brook.

We propose to carry out FEH Statistical (ungauged) and ReFH2 calculations for Netherly Brook. Details of the downstream catchment location at which the watercourse inflows will be calculated are provided below. If acceptable, we propose to use the FEH Statistical method to estimate peak flows and scale the ReFH2 hydrographs to match the FEH Statistical peaks. We will also apply the adjusted statistical method for the Q1000 peak flow.

Watercourse	Downstream Catchment Location (NGR)
Ditton Brook at the Manchester and Allerton Junction Rail line	346227, 385935

Where appropriate, catchment descriptors will be updated based on the latest available datasets (e.g AREA updated with LiDAR.

Events/ Scenarios Considered

Model study to simulate and compare the flood risk at the site for the existing (EXG) and proposed development (DEV) level. Table 1 provides a summary of the proposed events and scenarios.

Proposed Climate Change Allowance (CCA) for this site during the 1% AEP event is +44% in accordance with EA guidance (Site located in North West River Basin, Lower Mersey Management Catchment; development considered 'More Vulnerable' with predicted 100 year lifetime – 'central estimate' allowance category chosen):

A blockage scenario based on latest EA blockage guidance document will be carried out simulating a 33% blockage of the Greensbridge Lane bridge at approximately NGR 345727, 386423 during the 1% AEP CC1 event only.

Sensitivity Tests (ST) to be run:

- ST1 and ST2 - Roughness: +/-20% Manning's n roughness (channel & floodplain)
- ST3 and ST4 - Downstream Boundary Test: -20% slope
- ST5 and ST6 - Flow: +/-20% flow rate

Table 1*: Summary table of proposed model scenarios and events*

Event (AEP)	Scenario			
	Existing site layout and level (EXG)	Proposed site layout and levels (DEV)	Blockage	Sensitivity Tests (ST)
5%	✓	✓		
1%	✓	✓		
1% CC1	✓	✓	✓	✓
0.1%	✓	✓		

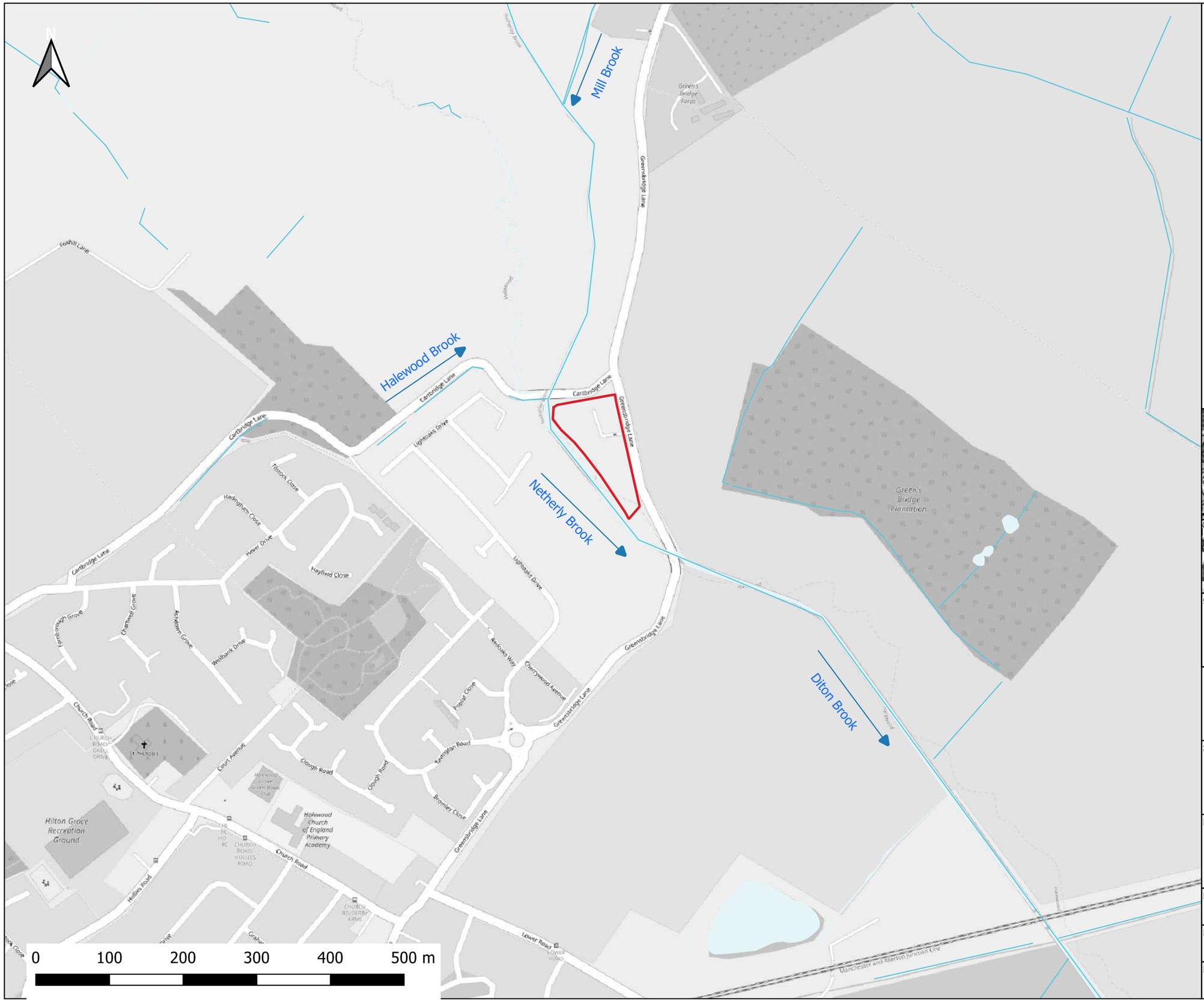
For Your Consideration

Please provide comment on our above methodology and whether you are in agreement with the approach outlined? Please also confirm if any hydrology updates are required?

Waterco Contact

Michael Farmer
01244 668128
Michael.farmer@waterco.co.uk

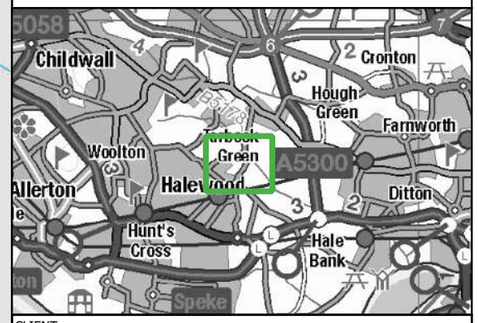
Site Location Plan



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Water Bodies
- Watercourses



CLIENT:
Mr. N Nasr

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Location Plan

PLOT STATUS:			DATE:
FINAL			27-05-2022
DRAWN: MF	CHECKED: LW	APPROVED:	PLOT SCALE AT A3: 1:5000
PLOT NAME: 14506_Location_Plan			REVISION: -

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Waterco Ltd
Eden Court Business Centre Lon Parcwr
Industrial Estate
Ruthin
Clwyd
LL15 1NJ

Our ref: SO/2022/122324/01-L01
Your ref: 220606/lk21 14506

Date: 03 August 2022

Dear Michael,

ENVPAC/1/GMC/00442 - EA / WATERCO - DOCUMENTATION REVIEW - PROPOSED HYDRAULIC MODELLING METHODOLOGY FOR EA COMMENT

FORMER MERSEYSIDE DOGS HOME, TARBOCK GREEN, PRESCOT, L35 1QH

Thank you for requesting a flood model methodology review by the Environment Agency relating to the potential development located at the Former Merseyside Dogs Home, Tarbock Green.

For the purpose of this request, the Environment Agency's Evidence & Risk (E&R) team have reviewed the following documents:

- Note – 14506-Former Merseyside Dogs Home, East Halewood - Proposed hydraulic modelling methodology for EA comment – Existing Model Build. File ref. 14506-220527-Former Dogs Home EA Modelling Methodology. Prepared by Waterco. Dated: May 2022.
- Location Plan – Former Merseyside Dogs Home, East Halewood. Plot Name: 14506_Location_Plan. Prepared by WaterCo. Dated: 27th May 2022.
- Aerial Plan – Aerial Plan. Former Merseyside Dogs Home, East Halewood. Plot Name: 14506_Aerial_Plan. Prepared by Waterco. Dated 27th May 2022.

Please note, in order to undertake a review of the above and provide this letter response, we have used 7 hours of established charge agreement ENVPAC/1/GMC/00442 (5 hours remaining).

Environment Agency E&R Commentary: Proposed Hydraulic Modelling Methodology

Our Flood Risk Modelling Advisor in the E&R team has reviewed the proposed hydraulic modelling methodology and provided the following commentary and advice detailed below:

<u>Model Approach</u>
We note the hydraulic modelling will be undertaken for a proposed development at the former Merseyside Dogs Home in Tarbock Green. To aid in determining the appropriateness of the flood model approach we require clarification on the type of development being proposed at this location.

We note the proposal includes updating the EA Netherley, Halewood and Woodend (2012) hydraulic model. We require further clarification as to why this approach was

chosen and whether changes need to be made to ensure it is suitable for this new use. We note that it is assumed the current model is fit-for-purpose. It is for you to review the model and make any changes needed to make it suitable for your intended use. As the model was originally built for another purpose, it may be fit for that purpose but will require changes in order to make it fit for your purpose.

If there are any pre-existing issues with the modelling, it should be mentioned in the model report for the model. When submitting a Flood Risk Assessment that uses a previous Environment Agency model, it is useful for the report of the previous model to be included or you ensure any information about the previous model is provided in your report. For instance, explaining why you have chosen (or kept) the roughness values, grid size, any changes to default parameters etc. This means from the first review we can understand why the model has been built that way, even if it has not changed from the previous model. If you have not received the model report for the previous 2012 model, we advise contacting inforequests.gmmc@environment-agency.gov.uk to request this information.

We understand the software that will be utilised is FMP-TUFLOW (1D/2D fluvial) model. We require further clarity as to why this approach has been chosen and, if it is the same as the previous model, whether other software was considered that may be more suited.

General Model Build

A model extent diagram has been included in the proposed hydraulic methodology note, however, there is no explanation as to why the upstream and downstream extents have been applied. We require further explanation as to why the upstream and downstream extents have been chosen. The downstream extent is at the railway bridge and it looks like there could be potential for some glass walling at this location. We advise establishing why this downstream extent is appropriate and how this potential issue will be overcome.

It is noted that a grid size of 4m is to be used. It has not been established what timesteps are intended to be utilised for this approach. Please note, we would typically see 2 seconds for 2D and 1 second for 1D with this grid size. We are unable to comment on whether a 4m grid size would be suitable at this stage but this will be checked when the model is reviewed to ensure that it is adequately representing flow pathways e.g. between buildings.

Model Input Data

We note a site specific topographical survey will be used to update the model. It is assumed at this time that this means there will be new survey for all of the 1D stretch of the model (please confirm). We require further clarification on what Lidar age and resolution will be used as it is assumed there is more up-to-date Lidar since the previous model from 2012.

We advise checking for any flood defence assets in the area that will need to be accounted for. A quick check of the Environment Agency's Asset Information Management System (AIMS) shows there are embankments and engineered high ground in the area.

Model Runs

The summary table indicates the 5%, 1%, 1% plus climate change and 0.1% design runs will be undertaken for the existing and proposed site. We can confirm that this seems appropriate at this time. We note the climate change allowance has been chosen

as the 'central estimate', however, it is unclear what the development proposals are. Therefore, we cannot comment on whether this is the correct category of climate change allowance to use. Please refer to the latest climate change allowances guidance to aid in determining whether the appropriate climate change allowance will be used.

We note the methodology proposes a blockage scenario for Greensbridge Lane bridge and outlines the sensitivity tests that will be run including roughness, downstream boundary and flow on the 1% plus climate change event. We require further information as to why the downstream boundary is only -20% slope and not 20% as well. Further information on how you calculated 33% blockage as an appropriate value would also be useful. We require further clarification as to why there is a proposed blockage scenario for the bridge at Greensbridge Lane and not for the bridge at Cartbridge Lane too.

Hydrology Review

We note the catchment is ungauged. We require clarification as to whether a review of all / any available river level / flow and rainfall gauges or other useful information will be undertaken, including a review of flood history for the catchment. Further to this, catchment descriptors will need to be checked against latest datasets (i.e. Lidar).

We note, FEH Statistical and ReFH2 calculations are to be conducted for the Netherley Brook. We require clarification as to why it has been provisionally decided to use FEH Statistical peaks that are scaled to ReFH2 hydrograph before a fair comparison of the two methods has taken place. There is no mention of how the calculations will be laid out, however, it is highly recommended to use the Food Estimation Calculation record format. This will ensure all information required for the review is included and minimise risk of it being rejected in the future.

Additional Guidance

In addition to the above, we would like to provide you with the following guidance, attached alongside our response, that will aid in the decision making and completion of your forthcoming hydrology and hydraulic model. This includes the following:

- LIT 18686 – NEC4 Minimum Technical Requirements for Modelling
- LIT 56326 – Fluvial Modelling Standards
- LIT 11832 – Flood Estimation Guidelines

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We trust you will find the contents of this letter beneficial. However, should you have any queries or questions further to this response, or wish to request a further review with the Environment Agency, then please do not hesitate to contact us.

Yours faithfully

Ms Anne-Marie McLaughlin
Planning Advisor

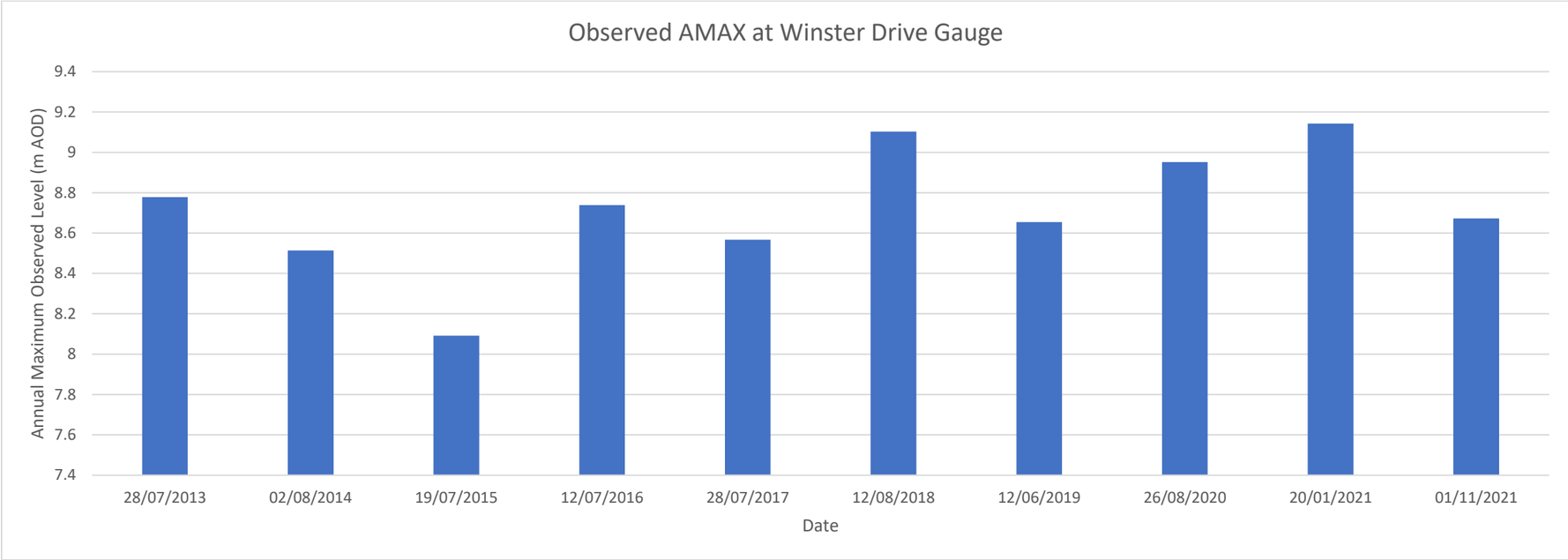
Direct e-mail anne-marie.mclaughlin@environment-agency.gov.uk

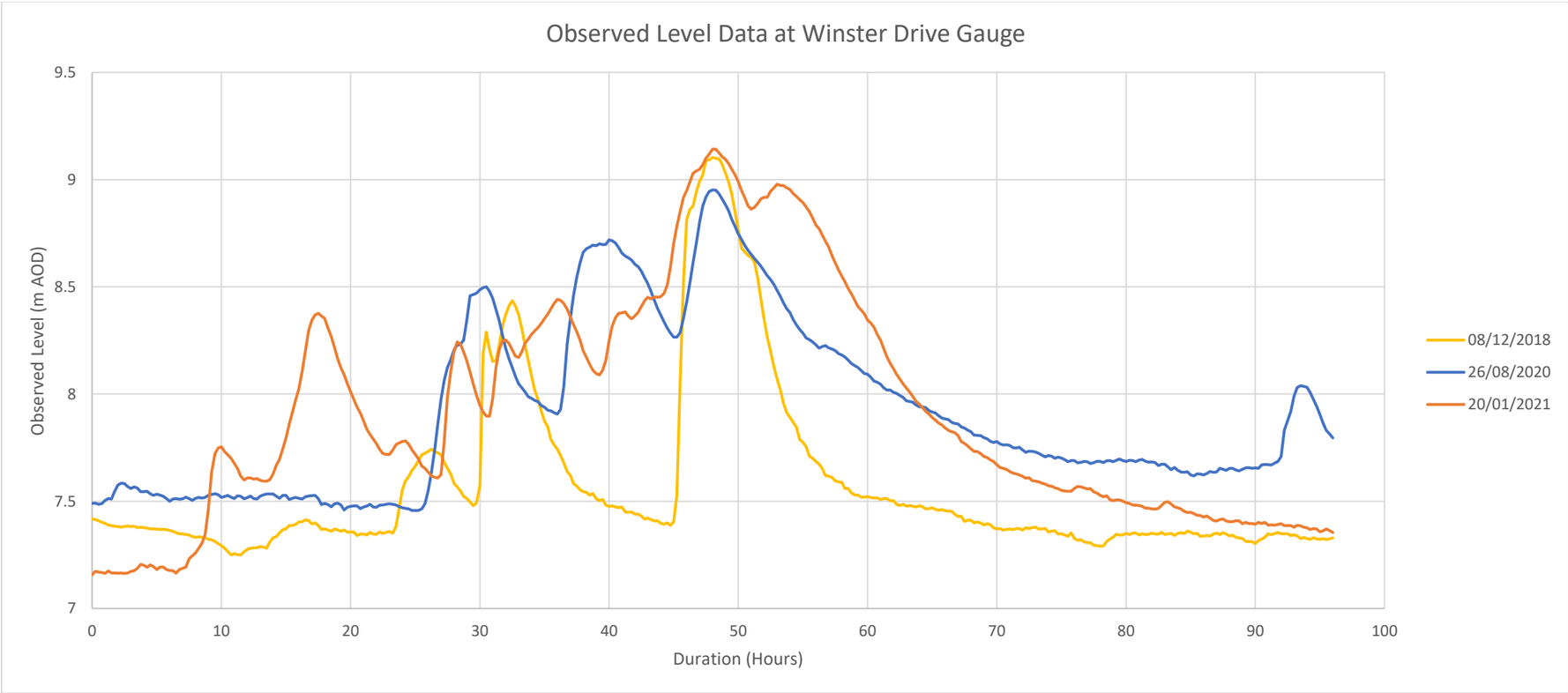
Disclaimer

Our opinion is based on the information available to us at the time of the enquiry. When the formal planning application is submitted, our position may change if there have been changes to environmental risk or evidence, and/or planning policy.

End

8.3 Observed Hydrographs





8.4 Pooling Group Analysis

Original Pooling group	DISTANCE SDM	Years of data	AREA	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19	DPLBAR	DPSBAR	PROPWET	included/ rejected	Reason to reject
53026 (Frome (Bristol) @ Frampton Cotterell)	0.845	43	80.6	800	0.169	0.991	0.064	0.385	9.75	26.4	0.35	Included.	
69032 (Alt @ Kirkby)	0.883	43	96.61	860	0.235	0.983	0.271	0.501	8.12	13.2	0.37	Included.	
34005 (Tud @ Costessey Park)	0.987	59	72.11	649	0.158	0.973	0.029	0.603	14.34	20.3	0.31	Included.	
33029 (Stringside @ Whitebridge)	1.034	55	95.412	628	0.226	0.991	0.007	0.879	9.45	13.5	0.23	Rejected.	Chalk catchment and negative L-SKEW
33031 (Broughton Brook @ Broughton)	1.12	48	70.062	629	0.144	0.967	0.038	0.424	10.75	29.1	0.31	Included.	
33032 (Heacham @ Heacham)	1.237	53	56.163	688	0.116	0.983	0.006	0.932	10.88	25.6	0.24	Rejected.	Topographical catchment area substantially exceeds the true contributing area (by a factor of about two). Predominantly chalk in parts overlain by boulder clay
84023 (Bothlin Burn @ Auchengeich)	1.241	33	34.763	1029	0.137	0.912	0.094	0.363	9.02	38.3	0.58	Included.	
33054 (Babingley @ Castle Rising)	1.244	45	48.53	686	0.118	0.944	0.005	0.895	9.57	28.4	0.24	Rejected.	Catchment predominantly chalk bedrock. Significant groundwater abstraction for PWS and industry/agriculture
53029 (Biss @ Trowbridge)	1.276	38	78.138	759	0.12	0.972	0.057	0.548	9.68	43.1	0.35	Included.	
26003 (Foston Beck @ Foston Mill)	1.342	60	59.593	698	0.106	0.987	0.004	0.894	15.04	48.4	0.3	Rejected.	negative L-SKEW
69008 (Dean @ Stanneylands)	1.35	55	58.867	954	0.103	0.96	0.063	0.577	14.48	87.2	0.52	Included.	

Final Pooling group	DISTANCE SDM	Years of data	AREA	SAAR	FPEXT	FARL	URBEXT2000	BFIHOST19	DPLBAR	DPSBAR	PROPWET	included/ rejected	Reason to reject
53026 (Frome (Bristol) @ Frampton Cotterell)	0.845	43	80.6	800	0.169	0.991	0.064	0.385	9.75	26.4	0.35	Included.	
69032 (Alt @ Kirkby)	0.883	43	96.61	860	0.235	0.983	0.271	0.501	8.12	13.2	0.37	Included.	
34005 (Tud @ Costessey Park)	0.987	59	72.11	649	0.158	0.973	0.029	0.603	14.34	20.3	0.31	Included.	
33031 (Broughton Brook @ Broughton)	1.12	48	70.062	629	0.144	0.967	0.038	0.424	10.75	29.1	0.31	Included.	
84023 (Bothlin Burn @ Auchengeich)	1.241	33	34.763	1029	0.137	0.912	0.094	0.363	9.02	38.3	0.58	Included.	
53029 (Biss @ Trowbridge)	1.276	38	78.138	759	0.12	0.972	0.057	0.548	9.68	43.1	0.35	Included.	
69008 (Dean @ Stanneylands)	1.35	55	58.867	954	0.103	0.96	0.063	0.577	14.48	87.2	0.52	Included.	

8.5 Additional Supporting Information

Number of simulations 500

Fitting	Z value	
Gen. Logistic	1.3795	*
Gen. Extreme Value	-0.3026	*
Pearson Type III	-1.2163	*
Gen. Pareto	-4.0398	
Kappa 3	0.7642	*

Lowest absolute Z-value indicates best fit

* Distribution gives an acceptable fit (absolute Z value < 1.645)

Number of simulations 500

L-CV / L-skewness distance

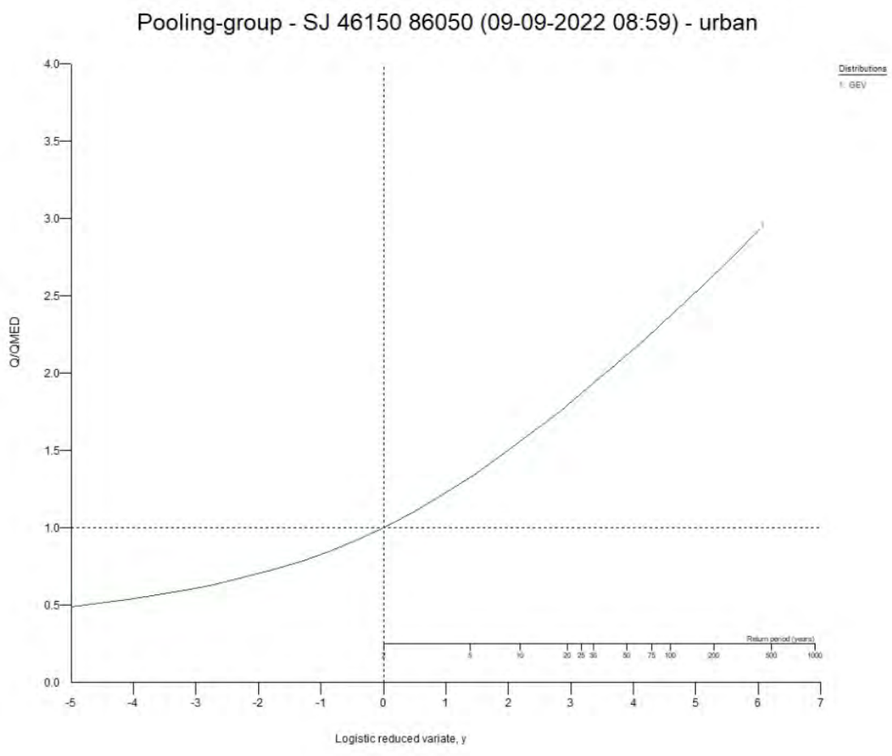
Observed average	0.1124
Simulated mean of average	0.0620
Simulated S.D. of average	0.0160
Standardised test value H2	3.1503

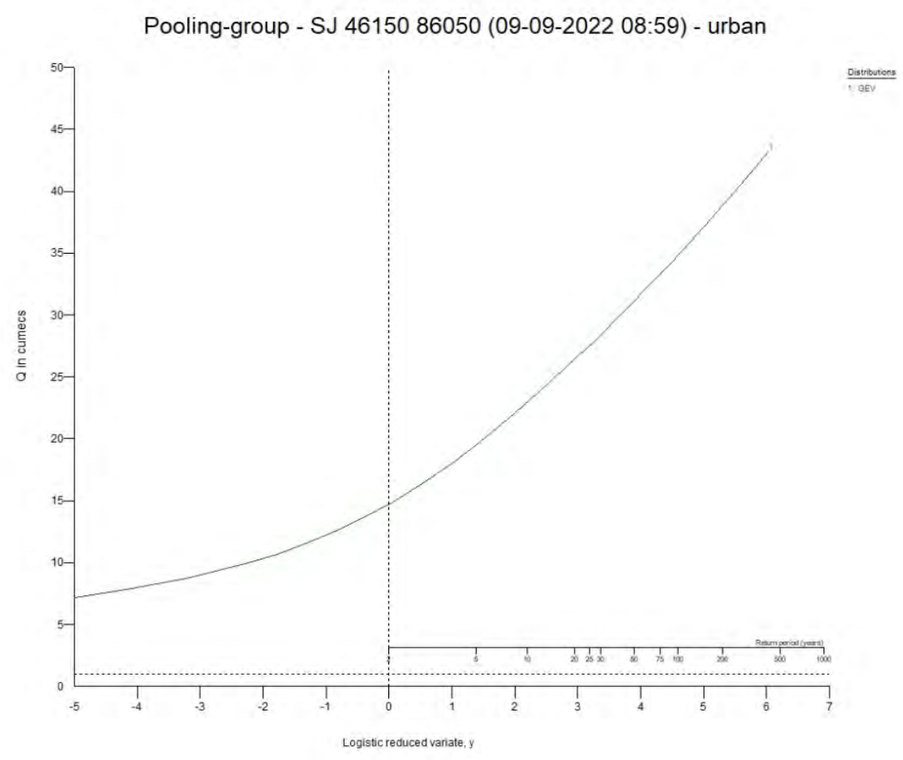
The pooling group is heterogeneous and a review of the pooling group is desirable

Standard deviation of L-CV

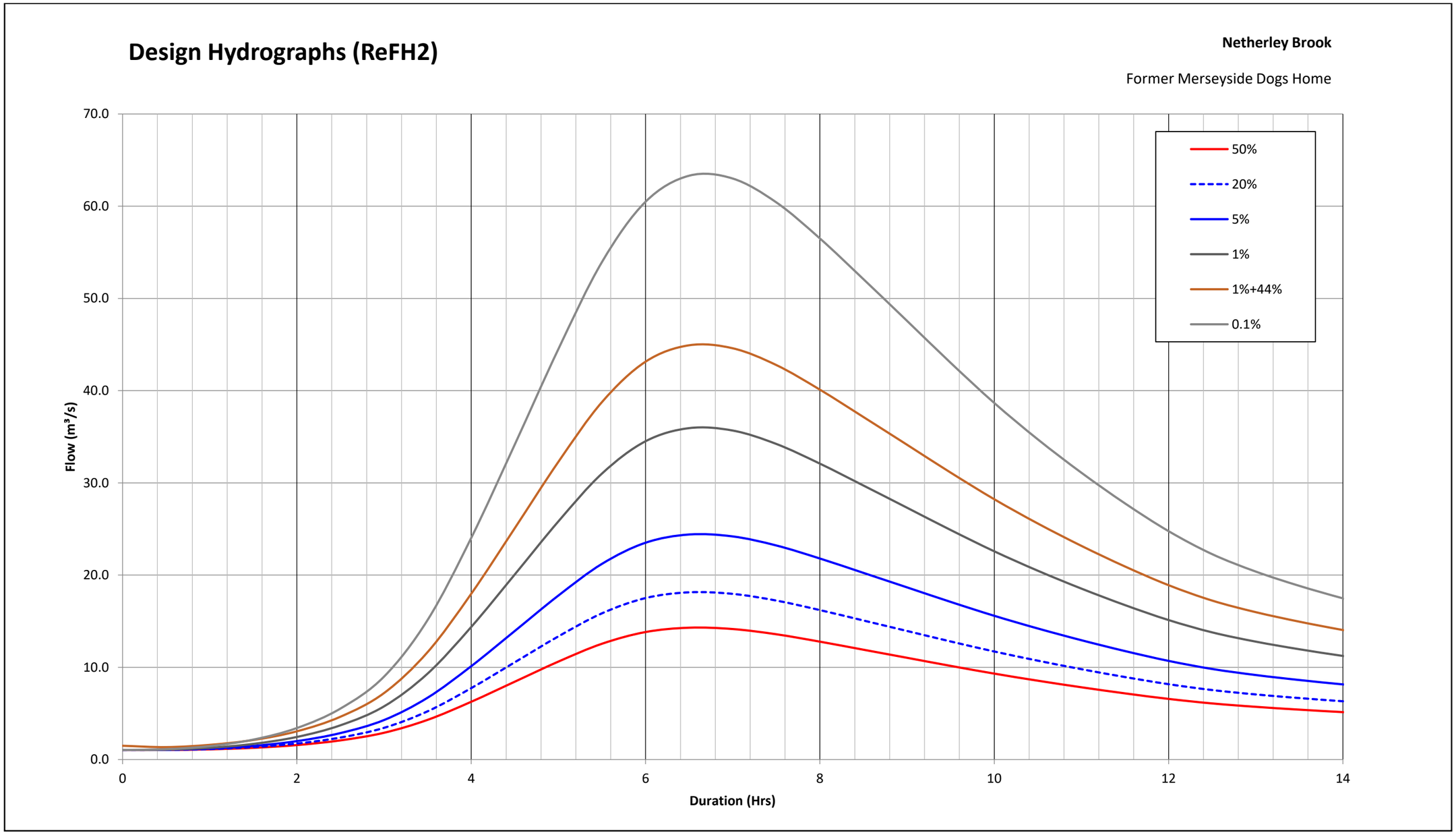
Observed	0.0536
Simulated mean	0.0220
Simulated S.D.	0.0067
Standardised test value H1	4.6841

Strongly Heterogeneous

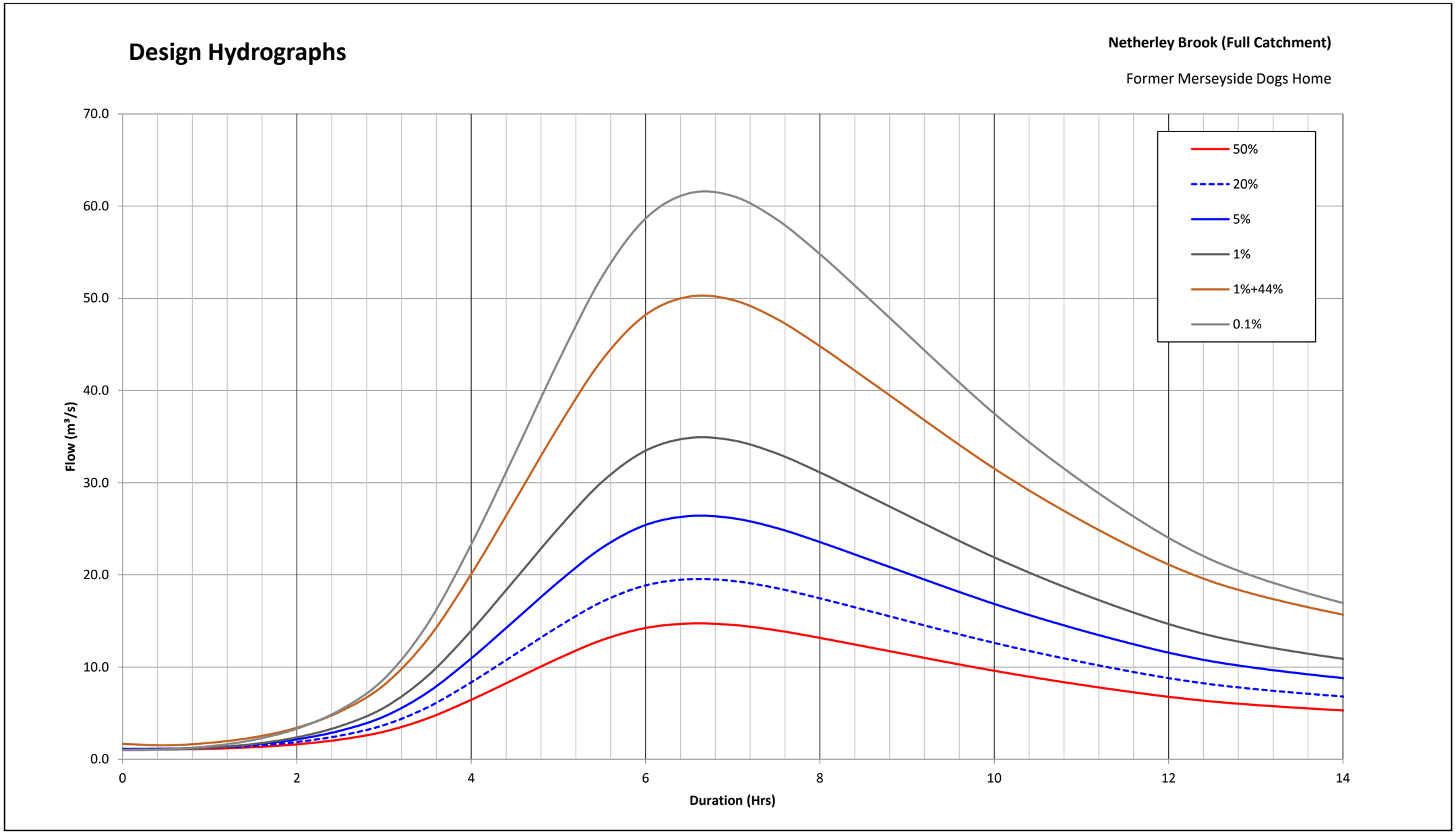


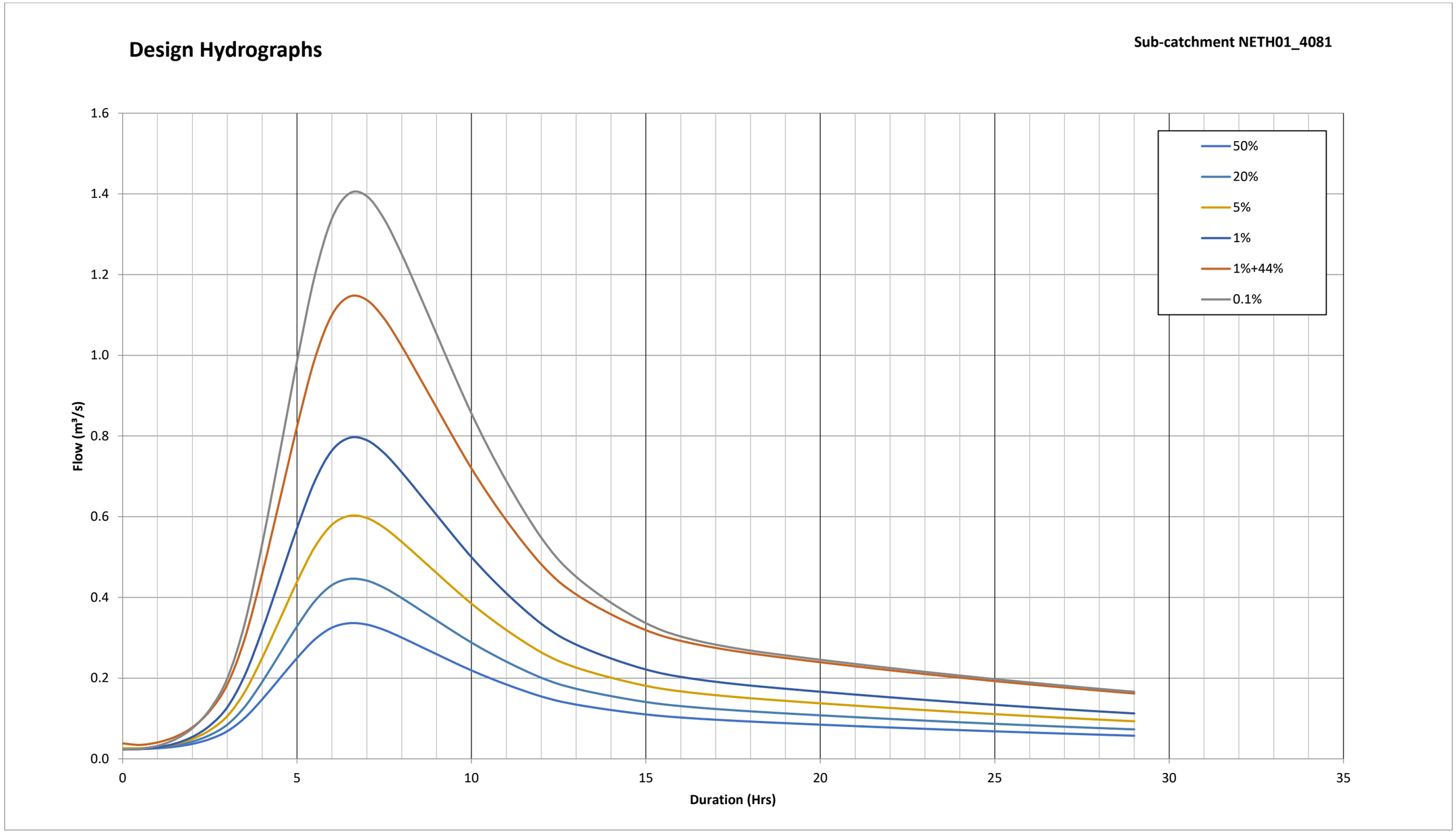


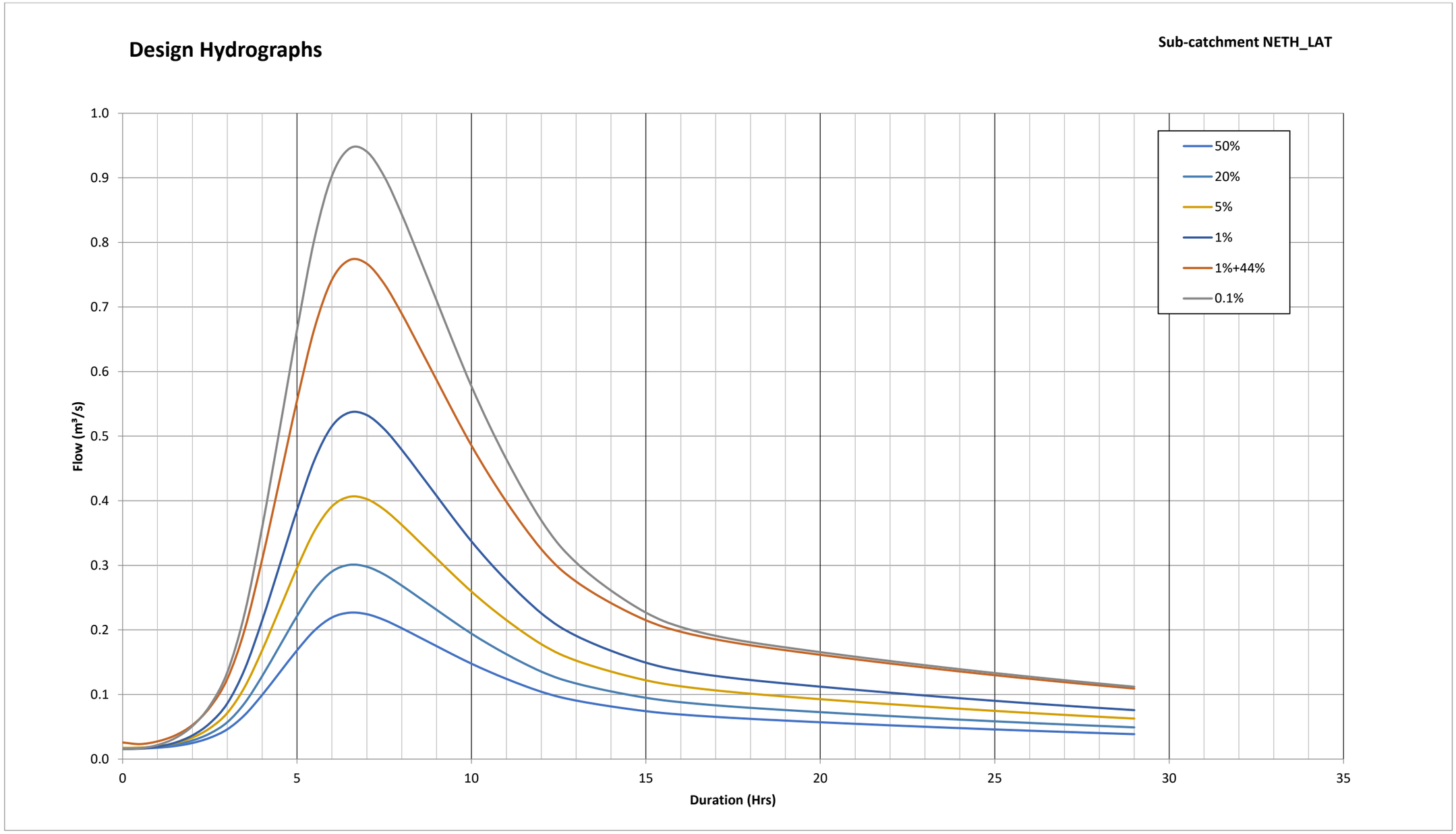
8.6 ReFH2 Hydrographs

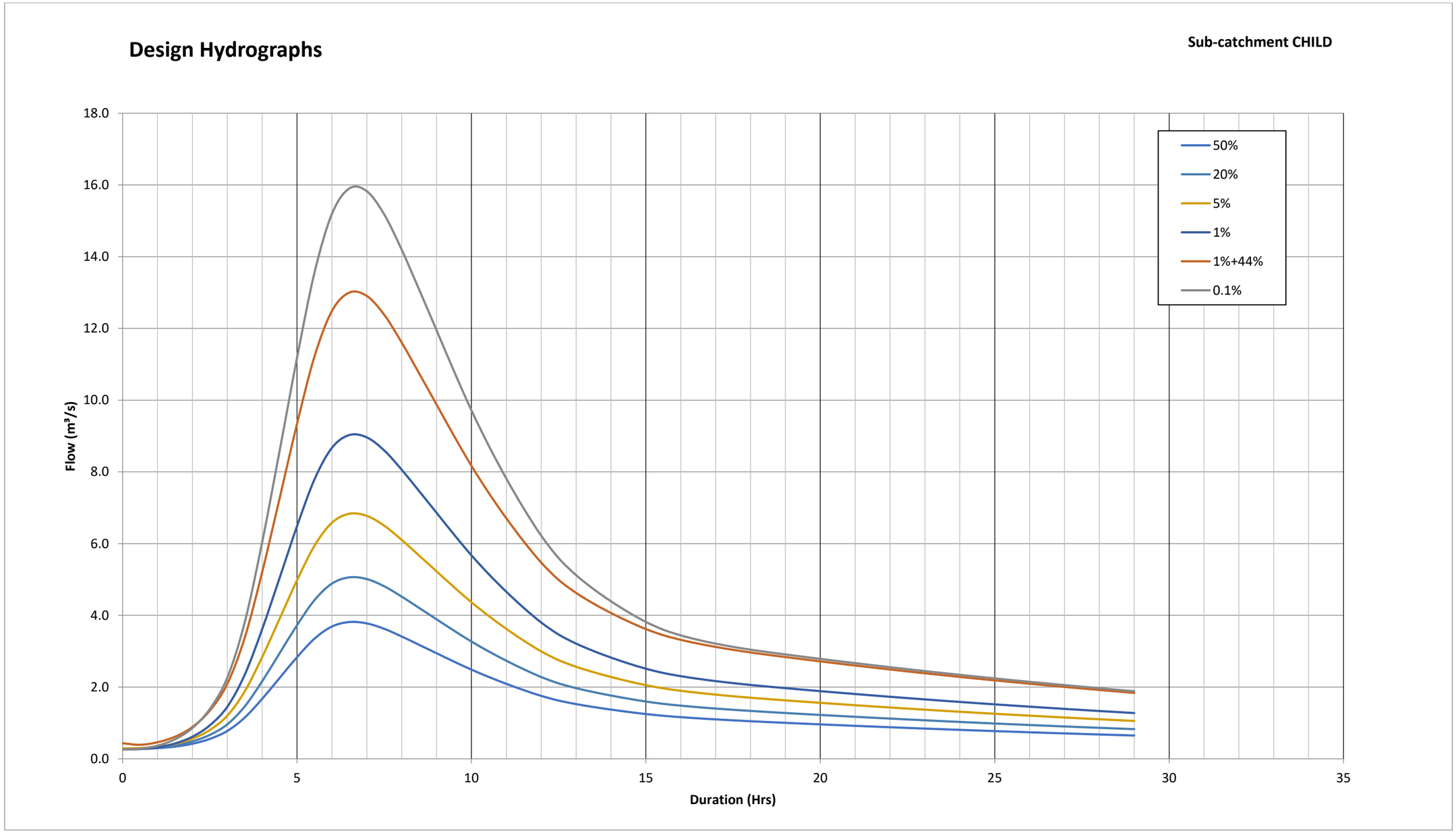


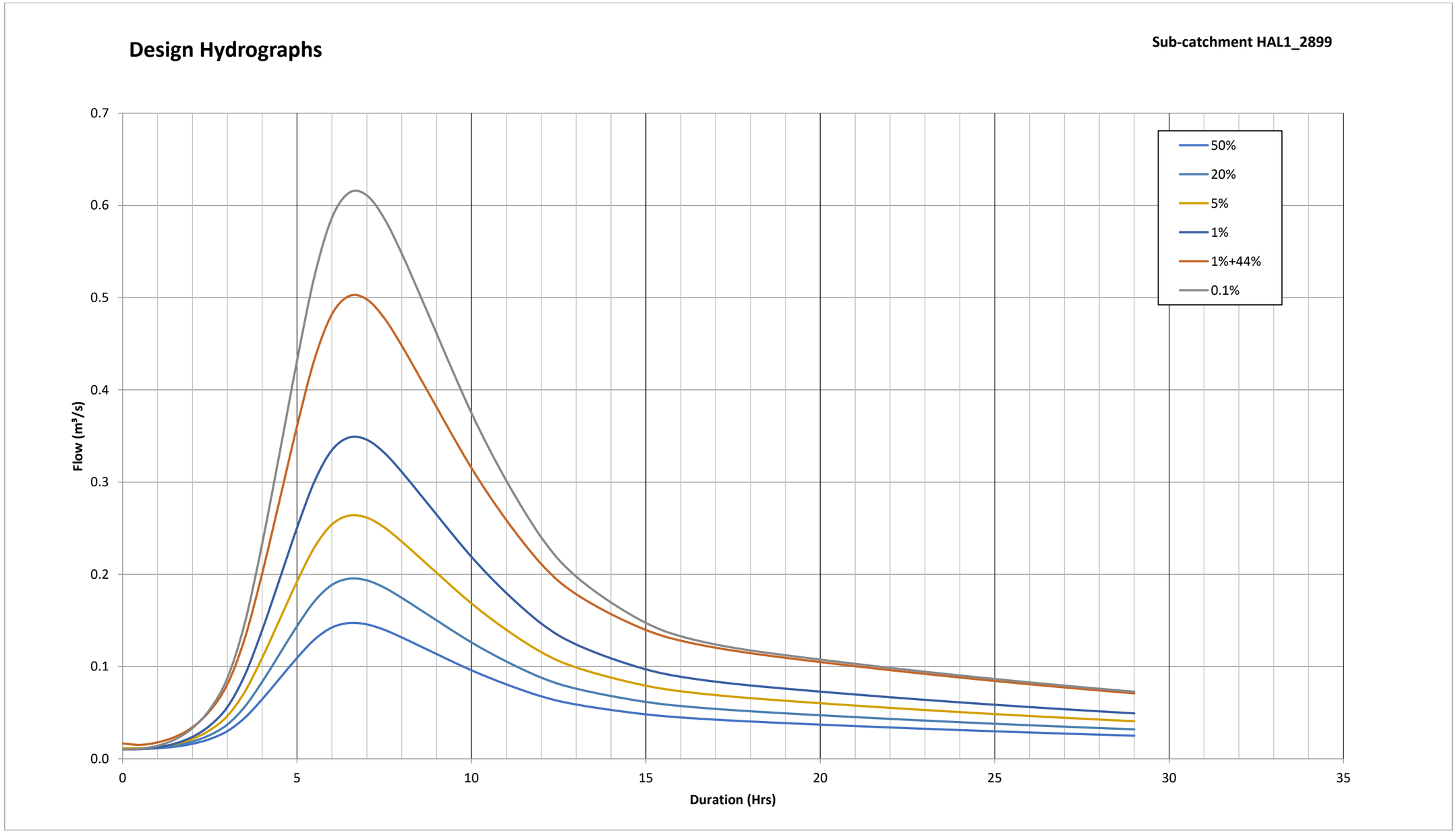
8.7 Design Hydrographs

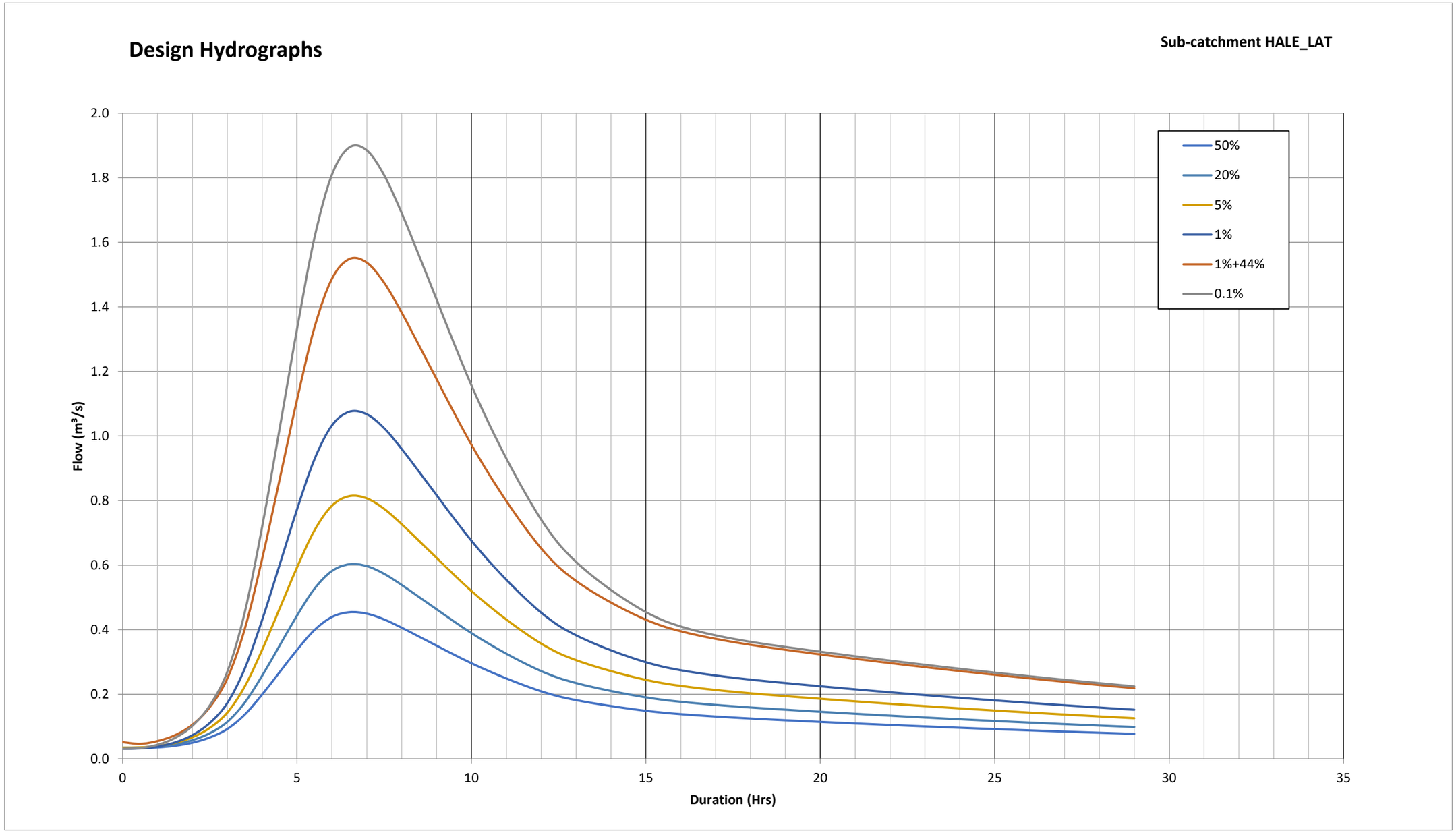


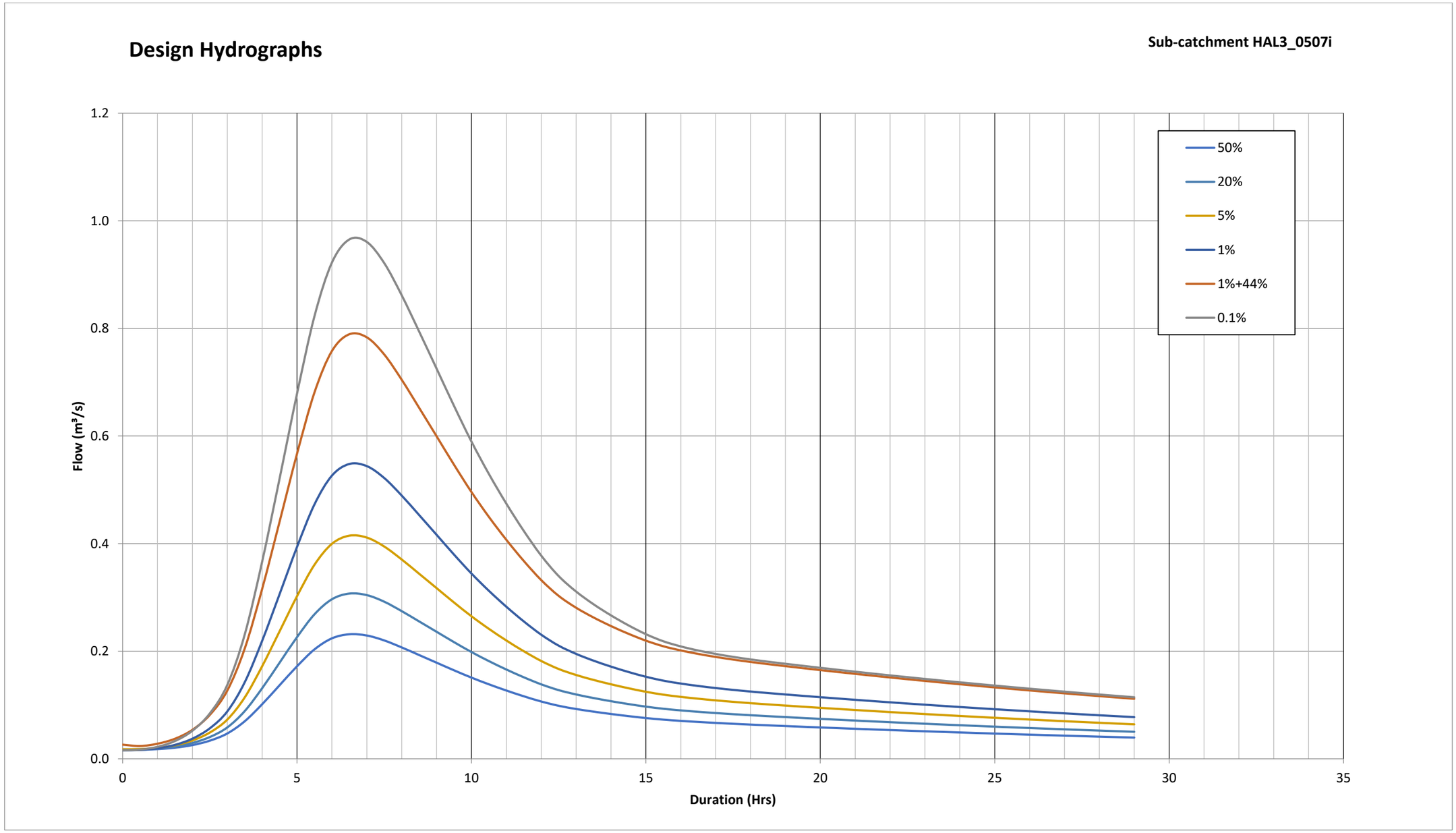

Design Hydrographs
Sub-catchment NETH01_4081
Flow (m³/s)
Duration (Hrs)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
5
10
15
20
25
30
35
50%
20%
5%
1%
1%+44%
0.1%

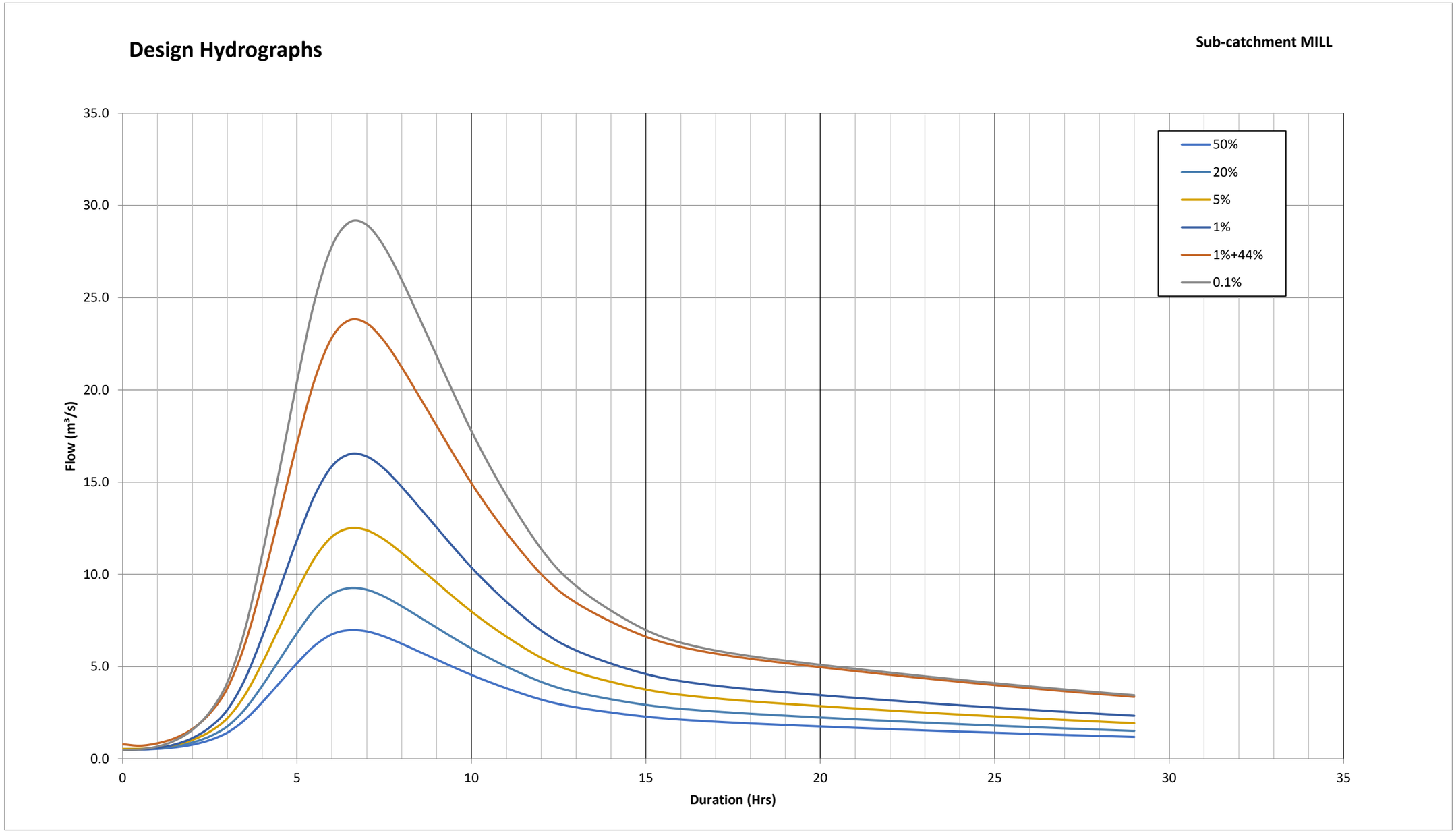

Design Hydrographs
Sub-catchment NETH_LAT
Flow (m³/s)
Duration (Hrs)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
50%
20%
5%
1%
1%+44%
0.1%

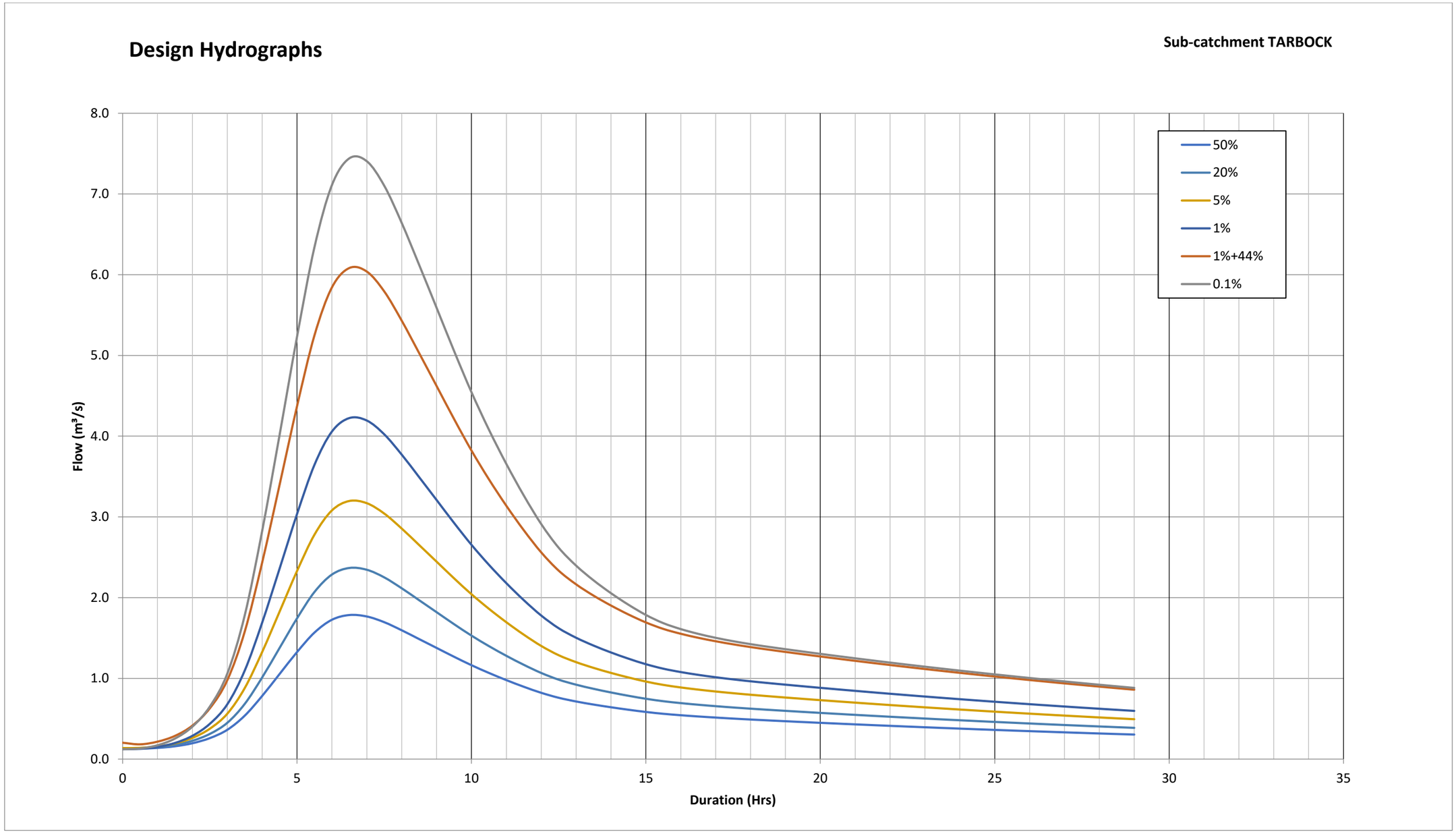

Design Hydrographs
Sub-catchment CHILD
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Flow (m³/s)
0
5
10
15
20
25
30
35
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%

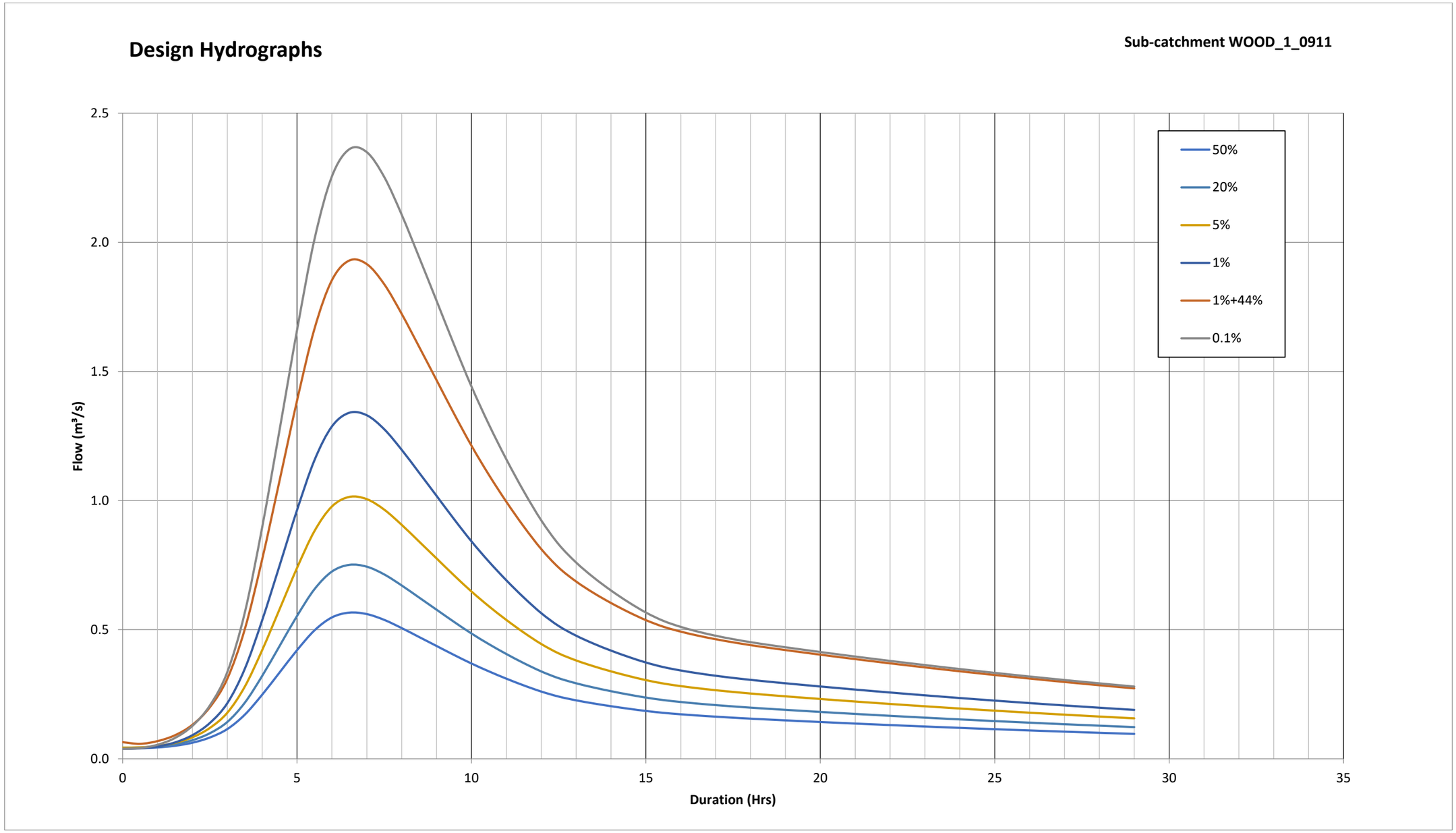

Design Hydrographs
Sub-catchment HAL1_2899
Flow (m³/s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%

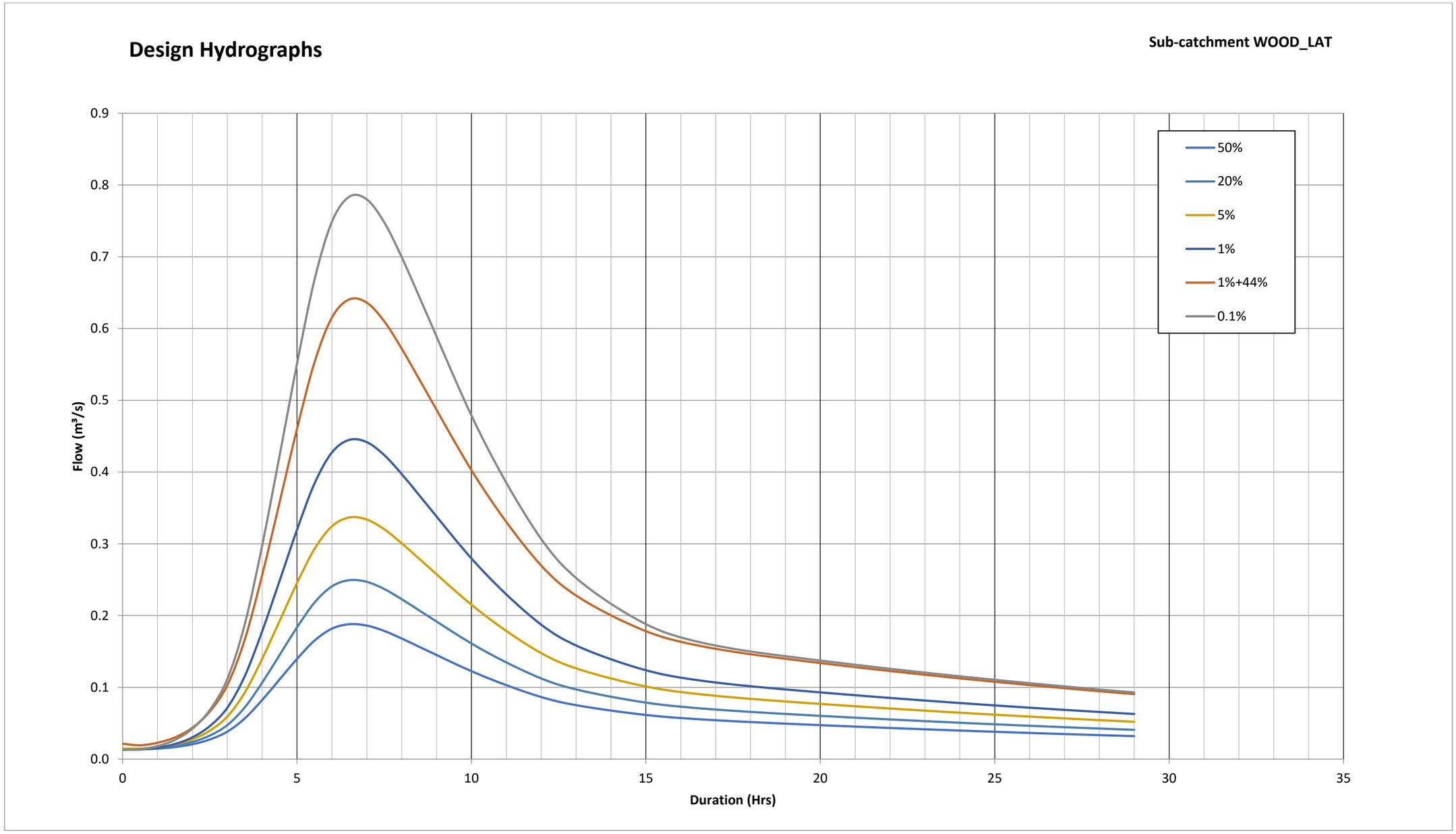

Design Hydrographs
Sub-catchment HALE_LAT
Flow (m³/s)
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
0
5
10
15
20
25
30
35


Design Hydrographs
Sub-catchment HAL3_0507i
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Flow (m³/s)
0
5
10
15
20
25
30
35
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%

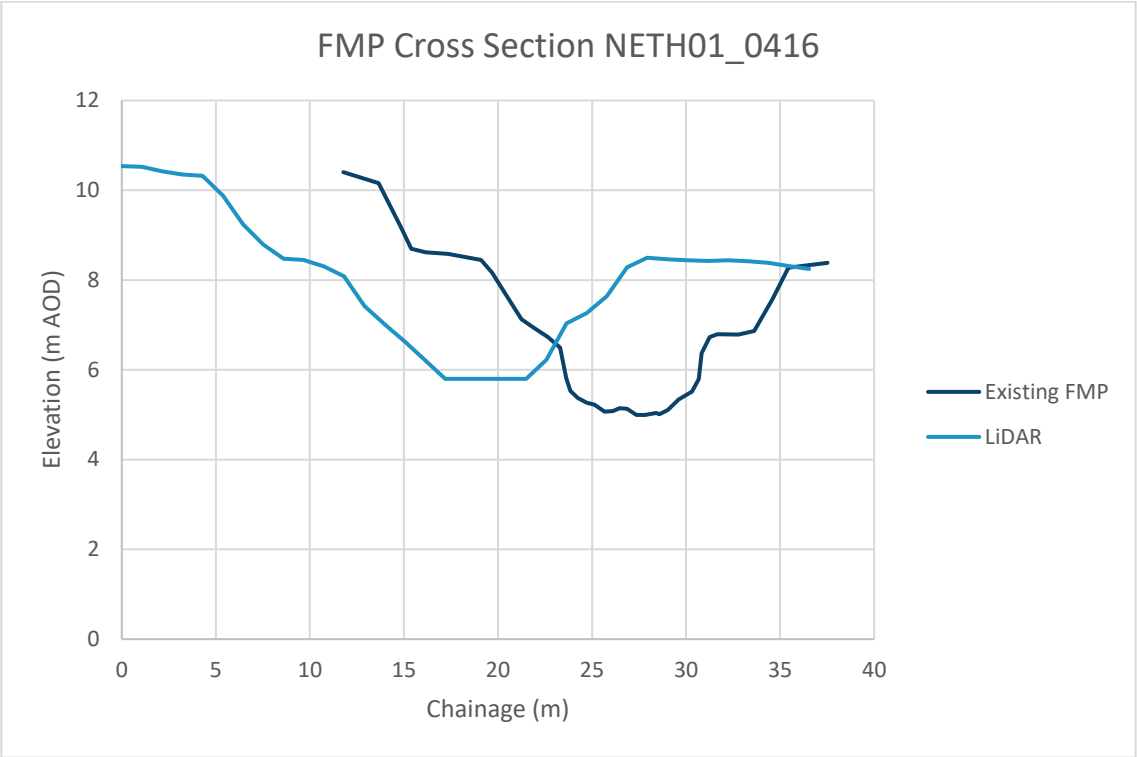

Design Hydrographs
Sub-catchment MILL
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Flow (m³/s)
0
5
10
15
20
25
30
35
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%

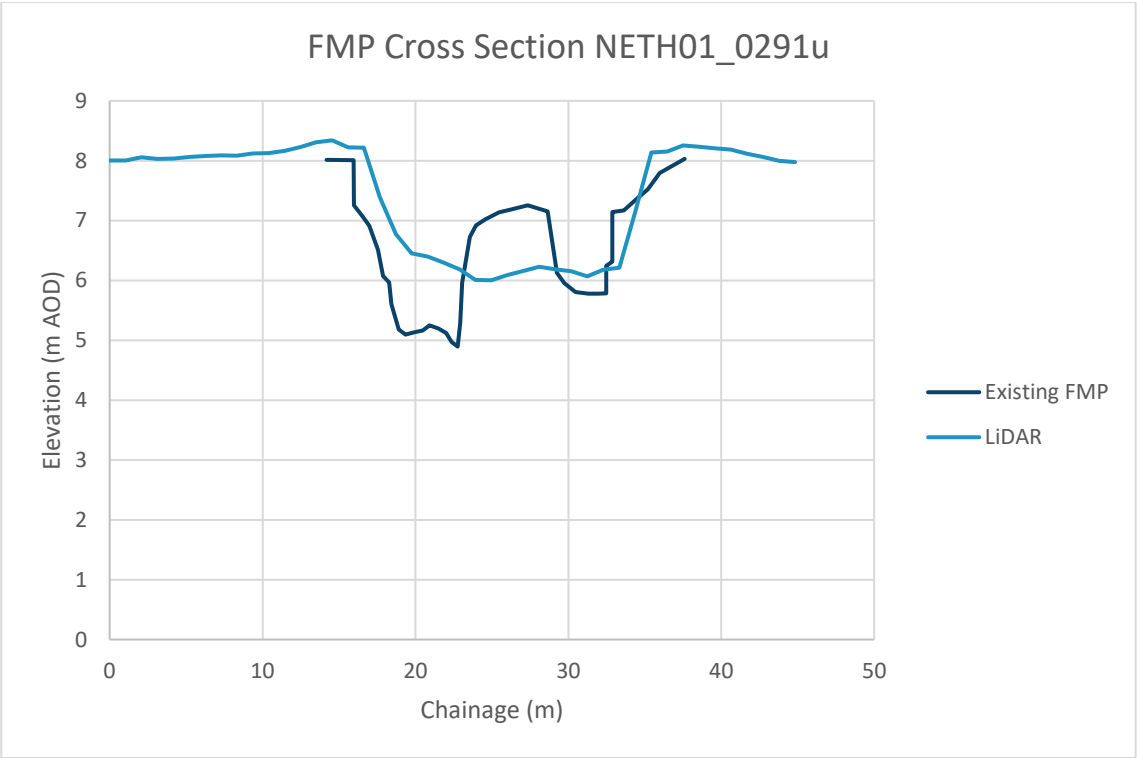

Design Hydrographs
Sub-catchment TARBOCK
Flow (m³/s)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
5
10
15
20
25
30
35
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%

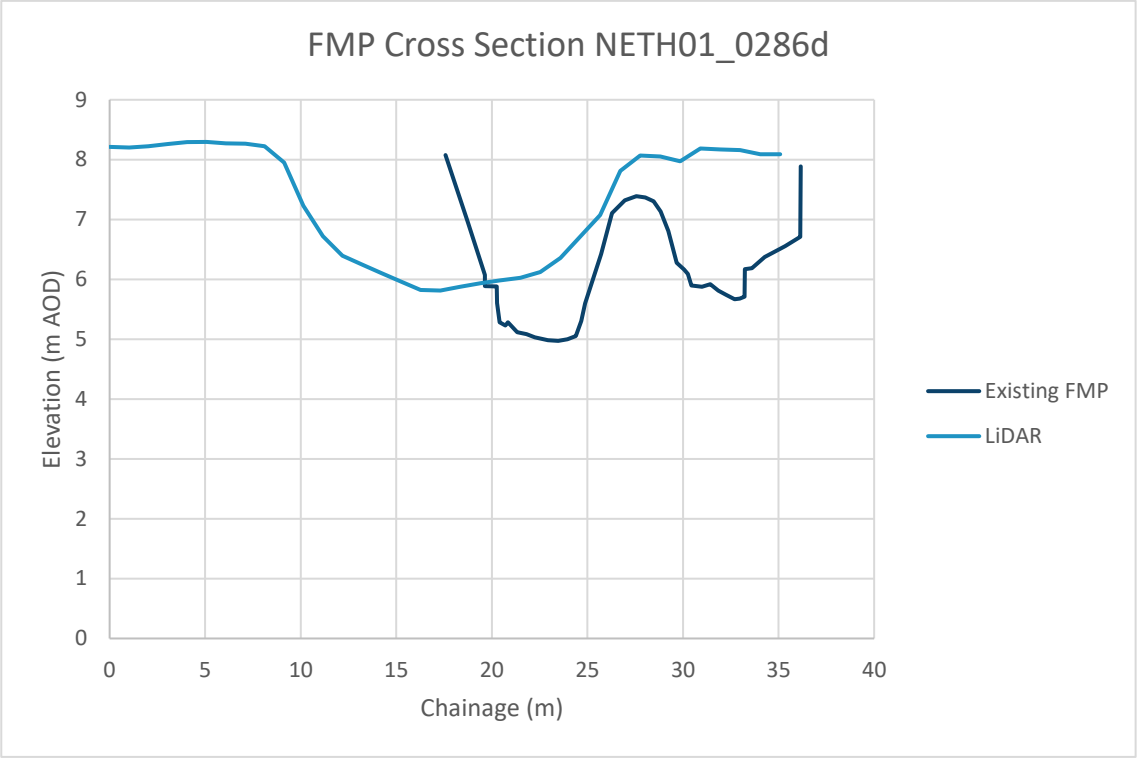

Design Hydrographs
Sub-catchment WOOD_1_0911
Flow (m³/s)
Duration (Hrs)
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
50%
20%
5%
1%
1%+44%
0.1%

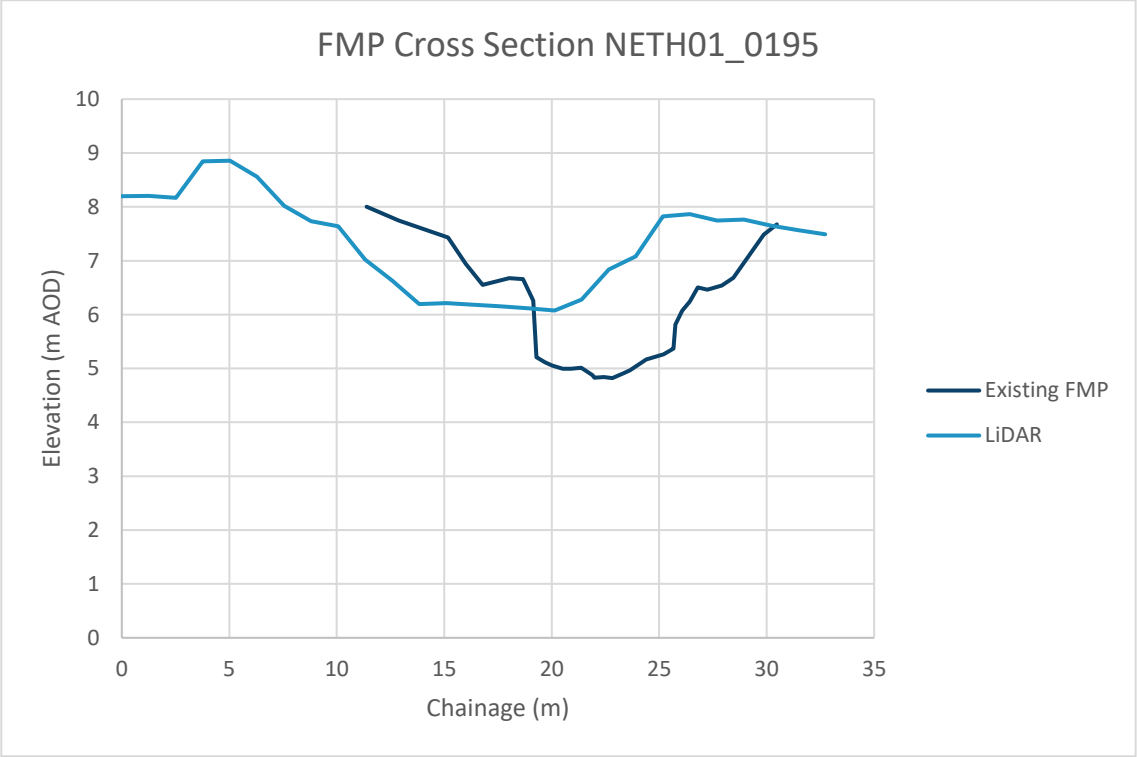

Design Hydrographs
Sub-catchment WOOD_LAT
Flow (m³/s)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
5
10
15
20
25
30
35
Duration (Hrs)
50%
20%
5%
1%
1%+44%
0.1%

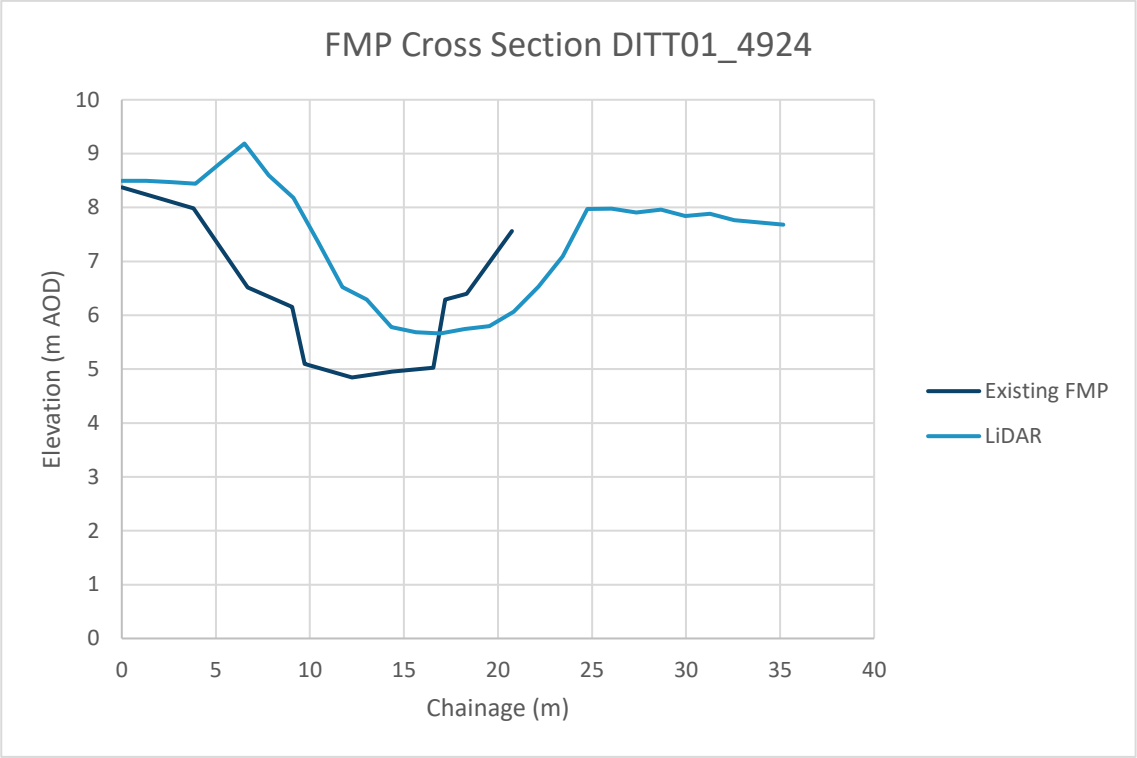
Appendix G Cross Section Comparisons

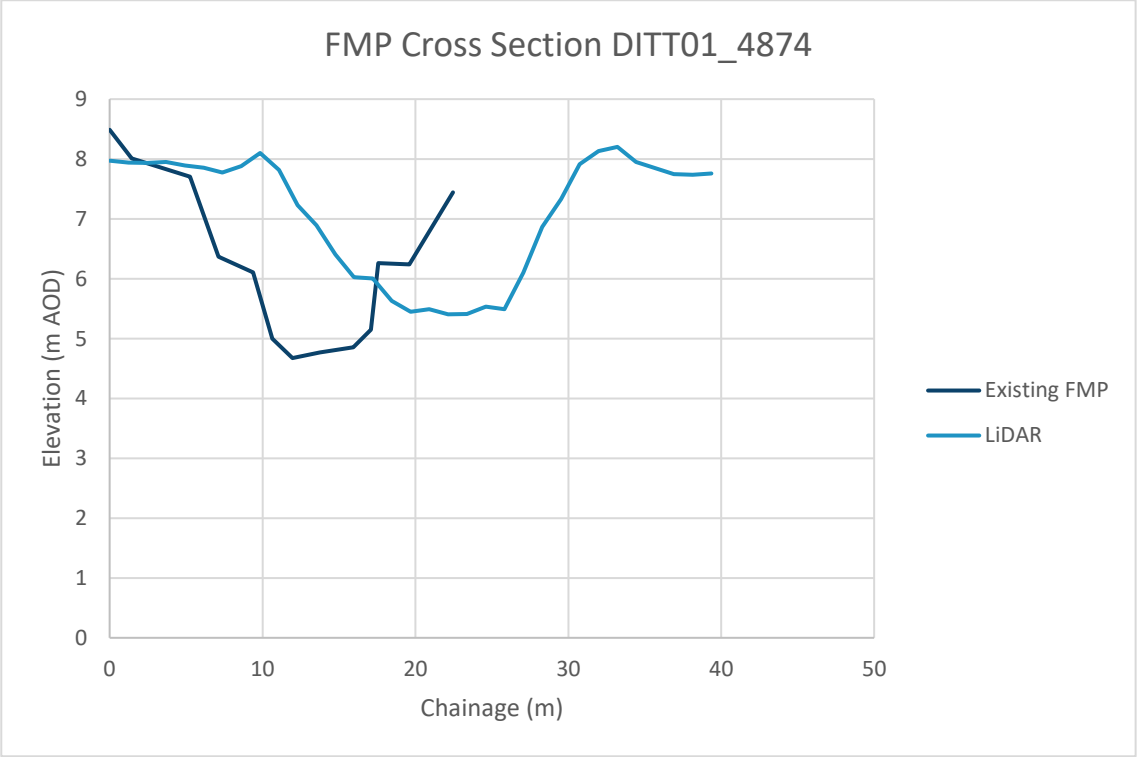


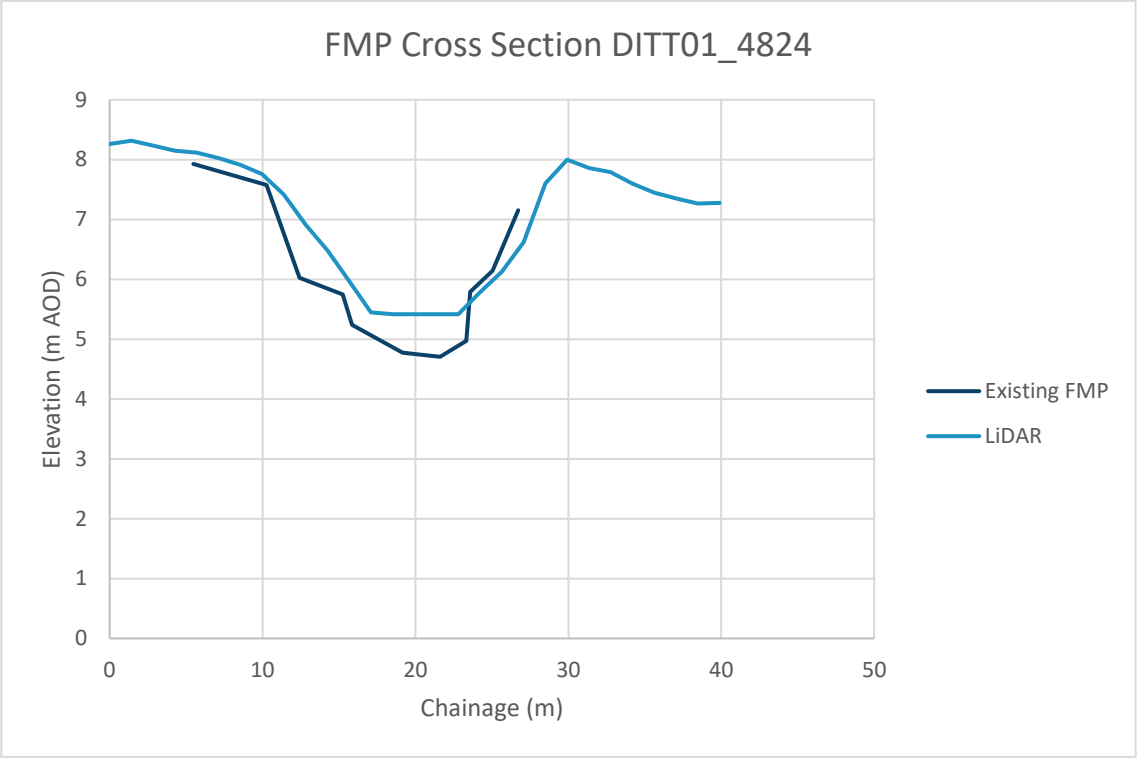


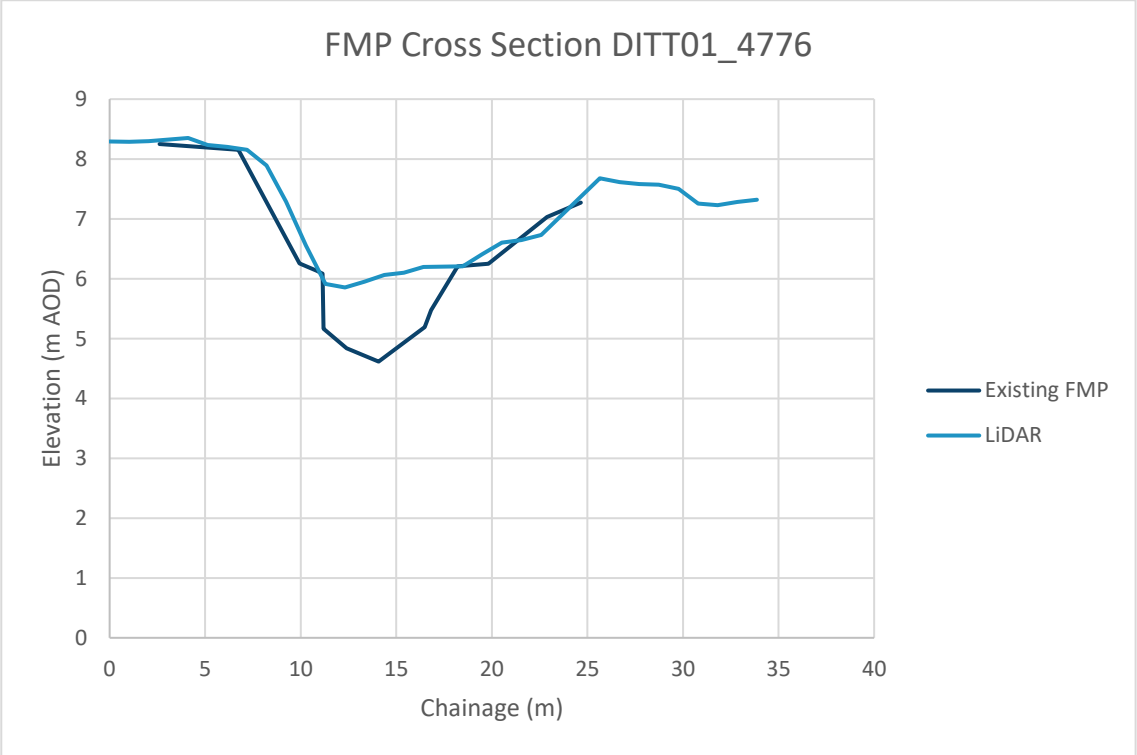

FMP Cross Section NETH01_0286d
Elevation (m AOD)
Chainage (m)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
Existing FMP
LiDAR

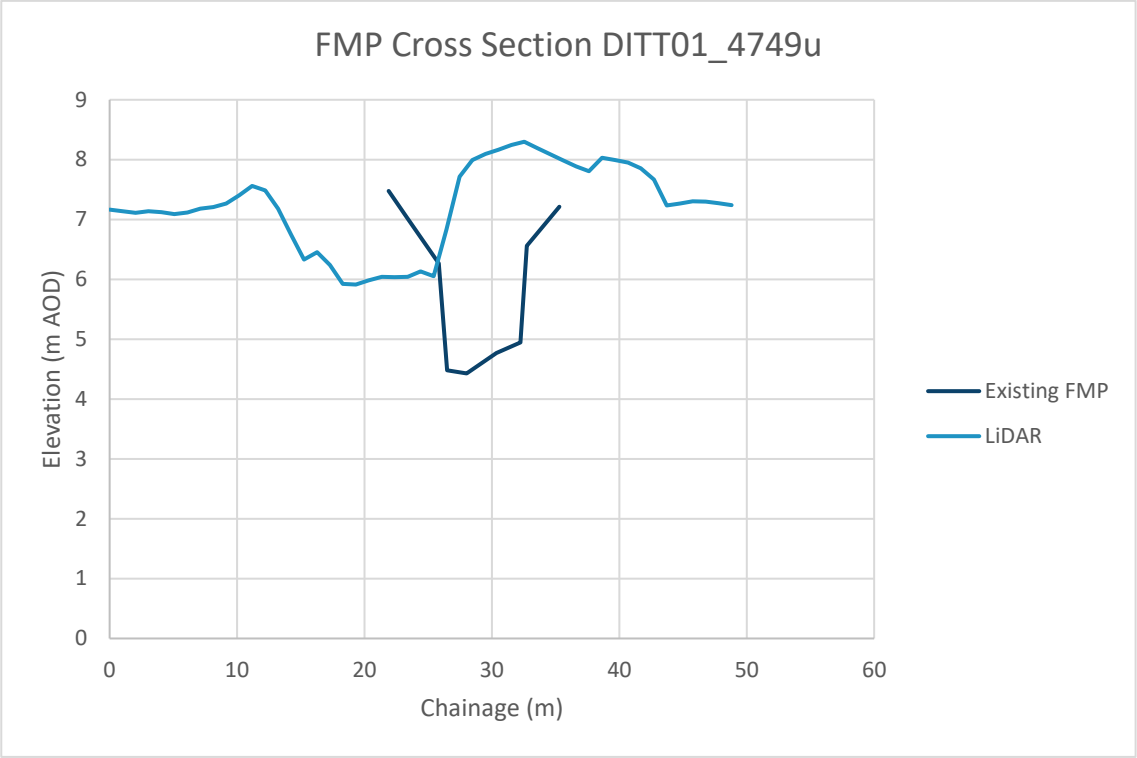

FMP Cross Section NETH01_0195
Elevation (m AOD)
Chainage (m)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
Existing FMP
LiDAR


FMP Cross Section DITT01_4924
Elevation (m AOD)
Chainage (m)
Existing FMP
LiDAR
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40


FMP Cross Section DITT01_4874
Elevation (m AOD)
Chainage (m)
Existing FMP
LiDAR
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50


FMP Cross Section DITT01_4824
Elevation (m AOD)
Chainage (m)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
Existing FMP
LiDAR


FMP Cross Section DITT01_4776
Elevation (m AOD)
Chainage (m)
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
Existing FMP
LiDAR


FMP Cross Section DITT01_4749u
Elevation (m AOD)
Chainage (m)
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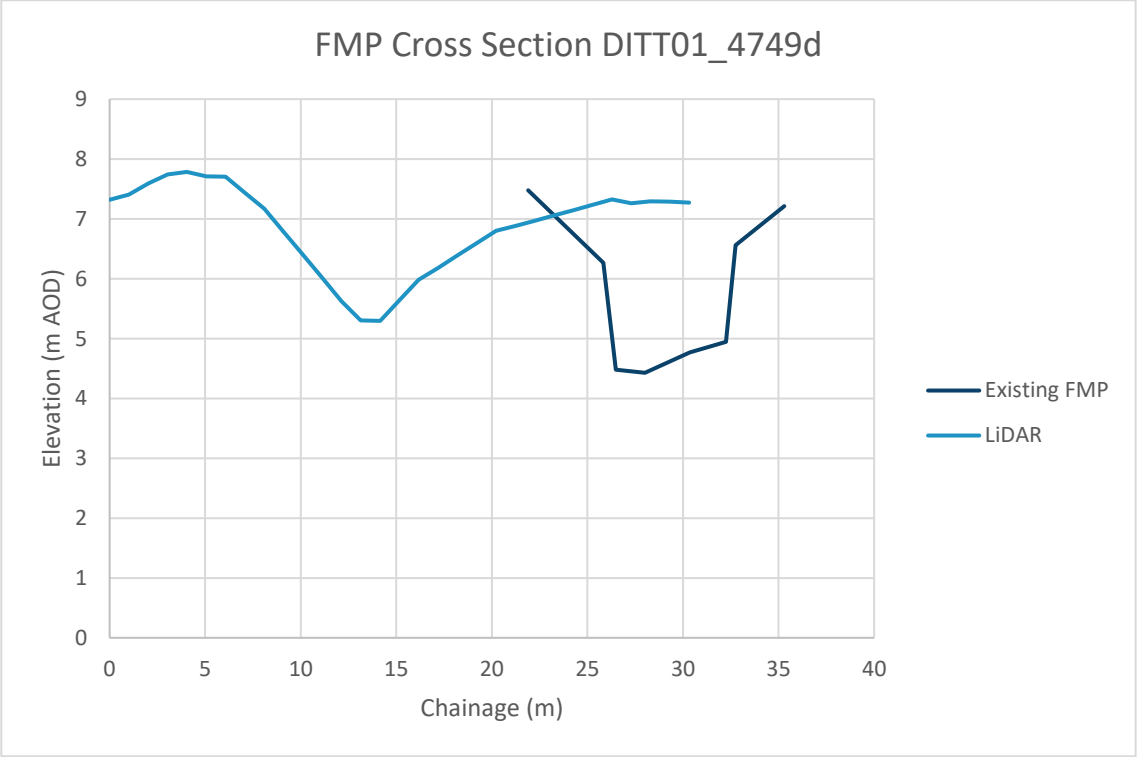
5
6
7
8
9
0
10
20
30
40
50
60
Existing FMP
LiDAR


FMP Cross Section DITT01_4749d
Elevation (m AOD)
Chainage (m)
0
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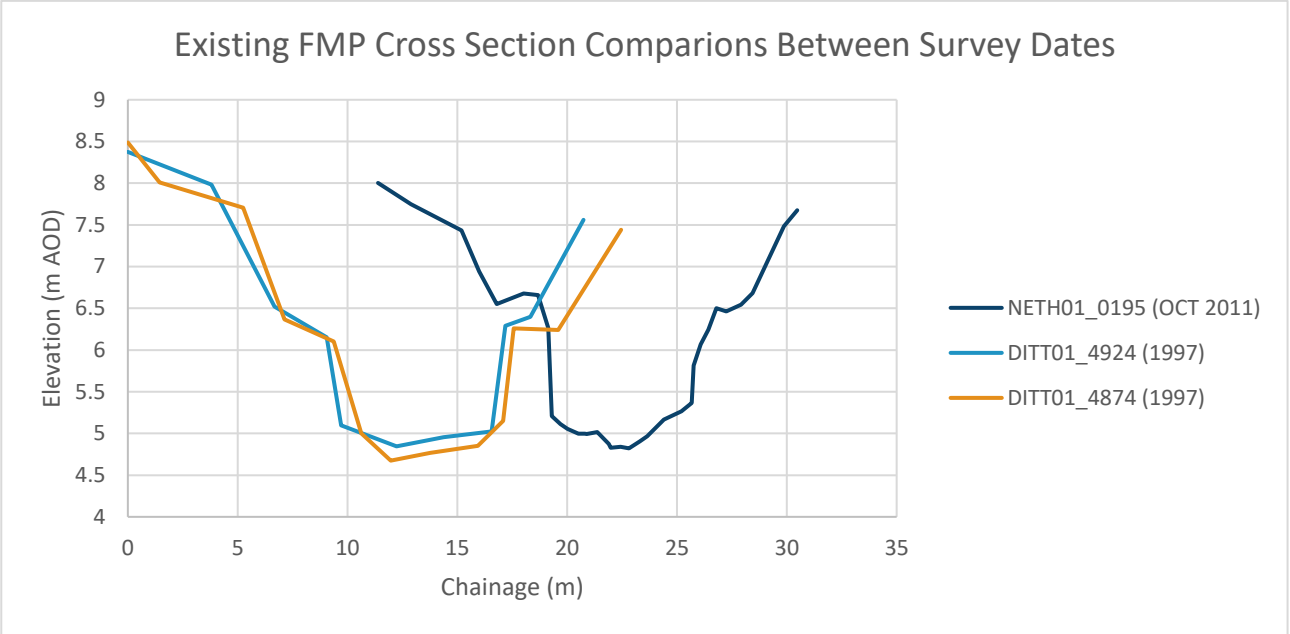
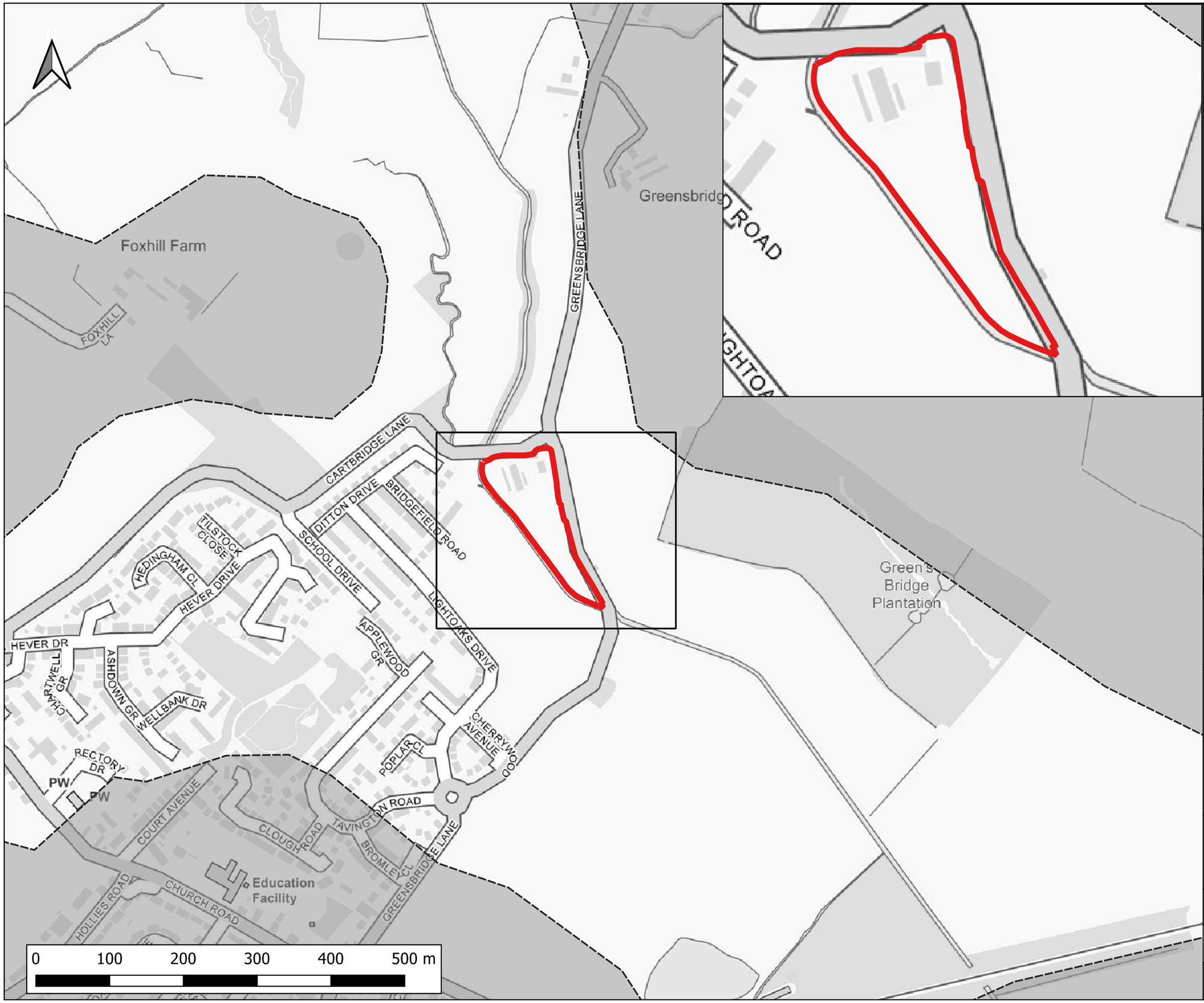
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40
Existing FMP
LiDAR


Existing FMP Cross Section Comparions Between Survey Dates
Elevation (m AOD)
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
0
5
10
15
20
25
30
35
Chainage (m)
NETH01_0195 (OCT 2011)
DITT01_4924 (1997)
DITT01_4874 (1997)

Appendix H Simulated Flood Maps



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

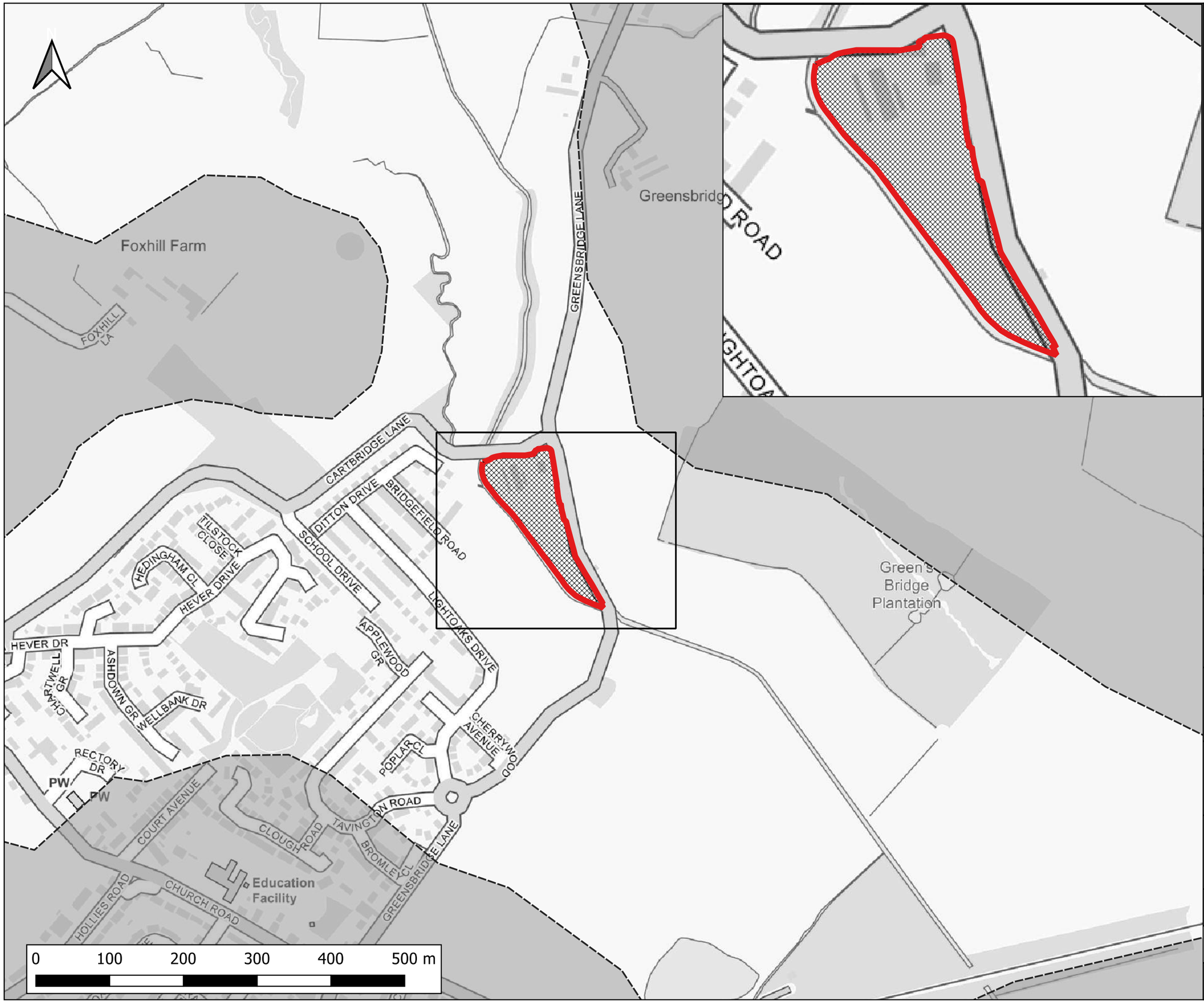
PLOT TITLE:
Maximum Flood Depth
5% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_EXG_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

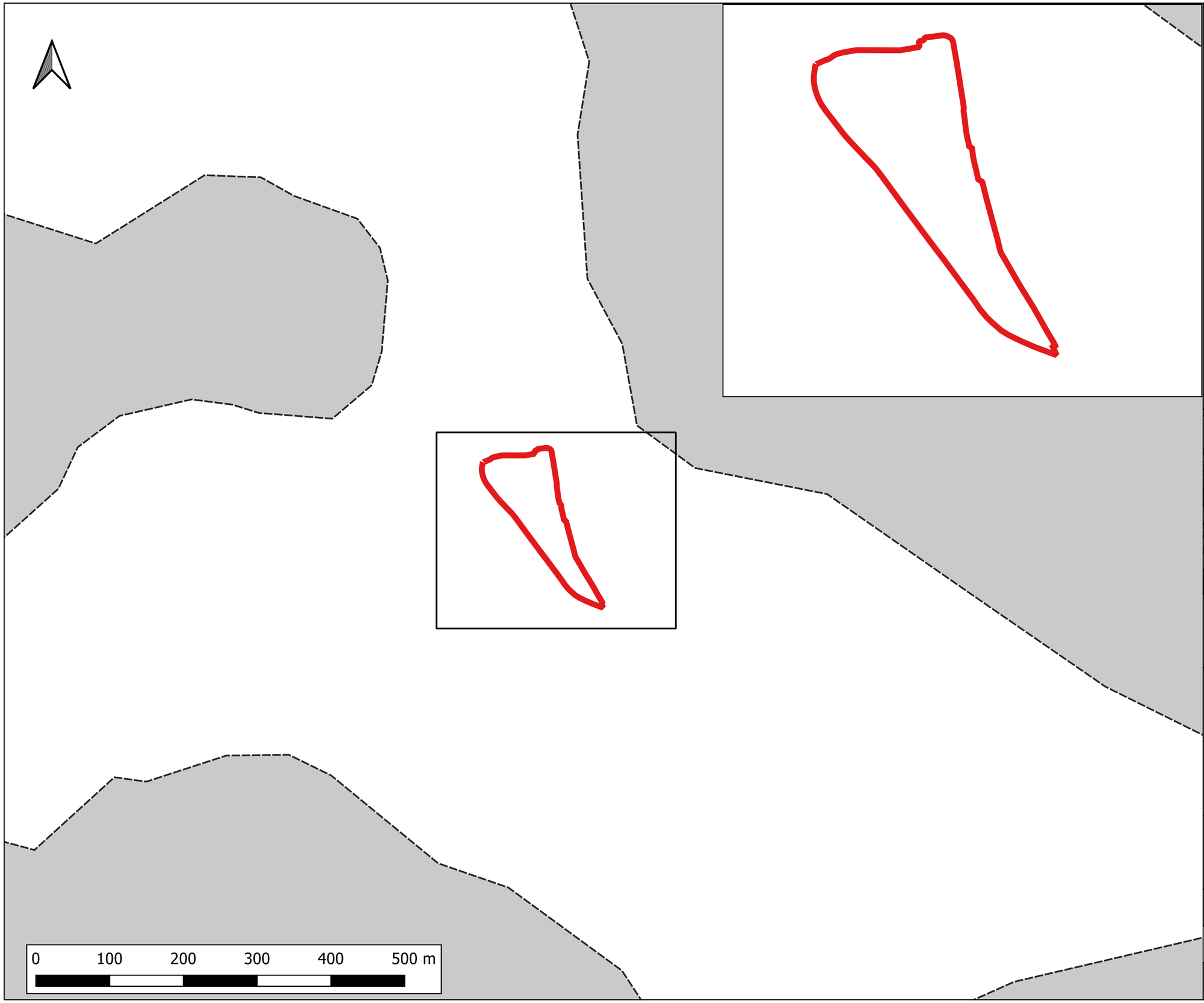
PLOT TITLE:
Maximum Flood Depth
5% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_DEVSITE_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Depth Variation

- > -100mm
- -50mm to -100mm
- -20mm to -50mm
- No Change (+/- 20mm)
- +20mm to +50mm
- +50mm to +100mm
- > +100mm

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

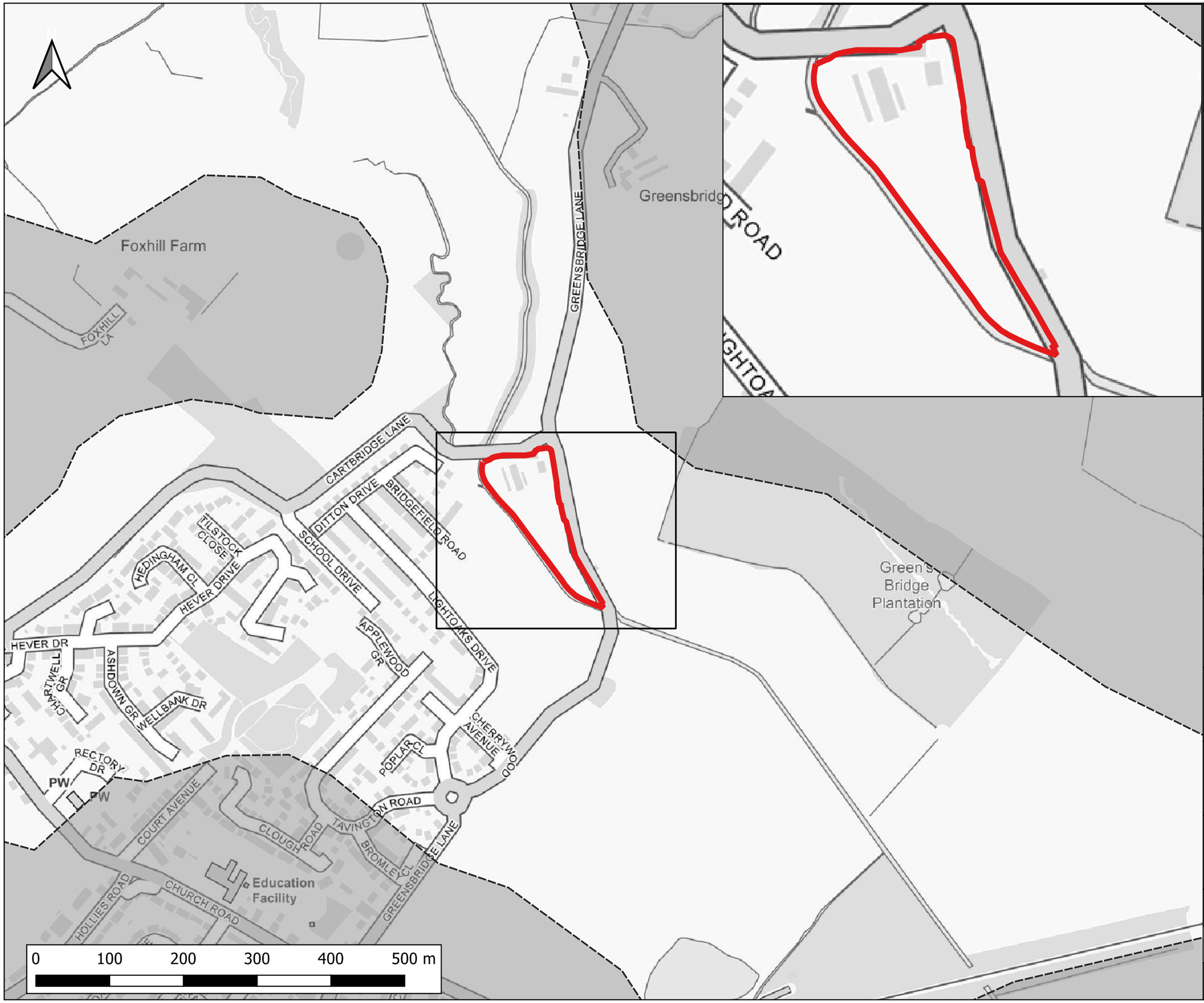
PLOT TITLE:
Maximum Depth Difference
5% AEP Fluvial Event
DEV-EXG

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_NC_DIFF_015	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

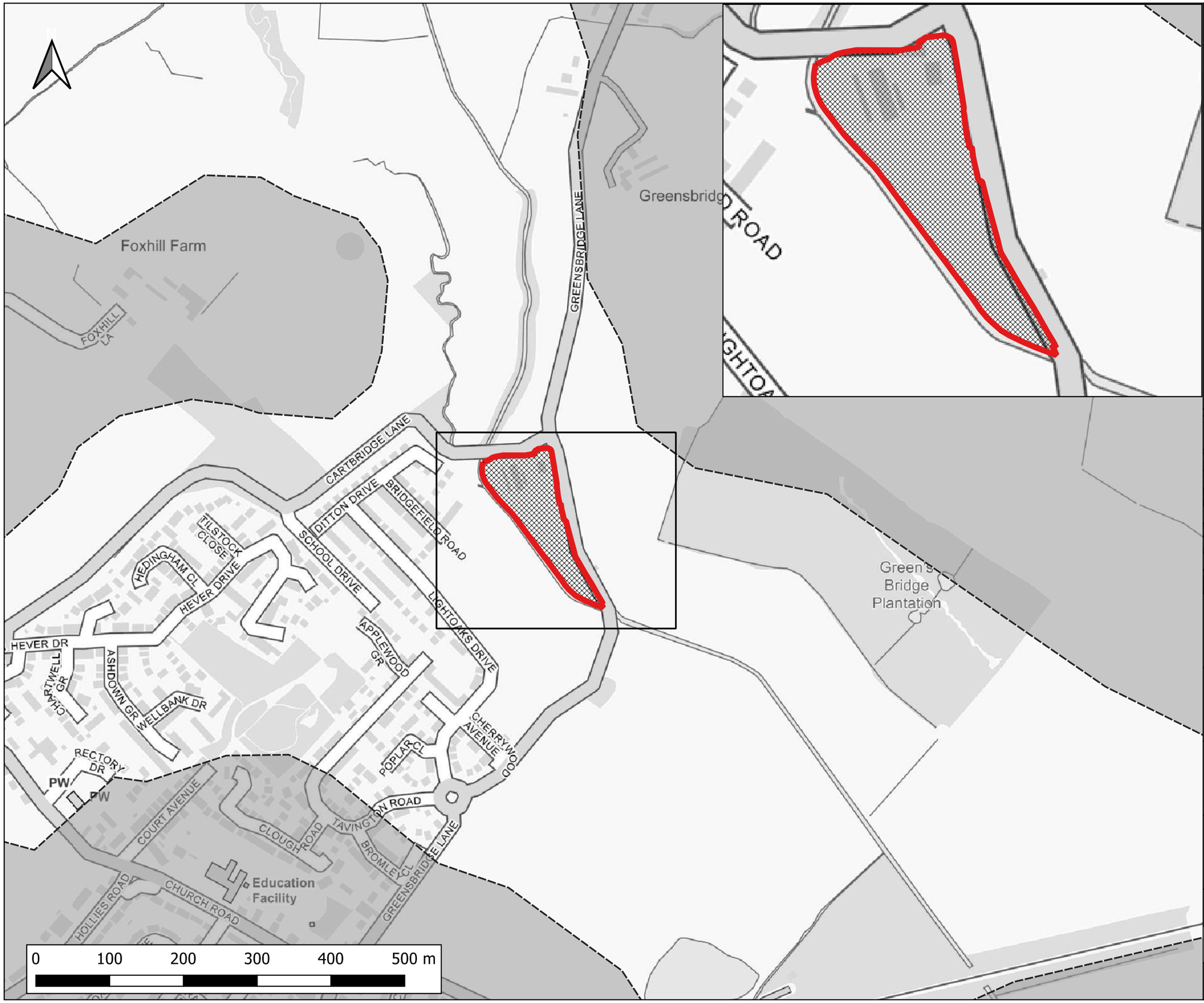
PLOT TITLE:
Maximum Flood Depth
1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_EXG_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

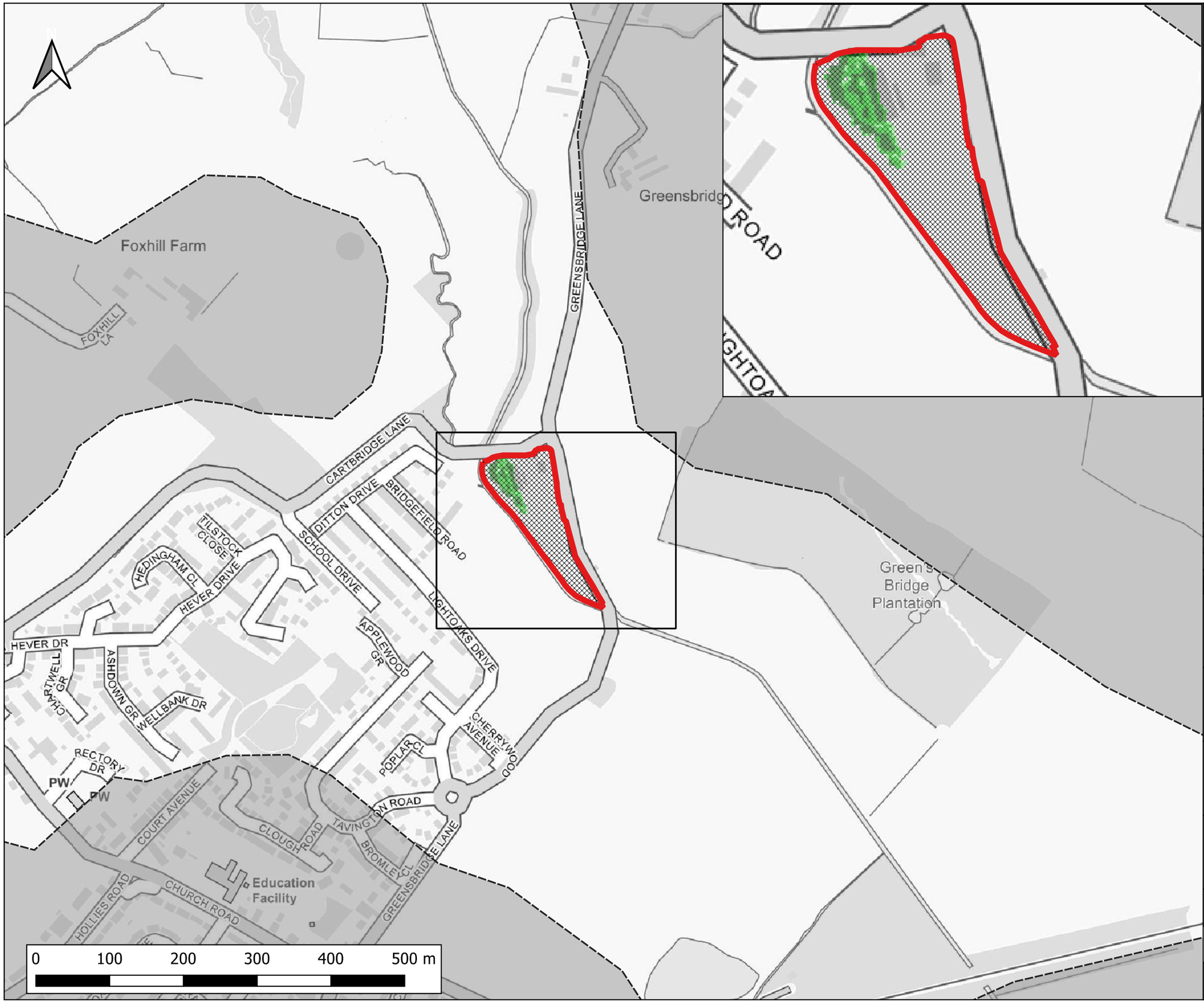
PLOT TITLE:
Maximum Flood Depth
1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_DEVSITE_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



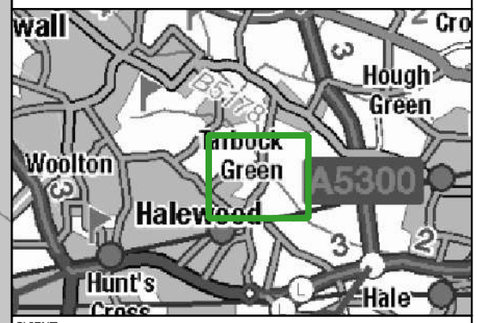
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Depth Variation

- > -100mm
- -50mm to -100mm
- -20mm to -50mm
- No Change (+/- 20mm)
- +20mm to +50mm
- +50mm to +100mm
- > +100mm



CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

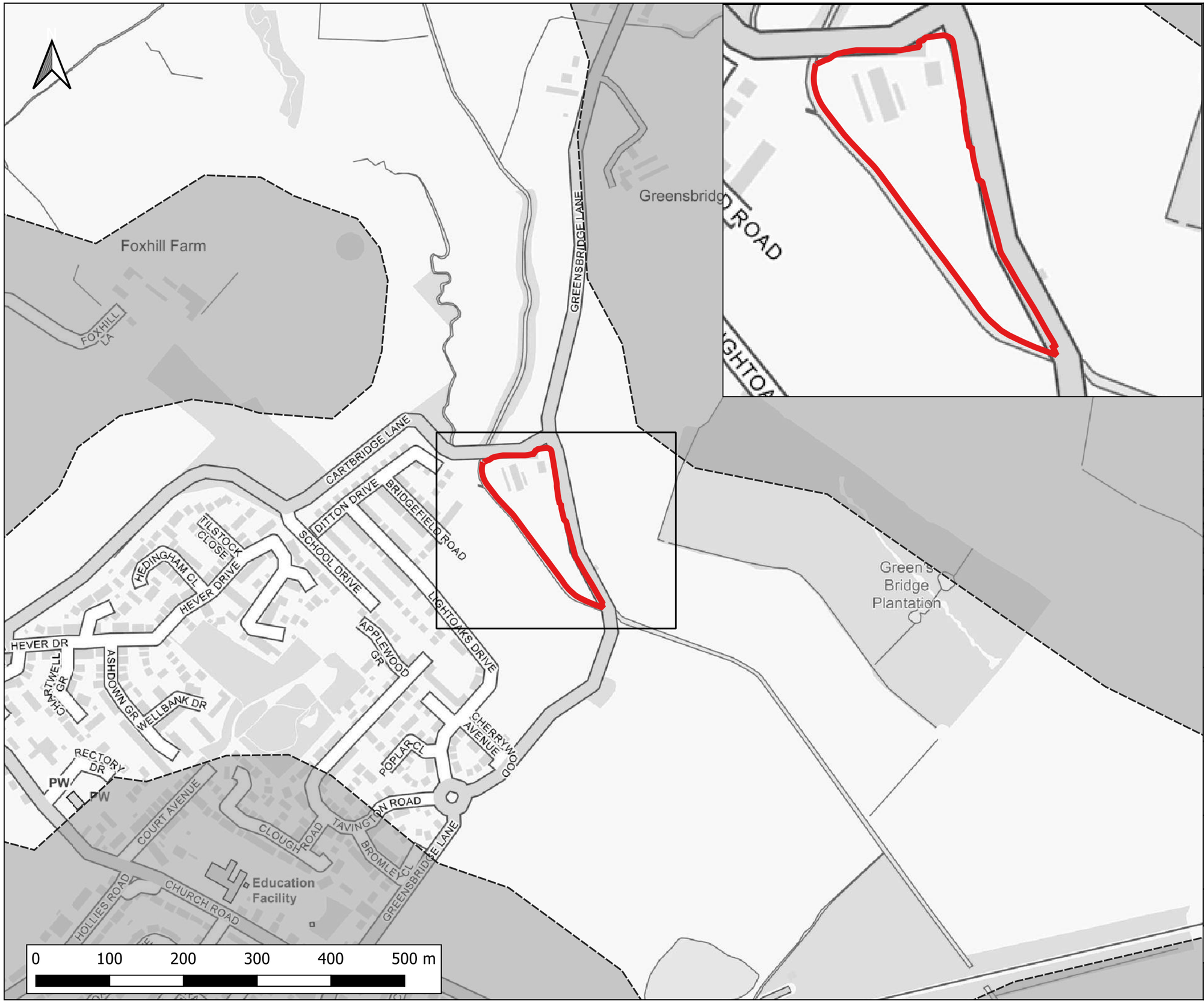
PLOT TITLE:
Maximum Depth Difference
1% AEP Fluvial Event
DEV-EXG

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_NC_DIFF_015	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

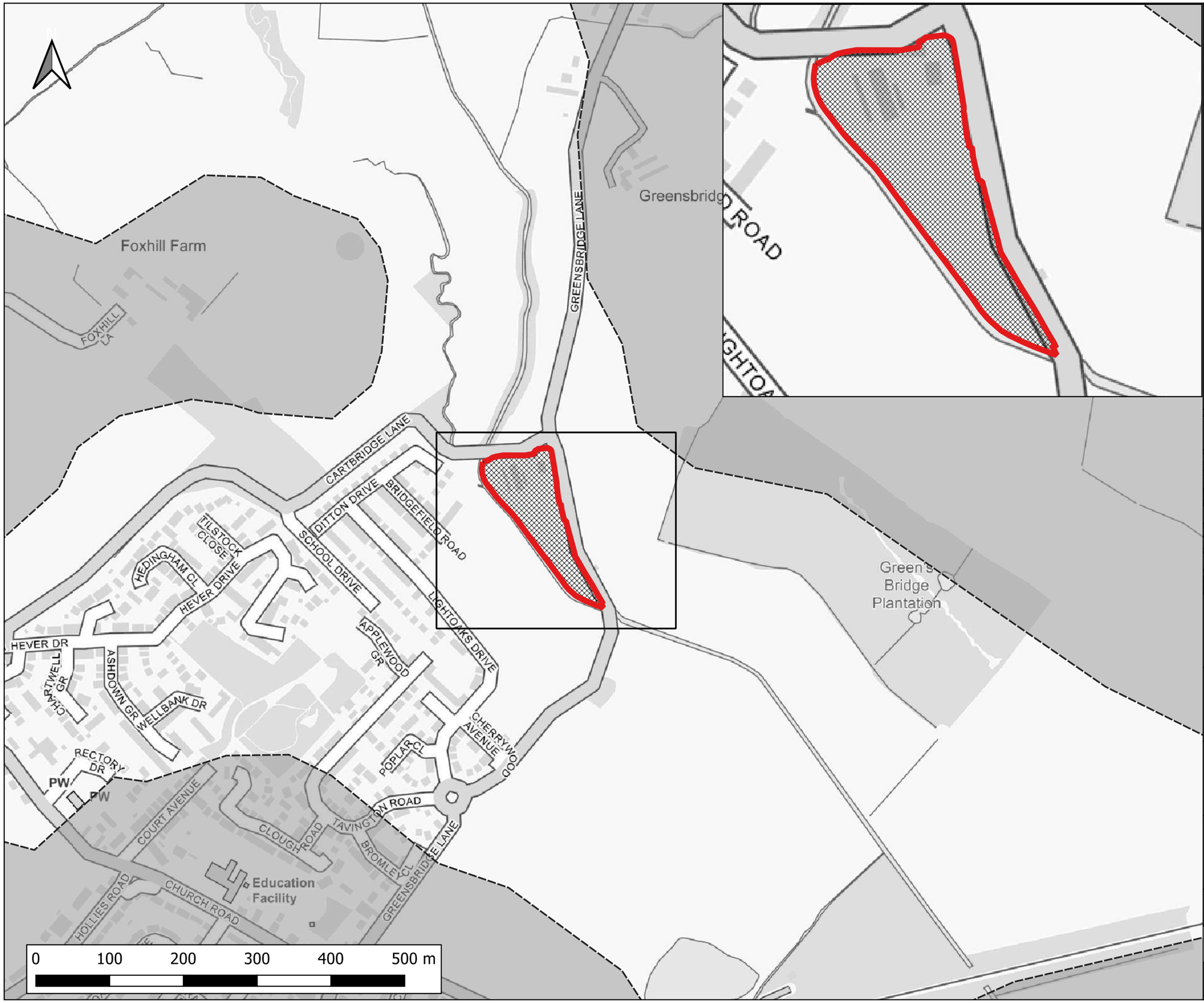
PLOT TITLE:
Maximum Flood Depth
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Depth
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)

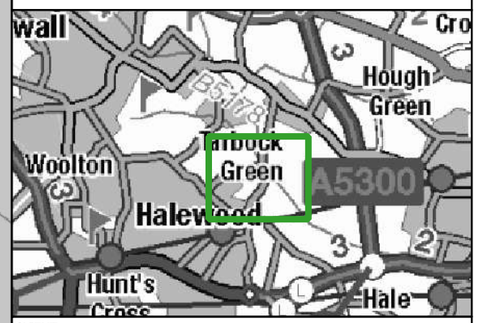
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Depth Variation

- > -100mm
- -50mm to -100mm
- -20mm to -50mm
- No Change (+/- 20mm)
- +20mm to +50mm
- +50mm to +100mm
- > +100mm



CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

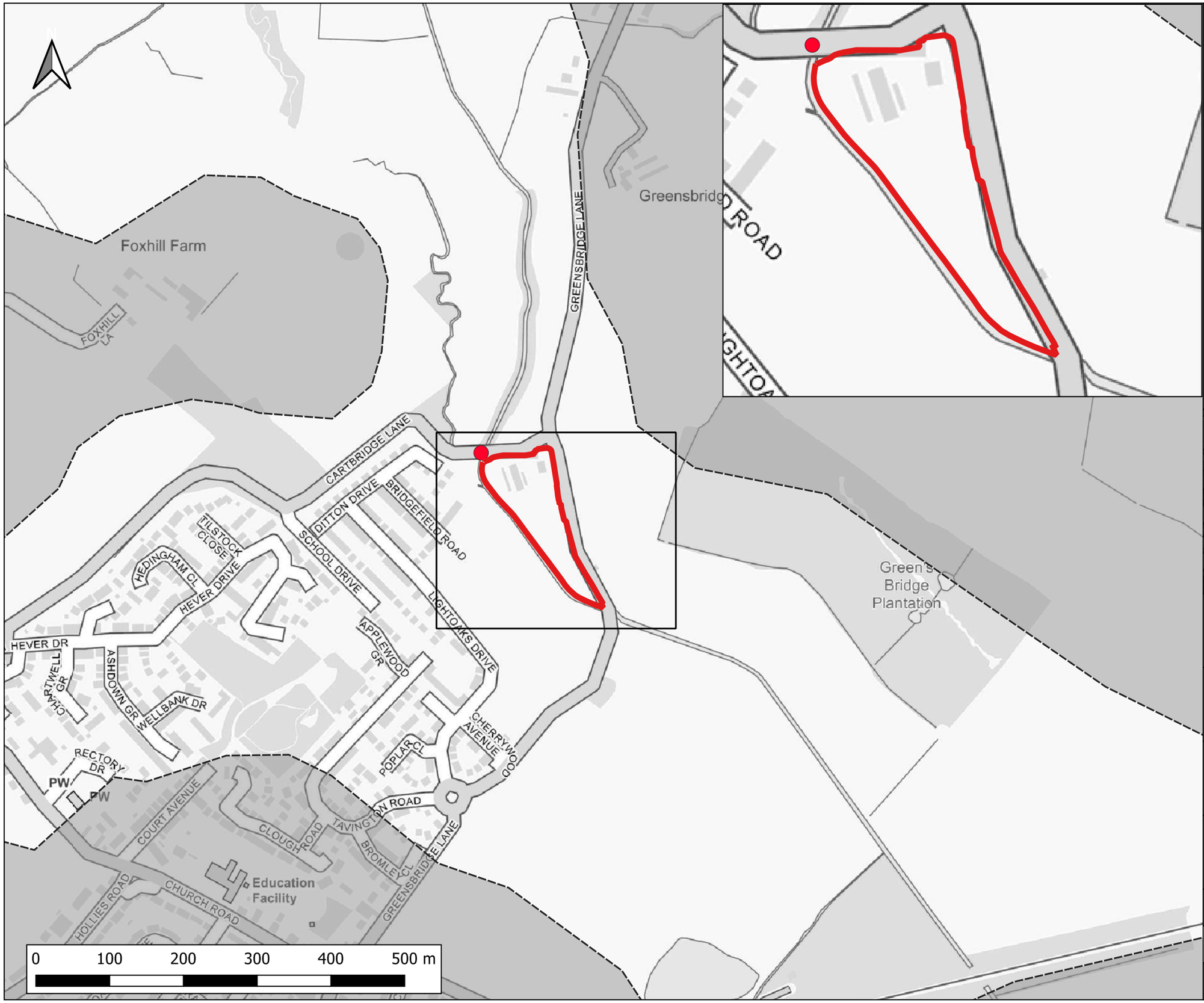
PLOT TITLE:
Maximum Depth Difference
1% AEP + 44% CC Fluvial Event
DEV-EXG

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_NC_DIFF_015	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Blockage 1

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

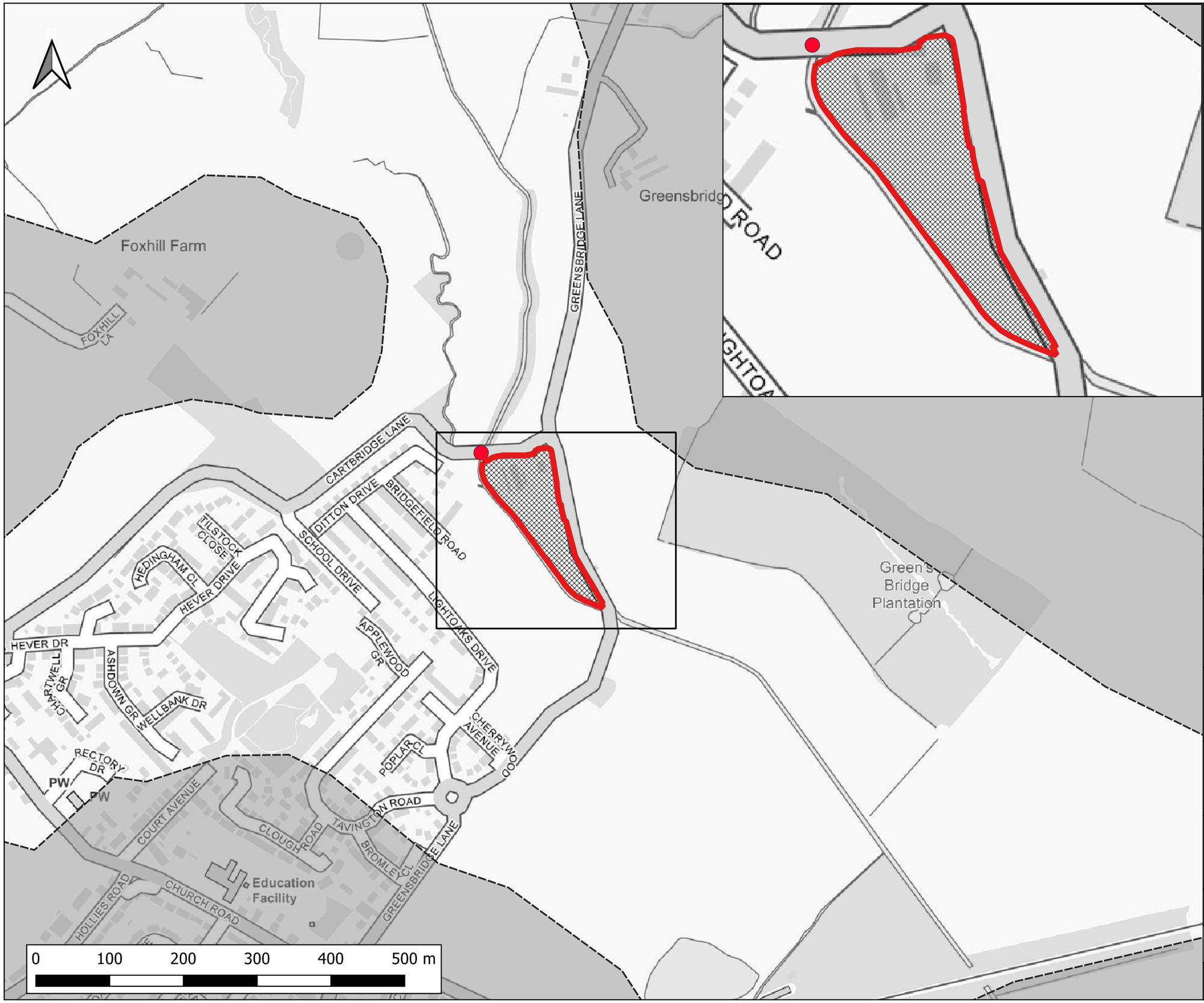
PLOT TITLE:
Maximum Flood Depth
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL1_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Blockage 1

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

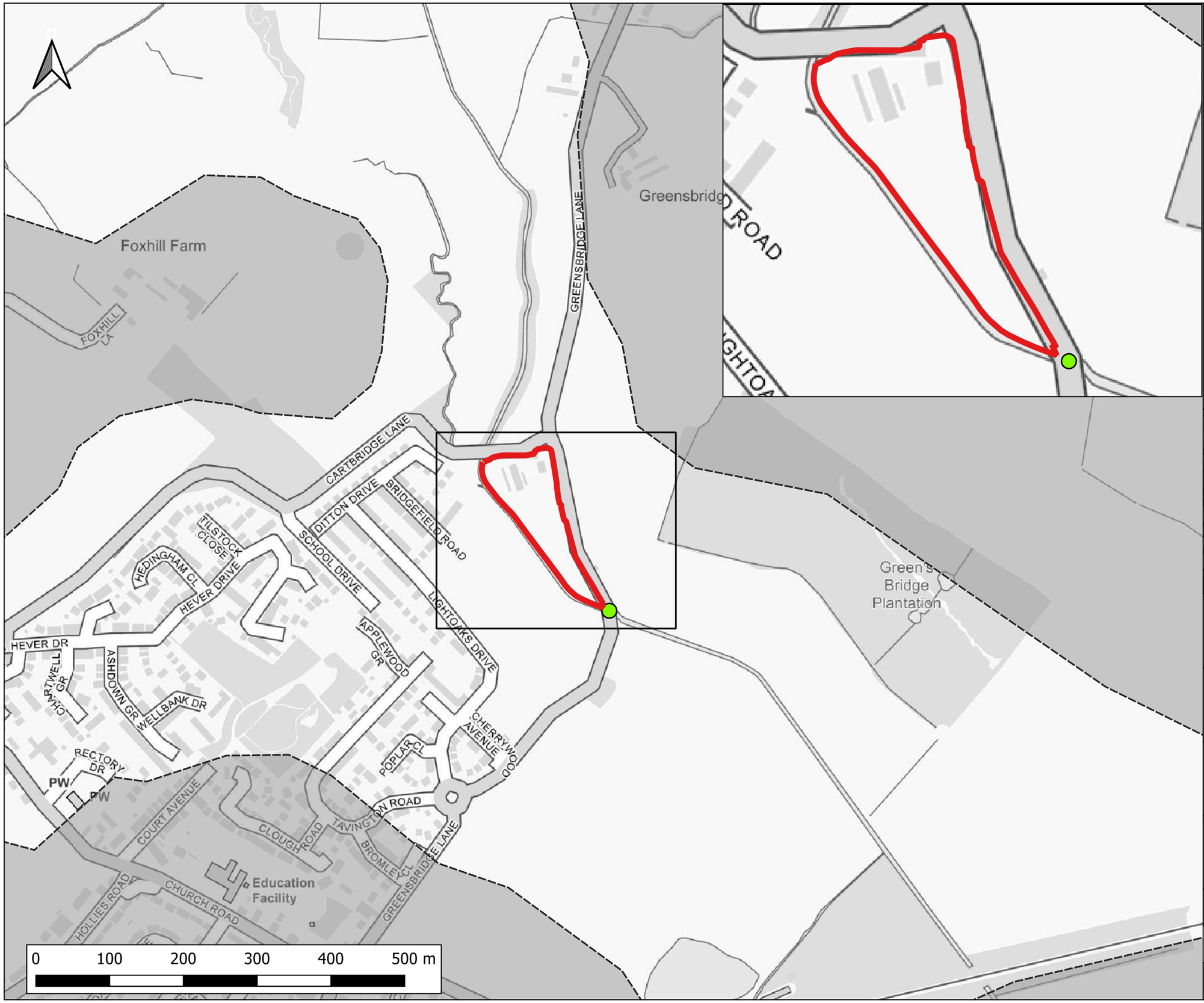
PLOT TITLE:
Maximum Flood Depth
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL1_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Blockage 2

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

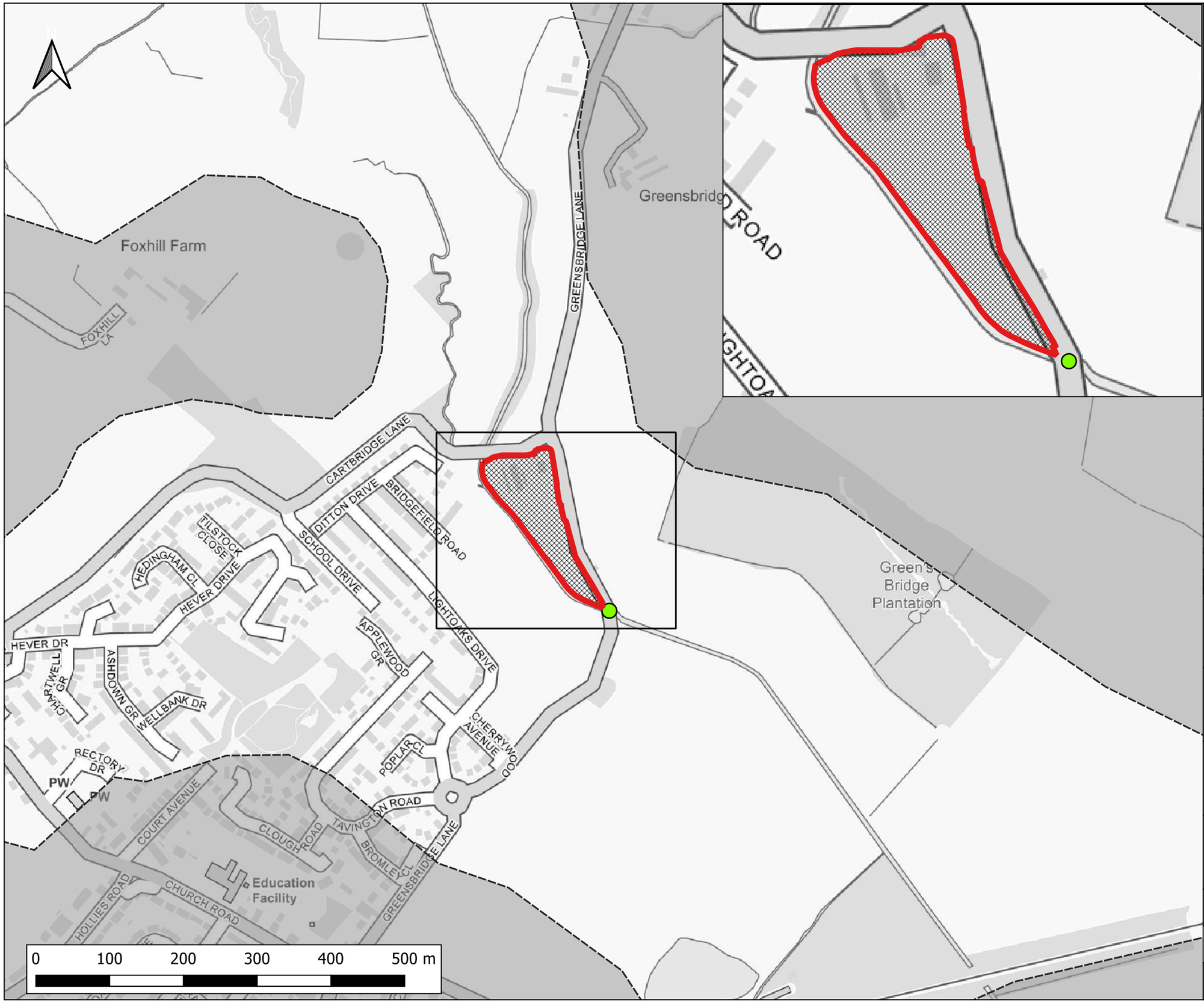
PLOT TITLE:
Maximum Flood Depth
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL2_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Blockage 2

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

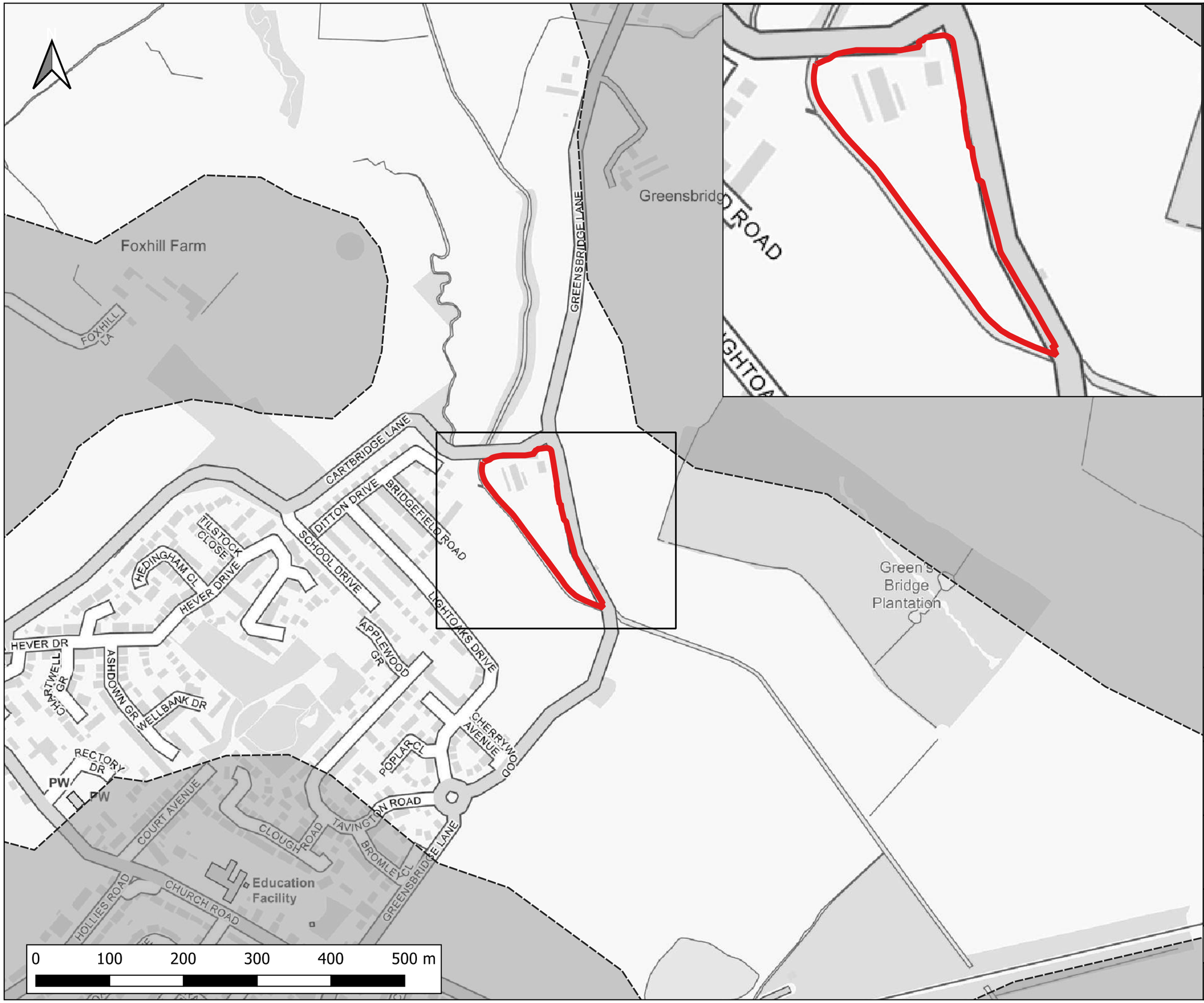
PLOT TITLE:
Maximum Flood Depth
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL2_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

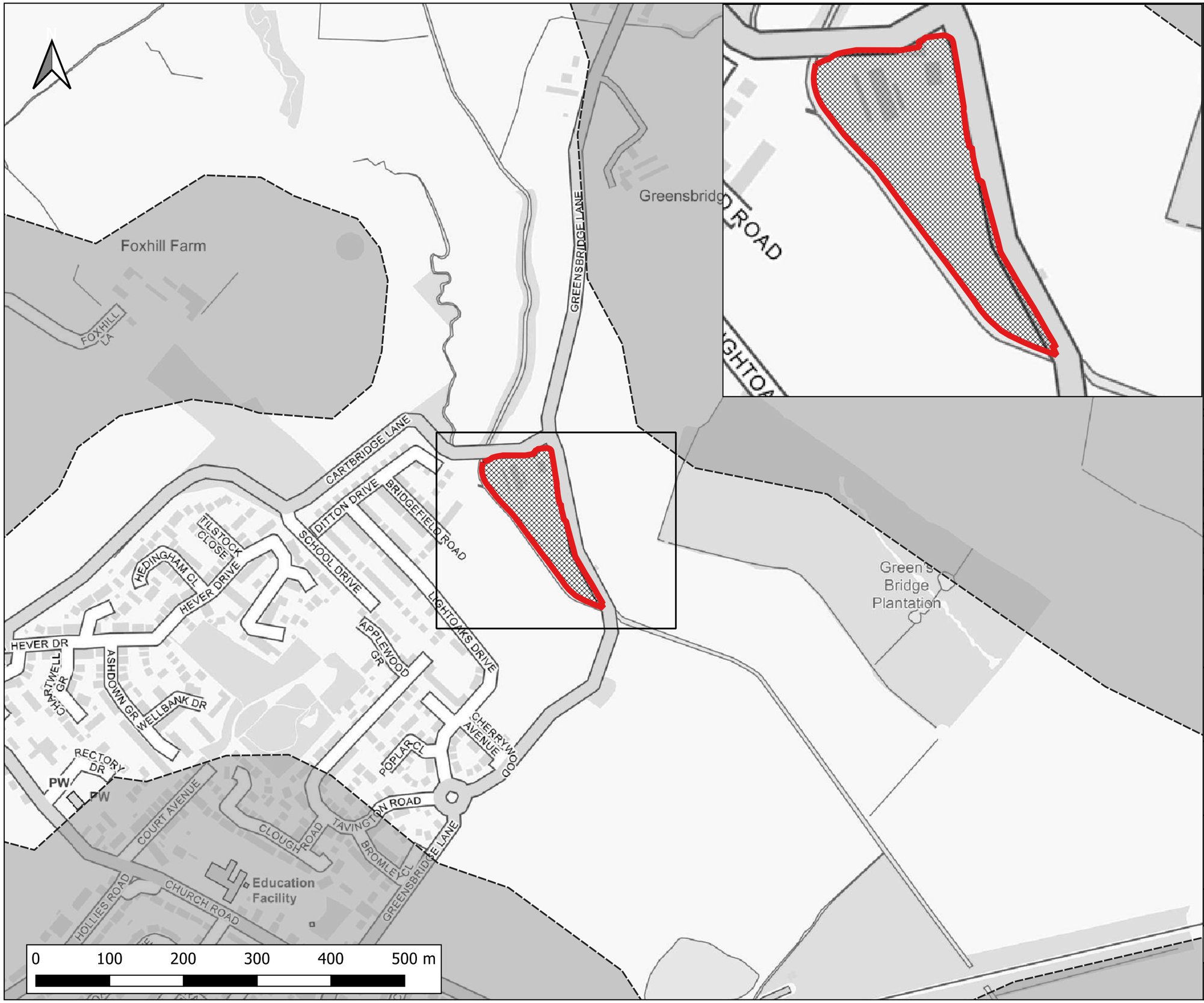
PLOT TITLE:
Maximum Flood Depth
0.1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_EXG_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Depth
0.1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_DEVSITE_NC_015_d_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)

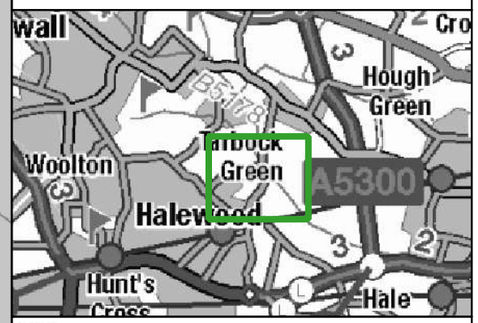
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Depth Variation

- > -100mm
- -50mm to -100mm
- -20mm to -50mm
- No Change (+/- 20mm)
- +20mm to +50mm
- +50mm to +100mm
- > +100mm



CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

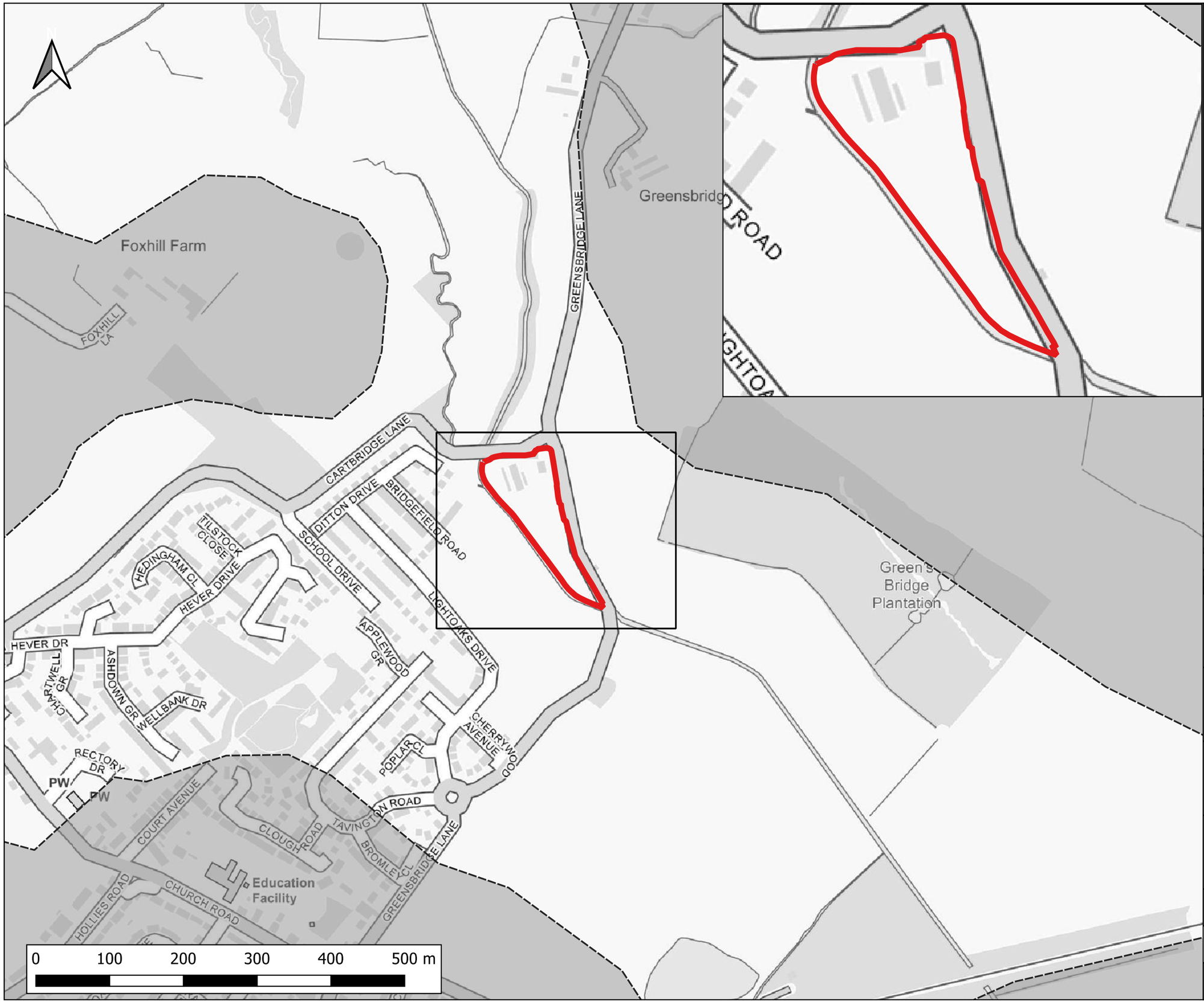
PLOT TITLE:
Maximum Depth Difference
0.1% AEP Fluvial Event
DEV-EXG

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_NC_DIFF_015	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

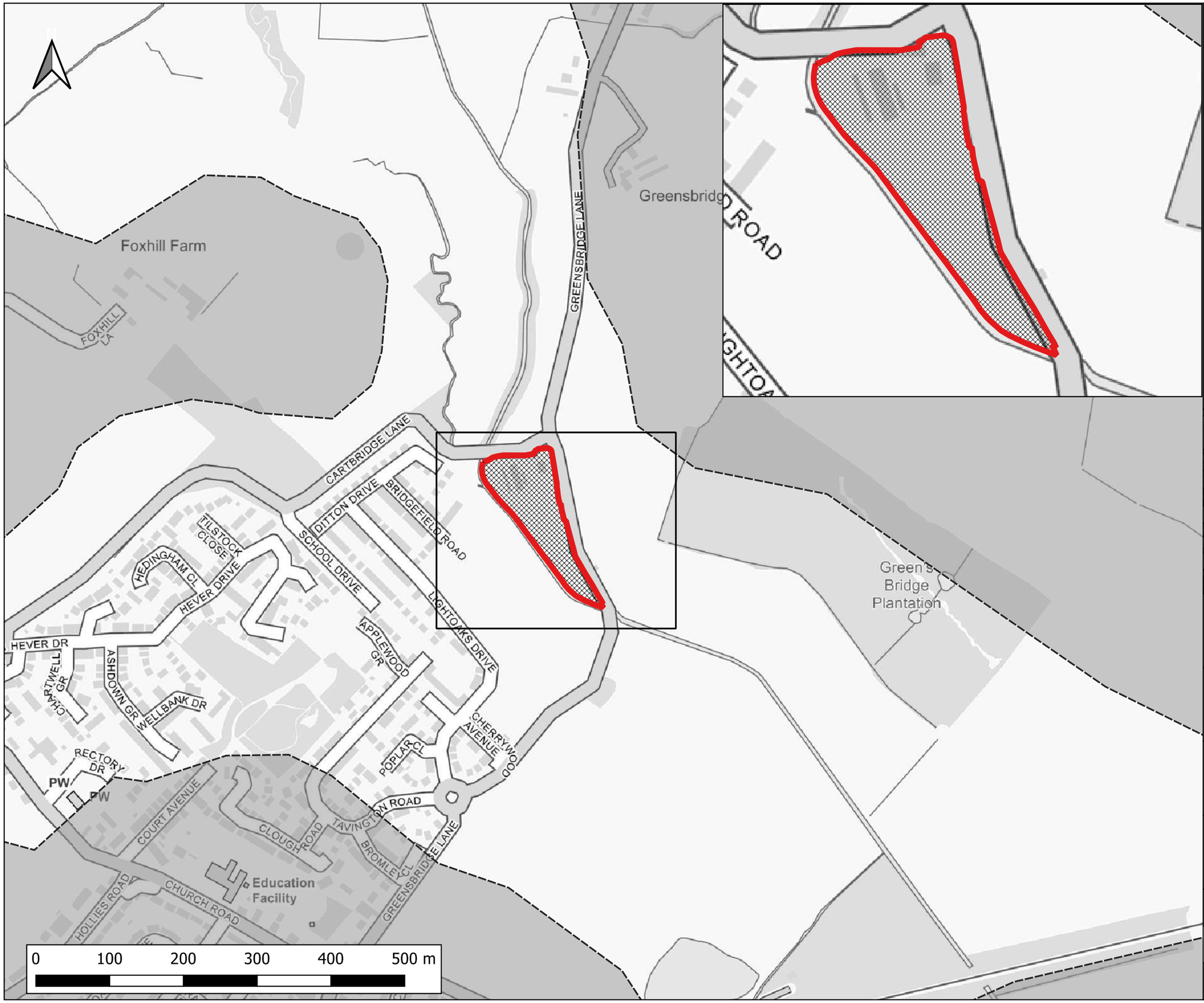
PLOT TITLE:
Maximum Velocity
5% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_EXG_NC_015_V_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
5% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_DEVSITE_NC_015_V_Max	-

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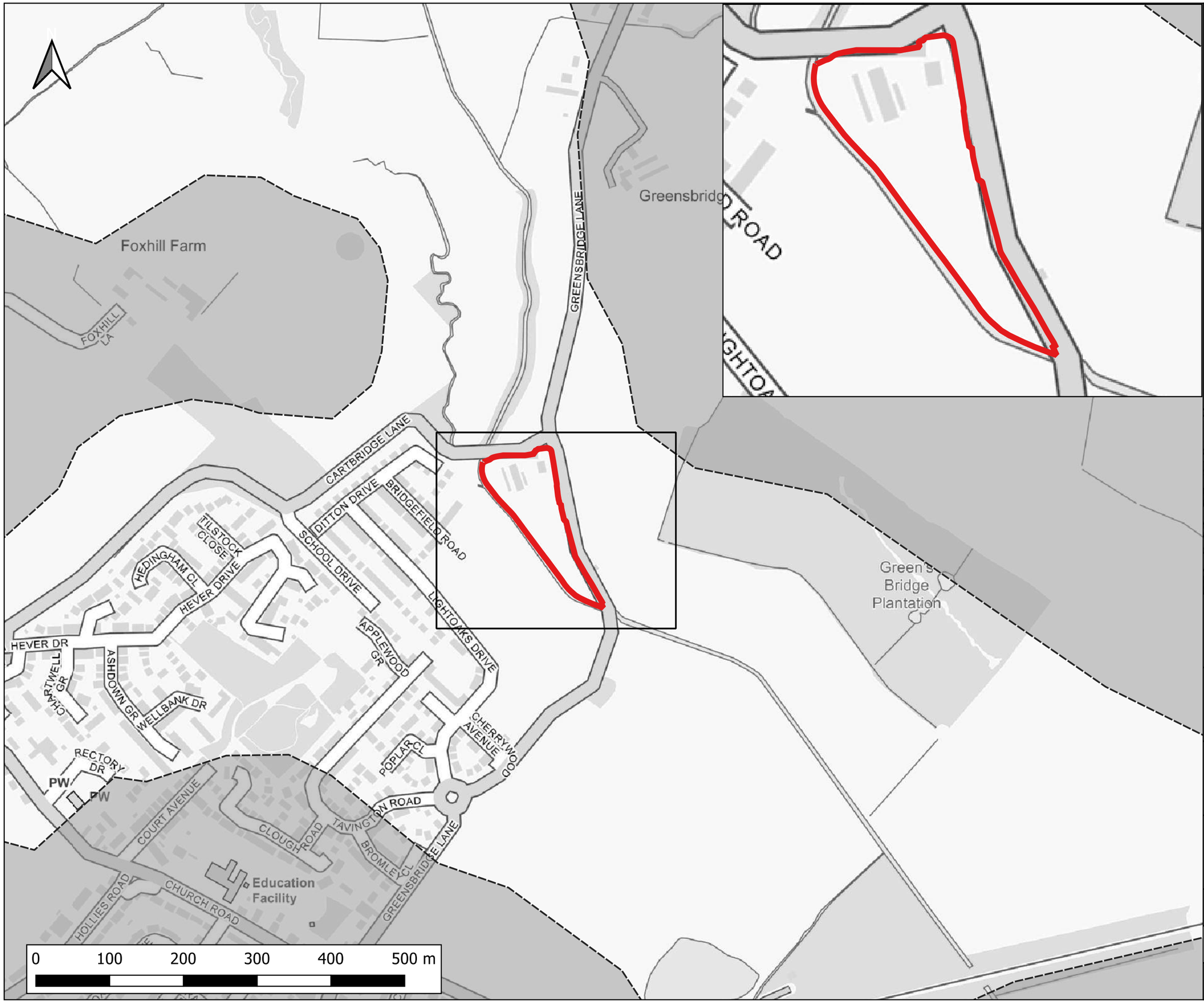


Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

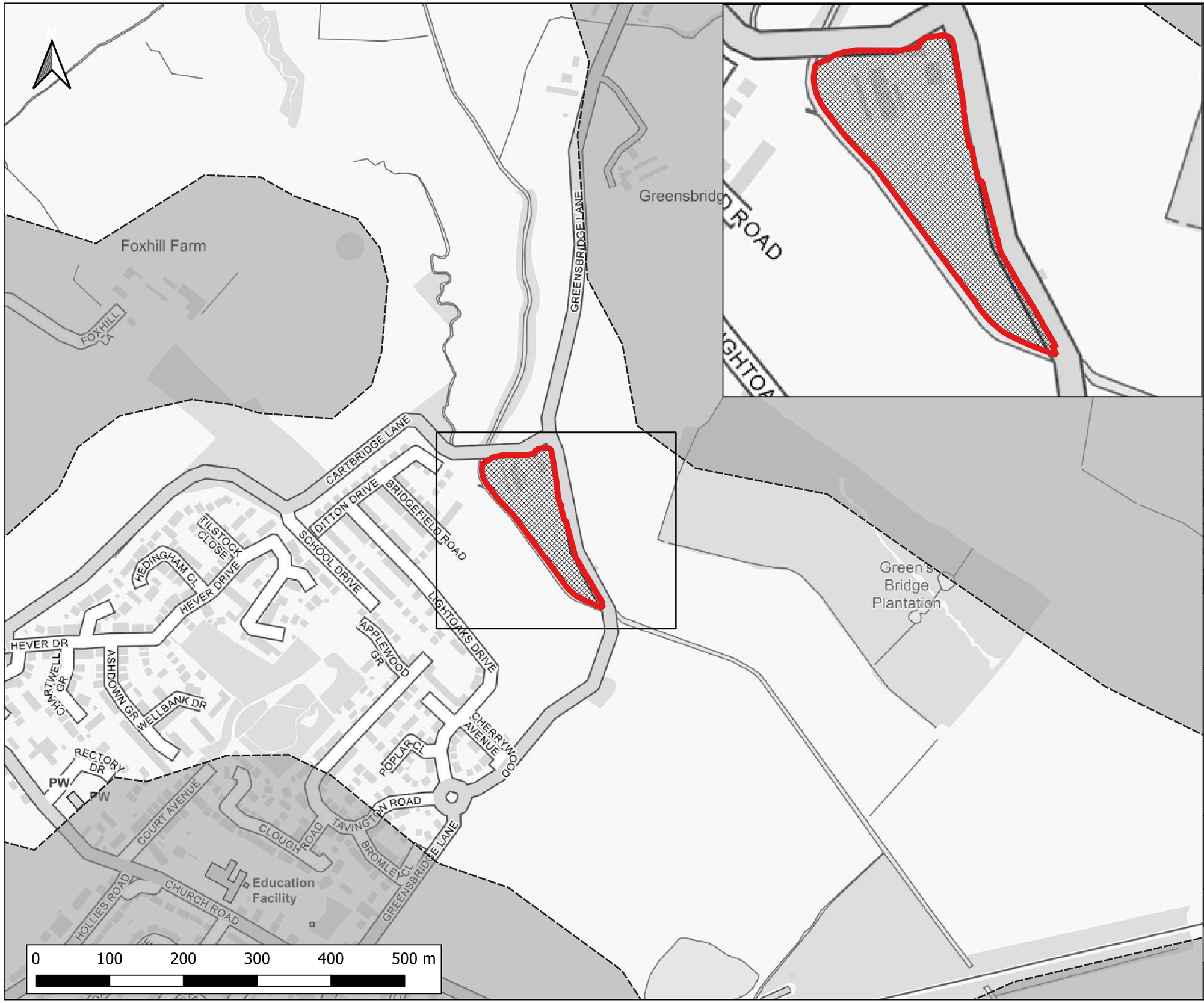
PLOT TITLE:
Maximum Velocity
1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_EXG_NC_015_V_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

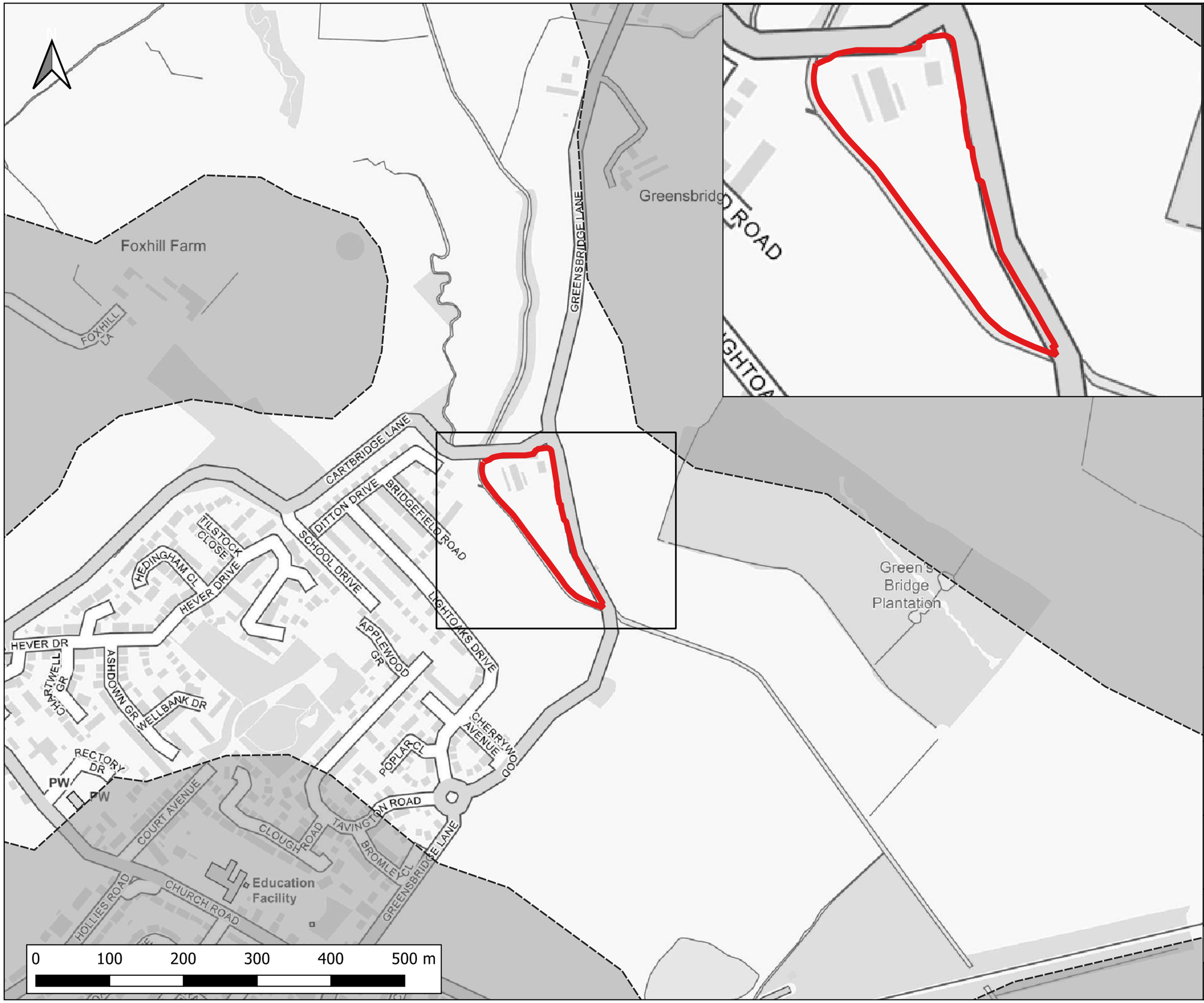
PLOT TITLE:
Maximum Velocity
1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_DEVSITE_NC_015_V_Max	-

CONTAINS OS DATA © CROWN COPYRIGHT (2021)



Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_NC_015_V_Max	-

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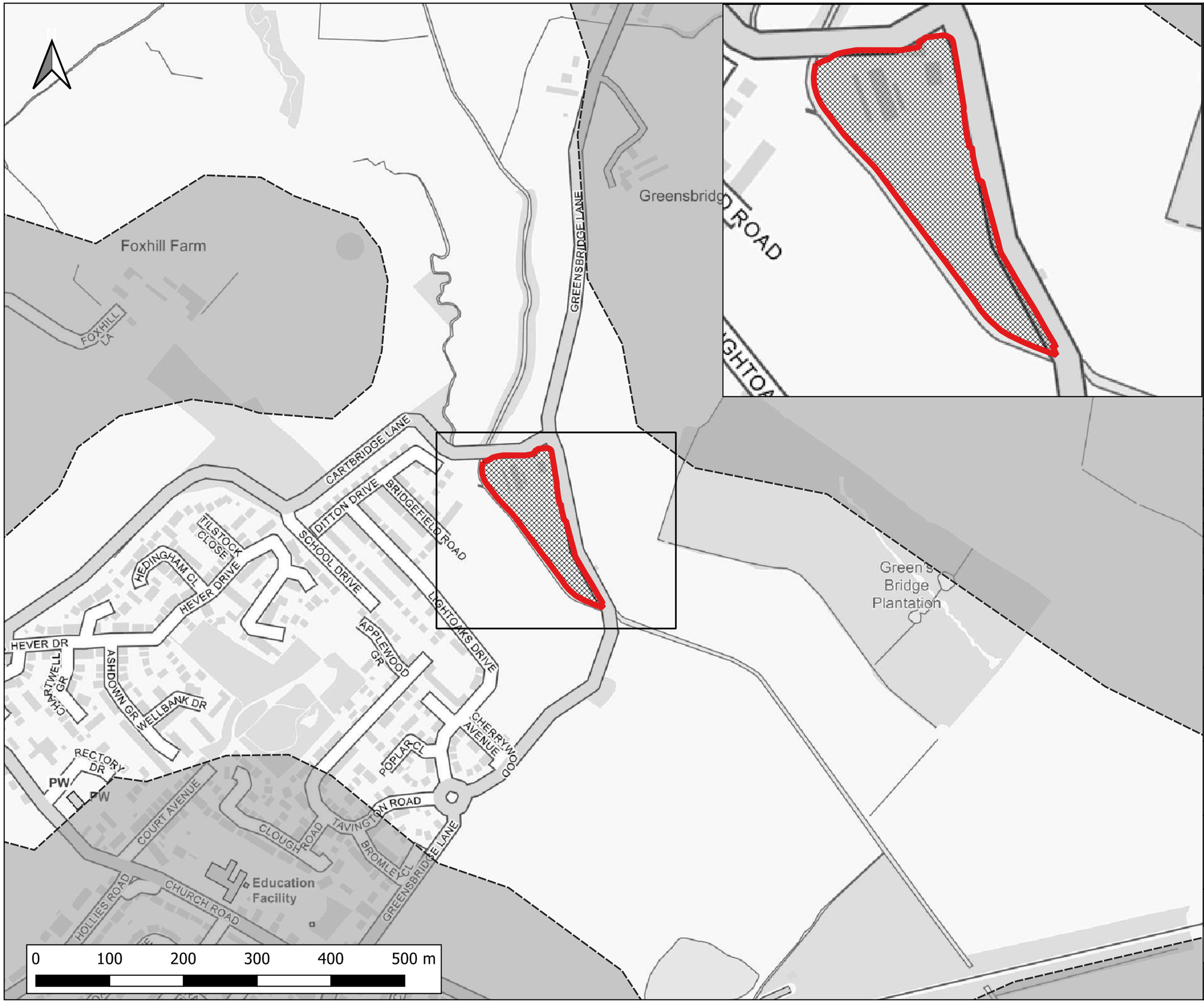

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_NC_015_V_Max	-

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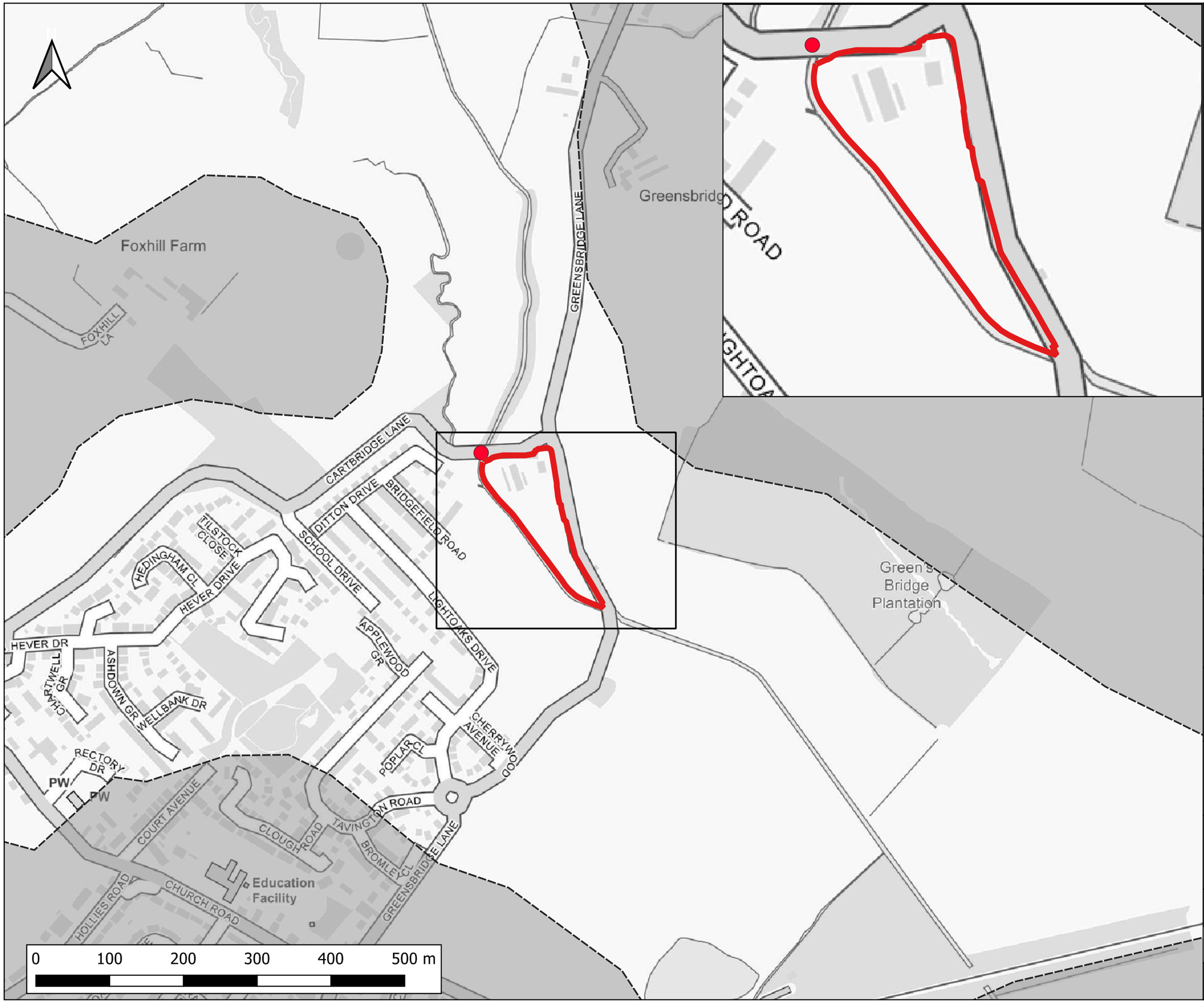


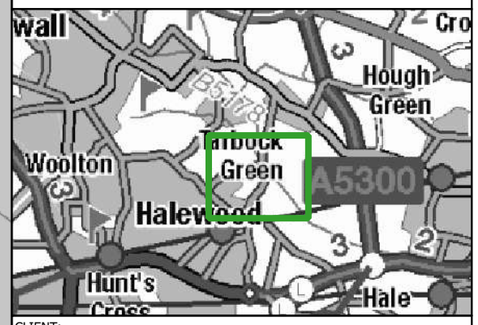
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Blockage 1

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2



CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL1_015_V_Max	-

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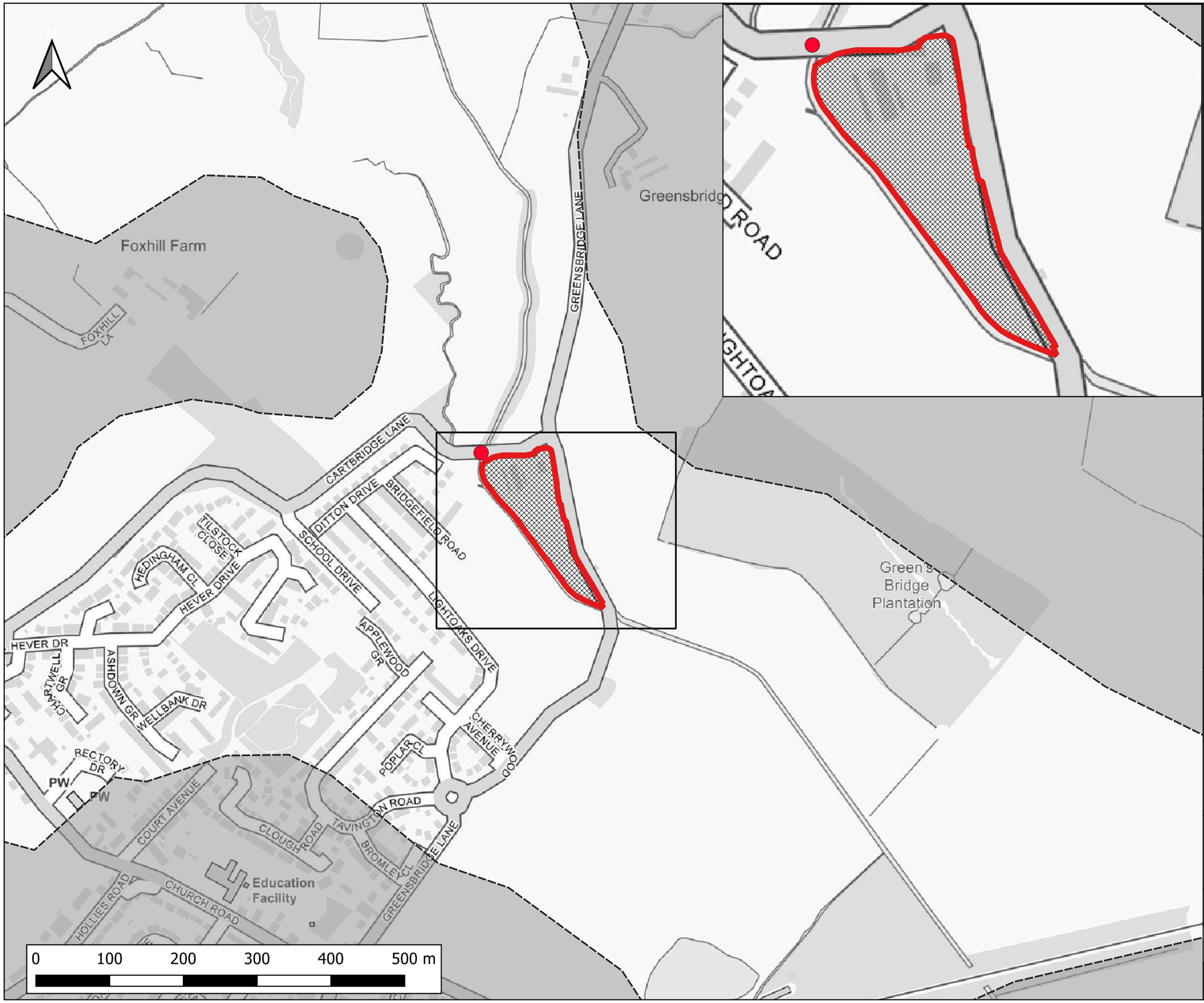

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Blockage 1

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

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www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL1_015_V_Max	-

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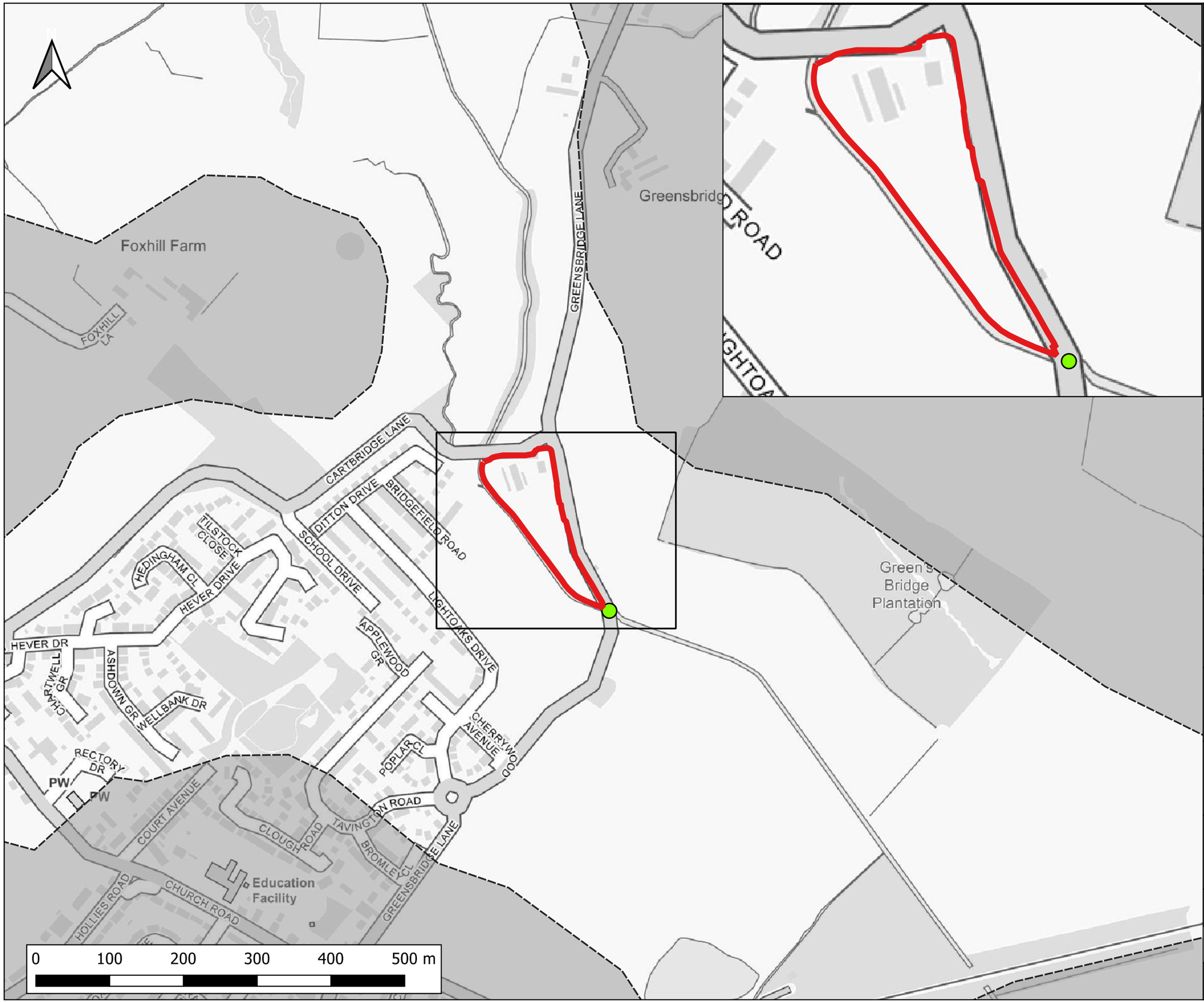

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Blockage 2

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL2_015_V_Max	-

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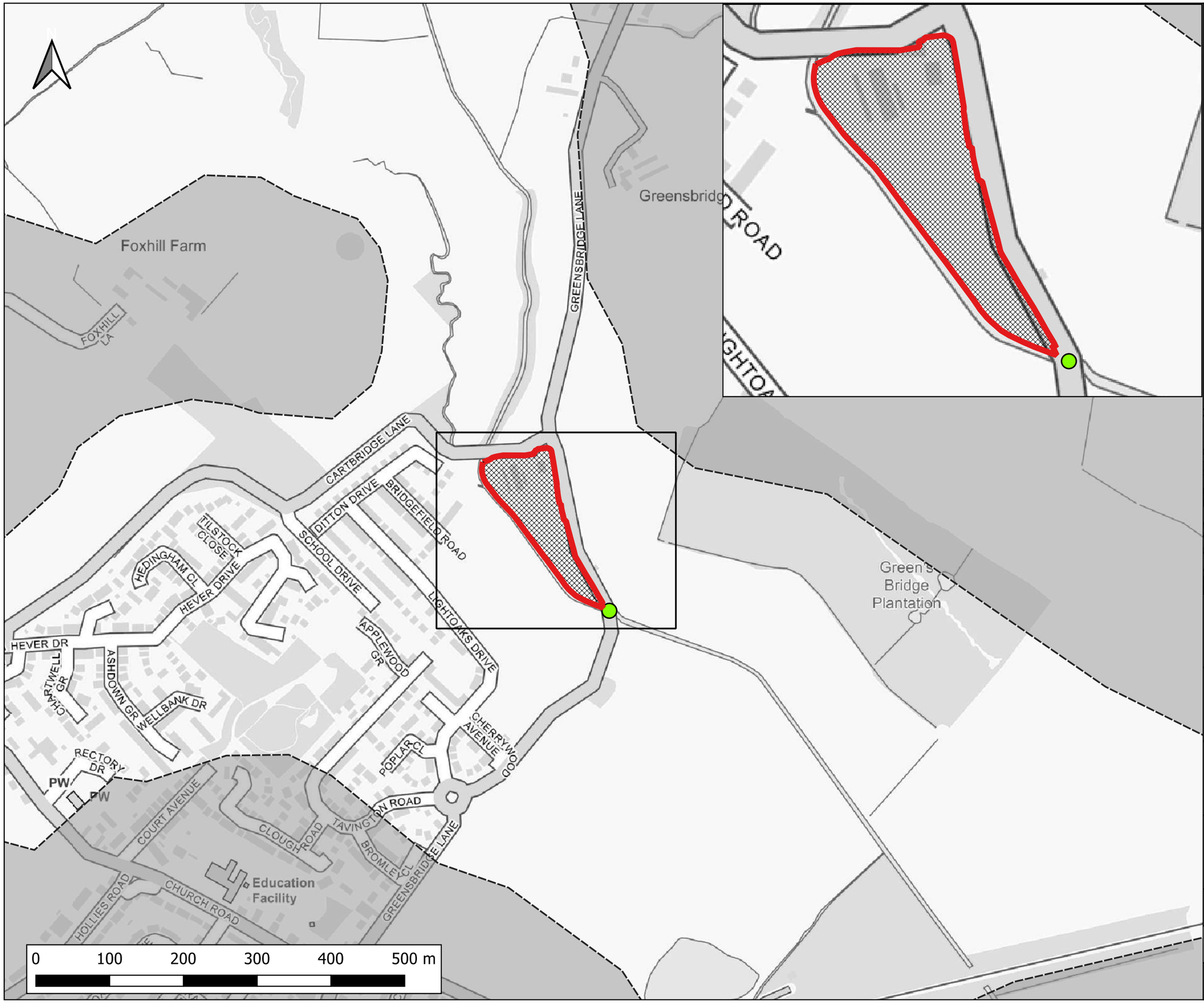

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Blockage 2

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL2_015_V_Max	-

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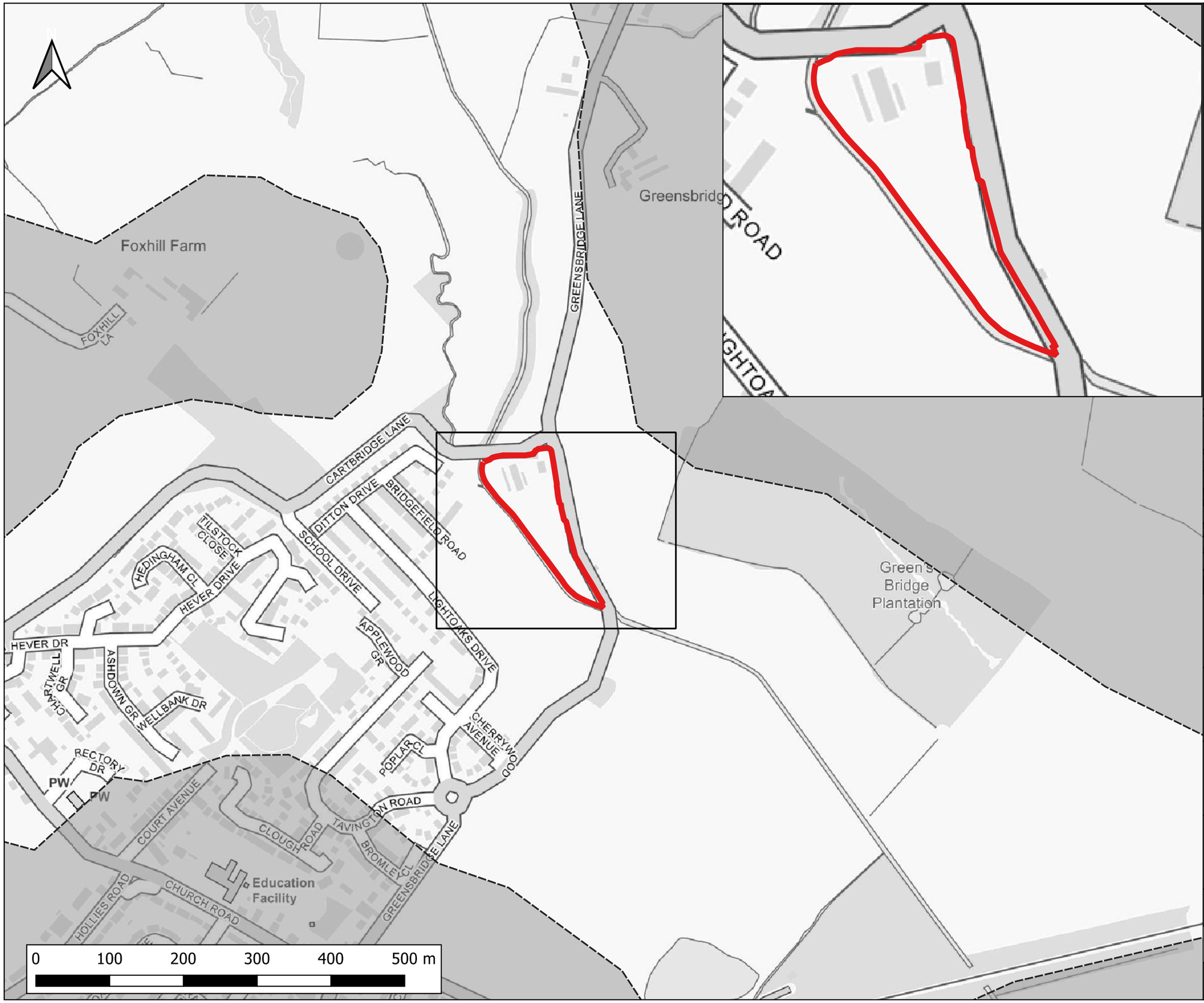

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
0.1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_EXG_NC_015_V_Max	-

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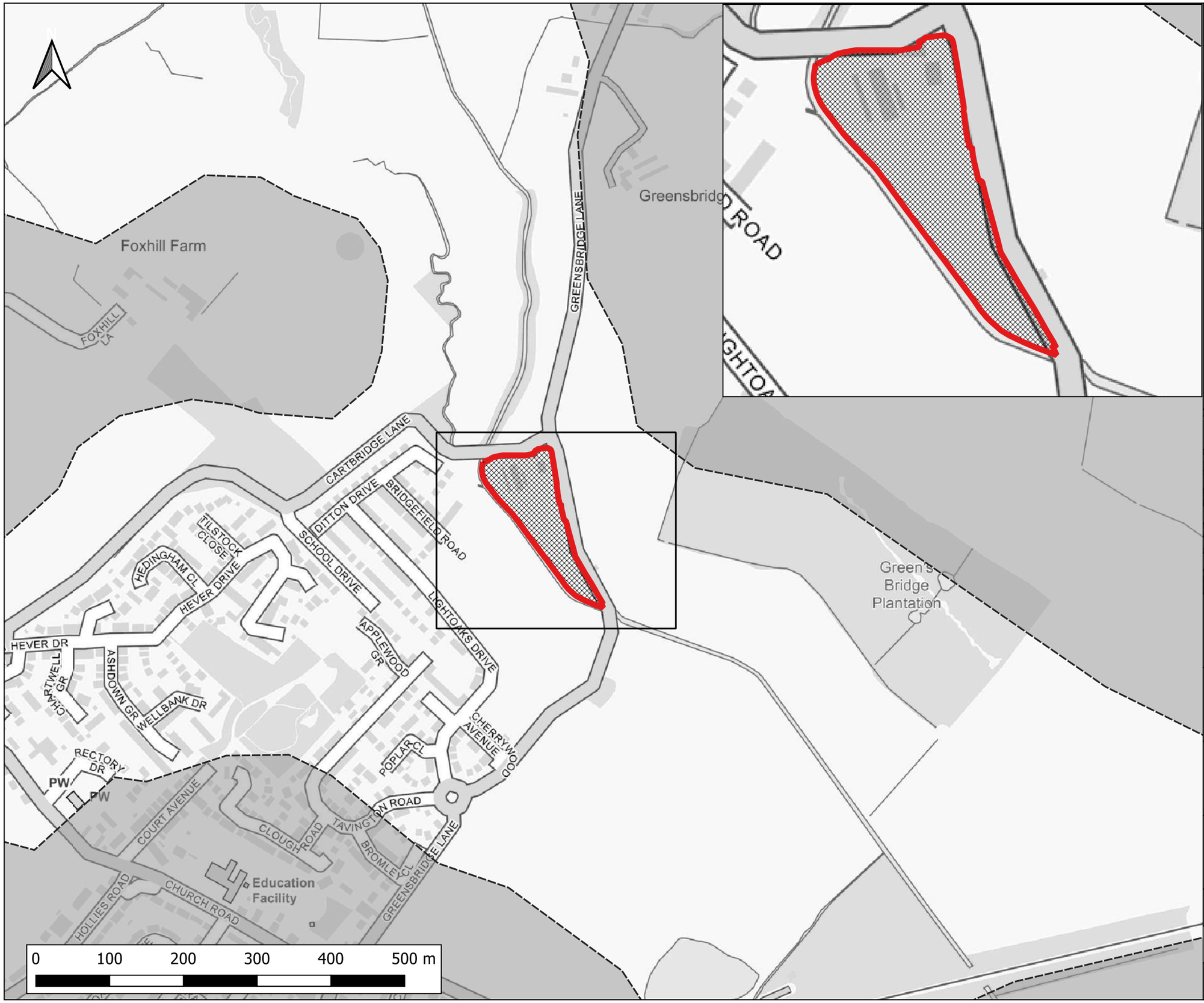

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Velocity (m/s)

- 0.0 - 0.3
- 0.3 - 0.6
- 0.6 - 0.9
- 0.9 - 1.2
- > 1.2

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Velocity
0.1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_DEVSITE_NC_015_V_Max	-

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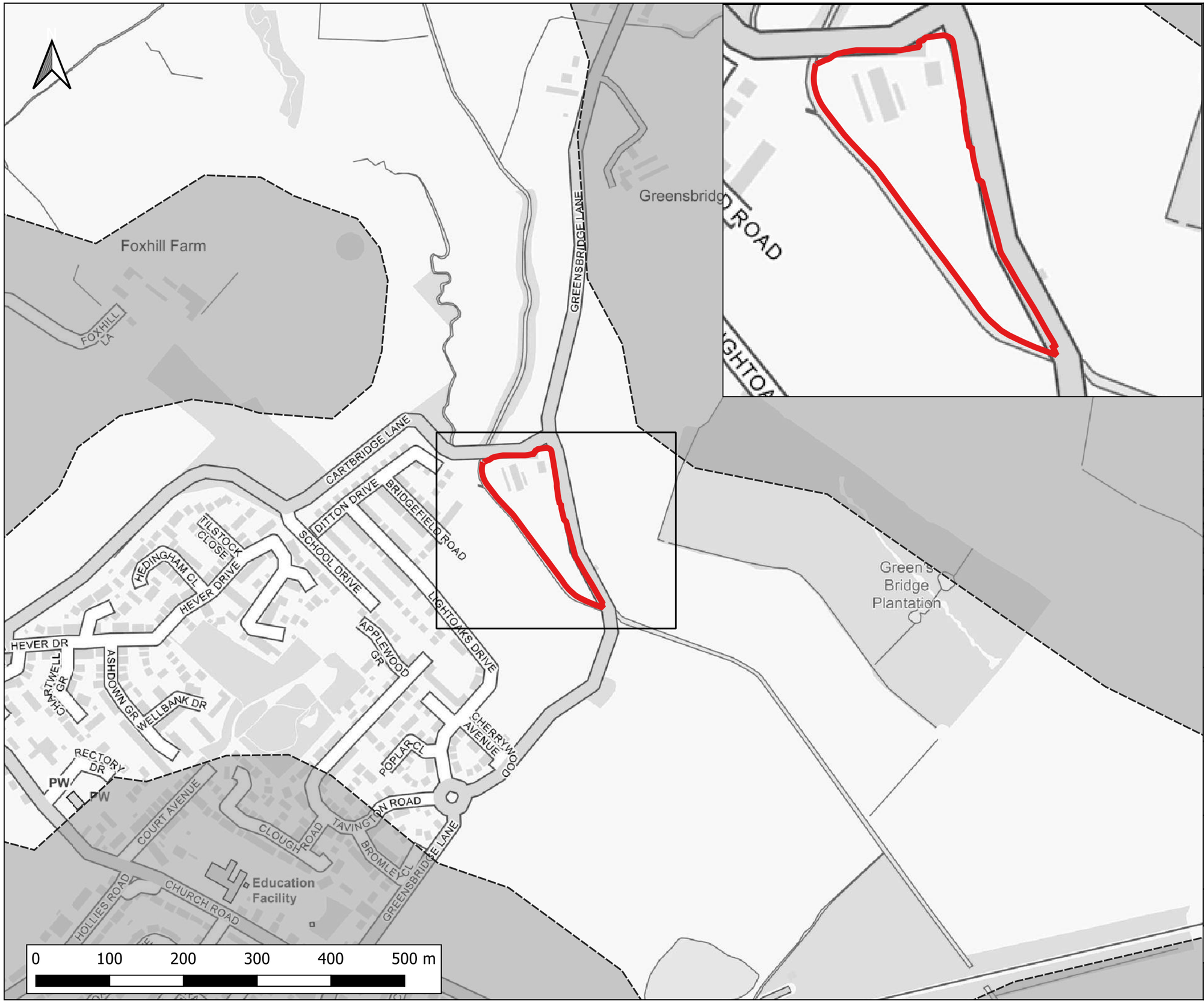

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
5% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_EXG_NC_015_ZUK2_Max	-

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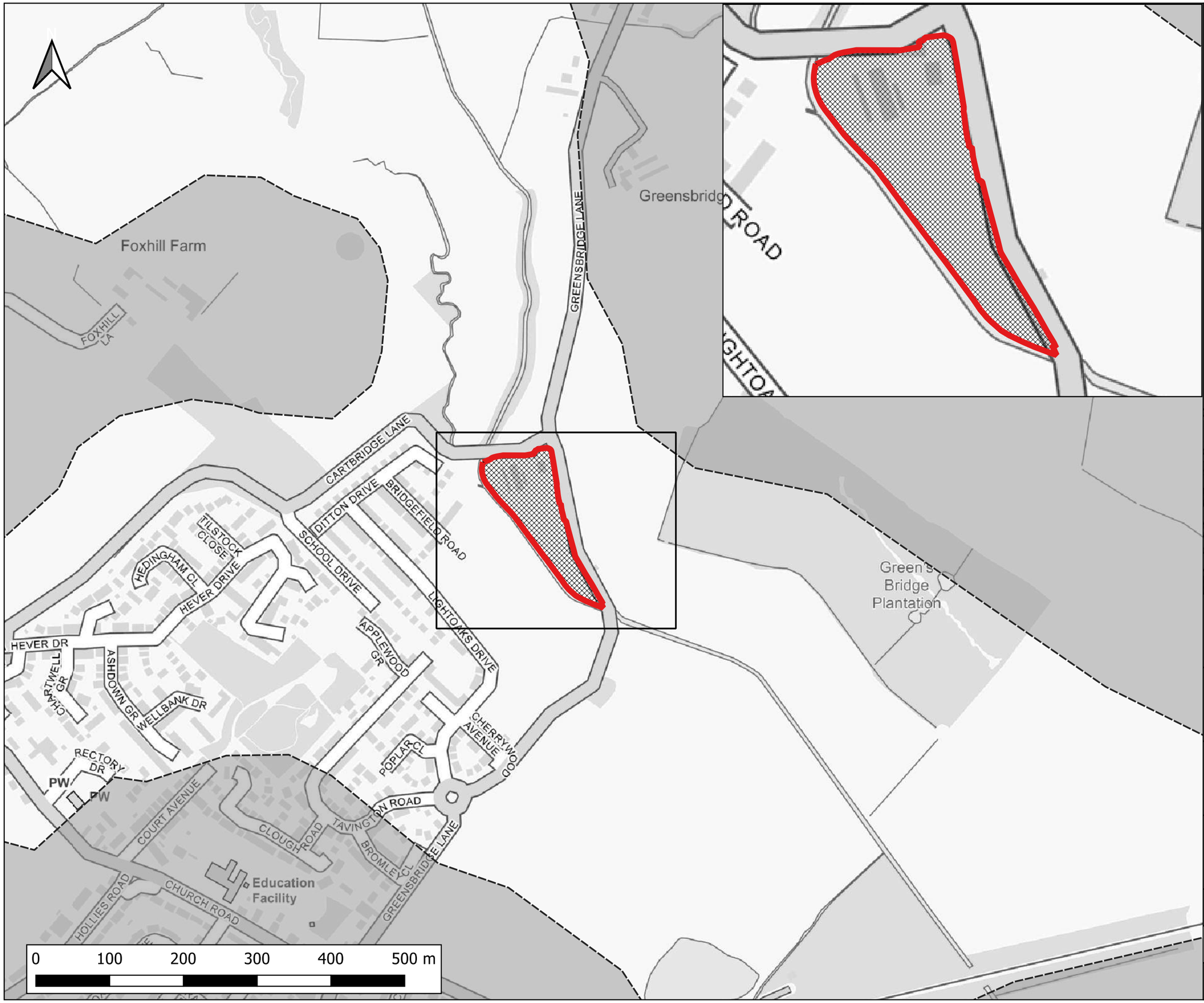

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
5% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q20_DEVSITE_NC_015_ZUK2_Max	-

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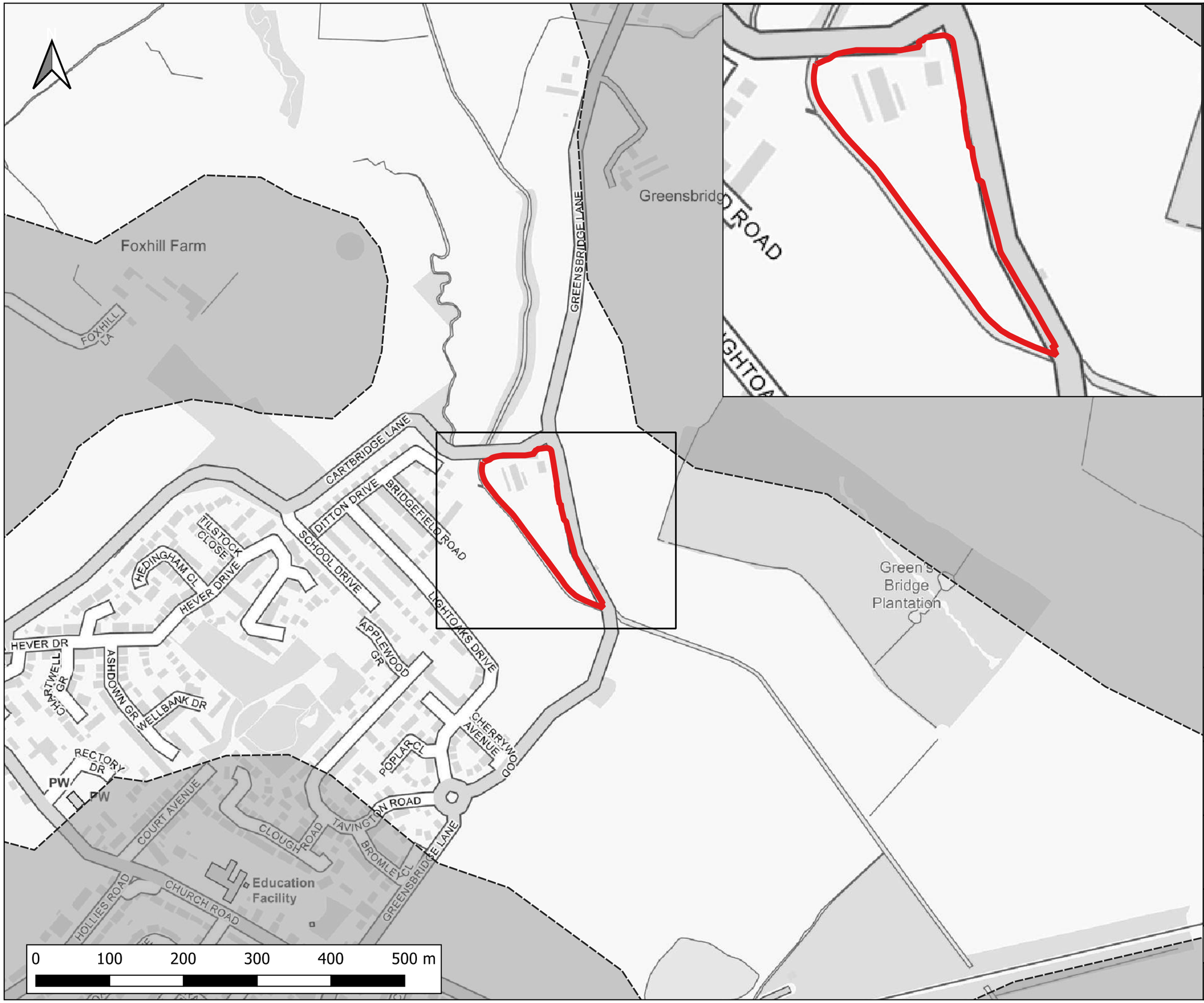

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

waterco
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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_EXG_NC_015_ZUK2_Max	-

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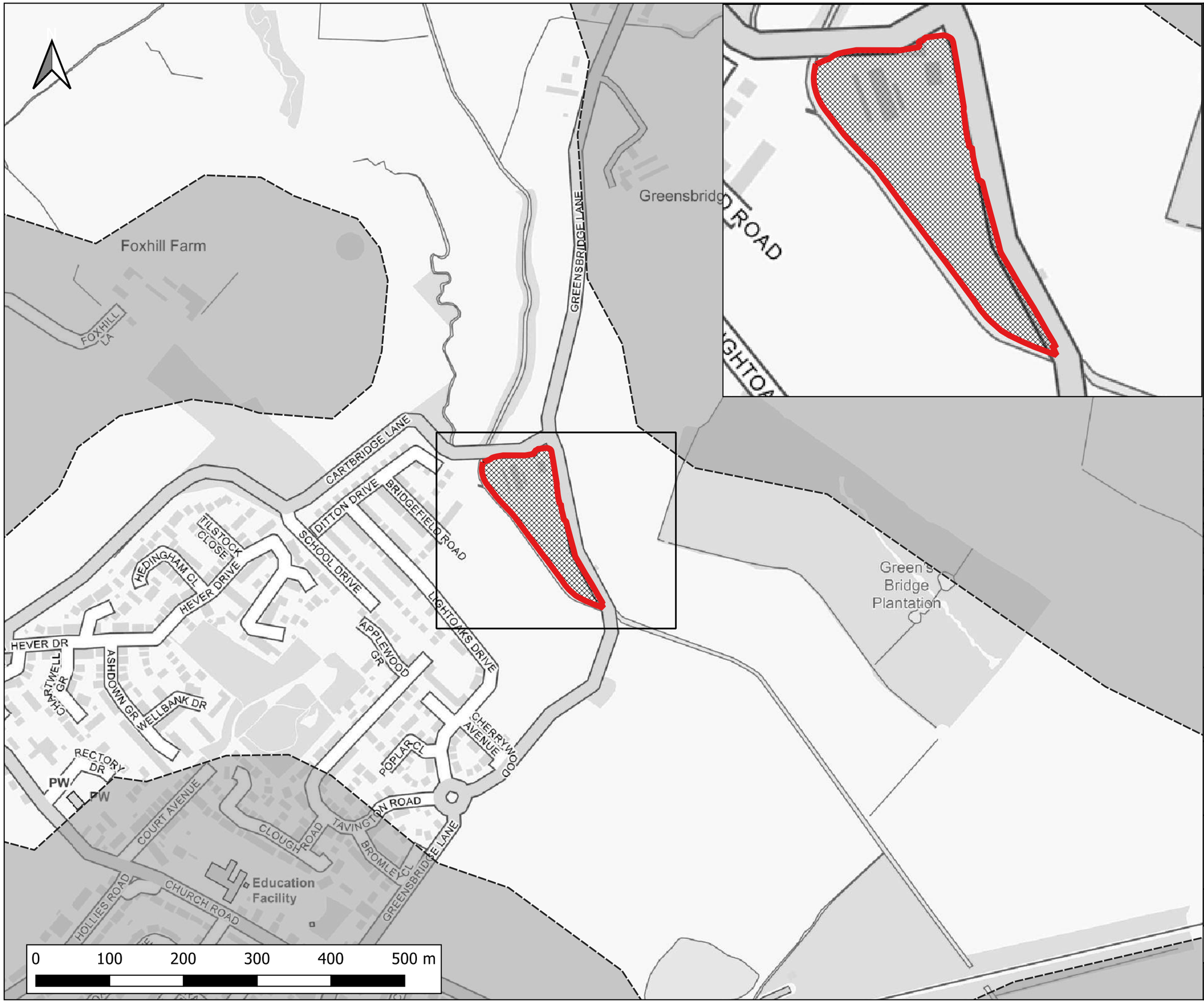

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

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www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100_DEVSITE_NC_015_ZUK2_Max	-

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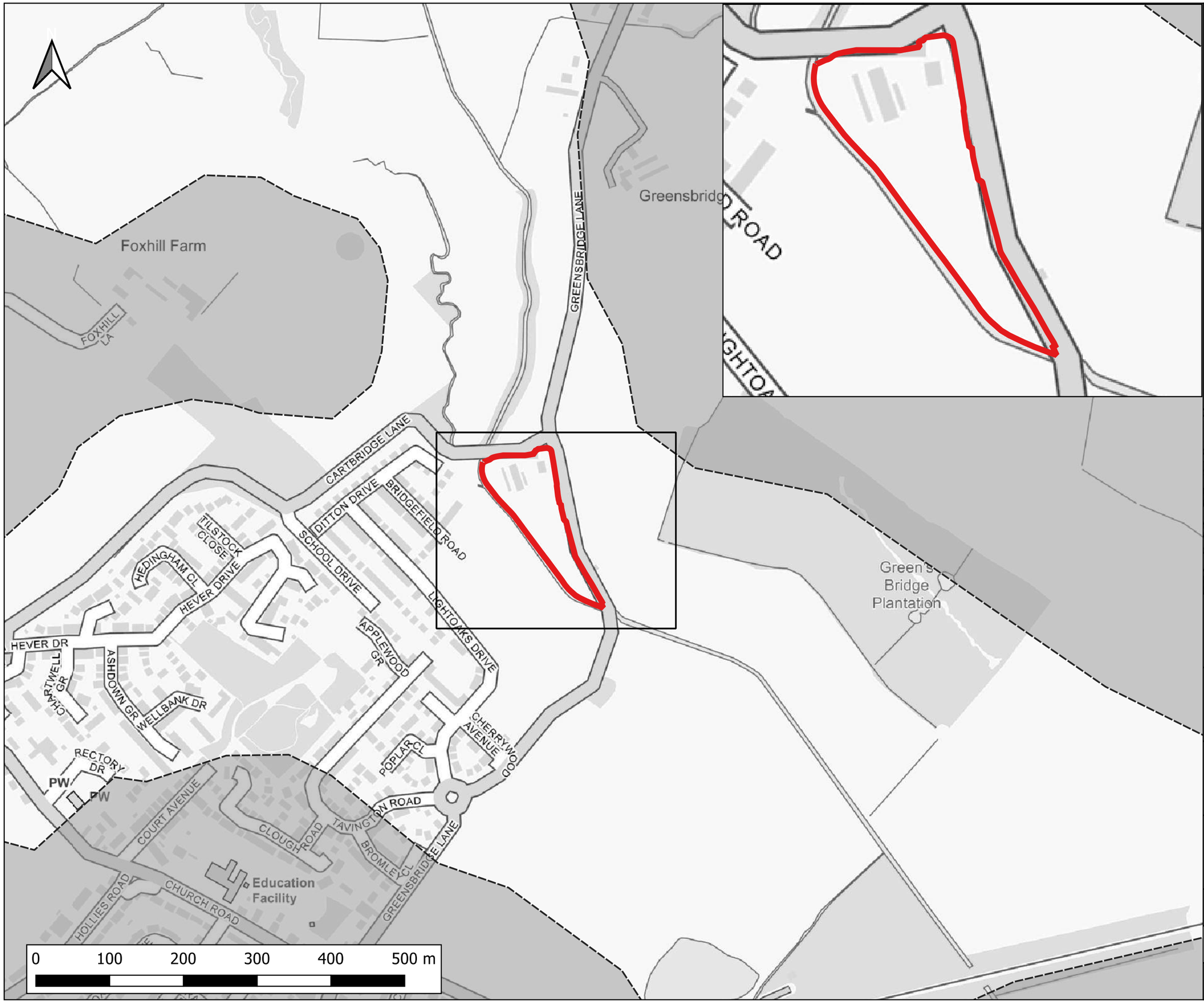

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_NC_015_ZUK2_Max	-

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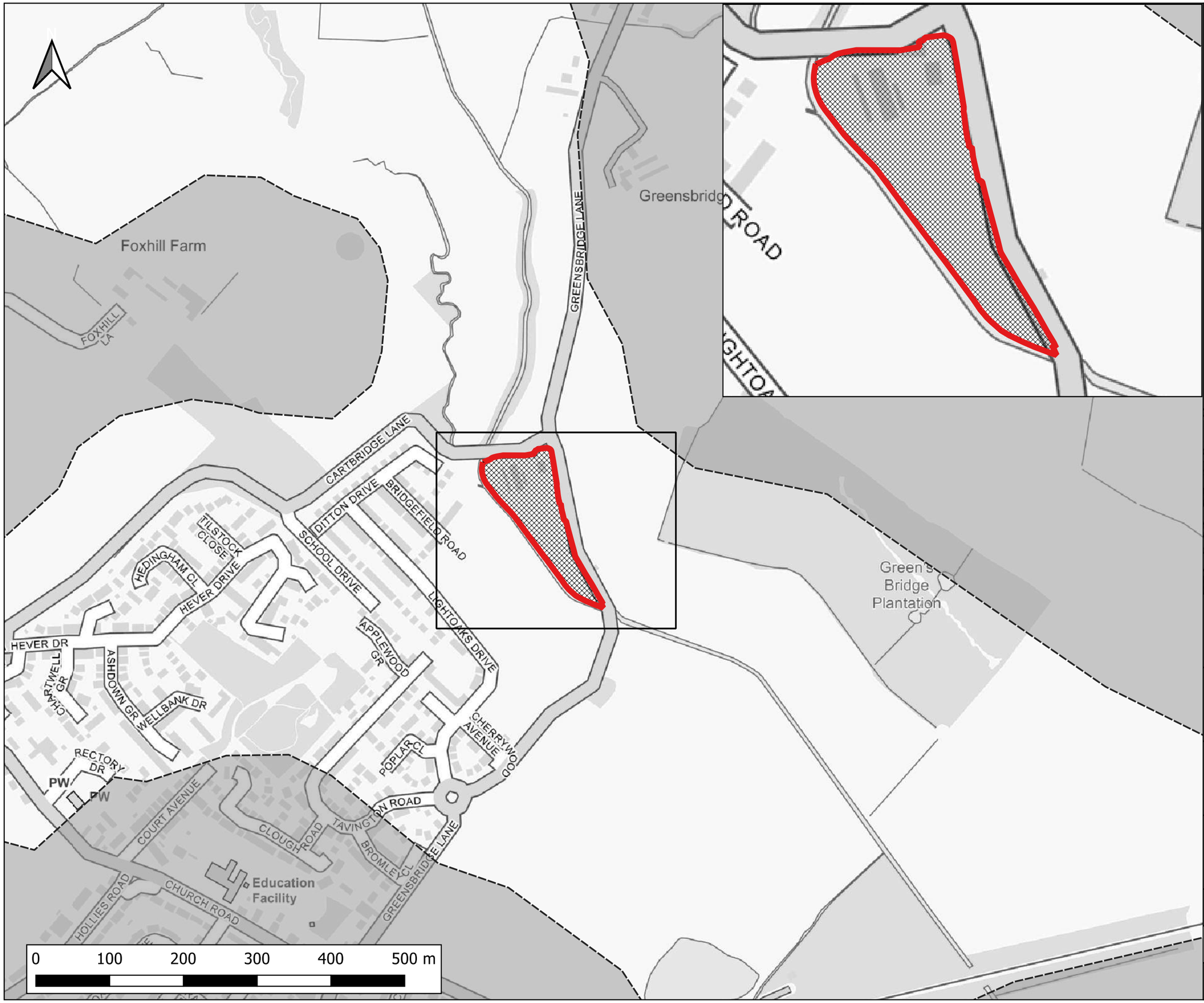

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_NC_015_ZUK2_Max	-

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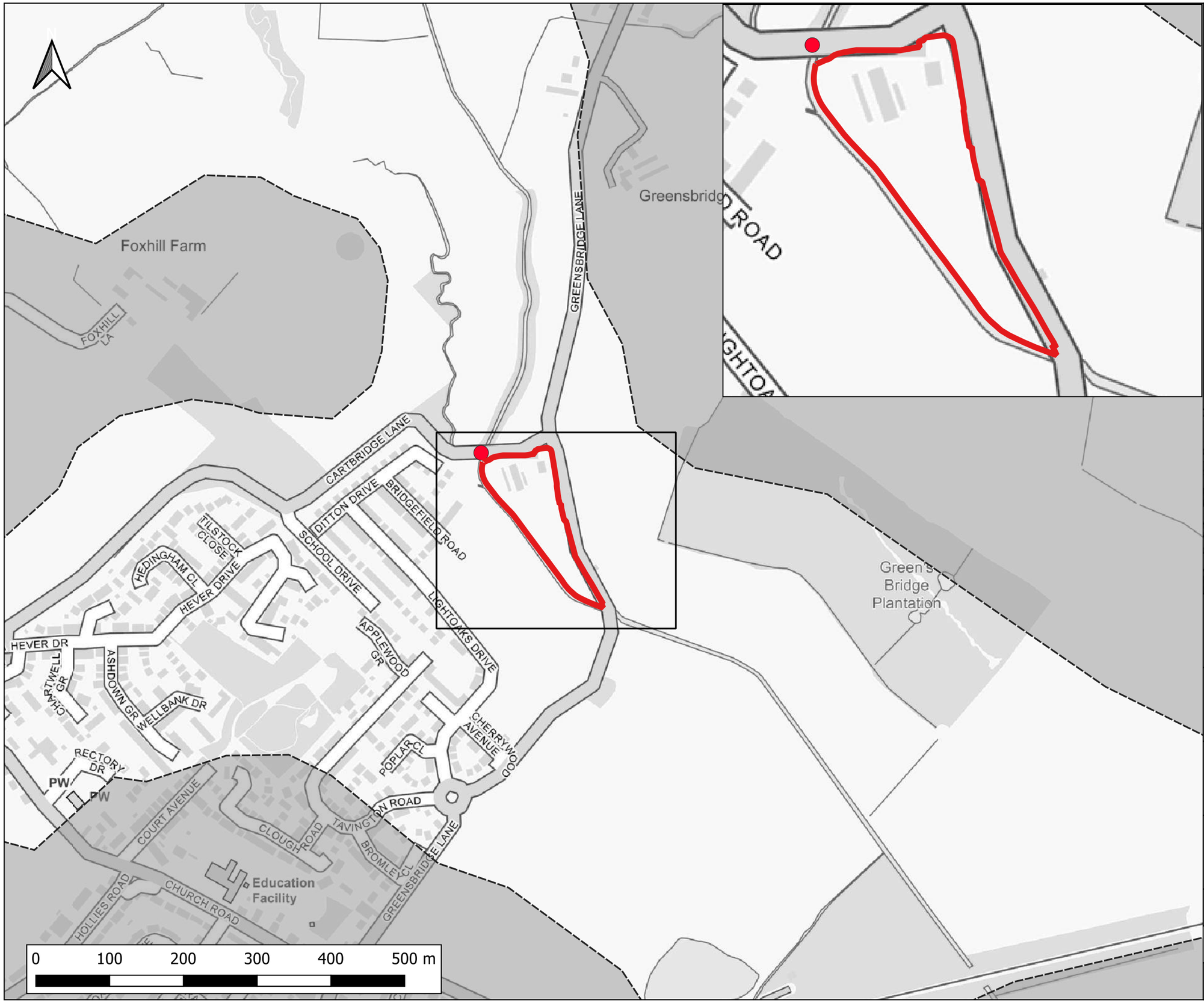


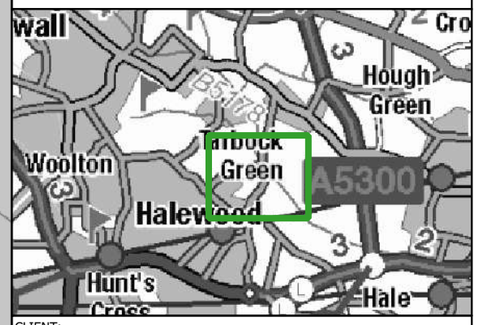
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Blockage 1

Maximum Flood Hazard Rating (FD2320)

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



CLIENT:
BBE Developments Ltd

waterco
www.waterco.co.uk

SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL1_015_ZUK2_Max	-

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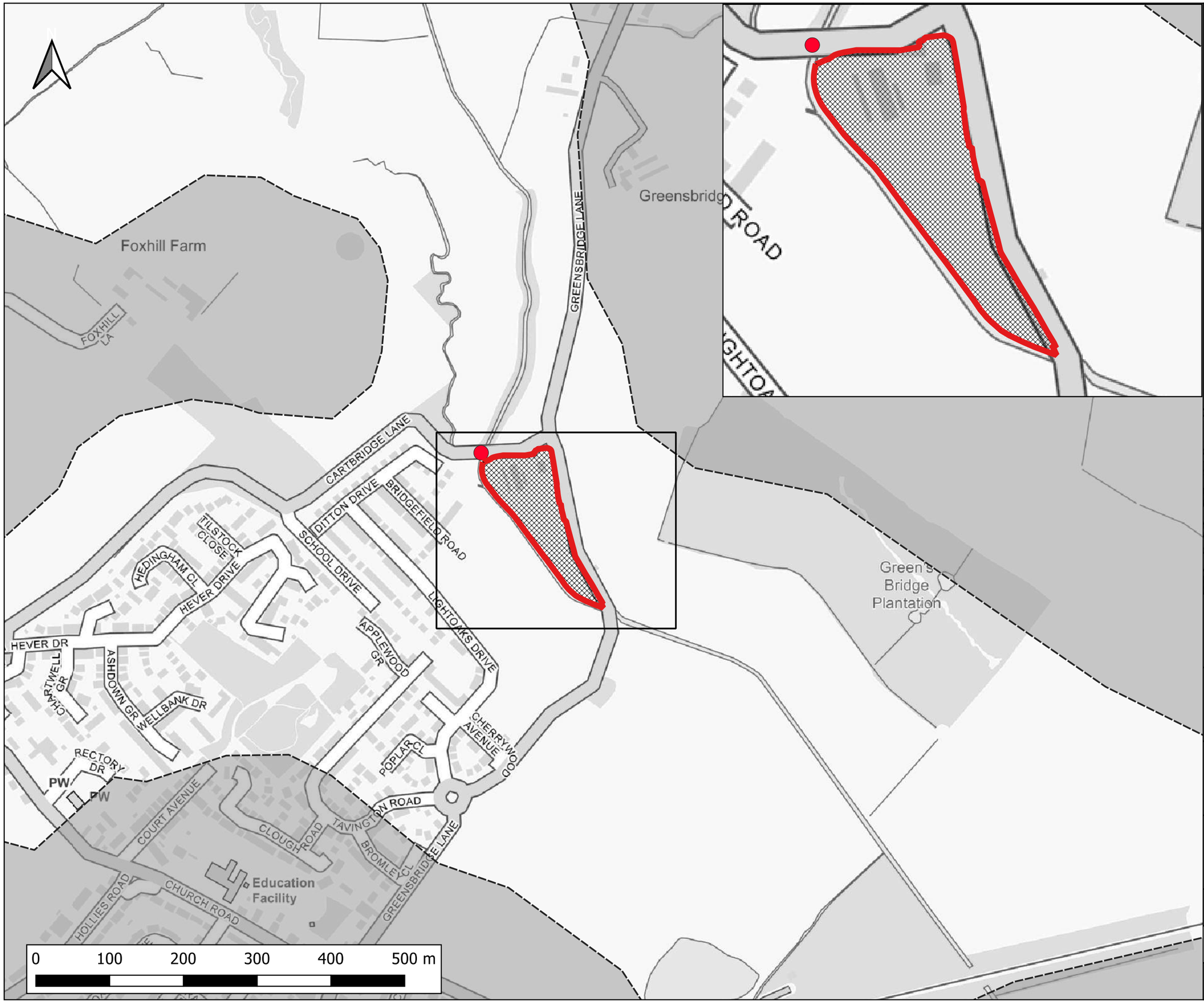

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Blockage 1

Maximum Flood Hazard Rating (FD2320)

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

CLIENT:
BBE Developments Ltd

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL1_015_ZUK2_Max	-

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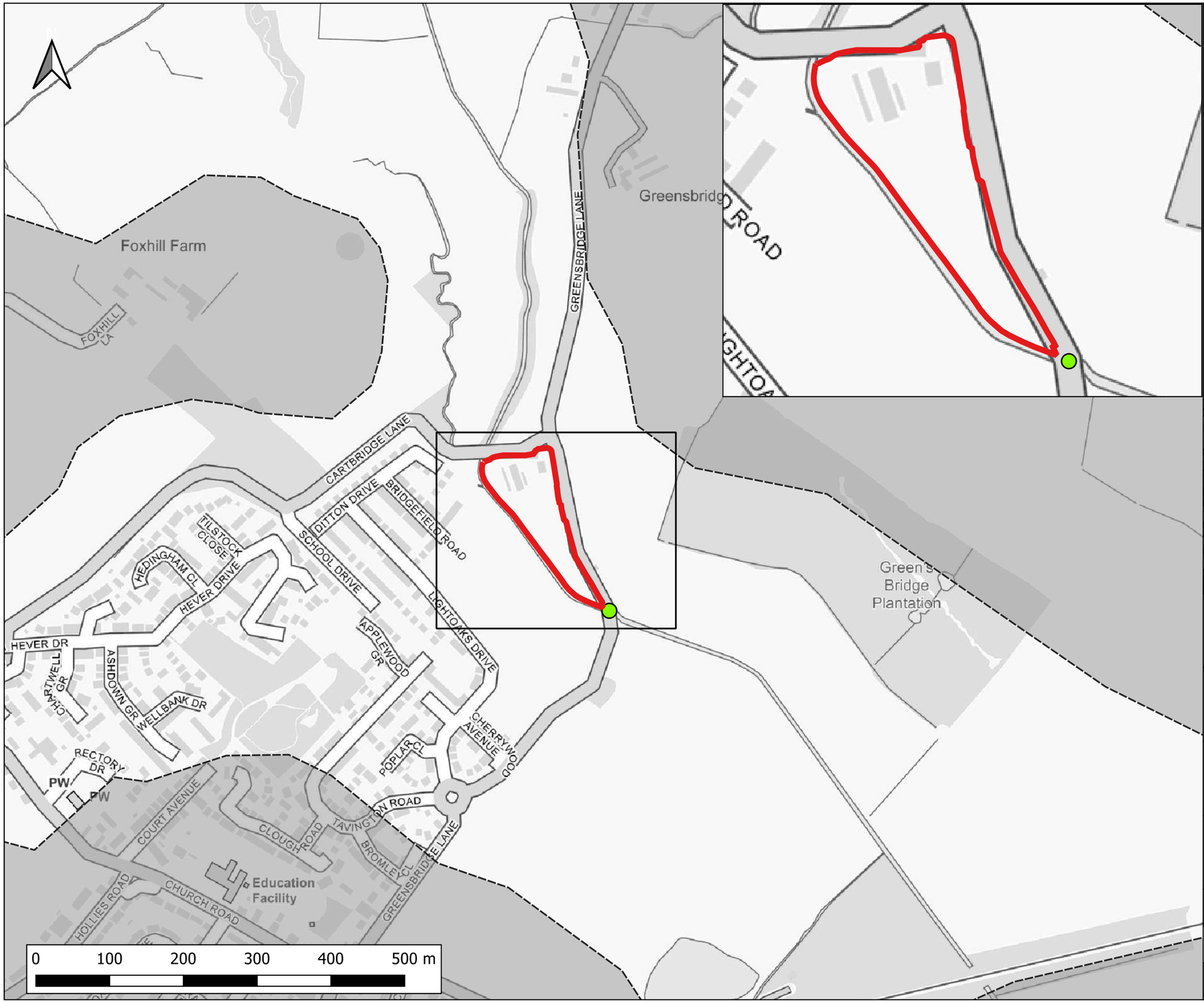


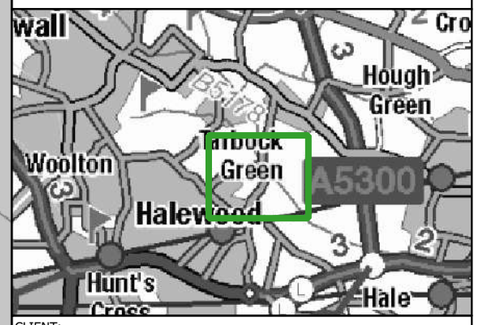
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Blockage 2

Maximum Flood Hazard Rating (FD2320)

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



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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL2_015_ZUK2_Max	-

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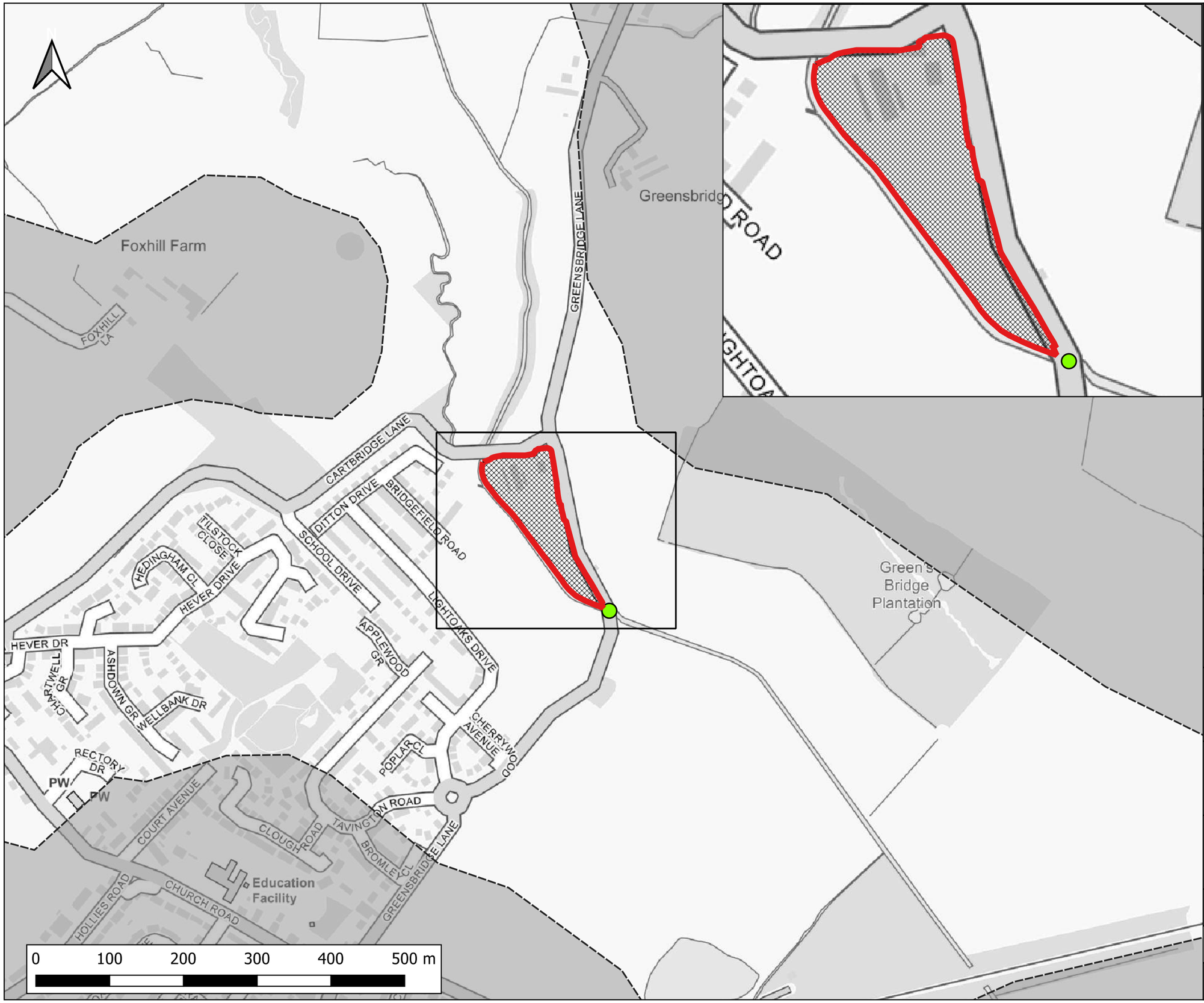

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Blockage 2

Maximum Flood Hazard Rating (FD2320)

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

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL2_015_ZUK2_Max	-

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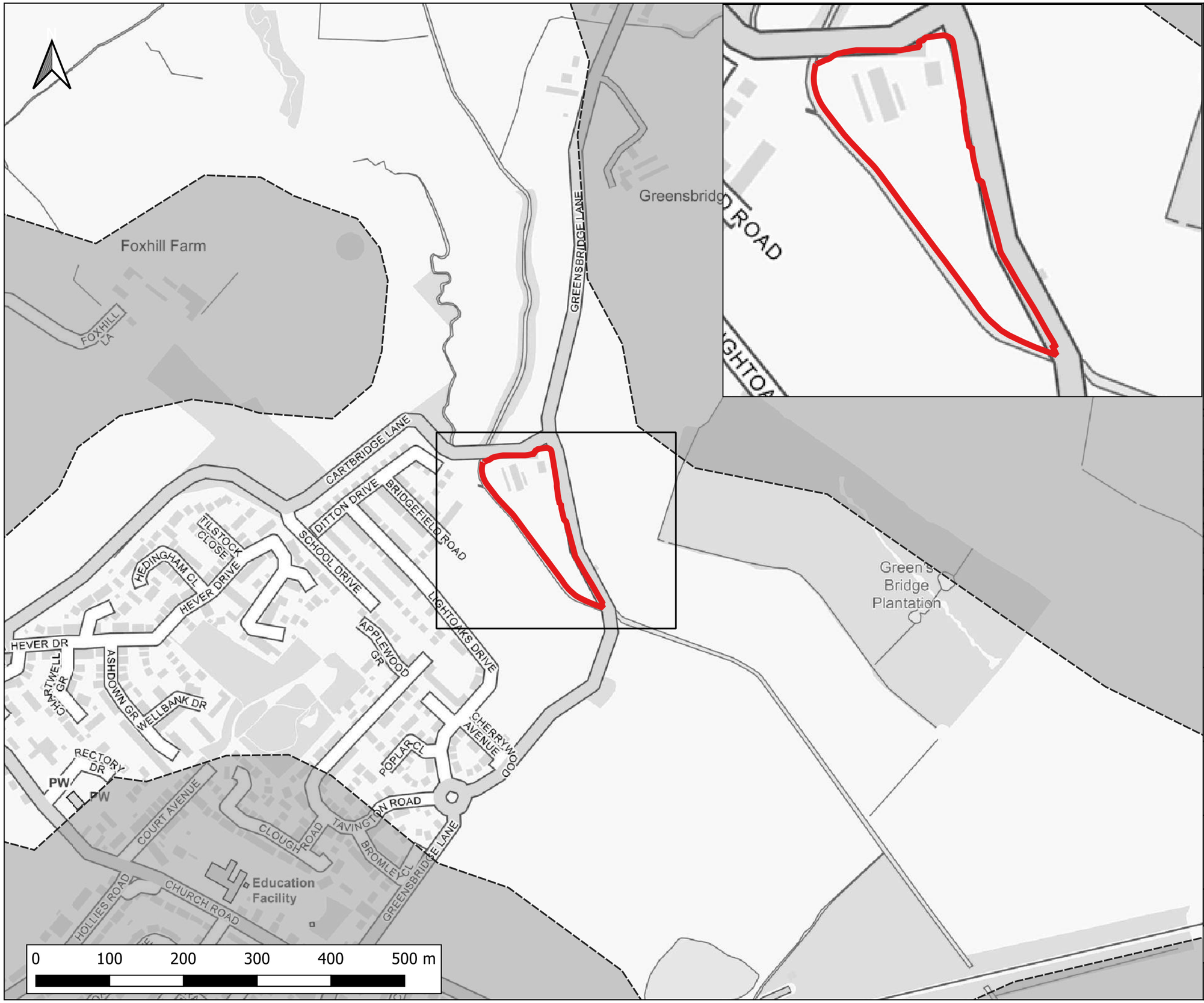

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent

Maximum Flood Hazard Rating (FD2320)

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

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
0.1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_EXG_NC_015_ZUK2_Max	-

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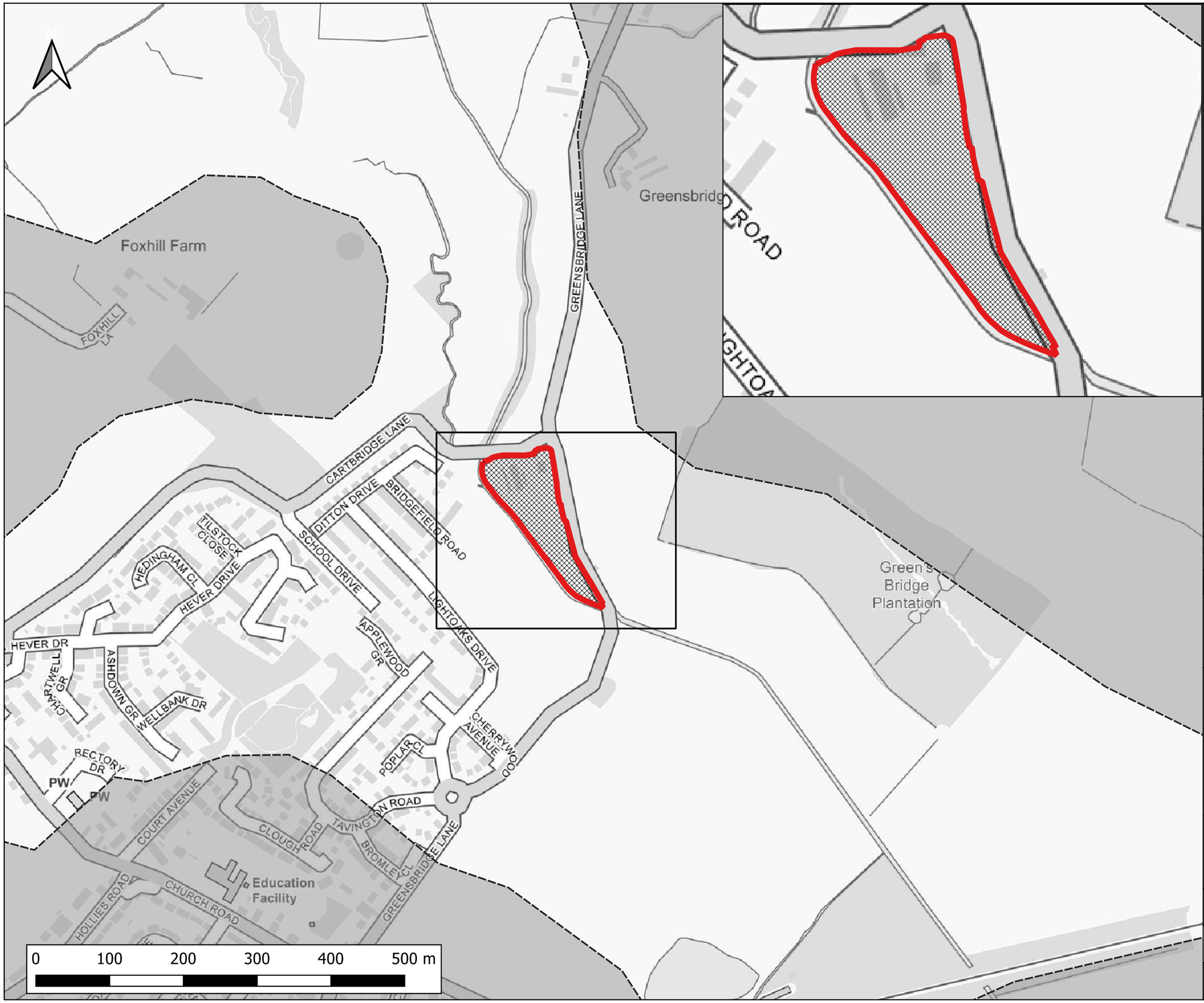

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform

Maximum Flood Hazard Rating (FD2320)

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

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Flood Hazard Rating
0.1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:5000

PLOT NAME:	REVISION:
14506-Neth_Q1000_DEVSITE_NC_015_ZUK2_Max	-

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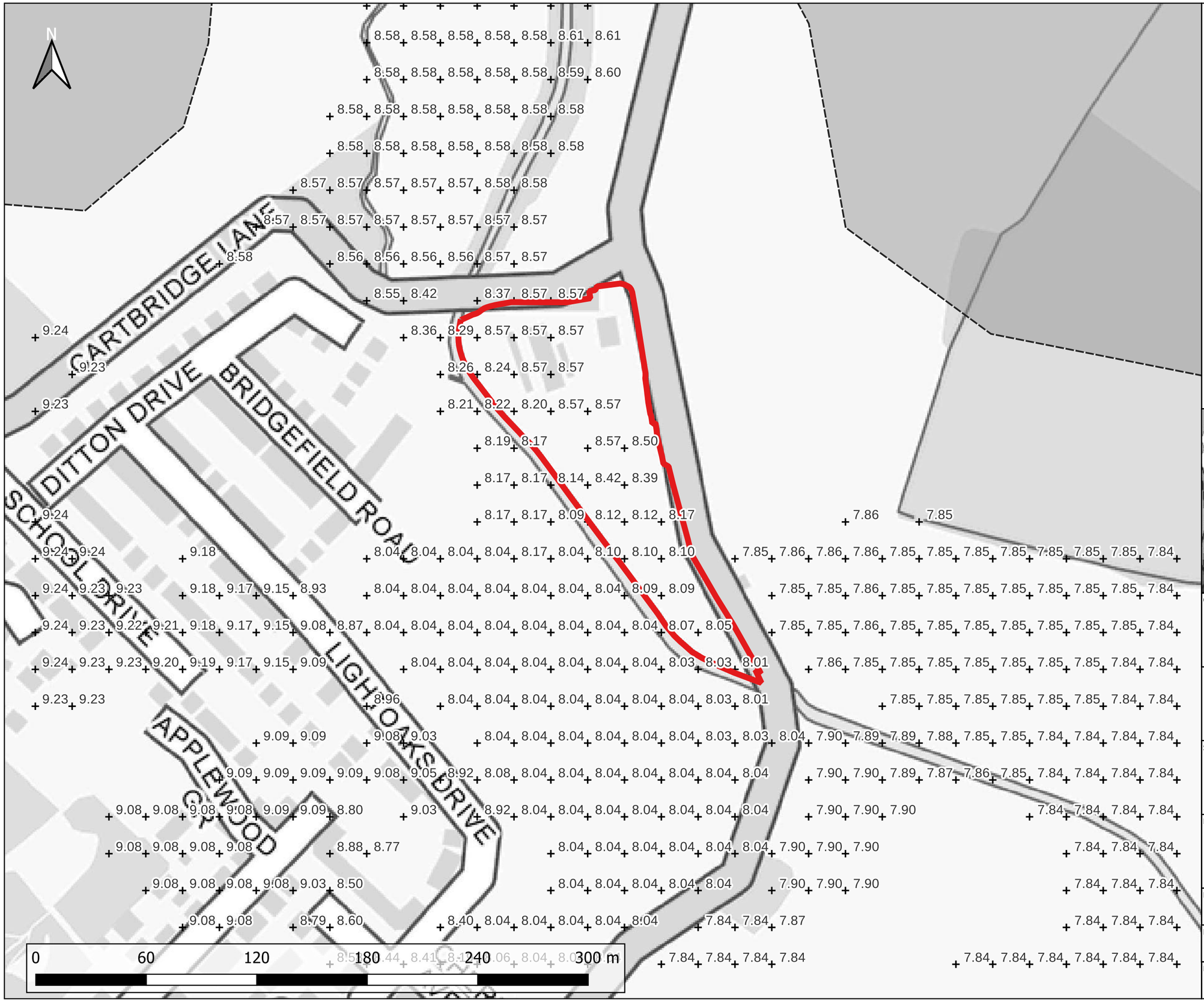
Appendix I 2D Model Water Level Map



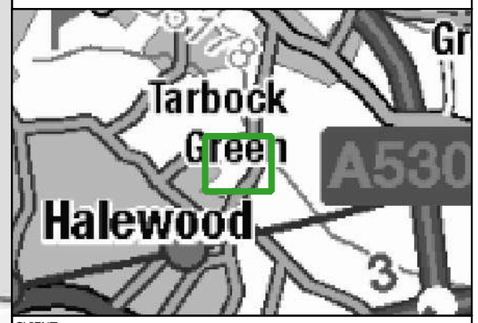
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Water Level (m AOD)

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m



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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_NC_015_h_Max_P	-

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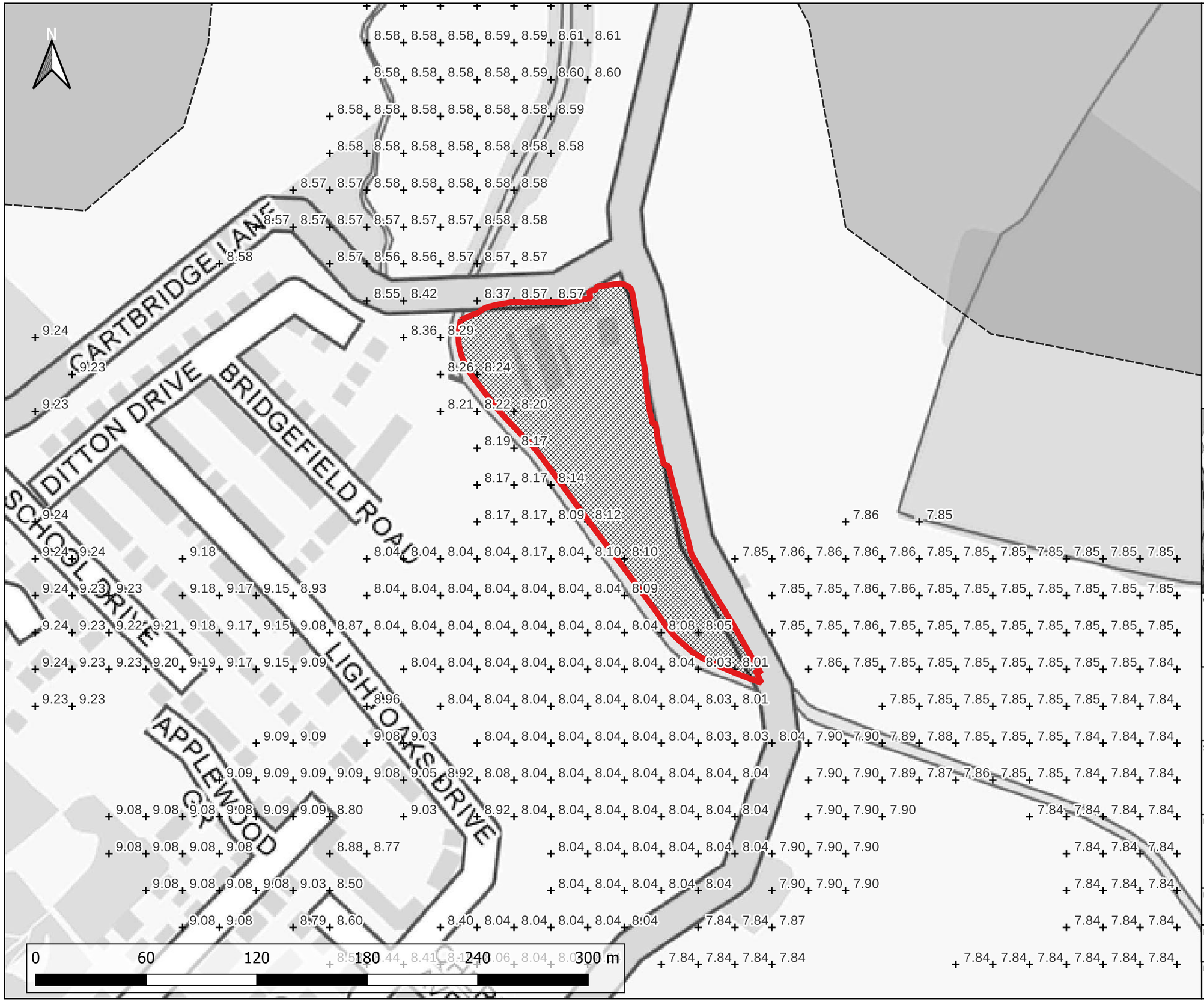


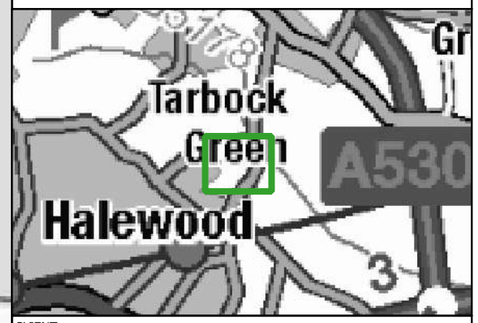
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Water Level (m AOD)

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m



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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_NC_015_h_Max_P	-

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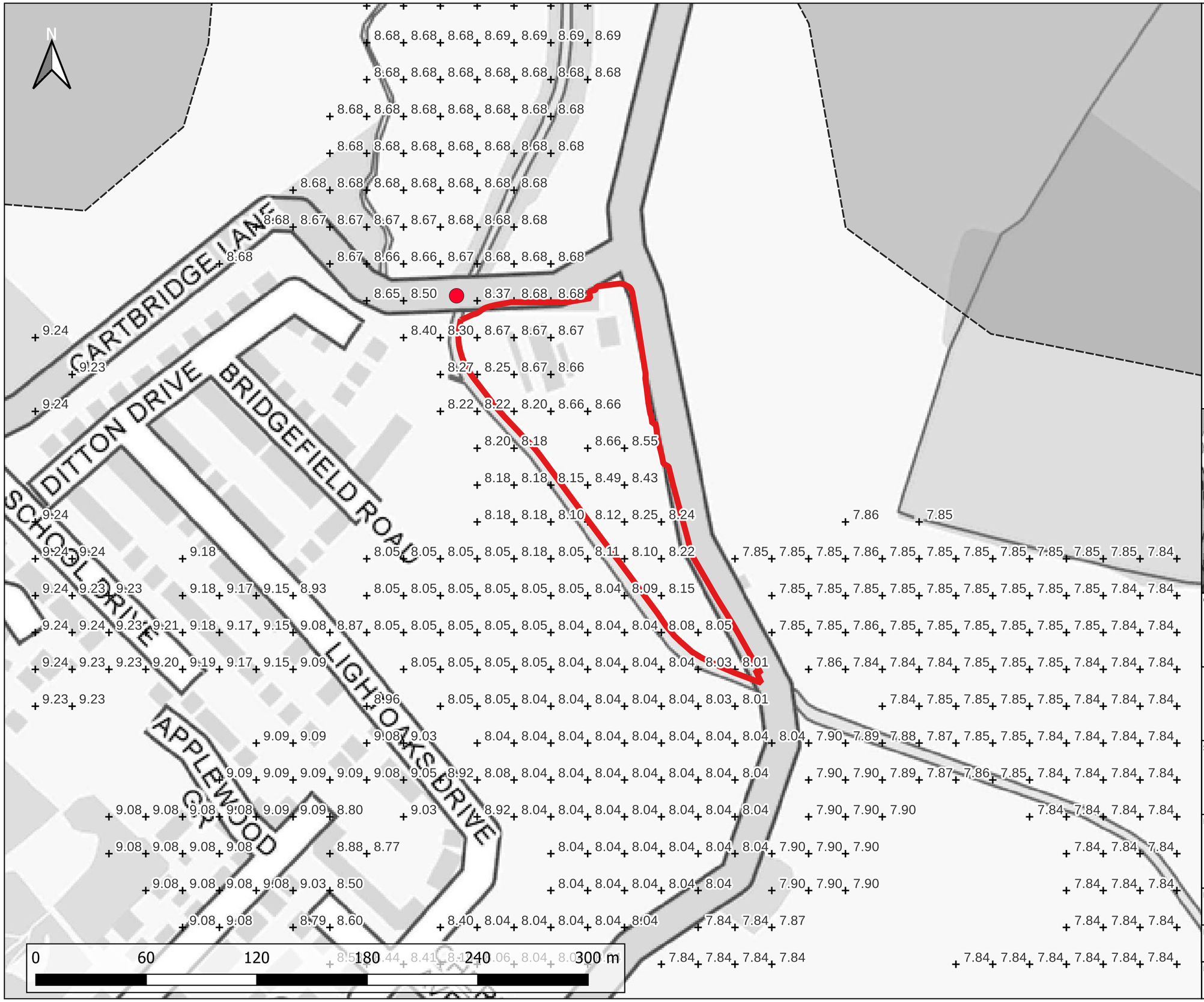


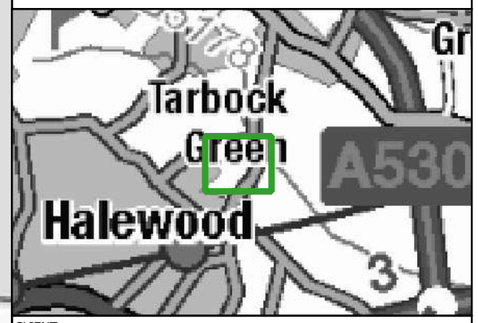
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Blockage 1
- 2D Model Extent
- Water Level (m AOD)

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m



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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL1_015_h_Max_P	-

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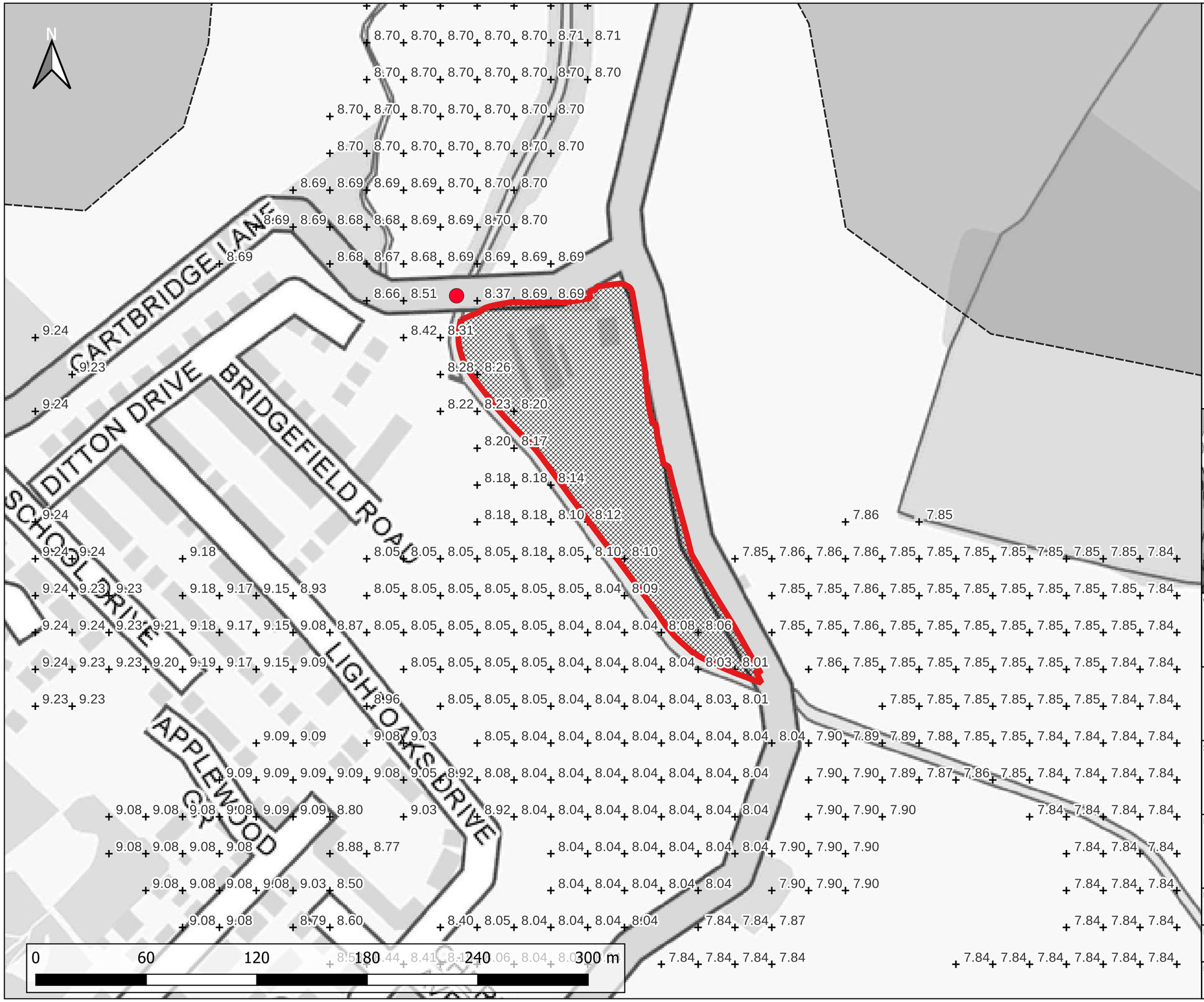

Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Blockage 1
- 2D Model Extent
- Development Platform
- Water Level (m AOD)

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
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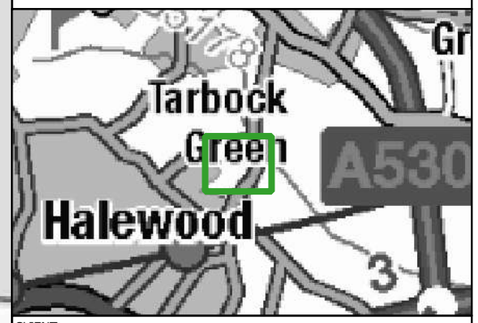

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Cartbridge Lane (BL1)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL1_015_h_Max_P	-

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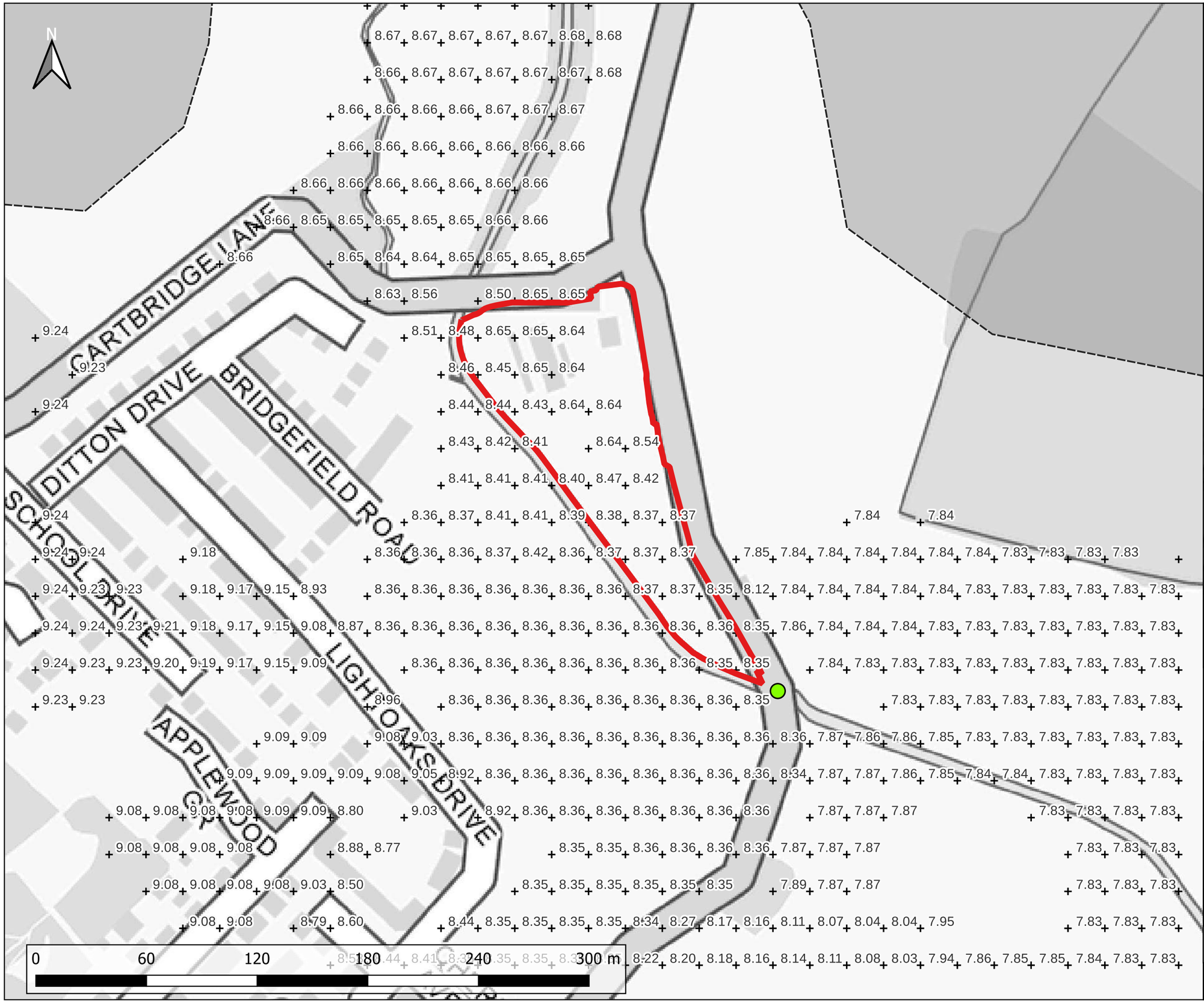


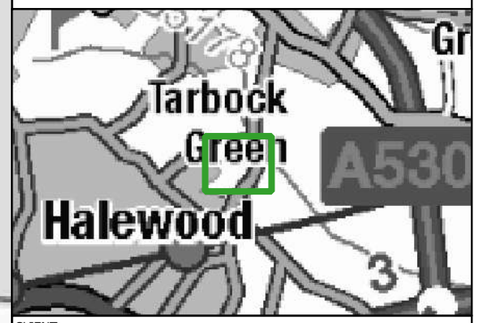
Notes:
1) All dimensions are in metres and all levels in metres above Ordnance Datum unless stated otherwise

LEGEND

- Site Boundary
- Blockage 2
- 2D Model Extent
- Water Level (m AOD)

Maximum Flood Depth (m)

- <= 0.3m
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m



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SCHEME:
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PLOT TITLE:
Maximum Water Level
1% AEP + 44% CC Fluvial Event
Existing Scenario (EXG) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_EXG_BL2_015_h_Max_P	-

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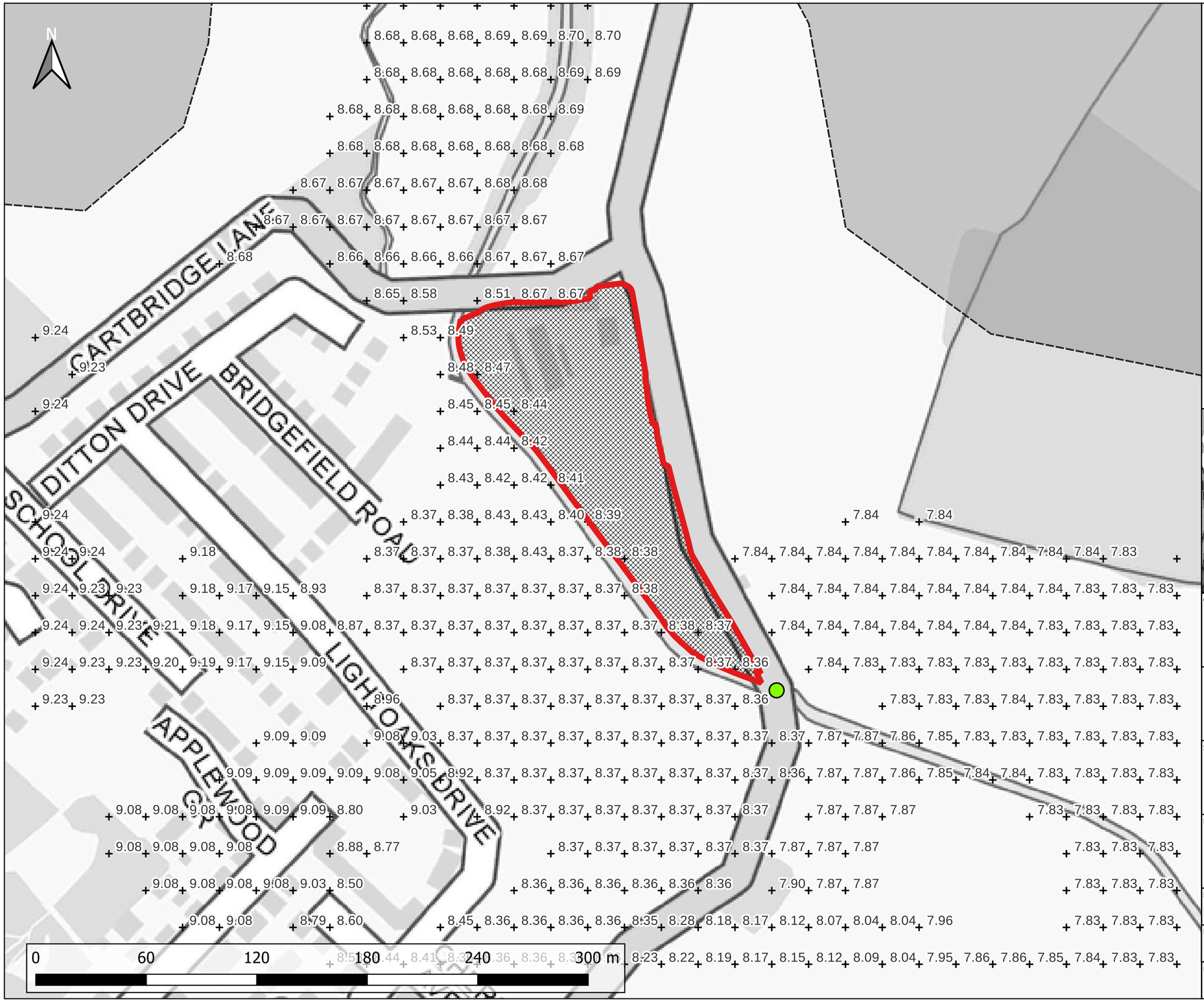

Notes:
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LEGEND

- Site Boundary
- Blockage 2
- 2D Model Extent
- Development Platform
- Water Level (m AOD)

Maximum Flood Depth (m)

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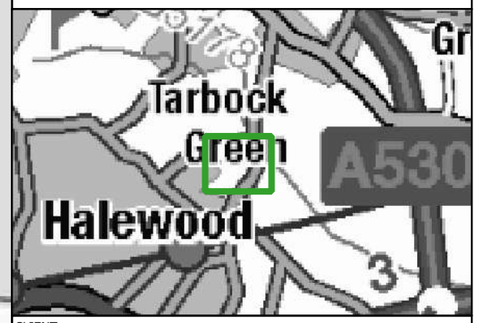

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
1% AEP + 44% CC Fluvial Event
Proposed Development (DEV) 33% Blockage of Greensbridge Lane (BL2)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q100CC44_DEVSITE_BL2_015_h_Max_P	-

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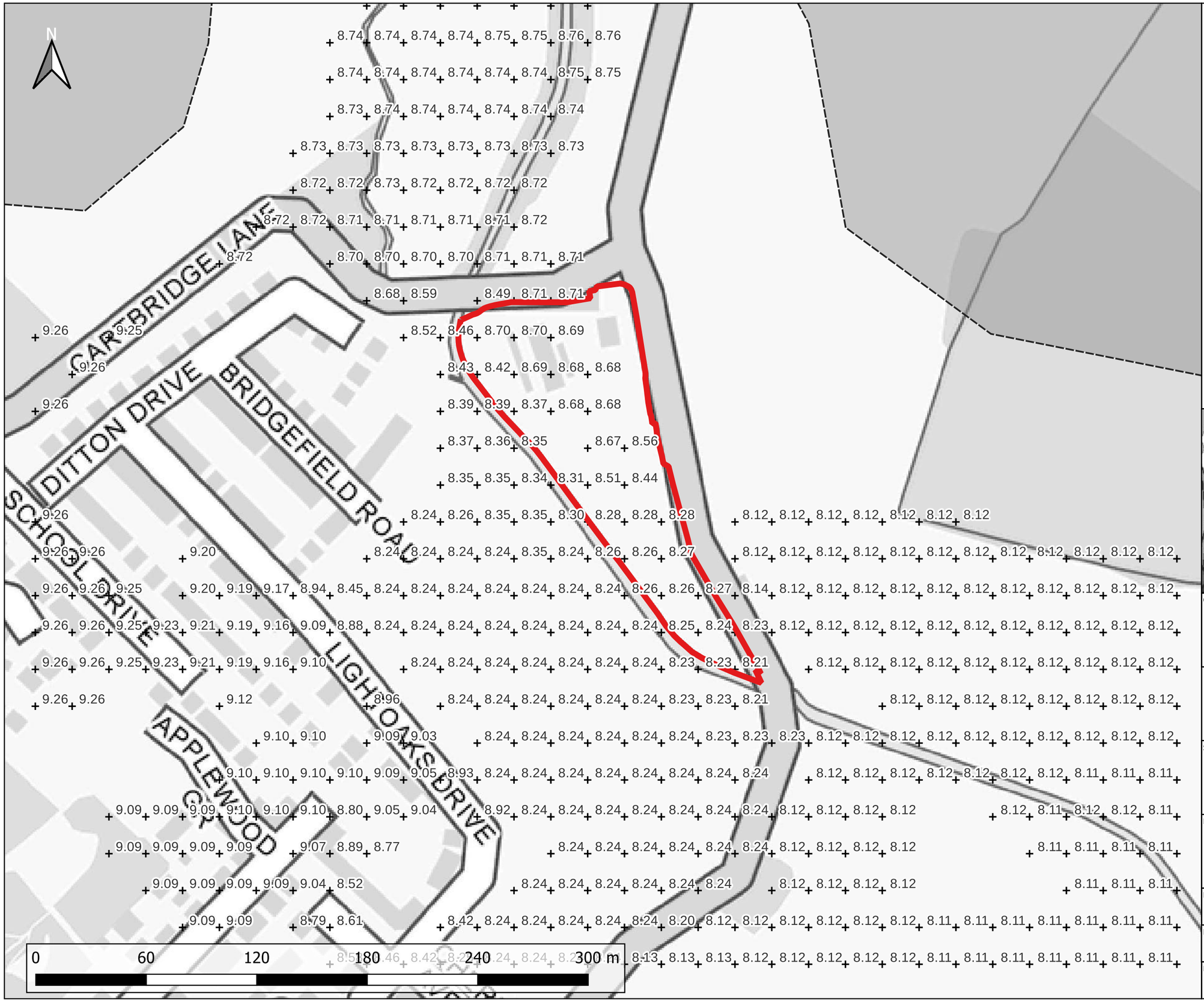

Notes:
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LEGEND

- Site Boundary
- 2D Model Extent
- Water Level (m AOD)

Maximum Flood Depth (m)

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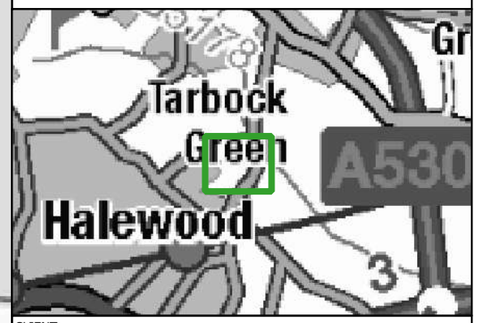

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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
0.1% AEP Fluvial Event
Existing Scenario (EXG)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q1000_EXG_NC_015_h_Max_P	-

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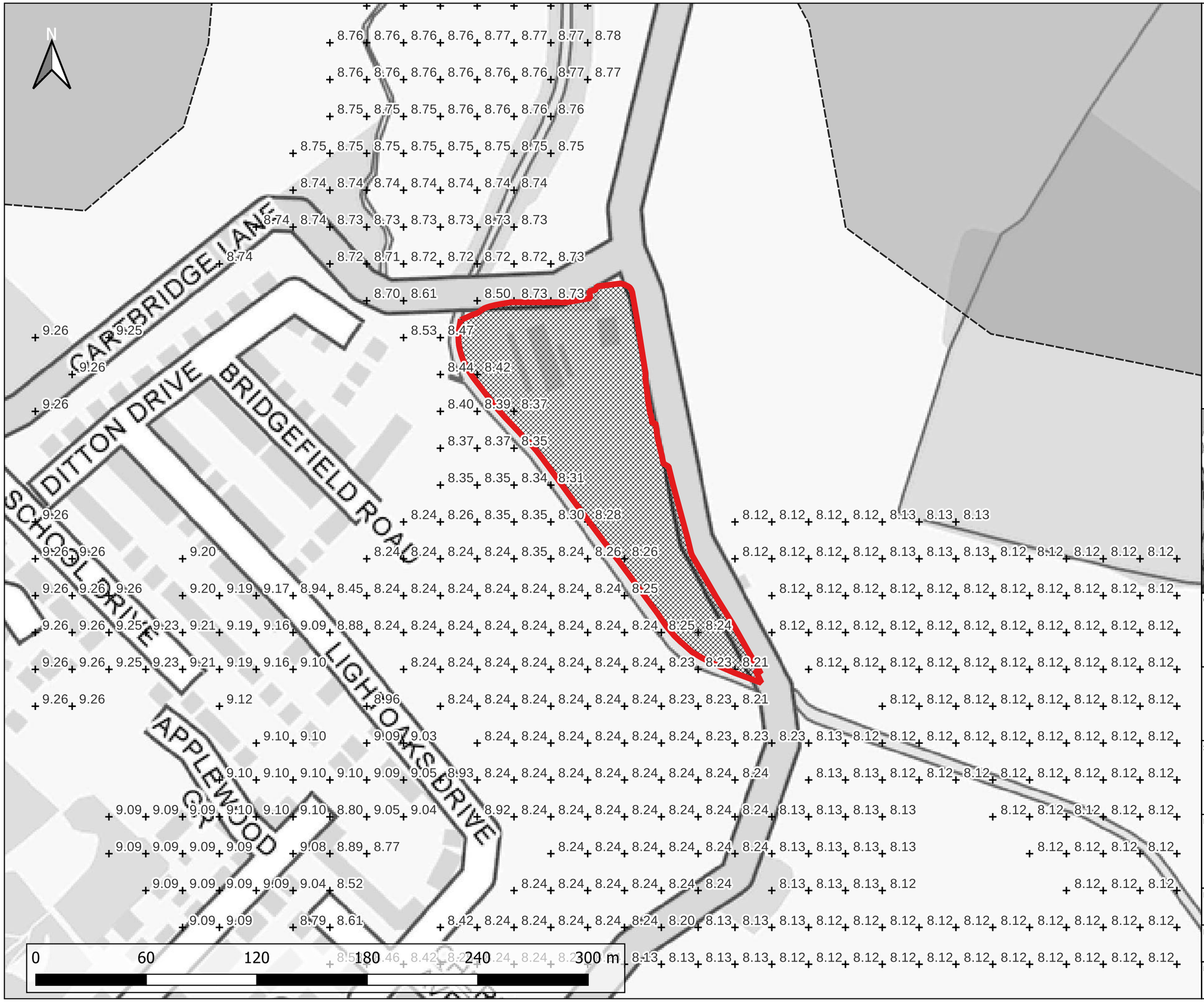

Notes:
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LEGEND

- Site Boundary
- 2D Model Extent
- Development Platform
- Water Level (m AOD)

Maximum Flood Depth (m)

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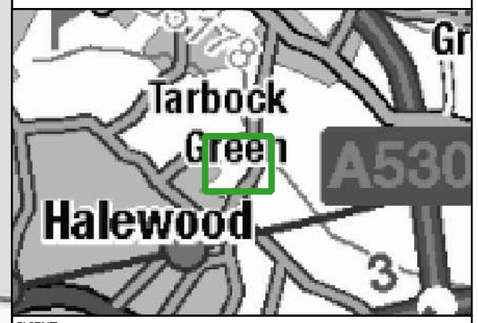
- 0.3m - 0.6m
- 0.6m - 1.2m
- 1.2m - 2.4m
- > 2.4m



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SCHEME:
Former Merseyside Dogs Home, East Halewood

PLOT TITLE:
Maximum Water Level
0.1% AEP Fluvial Event
Proposed Development (DEV)

PLOT STATUS:	DATE:
FINAL	16-11-2022

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
AQ	LW	AP	1:2000

PLOT NAME:	REVISION:
14506-Neth_Q1000_DEVSITE_NC_015_h_Max_P	-

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