Martha Hughes

From: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Sent: 18 September 2024 09:54
To: Martha Hughes
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Good morning Martha

Apologies for the delay in replying I've been on leave and am catching up on emails, our Hydrology team have confirmed that your methodology is suitable.

Kind regards

Richard Derrick
Arweinydd Tim Dadansoddi Perygl Llifogydd/ Team Leader Flood Risk Analysis
Rheoli Llifogydd a Dwr / Flood and Water Management
Rhif ffôn / Phone number 03000 653037

Croesewir gohebiaeth yn Gymraeg a byddwn yn ymateb yn Gymraeg, heb i hynny arwain at oedi.
Correspondence in Welsh is welcomed, and we will respond in Welsh without it leading to a delay.

From: Martha Hughes <martha.hughes@waterco.co.uk>
Sent: Wednesday, September 18, 2024 9:37 AM
To: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Cc: Bethan Lloyd Jones <Bethan.LloydJones@waterco.co.uk>
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Caution: This email originated from outside of the organisation. Do not click links, open attachments or scan QR Codes unless you recognise the sender and know the content is safe.

Good morning Richard,

I hope you are well.

Is there an update on when we can expect to receive a response from the hydrology team to our proposed methodology?

Kind Regards,

Martha Hughes MSc
Hydraulic Modeller

martha.hughes@waterco.co.uk

From: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Sent: 29 August 2024 16:47
To: Martha Hughes <martha.hughes@waterco.co.uk>
Cc: Bethan Lloyd Jones <Bethan.LloydJones@waterco.co.uk>
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Caution: This is an external email and may be malicious. Please take care when clicking links or opening attachments.

Good afternoon Martha

Thank you for your email, I have passed it on to our hydrology team for their comments. I'm on leave from tomorrow for two weeks so a member of my team will send on their comments when we receive them.

Kind Regards

Richard Derrick
Arweinydd Tim Dadansoddi Perygl Llifogydd/ Team Leader Flood Risk Analysis
Rheoli Llifogydd a Dwr / Flood and Water Management
Rhif ffôn / Phone number 03000 653037

Croesewir gohebiaeth yn Gymraeg a byddwn yn ymateb yn Gymraeg, heb i hynny arwain at oedi.

Correspondence in Welsh is welcomed, and we will respond in Welsh without it leading to a delay.

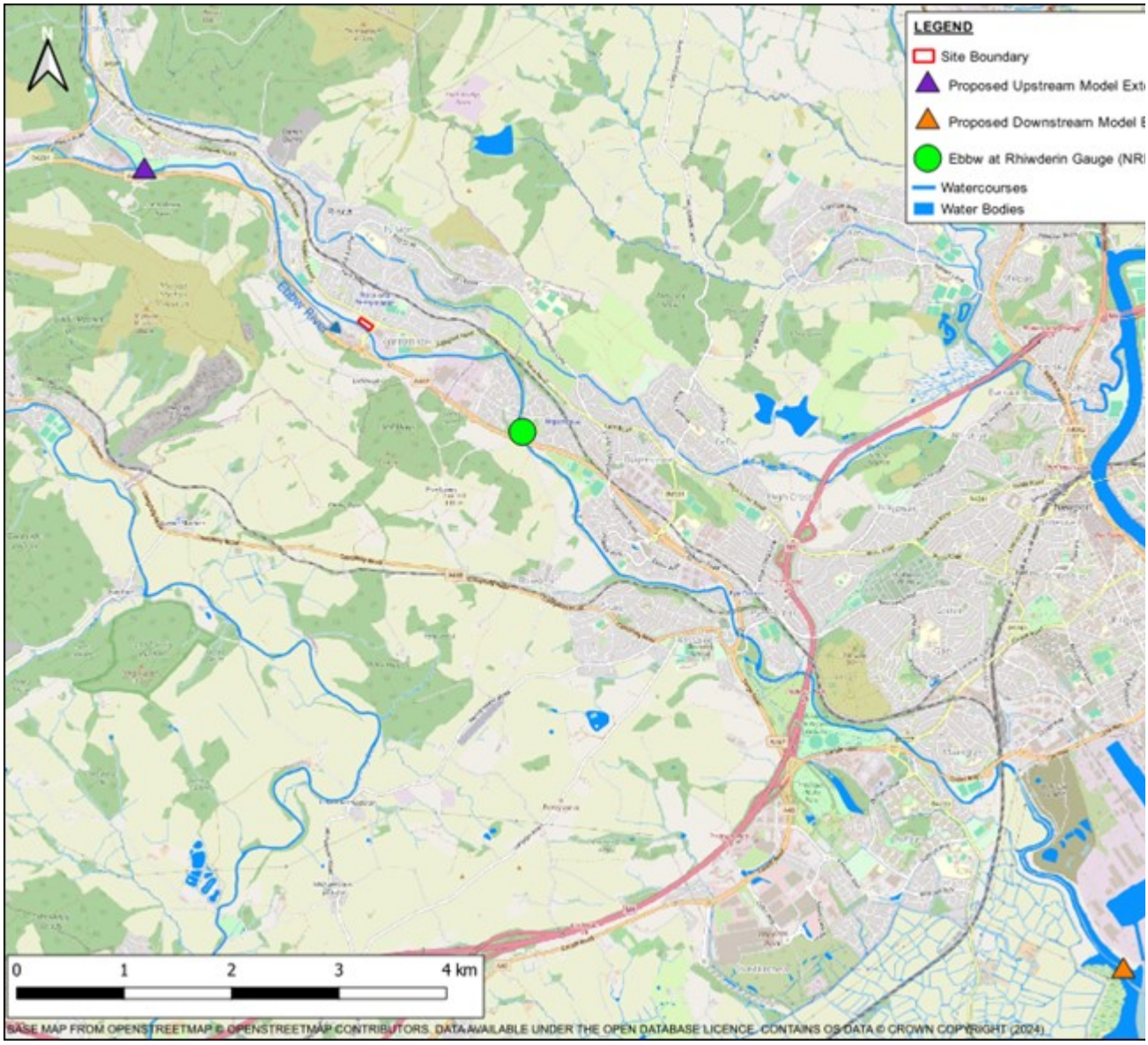
From: Martha Hughes <martha.hughes@waterco.co.uk>
Sent: Thursday, August 29, 2024 4:37 PM
To: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Cc: Bethan Lloyd Jones <Bethan.LloydJones@waterco.co.uk>
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Good afternoon Richard,

Further to your email below, we have reviewed the Ebbw River Hydrology Assessment Report provided (Ebbw Baseline Hydrology and Addendum to the Ebbw Baseline Hydrology, 2017) and the hydraulic model (EbbwLowerICM_5_V1.0_2018). Please see below an outline plan for the completion of the updated hydrology for your comment.

Proposed Methodology

- Model extent - the upstream extent of the hydraulic model will be truncated to the confluence between the Ebbw River and the Sirhowy River. The downstream extent of the model is to be maintained as per the NRW model. See extent outlined below.



- Due to the locations of the upstream and downstream boundaries of the hydraulic model and the large catchment area (>200km^2), a single inflow will be required for the hydraulic model.
- A single inflow is also recommended by our hydrology team due to the presence of a reliable gauging station 2.2km downstream of the subject site (Ebbw at Rhiwderin, NRFA ID 56002). There is a small catchment area difference between the catchment adjacent to the subject site and the catchment at the gauging station. The catchment area adjacent to the site is 207.34km^2 and at the gauging station is 211km^2, a difference in catchment area of 2%.
- A single catchment assessment will be carried out at the Ebbw at Rhiwderin gauging station using the enhanced single site analysis method. Gauged data has been requested from NRW for this station. The data will be used for two purposes, the first is to ensure that the number of AMAX years includes the most recent data and the second is to use the 15 minute gauge data for the AMAX floods to compare the real hydrograph shape with that of REFH2 and then possibly to use the real shape as the shape of the design hydrograph. **Please advise if you have any concerns about us using this particular station.**
- The results will be compared with historical flood records and the AMAX data on record.
- The two methods investigated will be ReFH2 and FEH Statistical Enhanced Single Site. ReFH2 will unlikely be the chosen method to produce the final peak flows due to the seemingly reliable gauge near to the site.
- Given the size of the model extent further downstream of our proposed calculation point, we propose to maintain the existing NRW hydrology within the hydraulic model downstream of our calculation point. Given the distance (~2.2km) from the site this will have negligible impact on water levels at the site. The reason for including the hydrology is to ensure the model still simulates.
- Gauged data for the three gauging stations located within the catchment (Ebbw at Rhiwderin, Sirhowy at Wattsville and Ebbw at Aberbeeg), any rain gauges and historical flood information has been requested.

If you do have any comments on the details above, please do not hesitate to let us know.

Kind Regards,

Martha Hughes MSc
Hydraulic Modeller

martha.hughes@waterco.co.uk

We're recruiting! For more information, please take a look at our website.

From: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Sent: 23 August 2024 13:36
To: Martha Hughes <martha.hughes@waterco.co.uk>
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Good afternoon Martha

Sorry for the delay in replying, I have spoken to our Hydrology team and they have confirmed that the updated hydrology is required and they will reject any modelling based on the existing hydrology.

Hope this clarifies the position, please come back to me if there's anything else I can do to help.

Kind Regards
Rich

Richard Derrick
Arweinydd Tim Dadansoddi Perygl Llifogydd/ Team Leader Flood Risk Analysis
Rheoli Llifogydd a Dwr / Flood and Water Management
Rhif ffôn / Phone number 03000 653037

Croesewir gohebiaeth yn Gymraeg a byddwn yn ymateb yn Gymraeg, heb i hynny arwain at oedi.
Correspondence in Welsh is welcomed, and we will respond in Welsh without it leading to a delay.

From: Martha Hughes <martha.hughes@waterco.co.uk>
Sent: Friday, August 16, 2024 3:22 PM
To: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Subject: FW: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Good afternoon Richard,

Please can you advise on my previous email and confirm whether the hydrology update is advisable or are the updates necessary to ensure that the model is suitable to support a planning application (are NRW likely object to a planning application if the hydrology in the model was not updated?).

Kind Regards,

Martha Hughes MSc
Hydraulic Modeller

martha.hughes@waterco.co.uk

From: Martha Hughes
Sent: 09 August 2024 15:47
To: 'Derrick, Richard' <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Hi Richard,

Thank you for your reply. In terms of the hydrology, please could you confirm whether these are recommended (advisable), or are the updates necessary to ensure the model is suitable to support a planning application i.e. would NRW likely object to a planning application if the hydrology in the model was not updated.

Kind Regards,

Martha Hughes MSc
Hydraulic Modeller

martha.hughes@waterco.co.uk

From: Derrick, Richard <Richard.Derrick@cyfoethnaturiolcymru.gov.uk>
Sent: 08 August 2024 12:21
To: Martha Hughes <martha.hughes@waterco.co.uk>
Subject: RE: 15679 - Land at Pontymister, Risca - Proposed Hydraulic Modelling Methodology

Good afternoon Martha

Thank you for your email outlining your methodology for a proposed hydraulic modelling study for Risca, please accept my sincere apologies for the delay in replying to you.

With regards to using the existing hydrology, our Hydrology team make the following comment:
1) there have been a number of dataset and software changes since 2019 and so revised hydrology would be recommended.

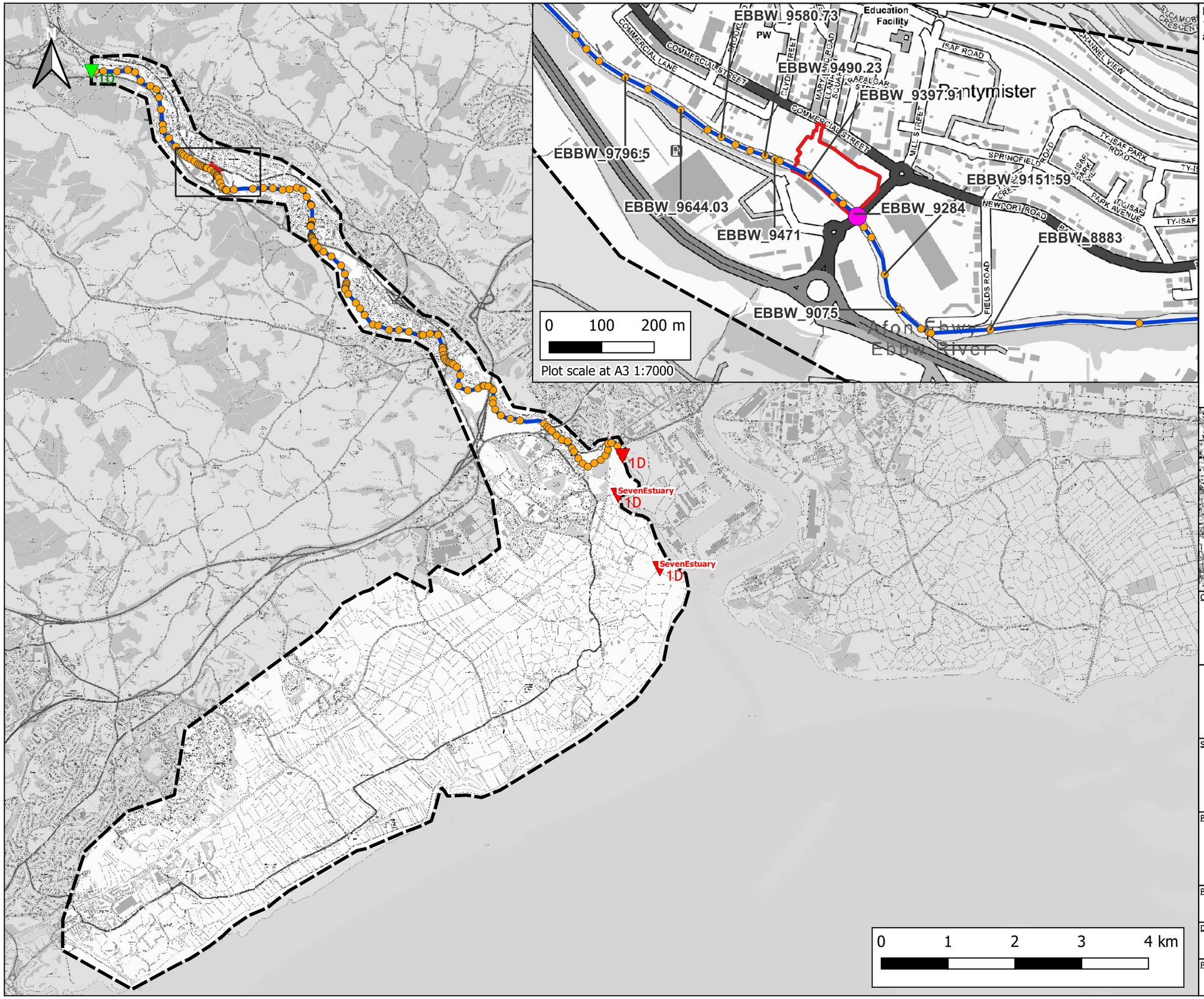
With regards to your methodology it is acceptable, however, I make the following comments:
1) We are not aware of any pre-existing issues with the model
2) There is new LiDAR available flown between 2020 and 2022 which is available from DataMapWales
3) If the model is to be truncated then we would recommend carrying out sensitivity analysis on the downstream boundary.

I hope this is of assistance to you but do please get in touch if I can be of further assistance.

Kind Regards

Richard Derrick

Appendix E 1D/2D Model Extent



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

LEGEND

- Site Boundary
- 2D Model Extent
- 1D Network
- 1D Cross Sections
- 1D Flow Boundary (QT)
- 1D Water Level Boundary (HT)
- Blockage Location 1 (BL1) - B4591 Bridge

CLIENT:

LIDL

Waterco
www.waterco.co.uk

SCHEME:

Land at Pontymister, Risca

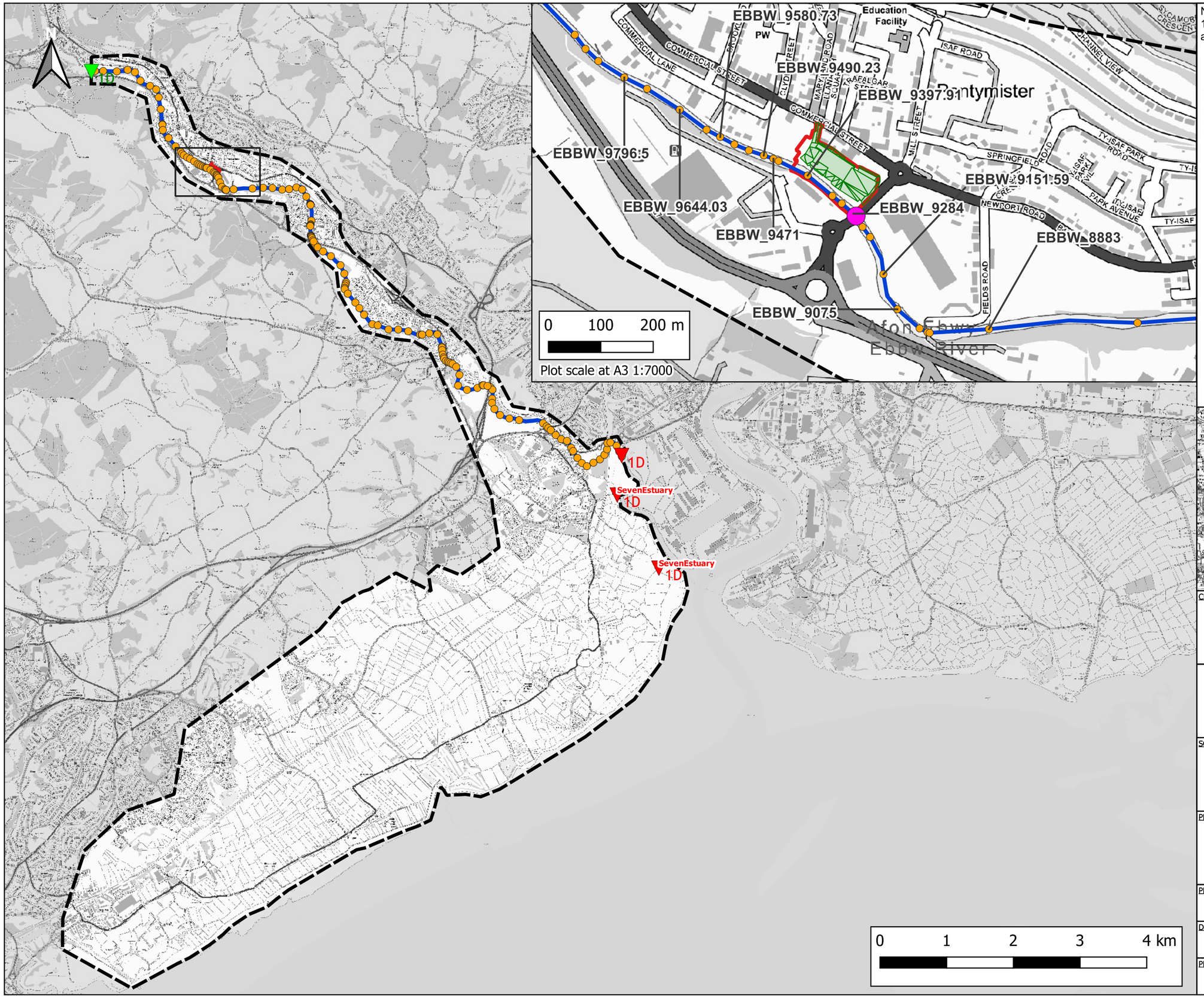
PLOT TITLE:

Model Extent
Existing Scenario

PLOT STATUS:	DATE:
FINAL	26-11-2024

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
MH	AA	LS	1:55000

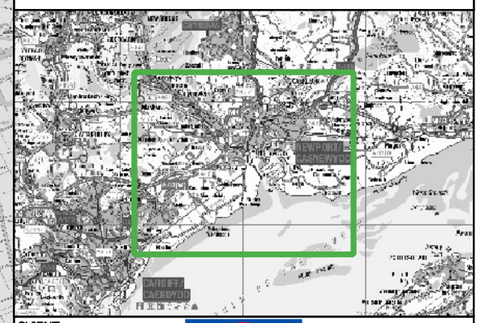
PLOT NAME:	REVISION:
15679_Model_Extent_Existing_Scenario	-



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

LEGEND

- Site Boundary
- 2D Model Extent
- 1D Network
- 1D Cross Sections
- 1D Flow Boundary (QT)
- 1D Water Level Boundary (HT)
- Blockage Location 1 (BL1) - B4591 Bridge
- Proposed Development Layout 2D Z-shape



CLIENT:

LIDL

Waterco
www.waterco.co.uk

SCHEME:

Land at Pontymister, Risca

PLOT TITLE:

Model Extent
Proposed Development Scenario

PLOT STATUS:	DATE:
FINAL	26-11-2024

DRAWN:	CHECKED:	APPROVED:	PLOT SCALE AT A3:
MH	AA	LS	1:55000

PLOT NAME:	REVISION:
15679_Model_Extent_Proposed-Development_Scenario	-

Appendix F Flood Estimation Calculation (FEC) Record

Flood estimation calculations record

Project	Land at Pontymister, Risca		**Date:** 4/11/2024
Job No	15679		
Revision	1	Date	Competence Level
Prepared by	Bethan Lloyd Jones BSc (Hons) MCIWEM C.WEM	17/10/2024	Level 3
Checked by	Louise Wilcock BSc (Hons) MCIWEM	21/10/2024	Level 2
Approved by	Adam Parkinson BSc (Hons) MCIWEM	31/10/2024	Level 3
Watercourse name:	Ebbw River		
Catchment NGR:	325850	188900	

River Basin District		
Severn		
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 NRW's FEC Record templates (GN 008 Flood estimation calculation record); supporting document to the Natural Resources Wales' 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

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: 325850, 188900	Ebbw River
Purpose of study and scope	Produce a single inflow hydrograph for the Ebbw River upstream of a proposed Lidl store	
Key catchment features	Moderately urbanised	
Flooding mechanisms	Fluvial	
Gauged / ungauged	Gauged	
Final choice of method	FEH Statistical Enhanced Single Site Analysis	
Key limitations / uncertainties in results		

1.2 Note on flood frequencies

Probability of flood occurrence is traditionally expressed within Hydrology as a Return Period, this is the average time between years with at least one larger flood. It can also be expressed as Annual Exceedance Probability (AEP), and this is often more appropriate to use when communicating with the public. Return Period has been retained within this document but can be replaced with AEP is wished.

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 Overview of requirements for flood estimates

Item	Comments
Overview: • purpose of study • names of river/s • location • number of calculation points (and if peak flows or hydrographs) • previous relevant calculations • availability of flood history	The purpose of the study is to provide hydrographs for the catchment of the River Ebbw which flows adjacent to a proposed development site at Commercial Street, Pontymister, Risca Newport, Caerphilly County NP11 6EE [NGR 324390 189865]. A location plan is included in Annex 8.1. Hydrographs are required for the 50% (Q2), 5% (Q20), 3.33% (Q30), 1% (Q100), 1%+25%CCA (Q100CC1), 1% +70%CCA (Q100CC2), 0.1% (Q1000), 0.1%+25%CCA (Q1000CC1) and 0.1%+70%CCA (Q1000CC2) AEP fluvial events to be used as inflow data for a hydraulic model of the Ebbw River. Model outputs will be used to assess fluvial flood risk from the River Ebbw. A proposed hydraulic modelling and hydrology methodology was submitted to NRW for review and comment on the 29/08/2024. Comments were received on the 18/09/2024 (see correspondence reported in Annex 8.2). A single inflow was agreed with NRW for the simplification of the hydraulic model. The gauging station 56002 - Ebbw River at Rhiwderin which is located 2.3km downstream from the proposed development site (catchment area 2% larger than that at the proposed development site) is suitable for pooling and therefore will be used for Enhanced Single Site Analysis.

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?	Moderately complex study. The NRW study *'River Ebbw Integrated Catchment Model'* completed in June 2019 (hydrology assessment originally completed in October 2017) by Wallingford HydroSolutions Limited undertook integrated catchment modelling for the River Ebbw. The study was intended to collate all relevant data (at the time) and to provide a consistent and up to date approach to assessing flood risk within the catchment. This study has been reviewed prior to the completion of the proposed hydrological methodology and forms the basis for this assessment. A historic review of flooding is included within the NRW study and a comparison of design peak flows will be carried out.

2.2 Overview of the catchment

For Hydrological Location Plan see Annex 8.1

Description: Brief description of catchment, including key features needing consideration or reference to section in accompanying report.	The River Ebbw catchment is located to the North of Caerphilly and includes Risca, Newbridge, Crumlin, Aberbeeg, Brynmawr, Ebbw Vale and Nantyglo. Photographs of the River Ebbw adjacent to the proposed site location from the B4591 Road bridge and upstream from the Dan y Graig Road bridge watercourse have been extracted from Google Streetview and are included in Annex 8.1. A Hydrological Location Plan showing the catchment location and extent in relation to the site and gauging station (56002-River Ebbw @ Rhiwderin) 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 bedrock comprising sandstone, limestone and coal measures in the upper reaches and mostly sandstone in the central and downstream reaches. The superficial deposits within the catchment boundary include peat, alluvium, Glacial Till and Head (containing clay, sit, sand and gravel). The predominant soil types

	within the catchment are described as loamy, humose loamy and peaty in the upper reaches and mostly loamy in the lower reaches with some clay. (source: http://www.landis.org.uk/soilscapes). This soil configuration is compatible with the FEH BFIHOST19 value of 0.499. The SAAR value of the catchment is 1454mm. A review of FEH Web service confirms that the FARL value of 0.975 is correct. The largest lakes within the catchment are located in the upper reaches near Ebbw Vale and Brynmawr and Tredegar.

2.3 Source of flood peak data

Was the NRFA dataset used? If so, which version?	NRFA peak flows dataset, Version 13, released August 2024 (most recent dataset at start of the project). This contains data up to 30th September 2023 for all the stations.

2.4 Gauging stations (flow or level)

Within, or near to, the study area. Most stations will be included on National River Flow Archive (NRFA), but other station data may also be available.

Watercourse	Station Name	Gauging Authority Number	NRFA number (used in FEH)	Grid Reference	Catchment Area (km²)	BFIHOST	Location relative to study area (e.g. within); note any significant differences in catchments (e.g. URBEXT)	Start and end of flow record
Ebbw River	Rhiwderin	56002	56002	ST258888	216.5	0.538	Station is located 2.3km downstream	24/4/1957-continuing

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?	Comments on data availability and quality e.g. use for Tp calculation, QMED calculation from daily mean flow, trends in flood peaks, outliers
56002-Rhiwderin	24/4/1957-continuing	No	Yes	Yes	No	Flow data is available for 15-minute intervals, monthly maximums and yearly maximums. There does not seem to be any trends in the AMAX data or significant outliers.

2.6 Rating equations

Station Name	Type of rating	Rating review needed?	Reasons e.g. availability of recent flow gaugings, amount of scatter in the rating
Rhiwderin		No	There are two rating curves for this station. NRW have confirmed that in 2012 hydraulic modelling was carried out to compute out of bank flows at this gauge and the NRFA have adopted the out of bank rating for the full period of record, however NRW have only adopted the rating from 2007 onwards. The data from the NRFA is likely to be more representative of the true value. However, the data from either source would be outside of the gauged range of 130 cumecs and so there will be some uncertainty around this value in either case. The rating curves on the NRFA website show little scatter overall.

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 NRW	Date obtained	Details
Historic flood data – give link to historic review if carried out.	Yes	Yes	The River Ebbw Integrated Catchment Model Report (June 2019)	01/2024	See Annex 8.3.
	Yes	Yes	NRW Historic Flood Map	29/10/2024	NRW Historical Flood Map included in Annex 8.3 shows that approximately half the site is shown to have flooded in the past.
Flow or level data for events	Yes	Yes	NRW email reference ATI-27411a	October 2024	**River Ebbw at Rhiwderin** Yearly maximums from 1957-2023. Monthly maximums from 1957-September 2024 15 minute flow data from 1982-2024 **Sirhowy @ Wattsville** Yearly maximums from 1970 to 1982 Monthly maximums from 1970 to May 1983 Sporadic 1 second flow data from January 1975 to April 1984
Rainfall data for events	N/A	N/A	N/A	N/A	

<table>
<tr><td>Results from previous studies</td><td>Yes</td><td>Yes</td><td>The River Ebbw Integrated Catchment Model Report (June 2019)</td><td>01/2024</td><td>A Catchment wide hydraulic modelling assessment of the River Ebbw and River Sirhowy was completed in 2019 to collate data from previous studies and provide an up to date approach for assessing flood risk within the catchment. The assessment estimated peak flows at the Rhiwderin and Aberbeeg stations on the River Ebbw and the Wattsville Station on the Sirhowy River for a number of return period events from the Q2 to Q1000. Two hydrology reports have been completed ‘Ebbw Baseline Hydrology’ and ‘Addendum to the Ebbw Baseline Hydrology’ in 2017. A hydraulic modelling report named ‘River Ebbw Integrated Catchment Model’ was completed in 2019.

<u>Ebbw Baseline Hydrology 2017</u>

The FEH Statistical and ReFH2 Methods have been used to obtain best estimates at the three gauging stations within the catchment (Sirhowy at Wattsville-56011, River Ebbw at Rhiwderin-56002 and River Ebbw at Aberbeeg-56019). For the River Ebbw at Rhiwderin gauging station, the Enhanced Single Site Analysis Method was chosen as the final method to obtain design peak flows for all events up to Q1000 return period. The ‘Ebbw Baseline Hydrology Derived’ peak flows are included in the table below.

<table>
<tr><th></th><th>Ebbw Baseline Hydrology Derived Peak Flows (m^3s^{-1})</th><th>Ebbw Baseline Hydrology Catchment Model Peak Flows (m^3s^{-1})</th></tr>
<tr><td>2</td><td>103.3</td><td>103.2</td></tr>
<tr><td>25</td><td>183.2</td><td></td></tr>
<tr><td>30</td><td>208.2</td><td>180</td></tr>
<tr><td>50</td><td></td><td></td></tr>
<tr><td>100</td><td>236.3</td><td>220.8</td></tr>
<tr><td>1000</td><td>383.6</td><td>357.2</td></tr>
</table>

<u>Addendum to the Ebbw Baseline Hydrology 2017</u>

Following an initial run of the 1D hydraulic model further modifications to the baseline hydrology were made to calibrate the model such that peak flows within the hydraulic model are largely commensurate with those estimated at the gauging stations detailed above. The calibration of the combined hydrological and hydraulic modelling of the Ebbw Catchment Model adopted an iterative approach. Attenuation of hydrographs, timings of peak flows and peak flow calibration were assessed, and the results showed that the baseline model did not capture the features successfully, however there is good correlation between the baseline design peak flows and peak flows produced at the gauges within the model.

In general, the percentage differences between the Ebbw Baseline Hydrology Catchment Model Peak Flows and the Ebbw Baseline Hydrology Derived Peak Flows are lowest at the QMED values and are larger for higher return periods, this is as expected as the models were calibrated at QMED.

At Rhiwderin the QMED estimate is very close, there is an underestimate of peak flows at the other return periods of between 5% and 7%. The Ebbw Baseline Hydrology Catchment Model Peak Flows are included in the table above.</td></tr>
<tr><td>Other data or information (e.g. groundwater, tides, etc...)</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
</table>

2.8 Initial choice of approach

Outline the conceptual model	The proposed development site is an area of brownfield land (0.01km^2) located on the left bank of the River Ebbw adjacent to the B4591 road to the south of Pontymister and Risca. Water spilling from the River Ebbw is the primary source of fluvial flood risk at the site. The site could be flooded if the local conveyance capacity of the River Ebbw is exceeded. The site is situated at approximately 43.5m AOD and is not tidally influenced.
Any unusual catchment feature to account for?	The catchment is moderately urbanised (URBEXT2000 is 0.0981) and corrections for urbanisation will be applied in-line with FEH guidelines. The other descriptors are within the standard range. FEH statistical and ReFH2 methods are appropriate.
Initial choice of method(s) and reasons	Initial flood estimates will be calculated using the FEH Statistical (Enhanced Single Site Analysis method) and ReFH2 rainfall-runoff methods; the results from the two approaches will be compared.
How will hydrograph shapes be derived if needed?	Two methods will be investigated for the production of the hydrograph shape, the 15 minute flow data for the gauging station Ebbw River at Rhiwderin and the ReFH2 method. Section 7.5 of the report provides further details on the choice of hydrograph shape.

Will the catchment be split into subcatchments? If so, how?	One analysis will be undertaken for the catchment as a whole and a single inflow produced and applied at the upstream boundary of the hydraulic model.
Software to be used (with version numbers)	FEH Web Service / WINFAP 5 / ReFH2.3

3 LOCATIONS WHERE FLOOD ESTIMATES REQUIRED

3.1 Map of study area, including subject site(s) and gauging stations (where applicable)

Maps reported in Annex 8.1

3.2 Summary of subject sites

Site code	Watercourse	Site name (description)	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered (km^2)
S01	Ebbw River	Lidl at Pontymister, Risca	325850	188900	211.82	211.82

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

Bold values have been updated.

Site code	AREA (km^2)	FARL	PROPWET	SAAR (mm)	BFIHOST	DPSBAR (m/km)	DPLBAR (km)	BFIHOST19	$URBEXT_{2000}$	FPEXT
S01	211.82	0.975	0.49	1454	0.538	182.3	22.27	0.499	**0.0981**	0.0391

3.4 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	The catchment boundary was checked using contours based on 50m resolution OS DTM. 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.
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 1454mm has been confirmed. FARL has been checked using OS maps and satellite images. The FARL value of 0.975 has been confirmed. URBEXT has been recalculated from 1:50,000 OS maps according to the catchment boundary; the urbanised area of the catchment appears to be equal to 33.044km^2 resulting in URBEXT values of URBEXT2000 = 0.0981 and URBEXT1990 = 0.0761.
Source of URBEXT	URBEXT2000 for FEH statistical and ReFH2.
Method for updating of URBEXT	URBAN50k

4 STATISTICAL METHOD

4.1 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. Include a map if necessary.

Comment on potential donor sites	The QMED has been derived from Annual Maxima data (provided in WINFAP data files v13.02) for Station 56002 - Ebbw River.

4.2 Donor sites chosen and QMED adjustment factors

NRFA no. and Station Name	Reasons for choosing or rejecting	Record Length	QMED from flow data (gauged)	QMED from flow data with urban influence removed (A)	QMED from catchment descriptors (B)	Adjustment ratio (A/B)
N/A	N/A	N/A	N/A	N/A	N/A	N/A

4.3 Overview of estimation of QMED at each subject site

Site code	QMED (rural) from CDs (m^3/s)	Method	Data transfer							Final estimate of QMED rural (m^3/s)	Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites used (see 4.2)	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 WINFAP4 (or later versions) method not used)	Weighted average adjustment		
S01	92.98	AM (Station 56002)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	97.67	106.30

Has the Kjeldsen (2014) urban adjustment method (as used in WINFAP4 or later versions) been applied? If not, why?	WINFAP urban adjustment procedure applied
How are the weights derived?	N/A
Are the values of QMED and QMED adjustment factors consistent, for example at successive points along the watercourse and at confluences?	There are two gauges upstream of the 56002-Rhiwderin gauge. Gauge 56019-Ebbw at Aberbeeg and 56011-Sirhowy at Wattsville. Aberbeeg gauge is located 17km upstream on the Ebbw River and has a catchment area of 71.7km². However, the gauge is not suitable for QMED and therefore it is not directly comparable with AMAX derived QMEDs, as such a comparison of this gauge has not been included. The gauge at Wattsville on the River Sirhowy (a tributary of the Ebbw River) is located 7km upstream and has a catchment area of 76.1km². The QMED value is 32.1m³/s. A comparison of QMED based on area is shown below. QMED per 1km² for Rhiwderin is 106m³/s/216.5km²= 0.49m³/s per km² QMED per 1km² for Wattsville is 32.1m³/s/76.1km²= 0.42m³/s per km² The results show similar QMED values per 1km² for both gauges.

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); FV – Flow variability (add details).

4.4 Derivation of pooling groups

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

Name of group	**Site code from which pooling group was derived**	**Site codes to which it is applied**	**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)	**Method:** Single Site / with History, Enhanced Single Site or Pooled / Small Catchment Pooled?
P01	S01	S01	WINFAP was used to generate an initial pooling group (minimum 500 years of data) for this gauged 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. No 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 583 years of data and remains 'acceptably heterogenous' within WINFAP, with a standardised test value H1 (the most reliable, according to Hoskins and Wallace*) of -0.1238 and H2 of -1.2148. A review of the pooling group is advised as 'not required' by WINFAP. A table with the final pooling group (including CDs of all the stations) is included in Annex 8.4.	Enhanced Single Site

* 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).

4.5 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	ESS	P01	GEV (best fit in WINFAP, equal to -0.3922)	Urban adjustment within WINFAP applied.	Location: 0.909 Scale: 0.247 Shape: -0.038 Bound: -5.574	2.15

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 (2014).
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 10**	**1 in 20**	**1 in 30**	**1 in 50**	**1 in 100**	**1 in 100 (+CCA1)**	**1 in 100 (+CCA2)**	**1 in 200**	**1 in 1000**	**1 in 1000 (+CCA1)**	**1 in 1000 (+CCA2)**
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	**20%**	**10%**	**5%**	**3.33%**	**2%**	**1%**	**1%+25%**	**1%+70%**	**0.5%**	**0.1%**	**0.1%+25%**	**0.1%+70%**
S01	106.30	137.13	158.29	179.16	191.42	207.03	228.58	285.73	388.59	250.63	304.00	380.00	516.80

5 REVITALISED FLOOD HYDROGRAPH (REFH2) METHOD FOR PEAK FLOW ESTIMATION

5.1 Parameters for ReFH2 model for peak flow estimation

Site code	**Details of method:** OPT: Optimisation (Calibration Utility) BR: Baseflow recession fitting CD: Catchment descriptors DT: Data transfer (give details)	**Tp (hours)** Time to peak	**C_{max} (mm)** Maximum storage capacity	**BL (hours)** Baseflow lag	**BR** Baseflow recharge
S01	CD	4.89	377.2	55.52	1.6-2.44
Brief description of any flood event analysis carried out (further details should be given below or in the annex).		N/a			

5.2 Design events for ReFH2 method for peak flow estimation

Site Code	**Season of design event** (summer or winter)	**Recommended storm duration (hours)**	**Storm area for ARF** (if not catchment area)	**Record any adjustment to default parameters**
S01	Winter	11.5	0.91	
Source of design rainfall statistic (FEH13 or FEH99)**.**	FEH22			

5.3 Peak flow estimates from the ReFH2 method

Site code	**Flood peak (m^3/s) for the following return periods (in years)**												
	1 in 2	**1 in 5**	**1 in 10**	**1 in 20**	**1 in 30**	**1 in 50**	**1 in 100**	**1 in 100 (+CCA1)**	**1 in 100 (+CCA2)**	**1 in 200**	**1 in 1000**	**1 in 1000 (+CCA1)**	**1 in 1000 (+CCA2)**
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	**20%**	**10%**	**5%**	**3.33%**	**2%**	**1%**	**1%+25%**	**1%+70%**	**0.5%**	**0.1%**	**0.1%+25%**	**0.1%+70%**
S01	90.27	115.87	132.94	150.05	160.20	173.80	193.94	242.43	329.70	217.32	295.40	369.26	502.19

5.4 Calibrated (where relevant)

Site code	**Flood peak (m^3/s) for the following return periods (in years)**												
	1 in 2	**1 in 5**	**1 in 10**	**1 in 20**	**1 in 30**	**1 in 50**	**1 in 100**	**1 in 100 (+CCA1)**	**1 in 100 (+CCA2)**	**1 in 200**	**1 in 1000**	**1 in 1000 (+CCA1)**	**1 in 1000 (+CCA2)**
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	**20%**	**10%**	**5%**	**3.33%**	**2%**	**1%**	**1%+25%**	**1%+70%**	**0.5%**	**0.1%**	**0.1%+25%**	**0.1%+70%**
N/a - No calibrated ReFH2 flows													

6 REVITALISED FLOOD HYDROGRAPH (REFH2) METHOD FOR MODEL INFLOW HYDROGRAPH

6.1 Parameters for ReFH2 model for model inflow hydrographs

Site code	**Details of method**	**Tp_{rural} (hours)**	**Tp_{urban} (hours)**	**C_{max} (mm)** Maximum storage capacity	**PR_{imp}** (% runoff for impermeable surfaces)	**BL (hours)**	**BR**
S01	CD	4.89	3.67	377.2	70	55.52	1.6-2.44
Brief description of any flood event analysis carried out (further details should be given in the annex)				No further analysis carried out.			
Methods: OPT: Optimisation (calibration utility), BR: Baseflow recession fitting, CD: Catchment descriptors, DT: Data transfer (give details)							

6.2 Design events for ReFH2 method for model inflow hydrographs

Site code	**Season of design event** (summer or winter)	**Storm duration** (hours)	**Source of Storm Duration and ARF**	**Why Chosen**
S01	Winter	11.5	ReFH2 software	Recommended on ReFH2

Were hydrographs scaled to alternative peak flow estimates? If so, give details	Hydrographs were scaled to match the FEH Stat peak values (hybrid method, see Section 7.3)			
Provide link/reference to location of hydrographs or provide in appendix	ReFH2 hydrographs provided in Annex 8.5			

7 FINAL PEAK FLOWS AND HYDROGRAPH ESTIMATES

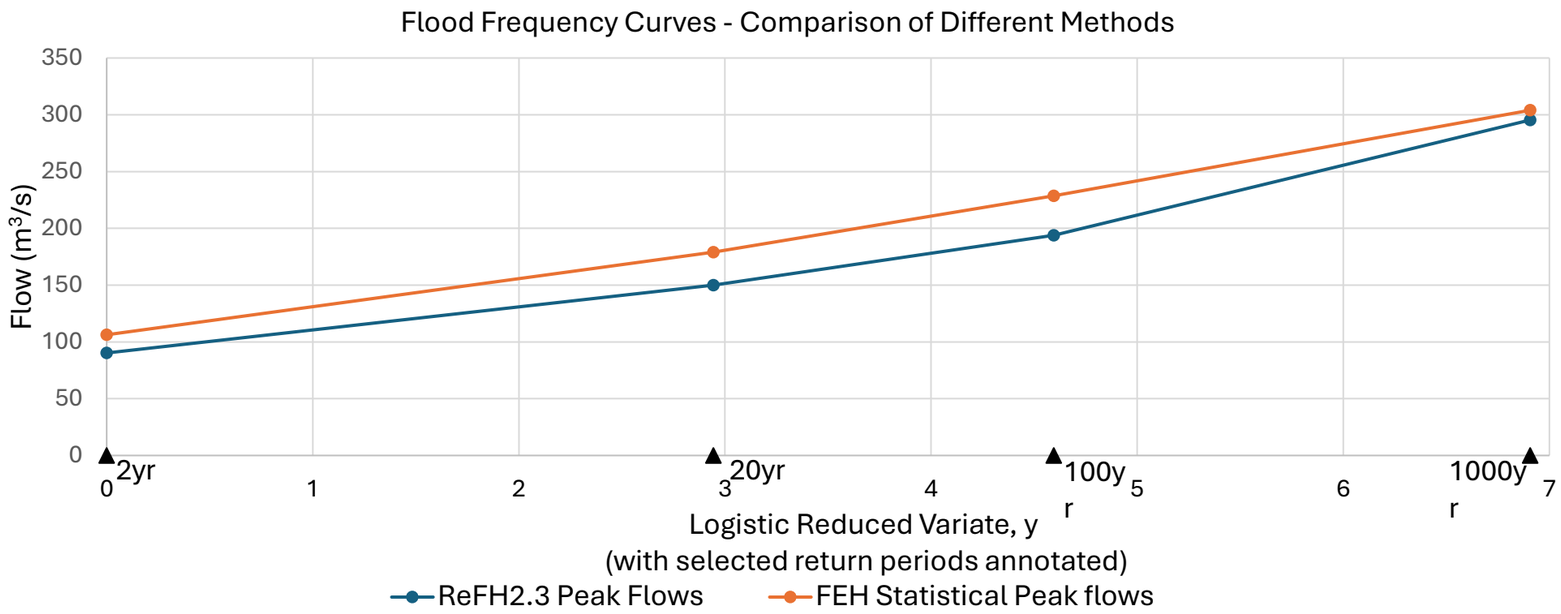
7.1 Comparison of peak flow estimates from different methods

This table compares peak flows from the ReFH method, FEH Statistical method and any available previous study at each site for two key return periods.

Site code	Ratio of peak flow to FEH Statistical peak						
	QMED - Return period 2 years / 50% AEP			Return period 100 years / 1% AEP			
	ReFH	ReFH2	Previous Study	ReFH	ReFH2	Previous Study	Comments
S01	N/a	0.849	N/a	N/a	0.848	N/a	

7.2 Final Peak Flow Estimates

Site code	Flood peak (m^3/s) for the following return periods (in years)												
	1 in 2	1 in 5	1 in 10	1 in 20	1 in 30	1 in 50	1 in 100	1 in 100 (+CCA1)	1 in 100 (+CCA2)	1 in 200	1 in 1000	1 in 1000 (+CCA1)	1 in 1000 (+CCA2)
	Flood peak (m^3/s) for the following AEP (%) events												
	50%	20%	10%	5%	3.33%	2%	1%	1%+25%	1%+70%	0.5%	0.1%	0.1%+25%	0.1%+70%
S01	106.30	137.13	158.29	179.16	191.42	207.03	228.58	285.73	388.59	256.13	348.16	435.20	591.88

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 generally higher (approximately 18% for the Q100 event) than the ReFH2 peaks.
	The FEH Statistical method peak flows have been preferred as the method makes best use of the gauged data from the Rhiwderin gauge allowing the Enhanced Single Site Analysis method to be performed. The gauge has a flow record dating back to 1957. Furthermore, the latest software WINFAP5 was used for this assessment. The ReFH2 method makes best use of the FEH22 rainfall model i.e. the most up to date design rainfall model currently available in the UK. The FEH Statistical method has been chosen as the preferred method for the design peak flows. 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 and Q200 return periods. In line with FEH recommendations, the Q1000 and Q200 peak flows estimate has been adjusted utilising the ReFH2 growth curve results, as follows: Q1000 = (Q1000ReFH2/Q100ReFH2) x Q100FEH Statistical = (295.405m^3/s / 193.943m^3/s) x 228.581m^3/s = 348.16m^3/s **Q1000 adjusted statistical peak = 348.16m^3/s**

7.3 Hydrographs for modelling

How were these calculated, for example by scaling ReFH hydrographs to final flow estimates? include link/reference to hydrographs.	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 design hydrographs are included in Annex 8.6.
How will the flows be applied to a hydraulic model? If intervening areas are used, will hydrographs be adjusted to better match downstream flows, or will best estimate inflows be used and resulting downstream flows accepted?	A single inflow will be applied to the upstream boundary of the hydraulic model as per the agreed methodology.

7.4 Checks

Are the results consistent, for example at confluences?	No gauges at confluences within the model
What do the results imply regarding the return periods / frequency of floods during the period of record?	The gauged floods at Rhiwderin are stated by NRW to be reliable up to the flow of 130m³/s. The peak flow of 130m³/s is between the return period flows of 1 in 2 and 1 in 5, as a result the gauged flows of higher return periods cannot be quantified or compared.
What is the range of 100-year / 1% AEP growth factors? Is this realistic?	ReFH2 = 2.15 FEH-Statistical = 2.15 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 = 1.33 FEH-Statistical = 1.52

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 comparison of the peak flows from the ESS Waterco 2024 hydrology assessment and the NRW Ebbw baseline hydrology assessment completed in 2017. The peak flows from the ESS in 2017 are similar to the peak flows derived through ESS in this assessment. The Waterco assessment has derived peak flows which vary from 3% higher in the Q2 event to 9% lower in the Q1000 event in comparison to the Ebbw Baseline Hydrology Derived Peak Flows, and from <1% higher in the Q2 event to 7% higher in the Q1000 event in comparison to the Ebbw Baseline Hydrology Model peak flows.

	Peak Flow Comparison		
	Waterco 2024 Assessment (m^3s^{-1})	Ebbw Baseline Hydrology Derived Peak Flows (m^3s^{-1})	Ebbw Baseline Hydrology Catchment Model Peak Flows (m^3s^{-1})
2	106.3	103.3	103.2
25	-	183.2	
30	191.423	208.2	180
50	207.033		
100	228.58	236.3	220.8
1000	348.16	383.6	357.2

	There are a number of differences in software and data since the 2017 assessment including: WINFAP 5, seven additional years of AMAX data, likely a differing pooling group composition (details of 2017 pooling group are unavailable for comparison). The 2024 Waterco flows are deemed to be more reliable as the latest software, guidance and gauge data available have been utilised to carry out an ESS assessment.
Are the results compatible with the longer-term flood history?	The document named 'February 2020 Floods in Wales: Flood Event Data Summary' October 2020 states that the flow in the River Ebbw during Storm Dennis was equivalent to a 1 in 40 (flow of 198m^3/s). Storm Dennis occurred on the 16/2/2020. The peak flow of 198m^3/s is shown to be between our estimated Q30 and Q50 peak flows.
Describe any other checks on the results	Checks will be performed on the hydraulic modelling results.

7.5 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	The ReFH2 hydrograph shape has been utilised. The hydrograph shape from the 5 highest peak flows of Station 56002 Ebbw River at Rhiwderin have been normalised and standardised for review and potential use as hydrograph shape. However, the average shape of the hydrograph was wider than the ReFH2 and as the peaks are to be scaled to match the adjusted Statistical peaks, flow volumes could be significantly over-estimated.
Discuss any particular limitations For example, applying methods outside the range of catchment types for which they were developed	The FEH Statistical ratio method has been used to derive the Q200 and Q1000 flows, this can add a degree of uncertainty.

Provide information on the uncertainty in the design peak flow estimates and the methodology used For example, using the methods detailed in 'Making better use of local and historic data, and estimating uncertainty in FEH design flood estimation (FEH Local) SC130009	Confidence limits for the FEH Statistical Enhanced Single Site Analysis are not included in the FEC record as the methodologies suggested by guidelines for ESS with GEV distribution (Bootstrapping and Monte Carlo) are beyond the scope of the present analysis. Confidence Limits of 95% on ReFH2 derived QMED value of m3/s, based on the EA Local Data Report SC13009/R Lower Limit = 41.210m³/s Upper Limit = 197.719m³/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.

8 ANNEX - SUPPORTING INFORMATION

8.1 FEH Catchment Descriptors, Hydrological Location Plan and Photographs

Catchment NGR: 325850 188900

Descriptor	FEH Original Value	Updated Value
AREA	211.82	211.82
ALTBAR	317	317
ASPBAR	183	183
ASPVAR	0.18	0.18
BFIHOST	0.538	0.538
BFIHOST19	0.499	0.499
DPLBAR	22.27	22.27
DPSBAR	182.3	182.3
FARL	0.975	0.975
FPEXT	0.0391	0.0391
FPDBAR	0.714	0.714
FPLOC	0.895	0.895
LDP	41.98	41.98
PROPWET	0.49	0.49
RMED-1H	11.8	11.8
RMED-1D	52.7	52.7
RMED-2D	70	70
SAAR	1454	1454
SAAR4170	1529	1529
SPRHOST	29.79	29.79
URBCONC1990	0.634	0.634
URBEXT1990	**0.0509**	**0.0761**
URBLOC1990	1	1
URBCONC2000	0.737	0.737
URBEXT2000	**0.0743**	**0.0981**
URBLOC2000	0.945	0.945
C	-0.02598	-0.02598
D1	0.46195	0.46195
D2	0.43526	0.43526
D3	0.34822	0.34822
E	0.28574	0.28574
F	2.54338	2.54338
C(1 km)	-0.025	-0.025
D1(1 km)	0.439	0.439
D2(1 km)	0.408	0.408
D3(1 km)	0.364	0.364
E(1 km)	0.284	0.284
F(1 km)	2.457	2.457