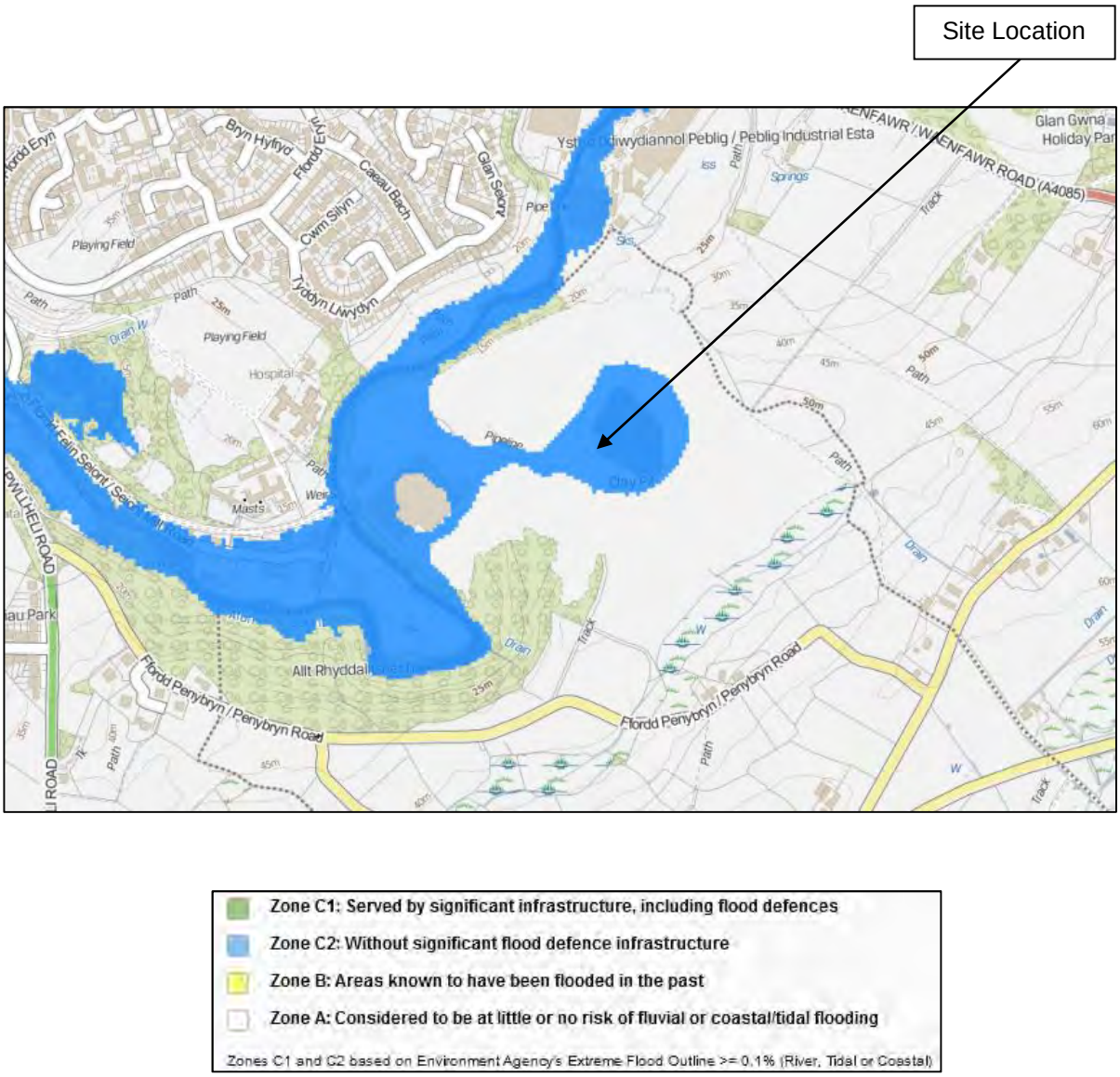
Appendix C – Flood Maps and NRW Correspondence



	Zone C1: Served by significant infrastructure, including flood defences
	Zone C2: Without significant flood defence infrastructure
	Zone B: Areas known to have been flooded in the past
	Zone A: Considered to be at little or no risk of fluvial or coastal/tidal flooding

Zones C1 and C2 based on Environment Agency's Extreme Flood Outline >= 0.1% (River, Tidal or Coastal)

Welsh Government TAN15 Development Advice Map (December 2016)

Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Title

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

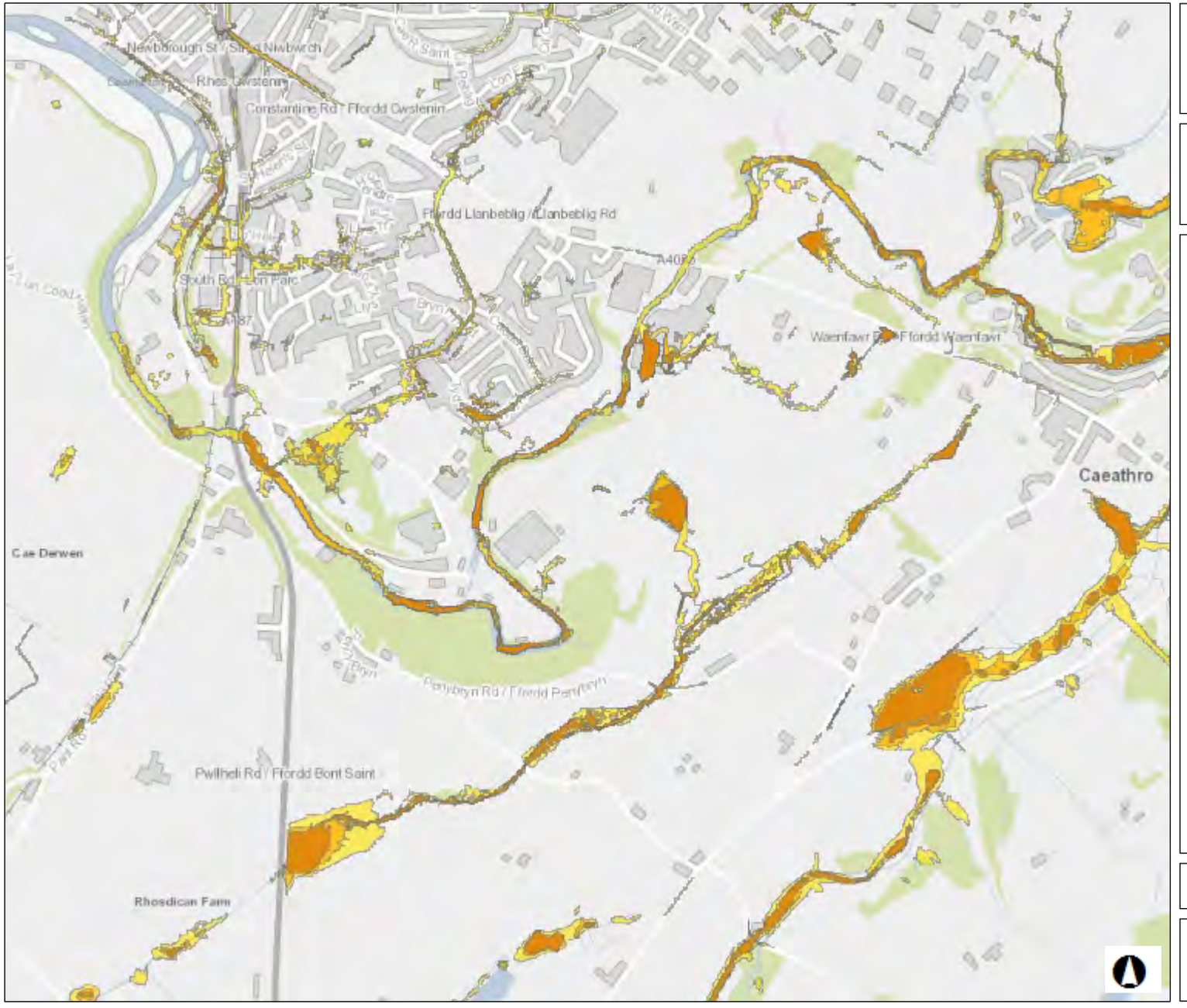
- Main rivers
- Floodmap Flood Zone 3
- Floodmap Flood Zone 2

Graddfa / Scale 1: 12,434

Dyddiad / Date
07/04/2016

0.4 0 0.20 0.4 Miles

British_National_Grid



Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Title

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

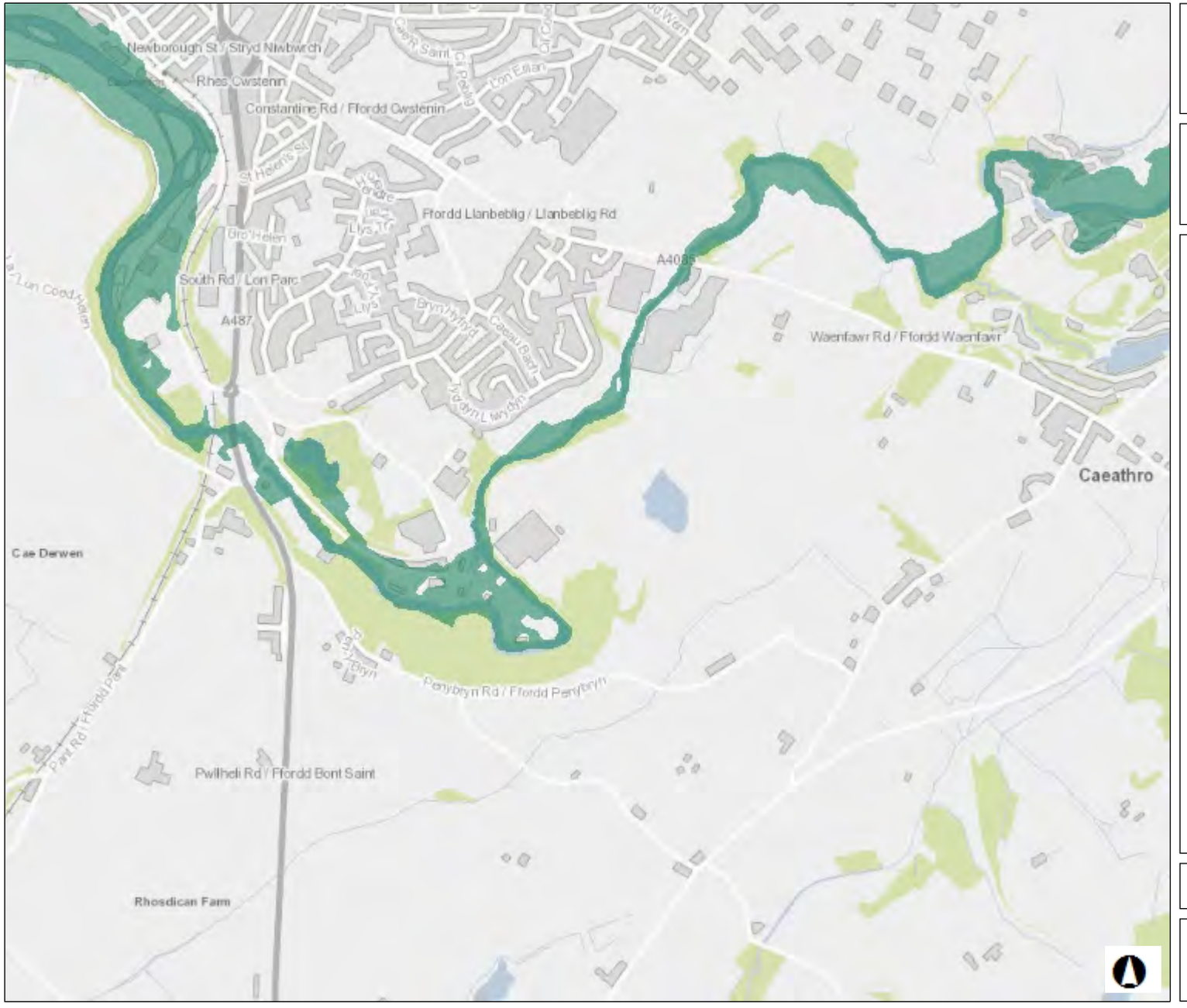
- Risk of flooding from surface water - High
- Risk of flooding from surface water - Medium
- Risk of flooding from surface water - Low

Graddfa / Scale 1: 12,434

Dyddiad / Date
07/04/2016

0.4 0 0.20 0.4 Miles

British_National_Grid



Cyfoeth Naturiol Cymru
Natural Resources Wales

Map Title

Map Perygl Llifogydd / Flood Risk Map

Allwedd / Legend

- Risk of flooding from reservoirs

Graddfa / Scale 1: 12,434

Dyddiad / Date
07/04/2016

0.4 0 0.20 0.4 Miles

British_National_Grid

Jordan Jones

From: Huws, Iwan <Iwan.Huws@cyfoethnaturiolcymru.gov.uk>
Sent: 09 September 2015 13:38
To: Jordan Jones
Subject: RE: w1910 - Seiont Brickworks, Caernafon - Hydraulic Modelling Proposal

Categories: Information received

Hi Jordan
I have looked at your outputs and note that the whole application site is shown to be flooded during the extreme event (0.1%). Should we therefore be consulted by the LPA on any planning permission required we would advise that the zone is within C2 as refer them to paragraph 6.2 of Tan15 i.e. should be looking at sites in zone A. We note that the majority of the site is flooded to less than 0.3m on the 0.1% event.
Stockpiles will have an impact on the flooding regime and since the model is available can an area (approx. to stockpile size/volume) be stamped out of the model and re-ran to assess the actual impact?
The results would give all parties a better steer on whether it is acceptable to store materials here or not.
Porta cabins should not be placed within the 1% (with blockage) outline- this would be effectively approval of stilts and voids which we discourage.
With regards to the access/egress we would only comment to the LPA that it has been addressed in the FCA. The emergency planners would also need to comment on this aspect. My question would be when would access along the haul road be available (since this would not be possible from day 1).

The model would be sufficient to be used for any FCA but should be manipulated to determine if the stockpiles would have an adverse effect elsewhere. Also of note is the fact that the former brickyard is to be excavated- you could investigate if this is a floodplain compensation? Again timing should be addressed.

Regards

Iwan Huws
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Gwefan / Website:
www.cyfoethnaturiolcymru.gov.uk / www.naturalresourceswales.gov.uk

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From: Jordan Jones [mailto:jordan.jones@waterco.co.uk]
Sent: 08 September 2015 15:22
To: Huws, Iwan <Iwan.Huws@cyfoethnaturiolcymru.gov.uk>
Subject: RE: w1910 - Seiont Brickworks, Caernafon - Hydraulic Modelling Proposal

Hi Iwan,

Please find attached our initial hydraulic modelling output for the Seiont Brickworks site (using REFH only).

As shown on the attached maps the lower northern extent is at risk during the 1% AEP event. Depths are less than 0.3m.

The majority of the site is shown at risk during the 0.1% AEP event, however a large area has depths less than 600mm.

In light of the attached we are now seeking whether you have any additional comments on the scheme, mainly in relation to:

Would all development, including stockpiles, be acceptable within the 0.1% AEP extent where depths are less than 600mm?
Would porta cabins be acceptable within the 1% AEP extent provided that they are set suitably above flood levels?

The existing site access will not achieve compliance with A1.15 of TAN15 due to the estimated velocities. However as shown on the attached plan, a haul road is proposed to the east of the site (south of the quarry). This road is shown to be flood free and could function as a safe means of access / egress during a flood event.

If you have any questions please do not hesitate to contact me.

Kind Regards,

Jordan Jones

waterco consultants

Waterco Ltd, Lon Parcwr Business Park, Ruthin LL15 1NJ
01824 702220 - www.waterco.co.uk - jordan.jones@waterco.co.uk

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From: Huws, Iwan [mailto:Iwan.Huws@cyfoethnaturiolcymru.gov.uk]
Sent: 23 July 2015 10:14
To: Chris Lewis
Cc: Jordan Jones
Subject: RE: w1910 - Seiont Brickworks, Caernafon - Hydraulic Modelling Proposal

Hi Chris
It may be appropriate to construct a 2D only model however you will be aware of the constriction the existing access bridge would give on high flows which could also catch debris and cause a blockage. If this can be considered and that suitable freeboards is also considered we may accept this approach.
From experience road scheme site compounds and storage areas can have a great deal of materials e.g. soil stockpiles which can have an effect on the flooding. As such this will also need to be considered.

I would therefore suggest that you proceed with the 2D only modelling work, however the FCA produced may demonstrate that certain areas are not suitable for storage of materials etc.

Regards

Iwan Huws
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Gwefan / Website:
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Ein diben yw sicrhau fod adnoddau naturiol Cymru yn cael eu cynnal, eu gwella a'u defnyddio yn gynaliadwy, yn awr ac yn y dyfodol.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, enhanced and used, now and in the future

---

From: Chris Lewis [mailto:Chris.Lewis@waterco.co.uk]
Sent: 23 July 2015 09:43
To: Huws, Iwan <Iwan.Huws@cyfoethnaturiolcymru.gov.uk>
Cc: Jordan Jones <jordan.jones@waterco.co.uk>
Subject: w1910 - Seiont Brickworks, Caernafon - Hydraulic Modelling Proposal

Iwan,

Hope all is well and thanks for your email to Jordan yesterday.

Given the relatively temporary nature of the proposed development the client is keen to avoid undertaking a full detailed hydraulic modelling study if possible, particularly the extensive watercourse survey works required which would take up both vital time and budget. As such we would like to propose constructing a detailed 2D-only hydraulic model of the site and surrounding area to improve flood mapping accuracy and inform the FCA.

Such a model would be built from 1m resolution LiDAR data and any site-specific topo survey which is available. Flows would be calculated in accordance with current NRW guidelines with both the ReFH and FEH Statistical methods most likely being used. Key structures would be surveyed and included in the model with other less critical structures included based on field observations and OS mapping. Any assumptions made would ensure a worst case for the assessment of risk at the site.

Whilst such a model does have some limitations relative to a full 1D/2D hydraulic model, its outputs would represent a significant improvement on the existing understanding of flood risk at the site. Would such an approach be acceptable in this particular case?

Thanks

Chris

Regards,

Chris Lewis Associate
MEng (Hons)

Waterco Ltd, Lon Parcwr Business Park, Ruthin LL15 1NJ
01824 702220 - www.waterco.co.uk - Chris.Lewis@waterco.co.uk

From: Huws, Iwan [mailto:Iwan.Huws@cyfoethnaturiolcymru.gov.uk]
Sent: 22 July 2015 14:30
To: Jordan Jones
Subject: RE: w1910 - Seiont Brickworks, Caernafon

Jordan
Can you please elaborate on how you propose a more simplistic approach? The proposal must be flood free for the 1% event (no need to consider impacts of climate change).

I was also consulted last week via our planning team and my comments were as follows-

"The proposal is within both our flood zones 2 and 3 and is within zone C2 as per the Development Advice Maps accompanying TAN15:Development and Flood Risk. As such we would expect that should you wish to proceed with using this area for a temporary compound, then a Flood Consequence Assessment should be compiled to ensure compliance with TAN15 and also ensure that all interested parties fully understand the flood risk to the proposal and the existing flooding regime. According to TAN15, the proposal should be flood free during the 1% event and access/egress should meet the requirements of A1.15 for the extreme event. We would have some concerns regarding the impact of the proposal elsewhere. Security fencing/storage of materials within a flood plain will affect the conveyance and could increase flooding upstream.

We do not have any detailed hydraulic modelling for the location and the flood zones will be based on our national modelling technique (JFLOW) which shouldn't be used for site specific flood risk/flood consequence assessment. As such, to produce a FCA, you may need to carry out a hydraulic modelling exercise to demonstrate that the risks can be managed accordingly."

Regards

Iwan Huws
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Gwefan / Website:
www.cyfoethnaturiolcymru.gov.uk / www.naturalresourceswales.gov.uk

Ein diben yw sicrhau fod adnoddau naturiol Cymru yn cael eu cynnal, eu gwella a'u defnyddio yn gynaliadwy, yn awr ac yn y dyfodol.

Our purpose is to ensure that the natural resources of Wales are sustainably maintained, enhanced and used, now and in the future

From: Jordan Jones [mailto:jordan.jones@waterco.co.uk]
Sent: 20 July 2015 11:01
To: Huws, Iwan <Iwan.Huws@cyfoethnaturiolcymru.gov.uk>
Subject: w1910 - Seiont Brickworks, Caernafon

Temporary Construction Compound at the former Seiont Brickworks, Caernarfon, LL55 2YL. Grid Reference: 248855E 361487N

Dear Iwan,

I have submitted an email requesting a pre-planning opinion for the above site which I hope you have received (email attached for reference). You have provided advice on modelling works in this area to us recently. In the absence of modelled flood levels for the proposed temporary construction compound site, please can you advise if hydraulic modelling will be required, or if a more simplistic approach can be adopted given the temporary nature of the development (site to be occupied for 2 years from December 2016).

If you have any questions please do not hesitate to contact me. I look forward to hearing back from you.

Kind Regards,

Jordan Jones

waterco consultants

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01824 702220 - www.waterco.co.uk - jordan.jones@waterco.co.uk

Appendix D – Afon Seiont Hydrology Data

FLOOD ESTIMATION CALCULATION RECORD

Project:	Seiont Brickworks, Caernarfon	**Job No:**	W3191

Prepared by	Manfredi Toraldo MEng MSc MCIWEM	**Date:**	23/03/2016
Checked by	Bethan Young BSc (Hons) MCIWEM	**Revision:**	-
Approved by	Chris Lewis MEng CEng MICE		

INTRODUCTION

This Flood Estimation Calculation (FEC) Record is based on the latest version of the EA's FEC Record template 197_08_SD01v2 (Aug 2015); a 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

ABBREVIATIONS

AM	Annual Maximum
AREA	Catchment area (km^2)
BFI	Base Flow Index
BFIHOST	Base Flow Index derived using the HOST soil classification
CFMP	Catchment Flood Management Plan
CPRE	Council for the Protection of Rural England
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FSR	Flood Studies Report
HOST	Hydrology of Soil Types
NRFA	National River Flow Archive
POT	Peaks Over a Threshold
QMED	Median Annual Flood (with return period 2 years)
ReFH	Revitalised Flood Hydrograph method
SAAR	Standard Average Annual Rainfall (mm)
SPR	Standard percentage runoff
SPRHOST	Standard percentage runoff derived using the HOST soil classification
Tp(0)	Time to peak of the instantaneous unit hydrograph
URBAN	Flood Studies Report index of fractional urban extent
URBEXT1990	FEH index of fractional urban extent
URBEXT2000	Revised index of urban extent, measured differently from URBEXT1990
WINFAP-FEH	Windows Frequency Analysis Package – used for FEH statistical method

1 METHOD STATEMENT

1.1 Overview of requirements for flood estimates

Item	Comments
Give an overview which includes: • Purpose of study • Approx. no. of flood estimates required • Peak flows or hydrographs? • Range of return periods and locations • Approx. time available	The purpose of the study is to provide peak flow estimates and hydrographs for the Afon Seiont which flows adjacent to a proposed development (temporary construction for proposed Caernarfon and Bontnewydd bypass road) at the site of the former Seiont Brickworks Factory, Caernarfon, Gwynedd, Wales [NGR: 248960E 361520N]. Hydrographs are required for the 50% (Q2), 5% (Q20) 1% (Q100), 1%+CCA (Q100+CCA) and 0.1% (Q1000) AEP fluvial events to be used as inflow data for a hydraulic model of the Afon Seiont at the site.

1.2 Overview of catchment

Item	Comments
Brief description of catchment, or reference to section in accompanying report	The FEH CD-ROM3 shows a fairly large catchment (77.9km^2) with very steep slopes (DPSBAR value of 258.2m/km) and elevations varying from 1062m AOD in the upper reaches to 2m AOD in the lower reaches. The catchment is mostly rural. The few urban areas are located near the lower reaches, at the towns of Caernarfon and Llanrug. There are numerous bedrock formations within the catchment boundary. The main formations (at 1:625000 scale) are the Llanvirn Rocks (Mudstone, Siltstone and Sandstone) and the Lower Cambrian Rocks (Sandstone and Conglomerate). Soil maps of area show a large variety of soil types. Most represented soil types are the freely draining slightly acid loamy soils, very acid loamy upland soils with a wet peaty surface and slowly permeable seasonally wet acid loamy and clayey soils. Such a variability of geology and soil cover is compatible with the overall BFIHOST value of 0.502. The SAAR value for the catchment is high at 2311mm, as would be expected from its high average elevation. This, combined with a medium permeability, has resulted in a moderate PROPWET value of 0.49. The main reservoirs within the catchment are Llyn Peris and Llyn Padarn, both located along the Afon Seiont and with a surface area of 0.57km^2 and 1.09km^2 respectively. Other smaller reservoirs are located on the upper reaches of the catchment, the main being Llyn Dwythwch (0.09 km^2) and Marchlyn Bach (0.05 km^2). The presence of these reservoirs is reflected in the FARL value of 0.852. Dinorwig Hydroelectric Power Station is located within the catchment. The power station uses Marchlyn Mawr and Llyn Peris as the upper and lower reservoirs for storage. The catchment area draining into Llyn Peris (and Llyn Peris) has therefore been classed as offline. The area of 3.83km² has been removed from the catchment area, as discussed with NRW (email exchange provided as Annex 7.7). For this reason the Area and FARL catchment descriptors have been recalculated, giving the new values of 77.9km^2 and 0.881 respectively. A location Plan of the catchment and site is provided in Annex 7.1.

1.3 Source of flood peak data

Was the HiFlows UK dataset used? If so, which version? If not, why not? Record any changes made	Yes – Version 3.3.4, August 2014

1.4 Gauging stations (flow or level)

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

Water-course	Station Name	Gauging Authority Number	NRFA number (used in FEH)	Grid Reference	Catch-ment Area (km²)	Type (rated / ultrasonic / level…)	Start and end of flow record
Seiont	Peblig Mill		65006	SH494622	74.4	Velocity-area	09/1975-12/2015

1.5 Data available at each flow gauging station

Station Name	Start and end of data in HiFlows-UK	Update for this study?	Suitable for QMED?	Suitable for pooling?	Data quality check needed?	Other comments on station and flow data quality – e.g. information from HiFlows-UK, trends in flood peaks, outliers.
Peblig Mill	1976-2015 (1991 rejected)	Y	Y	N	No	Few high flow gaugings. Rating does not consider out of bank flow. Added AM for years 2013-2016. Area and FARL adjusted after removal of Llyn Peris drain area (see 1.2)
Give link/reference to any further data quality checks carried out						

1.6 Rating equations

Station name	Type of rating e.g. theoretical, empirical; degree of extrapolation	Rating review needed?	Reasons – e.g. availability of recent flow gaugings, amount of scatter in the rating.
Peblig Mill	Empirical up to within 12% QMED, extrapolated from this point	N/A	Rating appears reasonable up to QMED.
Give link/reference to any rating reviews carried out			

1.7 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)					
Historic flood data – give link to historic review if carried out.		No	Internet search		Some generic references to Seiont floods in Caernarfon. The extents of the most recent event (26th December 2015) have been obtained from NRW and used to validate the model. NRW have stated that the return period of the

					flood was Q20-Q30 and the peak flow gauged at Peblig Mill gauging station was 73.5m^3/s. The Gwynedd Council Local Flood Risk Management Strategy document does not refer to any particular flood event in Caernarfon.
Flow data for events	AMAX data for 2013-16	Yes	NRW ref ATI-09600a	25/2/2016	AMAX data only. Data used to update $QMED_{obs}$.
Rainfall data for events					
Potential evaporation data					
Results from previous studies	None				
Other data or information (e.g. groundwater, tides)					

1.8 Initial choice of approach

Is FEH appropriate? (may not be for very small, heavily urbanised/complex catchments) If not, describe other methods to be used.	Yes, AREA (77.9 km^2) and $URBEXT_{2000}$ (0.0112) are within the tolerable limits for FEH methods.
Outline the conceptual model, addressing questions such as: • Where are the main sites of interest? • What is likely to cause flooding at those locations? (peak flows, flood volumes, tides combinations of peaks, groundwater, snowmelt) • Might those locations flood from runoff generated on part of the catchment only, e.g. downstream of a reservoir? • Is there a need to consider temporary debris dams that could collapse?	The main site of interest is the location of the former Seiont Brickworks Factory, at grid reference (248960, 361520). The hydraulic model will investigate flood risk to the existing site. The most likely cause of flooding to the site is from peak flows within the Afon Seiont following an extreme rainfall event. The hydraulic model will consider blockage scenarios of critical structures.
Any unusual catchment features to take into account? e.g. • highly permeable – avoid ReFH if BFIHOST>0.65, consider permeable catchment adjustment for statistical method if SPRHOST<20% • highly urbanised – avoid standard ReFH if URBEXT1990>0.125; consider FEH Statistical or other alternatives; consider method that can account for differing sewer and topographic catchments • pumped watercourse – consider lowland catchment version of rainfall-runoff method • major reservoir influence (FARL<0.90) – consider flood routing • extensive floodplain storage – consider choice of method carefully	The catchment has a moderate permeability (0.502 BFIHOST), below the threshold of 0.65. The catchment is mostly rural – $URBEXT_{2000}$ equal to 0.0112. Catchment is not pumped. The flood attenuation from reservoirs and lakes is fairly low, (FARL equal to 0.881). An area of 3.83 km^2 has been removed from the total catchment area to represent the lower (offline) reservoir of the Dinorwig Hydroelectirc Power Station. AREA and FARL of the catchment have been re-calculated accordingly (see section 1.2).
Initial approach and reasons Will the catchment be split into subcatchments? If so, how?	The hybrid method is the initial choice of method. The FEH Statistical method will be used to estimate the peak flows for all return periods up to the Q100 event (1% AEP) and the hydrographs produced using the ReFH method will be scaled to match the statistical peak flow estimates.

Software to be used (with version numbers)	FEH CD-ROM v3.0[1]; WINFAP-FEH v3.0.003[2]; ReFH spreadsheet v1.4

2 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.

2.1 Summary of subject sites

Site code	Watercourse	Site	Easting	Northing	AREA on FEH CD-ROM (km^2)	Revised AREA if altered
S001	Afon Seiont	A487 bridge	248240	361700	81.73	77.9
Reasons for choosing above locations	The location of the downstream boundary of the catchment matches the location of the downstream boundary of the model, which is located approximately 1 km downstream of the former Brickworks Factory.					

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

Site code	FARL	PROPWET	BFIHOST	DPLBAR (km)	DPSBAR (m/km)	SAAR (mm)	SPRHOST	URBEXT	FPEXT
S001	0.881	0.49	0.502	16.28	258.2	2311	39.18	0.0112	0.0642

2.3 Checking catchment descriptors

Record how catchment boundary was checked and describe any changes (refer to maps if needed)	The catchment boundary was checked using 1:50,000 scale OS mapping and a watershed analysis in GIS software, based on the OS DTM (50 m resolution). The area of 3.73km^2 draining to Llyn Peris (see point 2.1) has been subtracted from the total catchment area on the FEH CD-ROM (81.73km^2) resulting in a final catchment area of 77.9km^2.
Record how other catchment descriptors (especially soils) were checked and describe any changes. Include before/after table if necessary.	BFIHOST – has been checked using a Soil Survey of Britain map, indicating that the area has an average BFIHOST. SAAR – has been checked using 1941-1970 Average Annual Rainfall maps. FARL has been checked using OS maps; reservoir/lake influence is relevant. The value has been modified (original value of 0.852) to account for the exclusion of the area directly draining to Llyn Peris (see section 1.2). The final FARL value for the catchment is 0.881. URBEXT has been checked using OS maps – the catchment appears to be mostly rural.
Source of URBEXT	URBEXT1990 for ReFH / URBEXT2000 for FEH Statistical
Method for updating of URBEXT	UEF equation (Kjeldsen, 2010)

3 STATISTICAL METHOD

3.1 Search for donor sites for QMED (if applicable)

Comment on potential donor sites Mention: • Number of potential donor sites available • Distances from subject site • Similarity in terms of AREA, BFIHOST, FARL and other catchment descriptors • Quality of flood peak data Include a map if necessary. Note that donor catchments should usually be rural.	Station 65006 Seiont @ Peblig Mill has been chosen for donor transfer. The station is located approximately 1km upstream on the same watercourse (centroid distance of 0.2 km). Due to the close proximity of the gauging station and large nature of the catchment the catchment descriptors are almost identical. The QMED value for the station has been updated to include the AMAX values for the last 4 years (provided by NRW). The relatively high values of these four AMs have increased the QMED value of the station from 46.24m^3/s to 48.008m^3/s. The area and the FARL values of the station have been recalculated to exclude the drain area of Llyn Peris (see section 1.2)

3.2 Donor sites chosen and QMED adjustment factors

NRFA no.	Reasons for choosing or rejecting	Method (AM or POT)	Adjust-ment for climatic variation?	QMED from flow data (A)	QMED from catchment descriptors (B)	Adjust-ment ratio (A/B)
65006	Same river, lower centroid distance, similar descriptors	AM	No	48.008	42.899	1.119
Which version of the urban adjustment was used for QMED at donor sites, and why? Note: The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8).				Kjeldsen (2010)		

3.3 Overview of estimation of QMED at each subject site

Site code	Method	Initial estimate of QMED (m^3/s)	Data transfer						Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Power term, a	Moderated QMED adjustment factor, (A/B)[a]	If more than one donor: Weight	If more than one donor: Weighted average adjustment factor	
S001	DT	43.437	65006	0.2	0.949	1.113			**49.113 (after urban adjustment of QMED)**
Are the values of QMED consistent, for example at successive points along the watercourse and at confluences?									
Which version of the urban adjustment was used for QMED, and why?			Kjeldsen (2010)						

Site code	Method	Initial estimate of QMED (m^3/s)	Data transfer						Final estimate of QMED (m^3/s)
			NRFA numbers for donor sites used (see 3.3)	Distance between centroids d_{ij} (km)	Power term, a	Moderated QMED adjustment factor, $(A/B)^a$	If more than one donor		
							Weight	Weighted average adjustment factor	

Notes

Methods: AM – Annual maxima; POT – Peaks over threshold; DT – Data transfer; CD – Catchment descriptors alone.

When QMED is estimated from POT data, it should also be adjusted for climatic variation. Details should be added.

When QMED is estimated from catchment descriptors, the revised 2008 equation from Science Report SC050050 **Error! Bookmark not defined.** should be used. If the original FEH equation has been used, say so and give the reason why.

The guidelines recommend great caution in urban adjustment of QMED on catchments that are also highly permeable (BFIHOST>0.8). The adjustment method used in WINFAP-FEH v3.0.003 is likely to overestimate adjustment factors for such catchments. In this case the only reliable flood estimates are likely to be derived from local flow data.

The data transfer procedure is from Science Report SC050050. The QMED adjustment factor A/B for each donor site is given in Table 3.3. This 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 estimate from catchment descriptors.

If more than one donor has been used, use multiple rows for the site and give the weights used in the averaging. Record the weighted average adjustment factor in the penultimate column.

3.4 Derivation of pooling groups

The composition of the pooling groups is given in the Annex. Several subject sites may use the same pooling group.

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 Note also any sites that were investigated but retained in the group.	Weighted average L-moments, L-CV and L-skew, (before urban adjustment)
P001	S001	No	The default pooling group was derived with approximately 500yrs of data. All stations have been reviewed and no changes have been made to the default pooling group.	L-CV: 0.163 L-Skew: 0.167

Notes

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

The weighted average L-moments, before urban adjustment, can be found at the bottom of the Pooling-group details window in WINFAP-FEH.

3.5 Derivation of flood growth curves at subject sites

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group (3.4)	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

Site code	Method (SS, P, ESS, J)	If P, ESS or J, name of pooling group (3.4)	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
S001	P	P001	GEV was the best fit with a Z value of -0.3. GEV has therefore been used as the distribution. The GL distribution (which had a Z value of 1.89) has also been investigated for sensitivity. The results show that there is very little difference in peak flows using both distributions up to the Q100 event. The ReFH ratio is applied to generate higher return period peak flows and therefore the design flows are not sensitive to type of distribution.	Urban adjustment	Location = 0.910 Scale = 0.246 Shape = 0.002	2.036

Notes

Methods: SS – Single site; P – Pooled; ESS – Enhanced single site; J – Joint analysis

A pooling group (or ESS analysis) derived at one gauge can be applied to estimate growth curves at a number of ungauged sites. Each site may have a different urban adjustment, and therefore different growth curve parameters.

Urban adjustments to growth curves should use the version 3 option in WINFAP-FEH: Kjeldsen (2010).

3.6 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following return periods (in years)								
	2	20	100	1000					
S001 – GEV	49.113	80.474	100.013	127.548					
S001 – GL	49.113	79.380	104.193	152.862					

4 REVITALISED FLOOD HYDROGRAPH (REFH) METHOD

4.1 Parameters for ReFH model

Note: If parameters are estimated from catchment descriptors, they are easily reproducible so it is not essential to enter them in the table.

Site code	Method: OPT: Optimisation 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
S001	CD	3.74	368	47.3	1.38
Brief description of any flood event analysis carried out (further details should be given below or in a project report)					

4.2 Design events for ReFH method

Site code	Urban or rural	Season of design event (summer or winter)	Storm duration (hours)	Storm area for ARF (if not catchment area)
S001	rural	winter	12	
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?			No	

4.3 Flood estimates from the ReFH method

Site code	Flood peak (m^3/s) for the following return periods (in years)								
	2	20	100	1000					
	60.05	107.09	154.45	287.11					

5 FEH RAINFALL-RUNOFF METHOD

5.1 Parameters for FEH rainfall-runoff model

Methods:
FEA : Flood event analysis
LAG : Catchment lag
DT : Catchment descriptors with data transfer from donor catchment
CD : Catchment descriptors alone
BFI : SPR derived from baseflow index calculated from flow data

Site code	Rural (R) or urban (U)	Tp(0): method	Tp(0): value (hours)	SPR: method	SPR: value (%)	BF: method	BF: value (m^3/s)	If DT, numbers of donor sites used (see Section 5.2) and reasons

5.2 Donor sites for FEH rainfall-runoff parameters

No	Watercourse	Station	Tp(0) from data (A)	Tp(0) from CDs (B)	Adjustment ratio for Tp(0) (A/B)	SPR from data (C)	SPR from CDs (D)	Adjust-ment ratio for SPR (C/D)
1								
2								

5.3 Inputs to and outputs from FEH rainfall-runoff model

Site code	Storm duration (hours)	Storm area for ARF (if not catchment area)	Flood peaks (m^3/s) for the following return periods (in years)							
Are the storm durations likely to be changed in the next stage of the study, e.g. by optimisation within a hydraulic model?										

6 DISCUSSION AND SUMMARY OF RESULTS

6.1 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. Blank cells indicate that results for a particular site were not calculated using that method.

Site code	Ratio of peak flow to FEH Statistical peak					
	Return period 2 years			Return period 100 years		
	ReFH			ReFH		
	1.223			1.544		

6.2 Final choice of method

Choice of method and reasons – include reference to type of study, nature of catchment and type of data available.	The FEH Statistical peak flows have been chosen as the final design peak flows for all events up to and including the Q100 event. The pooling group is a good representation of the subject catchment and the donor station is located extremely near to the subject site providing gauged flows for 40 years. NRW have confirmed that the flood experienced within the catchment on the 26th December 2015 was a 1 in 20 to 1 in 30 return period flood. The gauged peak flow estimate for this flood is 73.5^3/s. Our estimate for Q20 is 80.5m^3/s providing confidence in the design peak flows. The FEH Statistical method does not output hydrographs, therefore the ReFH method has been used to generate a hydrograph shapes. Although the FEH method is considered more reliable for the lower return period events, it becomes less reliable at long return periods greater than 100yr. As such, the 1000yr (0.1% AEP) FEH Statistical peak has been adjusted as follows: (ReFH 1000yr peak / ReFH 100yr peak) * Statistical 100yr peak. The FEH Statistical 1000yr peak of 127.55m³/s has been altered to 185.92m³/s during this process. The design hydrographs have been produced by the ReFH method and scaled to the design peak flows (FEH Statistical with adjusted 1000yr as stated above).

6.3 Assumptions, limitations and uncertainty

List the main assumptions made (specific to this study)	As per NRW recommendation, the area directly draining to Llyn Peris has be considered offline and excluded from the catchment (see section 1.2).
Discuss any particular limitations, e.g. applying methods outside the range of catchment types or return periods for which they were developed	The 1000yr flows have been derived and have a large uncertainty.
Give what information you can on in the results – e.g. confidence limits for the QMED estimates using FEH **3** 12.5 or the factorial standard error from Science Report SC050050 (2008).	Confidence limits of 95% on FEH Statistical derived QMED: 49.113 Lower limit = 23.967 Upper limit = 100.583 NB: These limits do not apply to the ReFH method results.
Comment on the suitability of the	

results for future studies, e.g. at nearby locations or for different purposes.	
Give any other comments on the study, for example suggestions for additional work.	A single site analysis was carried out for comparison. The Q100 growth factor for the GL distribution is 1.722 and 1.634 for GEV. These growth factors are lower than the ungauged analysis. The results from this analysis are also likely to be wrong for Q100 event as it is recommended that for a station with 40 years of data, events up to Q20 are derived and not above. The Enhanced Single Site analysis has shown similar growth factors to the Single site analysis.

6.4 Checks

Are the results consistent, for example at confluences?	
What do the results imply regarding the return periods of floods during the period of record?	
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 to 4.0)	2.036 slightly outside of the typical range
If 1000-year flows have been derived, what is the range of ratios for 1000-year flow over 100-year flow?	FEH Stat = 1.328 FEH Rainfall Runoff = 1.859
What range of specific runoffs (l/s/ha) do the results equate to? Are there any inconsistencies?	Catchment area= 77.90 km² = 7790 ha 1 in 100 yr peak (FEH) = 100.013 m³/s= 100013 l/s Run off equates to 12.83 l/s/ha
How do the results compare with those of other studies? Explain any differences and conclude which results should be preferred.	
Are the results compatible with the longer-term flood history?	Yes
Describe any other checks on the results	

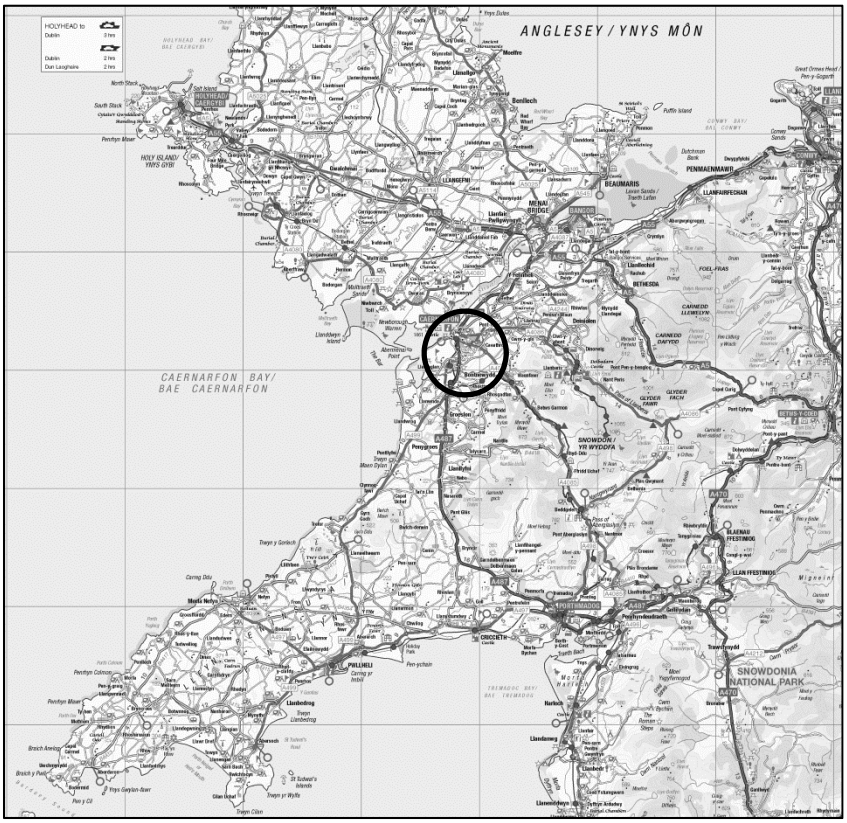
6.5 Final results

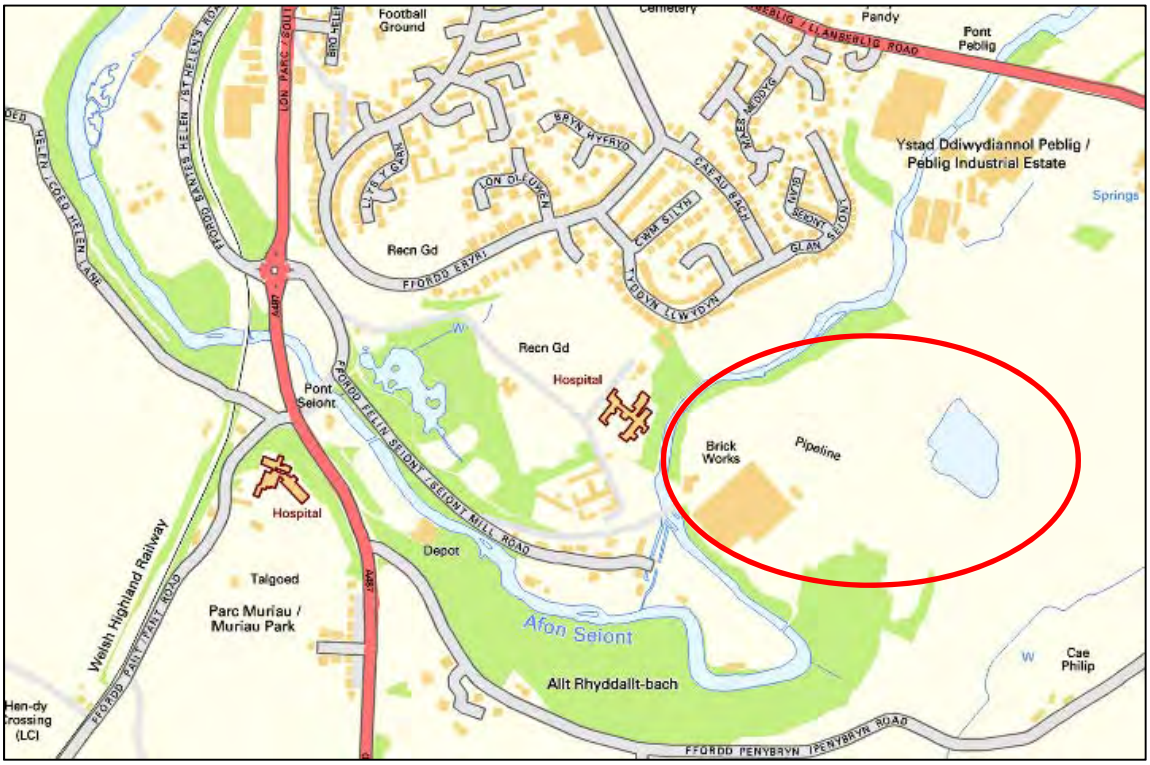
Site code	Flood peak (m^3/s) for the following return periods (in years)								
	2	20	100	100CC	1000				
S001	49.113	80.474	100.013	120.016	185.924				

If flood hydrographs are needed for the next stage of the study, where are they provided? (e.g. give filename of spreadsheet, name of ISIS model, or reference to table below)	See Annex 7.6

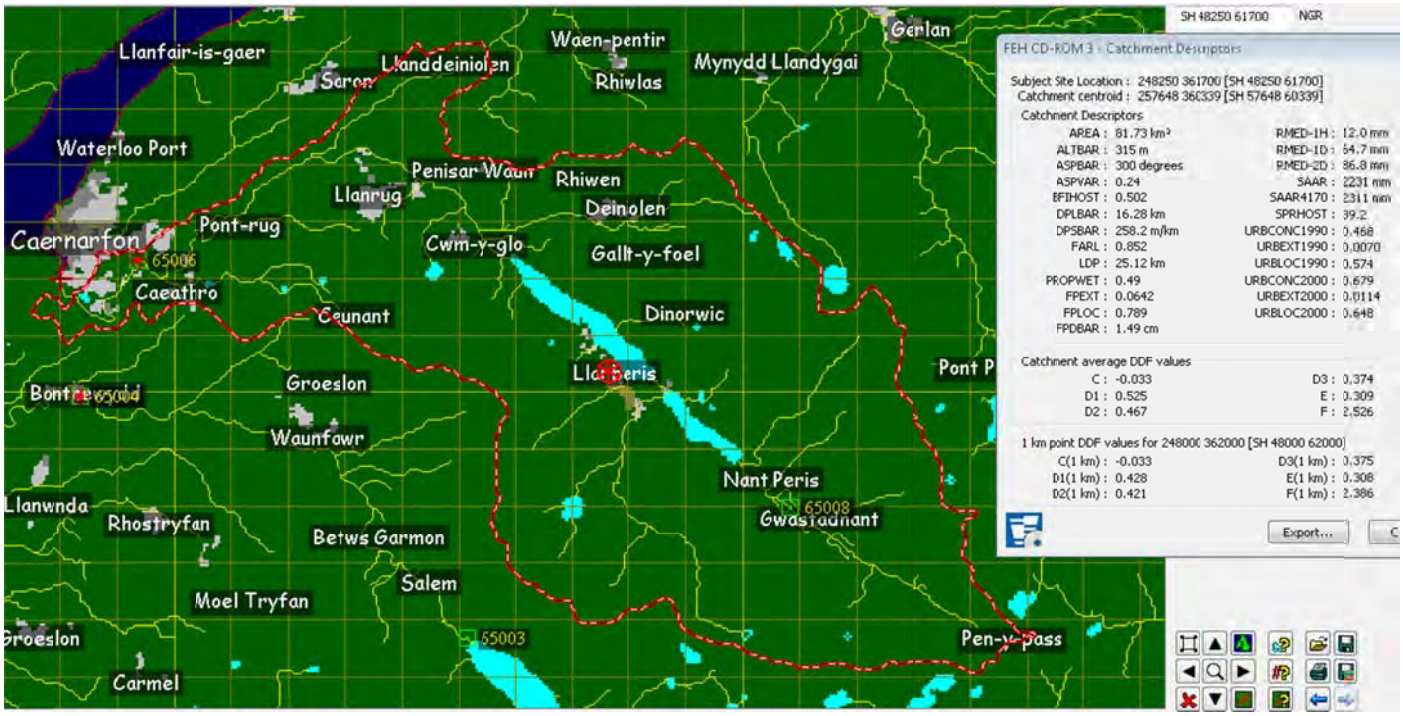
7 ANNEX - SUPPORTING INFORMATION

7.1 Site Location Plan

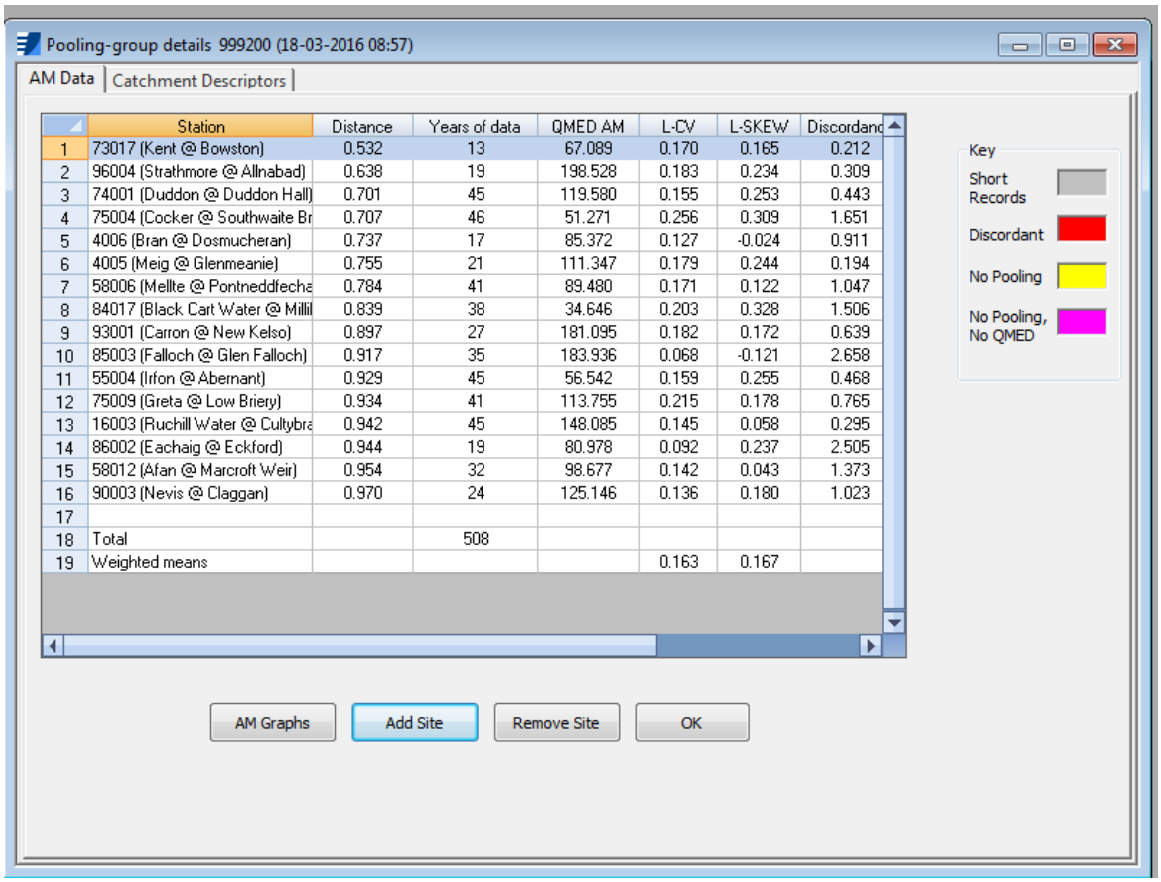


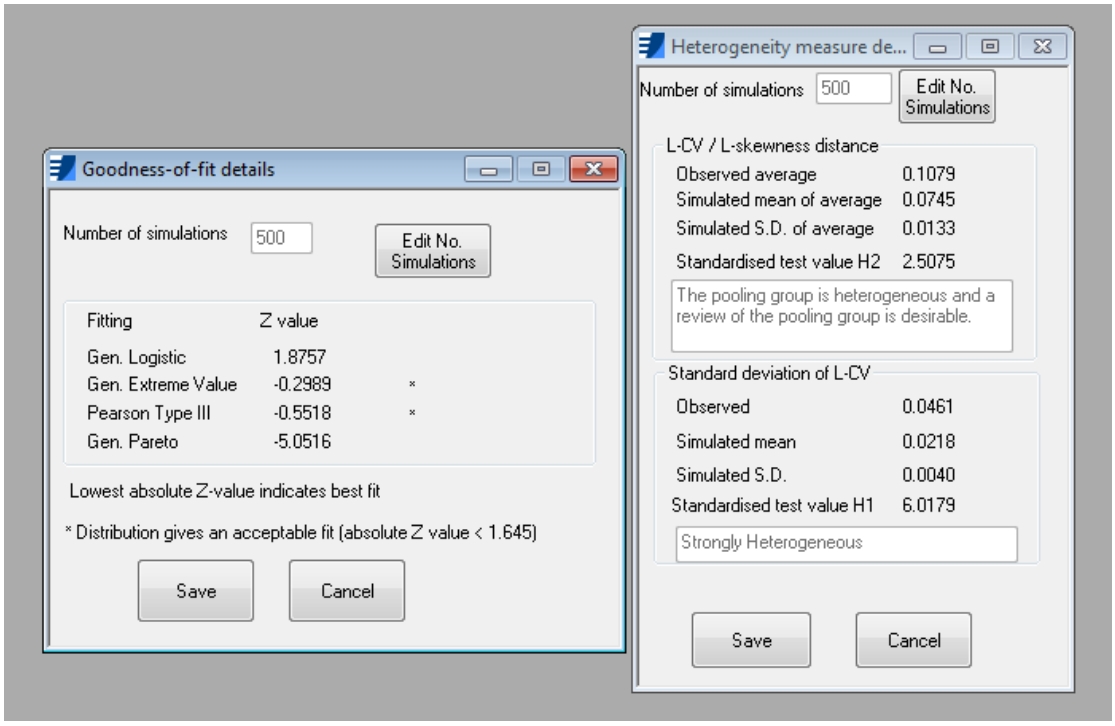


7.2 FEH CD-ROM3 Catchment Boundary and Descriptors



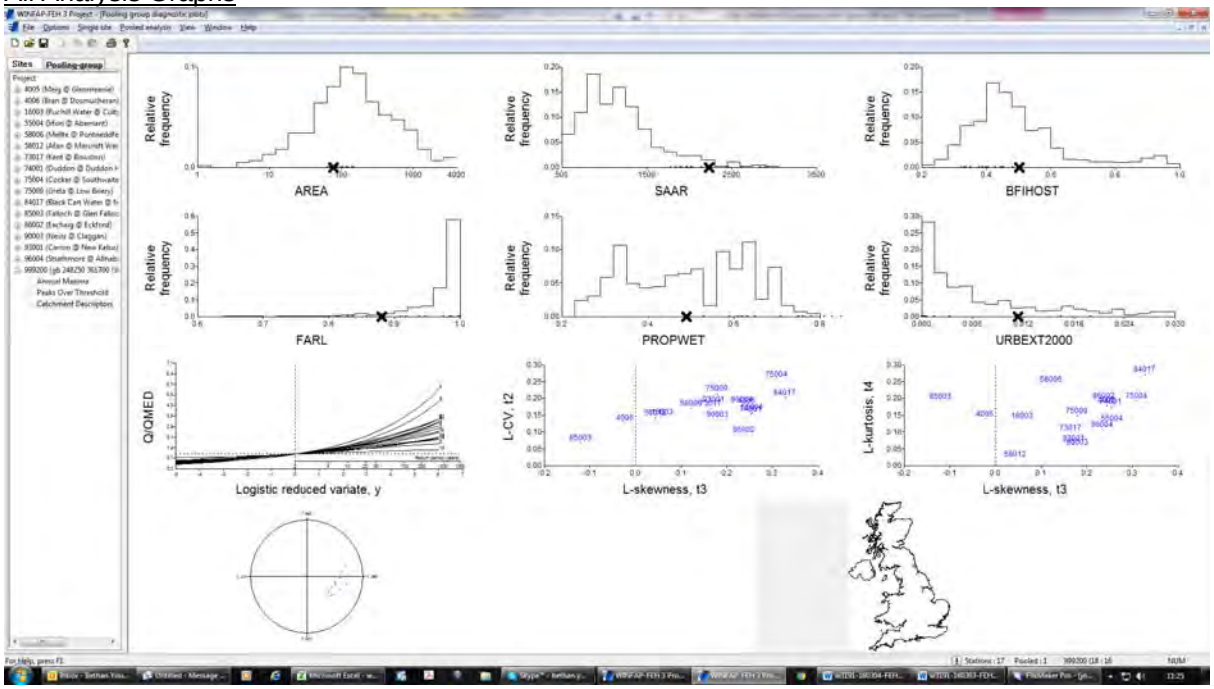
7.3 FEH Statistical Analysis – Pooling group composition



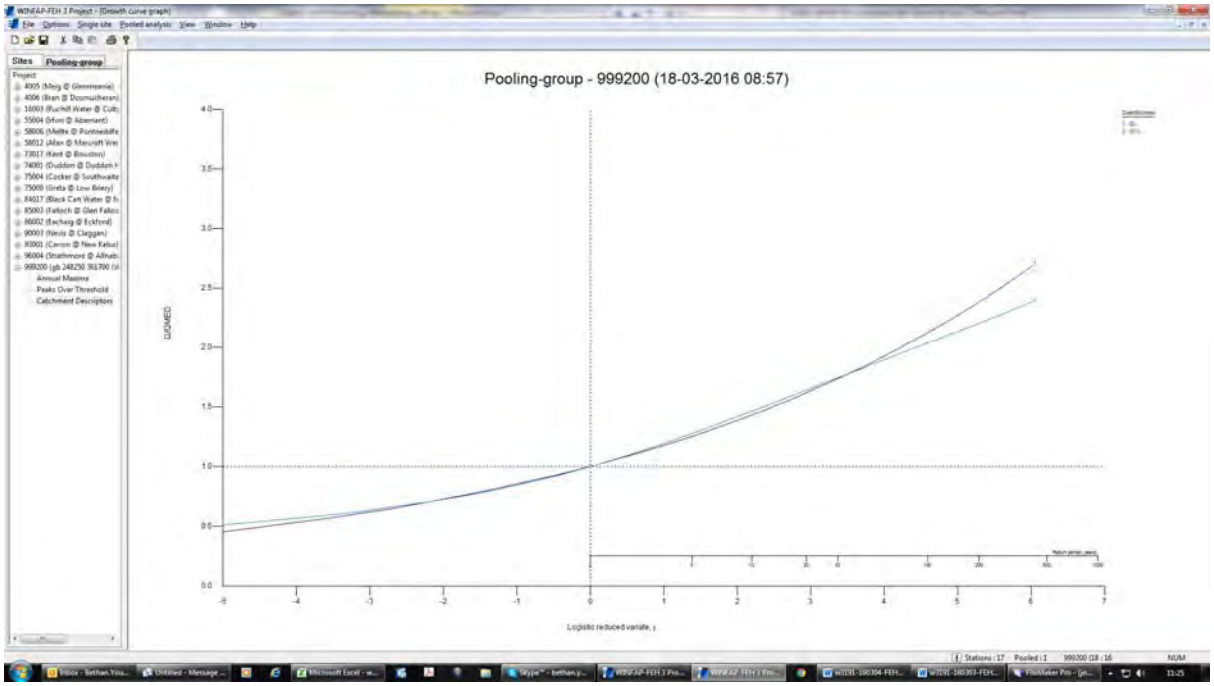


7.4 FEH Statistical Analysis – Additional supporting information

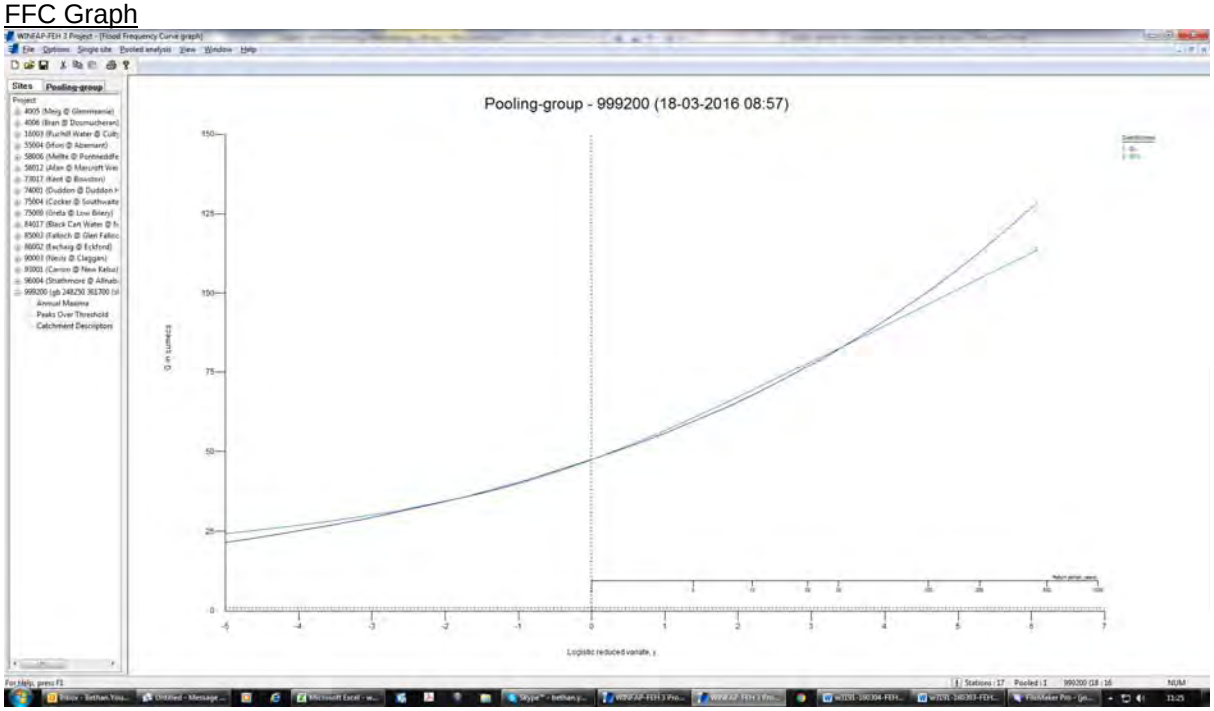
All Analysis Graphs



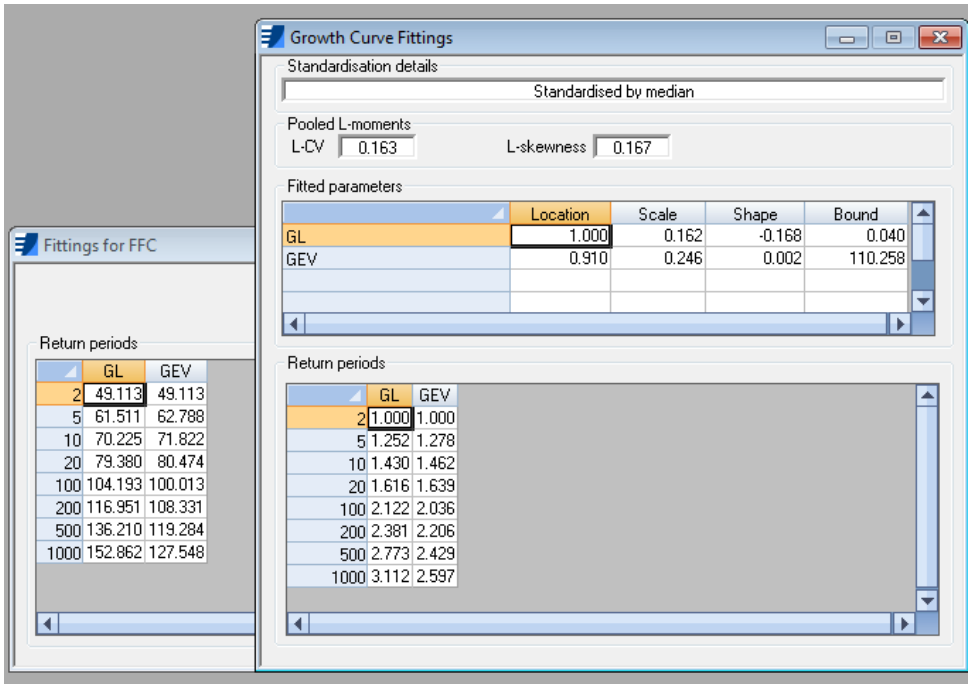
Growth Curve graph



FFC Graph

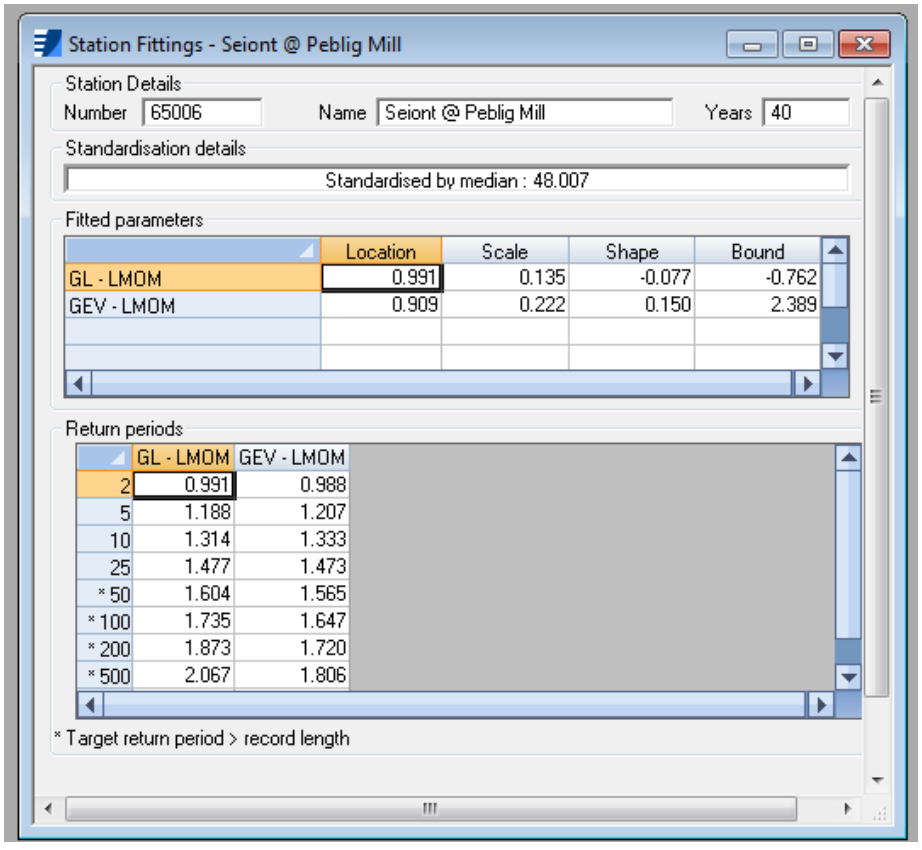


Growth curve factors for Ungauged analysis results (chosen Statistcal peaks)

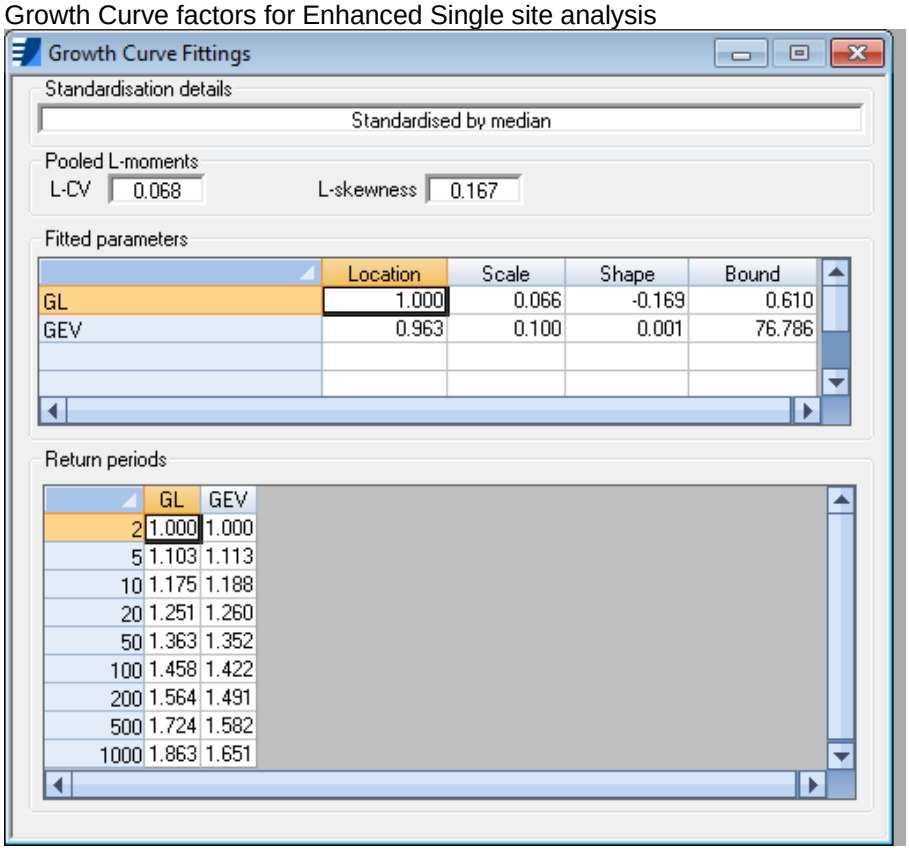


Growth Curve Factors for additional Statistical methods (SS and ESS)

Growth Curve factors for single site analysis results



Growth Curve factors for Enhanced Single site analysis



7.5 ReFH Hydrographs

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Manfredi Toraldo	**Catchment name**	Seiont at A487 bridge, Caernarfc	**Date/time modelled**	18-Mar-2016 11:46
Company name	Waterco	**Catchment easting**	248250	**Version**	1.4
Project name	w3191-Seiont Brickworks,	**Catchment northing**	361700		
		Catchment area	77.9		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	2	**C_{max} (mm)**	368	**T_p (hr)**	3.74	**BL (hr)**	47.3
Duration (hr)	12	**C_{ini} (mm)**	138	**U_p**	0.65	**BR**	1.38
Timestep (hr)	0.48	**α factor**	1	**U_k**	0.8	**BF_0 (m^3/s)**	10.5
Season	Winter						

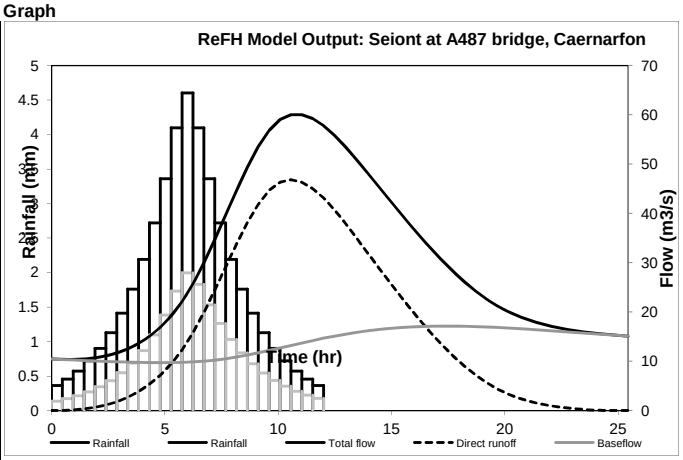
Summary of results

FEH DDF rainfall (mm)	50.1	**Peak rainfall (mm)**	4.6
Design rainfall (mm)	44	**Peak flow (m^3/s)**	60.1

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.00	0.4	0.1	0.0	10.5	10.5
0.48	0.5	0.2	0.0	10.4	10.4
0.96	0.6	0.2	0.1	10.3	10.4
1.44	0.7	0.3	0.3	10.2	10.5
1.92	0.9	0.3	0.7	10.1	10.7
2.40	1.1	0.4	1.1	10.0	11.1
2.88	1.4	0.5	1.8	9.9	11.7
3.36	1.8	0.7	2.7	9.8	12.5
3.84	2.2	0.9	3.9	9.8	13.6
4.32	2.7	1.1	5.4	9.7	15.1
4.80	3.4	1.4	7.2	9.7	16.9
5.28	4.1	1.7	9.5	9.7	19.2
5.76	4.6	2.0	12.3	9.8	22.1
6.24	4.1	1.8	15.8	9.9	25.7
6.72	3.4	1.5	19.9	10.0	30.0
7.20	2.7	1.3	24.4	10.3	34.7
7.68	2.2	1.0	29.1	10.5	39.7
8.16	1.8	0.8	33.8	10.9	44.6
8.64	1.4	0.7	38.1	11.2	49.4
9.12	1.1	0.5	41.9	11.7	53.5
9.60	0.9	0.4	44.7	12.2	56.9
10.08	0.7	0.4	46.4	12.7	59.0
10.56	0.6	0.3	46.8	13.2	60.0
11.04	0.5	0.2	46.3	13.7	60.1
11.52	0.4	0.2	45.0	14.2	59.2
12.00	0.0	0.0	43.1	14.7	57.8
12.48	0.0	0.0	40.7	15.1	55.8
12.96	0.0	0.0	38.0	15.5	53.5
13.44	0.0	0.0	35.1	15.9	50.9
13.92	0.0	0.0	32.1	16.2	48.3
14.40	0.0	0.0	29.2	16.4	45.6
14.88	0.0	0.0	26.3	16.7	42.9
15.36	0.0	0.0	23.4	16.8	40.2
15.84	0.0	0.0	20.6	17.0	37.6
16.32	0.0	0.0	17.9	17.1	35.0
16.80	0.0	0.0	15.5	17.1	32.6
17.28	0.0	0.0	13.1	17.2	30.3
17.76	0.0	0.0	11.0	17.1	28.1
18.24	0.0	0.0	9.0	17.1	26.1
18.72	0.0	0.0	7.2	17.1	24.3
19.20	0.0	0.0	5.7	17.0	22.6
19.68	0.0	0.0	4.4	16.9	21.2
20.16	0.0	0.0	3.3	16.7	20.1
20.64	0.0	0.0	2.5	16.6	19.1
21.12	0.0	0.0	1.8	16.5	18.3
21.60	0.0	0.0	1.3	16.3	17.6
22.08	0.0	0.0	0.9	16.2	17.1
22.56	0.0	0.0	0.6	16.0	16.6
23.04	0.0	0.0	0.4	15.9	16.3
23.52	0.0	0.0	0.2	15.7	16.0
24.00	0.0	0.0	0.1	15.6	15.7
24.48	0.0	0.0	0.0	15.4	15.5
24.96	0.0	0.0	0.0	15.3	15.3
25.44	0.0	0.0	0.0	15.1	15.1
Total (mm)	**44.0**	**19.1**	**19.1**	**16.5**	**35.6**

Graph



Audit comments

Model run with ReFH dll version 1.4.0005

Catchment

Catchment descriptors imported from file
Catchment descriptor file = 'w3191-160303-CDs Afon Seiont Altered.csv'
Catchment decriptor file exported from CD ROM version 3
Catchment descriptor file exported on 03-Mar-2016 11:47
BFIHOST value of 0.502 used
PROPWET value of 0.49 used
SAAR value of 2231 used
DPLBAR value of 16.28 used
DPSBAR value of 258.2 used
URBEXT value of 0.007 used
C value of -0.03319 used
D1 value of 0.52544 used
D2 value of 0.46731 used
D3 value of 0.37433 used
E value of 0.30899 used
F value of 2.52619 used

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Manfredi Toraldo	**Catchment name**	Seiont at A487 bridge, Caernarfc	**Date/time modelled**	18-Mar-2016 11:46
Company name	Waterco	**Catchment easting**	248250	**Version**	1.4
Project name	w3191-Seiont Brickworks,	**Catchment northing**	361700		
		Catchment area	77.9		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	20	**C_{max} (mm)**	368	**T_p (hr)**	3.74	**BL (hr)**	47.3
Duration (hr)	12	**C_{ini} (mm)**	138	**U_p**	0.65	**BR**	1.38
Timestep (hr)	0.48	**α factor**	0.94	**U_k**	0.8	**BF_0 (m^3/s)**	10.5
Season	Winter						

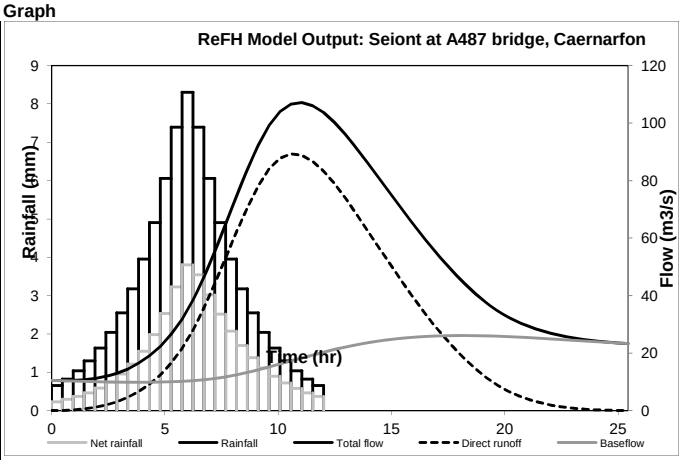
Summary of results

FEH DDF rainfall (mm)	90.4	**Peak rainfall (mm)**	8.3
Design rainfall (mm)	79.4	**Peak flow (m^3/s)**	107.1

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.00	0.7	0.2	0.0	10.5	10.5
0.48	0.8	0.3	0.1	10.4	10.4
0.96	1.0	0.4	0.2	10.3	10.5
1.44	1.3	0.5	0.6	10.2	10.7
1.92	1.6	0.6	1.1	10.1	11.2
2.40	2.0	0.7	1.9	10.0	11.9
2.88	2.5	1.0	3.0	9.9	13.0
3.36	3.2	1.2	4.6	9.9	14.4
3.84	4.0	1.5	6.6	9.9	16.5
4.32	4.9	2.0	9.2	9.9	19.1
4.80	6.1	2.5	12.4	9.9	22.4
5.28	7.4	3.2	16.5	10.0	26.5
5.76	8.3	3.8	21.6	10.2	31.8
6.24	7.4	3.5	28.0	10.4	38.4
6.72	6.1	3.0	35.6	10.8	46.4
7.20	4.9	2.5	44.1	11.2	55.3
7.68	4.0	2.1	53.1	11.8	64.9
8.16	3.2	1.7	62.1	12.5	74.6
8.64	2.5	1.4	70.7	13.3	83.9
9.12	2.0	1.1	78.2	14.2	92.4
9.60	1.6	0.9	84.1	15.1	99.2
10.08	1.3	0.7	87.8	16.2	104.0
10.56	1.0	0.6	89.3	17.3	106.5
11.04	0.8	0.5	88.8	18.3	107.1
11.52	0.7	0.4	86.7	19.4	106.0
12.00	0.0	0.0	83.3	20.3	103.7
12.48	0.0	0.0	79.0	21.3	100.2
12.96	0.0	0.0	73.9	22.1	96.0
13.44	0.0	0.0	68.4	22.9	91.3
13.92	0.0	0.0	62.8	23.6	86.3
14.40	0.0	0.0	57.1	24.2	81.3
14.88	0.0	0.0	51.5	24.7	76.2
15.36	0.0	0.0	46.0	25.1	71.1
15.84	0.0	0.0	40.6	25.4	66.0
16.32	0.0	0.0	35.4	25.7	61.1
16.80	0.0	0.0	30.6	25.9	56.5
17.28	0.0	0.0	26.1	26.1	52.1
17.76	0.0	0.0	21.9	26.1	48.0
18.24	0.0	0.0	18.0	26.1	44.1
18.72	0.0	0.0	14.5	26.1	40.6
19.20	0.0	0.0	11.4	26.0	37.4
19.68	0.0	0.0	8.8	25.9	34.7
20.16	0.0	0.0	6.8	25.7	32.5
20.64	0.0	0.0	5.1	25.6	30.6
21.12	0.0	0.0	3.7	25.4	29.1
21.60	0.0	0.0	2.7	25.2	27.8
22.08	0.0	0.0	1.9	24.9	26.8
22.56	0.0	0.0	1.3	24.7	26.0
23.04	0.0	0.0	0.8	24.5	25.3
23.52	0.0	0.0	0.5	24.2	24.7
24.00	0.0	0.0	0.2	24.0	24.2
24.48	0.0	0.0	0.1	23.7	23.9
24.96	0.0	0.0	0.0	23.5	23.5
25.44	0.0	0.0	0.0	23.3	23.3
Total (mm)	**79.4**	**36.3**	**36.3**	**22.5**	**58.8**

Graph



Audit comments

Model run with ReFH dll version 1.4.0005

Catchment

Catchment descriptors imported from file
Catchment descriptor file = 'w3191-160303-CDs Afon Seiont Altered.csv'
Catchment decriptor file exported from CD ROM version 3
Catchment descriptor file exported on 03-Mar-2016 11:47
BFIHOST value of 0.502 used
PROPWET value of 0.49 used
SAAR value of 2231 used
DPLBAR value of 16.28 used
DPSBAR value of 258.2 used
URBEXT value of 0.007 used
C value of -0.03319 used
D1 value of 0.52544 used
D2 value of 0.46731 used
D3 value of 0.37433 used
E value of 0.30899 used
F value of 2.52619 used

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Manfredi Toraldo	**Catchment name**	Seiont at A487 bridge, Caernarfc	**Date/time modelled**	18-Mar-2016 11:47
Company name	Waterco	**Catchment easting**	248250	**Version**	1.4
Project name	w3191-Seiont Brickworks,	**Catchment northing**	361700		
		Catchment area	77.9		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	100	**C_{max} (mm)**	368	**T_p (hr)**	3.74	**BL (hr)**	47.3
Duration (hr)	12	**C_{ini} (mm)**	138	**U_p**	0.65	**BR**	1.38
Timestep (hr)	0.48	**α factor**	0.83	**U_k**	0.8	**BF_0 (m^3/s)**	10.5
Season	Winter						

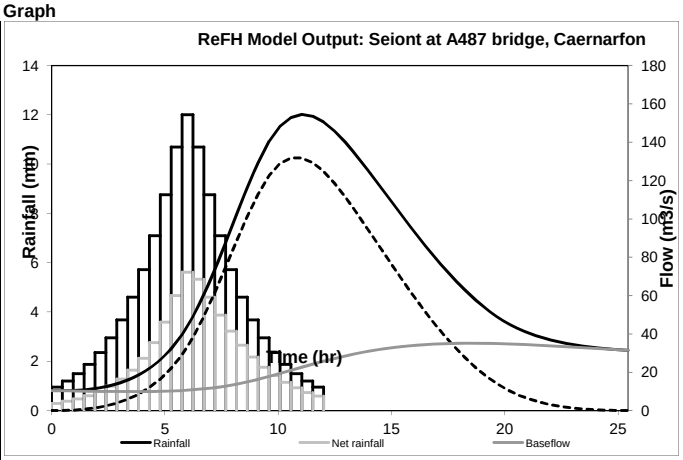
Summary of results

FEH DDF rainfall (mm)	130.8	**Peak rainfall (mm)**	12
Design rainfall (mm)	114.8	**Peak flow (m^3/s)**	154.4

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.00	1.0	0.3	0.0	10.5	10.5
0.48	1.2	0.4	0.1	10.4	10.4
0.96	1.5	0.5	0.3	10.3	10.6
1.44	1.9	0.6	0.7	10.2	10.9
1.92	2.4	0.8	1.4	10.1	11.5
2.40	2.9	1.0	2.5	10.0	12.5
2.88	3.7	1.3	3.9	9.9	13.9
3.36	4.6	1.6	6.0	9.9	15.9
3.84	5.7	2.1	8.7	9.9	18.6
4.32	7.1	2.8	12.1	10.0	22.1
4.80	8.8	3.6	16.5	10.1	26.5
5.28	10.7	4.7	22.0	10.2	32.3
5.76	12.0	5.6	29.1	10.5	39.6
6.24	10.7	5.3	38.2	10.8	49.0
6.72	8.8	4.6	49.1	11.3	60.5
7.20	7.1	3.9	61.6	12.0	73.6
7.68	5.7	3.2	74.9	12.8	87.7
8.16	4.6	2.7	88.4	13.8	102.2
8.64	3.7	2.2	101.5	15.0	116.5
9.12	2.9	1.8	113.2	16.4	129.5
9.60	2.4	1.4	122.6	17.8	140.5
10.08	1.9	1.1	128.9	19.4	148.3
10.56	1.5	0.9	131.9	21.0	152.9
11.04	1.2	0.7	131.8	22.6	154.4
11.52	1.0	0.6	129.3	24.2	153.5
12.00	0.0	0.0	124.8	25.8	150.5
12.48	0.0	0.0	118.7	27.2	145.9
12.96	0.0	0.0	111.4	28.5	139.9
13.44	0.0	0.0	103.4	29.7	133.1
13.92	0.0	0.0	95.1	30.8	125.9
14.40	0.0	0.0	86.7	31.8	118.4
14.88	0.0	0.0	78.3	32.6	110.9
15.36	0.0	0.0	70.0	33.3	103.3
15.84	0.0	0.0	61.9	33.9	95.8
16.32	0.0	0.0	54.1	34.3	88.5
16.80	0.0	0.0	46.9	34.7	81.5
17.28	0.0	0.0	40.0	34.9	75.0
17.76	0.0	0.0	33.7	35.1	68.8
18.24	0.0	0.0	27.8	35.2	63.0
18.72	0.0	0.0	22.5	35.2	57.7
19.20	0.0	0.0	17.8	35.1	52.9
19.68	0.0	0.0	13.9	35.0	48.8
20.16	0.0	0.0	10.6	34.8	45.4
20.64	0.0	0.0	8.0	34.6	42.5
21.12	0.0	0.0	5.9	34.3	40.2
21.60	0.0	0.0	4.2	34.0	38.3
22.08	0.0	0.0	3.0	33.7	36.7
22.56	0.0	0.0	2.0	33.4	35.4
23.04	0.0	0.0	1.3	33.1	34.4
23.52	0.0	0.0	0.8	32.8	33.5
24.00	0.0	0.0	0.4	32.5	32.9
24.48	0.0	0.0	0.2	32.1	32.3
24.96	0.0	0.0	0.0	31.8	31.9
25.44	0.0	0.0	0.0	31.5	31.5
Total (mm)	**114.8**	**53.6**	**53.6**	**28.4**	**82.0**

Graph



Audit comments

Model run with ReFH dll version 1.4.0005

Catchment

Catchment descriptors imported from file
Catchment descriptor file = 'w3191-160303-CDs Afon Seiont Altered.csv'
Catchment decriptor file exported from CD ROM version 3
Catchment descriptor file exported on 03-Mar-2016 11:47
BFIHOST value of 0.502 used
PROPWET value of 0.49 used
SAAR value of 2231 used
DPLBAR value of 16.28 used
DPSBAR value of 258.2 used
URBEXT value of 0.007 used
C value of -0.03319 used
D1 value of 0.52544 used
D2 value of 0.46731 used
D3 value of 0.37433 used
E value of 0.30899 used
F value of 2.52619 used

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application report

User name	Manfredi Toraldo	**Catchment name**	Seiont at A487 bridge, Caernarfc	**Date/time modelled**	18-Mar-2016 11:47
Company name	Waterco	**Catchment easting**	248250	**Version**	1.4
Project name	w3191-Seiont Brickworks,	**Catchment northing**	361700		
		Catchment area	77.9		

Summary of model setup

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters	
Return period (yr)	1000	**C_{max} (mm)**	368	**T_p (hr)**	3.74	**BL (hr)**	47.3
Duration (hr)	12	**C_{ini} (mm)**	138	**U_p**	0.65	**BR**	1.38
Timestep (hr)	0.48	**α factor**	0.7	**U_k**	0.8	**BF_0 (m^3/s)**	10.5
Season	Winter						

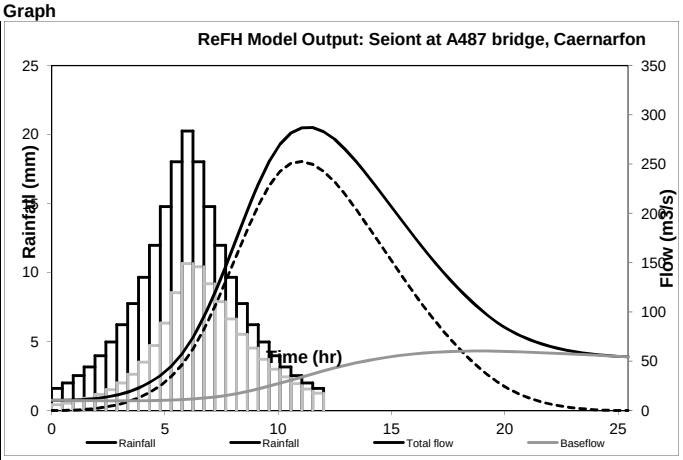
Summary of results

FEH DDF rainfall (mm)	220.6	**Peak rainfall (mm)**	20.2
Design rainfall (mm)	193.6	**Peak flow (m^3/s)**	287.1

Results

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Unit	mm	mm	m^3/s	m^3/s	m^3/s
0.00	1.6	0.4	0.0	10.5	10.5
0.48	2.0	0.5	0.1	10.4	10.5
0.96	2.5	0.7	0.4	10.3	10.7
1.44	3.2	0.9	1.1	10.2	11.2
1.92	4.0	1.2	2.1	10.1	12.2
2.40	5.0	1.5	3.6	10.0	13.6
2.88	6.2	2.0	5.8	10.0	15.8
3.36	7.8	2.6	8.8	10.0	18.8
3.84	9.6	3.5	12.9	10.0	23.0
4.32	12.0	4.7	18.3	10.2	28.5
4.80	14.8	6.3	25.3	10.4	35.6
5.28	18.0	8.5	34.4	10.7	45.1
5.76	20.2	10.7	46.5	11.1	57.6
6.24	18.0	10.4	62.4	11.8	74.1
6.72	14.8	9.2	82.2	12.7	94.9
7.20	12.0	7.9	105.4	13.8	119.3
7.68	9.6	6.6	130.9	15.3	146.2
8.16	7.8	5.5	157.4	17.2	174.6
8.64	6.2	4.5	183.6	19.4	203.0
9.12	5.0	3.7	207.8	21.9	229.7
9.60	4.0	3.0	228.1	24.7	252.9
10.08	3.2	2.4	242.6	27.8	270.4
10.56	2.5	2.0	250.7	30.9	281.6
11.04	2.0	1.6	252.8	34.1	286.9
11.52	1.6	1.3	249.9	37.2	287.1
12.00	0.0	0.0	242.8	40.3	283.1
12.48	0.0	0.0	232.2	43.2	275.4
12.96	0.0	0.0	219.0	45.9	264.9
13.44	0.0	0.0	204.0	48.4	252.4
13.92	0.0	0.0	188.2	50.6	238.9
14.40	0.0	0.0	172.1	52.6	224.8
14.88	0.0	0.0	156.0	54.4	210.3
15.36	0.0	0.0	139.9	55.9	195.7
15.84	0.0	0.0	123.9	57.1	181.1
16.32	0.0	0.0	108.7	58.2	166.9
16.80	0.0	0.0	94.5	59.0	153.5
17.28	0.0	0.0	81.1	59.6	140.8
17.76	0.0	0.0	68.6	60.1	128.7
18.24	0.0	0.0	57.0	60.3	117.4
18.72	0.0	0.0	46.4	60.5	106.9
19.20	0.0	0.0	37.0	60.4	97.4
19.68	0.0	0.0	29.0	60.3	89.2
20.16	0.0	0.0	22.3	60.0	82.3
20.64	0.0	0.0	16.8	59.7	76.5
21.12	0.0	0.0	12.4	59.3	71.7
21.60	0.0	0.0	9.0	58.8	67.8
22.08	0.0	0.0	6.3	58.4	64.7
22.56	0.0	0.0	4.2	57.8	62.1
23.04	0.0	0.0	2.7	57.3	60.0
23.52	0.0	0.0	1.6	56.8	58.4
24.00	0.0	0.0	0.8	56.2	57.0
24.48	0.0	0.0	0.3	55.6	56.0
24.96	0.0	0.0	0.1	55.1	55.2
25.44	0.0	0.0	0.0	54.5	54.5
Total (mm)	**193.6**	**101.8**	**101.8**	**44.7**	**146.6**

Graph



Audit comments

Model run with ReFH dll version 1.4.0005

Catchment

Catchment descriptors imported from file
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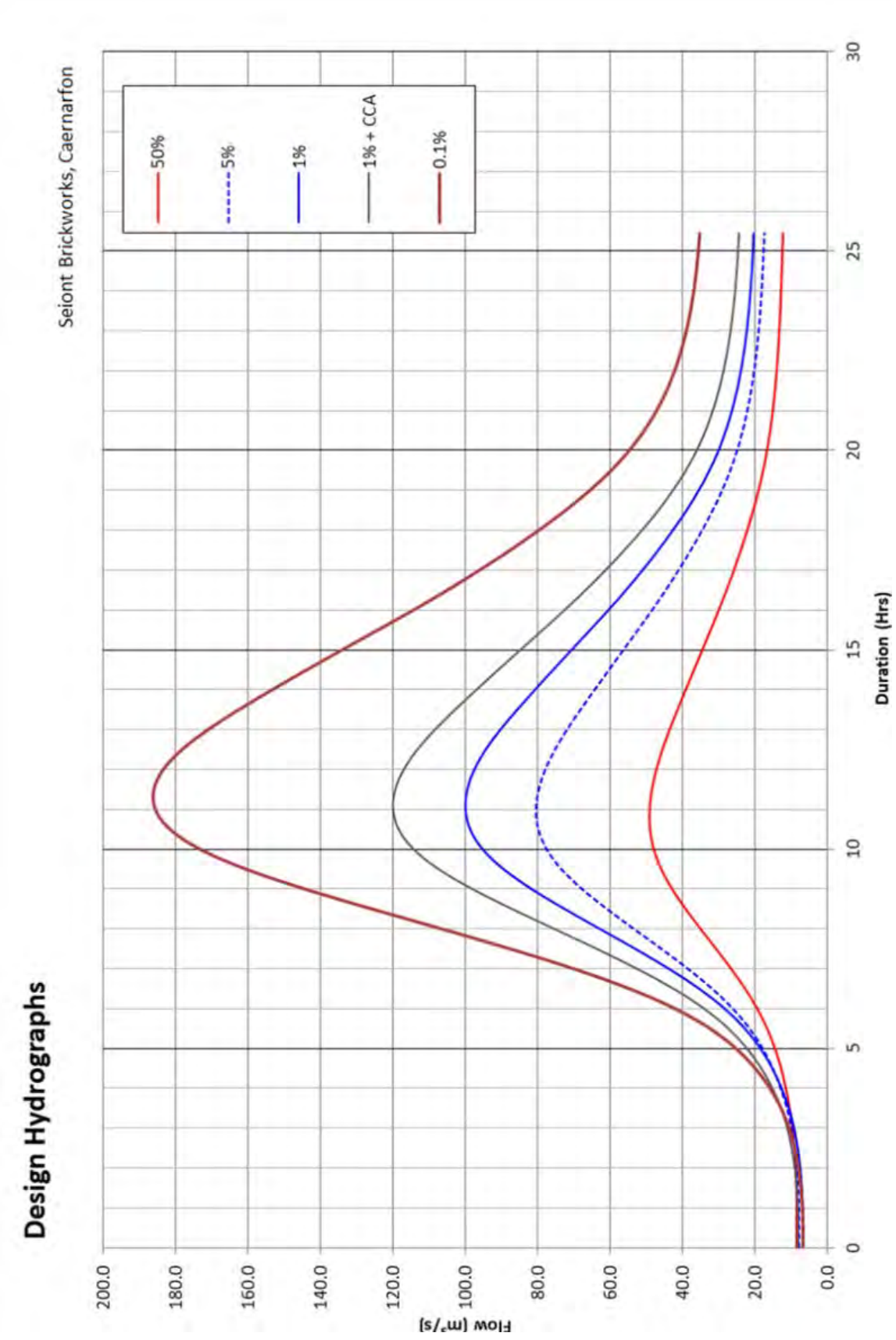
D1 value of 0.52544 used
D2 value of 0.46731 used
D3 value of 0.37433 used
E value of 0.30899 used
F value of 2.52619 used

7.6 Design Hydrographs



7.7 Previous Correspondence with NRW

Llyn Peris catchment area

Bissell, Robert <Robert.Bissell@cyfoethnaturiolcymru.gov.uk>

Follow up. Completed on 21 January 2015.

Information received

Sent: Tue 20/01/2015 16:10

To: Bethan Young

Message | LlynPeris.docx (969 KB)

Hi Bethan,

Apologies for the confusion! Here's a rough outline (attached) of the catchment that drains in to Llyn Peris, which needs 'removing' from the FEH catchment descriptors.

I've made a note of this to update the information held on the NRFA website so that future users of the Peblic Mill data know to adjust CD's if using for donor adjustment.

Any other queries just shout.

Thanks,
Rob