

# APPENDICES

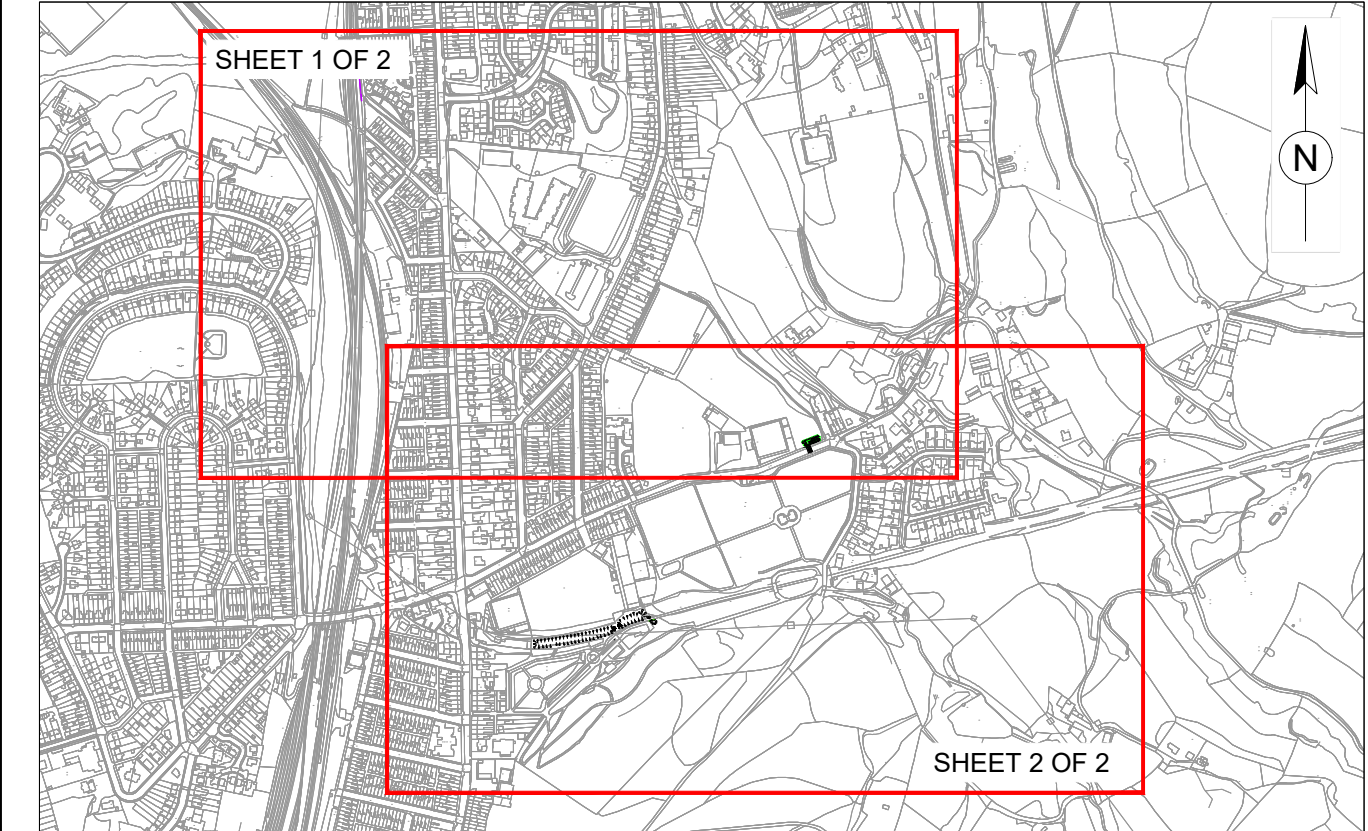
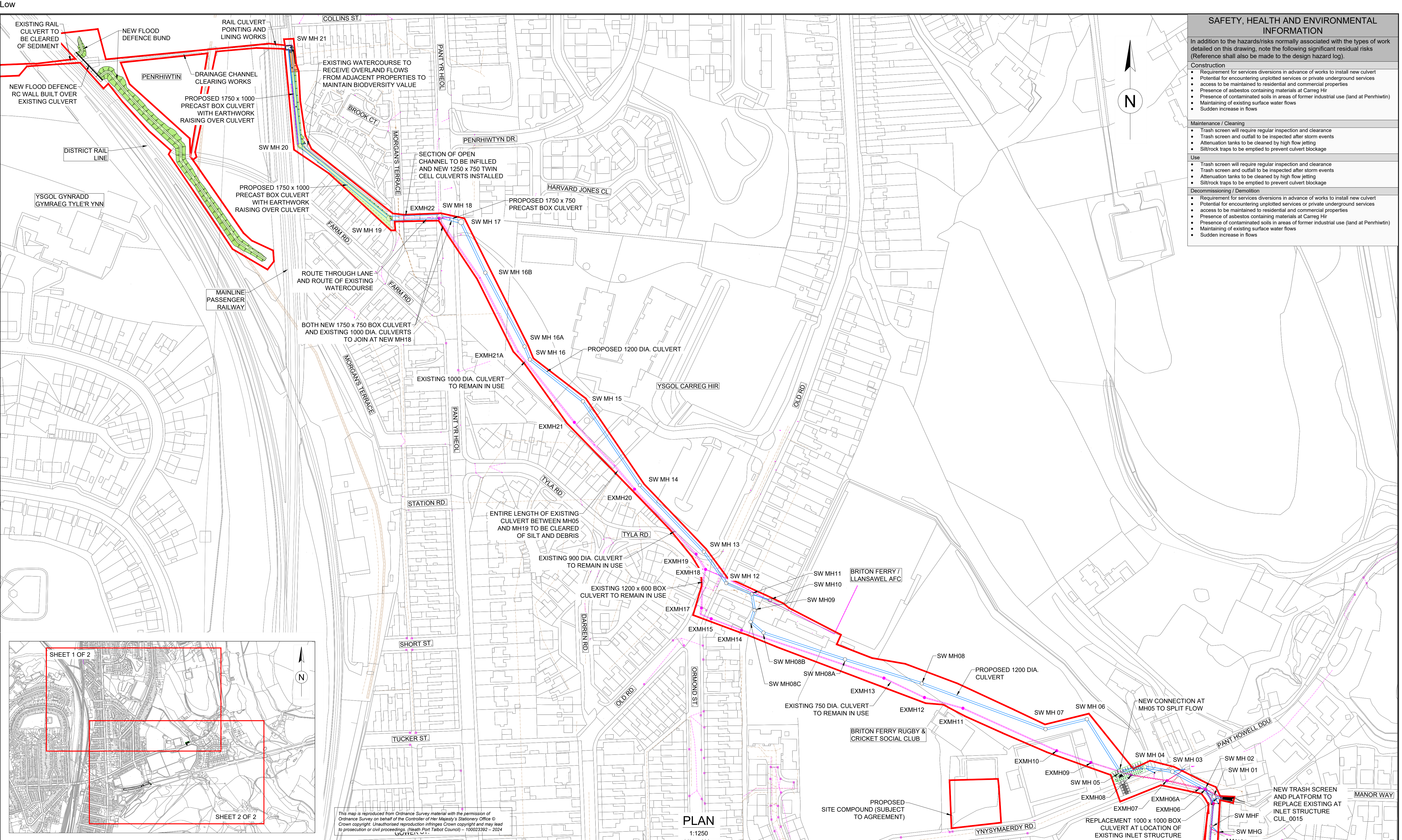


# Appendix A. Proposed Scheme Overview



DO NOT SCALE

100  
0 10  
Millimetres



This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. (Neath Port Talbot Council) - 100023392 - 2024

PLAN  
1:1250

| SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log). |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Construction                                                                                                                                                                                                 | <ul style="list-style-type: none"><li>Requirement for services diversions in advance of works to install new culvert</li><li>Potential for encountering unplotted services or private underground services</li><li>access to be maintained to residential and commercial properties</li><li>Presence of asbestos containing materials at Carreg Hir</li><li>Presence of contaminated soils in areas of former industrial use (land at Penrhiwlin)</li><li>Maintaining of existing surface water flows</li><li>Sudden increase in flows</li></ul> |
| Maintenance / Cleaning                                                                                                                                                                                       | <ul style="list-style-type: none"><li>Trash screen will require regular inspection and clearance</li><li>Trash screen and outfall to be inspected after storm events</li><li>Attenuation tanks to be cleaned by high flow jetting</li><li>Silt/rock traps to be emptied to prevent culvert blockage</li></ul>                                                                                                                                                                                                                                    |
| Use                                                                                                                                                                                                          | <ul style="list-style-type: none"><li>Trash screen will require regular inspection and clearance</li><li>Trash screen and outfall to be inspected after storm events</li><li>Attenuation tanks to be cleaned by high flow jetting</li><li>Silt/rock traps to be emptied to prevent culvert blockage</li></ul>                                                                                                                                                                                                                                    |
| Decommissioning / Demolition                                                                                                                                                                                 | <ul style="list-style-type: none"><li>Requirement for services diversions in advance of works to install new culvert</li><li>Potential for encountering unplotted services or private underground services</li><li>access to be maintained to residential and commercial properties</li><li>Presence of asbestos containing materials at Carreg Hir</li><li>Presence of contaminated soils in areas of former industrial use (land at Penrhiwlin)</li><li>Maintaining of existing surface water flows</li><li>Sudden increase in flows</li></ul> |

### NOTES

- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
- ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM UNLESS OTHERWISE NOTED.

### DRAINAGE SERVICES LEGEND

- Neath Port Talbot Borough Council - Drainage
- Neath Port Talbot Borough Council - Gully
- Dwr Cymru Welsh Water - Sewerage
- Dwr Cymru Welsh Water - Water

### KEY

PLANNING BOUNDARY, BASED ON SITE ACCESS ROUTES AND SITE COMPOUND

|             |  |          |       |         |          |            |                     |  |                                                                                                                                                                 |  |                                             |  |
|-------------|--|----------|-------|---------|----------|------------|---------------------|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------|--|
| Description |  |          |       |         |          |            | Drawing Suitability |  | Status                                                                                                                                                          |  | Project Title                               |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | FOR INFORMATION                                                                                                                                                 |  | S2                                          |  |
| Description |  |          |       |         |          |            |                     |  | West Glamorgan House<br>12 Orchard Street<br>Swansea<br>West Glamorgan<br>SA1 5AD<br>Tel: +44 (0)1792 641172<br>Fax: +44 (0)1792 472019<br>www.atkinsglobal.com |  | Drawing Title                               |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | AtkinsRéalis                                                                                                                                                    |  | PROPOSED SCHEME<br>OVERVIEW<br>SHEET 1 OF 2 |  |
| Description |  |          |       |         |          |            |                     |  | Copyright C AtkinsRéalis (2025)                                                                                                                                 |  |                                             |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | Client                                                                                                                                                          |  | Drawing Number                              |  |
| Description |  |          |       |         |          |            |                     |  |                                                                            |  | Project                                     |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | NEATH PORT TALBOT COUNTY<br>BOROUGH COUNCIL                                                                                                                     |  | NE05_001 - ATK - GEN -<br>SWMWREC           |  |
| Description |  |          |       |         |          |            |                     |  |                                                                                                                                                                 |  | Volume                                      |  |
| Description |  |          |       |         |          |            |                     |  |                                                                                                                                                                 |  | - DR - CD - 000001                          |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | Location                                                                                                                                                        |  | Type Role Number                            |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | Original Size: A1                                                                                                                                               |  | Scale: 1:1250                               |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  | Project Ref. No: 5192793                                                                                                                                        |  | Sheet: 1 of 2                               |  |
| Status      |  | Revision | Drawn | Checked | Reviewed | Authorised | Issue Date          |  |                                                                                                                                                                 |  | Rev: P01.4                                  |  |



## Appendix B. Hydrology Calculation Record



# Flood estimation – calculation record

**Site/project name: Grandison Brook FAS**

**Date: February 2026**

## Introduction

This document is a supporting document to the Natural Resources Wales Flood Estimation Technical Guidance Note V4, published in January 2026. It provides a template for recording calculations and decisions made during flood estimation. It will often be complemented by more general hydrological information given in a project report. The information given here should be enough to enable the work to be reproduced.

Note 1: Table, content or page layout can be adapted to best present relevant information. Additional rows should be added to, or removed from tables as appropriate.

Note 2: 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 non-hydrologists. Return Period has been retained within this document but can be replaced with AEP if wished.

## Contents

|                                                                                 |    |
|---------------------------------------------------------------------------------|----|
| 1. Method statement.....                                                        | 4  |
| 2. Locations where flood estimates are required .....                           | 14 |
| 3. Statistical method .....                                                     | 18 |
| 4. Revitalised flood hydrograph (ReFH) method for peak flow estimation .....    | 23 |
| 5. Revitalised flood hydrograph (ReFH) method for model inflow hydrographs..... | 25 |
| 6. Final peak flow and hydrograph estimates .....                               | 27 |
| Appendix: supporting information .....                                          | 32 |

<mailto:guidance.development@cyfoethnaturiolcymru.gov.uk?subject=Issue or problem with guidance>

## Approval

|                     | Name             | Qualifications                              | Date             |
|---------------------|------------------|---------------------------------------------|------------------|
| <b>Prepared by:</b> | Marlina Heinonen | MA (Soc Sci)<br>(Hons)                      | February<br>2026 |
| <b>Checked by:</b>  | Tracey Ashworth  | BSc (Hons),<br>MSc, MCIWEM,<br>CWEM, C. Sci | February<br>2026 |
| <b>Approved by:</b> | Dyfan Walters    | MSc, FRGS,<br>CGeog                         | April 2026       |

## Abbreviations

|                  |                                                                                                                                             |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| AEP              | Annual exceedance probability                                                                                                               |
| AMAX             | Annual maximum flow                                                                                                                         |
| AREA             | Catchment area (km <sup>2</sup> )                                                                                                           |
| BFI              | Base flow index                                                                                                                             |
| BFIHOST19        | Base flow index derived using the revised (2019) HOST soil classification                                                                   |
| BFIHOST19_Scaled | Base flow index derived using the revised (2019) HOST soil classification, updated in 2025 to better account for correlations with FARL2015 |
| DPLBAR           | Mean drainage path length (km)                                                                                                              |
| DPSBAR           | Mean drainage path slope (m/km)                                                                                                             |
| FARL             | FEH index of flood attenuation due to reservoirs and lakes                                                                                  |
| FARL2015         | FEH index of flood attenuation due to reservoirs and lakes using 2015 spatial data                                                          |
| FEH              | Flood Estimation Handbook                                                                                                                   |

|            |                                                                                                |
|------------|------------------------------------------------------------------------------------------------|
| FPEXT      | Floodplain extent                                                                              |
| HOST       | Hydrology of soil types soil classification                                                    |
| NRFA       | National river flow archive                                                                    |
| POT        | Peaks over a threshold                                                                         |
| QMED       | Median annual maximum flow (with Annual Exceedance Probability of 50% / return period 2 years) |
| ReFH       | Revitalised flood hydrograph – used for rainfall runoff method                                 |
| SAAR6190   | Standard average annual rainfall (mm) for years 1961 to 1990                                   |
| SAAR9120   | Standard average annual rainfall (mm) for years 1991 to 2020                                   |
| SPR        | Standard percentage run-off                                                                    |
| Tp         | Time to peak                                                                                   |
| URBEXT2000 | Index of urban extent using 2000 spatial data                                                  |
| URBEXT2015 | Index of urban extent using 2015 spatial data                                                  |
| WINFAP     | Windows Frequency Analysis Package – can be used for FEH statistical peak flow method          |

# 1. Method statement

## 1.1 Overview of requirements for flood estimates

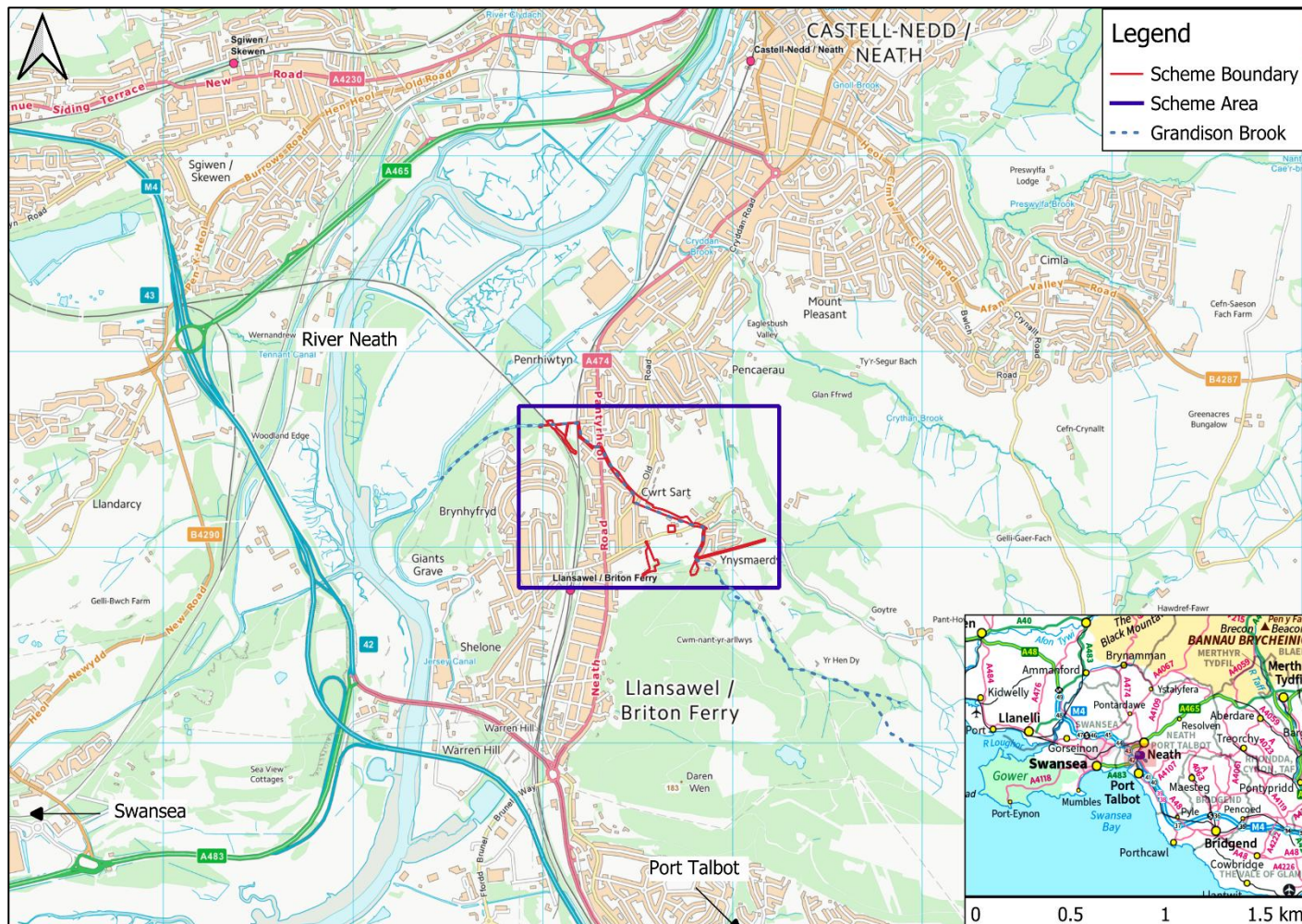
| Item                                                                                                                                                                                                                                                                                                                           | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Give an overview which includes:</p> <ul style="list-style-type: none"><li>• purpose of study</li><li>• names of river/s</li><li>• location</li><li>• number of calculation points and if peak flows or hydrographs are required</li><li>• previous relevant calculations</li><li>• availability of flood history</li></ul> | <p>AtkinsRéalis has been commissioned by Neath Port Talbot Council (NPTC) to produce the detailed design for the proposed flood alleviation scheme to address flooding from the Grandison Brook in a residential area of Briton Ferry in Neath Port Talbot, which is approximately 8km northeast of Swansea and 3km south of Neath.</p> <p>The Pantyrheol, Cwrt Sart and Ynysymaerdy areas of Briton Ferry, Neath, Wales, have been subjected to periodic flooding over many years, resulting in internal property flooding affecting residential and commercial properties.</p> <p>Flooding has been experienced many times after intense sustained periods of rainfall. The cause of the flooding has been identified as the under-capacity of the Grandison Brook culvert, forcing flows to the surface through surcharged culvert inlets and drainage connections. Overland flow paths develop as this water gravitates downhill, resulting in water collecting on the A474 before entering properties. The proposed scheme comprises modifications to an existing culvert inlet structure and an additional storm drainage culvert of minimum 1200mm diameter, thus increasing the overall capacity and reducing the risk of flooding to properties. At the lower end of the system larger box culverts are to be used to deal with the resulting increased flows. This works in combination with additional flood risk management solutions including an attenuation pond located in Jersey Park and a flood bund located in the northeast portion of the site.</p> |

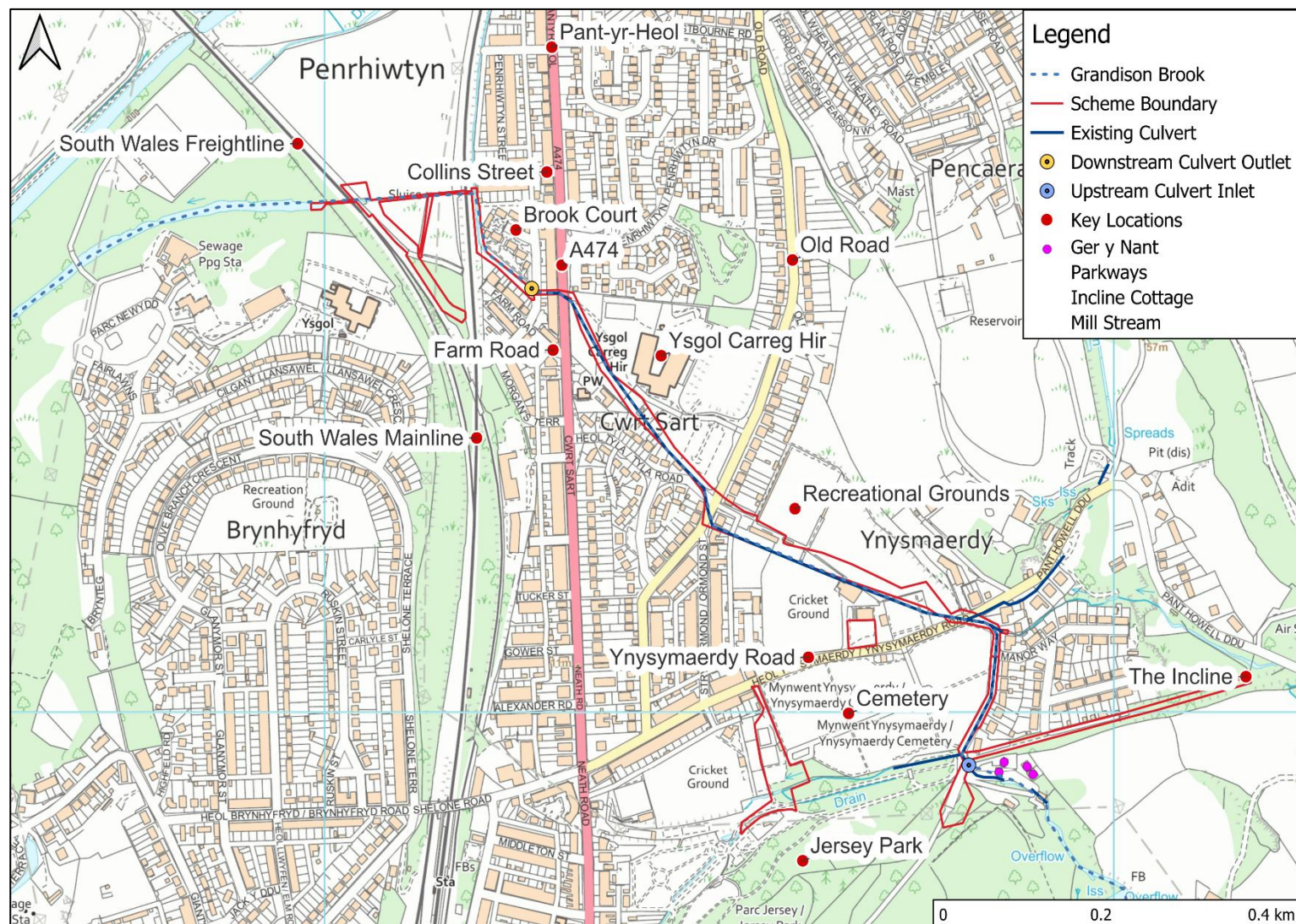
| Item | Comments                                                                                                                                                                                          |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | Flow hydrographs for the 2, 5, 10, 25, 30, 50, 75, 100, 200, 500 and 1000-year return periods are required. The impact of climate change will also be considered, based on the latest guidelines. |

## 1.2 Overview of catchment

| Item                                                                                                                                                                                                        | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Brief description of catchment, including key features needing consideration or reference to section in accompanying report.</p> <p>Map/s should be presented here or in section 2.1 of this report.</p> | <p>The Grandison Brook is a small tributary of the River Neath, with a catchment area of approximately 3.4 km<sup>2</sup> at the downstream extent. The watercourse rises in Margam Forest to the east of Briton Ferry. It flows in a north-westerly direction towards Ynysymaerdy and is culverted from Ynysymaerdy Road to Morgan's Terrace (between the A474 Neath Road and the railway line). The channel then curves around the north of Brynhyfryd, passing under the Neath Canal, to join the River Neath. At Ynysymaerdy Road, at the eastern edge of Jersey Park, there is a channel bifurcation with some water directed out of the catchment. This will be represented in the hydraulic model.</p> <p>The lower part of the catchment is moderately urbanised. The upper part of the catchment is rural with grassland and woodland being the predominant land uses. The topography is moderately steep with little floodplain in the upper catchment. There are no significant surface water features (lakes, reservoirs) in the catchment, although there are a couple of small ponds/storage areas in the upstream area.</p> <p>Soils and geology information for the catchment is detailed below and was obtained from:</p> <ul style="list-style-type: none"> <li>• <a href="http://www.landis.org.uk/services/soilscapes.cfm">http://www.landis.org.uk/services/soilscapes.cfm</a></li> <li>• <a href="http://mapapps2.bgs.ac.uk/geoindex/home.html">http://mapapps2.bgs.ac.uk/geoindex/home.html</a></li> </ul> |

| Item | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | <p>Most of the catchment is underlain by slowly permeable, wet, very acid upland soils with a peaty surface. The headwaters and northern part of the catchment are underlain by freely draining acid loamy soils over rock. The British Geological Survey (BGS) website 1:625,000 scale mapping shows that the catchment is underlain by bedrock geology of the South Wales Upper Coal Measures Formation. This is dominated by mudstone, siltstone, sandstone, coal, ironstone and ferricrete. The bedrock geology is overlain by superficial deposits of Till in some locations.</p> <p>The catchment response to rainfall is likely to be fast due to the small size of the catchment, steep topography, generally slowly permeable soils, and impermeable geology.</p> <p>A location map, plan showing the scheme and culvert location and a catchment map are in <b>Error! Reference source not found., Figure 2 and Figure 3.</b></p> |





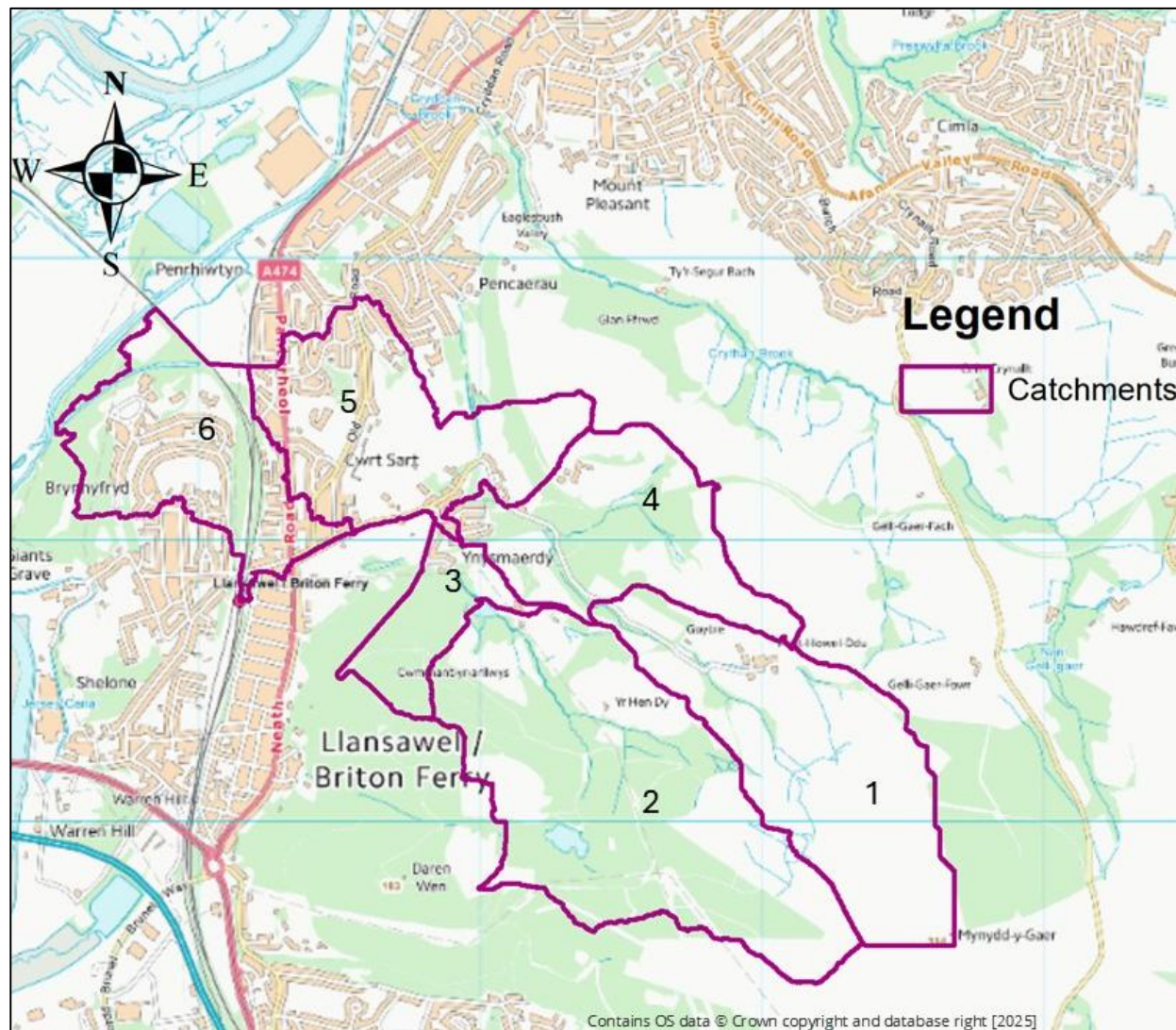


Figure 3 – Catchment map

### 1.3 Source of flood peak data

| Item                                                        | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Was the NRFA Peak Flows dataset used? If so, which version? | <p>The pooling group was originally developed in February 2020 and Version 8 of the NRFA was used, released in September 2019 and containing data up to the end of September 2018.</p> <p>A check of the FEH statistical flows using the NRFA version 13, containing data up to the end of September 2023 and WINFAP5.2 was also carried out and these results are in the report Appendix.</p> <p>For the updated hydrology, NRFA Version 14 was used, released August 2025. This contains data up to water year 2023-24 at most sites.</p> |

### 1.4 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 stations may also be available.

| Watercourse                | Station name | NRFA number | Grid reference | Catchment area (km <sup>2</sup> ) | Location relative to study area (eg, within), note any significant differences in catchments (eg URBEXT) |
|----------------------------|--------------|-------------|----------------|-----------------------------------|----------------------------------------------------------------------------------------------------------|
| The catchment is ungauged. |              |             |                |                                   |                                                                                                          |

## 1.5 Data available at each gauging station

| Station name or number | Start and end date on NRFA | Suitability (Pooling/ QMED/ Neither)? | Update for this study? | Comments on data availability (quality is covered in next section). If not a QMED or pooling station then describe how data will be used e.g. for Tp calculation or QMED calculation from daily mean flow |
|------------------------|----------------------------|---------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| N/A                    |                            |                                       |                        |                                                                                                                                                                                                           |

## 1.6 Data quality at each gauging station

| Station name or number | Comments on rating quality focusing on QMED and above<br>e.g. degree of extrapolation, availability of recent flow gaugings, amount of scatter in the gaugings, bank full level and out of bank flow |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| N/A                    |                                                                                                                                                                                                      |

## 1.7 Other data available and how it has been obtained

Consider flood history and local data if available.

| Type of data        | Source of data       | Details and reference/link to relevant reports                                                                         |
|---------------------|----------------------|------------------------------------------------------------------------------------------------------------------------|
| Historic flood data | JBA Flood Estimation | 2017s6786 - Grandison Brook-Calc Record_v1 (Aug 2018).pdf<br>This report contains information on the flood mechanisms. |

| Type of data                                                                               | Source of data                                | Details and reference/link to relevant reports                                                                                                                         |
|--------------------------------------------------------------------------------------------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                            | Calculation Record, 2018                      |                                                                                                                                                                        |
| 15-min river level/flow and rainfall data for events (if carrying out Tp or ReFH analysis) | N/A                                           |                                                                                                                                                                        |
| Results from previous studies                                                              | JBA Flood Estimation Calculation Record, 2018 | 2017s6786 - Grandison Brook-Calc Record_v1 (Aug 2018).pdf<br><br>This report contains flood flows for one site at the railway line, downstream of the flood risk area. |

## 1.8 Initial choice of approach

| Item                                                                                                                                                                                                                                                                                                                                                                                                                                       | Comment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Outline the conceptual model.</b> Address questions such as:</p> <ul style="list-style-type: none"> <li>Where are the main sites of interest?</li> <li>What is likely to cause flooding at those locations? (e.g. peak flows, flood volumes, combination of peaks, groundwater, snowmelt, tides)</li> <li>Might those locations flood from runoff generated on part of the catchment only e.g. downstream of a reservoir?</li> </ul> | <p>The main site of interest are the Pantyrheol, Cwrt Sart and Ynysymaerdy areas of Briton Ferry, Neath.</p> <p>Flooding has been experienced many times after intense sustained periods of rainfall. The cause of the flooding has been identified as the under-capacity of the Grandison Brook culvert, forcing flows to the surface through surcharged culvert inlets and drainage connections. Overland flow paths develop as this water gravitates downhill, resulting in water collecting on the A474 before entering properties.</p> |

| Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Comment                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <p><b>Any unusual catchment features to account for?</b> For example:</p> <ul style="list-style-type: none"> <li>• highly permeable (BFIHOST19_Scaled &gt; 0.65)</li> <li>• urbanised – consider choice of method carefully; consider artificial drainage and storm sewer inflow and outflows</li> <li>• major reservoir influence – consider flood routing</li> <li>• extensive floodplain storage – consider choice of method carefully</li> </ul>                                                                                                                                                  | <p>The catchment is small with urbanisation in the lower reaches.</p>                                                     |
| <p><b>Initial choice of method(s) and reasons</b></p> <ul style="list-style-type: none"> <li>• Will the method often known as FEH Hybrid be used for peak flow estimates? (Statistical for QMED to 1% AEP, then growth factor from ReFH applied to 1% event for events to 0.1% AEP)</li> <li>• If not appropriate, describe why and give details of the other method/s to be used.</li> <li>• What method will be used for hydrograph calculation?</li> <li>• Will the catchment be split into sub-catchments/intervening areas? If so, how will flows for intervening areas be estimated?</li> </ul> | <p>The hybrid method will be used, with flow hydrographs calculated using ReFH2 scaled to FEH statistical peak flows.</p> |
| <p>Software to be used including version number/s:</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <p>WINFAP5, ReFH2.3</p>                                                                                                   |

## **2. Locations where flood estimates are required**

### **2.1 Map of study area, including subject site(s) and gauging stations (where applicable).**

See figures in Section 1.2

## 2.2 Summary of subject sites

The table below lists the locations of subject sites. Use site codes in all subsequent tables to save space.

| Site code | Watercourse     | Site Name (description) | Easting | Northing | AREA (km <sup>2</sup> ) | Revised AREA if altered (km <sup>2</sup> ) | Peak flow, hydrograph or both required? |
|-----------|-----------------|-------------------------|---------|----------|-------------------------|--------------------------------------------|-----------------------------------------|
| 1         | Grandison Brook | Upstream inflow         | 275400  | 194800   | -                       | 0.708                                      | Hydrograph                              |
| 2         | Grandison Brook | Upstream inflow         | 275000  | 194800   | -                       | 1.060                                      | Hydrograph                              |
| 3         | Grandison Brook | Lateral inflow          | 274750  | 195000   | -                       | 0.176                                      | Hydrograph                              |
| 4         | Grandison Brook | Lateral inflow          | 274750  | 195050   | -                       | 0.473                                      | Hydrograph                              |
| 5         | Grandison Brook | Lateral inflow          | 274200  | 195600   | -                       | 0.542                                      | Hydrograph                              |
| 6         | Grandison Brook | Lateral inflow          | 273550  | 195450   | -                       | 0.460                                      | Hydrograph                              |
| Total     | Grandison Brook | Total catchment         | 273550  | 195450   | 3.18*                   | -                                          | Peak flow and hydrograph                |

## 2.3 Checking catchment descriptors

| Item                                                                                                                                                                                                                                                                                                                                                                                                                              | Comment                                                                                                                               |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| Record how catchment boundary was checked <ul style="list-style-type: none"><li>Describe any changes</li><li>Add maps if needed</li></ul>                                                                                                                                                                                                                                                                                         | Catchment boundaries were delineated using the FEH webservice and updated using LiDAR and OS maps.                                    |
| Method for updating URBEXT2000 (used in Rainfall Runoff method) and/or URBEXT 2015 (used in Statistical Method): <ul style="list-style-type: none"><li>OS 1:50,000 Map</li><li>UKCEH Landcover Map</li><li>OS Open Built Up Areas Dataset</li><li>If the catchment is rural, it is likely be appropriate to keep URBEXT values as they are or to use the General Urban expansion factor calculated for year of interest</li></ul> | Catchments 1 to 6: URBAN values were calculated from OS maps.<br><br>Total: URBEXT2000 and URBEXT2015 updated using FEH UEF equation. |
| Record how other catchment descriptors were checked, especially soils <ul style="list-style-type: none"><li>Describe any changes</li><li>Include a before and after table if necessary</li></ul>                                                                                                                                                                                                                                  | The BFIHOST19 values were checked against local geology and soils. No changes were needed.                                            |

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

| Site code | AREA (km <sup>2</sup> ) | BFIHOST 19 | BFIHOST 19_Scaled | FARL | FARL 2015 | SAAR (mm) | SAAR 9120 (mm) | URBEXT 2000 | URBEXT 2015 | Changes                                   |
|-----------|-------------------------|------------|-------------------|------|-----------|-----------|----------------|-------------|-------------|-------------------------------------------|
| 1         | 0.708                   | 0.508      | 0.508             | 1    | 1         | 1487      | 1579           | 0           | 0           | None                                      |
| 2**       | 1.06                    | 0.489      | 0.498             | 1    | 0.9657    | 1433      | 1506           | 0.12        | 0.12        | None                                      |
| 3**       | 0.176                   | 0.489      | 0.498             | 1    | 0.9657    | 1433      | 1506           | 0.12        | 0.12        | None                                      |
| 4**       | 0.473                   | 0.489      | 0.498             | 1    | 0.9657    | 1433      | 1506           | 0.12        | 0.12        | None                                      |
| 5**       | 0.542                   | 0.489      | 0.498             | 1    | 0.9657    | 1433      | 1506           | 0.12        | 0.12        | None                                      |
| 6**       | 0.460                   | 0.489      | 0.498             | 1    | 0.9657    | 1433      | 1506           | 0.12        | 0.12        | None                                      |
| Total     | 3.42                    | 0.473      | 0.473             | 1    | 0.9889    | 1415      | 1475           | 0.12        | 0.124       | URBEXT, URBEXT2015 updated to 2026 values |

### 3. Statistical method

#### 3.1 Donor stations and QMED adjustment factors

Note that donor catchments will usually be rural but may be urban provided this is accounted for in the adjustment process. Include a map and any notes on QMED calculation as appropriate.

| Station                      | Record Length        | Is station hydrologically connected to subject site/s? le, upstream / downstream | QMED Observed (A) (m <sup>3</sup> /s) | QMED Urban Catchment descriptors (B) (m <sup>3</sup> /s) | Adjustment ratio (A/B) | Chosen or rejected, with reasons and other comments |
|------------------------------|----------------------|----------------------------------------------------------------------------------|---------------------------------------|----------------------------------------------------------|------------------------|-----------------------------------------------------|
| Afan @ Marcroft Weir (58012) | 47 (to October 2024) | No                                                                               | 95.999                                | 84.894                                                   | 1.13                   | Chosen                                              |

#### 3.2 Overview of estimation of QMED at each subject site

- There is a presumption that catchment descriptor with donor transfer method will be used. If an alternative method was utilised, add a table to record details and reasons as appropriate.
- Urban adjustment procedures should be applied regardless of whether the subject site is rural or urban.

| Site code | Watercourse     | QMEDurban catchment descriptors (m <sup>3</sup> /s) | NRFA numbers for donor stations used                                 | Distance moderation applied? | QMED adjustment ratio | QMEDurban donor adjusted (m <sup>3</sup> /s) | Notes |
|-----------|-----------------|-----------------------------------------------------|----------------------------------------------------------------------|------------------------------|-----------------------|----------------------------------------------|-------|
| Total     | Grandison Brook | 3.426                                               | 58012<br>58007<br>58008<br>58001<br>57017<br>59001<br>58005<br>59004 | No                           | 1.06                  | 3.445                                        |       |

### 3.3 Derivation of pooling groups

- Several subject sites may use the same pooling group.
- The composition of pooling groups should be presented in the Appendix.

| Pooling group name | Site for which pooling group was derived | If applied to more than one site, list their codes | Method: Single Site / with History / Pooled?<br><br>Include reasons for choice of method | Changes made to default pooling group, with reasons<br><br>Include any sites that were investigated but retained in the group                                                                                                                                                                                                                                                                                                              |
|--------------------|------------------------------------------|----------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Total              | Total                                    | -                                                  | Pooled                                                                                   | 45816 (Haddeo @ Upton)<br>95004 (Abhainn a'Chnocain @ Elphin)<br>28033 (Dove @ Hollinsclough)<br>69047 (Roch @ Littleborough)<br>47022 (Tory Brook @ Newnham Park)<br>48004 (Warleggan @ Trengoffe)<br>72014 (Conder @ Galgate)<br>73015 (Keer @ High Keer Weir)<br>76011 (Coal Burn @ Coalburn)c<br>48009 (St Neot @ Craigshill Wood)<br>18014 (Bannock Burn @ Bannockburn)<br>76023 (Dacre Beck @ Dacre Bridge)<br>25019 (Leven @ Easby) |

|                                                                                 |  |  |                                       |                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------|--|--|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                 |  |  |                                       | 27073 (Brompton Beck @ Snainton Ings)<br>106002 (Laxdale @ Laxdale)<br>46005 (East Dart @ Bellever)<br>47021 (Kensey @ Launceston Newport)<br>73009 (Sprint @ Sprint Mill)<br>57010 (Ely @ Lanelay)<br>27051 (Crimple @ Burn Bridge)<br>71003 (Croasdale Beck @ Croasdale Flume)<br>Removed:<br>49005 (Bolingey Stream @ Bolingey Cocks Bridge)<br>44008 (South Winterbourne @ Winterbourne Steepleton) |
| <b>Were non-flood year adjustments made to any stations? if so give details</b> |  |  | Yes, automatic adjustment in Winfap 5 |                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>URBEXT2015 threshold used to create pooling group(s).</b>                    |  |  | 0.3                                   |                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Have pooling group growth curves been deurbanised?</b>                       |  |  | Yes                                   |                                                                                                                                                                                                                                                                                                                                                                                                         |

### 3.4 Derivation of flood growth curves at subject sites

- A pooling group derived at one location can be applied to estimate growth curves at several ungauged sites. However, each site may have a different urban adjustment, and therefore different growth curve parameters.
- Any relevant frequency plots, particularly showing any comparisons between single-site and pooled growth curves (including flood peak data on the plot) should be shown in an Appendix.

| Site code | Pooling group name | Distribution used and reason for choice | Was an urban adjustment made? | Growth factor for 100-year return period (1% AEP) event |
|-----------|--------------------|-----------------------------------------|-------------------------------|---------------------------------------------------------|
| Total     | Total              | Kappa 3 – Best fit                      | Yes, UAF = 1.203              | 2.489                                                   |

### 3.5 Flood estimates from the statistical method

| Site code | Flood peak (m <sup>3</sup> /s) for the following return period or AEP events |          |           |          |          |            |          |            |           |             |             |              |
|-----------|------------------------------------------------------------------------------|----------|-----------|----------|----------|------------|----------|------------|-----------|-------------|-------------|--------------|
|           | 2<br>50%                                                                     | 5<br>20% | 10<br>10% | 20<br>5% | 25<br>4% | 30<br>3.3% | 50<br>2% | 75<br>1.3% | 100<br>1% | 200<br>0.5% | 500<br>0.2% | 1000<br>0.1% |
| Total     | 3.445                                                                        | 4.575    | 5.397     | 6.263    | 6.556    | 6.801      | 7.519    | 8.125      | 8.576     | 9.741       | 11.469      | 12.937       |

## 4. Revitalised flood hydrograph (ReFH) method for peak flow estimation

This section records calculations for peak flow estimates and will generally use default parameters. If different calculations are subsequently made for hydrographs, details should be recorded in section 5.

### 4.1 Design events for ReFH method for peak flow estimation

| Site code | Changes made to drained area descriptors? | Season of design event (summer or winter) | Recommended Storm duration (hours)                | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------|-------------------------------------------|-------------------------------------------|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1         | Area                                      | Winter                                    | 5.75 hours, highest peak flow for Total catchment | Sewer flows for Catchment 5 and Catchment 6 were exported out of the catchment based on information received during the study from the engineers and hydraulic modellers. The exports were calculated using the methods discussed in the ReFH2 guidelines, with the urban parameters kept as default in the absence of any flow data. For the 5.75 hour duration, the sewer capacities were estimated as 0.4m <sup>3</sup> /s for Catchment 5 and 0.36m <sup>3</sup> /s for Catchment 6. |
| 2         | Area, URBEXT1990, URBEXT2000              |                                           |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3         | Area, URBEXT1990, URBEXT2000              |                                           |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 4         | Area, URBEXT1990, URBEXT2000              |                                           |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5         | Area, URBEXT1990, URBEXT2000              |                                           |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 6         | Area, URBEXT1990, URBEXT2000              |                                           |                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

|       |                                 |  |  |  |
|-------|---------------------------------|--|--|--|
| Total | Area, URBEXT1990,<br>URBEXT2000 |  |  |  |
|-------|---------------------------------|--|--|--|

## 4.3 Peak flow estimates from the ReFH method

Urban estimates should be used for all sites

|           | Flood peak (m <sup>3</sup> /s) for the following return periods (in years) or AEP |          |           |          |            |          |            |           |             |             |              |                              |
|-----------|-----------------------------------------------------------------------------------|----------|-----------|----------|------------|----------|------------|-----------|-------------|-------------|--------------|------------------------------|
| Site code | 2<br>50%                                                                          | 5<br>20% | 10<br>10% | 25<br>5% | 30<br>3.3% | 50<br>2% | 75<br>1.3% | 100<br>1% | 200<br>0.5% | 500<br>0.2% | 1000<br>0.1% | 100:1000<br>1%:0.1%<br>ratio |
| 1         | 0.54                                                                              | 0.72     | 0.84      | 0.99     | 1.02       | 1.11     | 1.18       | 1.24      | 1.39        | 1.63        | 1.88         | 0.66                         |
| 2         | 0.86                                                                              | 1.12     | 1.30      | 1.53     | 1.58       | 1.72     | 1.83       | 1.92      | 2.15        | 2.54        | 2.92         | 0.66                         |
| 3         | 0.15                                                                              | 0.20     | 0.31      | 0.39     | 0.40       | 0.46     | 0.50       | 0.54      | 0.64        | 0.78        | 0.97         | 0.66                         |
| 4         | 0.40                                                                              | 0.51     | 0.60      | 0.70     | 0.73       | 0.79     | 0.84       | 0.88      | 0.99        | 1.16        | 1.34         | 0.66                         |
| 5         | 0.54                                                                              | 0.70     | 0.81      | 0.95     | 0.98       | 1.06     | 1.13       | 1.18      | 1.32        | 1.55        | 1.77         | 0.64                         |
| 6         | 0.47                                                                              | 0.60     | 0.70      | 0.82     | 0.84       | 0.92     | 0.98       | 1.02      | 1.14        | 1.33        | 1.52         | 0.62                         |
| Total     | 2.74                                                                              | 3.55     | 4.10      | 4.84     | 4.98       | 5.60     | 5.77       | 6.04      | 6.76        | 7.94        | 9.10         | 0.66                         |

|                                                                                                |                                                                                      |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| Describe how do peak flows compare to statistical estimates (figures presented in section 6.1) | ReFH2 derived peak flows are lower than those estimated using the statistical method |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|

## 5. Revitalised flood hydrograph (ReFH) method for model inflow hydrographs

### 5.1 Parameters for ReFH model for model inflow hydrographs

This section records calculations for model inflow hydrographs, parameters may have been calibrated and storm durations changed.

If parameters are all estimated from catchment descriptors, they are easily reproducible, so it is not essential to record them here –Just enter ‘all’ under site code and ‘Catchment descriptors’ under method. Table can be amended as needed.

| Site code                                                                                                  | Details of method <ul style="list-style-type: none"> <li>Catchment descriptors (CD)</li> <li>Tp (Time to peak) calculation</li> <li>Optimisation (Calibration Utility)</li> </ul> | CD Tp (hours)         | Adjusted Tp if different (hours) |
|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------------------|
| All                                                                                                        | Catchment descriptors                                                                                                                                                             | Catchment descriptors | N/A                              |
| Description of any Tp calculation or calibration work, add references to other documents where appropriate |                                                                                                                                                                                   |                       |                                  |

## 5.2 Design events for ReFH method for model inflow hydrographs

| Storm duration (hours)                                                                 | ARF   | Source of Storm Duration and ARF | Why Chosen                                                                                    |
|----------------------------------------------------------------------------------------|-------|----------------------------------|-----------------------------------------------------------------------------------------------|
| 5.75 (Winter)                                                                          | 0.968 | Catchment                        | Gives highest ReFH2 peak flow for the 100-year event for Total catchment.                     |
| <b>Were hydrographs scaled to alternative peak flow estimates? If so, give details</b> |       |                                  | Yes, hydrographs were scaled to statistical peak flow estimates as they are more conservative |
| <b>Provide link/reference to location of hydrographs or provide in appendix</b>        |       |                                  | <b>Appendix</b>                                                                               |

## 6. Final peak flow and hydrograph estimates

### 6.1 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. Note and explain any significant difference from previous studies.

|           | QMED (50% AEP)   |      |                |         | 100-year return period / 1% AEP |      |                |         |
|-----------|------------------|------|----------------|---------|---------------------------------|------|----------------|---------|
| Site code | Statistical 2025 | ReFH | Previous Study | Comment | Statistical 2025                | ReFH | Previous Study | Comment |
| Total     | 3.45             | 2.74 | 1.8            |         | 8.58                            | 6.04 | 4.4            |         |
| 1         | -                | 0.56 | -              |         | -                               | 1.24 | -              |         |
| 2         | -                | 0.86 | -              |         | -                               | 1.92 | -              |         |
| 3         | -                | 0.15 | -              |         | -                               | 0.34 | -              |         |
| 4         | -                | 0.40 | -              |         | -                               | 0.88 | -              |         |
| 5         | -                | 0.28 | -              |         | -                               | 0.62 | -              |         |
| 6         | -                | 0.23 | -              |         | -                               | 0.50 | -              |         |

## 6.2 Final peak flow estimates

|                                                                                                                                                                                                                                             | Flood peak (m <sup>3</sup> /s) for the following return periods (in years) or AEP |          |           |                                                                                                                                                                                                                                                                       |            |          |            |           |             |             |              |  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------|------------|-----------|-------------|-------------|--------------|--|
| Site code                                                                                                                                                                                                                                   | 2<br>50%                                                                          | 5<br>20% | 10<br>10% | 25<br>5%                                                                                                                                                                                                                                                              | 30<br>3.3% | 50<br>2% | 75<br>1.3% | 100<br>1% | 200<br>0.5% | 500<br>0.2% | 1000<br>0.1% |  |
| Total                                                                                                                                                                                                                                       | 3.45                                                                              | 4.58     | 5.40      | 6.56                                                                                                                                                                                                                                                                  | 6.80       | 7.52     | 8.13       | 8.58      | 9.74        | 11.27       | 12.92        |  |
| 1                                                                                                                                                                                                                                           | 0.79                                                                              | 1.03     | 1.19      | 1.40                                                                                                                                                                                                                                                                  | 1.44       | 1.57     | 1.68       | 1.75      | 1.97        | 2.32        | 2.67         |  |
| 2                                                                                                                                                                                                                                           | 1.22                                                                              | 1.59     | 1.84      | 2.17                                                                                                                                                                                                                                                                  | 2.24       | 2.44     | 2.60       | 2.73      | 3.05        | 3.60        | 4.14         |  |
| 3                                                                                                                                                                                                                                           | 0.22                                                                              | 0.28     | 0.33      | 0.39                                                                                                                                                                                                                                                                  | 0.40       | 0.43     | 0.46       | 0.49      | 0.54        | 0.64        | 0.73         |  |
| 4                                                                                                                                                                                                                                           | 0.56                                                                              | 0.73     | 0.85      | 1.00                                                                                                                                                                                                                                                                  | 1.03       | 1.12     | 1.20       | 1.25      | 1.40        | 1.65        | 1.90         |  |
| 5                                                                                                                                                                                                                                           | 0.77                                                                              | 0.99     | 1.15      | 1.35                                                                                                                                                                                                                                                                  | 1.39       | 1.51     | 1.61       | 1.68      | 1.87        | 2.19        | 2.51         |  |
| 6                                                                                                                                                                                                                                           | 0.66                                                                              | 0.86     | 0.99      | 1.16                                                                                                                                                                                                                                                                  | 1.20       | 1.30     | 1.39       | 1.45      | 1.62        | 1.89        | 2.16         |  |
| <b>State choice of method, i.e.</b> <ul style="list-style-type: none"> <li>Hybrid approach (Statistical for QMED to 100 year, ReFH growth factor from 100yr applied to statistical 100yr, for rarer events)</li> <li>Statistical</li> </ul> |                                                                                   |          |           | Hybrid approach (Statistical for QMED to 100 year, ReFH growth factor from 100yr applied to statistical 100yr, for rarer events).<br><br>For Catchments 1 – 6 the ReFH2 hydrographs have been scaled using the Total catchment FEH statistical/ReFH2 scaling factors. |            |          |            |           |             |             |              |  |

- ReFH

## 6.3 Uncertainty

Give what information you can on uncertainty in the flood estimates

| Site Code | 95% confidence interval factor for QMED (eg 0.48-2.1 for ungauged locations with 0 donors) | 95% confidence interval factor for 100 year (1% AEP) flood | Comments, include comments on QMED estimation method, gauging station relative location/s, record length, data quality, consistency between stations, flood history and catchment characteristics |
|-----------|--------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Total     | 0.49 - 2.05                                                                                |                                                            | Ungauged, 8 donors for QMED<br><br>QMED CI range: 1.682 – 7.055<br><br>100-year CI range: 4.18799 – 17.5616                                                                                       |

## 6.4 Hydrographs for modelling

|                                                                                                                                                        |                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| How were these calculated, for example, scaling ReFH hydrographs to final flow estimates, adjusting $C_{ini}$ ? include link/reference to hydrographs. | ReFH2 hydrographs calculated using a 5.75 hour storm duration for catchments 1 to 6 were scaled using the Total catchment FEH statistical / ReFH2 scaling factors. |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                                                                                                                             |                                                                       |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <b>How will flows be applied in the model.</b> 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? | Best estimate inflows be used and resulting downstream flows accepted |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|

## 6.5 Checks

|                                                                                                                                           |                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| <b>Are the results consistent, for example at confluences?</b>                                                                            | Yes                                                                                                                           |
| <b>What do the results imply regarding the return periods of floods during the period of record?</b>                                      | N/A                                                                                                                           |
| <b>What is the 100-year growth factor? Is this realistic?</b><br>(The guidance suggests a typical range of 2.1 - 4.0)                     | Yes, 2.489                                                                                                                    |
| <b>If 1000-year flows have been derived, what is the range of ratios for the 1000-year flow over 100-year flow?</b>                       | 0.6629                                                                                                                        |
| <b>What is the range of specific runoffs (l/s/ha)? Are there any inconsistencies?</b>                                                     | No inconsistencies                                                                                                            |
| <b>How did the results compare with those of other studies?</b><br>Explain any differences and conclude which results should be preferred | Not directly comparable with the previous JBA study because of the difference in catchment area, but the results are similar. |
| <b>Are the results compatible with the longer-term flood history?</b>                                                                     | N/A                                                                                                                           |

|                                                 |      |
|-------------------------------------------------|------|
| <b>Describe any other checks on the results</b> | None |
|-------------------------------------------------|------|

## 6.6 Assumptions and limitations

|                                                                                                                                                   |                                                                                                           |
|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <b>List the main assumptions made specific to the study</b>                                                                                       | The CDs from the FEH webservice for Catchment 2 are suitable to also estimate flows for Catchments 3 – 6. |
| <b>Discuss any particular limitations</b><br><br>For example, applying methods outside the range of catchment types for which they were developed | The catchment is ungauged.                                                                                |
| <b>Comment on the suitability of the results for future studies</b><br><br>For example, at nearby locations or for different purposes             | Would be useful as a comparison.                                                                          |
| <b>Give any other comments on the study</b><br><br>For example, suggestions for additional work                                                   | The installation of a gauging station would reduce the uncertainty in the design flow estimates.          |

# Appendix: supporting information

## Pooling group composition

| Final pooling group                      | Distance (SDM) Years of data |     | QMED AM | L-CV Observed | L-CV Deurl | L-SKEW OI | L-SKEW Dr | Years | Non-flood | Percentage | Mann  | Kenc | MKZ | Signif | Discordan | Area   | SAAR9120 | FPEXT | FARL2015 | URBEXT20 | BFIHOST19 |
|------------------------------------------|------------------------------|-----|---------|---------------|------------|-----------|-----------|-------|-----------|------------|-------|------|-----|--------|-----------|--------|----------|-------|----------|----------|-----------|
| 45816 (Haddeo @ Upton)                   | 1.451                        | 31  | 3.456   | 0.283         | 0.283      | 0.410     | 0.41      | 31    | 1         | 3.23       | -0.36 | None |     |        | 1.451     | 6.808  | 1287     | 0.011 | 1        | 0.0010   | 0.535     |
| 95004 (Abhainn a' Chnocain @ Elphin)     | 1.634                        | 16  | 11.649  | 0.135         | 0.135      | 0.199     | 0.199     | 16    | 0         | 0          |       |      |     |        | 2.193     | 10.575 | 2095     | 0.049 | 0.934    | 0.0000   | 0.412     |
| 28033 (Dove @ Hollinsclough)             | 1.853                        | 49  | 4.15    | 0.233         | 0.233      | 0.359     | 0.359     | 49    | 1         | 2.04       |       |      |     |        | 0.762     | 7.915  | 1330     | 0.007 | 1        | 0.0010   | 0.347     |
| 69047 (Roch @ Littleborough)             | 1.967                        | 28  | 9.597   | 0.217         | 0.224      | 0.140     | 0.14      | 28    | 2         | 7.14       | 1.96  | 10   |     |        | 1.339     | 14.775 | 1369     | 0.038 | 0.878    | 0.05     | 0.467     |
| 47022 (Tory Brook @ Newnham Park)        | 1.993                        | 29  | 6.176   | 0.239         | 0.241      | 0.142     | 0.142     | 29    | 1         | 3.45       |       |      |     |        | 1.099     | 13.432 | 1482     | 0.023 | 0.947    | 0.0190   | 0.353     |
| 48004 (Warleggan @ Trengoffe)            | 2.171                        | 55  | 9.799   | 0.251         | 0.252      | 0.265     | 0.265     | 55    | 4         | 7.27       | 0.62  | None |     |        | 0.499     | 25.26  | 1531     | 0.035 | 0.97     | 0.0020   | 0.432     |
| 72014 (Conder @ Galgate)                 | 2.196                        | 57  | 16.912  | 0.227         | 0.229      | 0.140     | 0.14      | 57    | 3         | 5.26       | 1.24  | None |     |        | 0.447     | 28.992 | 1266     | 0.082 | 1        | 0.02     | 0.427     |
| 73015 (Keer @ High Keer Weir)            | 2.222                        | 34  | 12.59   | 0.201         | 0.202      | 0.174     | 0.174     | 34    | 1         | 2.94       | 3.41  | 5    |     |        | 0.247     | 30.043 | 1244     | 0.074 | 0.986    | 0.0080   | 0.455     |
| 76011 (Coal Burn @ Coalburn)             | 2.239                        | 47  | 1.813   | 0.170         | 0.17       | 0.300     | 0.3       | 47    | 0         | 0          |       |      |     |        | 0.883     | 1.63   | 1412     | 0.074 | 1        | 0.0000   | 0.274     |
| 48009 (St Neot @ Craigshill Wood)        | 2.257                        | 12  | 8.465   | 0.245         | 0.246      | 0.373     | 0.373     | 12    | 0         | 0          |       |      |     |        | 1.185     | 22.973 | 1558     | 0.023 | 0.962    | 0.0040   | 0.388     |
| 18014 (Bannock Burn @ Bannockburn)       | 2.320                        | 32  | 16.181  | 0.222         | 0.226      | 0.162     | 0.162     | 32    | 1         | 3.12       | -0.63 | None |     |        | 0.226     | 25.372 | 1446     | 0.054 | 0.889    | 0.0280   | 0.407     |
| 76023 (Dacre Beck @ Dacre Bridge)        | 2.339                        | 24  | 35.56   | 0.181         | 0.181      | 0.222     | 0.222     | 24    | 1         | 4.17       |       |      |     |        | 0.768     | 33.913 | 1559     | 0.072 | 0.993    | 0.003    | 0.411     |
| 25019 (Leven @ Easby)                    | 2.413                        | 46  | 5.384   | 0.337         | 0.337      | 0.367     | 0.367     | 46    | 3         | 6.52       |       |      |     |        | 2.158     | 15.088 | 892      | 0.019 | 1        | 0.001    | 0.495     |
| 27073 (Brompton Beck @ Snainton Ings)    | 2.419                        | 44  | 0.816   | 0.213         | 0.215      | 0.025     | 0.025     | 44    | 2         | 4.55       | 1.26  | None |     |        | 1.658     | 7.513  | 817      | 0.08  | 0.996    | 0.016    | 0.802     |
| 106002 (Laxdale @ Laxdale)               | 2.532                        | 17  | 17.673  | 0.098         | 0.098      | 0.134     | 0.134     | 17    | 0         | 0          |       |      |     |        | 1.921     | 10.64  | 2116     | 0.024 | 0.915    | 0        | 0.299     |
| 46005 (East Dart @ Bellever)             | 2.54                         | 60  | 37.38   | 0.162         | 0.162      | 0.083     | 0.083     | 60    | 1         | 1.67       | -0.11 | None |     |        | 0.574     | 22.273 | 2306     | 0.042 | 1        | 0.001    | 0.325     |
| 47021 (Kensey @ Launceston Newport)      | 2.542                        | 22  | 13.85   | 0.191         | 0.195      | 0.249     | 0.249     | 22    | 0         | 0          |       |      |     |        | 0.65      | 34.83  | 1375     | 0.022 | 0.998    | 0.028    | 0.514     |
| 73009 (Sprint @ Sprint Mill)             | 2.557                        | 55  | 43.85   | 0.178         | 0.178      | 0.175     | 0.175     | 55    | 0         | 0          | 3.46  | 5    |     |        | 0.116     | 34.695 | 2235     | 0.061 | 0.998    | 0.001    | 0.391     |
| 57010 (Ely @ Lanelay)                    | 2.564                        | 25  | 38.943  | 0.144         | 0.151      | 0.142     | 0.142     | 25    | 0         | 0          |       |      |     |        | 1.866     | 38.88  | 1832     | 0.044 | 1        | 0.079    | 0.436     |
| 27051 (Crimple @ Burn Bridge)            | 2.569                        | 52  | 4.641   | 0.215         | 0.216      | 0.132     | 0.132     | 52    | 4         | 7.69       | 1.5   | None |     |        | 0.492     | 8.172  | 866      | 0.013 | 1        | 0.009    | 0.329     |
| 71003 (Croasdale Beck @ Croasdale Flume) | 2.571                        | 37  | 10.9    | 0.212         | 0.212      | 0.323     | 0.323     | 37    | 1         | 2.7        |       |      |     |        | 0.465     | 10.71  | 1987     | 0.016 | 1        | 0        | 0.283     |
| Totals                                   |                              | 772 |         | 0.213         | 0.213      |           |           |       | 26        |            |       |      |     |        |           |        |          |       |          |          |           |

## Additional supporting information

Number of simulations   

| Fitting            | Z value |   |
|--------------------|---------|---|
| Gen. Logistic      | 1.0496  | * |
| Gen. Extreme Value | -1.0567 | * |
| Pearson Type III   | -2.7649 |   |
| Gen. Pareto        | -5.9339 |   |
| Kappa 3            | 0.3022  | * |
| Gen. Logistic NFY  | 2.1668  |   |

Lowest absolute Z-value indicates best fit

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

Number of simulations   

☐ Non-flood year adjustment

L-CV / L-skewness distance

|                            |        |
|----------------------------|--------|
| Observed average           | 0.1030 |
| Simulated mean of average  | 0.0785 |
| Simulated S.D. of average  | 0.0120 |
| Standardised test value H2 | 2.0413 |

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

Standard deviation of L-CV

|                            |        |
|----------------------------|--------|
| Observed                   | 0.0482 |
| Simulated mean             | 0.0279 |
| Simulated S.D.             | 0.0050 |
| Standardised test value H1 | 4.0888 |

Strongly Heterogeneous

| Final flows   |             |                          |  |
|---------------|-------------|--------------------------|--|
| Return period | Final flows | Final ratio (FEH / REFH) |  |
| 2             | 3.45        | 1.26                     |  |
| 5             | 4.58        | 1.29                     |  |
| 10            | 5.40        | 1.32                     |  |
| 25            | 6.56        | 1.35                     |  |
| 30            | 6.80        | 1.37                     |  |
| 50            | 7.52        | 1.34                     |  |
| 75            | 8.13        | 1.41                     |  |
| 100           | 8.58        | 1.42                     |  |
| 200           | 9.74        | 1.44                     |  |
| 500           | 11.47       | 1.44                     |  |
| 1000          | 12.94       | 1.42                     |  |

# AtkinsRéalis



**AtkinsRéalis UK Limited**

West Glamorgan House  
12 Orchard Street  
Swansea  
SA1 5AD

Tel: +44 (0)1792 641172

Fax: +44 (0)1792 472019

© AtkinsRéalis UK Limited except where stated otherwise