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Treforest Industrial Estate, Pontypridd

Strategic Flood Consequences Assessment

September 2015

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Executive Summary

Rhondda Cynon Taf County Borough Council (Rhondda Cynon Taf CBC) has commissioned Capita Property and Infrastructure to prepare an area wide Strategic Flood Consequence Assessment (SFCA) for the Treforest Industrial Estate Local Development Order (LDO) area. The SFCA is aimed at supporting a regeneration initiative within the Treforest Industrial Estate LDO area, which includes undertaking a site-specific assessment of flood risk and hazard constraints and opportunities and providing guidance for the redevelopment of vacant sites and buildings and changes of use of buildings.

The Treforest Industrial Estate LDO area covers an area of approximately 1.3 km^2 within the Rhondda Cynon Taf administrative area in South Wales. The LDO area is bisected by the River Taff, which flows through the LDO area in a north-south direction.

A comprehensive review of flood risk within the Treforest Industrial Estate identified fluvial flooding as the primary source of flood risk within the LDO area. More than half of the LDO area falls within area classified as Zone C1 / C2 as per the TAN 15 development advice zones, with 60% of the site area classified as Zone C1, and 3% identified as Zone C2. Approximately 7% is the site is classified as Zone B. Area classified as Zone C1 lies largely within the north western part of the site as well as areas to the west of the old dismantled railway (in the south western section).

In addition to Zones identified in the TAN 15 DAMs, fluvial flood risk has been assessed using more recent modeled flood outlines, produced as part of the Lower Taff Velocity and Depth Mapping study in December 2011. The model was developed using ISIS-TUFLOW and included a number of defences along the River Taff, including those in the south west of the LDO area. This report includes a description and assessment the updated model outputs, and it is recommended that future planning considerations within the Treforest Industrial Estate LDO use these outputs to supplement the TAN 15 DAMs.

As part of efforts at mitigating flood risk within the Treforest Industrial Estate Rhondda Cynon Taf CBC should take steps to ensure that surface water flood risk is not increased as a result of redevelopment or intensification within the industrial estate and that betterment should be sought for redevelopment within these areas. These recommendations are consistent with existing policy and guidance, including TAN 15, which specifies that "*redevelopment [is] to reduce run-off where possible.*" Sustainable Drainage Systems (SuDS) are recommended as a primary means of improving surface water management within the LDO area.

Fluvial flood risk mitigation measures have been identified in the Rhondda Cynon Taf Local Flood Risk Management Strategy (2013), and more detailed Flood Risk Management Plans are anticipated by December 2015. These will assess, map and develop action plans to manage flood risk and will consider a holistic approach to flood risk management and will not be solely reliant on traditional structural flood risk solutions.

To assist with guiding future development within the Treforest Industrial Estate LDO a bespoke flood hazard assessment was undertaken for the site. This assessment identified a number of indicative Zones within the LDO area where development conditions may be specified by Rhondda Cynon Taf CBC and Natural Resources Wales (NRW). This report recommends building upon this bespoke flood hazard assessment by undertaking a sensitivity analysis of a number of vacant and potentially underused sites within the LDO area. These sites can be reviewed to assess potential changes in the water levels across the site and to give an indication of finished floor levels. A broad assessment of areas within the Treforest LDO area that could be used to offset flood volumes as part of floodplain compensation is also recommended to aid future development within the LDO area.

1 Introduction

1.1 Background

Treforest Industrial Estate was originally a 1930s trading estate, built on flat green field land on the banks of the River Taff south of Pontypridd in Rhondda Cynon Taf, South Wales. It is adjoined by the more modern Parc Nantgarw, developed on brownfield land from the 1990s. The major landowner, the Council and Natural Resources Wales are working together to support the regeneration of the Treforest Industrial Estate.

A Strategic Flood Consequences Assessment (SFCA) was prepared on behalf of Rhondda Cynon Taf County Borough Council (Rhondda Cynon Taf CBC) in 2008. The information in the 2008 SFCA was used at the time to inform the Local Development Plan (LDP) and made special reference to eight strategic sites, which included the Treforest Industrial Estate. The LDP was adopted in 2011 and has a specific policy for Treforest Industrial Estate and Parc Nantgarw, which defines acceptable land uses in new development.

As part of the regeneration initiative, Rhondda Cynon Taf CBC and the major landowner are now working together to prepare a Local Development Order (LDO) for Treforest Industrial Estate, to provide a greater degree of planning certainty for the redevelopment of vacant sites and buildings and changes of use of buildings.

Rhondda Cynon Taf CBC commissioned Capita Property and Infrastructure in February 2015 to prepare an area wide SFCA for the Treforest Industrial Estate LDO area, in accordance with the Welsh Government's development planning guidance, Planning Policy Wales (PPW)[1] and the Technical Advice Note 15: Development and Flood Risk (TAN 15)[2].

1.2 Purpose of the SFCA

Strategic Flood Consequences Assessments (SFCAs) can be used to inform a range of activities, including land use planning, emergency planning, development control and the development of specific flood risk management policy. The level of detail included in the SFCA depends on the intended use.

This SFCA was developed at a strategic scale in support of the LDO, and thus the scale and detail within the assessment reflects this intended use. The overall purpose of this SFCA is to present sufficient information to enable Rhondda Cynon Taf CBC to identify the development classes that would be permitted by the LDO within the Treforest Industrial Estate LDO area.

The aims of this SFCA as identified in the tender brief (to satisfy the requirements of TAN 15 from both river and surface water flooding) are:

- Assess the flood risk for a range of return periods (2, 5, 10, 20, 50, 75, 100, 100 plus climate change and 1000 year).
- Assess the flood risk within the LDO area by the integration of depth, velocity and frequency of flooding into generalised risk areas.

[1] Welsh Government (July 2014). Planning Policy Wales, Edition 7

[2] Welsh Assembly Government (July 20014). Technical Advice Note 15: Development and Flood Risk

- Assess the sensitivity of different development classes and the types of industry within those classes, to flood risk within the area, with the aim of providing betterment in terms of flood risk for any future development.
- Summarise the development classes compared to flood risk on a LDO development area advice map, showing:
    - Areas where classes of development (new build and change of use) permitted by the LDO can be implemented without being subject to planning conditions or informative notes related to flood risk
    - Areas where classes of development (new build and change of use) permitted by LDO must be subject to planning consideration and/or informative notes related to flood risk, to be set out in the LDO;
    - Areas where specified types of development (new build and change of use) must have a planning application with a detailed FCA.

The SFCA will also be used to inform a flood management plan for the entire industrial estate.

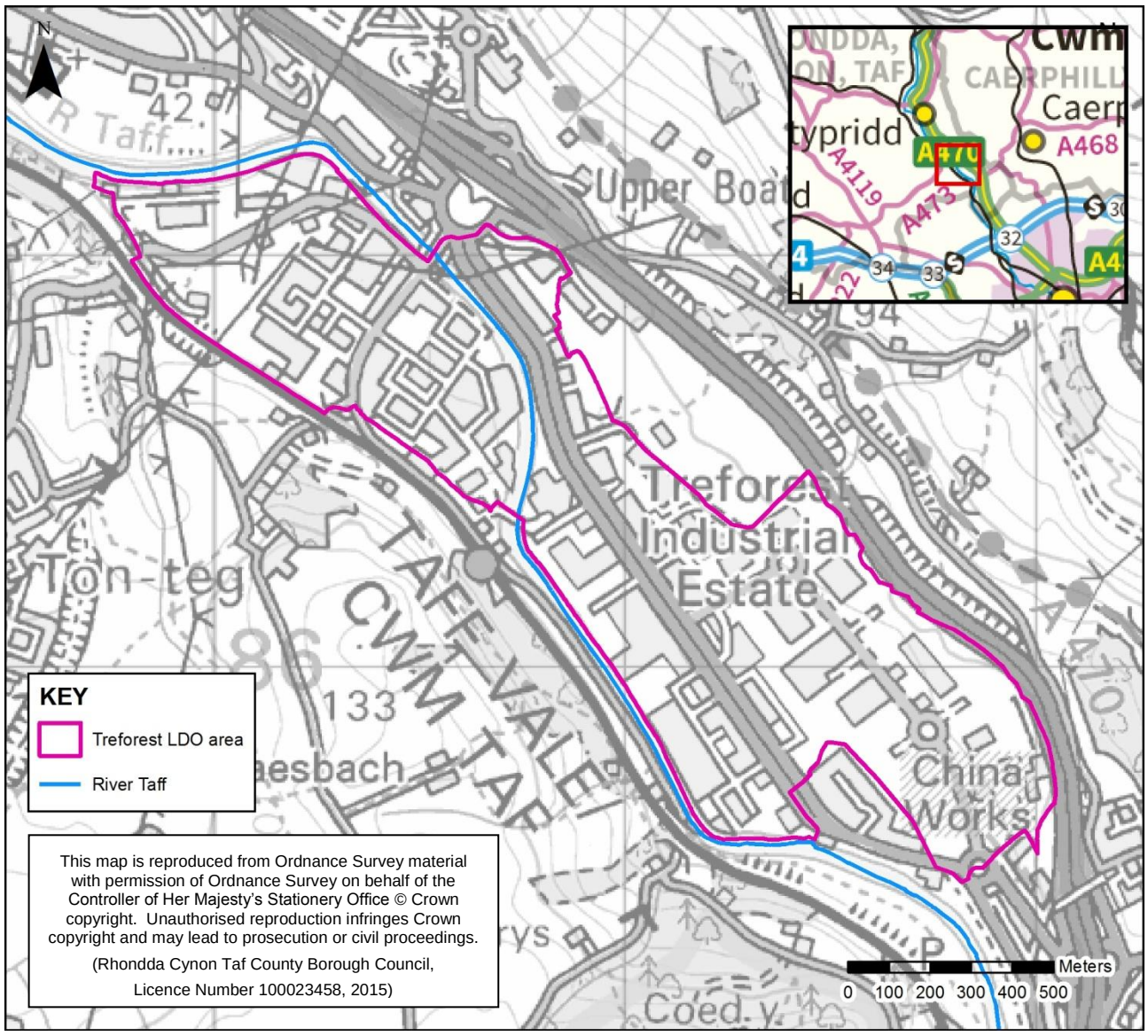
1.3 Report structure

This report provides background information to planning policy, definition and description of flood risk, a description of the strategic approach to evaluating flood risk and a summary of known flood risk from all sources in Treforest Industrial Estate LDO area. The report also provides a more detailed assessment of the fluvial flood risk by categorising the area into generalised risk 'zones', integrating the fluvial flood depths, velocities and frequencies to help inform the potential development classes within the LDO area. This report is supported by SFCA area wide maps and LDO area advice maps showing the development classes compared to flood risk, within the report and in Appendix A.

1.4 SFCA Study Area

The Treforest Industrial Estate SFCA study area (LDO area) covers an area of approximately 1.3 km^2 within the Rhondda Cynon Taf administrative area in South Wales (see Figure 1-1). The study area is located between the main towns of Pontypridd, to the northwest, and Caerphilly to the east and traverses both banks of the River Taff.

Figure 1-1 - Treforest Industrial Estate LDO area



Hydrology

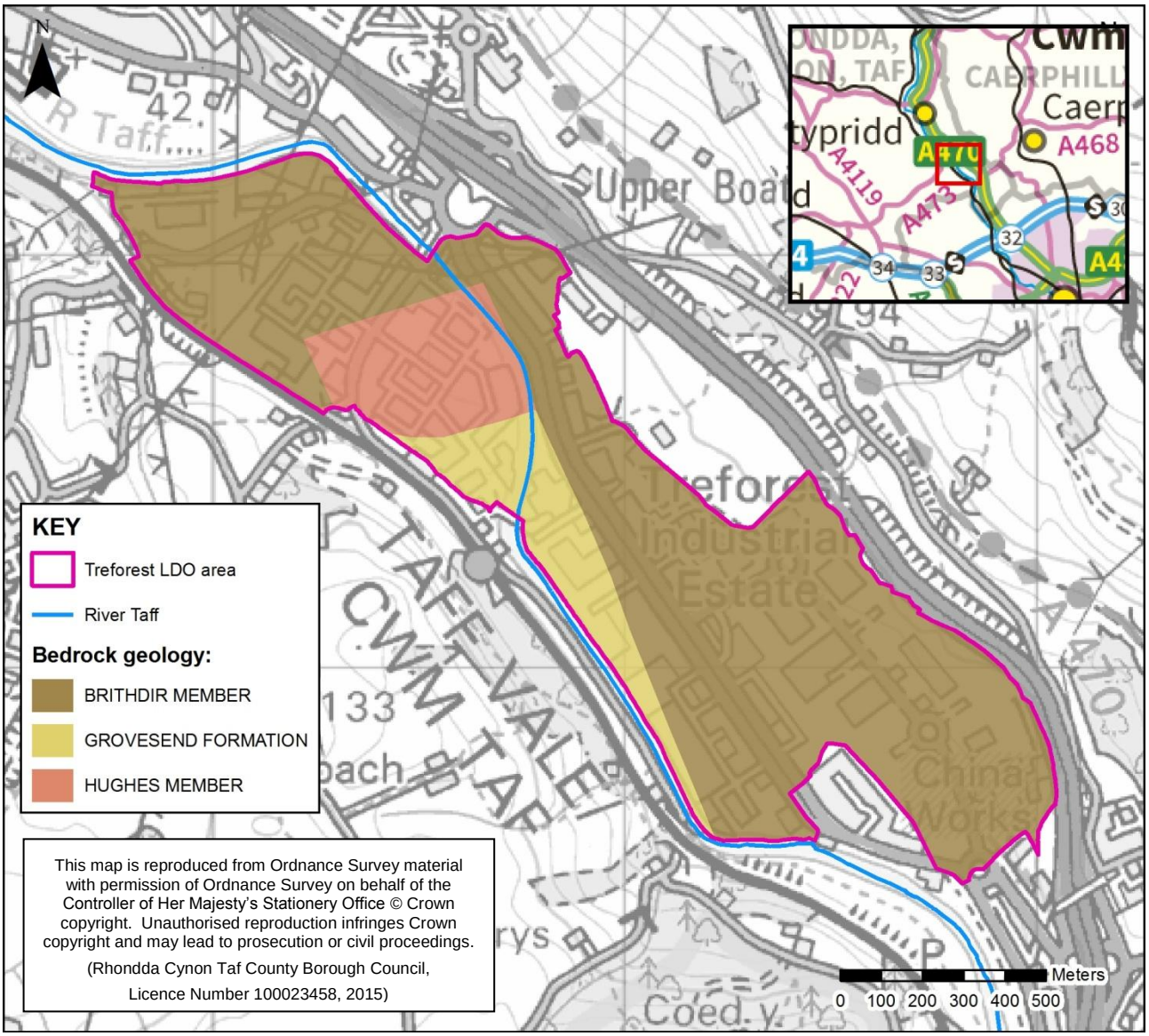
Fluvial flooding is the main source of flooding within the LDO area. The LDO area is bisected by the River Taff, which flows through the LDO area in a north-south direction. The River Taff originates in the Brecon Beacons, just north of Merthyr Tudful, and flows in a predominantly southerly direction to its outfall into Cardiff Bay. The LDO area is completely within the River Taff catchment, covering a very small proportion (<1%) of the total Taff catchment (527km^2).

Geology

The Treforest Industrial Estate is entirely underlain by superficial alluvium, which is comprised of consolidated clay, silt sand and gravel. They are moderately permeable deposits, capable of supporting local water tables, and potentially forming a source of baseflow to the River Taff. The bedrock that is unexposed

beneath these deposits, is a series of inter-faulted permeable sandstones, including the Brithdir, Hughes and Grovesend formations. The Grovesend formation contains some less permeable layers of mudstones and siltstones.

Figure 1-2 - Bedrock geology in the LDO area



Topography

The Treforest Industrial Estate is built on the River Taff floodplain, at the base of a river valley. The entire LDO area is based on relatively flat ground, with little variation in elevations across the site. The slight exception to this is in the far eastern parts of the catchment, where elevations are slightly higher.

2 Policy Context

2.1 Introduction

This section of the SFCA provides an overview of the responsibilities of flood risk management authorities within the Treforest Industrial Estate, as an area in the Rhondda Cynon Taf (RCT) County Borough. This section also describes policy documents and their statutory significance; and documents produced as a result of the Flood Risk Regulations 2009 that can provide higher level understanding of flood risks presented in the RCT County Borough. It is intended that this section provides support and guidance for development decisions by directing the reader to flood risk related documentation and authorities.

2.2 Roles and responsibilities

The Flood and Water Management Act 2010 sets out the responsibilities and statutory duties of authorities in relation to managing water and flood risk. The following section discusses these roles.

2.2.1 Natural Resources Wales

Natural Resources Wales (NRW) is a body formed by the Welsh Government[3] that has taken over the functions and responsibilities of the Environment Agency Wales (part of the Environment Agency for England and Wales) as of the 1st April 2013, along with those of the Countryside Council for Wales and the Forestry Commission Wales. NRW has the statutory duty to report to the Welsh Ministers about the management of flooding and coastal erosion in Wales, in accordance with section 18 of the Flood and Water Management Act 2010. Subsequently they have been assigned the following statutory duties, which were previously the Environment Agency's responsibilities:

- Maintain or improve any watercourses which are designed as Main Rivers. The Environment Agency have powers to clear blockages and carry out maintenance on Main Rivers where obstructions could cause a flood risk. Main Rivers are generally larger streams or rivers, but can be smaller watercourses of local significance;
- Maintain or improve any sea or tidal defences;
- Install and operate flood warning equipment;
- Control actions by riparian owners and occupiers which might interfere with the free flow of watercourses; and
- Supervise internal drainage boards.

Statutory powers means that NRW is required by law to fulfil the activities listed above. The NRW is a statutory consultee in the planning process within areas of flood risk (except minor developments).

NRW manage the main river and tidal flooding, whereas local flooding is devolved to a local level through the creation of Lead Local Flood Authorities (LLFAs).

[3] This was made possible under The Public Bodies Act 2011 which became law in December 2011 and allowed ministers to abolish or reform a specified list of public bodies.

2.2.2 Lead Local Flood Authority

Rhondda Cynon Taf County Borough Council (Rhondda Cynon Taf CBC) is the Lead Local Flood Authority (LLFA) for Rhondda Cynon Taf and it has the 'lead' role in managing flood risk from surface water, groundwater and ordinary watercourses across the county. This involves close working with partners involved in flood and water management, known as Risk Management Authorities.

By 2015, the main duties Rhondda Cynon Taf CBC will be responsible for will include:

- Develop, Maintain, Apply and Monitor the Local Flood Risk Management Strategy (described further in section 2.5.3).
- Cooperating with other Risk Management Authorities within Rhondda Cynon Taf, that will be affected by the Local Flood Risk Management Strategy. This includes the other districts and boroughs, water utility companies, the NRW and others.
- Publish a summary of the local Flood Risk Management Strategy that includes guidance about the availability of relevant information.
- Maintain a register of local structures and features that are likely to have a significant effect on flood risk.
- In the event of a significant flood, investigate to an appropriate level whether the relevant flood risk management functions were exercised correctly.
- Contribute towards sustainable development when exercising a flood risk management function.

Rhondda Cynon Taf CBC are further assigned the role of the Sustainable Drainage Approving Body (SAB), which is responsible for:

- Assessing and approving the drainage design for all construction work which has drainage implications; and
- Adoption and maintenance of SuDS schemes which connect more than one property (LFRMS 2013).

The Welsh government is at present developing a National Standard for Sustainable Drainage Systems and the Rhondda Cynon Taf CBC will be reviewing this upon publication.

2.2.3 Local Planning Authority

The Local Planning Authority (LPA) has a responsibility to ensure that all watercourses, for which NRW is not the responsible authority, are appropriately managed by the riparian landowner. Watercourses that are not main rivers are defined as Ordinary Watercourses. The LPA is responsible for determining planning applications, requiring consultation with the NRW in areas of flood risk.

2.2.4 Dwr Cyrmru Welsh Water/Sewerage Undertakers

Sewerage undertakers are responsible for surface water and foul drainage from developments, where this is adopted via adopted sewers. Dwr Cymru Welsh Water (DCWW) is the sewerage undertaker within the study area.

The Flood and Water Management Act 2010 is set to remove the automatic right to connect to public surface water sewers. This may require developers to provide more justification than is currently required in order to

connect to the Welsh Water drainage network. It may in future be necessary to provide evidence that surface water runoff cannot be appropriately managed within the site through the use of soakaways or direct discharge to surface water in order to gain approval for connection to the public surface water sewer. Additionally, they have a role of providing information to LPAs so that an SFCA takes into account any areas of critical drainage problems.

2.2.5 Highways Service

As an acting Risk Management Authority (RMA), the Highways Service is responsible for maintaining major roads throughout Wales; this includes the upkeep of the surface water drainage infrastructure associated with the road network. The Highways Service should act consistently with National and Local Strategies and may be scrutinised by the LLFA.

2.2.6 The Public

The LLFA has the responsibility to engage the public during the process of developing the LLFA. This is necessary to ensure that Local Strategies are able to be successfully implemented.

2.2.7 Landowners/Riparian owners

Riparian Landowners, owners of land adjoining to, above or with a watercourse running through it, have certain rights and responsibilities. These are outlined in the Environment Agency's 'Living on the Edge, 5th Edition' document[4]. The key responsibilities associated with flood risk are highlighted below:

- You must let water flow through your land without any obstruction, pollution or diversion which affects the rights of others.
- You must accept flood flows through your land, even if these are caused by inadequate capacity downstream. A landowner has no duty in common law to improve the drainage capacity of a watercourse he/she owns.
- You should keep the banks clear of anything that could cause an obstruction and increase flood risk, either on your land or downstream if it is washed away.
- You are responsible for maintaining the bed and banks of the watercourse and the trees and shrubs growing on the banks. You should always leave a development-free edge on the banks next to a watercourse
- You must keep any structures, such as culverts, trash screens, weirs and mill gates, clear of debris. Environment Agency of the above.
- You are responsible for protecting your property from water that seeps through natural or artificial banks. Where this damages a flood defence, your risk management authority may require you to pay for repairs.

If you are not sure what you have to do and/or are new to living near a watercourse, ask your risk management authority for advice.

[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/403435/LIT_7114.pdf

2.2.8 Developers

Developers play a critical role in ensuring effective local flood risk management through the avoidance of developing in areas at risk of flooding. Equally, NRW as a Risk Management Authority should advise and help planning authorities and developers to understand the causes and effects of flooding within a river catchment and early consultation with them is recommended.

2.3 European Policies (EU)

2.3.1 Water Framework Directive

The Water Framework Directive (WFD) is European legislation which promotes water management through river basin planning. It provides a framework to protect and improve the aquatic environment through greater integration between water and land management. It seeks to achieve 'good ecological status' of water bodies through integrated river basin management.

The implications of the Water Framework Directive on flood risk are likely to include controls on the type of flood alleviation schemes that can be implemented and that any schemes should also contribute to achieve 'good ecological status' through methods such as restoration of floodplains to their natural state and purpose. NRW is leading on the delivery of the WFD Wales.

Natural Resources Wales and the Environment Agency are currently consulting on a draft revised river basin management plans that will set objectives for Wales' rivers, lakes, estuaries, coastal and groundwaters for 2015 to 2021. The proposed plan will be submitted to Ministers in Autumn of 2015, and will be published in December 2015 if approved. Rhondda Cynon Taf is within the Severn River Basin District, which will be lead by the Environment Agency.

Dwr Cymru Welsh Water launched a funding scheme in July 2012 that supports projects for not-for profit organisations, in line with the EU Water Framework Directive, that will deliver improvements to Welsh rivers, lakes and waterways.

2.3.2 Floods Directive

The European Floods Directive on the Assessment and Management of Flood Risks (European Union, 2007) came into force on the 26th November 2007. The directive was transposed into English and Welsh law as the Flood Risk Regulations in December 2009. The directive requires member states to consider the potential impacts that domestic policies might have on flood risks and the management of flood risks to neighbouring member states. It recognises that objectives regarding the management of flood risk should be determined by the Member States themselves and should be based on local and regional circumstances.

The directive requires Member States to designate competent authorities to implement the Directive; which is the NRW for Wales. The directive requires the following elements to be undertaken:

- *Preliminary Flood Risk Assessments* to identify areas that are at potentially significant flood risk (December 2011);
- *Flood hazard maps* showing the likelihood and flow of the potential flooding and flood risk maps (showing the impact), (December 2013);
- *Flood risk management plans* showing measures to decrease the likelihood or impact of flooding (to be completed by December 2015); and

- Updates every 6 years thereafter that take into account the impact of climate change.

NRW already have in place flood risk mapping (Risk from Flooding from Rivers and Sea Map) and flood risk management plans (the relevant Catchment Flood Management Plan is described in 2.5.1). They further provide support for LLFAs in completing Preliminary Flood Risk Assessments (the Rhondda Cynon Taf assessment is detailed in 2.5.4).

2.4 National Policies

2.4.1 Flood and Water Management Act

The Flood and Water Management Act was passed in April 2010 and it intends on improving flood risk and water management processes through establishing roles and responsibilities of various authorities.

The Act places significantly greater responsibility on Local Authorities to manage and lead on local flooding issues. As the LLFA, the Act sets out the requirements and targets of Rhondda Cynon Taf, including:

- Taking an active role leading flood risk management as Lead Local Flood Authorities (LLFAs)
- Cooperating with other relevant authorities to manage local flood risk
- Investigating flood incidents and reporting upon them
- Maintaining an 'Asset Register' of assets that have a significant influence on local flood risk
- Designating 'features' that have a significant influence on local flood risk
- Regulating works on 'ordinary watercourses'
- Development and implementation of Local Flood Risk Management Strategies (LFRMS)
- Responsibility for first approval, then adoption, management and maintenance of Sustainable Drainage System (SUDS) where they service more than one property.

The Flood and Water Management Act also clarifies three key areas that influence development:

- *Sustainable drainage (SuDS)* - the Act makes provision for a national standard to be prepared on SuDS. Developers will be required to obtain local authority approval for the SuDS in accordance with the standards, likely with conditions. When they are designed and constructed robustly, local authorities will be required to adopt and maintain the SuDS that serve more than one property.
- *Flood risk management structures* - the Act enables NRW and local authorities to designate structures such as flood defences or embankments owned by third parties for protection if they affect flooding or coastal erosion. A developer or landowner will not be able to alter, remove or replace a designated structure or feature without first obtaining consent.
- *Permitted flooding of third party land* - NRW and local authorities have the power to carry out work which may cause flooding to third party land where the works are deemed to be in the interest of nature conservation, the preservation of cultural heritage or people's enjoyment of the environment or of cultural heritage.

2.4.2 Planning Policy Wales (7th Edition, 2014)

The Planning Policy Wales (PPW) sets out the National planning policy framework for addressing land use planning issues in preparing and developing Local Development Plans (LDPs). The PPW is supplemented by a series of Technical Advice Notes (TANs), including TAN 15: Development and Flood Risk.

PPW addresses a wide range of issues including sustainable settlements, the location of new development, the commitment to re-use of land and promoting sustainability through good design. Chapter 13, Environmental Risk and Pollution, of the PPW considers flood risk and climate change, setting out responsibilities and advising LPAs on how to proceed with developments emphasising the importance of sustainability.

2.4.3 Technical Advice Note 15: Development and Flood Risk (June 2004)

TAN 15 provides technical guidance which advises on development and flood risk. It achieves this through discussion of Development Advice Maps, the nature of development or land use, justifying locations of built developments, assessing flooding consequences, surface water run-off from new developments, action through Development Plans; and Development control.

The TAN aims to advise caution in the development of high flood risk areas by setting out a precautionary framework to guide planning. This is achieved by:

- A Development Advice Map (DAM) which contains three flood risk zones, and should be used to trigger the appropriate tests; and
- Definitions of vulnerable development and advice on permissible uses in relation to the location and consequences of flooding.

Development Advice maps have been drawn up for the whole of Wales, dividing it into three flood zones which represent different levels of risk from flooding. These flood zones are described fully in Table 2-1.

Table 2-1 - Flood Zones as defined by TAN 15

Zone	Description of Zone	Use within the precautionary framework
A	Considered to be at little or no risk of fluvial or tidal/coastal flooding.	Used to indicate that justification test is not applicable and no need to consider flood risk further.
B	Areas known to have been flooded in the past evidence by sedimentary deposits.	Used as part of a precautionary approach to indicate where site levels should be checked against the extreme (0.1%) flood level. If site levels are greater than the flood levels used to define adjacent extreme flood outline there is no need to consider flood risk further.
C	Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal).	Used to indicate that flood issues should be considered as an integral part of decision making by the application of the justification test including assessment of consequences.
C1	Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.	Used to indicate that development can take place subject to application of justification test, including the acceptability of consequences.
C2	Areas of floodplain without significant flood defence infrastructure.	Used to indicate that only less vulnerable development should be considered subject to application of justification test, including acceptability of consequences. Emergency services and highly vulnerable development should not be considered.

Source: Welsh Assembly Government (2004). Tan 15: Development and Flood Risk

As well as the risk of flooding, the type of development proposed is important when assessing flood risk. The precautionary framework identifies the vulnerability of different land uses to flooding and has sub-divided development into three categories as shown in Table 2-2.

Table 2-2 – Development categories from TAN 15

Development Category	Types
Emergency Services	Hospitals, ambulance stations, fire stations, police stations, coastguard stations, command centres, emergency depots and buildings used to provide emergency shelter in time of flood.
Highly vulnerable development	All residential premises (including hotels and caravan parks), public buildings (e.g. schools, libraries, leisure centres), vulnerable industrial developments (e.g. power stations, chemical plants, incinerators) and waste disposal sites.
Less vulnerable development	General industrial, employment, commercial and retail development, transport and utilities infrastructure, car parks, mineral extraction sites and associated processing facilities, excluding waste disposal sites.
Source: Welsh Assembly Government (2004). Tan 15: Development and Flood Risk	

In order to place a vulnerable development (either 'highly' or 'less' vulnerable) in Zone C, the planning authority should be justified and following that, the flood consequences of the development assessed. TAN 15 outlines a justification test. It states that development, including transport infrastructure will only be justified if it can be demonstrated that:

i. Its location in zone C is necessary to assist, or be part of, a local authority regeneration initiative or a local authority strategy required to sustain an existing settlement, or,

ii. Its location in zone C is necessary to contribute to key employment objectives supported by the local authority, and other key partners, to sustain an existing settlement or region;

iii. It concurs with the aims of PPW and meets the definition of previously developed land; and,

iv. The potential consequences of a flooding event for the particular type of development have been considered, and found to be acceptable in terms of criteria listed in the TAN 15 Sections 5 and 7 and Appendix 1.

2.4.4 Assessing Flood Consequences

When a development passes the justification test, it is in the knowledge of the potential of flooding and requires appropriate planning. A development should only proceed if the consequences of flooding can be managed to an acceptable level for the development, and therefore a Flood Consequence Assessment (FCA) should be completed. The assessment can be used to establish whether suitable mitigation measures can be incorporated within the design to ensure that the development is as safe as possible and there is:

- Minimal risk to life
- Minimal disruption to people living and working in the area
- Minimal potential damage to property
- Minimal impact of the proposed development on flood risk generally; and
- Minimal disruption to the natural environment.

TAN 15 also provides indicative guidance for different types of development, for the probability of flood risk when the development should be flood free up to the appropriate threshold frequencies (see Table 2-3). The lifetime of the development should be considered when referring to the indicative guidance and appropriate climate change allowance applied if necessary.

Table 2-3 - Flooding frequency thresholds for different development types from TAN 15

Type of development	Threshold frequency (years)	
	Fluvial	Tidal
Residential	1%	0.5%
Commercial/retail	1%	0.5%
Industrial	1%	0.5%
Emergency Services	0.1%	0.1%
General Infrastructure	1%	0.5%

Source: Welsh Assembly Government (2004). Tan 15: Development and Flood Risk

Beyond the threshold frequency it is expected that the development would be flooded during extreme conditions. However even with adequate mitigation measure in place it may still not be sensible to allow particular development to take place. TAN 15 provides indicative guidance on what it considers to be tolerable conditions, in terms of flood depth, velocity, rate of rise and speed of inundation, for different types of development (Table 2-4).

Table 2-4 - Indicative guidance on tolerable conditions in an extreme flood from TAN 15

Type of development	Maximum depth of flooding (mm)	Maximum rate of rise of floodwaters (m/hr)	Maximum speed of inundation of flood risk area (hrs)	Maximum velocity of flood waters (m/s)
	Property Access			Property Access
Residential	600 600	0.1	4	0.15 0.3
Commercial/retail	600 600	0.3	2	0.15 0.3
Industrial	1000 1000	0.3	2	0.3 0.45
Emergency Services	450 600	0.1	4	0.15 0.3
General Infrastructure	600 600	0.3	2	0.3 0.3

Source: Welsh Assembly Government (2004). Tan 15: Development and Flood Risk

TAN 15 is therefore fairly prescriptive and presents a series of tests and criteria that a development must satisfy before deemed acceptable. These considerations have been taken forward in this site specific SFCA to help inform the generalised risk 'zones' and in informing the potential development classes within the LDO area.

2.4.5 National Strategy for Flood and Coastal Erosion Risk Management in Wales

The National Strategy (November 2011) was published by the Welsh Government, under the terms of the Flood and Water Management Act 2010, to provide a national framework for flood and coastal erosion risk management in Wales. It sets out the overall objectives for management flood and coastal erosion risk. These are:

- Reducing the consequences for individuals, communities, businesses and the environment from flooding and coastal erosion;
- Raising awareness of and engaging people on flood and coastal erosion risk;
- Providing an effective and sustained response to flood and coastal erosion events; and
- Prioritising investment in the most at risk communities.

The National Strategy states that implementing these objectives is the responsibility of everyone involved in or affected by flood and coastal erosion risk management, including the Welsh Government and the Welsh

Risk Management Authorities (including NRW, LLFA, internal drainage district and Dwr Cymru Welsh Water).

2.4.6 Wales Spatial Plan

The Wales Spatial Plan (adopted in 2004 and updated in 2008) is a statutory framework to guide spatial policy development throughout Wales. It seeks to integrate the spatial aspects of national strategies, and splits Wales into six broadly categorised sub-regions or delivery areas for the principles outlined. Treforest is included within the South East sub-region which does not have any specific flood priorities, other than to manage flooding with regards to habitat. Although the plan is statutory it does not form part of the formal development plan for Wales. LPAs are required to regard the Wales Spatial Plan when developing their LDPs for relevant information.

2.5 Local Policies

2.5.1 Catchment Flood Management Plans

A catchment flood management plan (CFMP) is a high-level strategic planning document that provides an overview of the main sources of flood risk, and produces policies to secure the long-term sustainable management of flood risk within catchments. They are intended to inform planning and decision-making by key partners involving NRW, local authorities, internal drainage districts, transportation planners, land owners, the public and businesses.

The Treforest LDO area is covered by the Taff and Ely CFMP, which covers an area of 695km^2. The CFMP area is largely rural in nature with a few urban areas, including Treforest. Within the CFMP, Treforest is identified as having 100 to 500 properties at risk of flooding from a future 1% Annual Exceedance Probability (AEP) flood event. The Treforest Industrial Estate is encompassed in the *Pontypridd Treforest and Taffs Well* sub-area, which is defined as *areas of moderate to high flood risk where we can generally take further action to reduce flood risk*.

The sub-area is covered by Policy Option 5. Actions associated with this policy for this specific sub-area are to:

- Encourage and support partners to produce long term plans to manage all sources of flooding;
- Maintain defences and provide flood warning;
- Encourage and support studies by partners to identify surface water and sewer flooding issues and management options;
- Engage with the local community to encourage people at risk to take action to help themselves; and
- Encourage and support owners and operators to plan for and manage their current and future flood risks.

2.5.2 Rhondda Cynon Taf Local Development Plan (2011)

The Rhondda Cynon Taf Local Development Plan (LDP) is a statutory document adopted in March 2011. The LDP provides the development strategy and spatial policy framework for the LDP area over a 15 year period to 2021. The Plan is to be used by the RCT Council to guide and control development. It sets out

area wide policies intended to ensure that all development with the County Borough contributes towards achievement of the Vision and Core Strategy and also sets out policy objectives for the Northern and Southern Strategy areas to reflect the individual characteristics of the areas.

There are several policies which directly correspond to flood risk and the Treforest Industrial Estate, which are classed as either Area Wide (AW) or applying to the Southern Strategy Area (SSA). These are:

- *Policy AW2* includes criteria to guide the placement of developments in flood risk zones, referring to the guidance set out in TAN 15 for vulnerable development placements.
- *Policy AW10* sets out how development proposals would not be permitted where they would cause or result in a risk of unacceptable harm to health and/or local amenity, in which flooding is included as a potential risk.
- *Policy SSA27* permits development, redevelopment and changes of use in the area for specific government-classified uses in order to promote the economy. These uses include offices, research and development, light and general industry, storage and distribution and other sui generis employment generating uses which display the characteristics of B-Class Uses. Other uses will only be permitted where they are complimentary and to the main B-Class Uses. The policy directly references the Treforest Industrial Estate, indicating that *the council is keen to ensure that Treforest Industrial estate continues to play a major role in the local economy and the refurbishment and redevelopment of the sites will be supported*. The Council is intending on preparing a supplementary planning guidance document for the Treforest Industrial Estate that will detail the acceptable uses.

2.5.3 Rhondda Cynon Taf Local Flood Risk Management Strategy (2013)

As the Lead Local Flood Authority, Rhondda Cynon Taf CBC is required to develop, maintain, apply and monitor a Local Flood Risk Management Strategy (LFRMS). The Rhondda Cynon Taf LFRMS (January 2013) provides a comprehensive overview of flooding in the County Borough and identifies and describes the function of all relevant risk management authorities, internal and external stakeholder, statutory documents and best practice reports for flood risk management.

The identified and described documents are divided into several categories including emergency planning, asset management and development (flood forecasting, warning and response; development planning and adaptation; land, cultural and environmental management; asset management and maintenance; studies, assessment and plans). The LFRMS is consistent with the National Strategy for flood and coastal erosion management, by working within the four objectives identified in the National Strategy.

Four core objectives have been developed to summarise Rhondda Cynon Taf CBC's strategic position with regard to the management of flood risk:

1. To utilise a risk based approach to managing flood risk, recognizing that drainage and structural defences may not always be the most appropriate solution.
2. To develop a greater strategic understanding of flood risk from all sources within Rhondda Cynon Taf and at a wider catchment scale.
3. To raise community awareness of, and actively engage communities in the response to flood risk.
4. Use of local planning policy to ensure that no new flood risk is created and where possible, opportunities to reduce flood risk are taken.

These four core flood risk management objective will be delivered through a series of 16 detailed objectives which have due regard to the higher tier strategies (National Strategy for Flood and Coastal Erosion Risk Management in Wales (2011) and the Live. Grow. Apire. Achieve Rhondda Cynon Taf Community Strategy (2010)).

2.5.4 Rhondda Cynon Taf Preliminary Flood Risk Assessment (2011)

The Rhondda Cynon Taf Preliminary Flood Risk Assessment (PRFA) was prepared for the CBC in 2011. The report was prepared to ensure Rhondda Cynon Taf, as the LLFA, met their duty to deliver the requirements of the Flood Risk Regulations (2009).

The PRFA provides a high level overview of flood risk from local flood sources for the entire Rhondda Cynon Taf CBC administrative area, including information on past floods and the potential consequences of future floods.

3 Understanding Flood Risk

3.1 Sources of flooding

Flooding is a natural hazard that can have a major impact on lives, communities, the economy and the environment. It can occur from many different and combined sources and in many different ways. Major sources of flooding include:

- Fluvial (rivers)
- Tidal
- Surface water
- Groundwater
- Artificial sources/reservoir flooding

Flood hazard can vary greatly throughout catchments and even across floodplain areas. The hazard posed by floodwater is proportional to the depth of exposure, the velocity of flow and the speed of onset of flooding. Hazardous river flows can pose a significant risk to exposed people, property and infrastructure. Whilst low hazard flows are less of a risk to life (shallow, tranquil water), they can disrupt communities, require significant post-flood cleanup and can cause costly and possibly structural damage to property. Flood hazard within the study area is analysed in more detail and discussed further in Chapter 4 and Chapter 5.

3.1.1 Fluvial flooding

Flooding from rivers occurs when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (floodplain). The main reasons for water levels rising in rivers are:

- intense or prolonged rainfall causing runoff rates and flow to increase in rivers, exceeding the capacity of the channel. This can be exacerbated by wet antecedent (the preceding time period) conditions and where there are significant contributions of groundwater;
- constrictions in the river channel causing flood water to backup;
- blockage of structures or the river channel causing flood water to backup; and
- High water levels and/or locked flood gates preventing discharge at the outlet of the river.

The consequences of river flooding depend on how hazardous the flood waters are and what the receptor of flooding is. The hazard of river flood water is related to the depth and velocity, which depends on:

- the magnitude of flood flows;
- size, shape and slope of the river channel;
- width and roughness of the floodplain; and
- types of structures that cross the channel.

3.1.2 Tidal flooding

This form of flooding can occur from a combination of high tides and stormy conditions. The Treforest LDO area is completely landlocked and a considerable distance from the coast. There is no risk of tidal flooding to the LDO area.

3.1.3 Surface water flooding

Surface Water is classified several ways, as:

- Rainfall that infiltrates into the soil but resurfaces further down the hill;
- The water in lakes, marshes and reservoirs; and
- Water flowing over the ground surface that has not entered a natural channel or artificial drainage system is classified as surface water runoff or overland flow.

Surface water flooding often occurs when intense, often short duration rainfall is unable to soak into the ground or enter drainage systems, or when the ground is saturated and can hold no more water. The volume of surface runoff will usually depend on catchment size and shape, geology, slope, climate, rainfall, saturation, soil type and vegetation. Often, localised surface water flooding can occur with limited warning and can affect all forms of the built environment, including residential, commercial and industrial properties, infrastructure and agriculture.

Porous materials absorb water readily, whereas fine-grained bedrock or dense clays increase runoff potential. Urban settlements often have large areas of impermeable surfaces, which behave similarly to poorly drained materials and can increase surface water flood risk.

Developments which are close to artificial drainage systems, or located at the bottom of hillslopes, in valley bottoms and hollows, may be more prone to surface water flooding.

Flooding from land can also occur when structures used to manage flooding fail. For example, flooding would be worse if a culvert were to collapse or block.

Flooding may occur as sheet flow or as rills and gullies causing increased erosion of agricultural land. This can result in ‘muddy floods’ where soil and other material are washed onto roads and properties, requiring extensive clean-up.

Both rural and urban land use changes are likely to alter the amount of surface water in the future. Future development is also likely to change the position and numbers of people and/or developments exposed to flooding.

3.1.4 Groundwater flooding

Groundwater flooding is caused by the emergence of water originating from the bedrock. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land. Groundwater floods events tend to be long in duration developing over weeks or months and prevailing for days or weeks.

There are many mechanisms associated with groundwater flooding, which are linked to high groundwater levels, and can be broadly classified as:

- Direct contribution to channel flow;

- Springs emerging at the surface;
- Inundation of drainage infrastructure; and
- Inundation of low-lying property (basements).

Groundwater levels rise and fall in response to rainfall patterns and distribution, with a time scale of months rather than days. The significance of this rise and fall for flooding, depends largely on the type of rock it occurs in, i.e. how permeable to water the rock is, and whether the water level comes close to or meets the ground surface.

- The main impacts of groundwater flooding are:
- Flooding of basements of buildings below ground
- Overflowing of sewers and drains
- Flooding of buried services or other assets below ground level
- Inundation of farmland, roads, commercial, residential and amenity areas

Groundwater flooding generally occurs more slowly than river flooding and in specific locations. The rarity of groundwater flooding combined with the mobility of the population means that people often do not know there is a groundwater flood risk.

New developments are particularly at risk because often little consideration is given to groundwater as a source of flooding in the planning process. The sparse frequency of groundwater flood events can contribute to poor decision-making. The economic and social costs of groundwater flooding are compounded by the relative long duration of events.

3.1.5 Reservoir flooding

Reservoirs are defined as artificial lakes, used to store water for various uses. Managed or un-managed reservoir release may increase floodwater depths and velocities in adjacent areas. Reservoir flooding may occur as a result of failure of a reservoir's civil structure due to the system being overwhelmed; or malfunction of the water level control system.

3.1.6 Sewer flooding

The main causes of sewer flooding are:

- Lack of capacity in sewer drainage networks due to original under-design, increase in demand or due to events larger than the system designed event.
- Lack of maintenance of sewer networks which leads to a reduction in capacity and can sometime lead to total sewer blockage.
- Water mains bursting/leaking due to lack of maintenance or as a result of damage.
- Groundwater infiltration into poorly maintained or damaged pipe networks.
- Restricted outflow from the sewer systems due to high water levels in receiving watercourses.

Drainage systems often rely on gravity assisted dendritic systems, which convey water in trunk sewers located at the lower end of the catchment. Failure of these trunk sewers can have serious consequences,

which are often exacerbated by topography, as water from surcharged manholes will flow into low-lying land which may already be suffering from other types of flooding.

Whilst the impact of sewer flooding is usually confined to relatively small localised areas, when flooding is associated with blockage or failure of the sewer network, flooding can be rapid and unpredictable. Flood waters from this source are often contaminated with raw sewage and pose a health risk. The spreading of illness and disease can be a concern to the local population if this form of flooding occurs on a regular basis.

Flooding of contaminated land (such as landfills, motorways, and petrol station forecourts) will transport contaminants such as organics and metals to vulnerable receptors if the respective drainage systems are not designed to treat the water.

3.2 Defining flood risk

3.2.1 Source-pathway-receptor model

The source-pathway-receptor model can be used when assessing flood risk, which requires the identification of:

- **Sources** – where the flood water comes from. There are six sources of flooding (rivers, sea, land (surface water), groundwater, sewers and artificial sources)
- **Pathway** – how the receptor and source come into contact. Pathways for flooding include overland pathways, overtopping of flood defences, breaching of defences and underground barriers causing groundwater levels to rise
- **Receptor** – the people, property and/or environment affected by flooding. For land use planning, the receptors of concern are people and property.

The planning process is primarily concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk. It is therefore beneficial to define the components of flood risk as well as considering the source-pathway-receptor model.

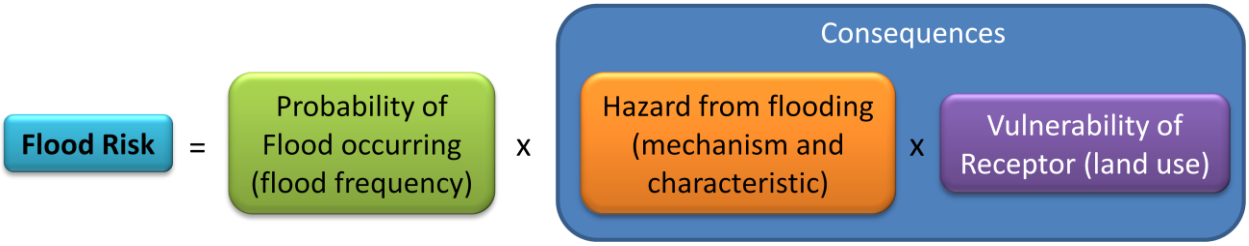
3.2.2 Probability and consequence

Flood risk is a combination of two components:

- The chance (or **probability**) of a particular flood event occurring; and
- The Impact (or **consequence**) that the event would have it if occurred.

By considering both the definition of risk and the source-pathway-receptor model, it is more useful to define the risk more precisely using Figure 3-1.

Figure 3-1 - Risk equation



The probability of flooding can be defined using data and statistical analysis. The hazard from flooding can be evaluated by considering the depth of floodwater, the velocity of flow, the speed of onset of flooding and the rate of rise of floodwater. The vulnerability of flooding can be assessed through analysis of the land use, property or people that would be affected by flooding.

It can be seen from the risk equation in

Figure 3-1 that by reducing the hazard or vulnerability of flooding, it is possible to reduce the risk. It follows that, development proposals within the LDO area should be developed and assessed using a risk-based approach that avoids risk where possible and manages it elsewhere. This approach is promoted in Planning Policy Wales (PPW) and TAH 15, which sets out a precautionary framework to guide planning decisions. The framework aims to:

- Direct new development away from those areas which are at high risk of flooding, and
- Only allow development which can be justified in high risk areas and where the consequences of flooding can be managed acceptably.

There is inherent uncertainty in the estimation of flood probability due to the need to simplify variability in rainfall, storm types, soil types, land cover and antecedent conditions into one design event. By separating flood risk into its three components, it is possible to gauge risk even if the exact probability of an event is uncertain. In this way a precautionary principle can be applied, as flood risk will be higher for floods with significant hazards and consequences, even when the probability of occurrence is uncertain.

3.2.3 Risk

This SFCA provides a range of information so that the hazard of flooding, not just the probability of flooding, can be examined. Risk varies depending on the severity of the flood event, the source of water, the pathways of flooding and the vulnerability of receptors as mentioned above.

Actual Risk

Actual risk provides information on flooding when the impact of existing flood defences is considered (assuming that they operate as they are supposed to). The actual risk of river flooding has been assessed for this SFCA. The maps provide a range of information; flood extent, maximum flood depth and maximum flood velocity. These maps can be used to determine if a development is likely to meet the acceptability criteria as detailed in TAN15, Appendix 1.

Actual risk of flooding from other sources (surface water, groundwater, sewers and artificial sources) can be assessed using a range of analyses. However, for the level of assessment required in an SFRA, these sources are usually assessed via a review of historic flood incidents records and a qualitative analysis of catchment characteristics and risk datasets.

Residual Risk

This involves the assessment of breach or failure of flood defences or other features, which may act as a defence. Such scenarios may include collapse of a flood defence wall, blockage of a culvert or structural failure of a canal or reservoir embankment. Whilst the probability of a breach or failure may be low (dependent on the integrity and maintenance of the structure), the consequences of an event are often very high.

3.3 Flood risk information/datasets

This section provides an overview of the flood risk information available for this SFCA at the time of publication. Table 3-1 provides a summary of the key datasets according to the sources of flooding, with

further details provided in Chapter 4 where they have been used to carry out an assessment of the flood risk in the Treforest Industrial Estate LDO area.

Table 3-1 - Key datasets

Flood source	Dataset
Fluvial	Development Advice Maps (NRW)
	Fluvial flood modelling (NRW)
	Taff and Ely CFMP (NRW)
	Local Flood Risk Management Strategy (Rhondda Cynon Taf CBC)
	Preliminary Flood Risk Assessment (Rhondda Cynon Taf CBC)
	Flood Consequence Assessment (National Grid)
	Historic Flood Map and Recorded Flood Outlines(NRW)
Surface water	Updated Flood Map for Surface Water (NRW)
	Local Flood Risk Management Strategy (Rhondda Cynon Taf CBC)
	Preliminary Flood Risk Assessment (Rhondda Cynon Taf CBC)
Groundwater	Areas Susceptible to Groundwater Flooding (NRW)
Reservoir	Risk of Flooding from Reservoir maps (NRW – online)
Sewer	Historical Flood Records (DG5 register) (Dwr Cymru Welsh Water)*
Other	Flood risk management: • Flood defence dataset (NRW) • Flood warning areas (NRW)

**Not available at time of issue*

4 Flooding in Treforest Industrial Estate LDO area

4.1 Introduction

This section of the SFCA provides a strategic assessment of the flood risk across the LDO area from all sources of flooding making best use of the available information. The information and guidance provided in this section can be used by Rhondda Cynon Taf CBC to inform development and flood risk and to enable application of the justification tests in TAN 15.

4.2 Historical flooding

The Hawthorn major river improvement scheme was implemented following the most significant flood event in the Treforest Industrial Estate in December 1960. There have subsequently been few historical fluvial flooding incidents reported. A review of several flood risk related reports and online published articles covering the whole of the Rhondda Cynon Taf administrative area and the River Taff floodplain, identifies a small number fluvial flooding incidents. The most relevant to the LDO area following 1960 are:

- December 1979 – notable and widespread flooding across the borough, including minor flooding in Treforest when flood defences overtopped.
- October 1998 – Gwaelod y Garth Road flooded, attributed to an extreme weather event. Additionally there was only 0.3m freeboard recorded immediately upstream of the Powys Road Bridge during this event. Following this incident the flood defences were raised.
- January 1998 to November 2000 – several episodes of flooding along Cardiff Road, Nantgarw (immediately downstream of the Industrial Estate) and along Park Street and John Street, Treforest (immediately upstream).

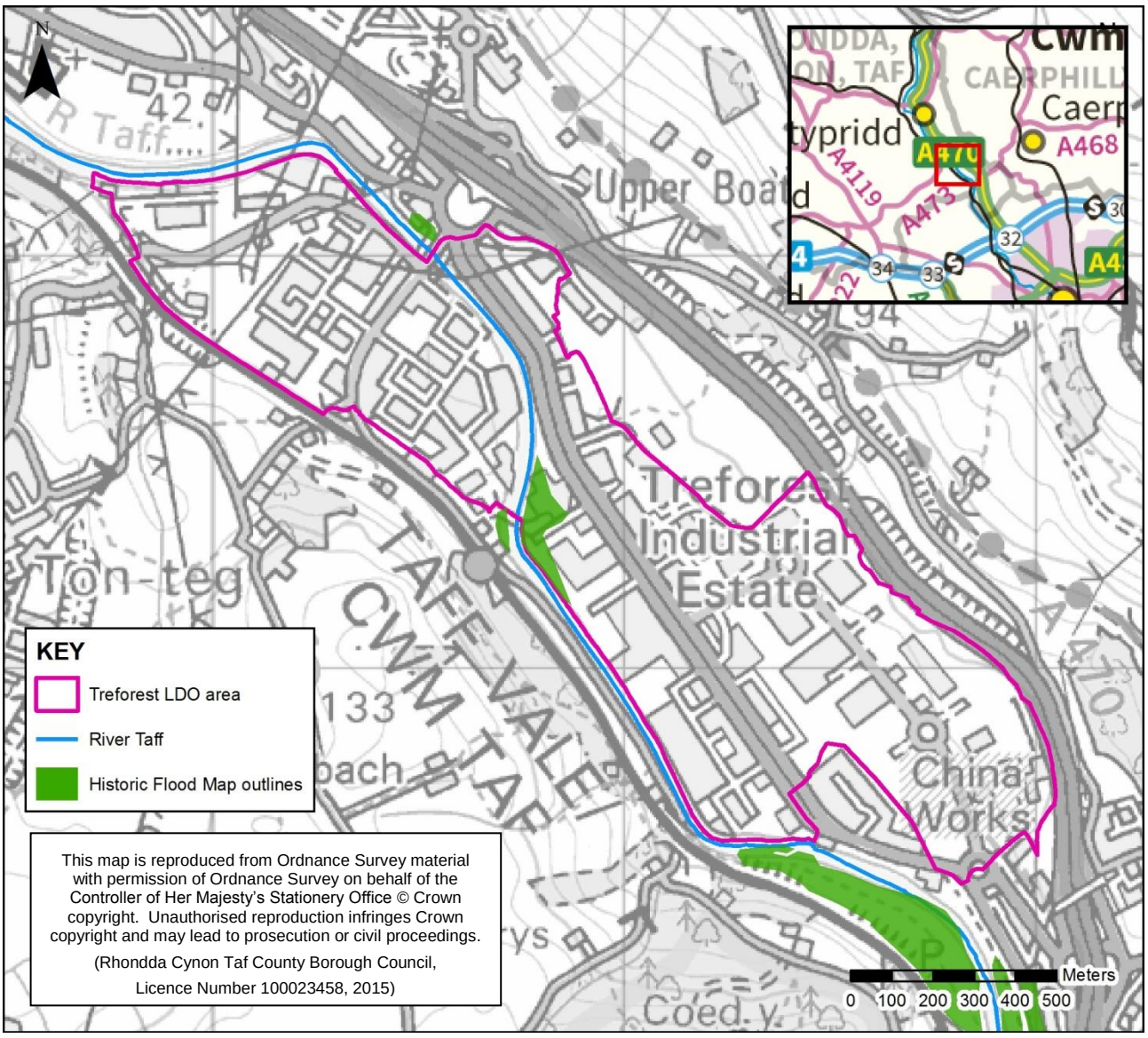
The Upper Boat modelling report, completed in 2014, indicated that surface water flooding frequently occurs on Tonteg Road during heavy rainfall events.

No groundwater flooding incidents have been reported in the SFCA, and collectively within the borough there has been little documented evidence of groundwater flooding.

Natural Resources Wales Historic Flood Map

The Historic Flood Map, provided by NRW, shows the combined extents of known flooding rivers, the sea and groundwater. The outlines for the LDO area are displayed below in Figure 4-1. This shows that there are limited recorded flood events in the Treforest Industrial Estate, with only a small patch in the central area, which appears to be a result of flooding from the River Taff.

Figure 4-1 - Historic Flood Map for the LDO area



4.3 Fluvial flooding

4.3.1 Natural Resources Wales TAN 15 Development Advice Maps

TAN 15 contains a development advice map (DAM). The DAM shows three development advice zones (A, B, C), which are attributed different planning actions. Zones A and B are areas of generally low risk (i.e. outside the main river floodplain). Zone C represents the extreme flood outline, and is further subdivided into two zones, these are:

- **Zone C1** – described as "areas of the floodplain which are developed and served by significant infrastructure, including flood defences".
- **Zone C2** – described as "areas of the floodplain without significant flood defence infrastructure.

Figure 4-1 shows the TAN 15 development advice zones across the LDO area as provided by Natural Resources Wales. Table 4-1 provides a summary of the locations covered by each of the zones within the LDO area.

Figure 4-2 - TAN 15 development advice zones in the LDO area

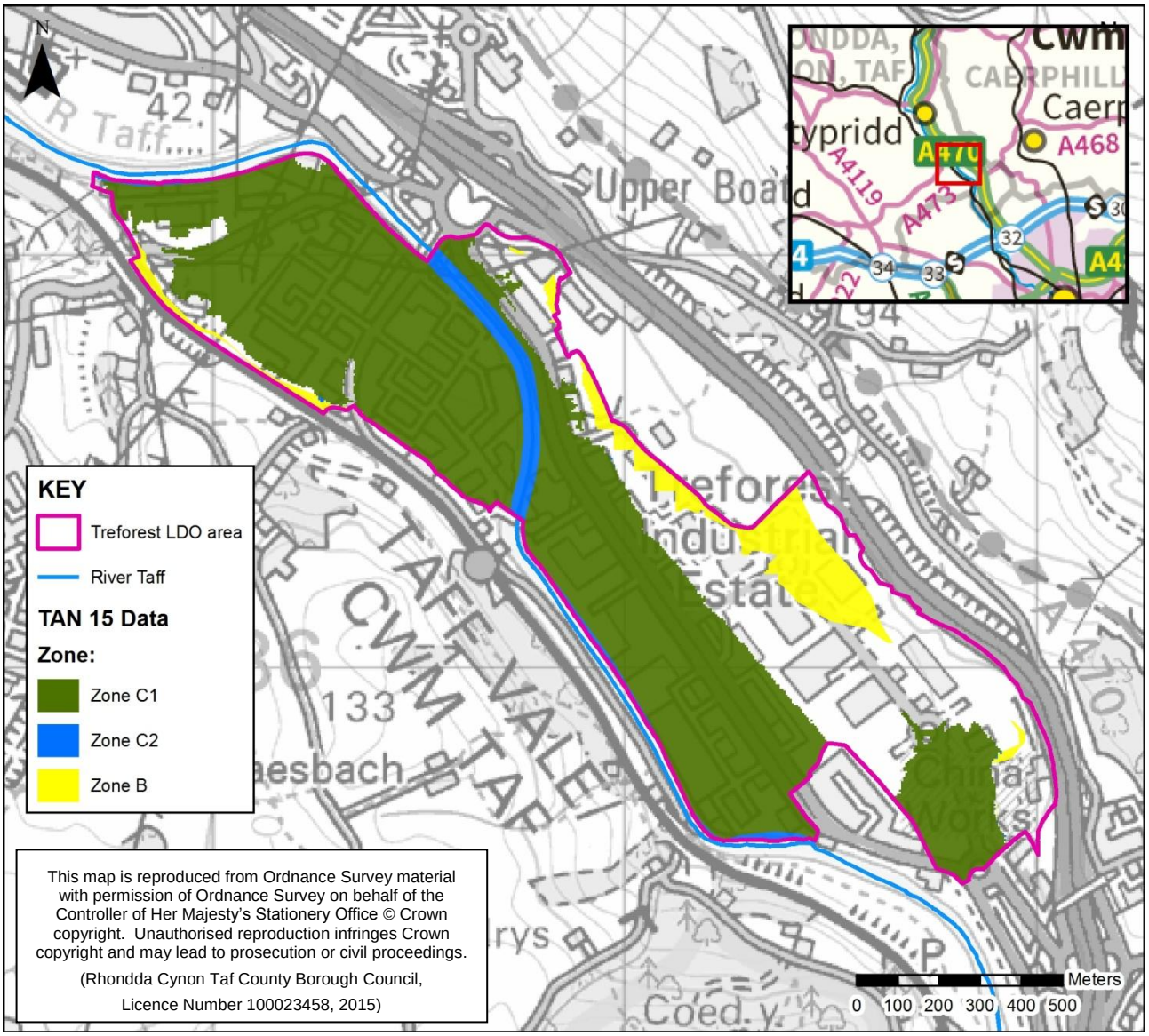


Table 4-1 - Summary of TAN 15 development advice zones in the LDO area

	Zone B	Zone C1	Zone C2
Description summary	A small part of the LDO area to the north and east of Heol Crochendy road falls within Zone B. It is likely that this is based on previously observed surface water flood events. The southern boundary along the railway line also falls within Zone B.	More than 50% of the LDO area falls within Zone C1. This includes: • the majority of the north western part of the site; • areas to the west of the old dismantled railway (in the south western section).	The central river corridor along the River Taff is within Zone C2. Within the LDO area Zone C2 does not stretch far from the central river channel corridor. This is as a result of artificial defences and raised embankments.
Area of LDO area in development advice zone	0.09km^2	0.78km^2	0.04km^2
% of total area in development advice zone	7%	60%	3%

As advised by NRW, it should be noted that the fluvial flooding within this SFCA has been assessed further using the modelled flood outlines (described in the following sections), as this provides more updated information on the fluvial flood risk in the LDO area. The TAN 15 DAMs have been included here for reference only and any future planning considerations should use the information in the following sections and that in Chapter 5.

4.3.2 Detailed hydraulic modelling

Natural Resources Wales completed the Lower Taff Velocity and Depth Mapping study in December 2011. The aim of the study was to undertake hydraulic modelling of the River Taff between Treforest and Llandaff North for the purpose of velocity depth mapping and subsequent revision of the flood warning arrangements.

The model was developed using ISIS-TUFLOW. A number of defences along the River Taff were incorporated into the model, including those in the south west of the LDO area. The study produced flood extents, depths, velocity and hazard maps for a range of flood frequencies, including, 20%, 10%, 5%, 2%. 1.5%, 1%, 1% plus climate change, 0.5% and 0.1% annual exceedance probability (AEP) for the defended scenario. Flood extents were also produced for the 1% and 0.1% for the undefended scenario.

This section provides greater detail than the TAN 15 development advice zones and should be used to inform any planning decisions. For the purposes of this study the defended results have been mapped and analysed. The results of the hydraulic model outlines have been summarised in Table 4-2. Figure 4-3 displays the flood outlines from all the flood frequencies modelled. Maps showing the depths and velocities are included in Appendix A.

Overview - The raised embankment along the left bank (eastern side) of the channel defends the area up to approximately the 1% AEP event. Flood risk is significantly less in the south eastern defended part of the site as a result of the defences. Flooding in the north western part of the site is extensive, with some areas at risk from the 5% AEP event. Flood velocities and depths are much greater in the less defended north western part of the LDO area.

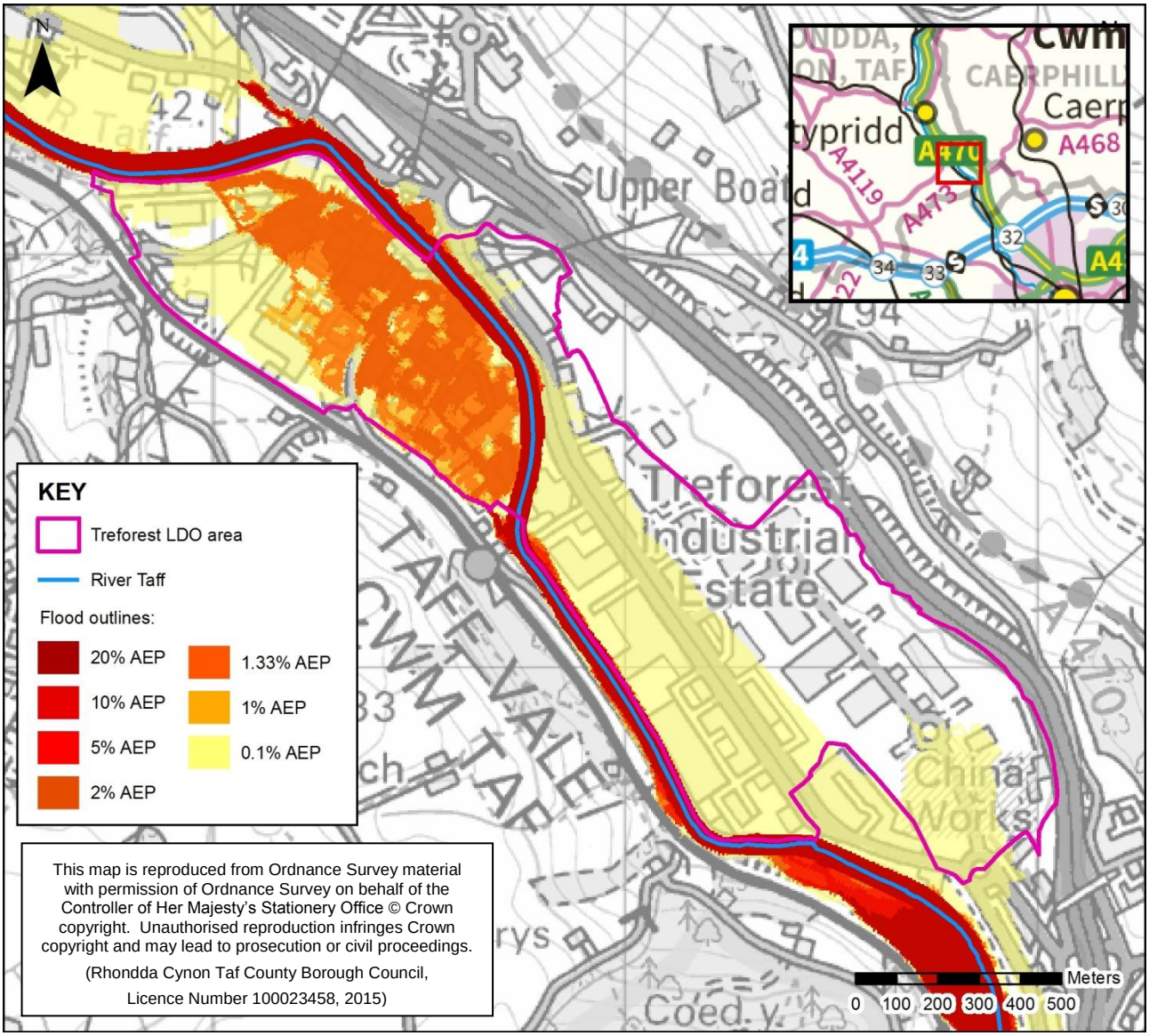
Table 4-2 – Analysis of results from detailed hydraulic modelling

Flood frequency	Outlines	Depth	Velocity
OVERVIEW	The raised embankment along the left bank (eastern side) of the channel defends the area up to approximately the 1% AEP event. Flood risk is significantly less in the south eastern part of the site as a result of the defences. Flooding in the north western part of the site is extensive, with some areas at risk from the 5% AEP event. Flood velocities and depths are much greater in the less defended north western part of the LDO area.		
20% AEP	The area covered by the 20% AEP flood outline is 53,900 m^2 (4.2% of total LDO area)	Not applicable as flows remain within the channel.	Not applicable as flows remain within the channel.
10% AEP	The area covered by the 10% AEP flood outline is 57,600 m^2 (4.5% of total LDO area)	Not applicable as flows remain within the channel.	Not applicable as flows remain within the channel.
5% AEP	The area covered by the 5% AEP flood outline is 212,200 m^2 (16% of total LDO area)	Not applicable as flows remain within the channel.	Not applicable as flows remain within the channel.
2% AEP	The area covered by the 2% AEP flood outline is 282,800 m^2 (22% of total LDO area)	Flooding is expected to occur only in the north western part of the LDO area. Flood depths are expected to be shallow (below 0.45 m), except at the low point by Severn Road, where depths reach 0.5 m	Only the Tonteg Road and Taffs Mead Roads are predicted to flood during this event, velocities are predicted to reach over 0.45 m/s. Most of the flooding otherwise is within bank and there is little risk to buildings.
1.33% AEP	Flood extents not available for this AEP event.	Shallow flood waters are predicted to inundate a large proportion of the north western part of the site, including roads and buildings. Flood depths are increased near the Powys Road bridge.	There is further increased risk along Severn Road, Bridge Road and Ford Road where velocities exceed 0.45 m/s. Elsewhere velocities are mostly between 0.15 – 0.3 m/s. There is fluvial risk to some of the buildings within the Treforest Industrial Park.

1% AEP	The area covered by the 1% AEP flood outline is 617,300 m^2 (48% of total LDO area)	Flooding across the north western part of the site is similar to the 1.33% AEP event, however some areas in between the buildings reach up to 0.6 m in depth.	During this event, there is increased risk to buildings and roads within 300m of the River Taff in the north west part of the area. Many of the roads are expected to be subject to faster (>0.45 m/s) floodwaters. Velocities are greatest in areas closer to the river channel.
1% AEP + climate change	The area covered by the 1% AEP + CC flood outline is 826,000 m^2 (64% of total LDO area)	During this event, there is significant flooding across much of the LDO area. In the north western part, depths are predicted to exceed 0.6 m, with some of the areas along Tonteg, Taffs Fall and Ford Road exceeding 1 m. The southern part of the LDO area is predicted to flood during this event, with parts of St Davids Close and Main Avenue at Upper Boat predicted to exceed 0.6 m.	The climate change scenario shows a significant increase in flood risk from fast moving flood waters across most of the north western part of the LDO area. Many of the buildings within the Treforest Industrial Estate are expected to be at high risk, with velocities exceeding 0.45 m/s in many areas. Parts of the southern half of the site are expected to flood during this event, with the Main Avenue and areas of upper Boat exposed to faster moving flood water.
0.5% AEP	The area covered by the 0.5% AEP flood outline is 772,400 m^2 (60% of total LDO area)	Most of the north western part of the LDO site is at significant risk of deep water flooding greater than 0.6m. Most of the buildings are at risk of flooding. Depths are greatest in the very northern part of the site. In the southern half of the LDO area, some buildings and roads to the south of the police station are at risk of shallow flooding.	The 0.5% AEP event is predicted to be less extensive than the 1%AEP plus climate change event. Many of the roads and buildings in the north western part are likely to be at high risk of moderately fast moving flood waters.
0.1% AEP	The entire LDO area is covered by the 0.1% AEP flood outline (100% coverage)	During this event, the entire site to the west of the dismantled railway is at severe risk of very deep flooding; with depths exceeding 1m. To the east of the old railway, there remains very little flood risk, with only a small corner in the southern most part at	All of the areas to the west of the old dismantled railway except for a few small areas in the very north west are predicted to flood during this event, with velocities exceeding 0.45 m/s across most areas, except for a few buildings. Velocities are

		risk.	greatest in areas closer to the river channel, and dissipate with distance away from the channel.

Figure 4-3 - Fluvial flood outlines from hydraulic model



4.3.3 Climate change considerations

The Welsh Government has committed to tackling climate change, citing the issue as one of the 'most important challenges facing the world'[5]. As well as committing to meet a 40% reduction in all greenhouse gas emissions in Wales by 2020 against a 1990 baseline, they set out planning policy to improve resilience to extreme weather events.

[5] Welsh Government (2014). Planning Policy Wales

The Welsh Government advises that local planning authorities should locate development in settlements that are resilient to the effects of climate change. However, where developments take place in areas of known risk, local planning authorities should ensure that the design of the development is resilient over its lifetime (100 years for residential and 75 years for non-residential development). Furthermore, settlements should minimise land-take (especially extensions to the area of impermeable services), provide sustainable urban drainage and incorporate good design to ensure on-development adaptation [6].

The twin track approach aims to address both the causes and consequences of climate change, whilst recognising that climate change is largely unavoidable and resilience planning is key in reducing the vulnerability of the built environment in Wales. Planning policy states that consideration of the impacts of climate change should use the latest set of UK Climate Change Projections and Risk Assessment within scenario planning.

Future climate change projections indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long duration rainfall are to be expected. Wales can expect to see more severe flooding and coastal erosion in the future[7]. Winters are expected to be wetter and summers expected to be dryer.

Ongoing research by the UK Climate Projections (UKCP09) Programme[8] help to inform fluvial flood risk in response to climate change. Increased rainfall, particularly high intensity rainfall events are likely to increase fluvial flood risk, and a precautionary approach is recommended such that future flood event scenarios are considered when managing fluvial flood risk. Further comments surrounding managing surface water flood risk are included in Chapter 6.

It is recommended that any future fluvial flood modeling or management / flood risk management plan documents, should use the 1% AEP plus climate change scenario to analyse future flows and surface water flood risk. The UKCP 09 projects of rainfall and temperature were used to develop river flood flows projection for a standard catchment within river basin districts (RBD). The LDO area is located in the River Severn RBD). The anticipated changes to river flood flows for this RBD are shown in Table 4-3. The table also includes an additional scenario (H++), which represents an extreme change where the consequences of rare events could be extreme (above those predicted for a standard catchment). In certain sensitive or contingency planning situations these extreme values could be considered.

Table 4-3 - UKCP09 Change factors to flood flows for the Severn River Basin District

Parameter	Estimates	2020s	2050s	2080s
Peak river flow	H++	40%	55%	100%
	Upper end estimate	25%	40%	70%
	Change factor	10%	20%	25%
	Lower end estimate	-10%	-5%	0%

Source: Environment Agency. Adapting to climate change: advice for flood and coastal erosion risk management authorities.

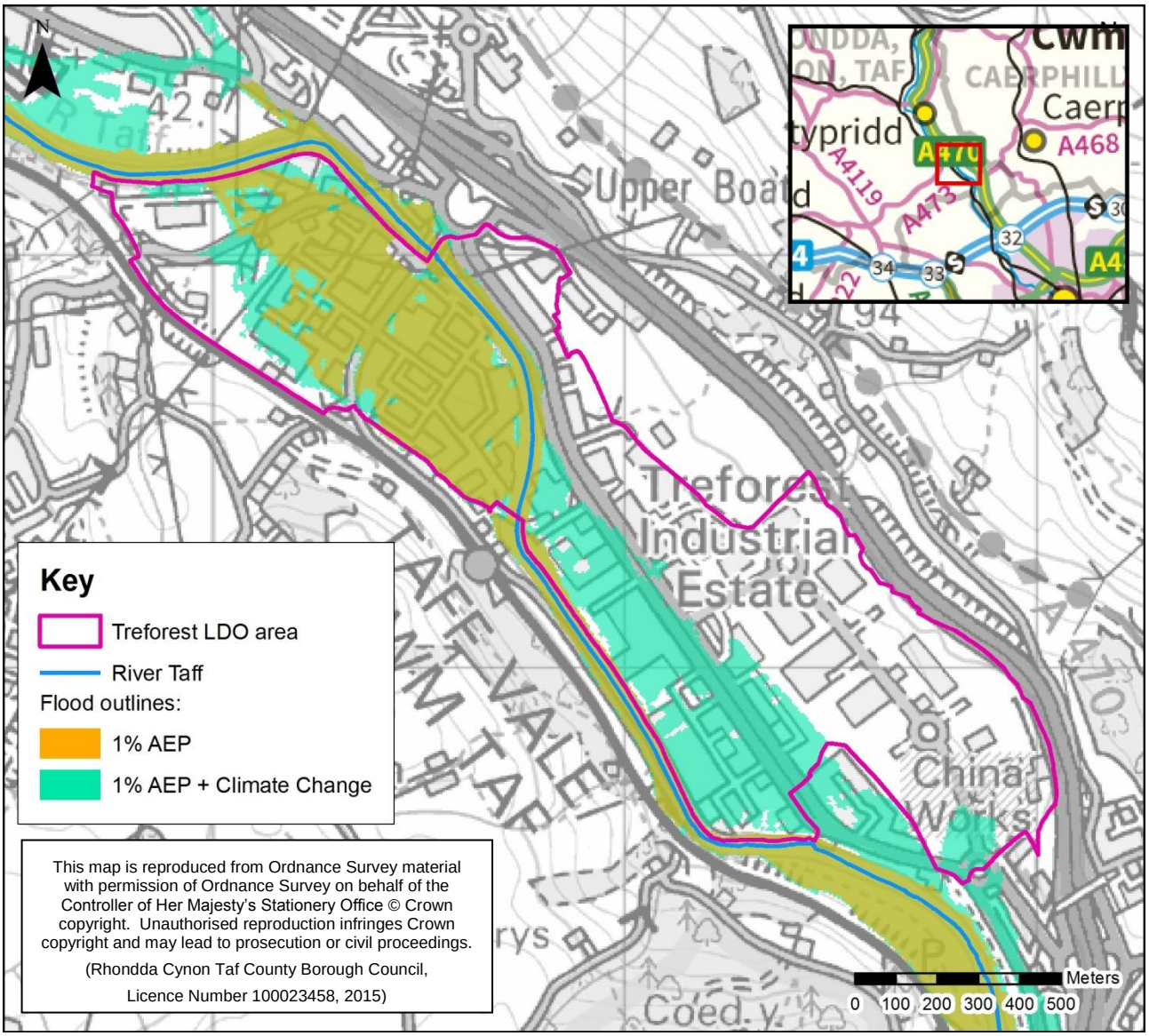
[6] Welsh Government (2014). Planning Policy Wales. Also cited is the Practice Guidance – Planning for Sustainable Buildings.

[7] Welsh Government (2011). National Strategy for Flood and Coastal Erosion Risk Management in Wales https://www.gwynedd.gov.uk/en/Residents/Documents-Residents/Parking,-roads-and-travel/Flood-and-Coastal-Risk-Management/National-strategy-for-flood-and-costal-erosion-risk-mamagement-in-Wales.pdf

[8] UK Climate Projections (2009), Maps and Key Findings, http://ukclimateprojections.metoffice.gov.uk/21708

The modelled climate change scenario compared to the 1% AEP flood event is shown in Figure 4-4. Maps showing the depths and velocities are included in Appendix A.

Figure 4-4 – Climate change flood outlines from hydraulic modelling



The Lower Taff velocity and depth mapping study (Mott Macdonald, 2011), which underpins the modeling used in this study, used a 100-year + Climate Change scenario. Whilst it was not apparent from the main report what climate change factor was used, the study noted that the 100-year + Climate Change scenario had a greater flow than for the 200yr event and upstream extents were similar to that of the 200yr event. Studies of this type have typically used +20% as the climate change factor.

4.4 Surface water flooding

4.4.1 Updated Flood Map for Surface Water (2013)

NRW updated the Flood Map for Surface Water (uFMfSW) in 2013, post-dating the production of the RCT flood risk studies including the SFCA (2008), PFRA (2011) and LFRMS (2013). The uFMfSW is the third generation national surface water flood map and provides more detailed hydrological modelling using several rainfall events, a higher resolution DTM and manual edits to the DTM to better represent flow routes and road networks. NRW have provided the uFMfSW dataset, which shows areas that are at risk of surface water flooding for the 3.3% AEP, 1% AEP and 0.1% AEP event outlines. These categories have been used to broadly assess which areas are at higher risk of surface water flooding.

It is important to note that quantifying surface water flood risk depends on many other factors, including antecedent conditions and drainage maintenance conditions. Historic records of surface water flooding may indicate an increased risk; however, attention to the problems in these areas may change the associated risk through time.

The uFMfSW dataset has been used to identify the key areas within the LDO area that are susceptible to surface water flooding. These are identified below and shown in Figure 4-5. Table 4-4 further discuses the level of flood risk across the LDO area.

- The Upper Boat substation;
- Between Severn Road and Gwaelod-Y-Garth Road;
- Land adjacent to the Riverside Industrial Park along Bridge Road;
- Along the Main Avenue where The Willowford and St David's Close adjoin; and
- Land adjacent to Heol Pardoe
- The main roads at risk include Tonteg Road, Gwaelod-Y-Garth Road, Taffs Fall Road, Ford Road, Main Avenue, Heol Crochendy, Heol Pardoe and St David's Close

When evaluating the uFMfSW, it is important to consider the method used to derive the flood outlines. Roads are lowered, and buildings are elevated, to represent flow along the roads confined by kerbs.

Figure 4-5 - Surface water flood risk in the LDO area

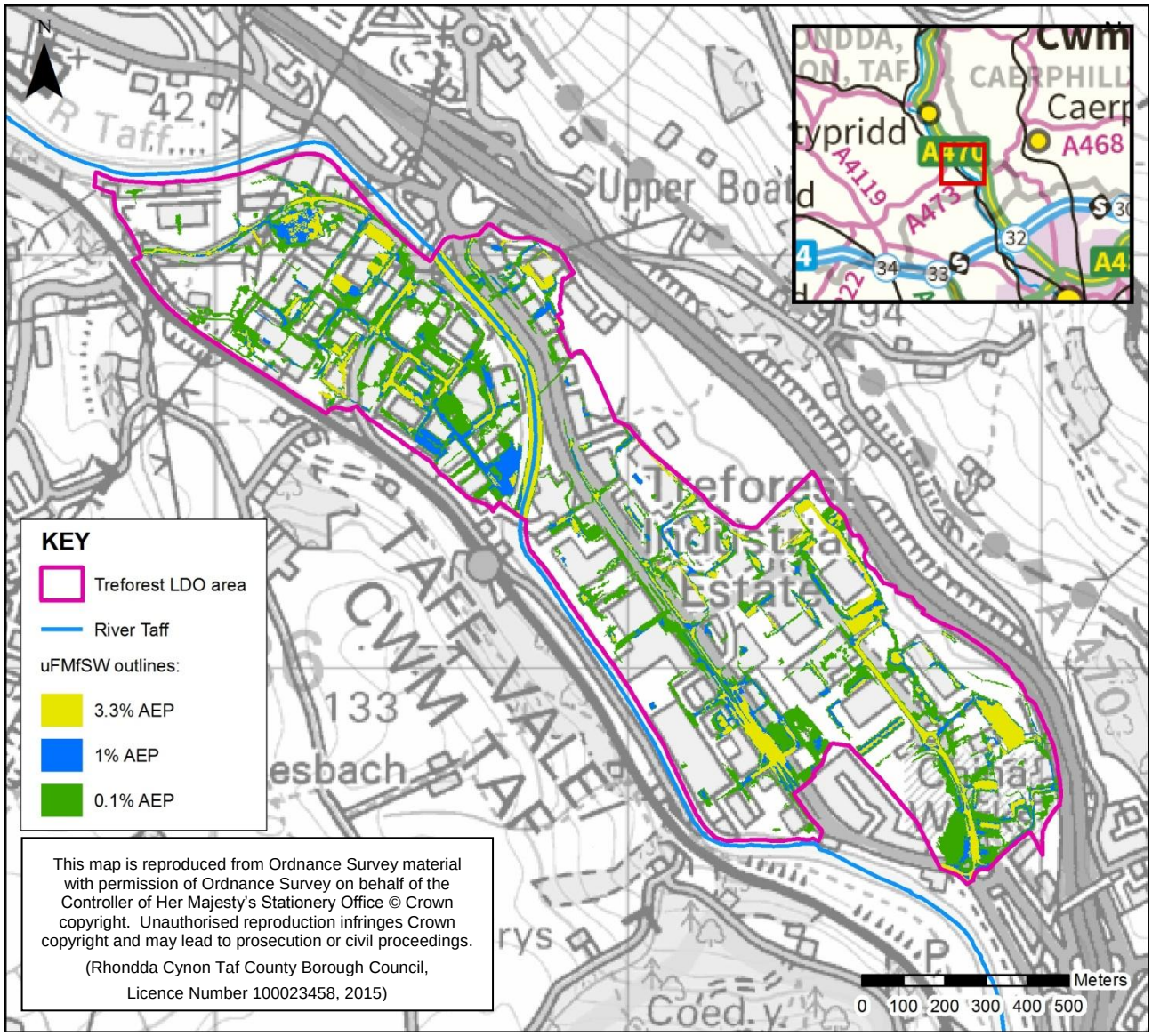


Table 4-4 – Surface water flood risk within the Treforest LDO area

3.33% AEP	1% AEP	0.1% AEP
The areas shown at risk of flooding during this event are classified as high risk areas. Main Avenue at Upper Boat is at high risk, where surface water flooding of the road network has potential to prohibit movement through the area. Roads within Pare Nantgarw and Quarry are also at high risk. In the north western industrial Estate, Ponteg Road, Gwaelod-u-Garth Road and Taffs road are at high risk. 8.4% of the LDO area is at high risk of flooding, most of this coverage is of the road network.	The areas shown at risk of flooding during this event are classified as medium risk areas Flooding during the 1% AEP event is more widespread than the 3.33% AEP event with some areas of open space at medium risk. In the southern half of the LDO site, Heol Crochenoy, Main Evenue and Powys Road are the main roads at medium risk. Some of the acess and egress routes to the buildings and units are shown to be at risk of flooding. In the north western part, medium risk areas ar mostly constrained to roads, with some small areas of open space at medium risk, particularly between Severn Road and Gwaelod-u-Garth Road. 14.3% of the LDO area is at medium risk of flooding.	Whilst the flood extents of the 0.1% AEP event are very large, this is an exceptionally rare event, and as the probability of occurrence is very low, these areas are considered to be at low surface water flood risk. A large proportion of the open space and road networks in the southern half of the area are at low risk of flooding, including Main Evenue and Heol Crochendy Road. In the north western part, most of the areas of open space are at low risk of surface water flooding. 30.5% of the study area is at risk of flooding from the 0.1% AEP event.

4.4.2 Climate change considerations

Future climate change projections indicate that more frequent short- duration, high intensity rainfall and more frequent periods of long duration rainfall are to be expected. Whilst ongoing research by the UK Climate Impacts Programme will help inform coastal erosion and fluvial flood risk in response to climate change, there is currently little evidence surrounding the impacts on surface water flood risk.

Increased rainfall, particularly high intensity rainfall events are likely to increase surface water flood risk, and a precautionary approach is recommended such that future flood event scenarios are considered when managing surface water flood risk. Further comments surrounding managing surface water flood risk is included in Chapter 6.

It is recommended that any future surface water modelling or management / flood risk management plan documents, should use the 1% AEP plus climate change scenario to analyse future flows and surface water flood risk.

4.5 Groundwater flooding

4.5.1 Areas Susceptible to Groundwater Flooding (NRW)

The Areas Susceptible to Groundwater Flooding (AStGWF) dataset, provided by NRW, is a strategic scale map showing groundwater flood areas on a 1km square grid[9]. It was produced by the Environment Agency for use by LLFAs for use in Preliminary Flood Risk Assessments. It is important to note that this is a susceptibility dataset, where geological and hydrogeological conditions indicate where groundwater might emerge. It does not indicate flood hazard or the risk of groundwater occurring.

For the purposes of this SFCA, groundwater flood risk analysis has been based on the AStGWF dataset and by evaluating the underlying geology.

The superficial geology mainly comprises of river terrace alluviums, consisting of sands and gravels deposited in the channel and across the floodplain. The underlying bedrock geology is permeable Birthdir Member sandstone, sedimentary bedrock also laid down by rivers.

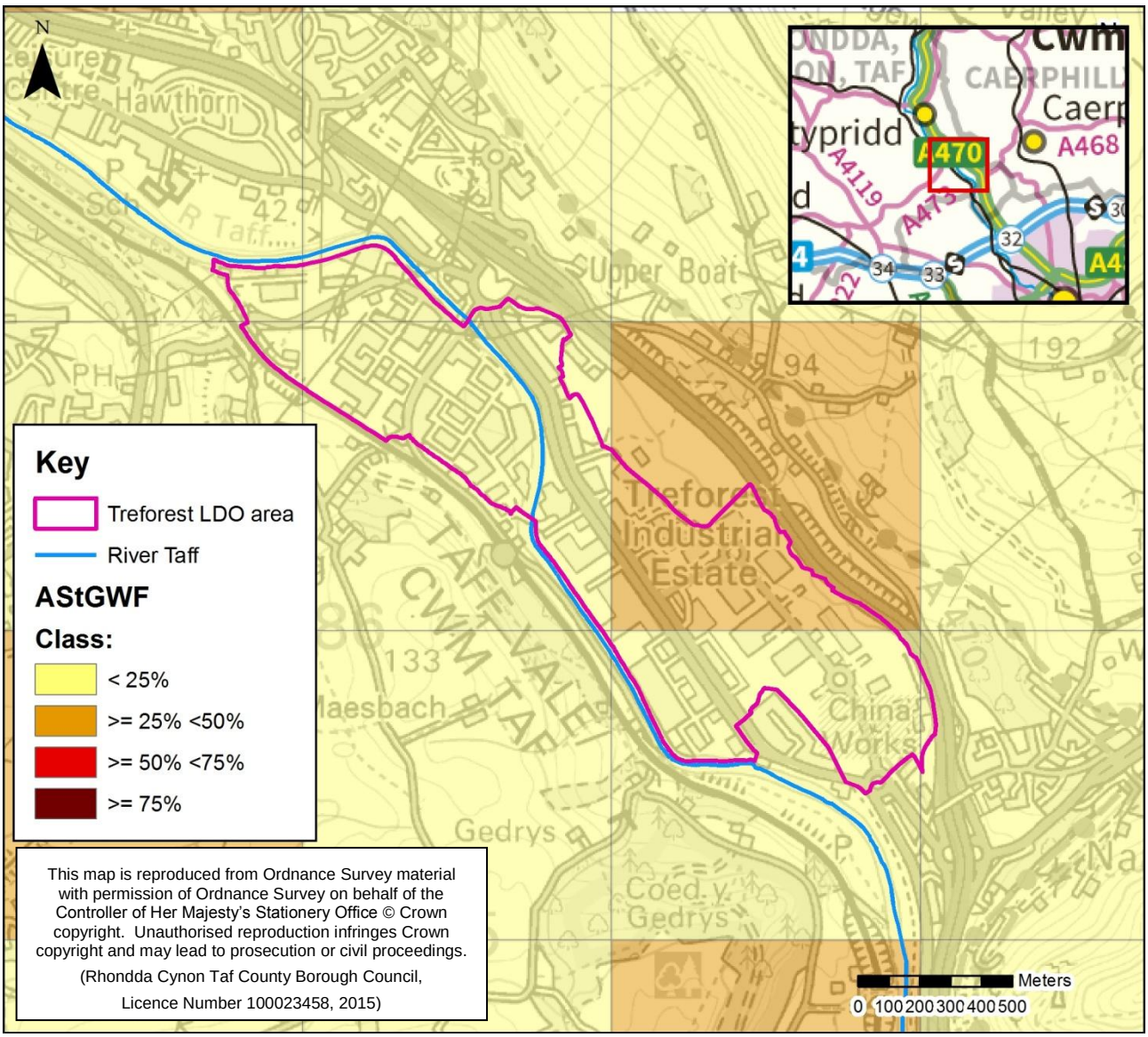
The combination of the permeable bedrock and superficial deposits, mean that water can move and be stored in the underlying ground, which can lead to increased groundwater flood risk. Combined with a high water table due to close proximity to the River Taff, it is thought that there is a moderate risk of groundwater flooding across the LDO area. Monitoring the level of the water table through borehole log measurements could further improve the understanding of groundwater flood risk across the LDO area.

Figure 4-6 shows the AStGWF map, which identifies the susceptibility category of the 1 km^2 grids for the LDO area. These categories show the proportion of each grid square that is susceptible to groundwater emergence. As the figure shows, most of the site is identified as low risk, with less than 25% of the areas at risk of groundwater emergence. There is increased groundwater flood risk in the central eastern part of the site, where between 25 and 50% of the grid square may be susceptible to groundwater flooding.

Due to the coarse nature of this dataset, and the permeable nature of the geology, further development plans should consider the susceptibility to groundwater flooding.

[9] Environment Agency (2010). Areas Susceptible to Groundwater Flooding – guidance document.

Figure 4-6 - Areas susceptible to groundwater flooding



4.5.2 Climate change considerations

There is currently very little research specifically considering the impact of climate change on groundwater flooding. The mechanisms of flooding from aquifers are unlikely to be affected by climate change, however if winter rainfall becomes more frequent and heavier, groundwater levels may increase. Higher winter recharge may however be balanced by lower recharge during the predicted hotter and drier summers.

4.6 Reservoir flooding

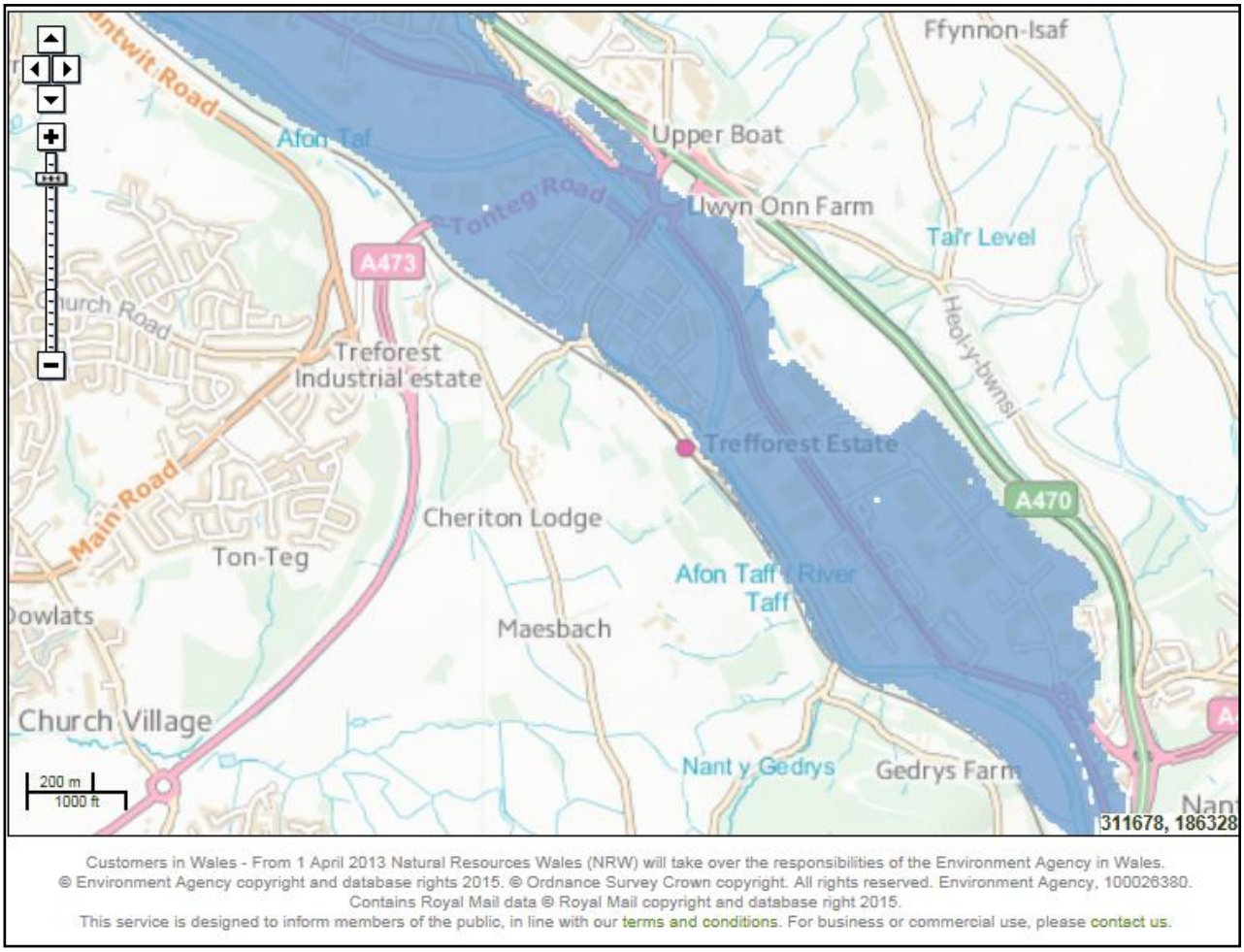
4.6.1 Risk of flooding from reservoirs (online map)

For the purpose of this SFCA, flooding from reservoirs has been defined as that arising from failure of reservoir embankments. To understand flooding from artificial sources the Environment Agency 'Risk of Flooding from Reservoirs' interactive online map[10] has been used. The map shows the maximum flood outline predicted should the reservoirs fail and release all of the water they hold.

According to the online information there are four reservoirs that could affect the LDO area; Beacons, Cantref Pontsticill (Taf Fechan) and Llwyn-On. For each of these the "risk designation" is set as "to be determined". Figure 4-7 is a screenshot showing the interactive map for the area, which displays the largest area that could be flooding if a reservoir were to fail and release all of its water. The following figure (Figure 4-8) shows the associated predicted flood depths.

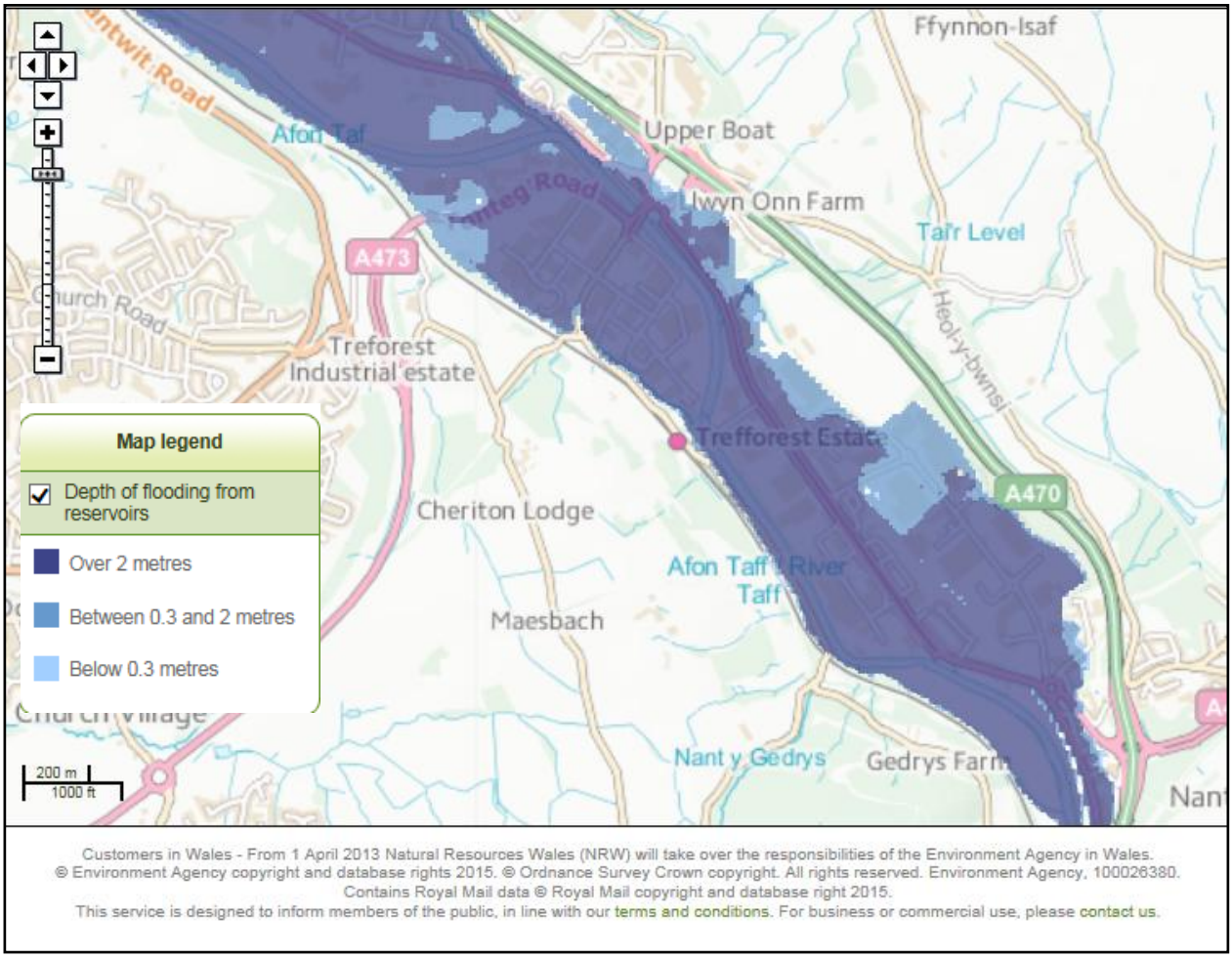
[10] http://watermaps.environment-agency.gov.uk/wiyby/wiyby.aspx?lang=_e&topic=reservoir&layer=0&x=310500&y=186500&scale=10&location=Treforest+Industrial+Estate%2c+Rhondda%2cCynon%2cTaff#x=310443&y=186433&scale=10

Figure 4-7 - Risk of Flooding from Reservoirs (online map)



(Source: http://watermaps.environment-agency.gov.uk)

Figure 4-8 - Depth of flooding from reservoirs



(Source: http://watermaps.environment-agency.gov.uk)

Reservoir flooding is extremely unlikely to happen; there has been no loss of life in the UK from reservoir flooding since 1925. Although potentially large uncontrolled releases of water from the reservoirs could result in deep fast moving floodwaters and place people's lives in danger, the probability of occurrence is very low and therefore flood risk is considered low.

4.7 Sewer flooding

4.7.1 DG5 records (Dwr Cymru, Welsh Water)

DG5 records were unavailable at the time of issue.

5 LDO area development classes and flood risk advice maps

5.1 Overview

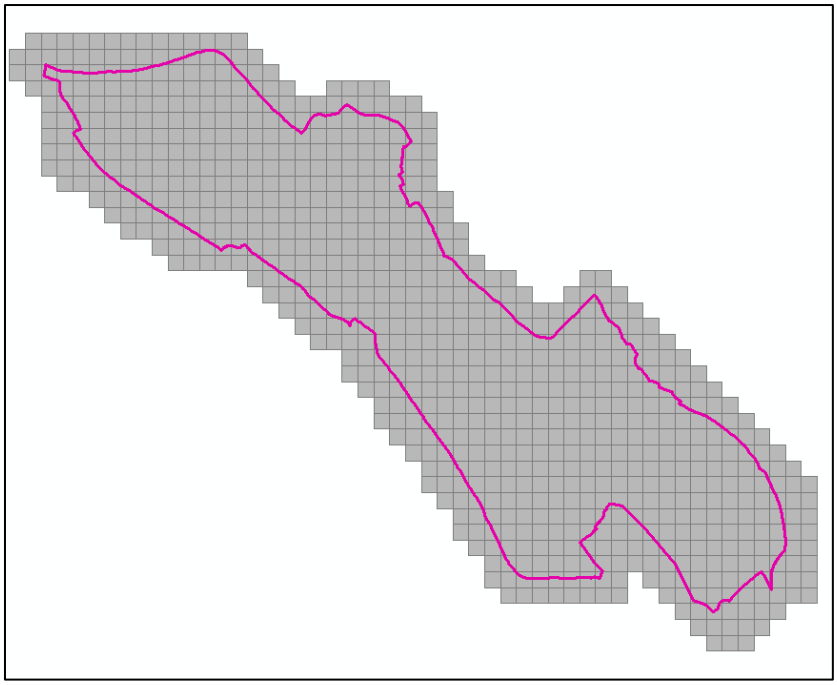
To provide a means of guiding future development within the Treforest Industrial Estate LDO area, a bespoke assessment has been undertaken. The purpose of this bespoke assessment was to provide guidance for the redevelopment of vacant sites and buildings and changes to use of buildings.

The total LDO area has been categorised, based on fluvial flood risk, into four generalised hazard 'zones', integrating fluvial flood depths and velocities for a number of flood event frequencies, using hydraulic modelling information. Indicative advice maps have been produced using these 'zones' to help inform the development classes that would be permitted by the LDO within the Treforest Industrial Estate LDO area. At the time of issue of this report, these areas are still undergoing further review and refinement, and as such should be considered preliminary. The following sections describe the methodology and presents the indicative LDO advice map.

5.2 Methodology

This section describes the process used to develop the LDO advice map. The first step used to develop the map was to divide the Treforest Industrial Estate LDO area into a series of 50m^2 sub-areas (see Figure 5-1). For further details on the selection of 50m^2 for the grid size, please refer to Appendix B.

Figure 5-1 - Division of Treforest Industrial Estate LDO into 50m^2 grids



Using the hydraulic modelling results from the Lower Taf Velocity and Depth Mapping Study, the maximum flood depth and maximum velocity for each of the flood frequencies was assigned to each of these 50m^2 sub-areas. The flood frequencies used in this process includes 20%, 10%, 5%, 2%. 1.5%, 1%, 1% plus climate change, 0.5% and 0.1% annual exceedance probability (AEP). Note that only defended model outputs have been used in this process to replicate the actual risk.

The next step was to assign a flood hazard rating to each of these sub-areas. The degree of hazard for each sub-area was determined using the flood depths and velocities (for all flood frequency events) and guidance provided in TAN 15 and the Flood Risks to People Methodology (FD2321/TR1[11]) and its supplementary note[12]. By examining flood hazard across this wide range of return periods ensures that hazard is not only considered for the typical 1% AEP or 1% plus climate change events, but also flood events that will occur with much greater frequency in the Treforest Industrial Estate study area.

With the predicted maximum depth and velocity identified for each sub-area, the Hazard to People Classification was determined using the standard Hazard Rating calculation. The Hazard Rating was calculated using the following formula:

Hazard Rating (HR) = d x (v + 0.5) + DF)

Where:

d - depth (m)

v - velocity (m/s)

DF - Debris Factor

When calculating the hazard rating a Debris Factor of 0.5 was assumed for flood depths <0.25m and a Debris Factor of 1.0 was assumed for greater flood depths. These assumptions were in line with the methodology from FD2320/TR2 technical guidance. The resulting hazard ratings for a small sample of the sub-areas is reproduced below in Table 5-1.

Table 5-1 - Hazard ratings for each flood frequency event for a sample number of sub-areas

Sub-area code	Hazard Ratings									
	Flood frequency									Average
	20% AEP	10% AEP	5% AEP	2% AEP	1.5% AEP	1% AEP	1% +CC AEP	0.5% AEP	0.1% AEP	
K2	17.1	18.7	19.8	21.6	21.8	22.5	24.1	24.1	31.0	22.3
K3	0.0	0.0	0.0	1.5	1.8	2.2	4.5	4.0	9.4	2.6
K4	0.0	0.0	0.0	0.0	0.6	0.6	2.5	2.1	6.5	1.4

[11] Defra and Environment Agency (2006). The Flood Risks to People Methodology.

[12] Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1.

An issue that was identified with this approach as it stands is that when averaging flood hazard across the various return period flood events the hazard from the 1% AEP flood event and greater magnitude events would tend to skew the result. To adjust this issue and ensure that the hazard from more frequent flood events was given greater consideration, a weighting factor was applied to the hazard ratings, as shown in Table 5-2. Further details regarding selection of these weighting factors is provided in Appendix B.

Table 5-2 - Flood hazard rating weighting factors

Flood frequency	20% AEP	10% AEP	5% AEP	2% AEP	1.5% AEP	1% AEP	1% +CC AEP	0.5% AEP	0.1% AEP
Weighting factor	7.3	4	2.3	1.3	1.2	1.1	1	0.75	0.25

Following application of these weighting factors, the selected hazard ratings from Table 5-2 above have been modified to the weighted hazard ratings and applied to each sub-area. The revised hazard ratings for the sample sub-areas are shown in Table 5-3.

Table 5-3 - Weighted hazard ratings for each flood frequency event for a sample number of sub-areas

Sub-area code	Hazard Ratings									
	Flood frequency									Average
	20% AEP	10% AEP	5% AEP	2% AEP	1.5% AEP	1% AEP	1% +CC AEP	0.5% AEP	0.1% AEP	
K2	125	75	46	29	25	24	24	18.0	7.7	41.6
K3	0	0	0	2.1	2.1	2.3	4.5	3.0	2.3	1.8
K4	0	0	0	0	0.7	0.7	2.5	1.5	1.6	0.78

Once weighting factors were applied to the flood hazard values, the weighted average was taken across each of the return period flood events to provide a representative hazard value for the sub-area. This process was applied across each of the sub-areas to provide a comprehensive assessment of flood hazard across the Treforest Industrial Estate LDO area.

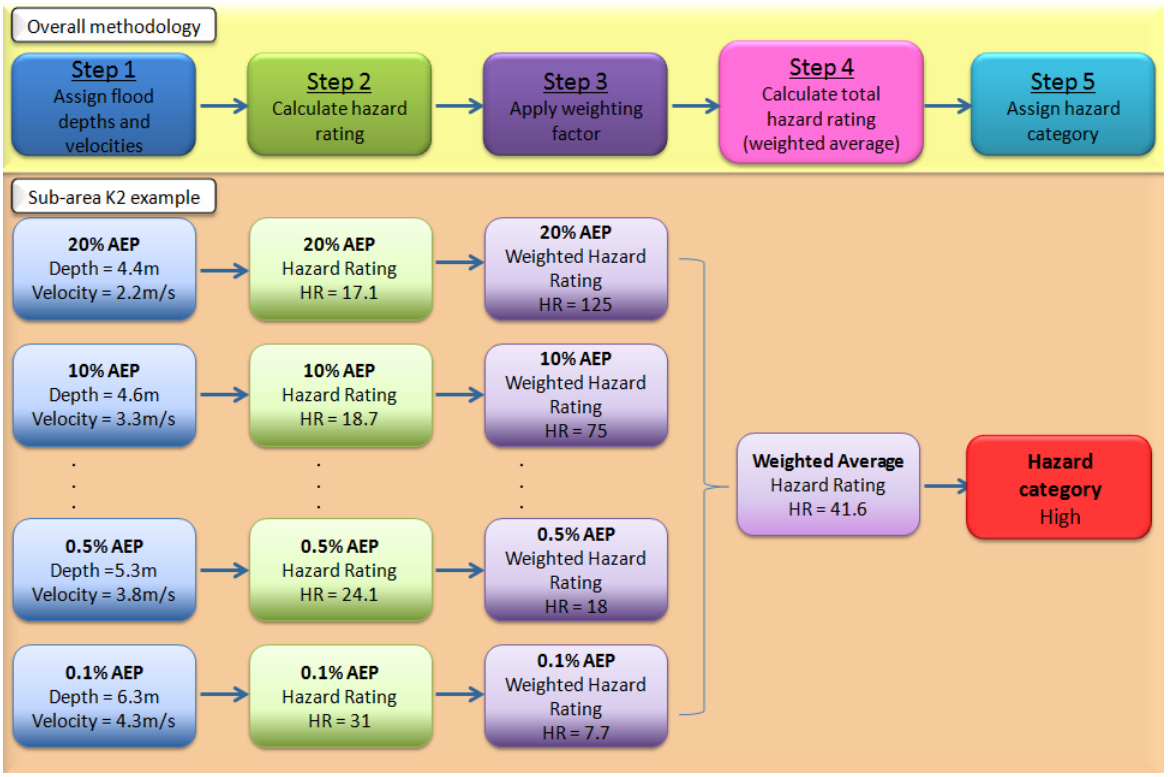
The bespoke hazard rating values were then used to establish thresholds for categorizing the hazard zones as Zone 1, Zone 2, Zone 3 and Zone 4 based upon the value of the Hazard Rating for selected return period events. The return period events selected include the 1 in 20 year event, the 1 in 100 + CC year event and the 1 in 1000 year return period events. A summary of the hazard categories and corresponding zones are provided in Table 5-4.

Table 5-4 - Hazard categories based on the hazard to people classifications

LDO Hazard Categories	Return Period Thresholds	Colour code	LDO Flood Hazard Zones
Each year, there is a chance of flooding of less than 1 in 1000 (<0.1% AEP)	HR = 0 for 0.1% AEP event		Zone 1
Each year, there is a chance of flooding of between 1 in 100+CC and 1 in 1000 (between 1%+CC – 0.1% AEP)	HR > 0 for 0.1% AEP event		Zone 2
Each year, there is a chance of flooding between 1 in 20 and 1 in 100+CC (between 5% - 1%+CC AEP)	HR > 0 for 1%+CC event		Zone 3
Each year, there is a chance of flooding of greater than 1 in 20 (>5% AEP)	HR > 0 for 5% AEP event		Zone 4

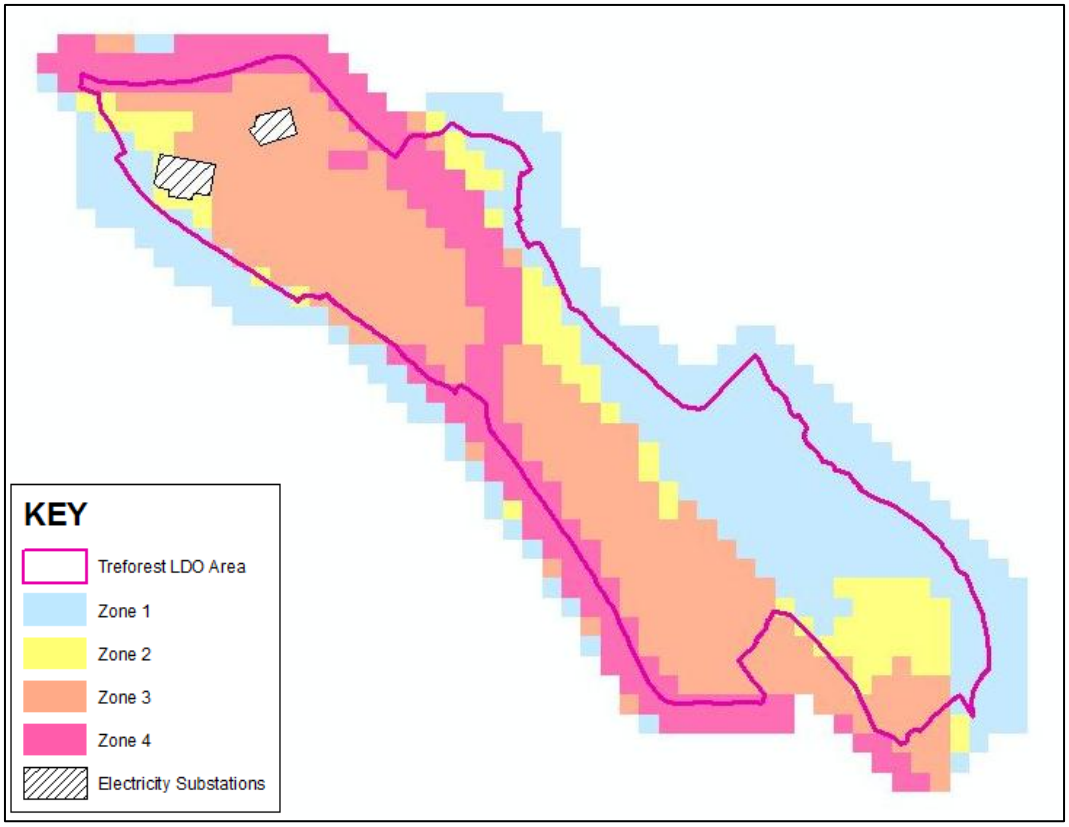
The overall methodology is summarised in the figure below using the sub-area K2 as an example.

Figure 5-2 - Overall methodology (showing sub-area K2 as an example)



The resultant hazard map, displayed by the 50m^2 sub-areas for the Treforest Industrial Estate is provided in Figure 5-3 below. The final stage of the process is to then group the areas with the same hazard categories to produce the LDO area advice map as described in the next section.

Figure 5-3 – Treforest Industrial Estate LDO hazard map (using 50m^2 sub-areas)



The final stage in the process is to essentially re-draw this gridded hazard map into 'zones' and then identify the development classes that may be suitable in each zone. Refer to the following section to review an indicative LDO Advice Map and associated development advice.

5.3 Indicative LDO advice map

As seen in Figure 5-3 above, the LDO area hazard map identifies distinct bands of hazard categories within the industrial estate. These hazard bands were grouped into four distinct zones, shown in Figure 5-4, below.

Figure 5-4 – Indicative Treforest Industrial Estate LDO advice map

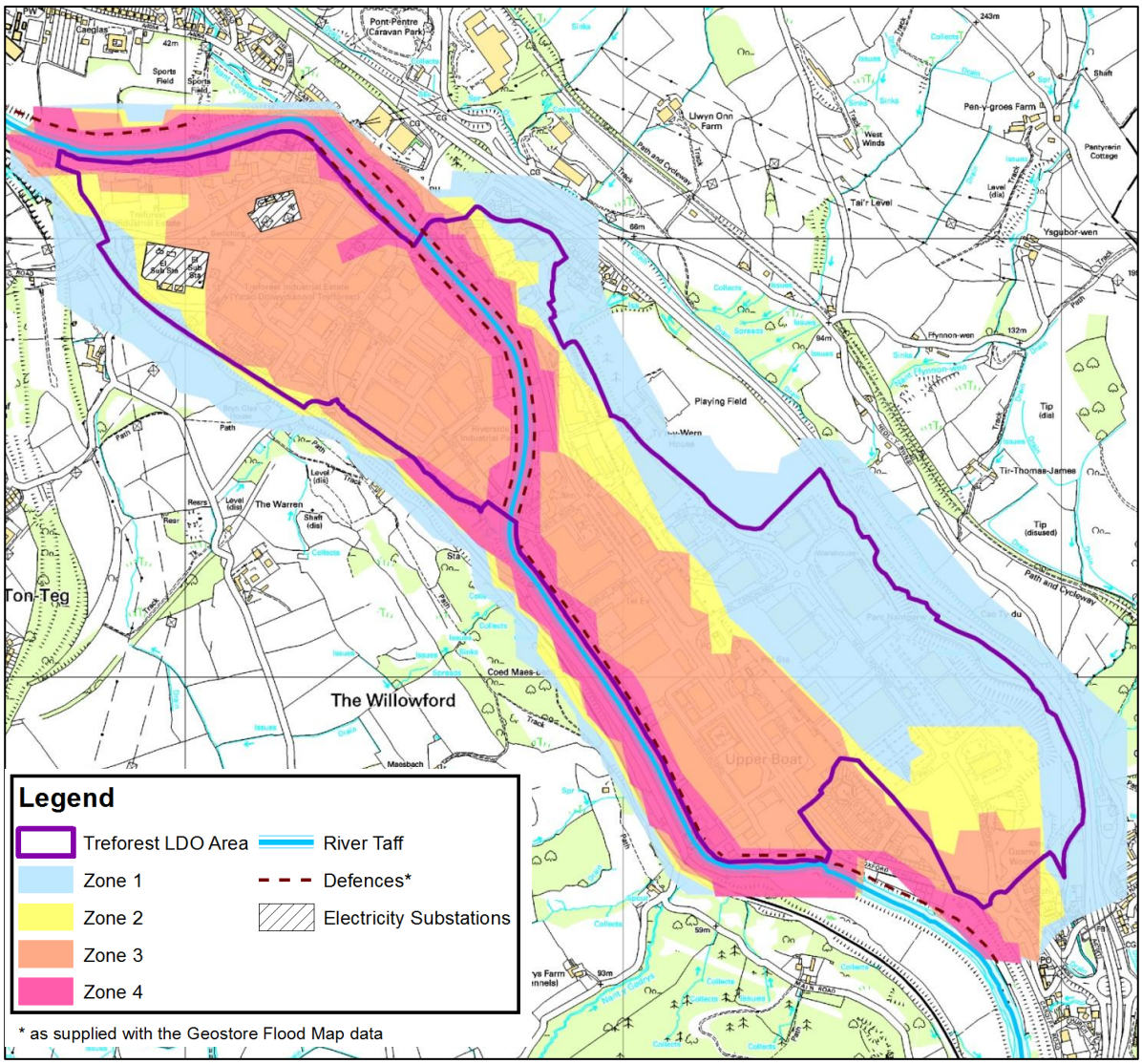


Figure 5-4 provides an indicative map that can be used to guide development decisions within the Treforest LDO. At the time of publication, further assessment work is ongoing to refine the Zones identified in Figure 5-4 and to produce associated development advice. For further details regarding further assessment work, refer to Chapter 7 Conclusions and Recommendations.

Prior to any proposed development within the Treforest LDO Rhondda Cynon Taf CBC and NRW should be consulted to verify the Zone(s) and requirements associated with development proposals.

5.4 Management of fluvial flood risk

5.4.1 Overview

Flooding from rivers occurs when water levels rise higher than bank levels, causing floodwater to spill across adjacent land (floodplain). Managing flood risk requires attention to the source of flooding (such as slowing upstream run-off), the pathway of flooding (such as directing flood water downstream or to attenuation areas) and the receptors (such as ensuring properties are flood resilient).

Fluvial flooding is the main source of flooding within the LDO area. The LDO area is bisected by the River Taff, which flows through the LDO area in a north-south direction towards its outfall into Cardiff Bay.

There are flood defences located along parts of the River Taff, which includes a section of the LDO area (see Figure 2, Appendix A). The hydraulic modelling (see section 4.3.2) included these flood defences in the development of the flood extents. The Standard of Protection of the defences varies across the LDO area and this was established for the model by determining the lowest point for each raised defence and the return period when the freeboard at that particular location was less than 0.25m for hard defences and 0.5m for soft defences.

As a result, the raised embankment along the left bank (eastern side) of the channel currently defends the area up to approximately the 1% AEP flood event. Flood risk is significantly less in the south eastern defended part of the site as a result of the defences. Flooding in the north western part of the site is more extensive, with some areas at risk from the 5% AEP flood event, where a low standard of protection has been provided. Flood velocities and depths are much greater in the less defended north western part of the LDO area. The extent of the flooding expected is described in section **Error! Reference source not found.**. Historical flood event information is described in section **Error! Reference source not found.**.

5.4.2 Approach to fluvial flood risk management

The Rhondda Cynon Taf Local Flood Risk Management Strategy[13] (2013) outlines 38 measures to manage flooding in the area. Measure 32 explains a statutory requirement to publish Flood Risk Management Plans by December 2015. These will assess, map and develop action plans to manage flood risk. The Strategy states that 'it should be stressed that the plan will consider a holistic approach to flood risk management and will not be solely reliant on traditional structural flood risk solutions' (Rhondda Cynon Taf, 2013).

Measure 26 of the Rhondda Cynon Taf Local Flood Risk Management Strategy (2013) is to raise awareness of the techniques available to reduce flood damages at the point of flood repair. Meanwhile, measure 27 outlines the need to encourage property owners to install individual property measures and preparedness strategies.

As per measure 24, outline requirements for capital flood defence works will be identified initially through Flood Risk Management Plans in December 2015. This process will outline in detail the investment options considered, appraised and chosen to manage flood risk in the area.

[13] http://www.rctcbc.gov.uk/en/relateddocuments/publications/flooding/localfloodriskmanagementstrategyv1.pdf

5.4.3 Future works

There are already four projects in the pipeline for funding[14] in the area. Three of these relate to maintenance of existing structures, including assessment and repair whilst one relates to a small capital project in Hawthorn/Treforest, to the north of the Industrial Estate, which is expected to begin construction in 2021. **Error! Reference source not found.** outlines the projects which expect to receive Grant in Aid funding. More information on the design and outcomes of these investments are not currently available on the Natural Resources Wales or Rhondda Cynon Taf websites. We expect that more information will be provided publicly as part of the Flood Risk Management Plans, which are due to be published in December, 2015.

5.5 Management of surface water flood risk

5.5.1 Overview

Key areas within the Treforest Industrial Estate LDO area susceptible to surface water flooding were identified in Section 4.4. These areas were identified using the updated Flood Map for Surface Water (FMfSW), supplied by NRW.

It is recommended that as part of its efforts at mitigating flood risk within the Treforest Industrial Estate Rhondda Cynon Taf CBC take steps to ensure that surface water flood risk is not increased as a result of redevelopment or intensification within the industrial estate and that betterment should be sought for redevelopment within these areas. These recommendations are consistent with existing policy and guidance, including TAN 15, which specifies that "*redevelopment [is] to reduce run-off where possible.*"

One of the primary means of enhancing the management of surface water within the Treforest Industrial Estate is through the use of sustainable drainage systems (SuDS). The following sections provide an overview of SuDS, opportunities and constraints within the industrial estate and guidance on how to ensure the best outcomes from implementing SuDS. This guidance includes promoting the right types of SuDS, signposting to design and construction resources, and ensuring adequate adoption and maintenance protocols are put in place to ensure SuDs practices perform as per the intended design.

5.5.2 What are SuDS?

The SuDS approach is centred on mimicking natural drainage. SuDS encourages the management of water as close to its source as possible, using features that collect, filter, store and/or infiltrate water using mechanisms similar to that found in nature. SuDS practices should be designed taking the following criteria into consideration:

- water quantity;
- water quality; and
- amenity/biodiversity.

[14] Natural Resources Wales (2014), Welsh Investment Plan, 2014https://www.naturalresourceswales.gov.uk/flooding/managing-flood-risk/our-capital-investment-programme-for-rivers-and-the-coastline/?lang=en

Water Quantity

SuDS practices can play a key role in managing surface water through two mechanisms: runoff rate and storage volumes. As SuDS features often utilise pervious surfaces, they reduce runoff rates from the site compared to conventional development comprised primarily of impervious surfaces. SuDS can also help supplement the volume of water that must be stored on-site (attenuation volume) to achieve the desired runoff rate from the site. SuDS practices can store and/or infiltrate surface water into the surrounding soil, providing the necessary for attenuation storage for frequent rainfall events.

Water Quality

SuDS techniques help to improve surface water quality through the use of a 'Management Train,' which recommends incorporating a chain of techniques throughout a development, (as outlined in CIRIA C697, Woods Ballard *et al*, 2007), where each component adds to the performance of the whole system. The Management Train approach consists of four stages:

1. **Prevention** - good site design and upkeep to prevent runoff and pollution (e.g. limited paved areas, regular pavement sweeping)
2. **Source control** - runoff control at/near to source (e.g. rainwater harvesting, green roofs, pervious pavements)
3. **Site control** - water management from a multitude of catchments (e.g. route water from roofs, impermeable paved areas to one infiltration/holding site)
4. **Regional control** - integrate runoff management from a number of sites (e.g. into a wetland).

Amenity/Biodiversity

As SuDS techniques can be integrated within the fabric of a site, they provide opportunities to create amenity areas and improve the site's biodiversity. Many SuDS techniques are landscaped with grasses and/or plantings that help to create green streets, neighbourhoods and commercial/industrial properties. SuDS can also be implemented as part of multi-functional places, enabling both the management of surface water and other uses like recreation within the same space.

5.5.3 SuDS Techniques

There are a wide range of SuDS techniques available for use throughout the four stages of the Management Train. Techniques available to manage the quantity of surface water typically operate in combination or solely on the basis of the following two main principles:

- Infiltration
- Attenuation

The effectiveness of techniques in achieving the goals of attenuating discharges, reducing pollution and providing amenity benefit will depend on a number of other factors such as filtration, settlement and oxidation.

The SuDS Manual (C697)[15] provides a summary of SuDS techniques and their suitability to meet the three goals of sustainable drainage systems (water quantity, water quality and amenity biodiversity) and their suitability within the stages of the Management Train. Table 5-5 presents a summary of a variety of SuDS techniques along with their suitability in achieving the goals of sustainability and their place within the Management Train.

[15] CIRIA, The SUDS Manual (C697), March 2007

Table 5-5: Functions of SuDS techniques

Management Train	SuDS Technique	Description	SuDS Principle	Water Quantity	Water Quality	Amenity Biodiversity
Source Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	Attenuation	●	●	●
Source Prevention	Rainwater harvesting	Capturing and reusing rainwater for domestic or irrigation uses.	Attenuation	●	○	○
Source Prevention	Permeable pavements	Infiltration through the surface into underlying layer.	Infiltration	●	●	○
Source	Filter drains	Drain filled with permeable material with a perforated pipe along the base.	Infiltration	●	●	X
Source	Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	Infiltration	●	●	X
Source	Soakaway	Underground structure used for store and infiltration.	Attenuation	●	●	X
Source	Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	Attenuation	●	●	●
Source	Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	Attenuation	●	●	○
Source	Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	Infiltration	●	●	X
Site	Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	Attenuation	●	●	○
Site	Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	Attenuation	●	●	●
Site	Wetlands	Similar to ponds, but are designed to provide continuous flow through vegetation.	Attenuation	●	●	●
Regional						

Key: ● – highly suitable, ○ - suitable depending on design, X – unsuitable

5.5.4 Surface Water Management / SuDS Policies and Guidance

The planning of any surface water drainage system, including SuDS schemes, will need to take account of a range of relevant legislation, including the planning and development control system. This section provides a summary of this information as well as changes to the UK planning regime that have taken place between December 2014 and April 2015. These changes will affect the implementation of surface water management schemes (particularly SuDS) in the Treforest Industrial Estate.

Specific policies applicable to surface water drainage systems / SuDS are listed below:

- Planning Policy Wales: Technical Advice Note 15: Development and Flood Risk
- Building Regulations, Part H
- Flood and Water Management Act 2010 / Delivering Sustainable Drainage Solutions – Consultation (September 2014 – December 2014)
- Interim non-statutory standards for sustainable drainage (SuDS) in Wales

Planning Policy Wales: Technical Advice Note 15: Development and Flood Risk

Section 8 of TAN 15 sets out advice for surface water runoff from new development, including recommendations for the use of SuDS. Specific provisions relating to SuDS and redevelopment guidance applicable to the Treforest Industrial Estate include:

> **8.2** ...SuDs can perform an important role in managing run-off from a site and should be implemented, wherever they will be effective, in all new development proposals, irrespective of the zone in which they are located.
>
> **8.3** Development in one part of a catchment may increase run-off and hence flood risk elsewhere, therefore, the aim should be for new development not to create additional run-off when compared with the undeveloped situation, and for redevelopment to reduce run-off where possible. It is accepted that there may be practical difficulties in achieving this aim.
>
> **8.4** Information with regard to the appropriate mechanisms for considering SuDs is contained in the *'Interim Code of Practice for Sustainable Drainage Systems'* (2004) developed by the National Suds Working Group. Planning authorities may consider imposing a condition requiring developers to examine the SuDS option and provide the planning authority with details and options. If it is demonstrated that SuDS could work on a site, and subject to the appropriate agreements being in place with regard to adoption, then the planning authority would require SuDS to be implemented. Developers will need to give good reason why SuDS could not be implemented. If a conventional drainage system does not improve the status quo or has a negative impact then this can be a valid reason for refusal.

Building Regulations, Part H

Part H of the Building Regulations (2002) sets out technical requirements for surface water drainage. These will continue to apply within the curtilage of the property. Part H sets out a hierarchical preference for the discharge of rainwater with discharge into a sewer as the last and least preferred option. The Interim Non-Statutory Standards for Sustainable Drainage in Wales (Consultation document, February 2015) provides

standards and further guidance on application of the hierarchical approach, and application of SuDS requirements beyond the cartilage of a development.

Flood and Water Management Act 2010 / Delivering Sustainable Drainage Solutions – Consultation (September 2014 – December 2014)

Delivery of SuDS is changing in response to recent changes to the UK planning regime. Schedule 3 of the Water Management Act required new developments to include Sustainable Drainage Systems (SuDS) features that comply with national standards. The Act also called for the establishment of a SuDS Approving Body (SAB) to be set up within lead local flood authorities (LLFAs). The act mandated that:

- Construction on any project that has drainage implications cannot begin until the scheme is approved in line with national standards for sustainable drainage by the approval body (SAB);
- Upon approval and delivery the SAB will then adopt and maintain SUDS that serve more than one property; and
- There will no longer be an automatic right of connection (Section 106 of the Water Industry Act).

SAB responsibilities included:

- Review and approval of development applications;
- Construction, validation and adoption of SuDS; and
- Maintenance of adopted systems

Government consulted on the implementation of Schedule 3 from September 2014 to December 2014. On 18th December 2014 the Department for Communities and Local Government and Department for Environment, Food and Rural Affairs issued the SuDS Consultation Response (Written Statement HCWS161)[16]. This statement announced that SuDS will not be delivered as described in Schedule 3 of the Flood and Water Management Act, 2010, but be delivered through the planning system. As part of this announcement the use of SuDS Approval Bodies (SABs) as the primary mechanism for SuDS review, approval and management was dropped.

A summary of changes arising from the government's consultation is provided below:

- The LLFA becomes a statutory consultee with regard to planning applications for surface water management.
- Amendments to planning guidance will be made to set out what is expected of local planning authorities and developers when planning applications are submitted for new developments in relation to the provision of sustainable drainage systems.
- The guidance / policy would only apply to major developments of 10+ houses (or non-residential equivalent) – excluding minor development.

[16] http://www.parliament.uk/business/publications/written-questions-answers-statements/written-statement/Commons/2014-12-18/HCWS161/

- Planning conditions would be set to ensure sustainable drainage systems are maintained for their lifetime. Responsibility for adoption and maintenance of the scheme is left open for the Local Planning Authority to agree with the developer – Options include, but are not limited to, the following:
    - Service Management Companies (including Charitable Trusts)
    - Water and Sewerage Companies
    - Local Authorities
    - Private Individuals (property owners / occupiers)

As part of the changes to the planning regime following issuance of the SuDS Consultation Response the Department for Environment Food and Rural Affairs published Non-statutory Technical Standards for Sustainable Drainage Systems on 23 March 2015. The Planning Practice Guidance for Flood Risk and Coastal Change has also been recently (April 2015) to discuss the application of SuDS for new development. Although these documents do not apply to Wales, they are indicative of changes that may be adopted by the Welsh Government.

The Welsh Government is currently consulting on non-statutory technical standards for SuDS in Wales, with interim standards and guidance issued February 2015 with responses due by 30 April 2015. Details regarding timing and content of changes to TAN 15 to reflect the new planning regime are not known at the time of writing (mid-April 2015).

Interim Non-statutory Standards for Sustainable Drainage (SuDS) in Wales – designing, constructing, operating and maintaining surface water drainage systems, Consultation Document – issued 12 February 2015, Responses by 30 April 2015

The Interim Non-statutory Standards for SuDS consultation document provides draft standards and associated guidance for the implementation of SuDS in Wales. The Consultation response period closes 30 April 2015, after which it is assumed that a final document will be issued by the Welsh Government later in 2015.

The document contains standards and guidance organised into the following categories:

S1. Surface water runoff destination;

S2. Surface water runoff hydraulic control;

S3. Water Quality;

S4. Amenity;

S5. Biodiversity; and

S6. Design of drainage for construction, operation and maintenance.

Standard S1 (the 'Hierarchy Standard' gives criteria for prioritising the choice of runoff destination, whereas Standards S2 to S6 give design standards which state the minimum design criteria that all SuDS should satisfy and standards which state how SuDS should be constructed, maintained and operated.

The interim non-statutory standards provide advice and guidance on providing betterment of surface water management when redeveloping previously developed sites. As a majority of development within the

Treforest Industrial Estate will take place on previously developed lands, key provisions from the interim non-statutory standards are reproduced below:

> **G2.16.** For a previously developed site, where there is sufficient detail to enable an accurate simulation model to be built to represent the drainage system and contributing areas, limiting the discharge rate to significantly less than the peak rate of discharge from the existing drainage system for the 1in1 year rainfall event. The accepted discharge runoff rate should usually be the greenfield 1in1 year peak runoff rate, but where this is not possible, betterment should be a reduction to less than 70% of the existing peak system discharge rate and lower wherever practicable.
>
> **G2.16.** For a previously developed site, where there is insufficient detail to enable an accurate simulation model to be built to represent the drainage system, or the drainage system is known to no longer operate effectively, the rate of discharge should be limited to the peak greenfield rate for the site, but the soil type used for the analysis can be selected to reflect the likely higher rate of discharge from the site due to the impermeable surfaces.
>
> **G2.17** If it cannot be demonstrated that the previously developed land has a positive drainage system or the details of components cannot be ascertained even if there are known outfalls serving the site, an assumption should be made that the system is no longer operational and a greenfield analysis approach used (as above).

The Interim Non-statutory Standards for SuDS in Wales also provides direction on the adoption and maintenance of SuDS, stating “it is essential that arrangements are put in place for the future maintenance of SuDS features serving more than one property. Adoption by the local authority with suitable funding arrangements is one possible option.”

5.5.5 Constraints and opportunities for SuDS within the LDO area

The underlying ground conditions of a development site will often influence the type(s) of SuDS technique suitable at an individual site. During the design process, in addition to considering the properties of the underlying soils and strata it is necessary to also consider the sensitivity of the receiving water body and any previous uses of the site.

The use of SuDS can be limited based on a number of constraints, which include:

- Groundwater vulnerability and potential contamination of an aquifer;
- Current or target water quality of a receiving watercourse;
- The presence of groundwater Source Protection Zones and potential contamination of a potable water source;
- Restrictions on infiltration on contaminated land to prevent the spread of contamination; and,
- Restricted area on development sites where housing densities are high.

While this will need to be determined through ground investigations carried out on-site, an initial assessment of the site’s suitability to the use of SuDS can be obtained from a review of the available soils/geological survey of the area.

Much of LDO area is underlain by superficial alluvium, which is comprised of consolidated clay, silt sand and gravel. They are moderately permeable deposits, capable of supporting local water tables, and potentially forming a source of baseflow to the River Taff. The bedrock geology comprising the industrial estate is shown Figure 1-2 earlier in the report.

The British Geological Survey identifies the Brithdir and Hughes Members as comprised primarily of sandstone, with Grovesend Formation comprised of a mixture of Mudstone, Siltstone and Sandstone.

Detailed records on water table height for the region were not available, however British Geological Survey borehole records were examined at several locations across the industrial estate. A borehole located in the southern portion of the site (BGS Reference: ST18NW165) at the intersection of Heol Crochendy and Main Avenue encountered fill comprised of topsoil, concrete and brick fragments, brown clay with flaggy gravel and cobbles, followed by loose pale brown clayey fine sandy silt from grade to 2.9m below ground. Groundwater was encountered at 3.2m below ground in this area.

A borehole on Bridge Road near the western bank of the River Taff (BGS Reference: ST18NW162) encountered fill (railway ballast, grey brown sandy silty clay) up to a depth of 2.8m below ground, followed by grey silty clay with occasional gravel up to 4.0m below ground. Groundwater was first encountered at 3.8m below ground.

Near the north western boundary of the industrial estate, another borehole (BGS Reference: ST08NE345) struck groundwater at 2.5m below ground. Soil and underlying geology encountered included black sand and gravel down to 2.0m below ground. Brown sandy clay with fine to medium gravel was observed from 2.0m to 11.45m below ground at this location.

Based upon the variability of ground conditions and groundwater depths identified in the borehole records assessed for the site, it is difficult to make general assumptions regarding the performance of SuDS across the LDO area. As such, the suitability of infiltrating SuDS practices will need to be assessed on a site-by-site basis. It is recommended that a more detailed SuDS Suitability Assessment be undertaken by Rhondda Cynon Taf CBC to clearly identify the areas where infiltrating SuDS and non-infiltrating SuDS can be implemented to guide redevelopment within the Treforest Industrial Estate.

SuDS Opportunities

It is recommended that ground conditions be examined as early as possible during the development process to verify whether infiltrating SuDS practices are suitable given a site's soil, geology and depth to groundwater. These tests should include infiltration testing. If ground conditions are suitable (i.e., infiltration rates are in excess of 1.0×10^{-3} m/s and other suitability criteria are met[17]) infiltrating SuDS should be implemented to the greatest extent possible to improve surface water management across the industrial estate.

If ground conditions do not support the implementation of infiltrating SuDS practices for a particular site, there are numerous alternatives that should be implemented instead. Sustainable drainage can be achieved through the use of the following techniques:

- Ponds;
- Swales; and
- Wetlands

The above methods do not rely on infiltration into the ground, but continue to provide the benefits associated with SuDS, including improved water quality and amenity/biodiversity benefits. These practices also provide

[17] SuDS for Roads. 2009. WSP Development and Transportation.

a water quantity function – providing a means for the attenuation of surface water, as part of a surface water management scheme for a particular development.

The large roof surfaces and low densities of the industrial estate also present opportunities for other SuDS practices – particularly green roofs and rainwater harvesting. These practices provide numerous benefits, including reduced heat island effect and reduced roof runoff from green roofs and reduced potable water consumption from the use of rainwater for non-potable applications like toilet flushing and outdoor watering. Further guidance on how to implement SuDS in the Treforest Industrial Estate is provided in the following section.

5.5.6 Implementation of SuDS within the Treforest Industrial Estate

Pre-Application Consultation with the LLFA

It is recommended that developers should consult Rhondda Cynon Taf CBC in its role as LLFA and LPA, NRW, and relevant service authorities and Dwr Cymru Welsh Water at the earliest stage of the development process to establish the best solution for a particular site. The flexibility of SuDS allows it to be placed throughout a site, to meet a variety of criteria and be integrated within the urban fabric means that it is suitable for a wide range of land use types. Often a successful SuDS solution will utilise a number of techniques in combination, providing flood risk, water quality and landscape/wildlife benefits to the site and surrounding area. This following sections provides some guidance on how to incorporate SuDS techniques as part of the master planning and outline planning stages. It has been adapted from C687 Planning for SuDS.

Examine site topography and geology

As part of the pre-application and outline planning stages it is recommended that all sites undergoing redevelopment have site ground conditions examined. These investigations should include borehole testing for water table depths and structural suitability as well as infiltration testing to assess site-specific infiltration rates. This information can then be used to identify where, and what type(s), of SuDS practices can be located on site.

Create a spatial framework for SuDS

The next step in the planning process is to develop an estimate of impermeable (paved roadway and buildings) and permeable surface across the site. This information is used to assess pre- and post-development runoff rates and volume, from which attenuation storage/infiltration targets can be set. The number, type(s) and size of SuDS practices can then be determined as part of the surface water management scheme at the site.

Look for multi-functional spaces

A common concern with incorporating SuDS in developments is the belief that all SuDS are ‘land hungry’ and significantly impact on the developable area of sites. By applying the principles discussed above, SuDS can be considered at the earliest opportunity, ensuring that they are integrated within the site using as little land as possible, whilst creating multi-functional spaces that improve the amenity value of the property.

Implementing SuDS as part of road improvement works

Additional benefits can be achieved if SuDS are also implemented during any roads work associated with redevelopment of the Treforest Industrial Estate. It is recommended that whilst planning roads / highways improvements in the industrial estate, SuDS be considered early in the planning stages by Rhondda Cynon Taf CBC, the Highways Service, DCWW and the major landowner. Examples of SuDS practices that can be implemented with roads include swales, which can be located along the road network to accept street runoff, tree planters, rain gardens and bioretention techniques which can be used to create 'green streets' that improve the amenity of industrial estate. Large below-ground storage/infiltration practices can also be located beneath the street network, space permitting.

5.5.7 Adoption and maintenance of SuDS

The Interim Non-statutory Standards for SuDS in Wales provides direction on the adoption and maintenance of SuDS, stating "it is essential that arrangements are put in place for the future maintenance of SuDS features serving more than one property. Adoption by the local authority with suitable funding arrangements is one possible option." These discussions should take place at the earliest possible stage of the development process to ensure the best solution for a particular site.

The direction provided by the Interim Non-statutory Standards for SuDS in Wales should also take into consideration changes to the planning regime as part of government's Delivering Sustainable Drainage Solutions – Consultation (September 2014 – December 2014). The SuDS Consultation Response directed that responsibility for adoption and maintenance of the scheme is open for the Local Planning Authority to agree with the developer.

Options that may be pursued by Rhondda Cynon Taf CBC for adoption maintenance of SuDS include, but are not limited to:

- Service Management Companies (including Charitable Trusts);
- Water and Sewerage Companies;
- Local Authorities; and
- Private Individuals (property owners / occupiers).

When considering the adoption and long-term maintenance of SuDS techniques, it is important to emphasize that many SuDS techniques rely upon vegetation/landscaping as the primary means of managing surface water runoff. As such, the majority of SuDS techniques can be maintained as part of a typical landscape management process, which entails tasks like litter collection, grass cutting, and visual inspection of any inlets or outlets to look for blockages.

5.5.8 Further Guidance on SuDS

For further information on SuDS, refer to the following guidance documents:

- CIRIA C687 Planning for SuDS – Making it Happen (2010)

- Communities and Local Government – Guidance on the Permeable Surfacing of Front Gardens (2008)
- CIRIA C697 The SUDS Manual (2007)
- CIRIA C698 Site Handbook for the Construction of SuDS (2007)
- BRE 365 Soakaway Design (2007)
- CIRIA C635 Designing for Exceedance in Urban Drainage – Good Practice (2006)
- CIRIA C609 Sustainable Drainage Systems – Hydraulic, structural and water quality advise (2004)
- Interim Code of Practice for Sustainable Drainage Systems (2004)

5.5.9 Management of sewer flooding

Flooding from sewers or urban areas can theoretically be managed with engineering works for any size event. However such works are not always economically or environmentally sustainable. Improvements to urban drainage can also lead to rapid rainfall runoff into rivers, increasing flood risk downstream and potentially transporting contaminants. TAN 15 recommends that Sustainable Urban Drainage Systems (SuDS) are used to decrease the probability of flooding by limiting the peak demand on conventional drainage infrastructure.

5.6 Emergency planning

Councils have a duty to warn and inform its residents of the risk and implications of flooding (Civil Contingencies Act, 2004) meanwhile Natural Resources Wales have a duty to provide flood forecasting information. Early warning systems are able to make a positive difference to flood damages, as they warn residents to move valuable assets away from risk where it is possible.

Alongside early warnings, emergency planning provides critical first response to prevent and reduce harm. A command and control system is in place, managed by the Rhondda Cynon Taf Flood Review Group, to organize the different agencies responsible for risk response. The group also has a duty to arrange joint training and exercising.

The Rhondda Cynon Taf Local Flood Risk Management Strategy[18] (2013) outlines 38 measures to manage flooding in the area. Measure 6 is related to flood warnings. In this, it states that a flood response plan for warning dissemination shall be in place. In this local media outlets and door knocking will be used to warn residents. The Council's Call Centre will be used to receive flood related calls and calls will be transferred between the Council, Natural Resources Wales and Welsh Water depending upon the type of flooding. Furthermore, measures 7, 8 and 9 plans for emergency response plans, community plans and multi-agency plans for all sources of flood risk to be completed and rolled out.

[18] http://www.rctcbc.gov.uk/en/relateddocuments/publications/flooding/localfloodriskmanagementstrategyv1.pdf

6 Conclusions and Recommendations

6.1 Conclusions

Rhondda Cynon Taf CBC commissioned Capita Property and Infrastructure to prepare an area wide SFCA for the Treforest Industrial Estate LDO area. The SFCA was aimed at supporting regeneration within the Treforest Industrial Estate LDO area. An assessment of flood risk and hazard constraints and opportunities was undertaken for the site and guidance was developed with the aim of providing a greater degree of planning certainty for the redevelopment of vacant sites and buildings and changes of use of buildings within the site.

Flood risk was assessed from all sources. Surface water flood risk was assessed using the uFMfSW. The uFMfSW indicates that approximately 8.4% of the LDO area is at high risk of flooding, with the majority of this area falling within the road network. The remaining areas at risk from surface water include 14.3% of the site at medium risk, and 30.5% of the study area is at risk of flooding from the 0.1% AEP event. A majority of the site is identified as at low risk of groundwater flooding, with less than 25% of the areas at risk of groundwater emergence. The site is at risk of flooding from a reservoir breach.

Fluvial flooding is the primary source of flood risk within the Treforest Industrial Estate LDO area. More than half of the LDO area falls within area classified as Zone C1 / C2 as per the TAN 15 development advice zones, with 60% of the site area classified as Zone C1, and 3% identified as Zone C2. Approximately 7% is the site is classified as Zone B. Area classified as Zone C1 lies largely within the north western part of the site as well as areas to the west of the old dismantled railway (in the south western section). This report includes a description and assessment of the updated model outputs generated as part of the Lower Taff Velocity and Depth Mapping study. It is recommended that future planning considerations within the Treforest Industrial Estate LDO use these outputs to supplement the TAN 15 DAMs.

As part of efforts at mitigating flood risk within the Treforest Industrial Estate Rhondda Cynon Taf CBC should take steps to ensure that surface water flood risk is not increased as a result of redevelopment or intensification within the industrial estate and that betterment should be sought for redevelopment within these areas. These recommendations are consistent with existing policy and guidance, including TAN 15, which specifies that "*redevelopment [is] to reduce run-off where possible.*"

Sustainable Drainage Systems (SuDS) are recommended as a primary means of improving surface water management within the LDO area. A high-level SuDS review found that ground conditions are variable throughout the site, making it difficult to make general assumptions regarding the performance of SuDS across the LDO area. It is recommended that the suitability of infiltrating SuDS practices be examined through infiltration testing as early as possible during the development process, and where suitable, infiltrating SuDS should be implemented to the greatest extent possible.

Fluvial flood risk mitigation measures have been identified in the Rhondda Cynon Taf Local Flood Risk Management Strategy (2013), and more detailed Flood Risk Management Plans are anticipated by December 2015. These will assess, map and develop action plans to manage flood risk and will consider a holistic approach to flood risk management and will not be solely reliant on traditional structural flood risk solutions.

To assist with guiding future development within the Treforest Industrial Estate LDO a bespoke flood hazard assessment was undertaken for the site. This assessment identified a number of indicative Zones within the LDO area where development conditions may be specified by Rhondda Cynon Taf CBC and Natural

Resources Wales (NRW). Flood hazard mapping and associated development conditions are currently undergoing further assessment and review by Rhondda Cynon Taf CBC and NRW.

6.2 Recommendations and Next Steps

The bespoke flood hazard assessment undertaken for the site has identified a number of indicative LDO Flood Hazard Zones where development conditions may be specified by Rhondda Cynon Taf CBC and Natural Resources Wales (NRW). It is recommended that these Zones undergo further review and refinement to aid with redevelopment of the Treforest Industrial Estate LDO area.

It is recommended that a sensitivity analysis be undertaken to further understand the sensitivity of the indicative Zones (and future development within them) to flood hazard. As part of this sensitivity analysis a number of vacant and potentially underused sites within the LDO area (approximately 16 sites) can be reviewed to assess potential changes in the water levels across the site and to give an indication of finished floor levels. A broad assessment of areas within the Treforest LDO area that could be used to offset flood volumes as part of floodplain compensation analysis should also be undertaken.

The outputs from this sensitivity analysis are yet to be determined, but could include revised LDO Flood Hazard Zones, or another means of grouping areas or sites within the Treforest Industrial Estate under similar types of flood hazard to guide future redevelopment decisions.

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Glossary

Term	Definition
Alluvium	Sediments deposited by fluvial processes / flowing water
Annual Exceedance Probability (AEP)	The probability of an event occurring within any one given year.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Breach	An opening – For example in the sea defences
Brownfield	Previously developed land, usually of industrial land use within inner city areas.
Catchment Flood Management Plan	A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert/culverted	A channel or pipe that carries water below the level of the ground.
Drift Geology	Sediments deposited by the action of ice and glacial processes
Estuary	A tidal basin , where a river meets the sea, characterised by wide inlets
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Resilience	Resistance strategies aimed at flood protection
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption)
Flood Consequence Assessment	Considerations of the flood risks inherent in a project, leading to the development actions to control, mitigate or accept them.
Flood storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone	The extent of how far flood waters are expected to reach.
Fluvial	Relating to the actions, processes and behaviour of a water course (river or stream)
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Freeboard	Height of the flood defence crest level (or building level) above designed water level.
GIS	Geographic Information System – A mapping system that uses computers to

Term	Definition
	store, manipulate, analyse and display data
Greenfield	Previously undeveloped land.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Highly Vulnerable Developments	Developments that are at highest risk of flooding.
Hydraulic Modelling	A computerised model of a watercourse and floodplain to simulate water flows in rivers too estimate water levels and flood extents.
Hydrodynamic Modelling	The behaviour of water in terms of its velocity, depth and hazard that it presents. Infiltration The penetration of water through the grounds surface.
Infrastructure	Physical structures that form the foundation for development. Inundation Flooding.
Justification test	Aims to steer development to areas of lowest flood risk.
LiDAR	Light Detection And Ranging – uses airborne scanning laser to map the terrain of the land.
Local Planning Authority	Body that is responsible for controlling planning and development through the planning system.
Main River	Watercourse defined on a 'Main River Map' designated by DEFRA. The environment Agency has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Overtopping	Water carried over the top of a defence structure due to the wave height exceeding the crest height of the defence.
Reach/ Upper reach	A river or stream segment of specific length. The upper reach refers to the upstream section of a river.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
Risk	The probability or likelihood of an event occurring.
River Catchment	The areas drained by a river
SAR	Synthetic Aperture Radar - a high resolution ground mapping technique, which uses reflected radar pulses.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Solid Geology	Solid rock that underlies loose material and superficial deposits on the earth's surface
Source Protection	Defined areas in which certain types of development are restricted to ensure

Term	Definition
Zone	that groundwater sources remain free from contaminants.
Standard of Protection	The flood event return period above which significant damage and possible failure of the flood defences could occur.
Storm surge	A high rise in sea level due to the winds of the storm and low atmospheric pressure.
Sustainability	To preserve /maintain a state or process for future generations.
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs
TAN 15 Zone A	Considered to be at little or no risk of fluvial or tidal/coastal flooding.
TAN 15 Zone B	Areas known to have been flooded in the past evidence by sedimentary deposits.
TAN 15 Zone C	Based on Environment Agency extreme flood outline, equal to or greater than 0.1% (river, tidal or coastal).
TAN 15 Zone C1	Areas of the floodplain which are developed and served by significant infrastructure, including flood defences.
TAN 15 Zone C2	Areas of floodplain without significant flood defence infrastructure.
Tidal	Relating to the actions or processes caused by tides.
Topographic survey	A survey of ground levels.
Tributary	A body of water, flowing into a larger body of water, such as a smaller stream joining a larger stream.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

Appendix A – SFCA mapping

Appendix B – Treforest LDO area development advice map methodology

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