Ty Nant, Prestatyn

Flood Consequences Assessment

November 2014

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w1697-141105 FCA

DOCUMENT VERIFICATION RECORD

CLIENT:

Denbighshire County Council

SCHEME:

Flood Consequences Assessment for a development at Ty Nant, Nant Hall Road, Prestatyn, Denbighshire, LL19 9LG. The purpose of this report is to support the Planning Application.

INSTRUCTION:

The instruction to carry out this Flood Consequences Assessment was received from Mr David Rich of Denbighshire County Council.

REPORT FORMAT:

This report has been prepared in accordance with Technical Advice Note 15: Development and Flood Risk (TAN15).

ISSUE HISTORY:

Issue Date	Comment
05/11/2014	First issue

DOCUMENT REVIEW & APPROVAL

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Reviewed by	Aled Williams BSc (Hons)
Approved by	Dr Deepak B Kharat BE MTech PhD MCIWEM CWEM CSci

Waterco Document Reference Number.....w1697-141105-FCA

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Supporting Documents:

Welsh Government Technical Advice Note (TAN) 15: Development and Flood Risk (2004)

Denbighshire County Council Strategic Flood Consequences Assessment – Update (July 2014)

Denbighshire County Council Preliminary Flood Risk Assessment (June 2011)

Abbreviations

AEP	*Annual Exceedance Probability*
CCA	*Climate Change Allowance*
DCWW	*Dwr Cymru Welsh Water*
EA	*Environment Agency*
FCA	Flood Consequences Assessment
LiDAR	*Light Detection and Ranging*
mAOD	*metres Above Ordnance Datum*
NRW	*Natural Resources Wales*
PFRA	*Preliminary Flood Risk Assessment*
SFCA	*Strategic Flood Consequences Assessment*
SUDS	*Sustainable Drainage Systems*
TAN15	*Welsh Government Technical Advice Note 15: Development & Flood Risk*

1 Introduction

1.1 Waterco Consultants were instructed to prepare a Flood Consequences Assessment report in respect of a development site at Ty Nant, Nant Hall Road, Prestatyn, Denbighshire, LL19 9LG (grid reference: 306694E 382876N). A location plan and an aerial image of the site are included in Appendix A.

1.2 The site covers an area of approximately 9340m² and is bordered by commercial units to the north, residential properties to the east, a car park and church to the south and commercial units and a vicarage to the west. The existing site comprises of council offices, a library and associated car parking.

1.3 As shown on the Topographical Survey included in Appendix B, site levels vary from a low of approximately 5.5m AOD in the north-western extent to a high of approximately 10.5m AOD in the south.

1.4 The purpose of this report is to determine acceptable site uses and establish the mitigation measures (if any) required for future commercial / industrial / residential development, achieving compliance with TAN15.

2 Flood Zone Category and Justification

2.1 The Welsh Government Development Advice Map included in Appendix C shows that the site is partially located within Flood Zone C1 – an area at flood risk, but served by significant infrastructure, including flood defences, with a 0.1% (1 in 1000) chance or greater of flooding in any given year. The majority (> 90%) of the site is shown within Flood Zone A – an area considered to be at little or no risk of fluvial or tidal flooding.

2.2 The EA Flood Map (Appendix C) shows that the site is partially located within the defended Flood Zone 3 – an area at risk with a 0.5% chance or greater of flooding from the sea in any given year, however benefits from flood defences. The majority of the site is located within Flood Zone 1 – an area considered to have the lowest probability of flooding.

2.3 TAN 15 states that highly vulnerable and less vulnerable development can be considered in Flood Zone C1 subject to the application of the justification test and acceptability of consequences.

Justification

2.4 Development will be justified if it can be demonstrated that:

i. Its location in Zone C is necessary to assist, or be a 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; **and**,
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 in terms of the criteria contained in sections 5 and 7 and appendix 1 (of TAN15) found to be acceptable.

2.5 It is considered that the justification test will be satisfied as the development would be required to support regeneration initiatives and to sustain an existing settlement. The southern extent of the site is outlined in the Denbighshire SFCA (July 2014 Update) as a 'Key Development Site' for employment use. The existing site is brownfield with commercial use and meets the definition of previously developed land.

2.6 The majority of the land is located within Flood Zone A. All 'highly vulnerable' residential use should be located in Flood Zone A – an area where 'highly vulnerable' development is considered to be appropriate.

2.7 The acceptability of consequences is discussed further in this report.

3 TAN15 Acceptability Criteria

3.1 TAN15 section 9 'Summary of Policy Requirements' states that for 'highly vulnerable' development in Zone C1 the following Acceptability Criteria should be satisfied:

- Acceptable consequences for nature of use
- Flood defences adequate
- Agreement for construction and maintenance costs secured

- Occupiers aware of flood risk
- Escape/evacuation routes present
- Effective flood warning provided
- Flood Emergency plans and procedures
- Flood resistant design
- No increase in flooding elsewhere

3.2 The above criteria are considered in subsequent sections, but firstly the potential sources of flooding are considered below to provide context for the assessment.

4 Potential Sources of Flooding and Probability

4.1 This section will document the likely sources of flooding that could affect the proposed development site and the probability of occurrence. In order to determine these sources, a review of the following has been undertaken:

- Welsh Government Development Advice Map (Appendix C)
- Environment Agency Flood Map (Appendix C)
- Natural Resources Wales Tidal Flood Level Data and Flood Mapping (Appendix C)
- Denbighshire County Council Strategic Flood Consequences Assessment (SFCA) (March 2007 & July 2014)
- Denbighshire County Council Preliminary Flood Risk Assessment (PFRA) (May 2011)
- Site Specific Homecheck Flood Report (obtained from Landmark) (Appendix D)
- Internet Searches for Historic Flood Events

Fluvial & Tidal

4.2 The site is located approximately 1km from the coastline. The nearest major watercourse is the Prestatyn Gutter which is located approximately 465m north-west of the site. The Prestatyn Gutter flows north-east in this location to its discharge to the sea. Other watercourses in the area include an unnamed drain located approximately 260m north of the site.

4.3 The NRW 'Fluvial Flood Zones at Ty Nant, Prestatyn' map (Appendix C) shows that the site falls outside the extreme fluvial flood extent and is therefore not considered to be at risk from fluvial flooding. The main risk of flooding to the site is considered to be tidal flooding. As shown on the 'Tidal Flood Zones at Ty Nant Prestatyn' map, the site falls partially within tidal Flood Zone 3.

4.4 The site is located in an area which is defended from tidal flooding by flood defences in the form of a sea wall and natural high ground (sand dunes). The crest level of the sea wall is 6.8m AOD.

4.5 Tidal flooding could occur due to a failure, breach or overtopping of the sea defences. Tidal flooding occurred in Prestatyn in February 1990 and recently in December 2013 and January 2014. This flooding was the result of overtopping of the defences caused by wave action and tidal surge. There are no records of past tidal flooding affecting the site.

NRW Estimated Flood Levels

4.6 Estimated extreme sea levels have been obtained from NRW in October 2014 and are included in Appendix C. A summary of the tidal peak water levels is provided in Table 1 below. An allowance for future net sea level rise has been provided up to the year 2114.

Table 1 – NRW Extreme Sea Levels

		Flood Levels (m AOD)		
Year	**Sea level rise (m)**	**1% AEP***	**0.5% AEP**	**0.1% AEP**
2014	0.021	6.0	6.1	6.4
2064	0.403	6.4	6.4	6.8
2089	0.703	6.7	6.7	7.1
2114	1.065	7.0	7.1	7.4

*AEP = Annual Exceedance Probability

4.7 By comparing the maximum tidal peak water levels to flood defence levels (6.80m AOD) it can be seen that no overtopping of the flood defences is estimated during all the present day events up to and including the 0.1% (1 in 1000) AEP event. Similarly, no overtopping is estimated during all events up to and including the 0.1% AEP event when accounting for 50 years Climate Change Allowance (CCA).

4.8 No overtopping of the defences is estimated during all events up to and including the 0.5% AEP event including 75 years CCA. However, 300mm of overtopping is estimated during the extreme 0.1% AEP event when accounting for 75 years CCA.

4.9 Overtopping is estimated during all the events up to and including the 0.1% (1 in 1000) AEP event when accounting for 100 years CCA. Overtopping of the defences could lead to potential flooding at the site.

4.10 A residual risk of flooding arises from a breach or failure of the flood defences. Tidal breach modelling was undertaken as part of the 2007 and 2014 Denbighshire SFCA. The 2007 SFCA 'Prestatyn: 0.1% depth grid and 0.5% outline' map (Appendix E) shows the site to be outside of the present day 0.5% AEP and 0.1% AEP flood extents during a breach event.

4.11 Breach mapping obtained from the 2014 SFCA (Appendix E) shows that the site falls outside of the 0.5% AEP and 0.1% AEP flood extents during a breach event when allowing for CCA up to the year 2106. According to the SFCA, the 2106 modelled breach flood extent is also representative of potential flood extents during an overtopping event of the defences. Therefore, it is considered unlikely that an overtopping event of the defences (as estimated during the 0.5% AEP and 0.1% AEP events when accounting for 100 years CCA) would affect the site.

Pluvial flooding

4.12 This is defined as local flooding in areas not normally associated with natural or manmade watercourses, which result from rainfall-generated overland flow before the run-off enters any watercourse or sewer. It is usually associated with high intensity rainfall events, but can also occur with lower intensity rainfall or melting snow, where the ground is saturated, frozen or developed, resulting in overland flow and ponding in depressions in topography. Pluvial flooding is unpredictable to the extent that localised heavy rainfall can occur anywhere without any warning. However, flow paths and depths can be determined by consideration of contours and relative levels.

4.13 The Envirocheck report (Appendix D) shows that the majority of the site is not at risk from pluvial flooding during all events up to and including the 1 in 100 year event.

4.14 The lower southern extent of the site is shown partially at risk of pluvial flooding during the 1 in 75 and 1 in 100 year events. The majority of the site is shown at risk during the extreme 1 in 1000 year event.

4.15 The PFRA states that 'some areas of Prestatyn have been prone to surface water flooding'. However there are no records of surface water flooding affecting the site. Any potential surface water flooding arising at or near to the site would be directed north-west, away from the site, following the local topography. It can therefore be concluded that the risk of pluvial flooding is low.

Groundwater flooding

4.16 Groundwater flooding occurs when water levels underneath the ground rise above normal levels. Prolonged heavy rainfall soaks into the ground and can cause the ground to become saturated. This results in rising groundwater levels which leads to flooding above ground.

4.17 The Envirocheck report shows that the site is located in an area with potential for groundwater flooding to occur at the surface. However the PFRA states that 'there is no recorded history of significant groundwater flooding in Denbighshire'.

4.18 It can therefore be concluded that the risk of groundwater flooding is low.

Sewer flooding

4.19 Flooding from sewers can occur when a sewer is overwhelmed by heavy rainfall, becomes blocked, is damaged or is of inadequate capacity. This is mostly applicable to combined and surface water sewers.

4.20 The SFCA states that 'Prestatyn has had the highest number of sewer flooding incidents with around 240 incidents recorded'. The SFCA contains records of 3 external sewer flooding incidents occurring on Nant Hall Road. The nearest sewer flooding incident occurred immediately north of the site. As shown on the Topographical Survey (Appendix B), site levels are approximately 200mm-300mm above Nant Hall Road. Therefore any potential flooding arising from the sewer network in Nant Hall Road would not reach the site. Flooding would likely be directed north, away from the site, following the local topography.

4.21 It can therefore be concluded that the risk of sewer flooding is low.

Artificial sources of flooding

4.22 There are no canals or reservoirs in the vicinity of the site. The EA Flooding from Reservoirs Map (included in Appendix C) shows that the site is not at risk of flooding from reservoirs. Therefore the risk of flooding from artificial sources is low.

5 Acceptable Consequences for Nature of Use

5.1 In accordance with section A1.14 of TAN15 there is a frequency threshold of flooding below which flooding of development should not be allowed. The following table, taken from TAN15, provides indicative guidance as to what the frequency threshold could be for different types of development in terms of annual probability of occurrence.

Table 2 – TAN15 Flood frequency thresholds

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%

5.2 According to the table, no flooding should occur for residential, commercial or industrial development during the 0.5% AEP tidal event. As detailed in Section 4, no flooding is estimated on site during the defended and undefended 0.5% AEP event. Tidal breach modelling undertaken as part of the Denbighshire SFCA shows that the site is flood free during a defence breach coinciding with the 0.5% AEP event when accounting for CCA up to the year 2106. The development is therefore compliant with section A1.14 of TAN15.

5.3 In accordance with section A1.15 of TAN15, beyond the threshold frequency (beyond the 0.5% AEP event in this case) the proposed development would be expected to flood under extreme conditions. The following table, taken from TAN15, provides indicative guidance on what is considered tolerable conditions for different types of developments.

Table 3 – TAN15 Tolerable conditions

Type of Development	Max depth of flooding (mm)	Max rate of rise of floodwaters (m/hr)	Max speed of inundation of flood risk area (hrs)	Max velocity of floodwaters (m/s)
	Property Access			Property Access
Residential (habitable rooms)	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

5.4 Tidal breach modelling undertaken as part of the Denbighshire SFCA shows that the site is flood free during a defence breach coinciding with the 0.5% AEP and 0.1% AEP events when accounting for CCA up to the year 2106. The site is therefore compliant with Section A1.15 of TAN15.

6 Flood Resistant Design / Consideration of Layout

6.1 As described above, no flooding is estimated during the defended and undefended 0.5% AEP events. No flooding is estimated during a tidal breach event coinciding with the 0.5% AEP event when accounting for CCA up to the year 2106. However taking a precautionary approach, flood mitigation measures should be adopted.

6.2 Proposed residential properties should be designed to be above the 0.5% AEP + 100 years CCA flood level i.e. at or above 7.1m AOD. The design life of residential development is considered to be 100 years.

6.3 Less vulnerable commercial / industrial use is already established on site. Any proposed commercial / industrial units located within the tidal flood extent should incorporate flood resilience measures to provide betterment to the existing situation. This could include:

- Install non–return valves on all drains to prevent backflow.
- The use of non-hygroscopic renders

- Raise electrical control units and sockets above the 0.5% AEP + 75 years CCA flood level i.e. above 6.7m AOD (the design life of commercial / industrial development is considered to be 75 years).

6.4 The recommendations included in the RIBA publication 'Improving the Flood Performance of New Buildings, Flood Resilient Construction' dated May 2007 should be considered for all proposed buildings wherever practical.

7 Flood Emergency Plans and Procedures

7.1 The site owners should prepare a Flood Plan to provide advice on how to prepare for, respond to and recover from a flood event.

7.2 The Flood Plan should include details of a safe evacuation route to be used during a flood event. In the unlikely event of flooding, site users should evacuate towards the south-west of the site and head south on the High Street. The southern extent of the site and access onto the High Street is shown within Flood Zone 1 – an area considered to have the lowest probability of tidal flooding. An evacuation route plan is included in Appendix F.

8 Occupiers Aware of Flood Risk

8.1 All site users should be made aware that the site is at risk of flooding and should read the Flood Plan. The evacuation route should also be displayed on site.

9 Effective Flood Warning Provided

9.1 The EA's Floodline Warnings Direct service covers this area. Floodline Warnings Direct is a free service that provides flood warnings direct by telephone, mobile, email, SMS text message and fax. The property owners / residents should register on the EA Floodline Warnings Direct service. This would give site users prior warning of a tidal flood event.

10 No Increase in Flooding Elsewhere

10.1 The proposed development is not located in the functional floodplain; therefore the development will not be depriving flood storage space from the floodplain. It is therefore reasonable to conclude that there will be no increase in flooding elsewhere as a result of the proposed development.

11 Surface Water – No Adverse Impact

11.1 The existing site is approximately 95% impermeable, and consists of a library, council offices and a car park. It is assumed that surface water runoff currently discharges to the public sewer system. A connection to the public sewer should be retained for any proposed development. It is likely that Dwr Cymru Welsh Water (DCWW) will request that betterment is provided to the existing flow rates from the site.

11.2 For information, surface water runoff rates and volumes have been estimated using a spreadsheet calculation in accordance with current best practice (see Appendix G). An estimated impermeable area of 50% of the total site area has been applied for the post development scenario. The additional surface water runoff resulting from a 30% increase for climate change has been taken into account in the calculations.

Table 4 – Pre and post-development run-off rates

Peak Flow (l/s)	1 yr	30 yr	100 yr
Existing Peak Flow	63.66	158.13	199.35
Assumed Post-development Peak Flow	45.60	112.69	141.88
Decrease	-18.06	-45.44	-57.47

Table 5 – Pre and post-development run-off volumes

Volume (m^3)	100 yr
Existing	500.10
Assumed Post-development	490.96
Decrease	-9.14

12 Agreement for Construction and Maintenance Costs Secured

12.1 No new flood defences are proposed as part of this development.

12.2 The existing flood defences are owned by NRW and Denbighshire County Council who are responsible for their maintenance.

13 Summary and Conclusions

13.1 The site is located partially within Zone C1 on the Welsh Government Development Advice Map and the defended Flood Zone 3 on the EA Flood Map. The majority of the site is located within Flood Zone A / Flood Zone 1 – an area considered to have the lowest probability of fluvial and tidal flooding.

13.2 All potential sources of flooding have been considered as part of this report including fluvial, tidal, pluvial, sewer, groundwater and artificial sources. Tidal flooding is considered to be the primary source of flooding to this site.

13.3 The area benefits from flood defences with a sea wall and sand dunes along the coastline. The minimum crest level of the wall is 6.80m AOD.

13.4 Estimated undefended tidal peak water levels have been obtained from NRW and show that no overtopping of the defences is estimated during all events up to and including the present day 0.1% AEP event. No overtopping is estimated when accounting for 50 years CCA.

13.5 Overtopping of the defences is estimated during the 0.1% AEP event when accounting for 75 years CCA. Overtopping is also estimated during the 0.5% AEP and 0.1% AEP events when accounting for 100 years CCA.

13.6 Tidal breach modelling undertaken as part of the Denbighshire SFCA shows that the site is flood free during a defence breach coinciding with the 0.5% AEP and 0.1% AEP events when accounting for CCA up to the year 2106. The 2106 modelled breach flood extent is also representative of potential flood extents during an overtopping event of the defences. Therefore, it is considered unlikely that an overtopping event of the defences would affect the site.

13.7 Taking a precautionary approach, flood mitigation measures should be incorporated to ensure that all residential properties are located above the 0.5% AEP + 100 years CCA flood level. Flood resilience measures should be incorporated for any proposed commercial or industrial development to provide betterment to the existing situation.

13.8 A safe evacuation route is available via the southern extent of the site leading onto the High Street.

13.9 The proposed development will not increase flood risk elsewhere.

14 Recommendations

14.1 Proposed residential properties should be designed to be above the 0.5% AEP + 100 years CCA flood level i.e. at or above 7.1m AOD.

14.2 Less vulnerable commercial / industrial use is already established on site. Any proposed commercial / industrial units located within the tidal flood extent should incorporate flood resilience measures to provide betterment to the existing situation. This could include:

- Install non–return valves on all drains to prevent backflow.
- The use of non-hygroscopic renders
- Raise electrical control units and sockets above the 0.5% AEP + 75 years CCA flood level i.e. above 6.7m AOD.

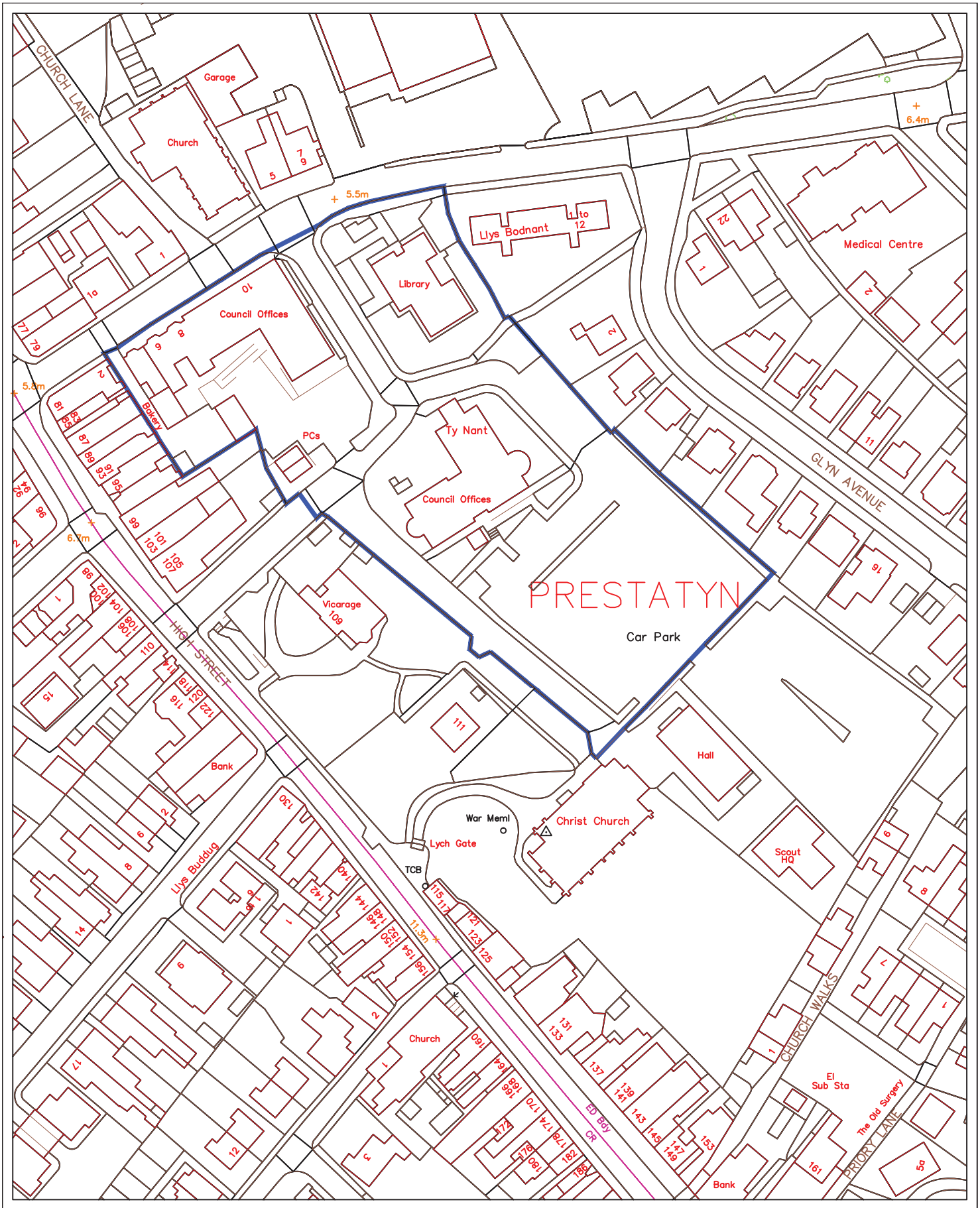
14.3 The recommendations included in the RIBA publication 'Improving the Flood Performance of New Buildings, Flood Resilient Construction' dated May 2007 should be adopted for all proposed buildings wherever practical.

14.4 The site owners should prepare a Flood Plan to provide advice on how to prepare for, respond to and recover from a flood event. The Flood Plan should include details of the safe evacuation route to be used during a flood event.

14.5 Surface water runoff from the development should be discharged to the public sewer system retaining the existing connection. Discharge rates should be agreed with DCWW.

14.6 This Flood Consequences Assessment Report should be submitted to the Local Planning Authority in support of the planning application.

Appendix A – Location Plan and Aerial Image



Cyngor
Sir Ddinbych
Denbighshire
County Council

Dylunio a Datblygu Sir Ddinbych
Denbighshire Design & Devlopment

Drawn By:	Dwg. Name:	Scale:
	LOCATION PLAN	1:1250

Project Name:
Nant Hall Development, Prestatyn.

Job No. : FWB/ 13/ 009A - Nant Hall Development, Prestatyn.

Revisions:
A : 26:08:14 : Boundary line re-aligned.
B : 12:09:14 : Boundary line re-aligned.

Drawing No.:	
AL(0)01B	08/05/14

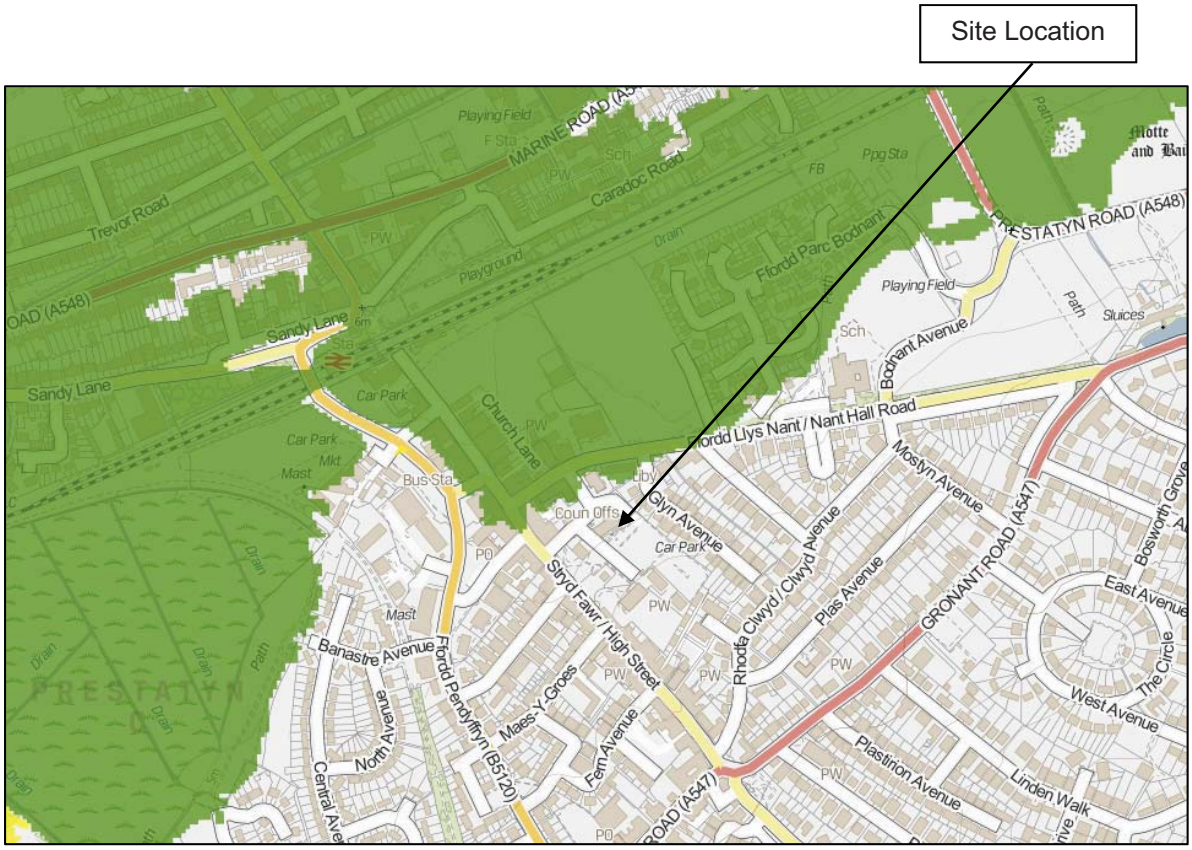
Aerial Photograph

(Source: Google)

Appendix B – Topographical Survey


C. A. B.
Presbyterian Church
Iceland Car Park
Council Offices
Library
Toilets
Car Park

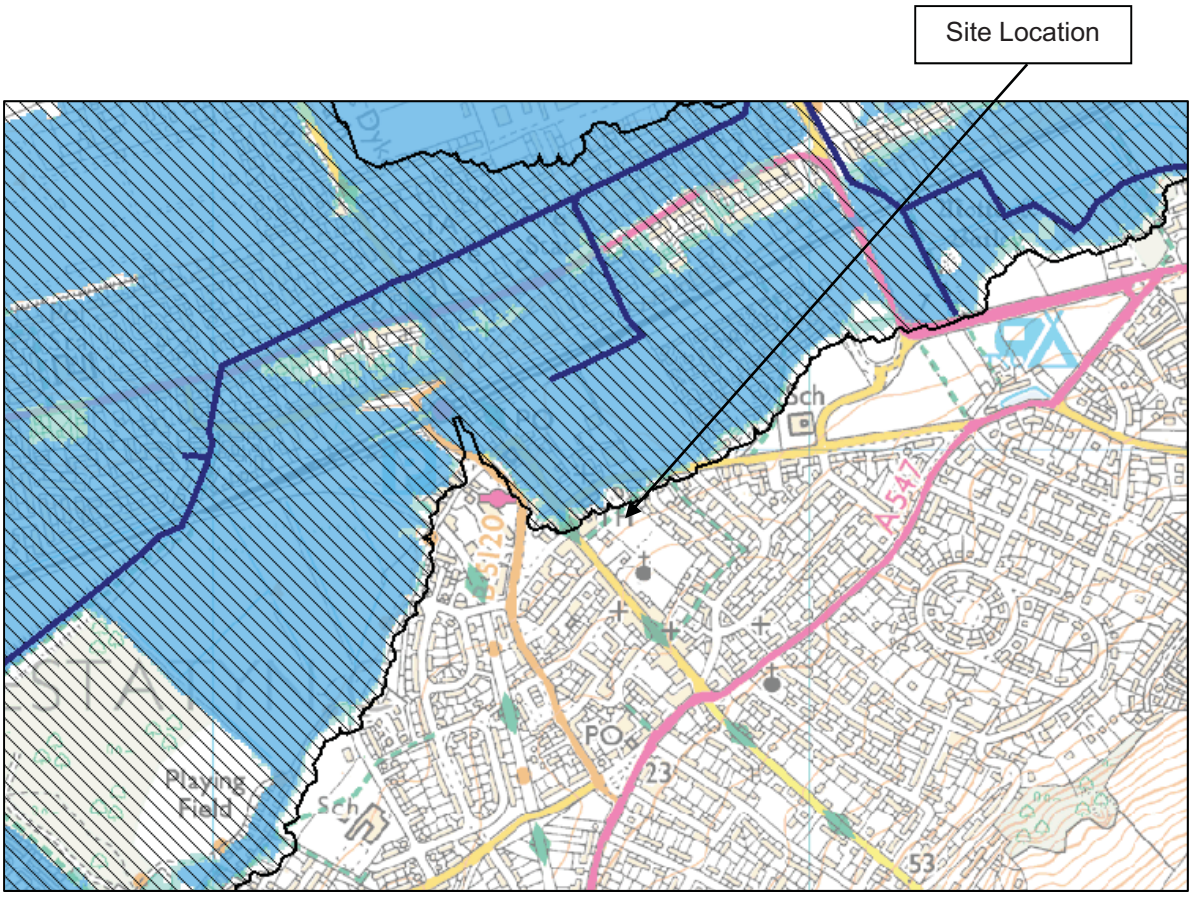
Appendix C – Flood Maps, NRW Correspondence and Data



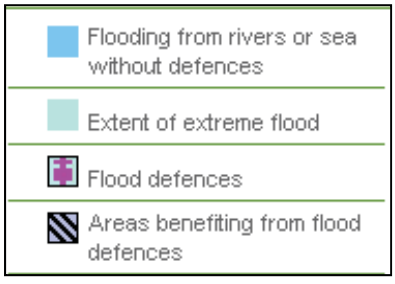
	Zone C1: Served by significant infrastructure, including flood defences
	Zone C2: Without significant flood defence infrastructure
	Zone B: Areas known to have been flooded in the past
	Zone A: Considered to be at little or no risk of fluvial or coastal/tidal flooding

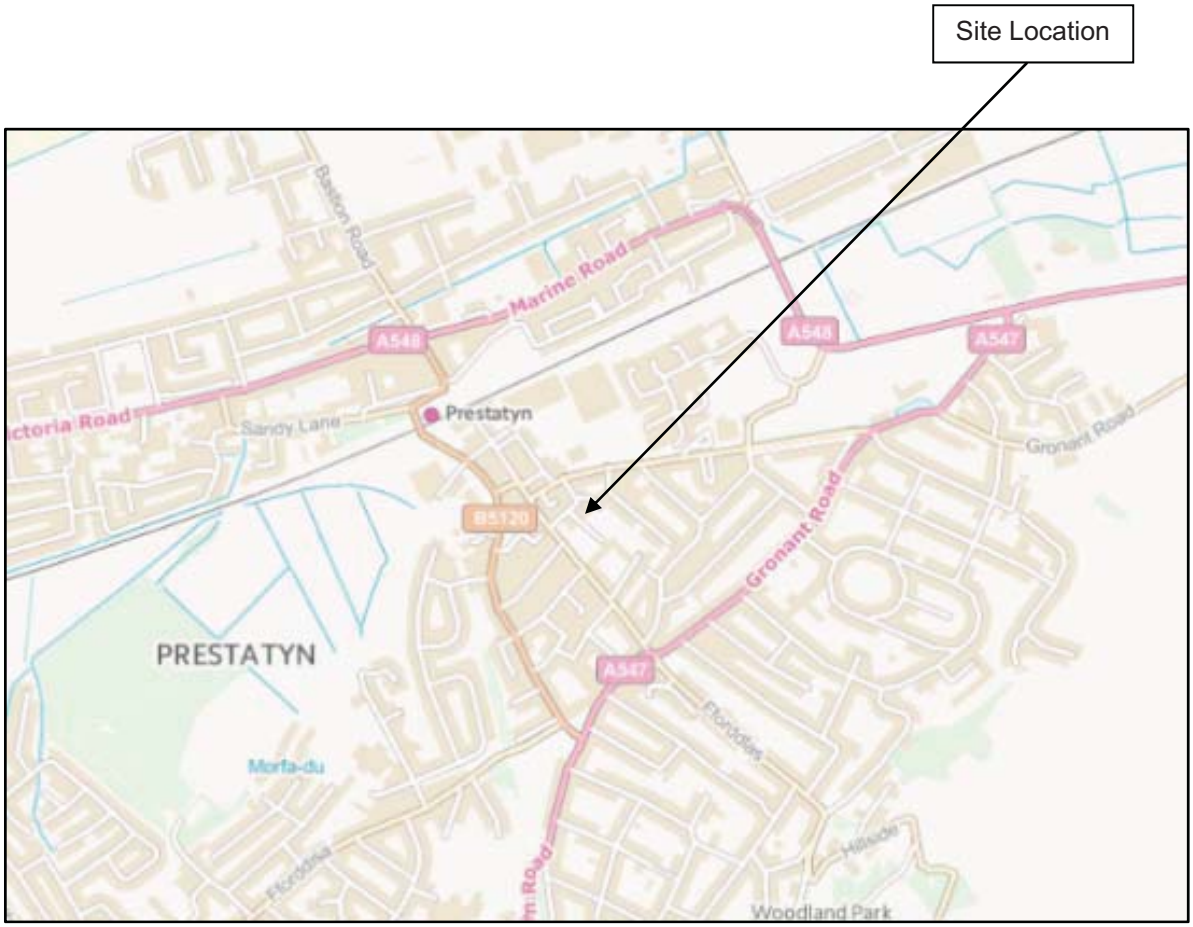
Zones C1 and C2 based on Environment Agency's Extreme Flood Outline >= 0.1% (River, Tidal or Coastal)

Welsh Government TAN15 Development Advice Map (November 2014)

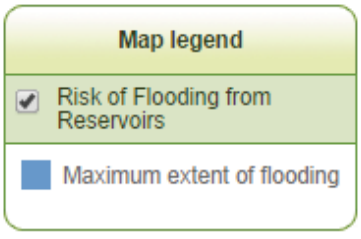


EA Flood Map (November 2014)



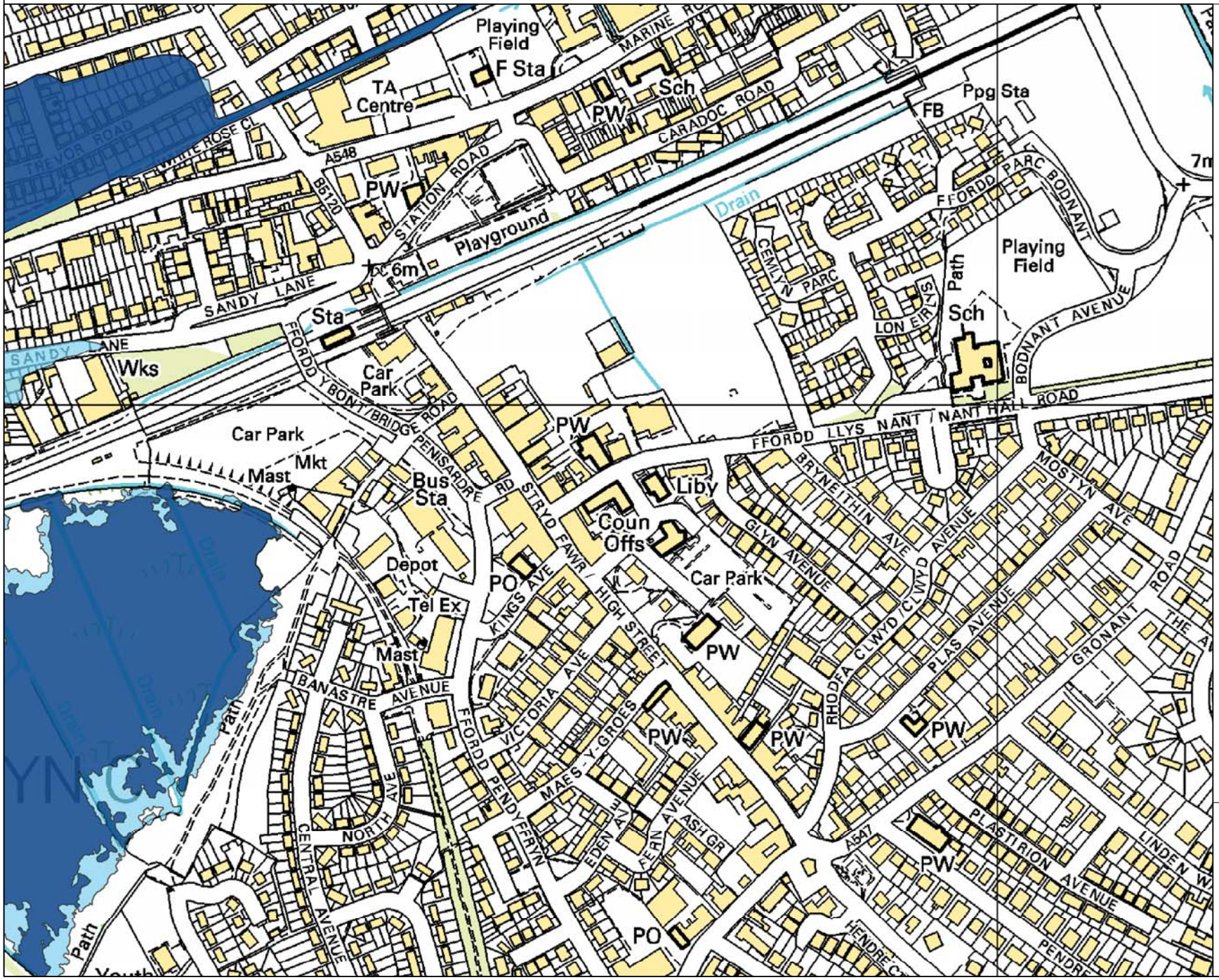


EA Flooding from Reservoirs Flood Map (November 2014)



Cyfoeth Naturiol Cymru
Natural Resources Wales

Fluvial Flood Zones at Ty Nant, Prestatyn



Legend

Fluvial Flood Zone 3

Fluvial Flood Zone 2

Flood Zone 3 (fluvial) indicates the area that could be flooded with a 1% (1 in 100) or greater chance of happening each year.

Flood Zone 2 (fluvial) indicates the extent of an extreme flood from a river. These areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year.

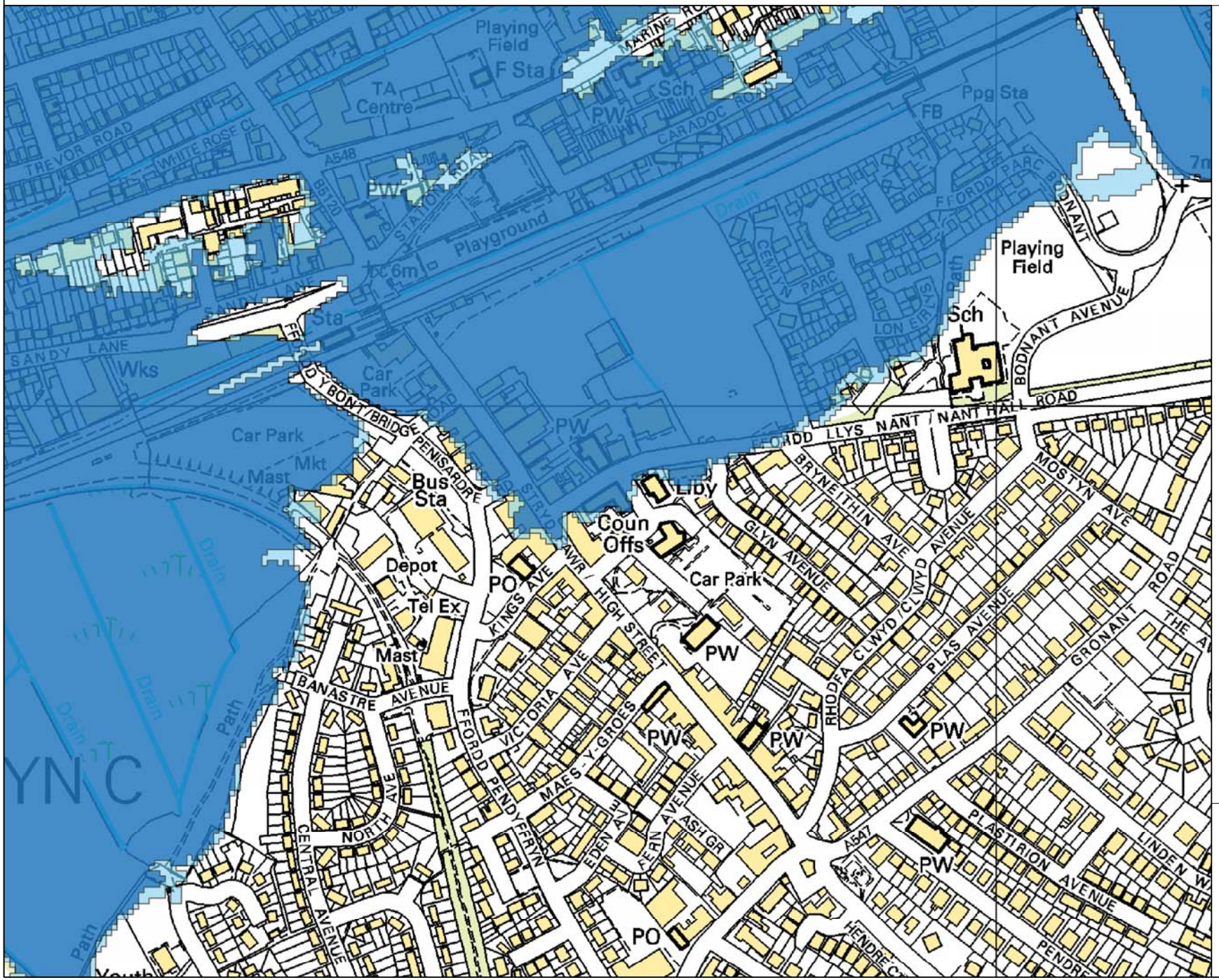
Flood Zones do not provide information on flooding from groundwater or other sources.

0 2550 100 Meters

N

Cyfoeth Naturiol Cymru
Natural Resources Wales

Tidal Flood Zones at Ty Nant, Prestatyn



Legend

Tidal Flood Zone 3

Tidal Flood Zone 2

Flood Zone 3 (tidal) indicates the areas that could be flooded with a 0.5% (1 in 200) or greater tidal chance of happening each year.

Flood Zone 2 (tidal) indicates the extent of an extreme flood from the sea. These areas are likely to be affected by a major flood with up to a 0.1% (1 in 1000) chance of occurring each year.

0 25 50 100 Meters

N

Prestatyn - Flood Risk Management assets

Cyfoeth Naturiol Cymru
Natural Resources Wales

Meters
0 255 510

1:25,000

29697
Target condition - 3
Actual condition- 2
Effective crest level
6.8m AOD

29828
Target condition - 3
Actual condition- 3
Crest levels:
US 4.7m AOD
DS 5.7m AOD

Contact Us: Customer Contact Centre, Natural Resources Wales, Tŷ Cambria, 29 Newport Road. Tel: 0300 065 3000. Email: enquiries@naturalresourceswales.gov.uk

North Wales Tidal Water Level Information

This document is provided as part of requests for flood risk data in the vicinity of North Wales Coastline and is used under licence from Natural Resources Wales.

Current Flood Map

The attached flood map shows the current flood zones at this location. This represents the undefended fluvial and tidal flood extents derived from a combination of detailed and generalised modelled data.

The current tidal flood map in this area is derived from a mapping study undertaken by JBA (2011)[1]. This study uses sea levels at discrete node locations around the North Wales coast, taken from the 'Coastal Flood Boundaries for the UK Mainland and Islands' project (2011)[2]. The levels were projected inland over a digital terrain model to produce tidal mapped outlines for both the 0.5% (1 in 200) AEP (annual exceedance probability) and the 0.1% (1 in 1000) AEP.

The flood map can be viewed on the **Environment Agency's** website at http://maps.environment-agency.gov.uk/wiyby

The Coastal Flood Boundary levels were derived using a tidal model calibrated to UK tidal gauge data. The model output is provided for node locations spaced at approximately 2km. 95% confidence bounds for these values were also derived using the confidence intervals for each node location. The extreme sea levels comprise still water level including storm surge, however they do not account for local wave action. The baseline estimations are for the year 2008, so climate change is calculated relative to this year, for example add 18mm for the year 2013.

Extreme sea levels for the node points closest to the site location are included in Table 1 for a range of return periods (events) e.g. T100 is the 1 in 100 year return period tide, which is equivalent to the 1% AEP (Annual Exceedance Probability). The node locations are shown in the enclosed map.

Table 1 - Extreme sea levels for adjacent nodes

Node	Easting	Northing	Extreme Event Sea Level (mAOD)					
			T25	T50	T75	T100	T200	T1000
1140	305505	383570	5.55	5.64	5.70	5.73	5.82	6.04
1142	307342	384118	5.58	5.67	5.72	5.76	5.85	6.07

[1] *North Wales Tidal Mapping Study Final Report.* JBA Consulting, November 2011.

[2] *Coastal flood boundary conditions for UK mainland and islands. R&D Report SC060064/TRD: Practical guidance design sea levels.* Environment Agency / Defra, 2011.

To provide the estimate of extreme sea levels for the site (Table 2), levels were interpolated from the adjacent nodes.

Table 2 - Extreme sea levels interpolated between adjacent nodes

Node	Easting	Northing	Extreme Event Sea Level (mAOD)					
			T25	T50	T75	T100	T200	T1000
Site	306694	382876	5.57	5.66	5.71	5.75	5.84	6.06
95% Confidence Bound (+/- m):			*0.10*	*0.10*	*0.10*	*0.20*	*0.20*	*0.30*

The current guidance on climate change from DEFRA (2006)[3] is as follows:

Table 3 - Sea level rise (mm per year)

Assumed vertical land movement	1990 2025	2025 2055	2055 2085	2085 2115
-0.5	3.5	8.0	11.5	14.5

The calculated future extreme sea levels are shown in Table 4. Adopting a precautionary approach as advised by Agency guidance (2011)[4], these levels include the upper level 95% confidence bound.

Table 4 - Extreme sea levels for the site (including 95% Confidence Bound)

Year	Sea level rise(m)	Extreme Event Sea Level (mAOD)					
		T25	T50	T75	T100	T200	T1000
2014	0.021	5.7	5.8	5.8	6.0	6.1	6.4
2064	0.403	6.1	6.2	6.2	6.4	6.4	6.8
2089	0.703	6.4	6.5	6.5	6.7	6.7	7.1
2114	1.065	6.7	6.8	6.9	7.0	7.1	7.4

Additional Information

The local authority may be able to provide information on issues such as localised flooding from sewers, drains and culverts.

Please also find enclosed the Surge Shape required to derive a design tidal-graph. For details on how to perform the necessary calculations please see the associated Technical Report (2011)[2].

Notes

Undefended scenarios are provided as being a possible worst case scenario in the event of defence failure. They are used as the basis of the Flood Map.

[3] *Flood and Coastal Defence Appraisal Guidance: FCDPAG3 Economic Appraisal. Supplementary Note to Operating Authorities – Climate Change Impacts.* Defra, October 2006

[4] *Using the national coastal flood boundary data for England and Wales (Operational Instruction 490_11).* Environment Agency, February 2011.

Extreme sea levels provided as part of this project are accurate to one decimal place (Table 4). Two decimal places have been provided to show the gradual change between nodes seen in the model; however, this does not imply greater accuracy

The scope of the model is the mapping of flood risk; it is not intended for detailed design. The model should be considered as the starting point for more detailed modelling, commensurate with the consequences of flooding at the site of interest.

Natural Resources Wales models are available under licence agreement for the purpose of further development. Please contact Natural Resources Wales External Relations for details of terms, conditions and pricing.

If the data is used in support of a Flood Consequence Assessment, please include the reference number.

Please refer to Natural Resources Wales' standard terms and conditions.

26 September 2014
Food Risk Analysis

Cyfoeth Naturiol Cymru
Natural Resources Wales

Mr Jordan Jones
Waterco
Eden Court Business Centre Lon Parcwr
Industrial Estate
Ruthin
Clwyd
LL15 1NJ

Ein cyf / Our ref: NT/2014/116276/01-L01
Eich cyf / Your ref: w1697

Dyddiad/Date: 16 October 2014

Annwyl / Dear Mr Jones

PRE PLANNING OPINION TY NANT, PRESTATYN, DENBIGHSHIRE, LL19 9AR

Thank you for consulting Natural Resources Wales regarding the above, which was received on 25th September 2014.

Flood Risk
The northern portion of the site lies in Zone C1 as defined by Welsh Government's Development Advice Map referred to under TAN15: Development & Flood Risk. Our Flood Map also confirms that the site lies partially within the extreme flood risk outline. Ordnance Survey mapping suggests that land levels rise relatively sharply in the mid and southern sections of the site.

Prestatyn, and other defended low lying coastal settlements in North Wales, would be particularly vulnerable to flooding should there be failure of key flood defence assets and the flood risks and consequences of flooding are likely to increase with the continuation of sea level rise and climate change. The breach analysis work undertaken in Denbighshire County Council's updated Strategic Flood Consequences Assessment should also be of assistance to you (Appendix C). The outputs of this work indicate that the northern fringes of the site could be vulnerable to flooding in the event that coastal flood defences were to fail.

http://denbighddms.wisshost.net/english/research_and_info.htm

In light of the above, and given the potential scale of re-development at this site, we would recommend that a full Flood Consequences Assessment be undertaken as required under TAN15.

Protected Species
There would be a need to demonstrate as part of any formal planning application for conversion or demolition of the existing buildings on site that the proposal would not be detrimental to the maintenance of the Favourable Conservation Status (FCS) of protected species including bats.

Local and Regional Interests
Please note however that we have not considered possible effects on all local or regional interests. Therefore, you should not rule out the possibility of adverse effects on local or regional interests. The Local Authority has a general duty to have regard to conserving biodiversity, as set out in section 40 of the Natural Environment and Rural Communities (NERC) Act (2006). This advice includes any consideration of the planned provision of “linear” and “stepping stone” habitats as defined in Article 10 of the Habitats Directive.

We recommend that you seek further advice from your Authority’s internal ecological adviser and/or third sector nature conservation organisations such as the local wildlife trust, RSPB, etc. The Wales Biodiversity Partnership's web site has guidance for assessing proposals that have implications for section 42 habitats and species (www.biodiversitywales.org.uk).

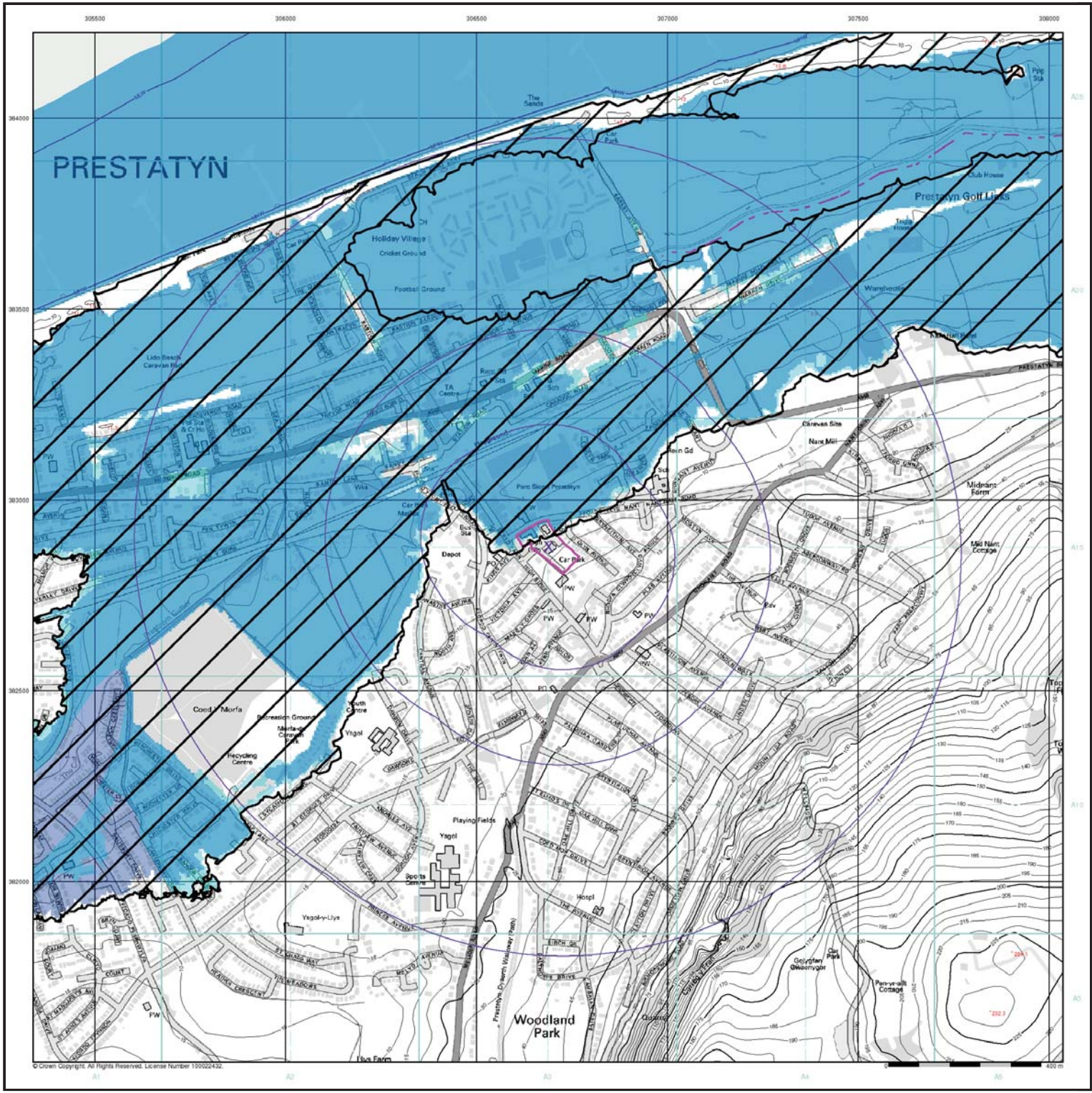
We thank you for consulting Natural Resources Wales. Should you wish to discuss this matter further please do not hesitate to contact us.

Yr eiddoch yn gywir / Yours sincerely

Deborah Hemsworth
Swyddog Cyswllt Cynllunio/Planning Liaison Officer

Ebost/Email: debbie.hemsworth@naturalresourceswales.gov.uk
Ffôn/Tel: 01248 484068

Appendix D – Envirocheck Flood Report



Envirocheck® Flood

EA/NRW Flood Data Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

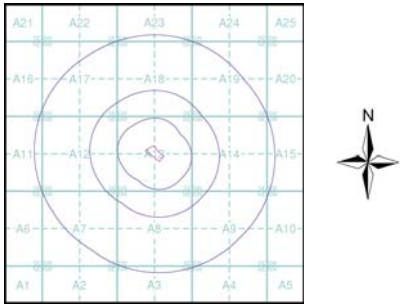
Flood Data

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Contours (height in meters)

- Standard Contour
- Master Contour
- Spot Height
- MLW Mean Low Water
- MHW Mean High Water

EA/NRW Flood Data Map - Slice A



Order Details

Order Number:	60918790_1_1
Customer Ref:	w1697
National Grid Reference:	306690, 382880
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details

Denbighshire County Council, Social Services Department, Ty Nant, Nant Hall Road,, PRESTATYN, Clwyd, LL19 9LG

Landmark® Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Envirocheck® Flood

RMS 75 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

RMS 75 year Return Flood Data

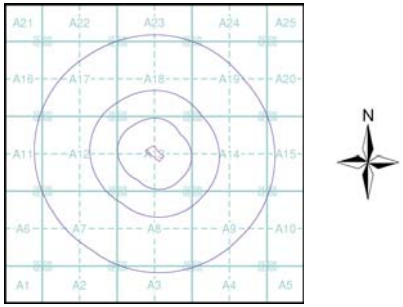
Flood Depth (mm)	Flood Type: Defended Flood	Flood Type: Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in meters)

Standard Contour 105
Master Contour 100 95
Spot Height 167.8

MLW Mean Low Water
MHW Mean High Water

RMS 75 year Return Flood Map - Slice A



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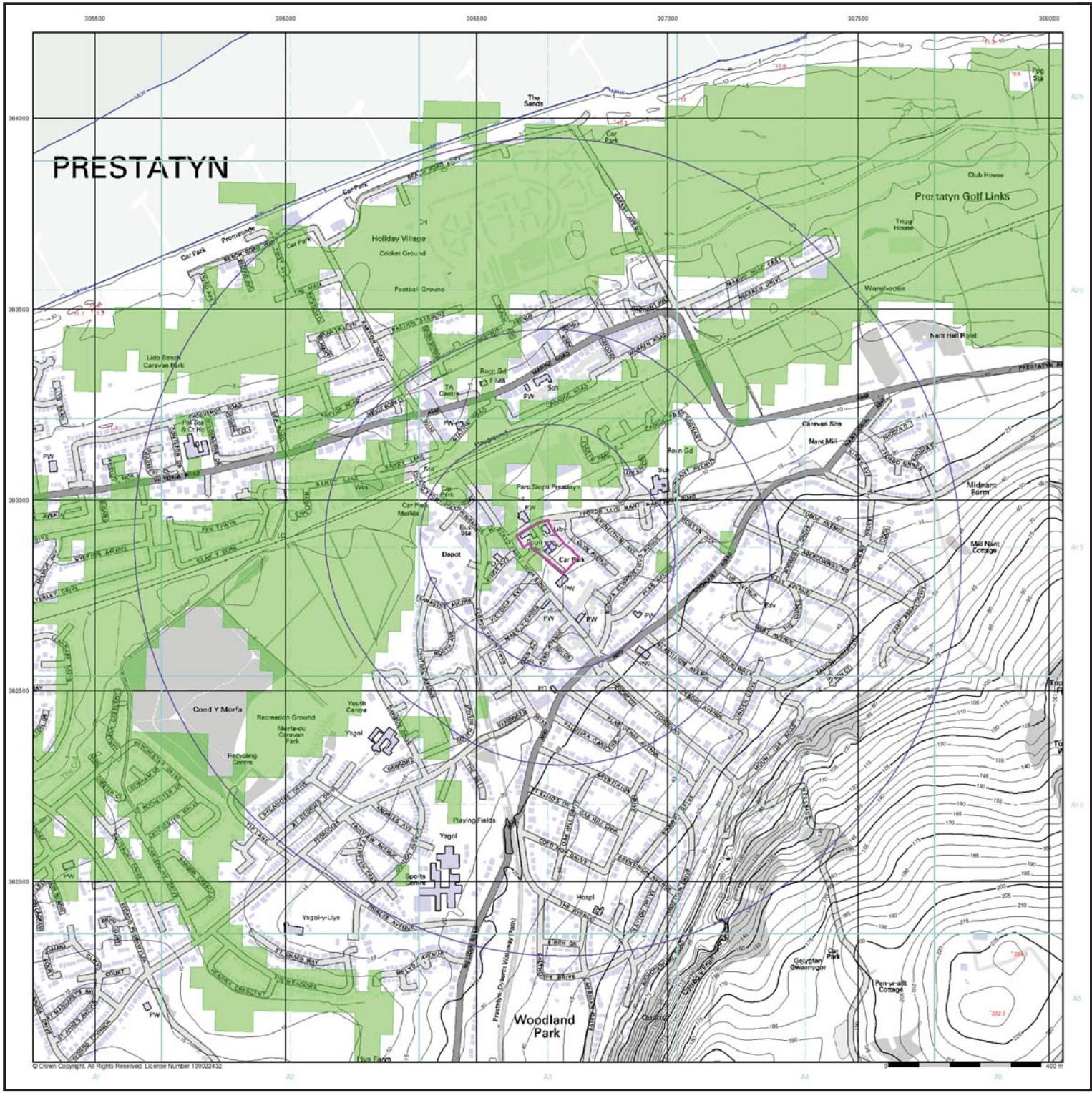


Envirocheck® Flood

RMS 100 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

RMS 100 year Return Flood Data

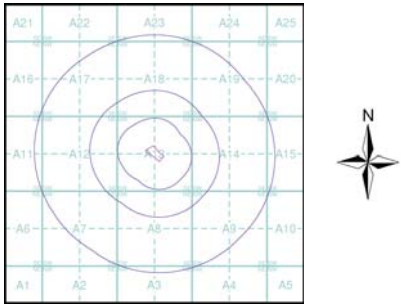
Flood Depth (mm)	Flood Type: Defended Flood	Flood Type: Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in meters)

Standard Contour 105
Master Contour 100 95
Spot Height 167.8

MLW Mean Low Water
MHW Mean High Water

RMS 100 year Return Flood Map - Slice A



Order Details

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Slice:	A
Site Area (Ha):	1.02
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Denbighshire County Council, Social Services Department, Ty Nant, Nant Hall Road,, PRESTATYN, Clwyd, LL19 9LG

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Envirocheck® Flood

RMS 1000 year Return Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

RMS 1000 year Return Flood Data

Flood Depth (mm)	Flood Type: Defended Flood	Flood Type: Undefended Flood	Pluvial & Minor River Flood (flood depth n/a)
0 - 200			
201 - 500			
501 - 2000			
2001 +			

Contours (height in meters)

Standard Contour 105

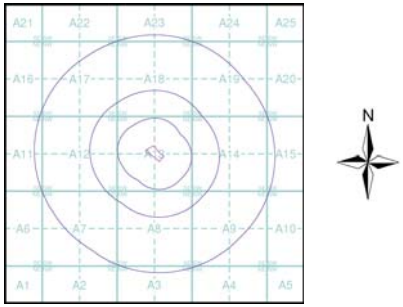
Master Contour 100

Spot Height *167.8

MLW Mean Low Water

MHW Mean High Water

RMS 1000 year Return Flood Map - Slice A



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Site Area (Ha):	1.02
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Site Details

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Envirocheck® Flood

Detailed River Network Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

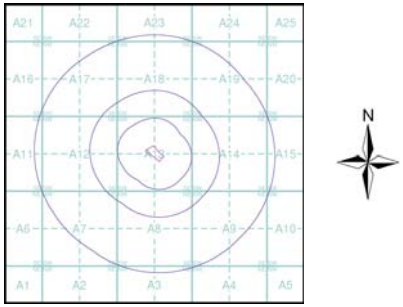
Detailed River Network Data

- Primary River
- Secondary River
- Tertiary River
- Canal
- Canal Tunnel
- Undefined River
- Lake/Reservoir
- Extended Culvert (greater than 50m)
- Underground River (inferred)
- Underground River (local knowledge)
- Downstream of High Water Mark
- Downstream of Seaward Extension
- Not assigned River feature
- Source
- Junction
- Sink
- Non-interactive Node
- Offline Drainage Feature
- Not assigned River feature
- Pseudo Node (general)
- Pseudo Node (High Water Mark)
- Pseudo Node (OS MasterMap polygon boundary)

Contours (height in meters)

- Standard Contour
- Master Contour
- Spot Height (167.3)
- MLW Mean Low Water
- MHW Mean High Water

Detailed River Network Map - Slice A



Order Details

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Site Area (Ha):	1.02
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Envirocheck® Flood

EA/NRW Historic Flood Map (1:10,000)

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Map ID

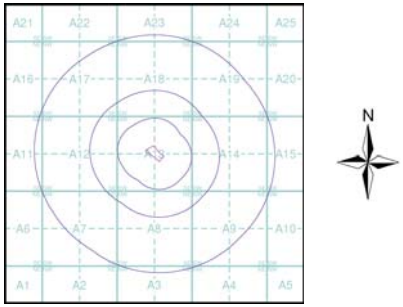
Historic Flood Events Data

- Channel Capacity Exceeded (no raised defences)
- Groundwater/High Water Table
- Local Drainage/Surface Water
- Mechanical Failure
- Obstruction/Blockage - Bridge
- Obstruction/Blockage - Channel
- Obstruction/Blockage - Culvert
- Obstruction/Blockage - Debris Screen
- Operational Failure/ Breach of Defence
- Other
- Overtopping of Defences
- Unknown
- Historical Flood Liabilities

Contours (height in meters)

- Standard Contour
- Master Contour
- Spot Height
- MLW Mean Low Water
- MHW Mean High Water

EA/NRW Historic Flood Map - Slice A



Order Details

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Customer Ref:	w1697
National Grid Reference:	306690, 382880
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details

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Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Envirocheck® Flood

BGS Flood Data (1:50,000)

General

Specified Site | Specified Buffer(s) | Bearing Reference Point

Slice | Map ID

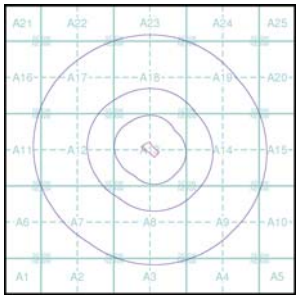
BGS Geological Indicators of Flooding

Coastal

Inland

Bodies of Water

BGS Flood Data Map - Slice A



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Customer Ref:	w1697
National Grid Reference:	306690, 382880
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Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details

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Envirocheck® Flood

BGS Flood Data (1:50,000)

General

Specified Site | Specified Buffer(s) | Bearing Reference Point

Slice | Map ID

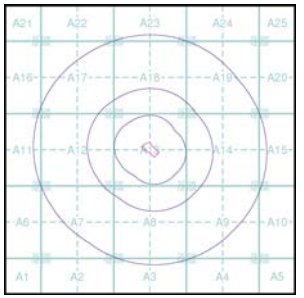
BGS Groundwater Flooding Susceptibility

Potential for Groundwater Flooding to Occur at Surface

Potential for Groundwater Flooding of Property Situated Below Ground Level

Limited Potential for Groundwater Flooding to Occur

BGS Flood Data Map - Slice A



Order Details

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Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

Site Details

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Landmark Information Group

Tel: 0844 844 9952
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Web: www.envirocheck.co.uk

Envirocheck® Flood

EA/NRW NaFRA Data (1:50,000)

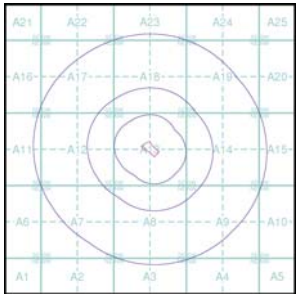
General

Specified Site | Specified Buffer(s) | Bearing Reference Point
Slice | Map ID

National Flood Risk Assessment (NaFRA)

- High Risk
- Medium Risk
- Low Risk
- Very Low Risk

EA/NRW NaFRA Data Map - Slice A



Order Details

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National Grid Reference:	306690, 382880
Slice:	A
Site Area (Ha):	1.02
Search Buffer (m):	1000

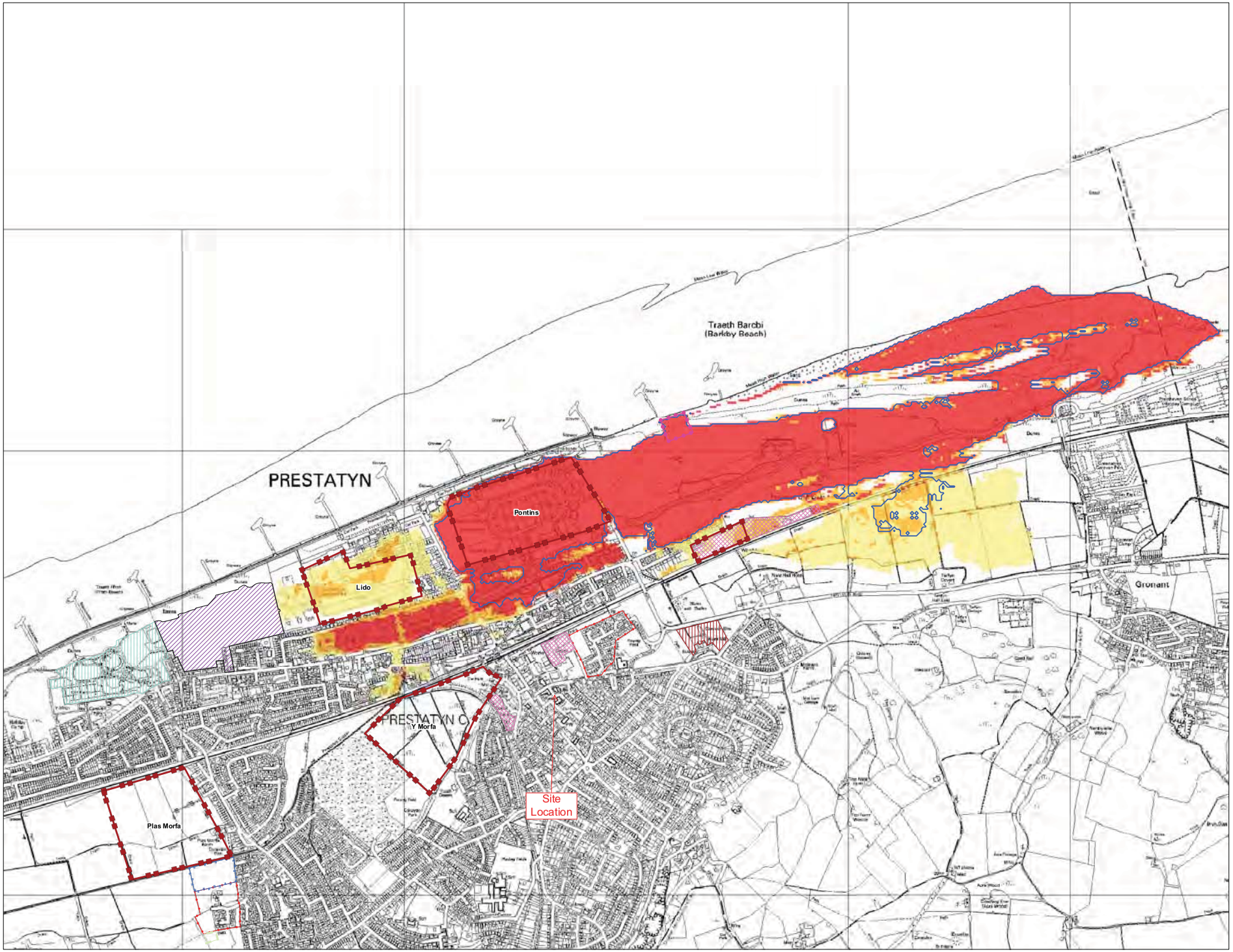
Site Details

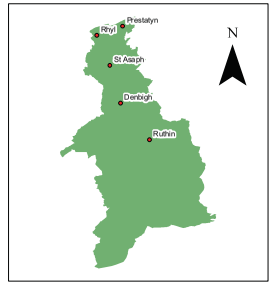
Denbighshire County Council, Social Services Department, Ty Nant, Nant Hall Road,, PRESTATYN, Clwyd, LL19 9LG

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Appendix E – SFCA Maps





LEGEND

Regeneration areas

UDP

- MDA 3: Tower beach, Prestatyn (Built)
- Proposed Touring Caravan site
- School site
- Employment allocation
- Housing allocation or commitment: Main centres
- Community facilities
- Tourism development area

Flooding

- Breach locations

0.1% depth (Also represents 0.5% climate change outline)

- 0m - 0.3m
- 0.3m - 0.6m
- >0.6m
- 0.5% outline

Rev.	Modifications	Date	Drawn	Approved
2	Regeneration areas added	April 07	A L	C S

The Brew House
Wilderspool Park
Greenall's Avenue
Warrington
Cheshire
WA4 6HL

www.jbaconsulting.co.uk
Tel: +44 (0)1925 437020
Fax: +44 (0)1925 437029

Email: jonathan.cooper@jbaconsulting.co.uk

Other offices at Skipton, Bramham, Altrincham, Newcastle upon Tyne, Edinburgh, Thirsk, Doncaster & Ardington

for

Denbighshire County Council : SFCA for Denbighshire

Prestatyn: 0.1% depth grid and 0.5% outline

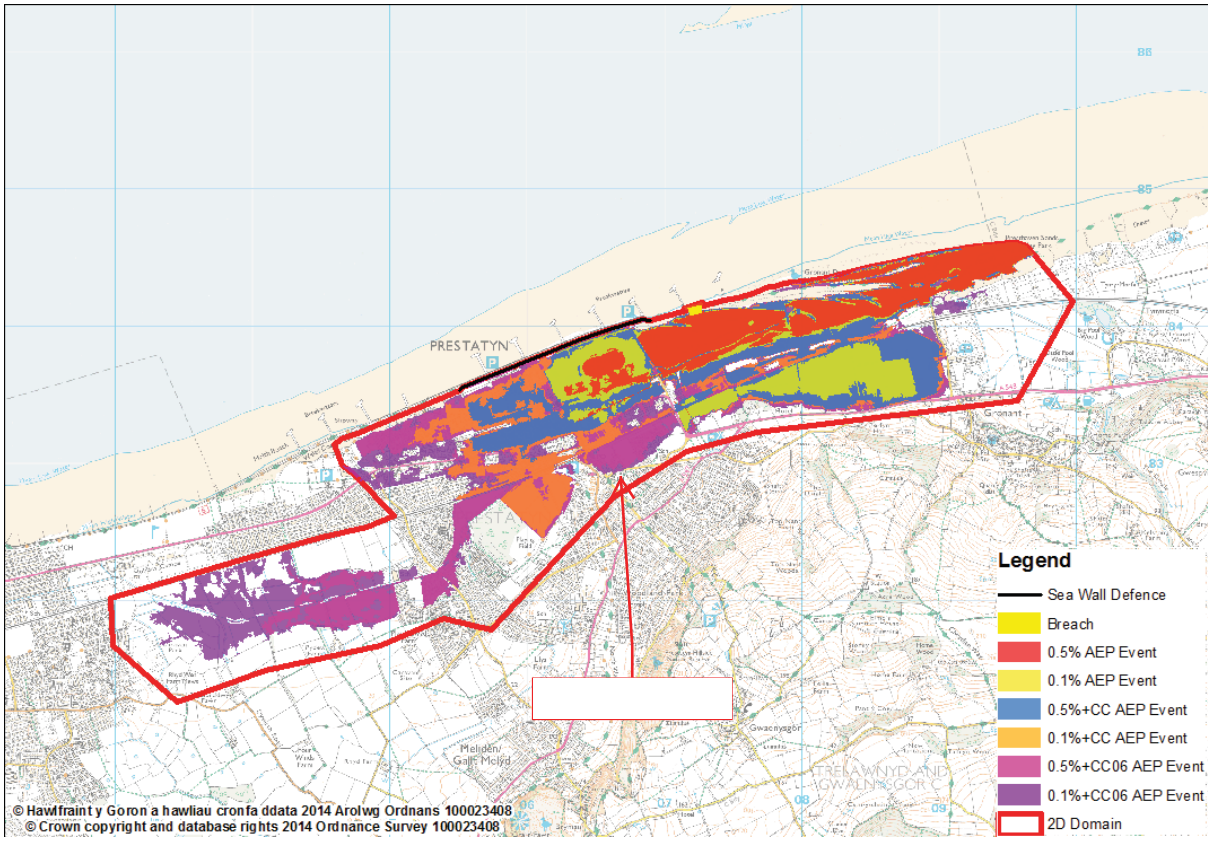
Scale	Drawn	Anneka Lowis	Jan 07
0 0.05 0.1 0.15 0.2 Kilometres	Checked	Chris Smith	
	Approved	Chris Smith	

File Reference: 2006s2017

Figure	Sheet No	Status	Rev.
5 - 3	1 of 1	Final	2

Original @ A1

Figure 6: Extent of flooding for the Prestatyn Breach Model

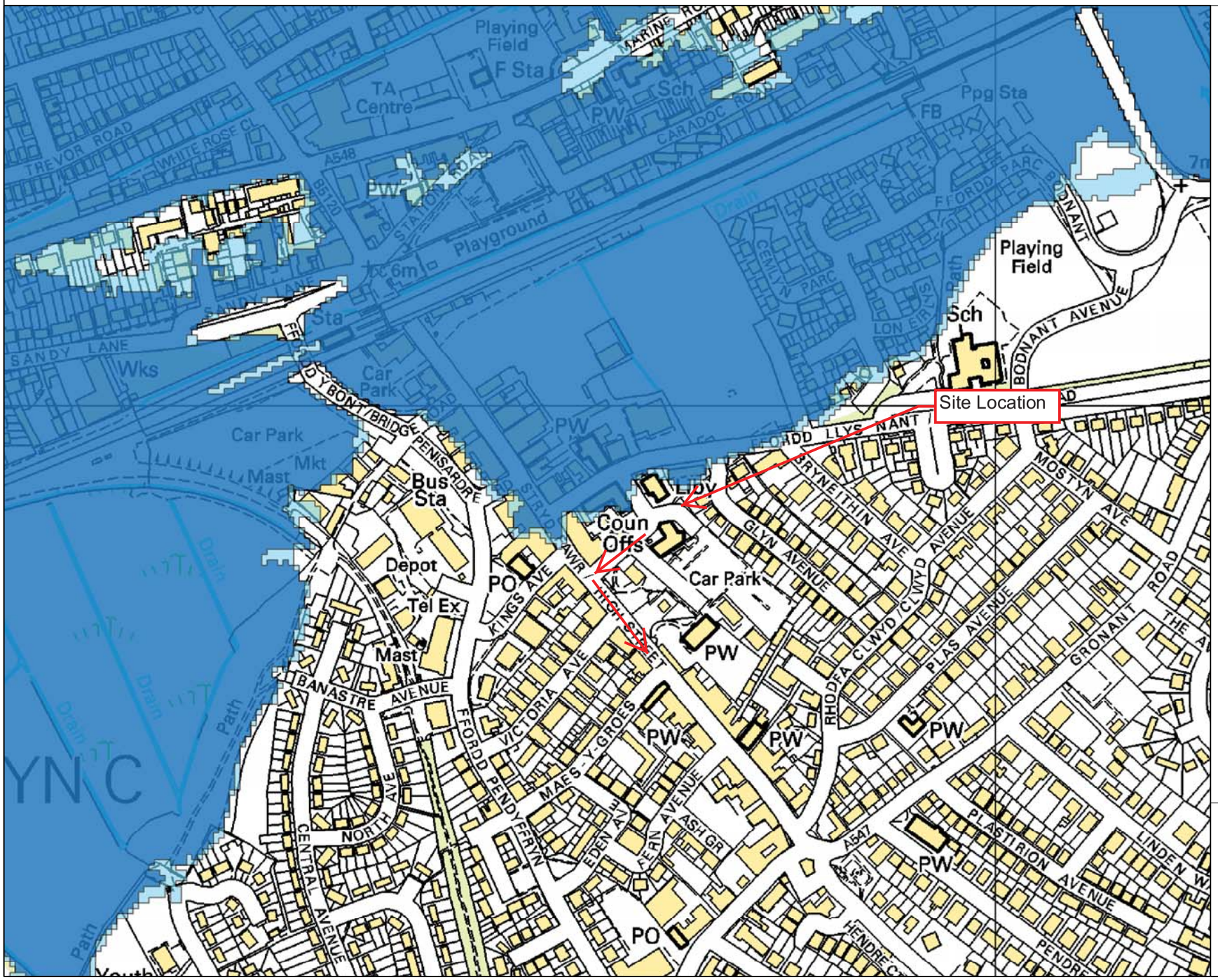


Appendix F – Evacuation Route Plan

Cyfoeth Naturiol Cymru
Natural Resources Wales

Evacuation Route

Tidal Flood Zones at Ty Nant, Prestatyn



Legend

- Tidal Flood Zone 3
- Tidal Flood Zone 2

Flood Zone 3 (tidal) indicates the areas that could be flooded with a 0.5% (1 in 200) or greater tidal chance of happening each year.

Flood Zone 2 (tidal) indicates the extent of an extreme flood from the sea. These areas are likely to be affected by a major flood with up to a 0.1% (1 in 1000) chance of occurring each year.

→ = Access / egress route during flood

0 2550 100 Meters

N

Appendix G – Surface Water Runoff Calculations

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref **w1697**

Client :	Denbighshire County Council	no of pages attached: 1of 14	
Scheme :	Ty Nant, Prestatyn	prefix	revision
Section :	Surface Water Run-off	SWR	A

prepared by:	Johanne Williams	date:	05/11/2014
checked by:	Aled Williams	date:	05/11/2014
approved by:	Deepak Kharat	date:	05/11/2014

Comparison of pre-development and post-development run-off rates and volumes for greenfield or brownfield sites up to 200 Ha

Site description
Proposed development of land at Ty Nant, Nant Hall Road, Prestatyn, Denbighshire, LL19 9LG.

National Grid Reference (centre of site) approx. 306694E 382876N

Design Brief
To calculate both pre and post development rainfall run-off in accordance with the requirements of the Interim Code of Practice for Sustainable Drainage Systems. The peak run-off rates are to be estimated for return periods of up to 100 years and the run-off volumes are also to be calculated for a 1 in 100 year event of 6 hour duration. An allowance for climate change should be included only in the case of the post-development run-off calculation.

Documents Referenced
1. Interim Code of Practice for Sustainable Drainage Systems (ICP-SUDS)(July 2004)
2. I o H Report 124 - Flood Estimation for Small Catchments (Marshall & Bayliss, 1994)
3. FSSR 16 runoff model - Fixed Percentage Runoff Method
4. Wallingford Procedure 1981
5. CIRIA C697 - The SUDS Manual (Feb 2007)

Basis of estimates
The Interim Code of Practice for Sustainable Drainage Systems (July 2004)[1] recommends the use of I o H 124[2] for calculating peak greenfield run-off rates for sites up to 200 Ha. For site less than 50 Ha, the run-off should be caculated for 50 Ha and adjusted in proportion for the actual area. For sites greater than 200 Ha, the FEH run-off model should be used. CIRIA C697[5] recommends the use of the FSSR 16[3] run-off method for calculating the run-off volume for greenfield sites.

For brownfield sites with a recognised drainage system, the Rational Method[4] has been used to calculate the run-off for the impermeable portions of the catchment (pre- & post development). For sites without a proper drainage system, the pre-development run-off is calclulated as for a greenfield site, assuming soil type 5, regardless of type indicated on mapping.

In accordance with TAN15 and assuming a 100yr projection, a 30% on peak rainfall intensity increase in rainfall / run-off has been included to allow for the climate change anticipated in the years 2085 - 2115.

Rainfall data is taken from maps in Defra / EA Tech Report W5-074/A Rev D (see page SWR10 & 11).

Standard Average Annual Rainfall and Soil classification from maps in FSR Report (see page SWR8 & 9).

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR2
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Basis of calculations

Peak run-off rate based on combination of IOH 124 method & Rational method

Run-off volume based on combination of FSSR 16 method & Rational method

N.B. Rational method used for impervious portion of total area for both pre and post development, allowing for pre-development of site where appropriate.

Catchment Details - input data

Proportions of soil type (from maps)

Prop S1	(fraction)		(x 0.15)
Prop S2	(fraction)		(x 0.30)
Prop S3	(fraction)		(x 0.40)
Prop S4	(fraction)	1.000	(x 0.45)
Prop S5	(fraction)		(x 0.50)
Total fraction		1.000	OK - total = 1
Calculated value of SOIL		0.450	
Calculated value of SPR		47.000	

SOIL = (0.15S1+0.3S2+0.4S3+0.45S4+0.5S5) / (S1+S2+S3+S4+S5)
SPR = 10S1 + 30S2 + 37S3 + 47S4 + 53S5

Region number		9	Select from list
AREA	(Ha)	0.9340	(1Ha =0.01Km^2)
SOIL	(fraction)	0.450	Calculated above
SAAR	(mm)	700	From FSR maps
CWI		105	From FSR graph
M5-60 rainfall (mm)		17.00	From Defra / EA maps
Ratio M5-60/M5-2d		0.40	From Defra / EA maps
M100-6hr rainfall (mm)		55.00	From Defra / EA maps
Storm duration (min)		15	**(To give peak run-off-15 min for small site)**
PIMP Pre-develop (%)		95.00	Provided by client
PIMP Post-develop (%)		50.00	Provided by client
Pre-dev drain system?		**Yes**	If "No", whole site assumed pervious - Soil type 5 & pre-dev PIMP taken as zero in following calcs
Climate change			
Rainfall increase (%)		30	Based on TAN15 (for years 2085 - 2115) Applied to post development case only

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR3
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Pre- & Post-development peak run-off - Rational Method
(for impervious portions of catchment only)

Input data from sheet 2

Total area (Ha)	0.9340	from sht 2
Pre dev PIMP (%)	95.00	from sht 2 Or zero if no pre-development drainage
Post dev PIMP (%)	50.00	from sht 2
Pre-dev Imp area (Ha)	0.8873	calculated
Post-dev Imp area (Ha)	0.4670	calculated
M5-60min rain (mm)	17.00	from sht 2
Ratio "r"	0.40	from sht 2
Climate change (%)	30	from sht 2
Storm duration (min)	15.00	from sht 2

Rational Method

Peak run-off Qi = 2.78 Cv Cr i A

Z1 Factor from table	0.633	pro-rata
Volume coeff Cv	0.75	(Typical 0.75)
Routing coeff Cr	1.30	(Standard value 1.3)

Calculation

M5-Dmin rain (mm)	10.761	M5-60min * Z1 factor
Climate change factor	1.30	Applied to post-development run-off only

Return period	1 yr	30 yr	100 yr
Z2 factor from table	0.612	1.525	1.922
Rainfall (mm)	6.59	16.41	20.68
Rainfall intensity (mm/hr)	26.4	65.6	82.7
Rainfall + CC (mm)	8.57	21.33	26.88
R. Intensity + CC (mm/hr)	34.3	85.3	107.5

Peak run-off rate

Pre-development Qi (l/s)	63.49	157.77	198.90
Post-development Qi(l/s)	43.42	107.97	136.07

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR4
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Pre & Post development peak run-off
IOH124 method for pervious areas - Rational method for impervious areas

Input data from sheet 2

Total Area (Ha)	0.9340	from sht 2
Pre-dev PIMP (%)	95.00	from sht 2 Or zero if no pre-development drainage
Post-dev PIMP (%)	50.00	from sht 3
Pre-dev Perv area (Ha)	0.0467	Calculated **< 50 Ha or 0.5 Km2**
Post-dev Perv area (Ha)	0.4670	Calculated **< 50 Ha or 0.5 Km2**

Region number		9	from sht 2	Pre-dev	
SOIL	(fraction)	0.450	from sht 2	SOIL 0.450	from sht 2 or fixed 0.5
SAAR	(mm)	700	from sht 2		if no drainage system

Regional growth factors

Multiplier for 1/1 yrs	0.82	FSSR 14 table 1 (lookup table)
Multiplier for 1/30 yrs	1.77	FSSR 14 table 1
Multiplier for 1/100 yrs	2.18	FSSR 14 table 1

Climate change factor 1.3 Applied to post-development run-off only

Mean annual flood Qbar = 0.00108*(AREA/100)^0.89*SAAR^1.17*SOIL^2.17

	Pre-development		Post development	
Qbar' (for 50 Ha) (m3/s)	0.21966	basis of pro-rata	0.21966	basis of pro-rata
Qbar (actual area) (m3/s)	0.00021	pro-rata (A/50)*Qbar'	0.00205	pro-rata (A/50)*Qbar'

Peak flows (IoH 124)

Return period	1 yr	30 yr	100 yr	1 yr	30 yr	100 yr
Multiplier	0.820	1.770	2.180	0.820	1.770	2.180
Peak run-off (m^3/s)	0.00017	0.00036	0.00045	0.00168	0.00363	0.00447
Peak + CC Qp (m^3/s)	n/a	n/a	n/a	0.00218	0.00472	0.00581

Total peak flows (l/s)

Perv area flow-Qp (l/s)	0.17	0.36	0.45	2.18	4.72	5.81
Imp area flow -Qi (l/s)	63.49	157.77	198.90	43.42	107.97	136.07
Total peak flow Q (l/s)	63.66	158.13	199.35	45.60	112.69	141.88
Peak flow increase (l/s)				-18.06	-45.44	-57.47

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR5
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Pre & Post development run-off volume - FSSR 16
Applied to pervious and impervious areas
For 1 in 100yr 6hr storm

Input data from sheet 2

Total area (Ha)	0.9340	from sht 2				
Pre-dev PIMP (%)	95.00	from sht 2	Or zero if no pre-development drainage			
Post-dev PIMP (%)	50.00	from sht 2				
Pre-dev Perv Area (Ha)	0.0467	calculated				
Pre-dev Imp Area (Ha)	0.8873	calculated				
Post-dev Perv Area (Ha)	0.4670	calculated	**Rainfall data**			
Post-dev Imp Area (Ha)	0.4670	calculated	(M100-360 min)			
SAAR (mm)	700.0	from sht 2	**Rainfall P (mm)**	55.00	from sht 2	
CWI	105	from sht 2	CC factor	1.30	from sht 2	
SPR (%)	47.00	from sht 2	**Rainfall Pcc (mm)**	71.50	calculated	

DPR_{CWI} (%)		-5.000	calc	0.25*(CWI-125)
DPR_{RAIN} (%)		5.035	calc	0.45*(P-40)^0.7 for P>40mm
PR_p (%)	(perv area)	47.035	calc	SPR + DPR_{CWI} + DPR_{RAIN}
PRi (%)	(imp area)	100.000	defined	100% of impervious area

Storm duration (mins)	360	defined

Run-off volume V = PR/100 * A*10000 * P/1000 = PR * A * P / 10 (m3)

where	PR = Percentage run-off	PR_p or PRi (%)	
	A = Catchment area	A_p or A_i	(Ha)
	P = Rainfall depth (M100-360)	P or Pcc	(mm)
	(including climate change for post development only)		

	Pre-dev	Post dev
	-	incl CC
Run-off volume- Pervious area (m3)	12.08	157.05
Run-off volume- Impervious area (m3)	488.02	333.91
Total run-off volume (m3)	500.10	490.96
Volume increase (m3)		-9.14

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR6
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Z1 Factor for England & Wales (Values from BRE 365 - Table 1)

Ratio	Rainfall Duration (mins)					
r	15	30	60	120	240	360
0.12	0.450	0.670	1.000	1.480	2.170	2.750
0.15	0.480	0.690	1.000	1.420	2.020	2.460
0.18	0.510	0.710	1.000	1.360	1.860	2.250
0.20	0.530	0.723	1.000	1.340	1.800	2.163
0.21	0.540	0.730	1.000	1.330	1.770	2.120
0.24	0.560	0.750	1.000	1.300	1.710	2.000
0.25	0.567	0.753	1.000	1.290	1.687	1.960
0.27	0.580	0.760	1.000	1.270	1.640	1.880
0.30	0.590	0.770	1.000	1.250	1.570	1.780
0.33	0.610	0.780	1.000	1.230	1.530	1.730
0.35	0.617	0.787	1.000	1.223	1.497	1.690
0.36	0.620	0.790	1.000	1.220	1.480	1.670
0.39	0.630	0.800	1.000	1.210	1.460	1.620
0.40	0.633	0.803	1.000	1.207	1.447	1.603
0.42	0.640	0.810	1.000	1.200	1.420	1.570
0.45	0.650	0.820	1.000	1.190	1.380	1.510

Z2 Factors for England & Wales from table 6.2 - Wallingford Procedure

M5 Rain (mm)	Diff (mm)	M1	M30	M100
		1	**30**	100
5.00	5	0.62	**1.45**	1.79
10.00	5	0.61	**1.52**	1.91
15.00	5	0.62	**1.55**	1.99
20.00	5	0.64	**1.58**	2.03
25.00	5	0.66	**1.57**	2.01
30.00	10	0.68	**1.55**	1.97
40.00	10	0.70	**1.50**	1.89
50.00	25	0.72	**1.45**	1.84
75.00	25	0.76	**1.36**	1.64
100.00	50	0.78	**1.32**	1.54
150.00	50	0.78	**1.26**	1.45
200.00		0.78	**1.24**	1.40
N.B. M30 Factors interpolated graphically				

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

Hydrological Regions (From Defra / EA R&D Tech Report W5-074/A Rev D)

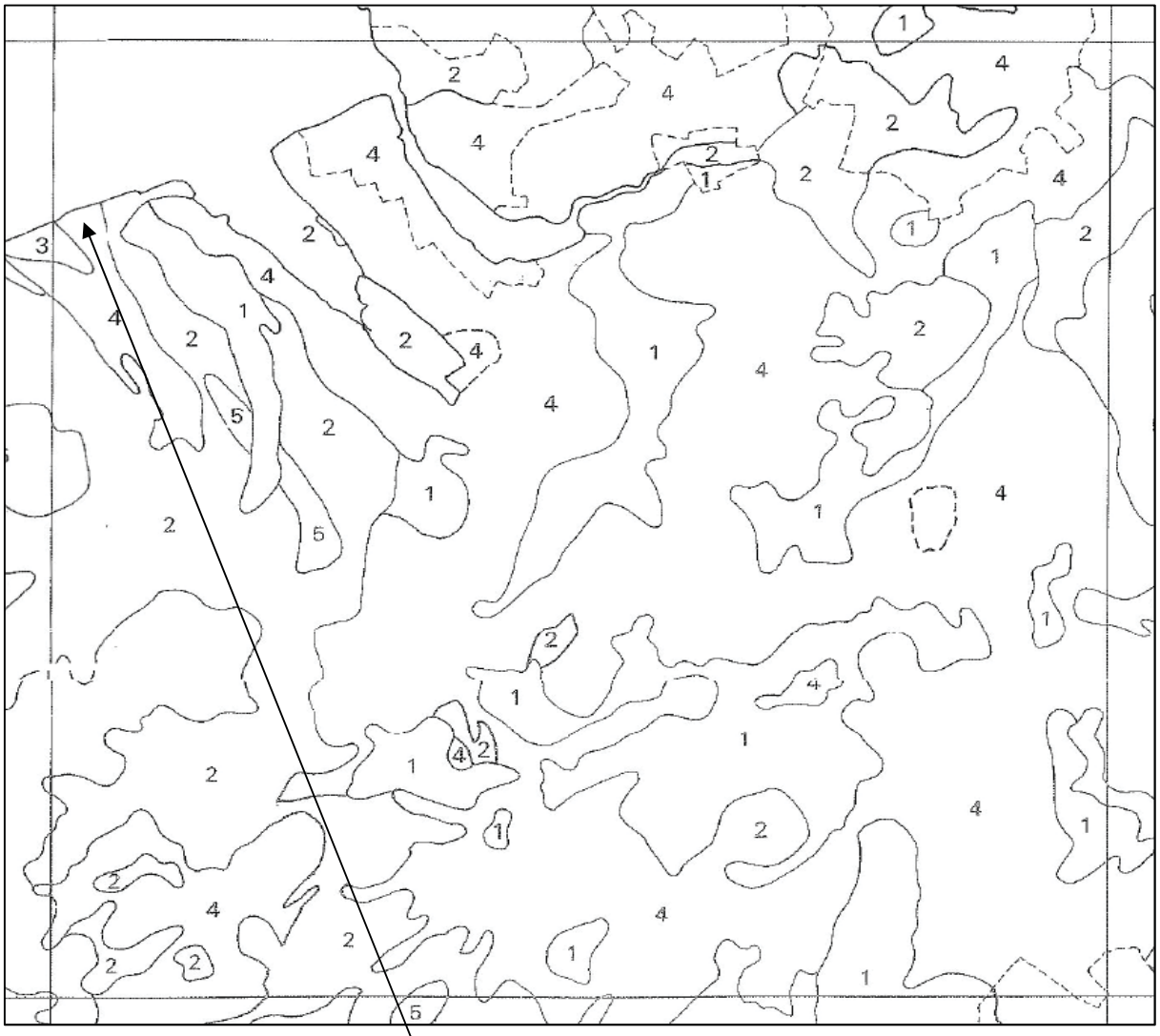
Figure 1.1 Hydrological regions of UK

Grid Ref: - 306694E 382876N - Hydrological Region 9

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR8
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Soil Classification Chart

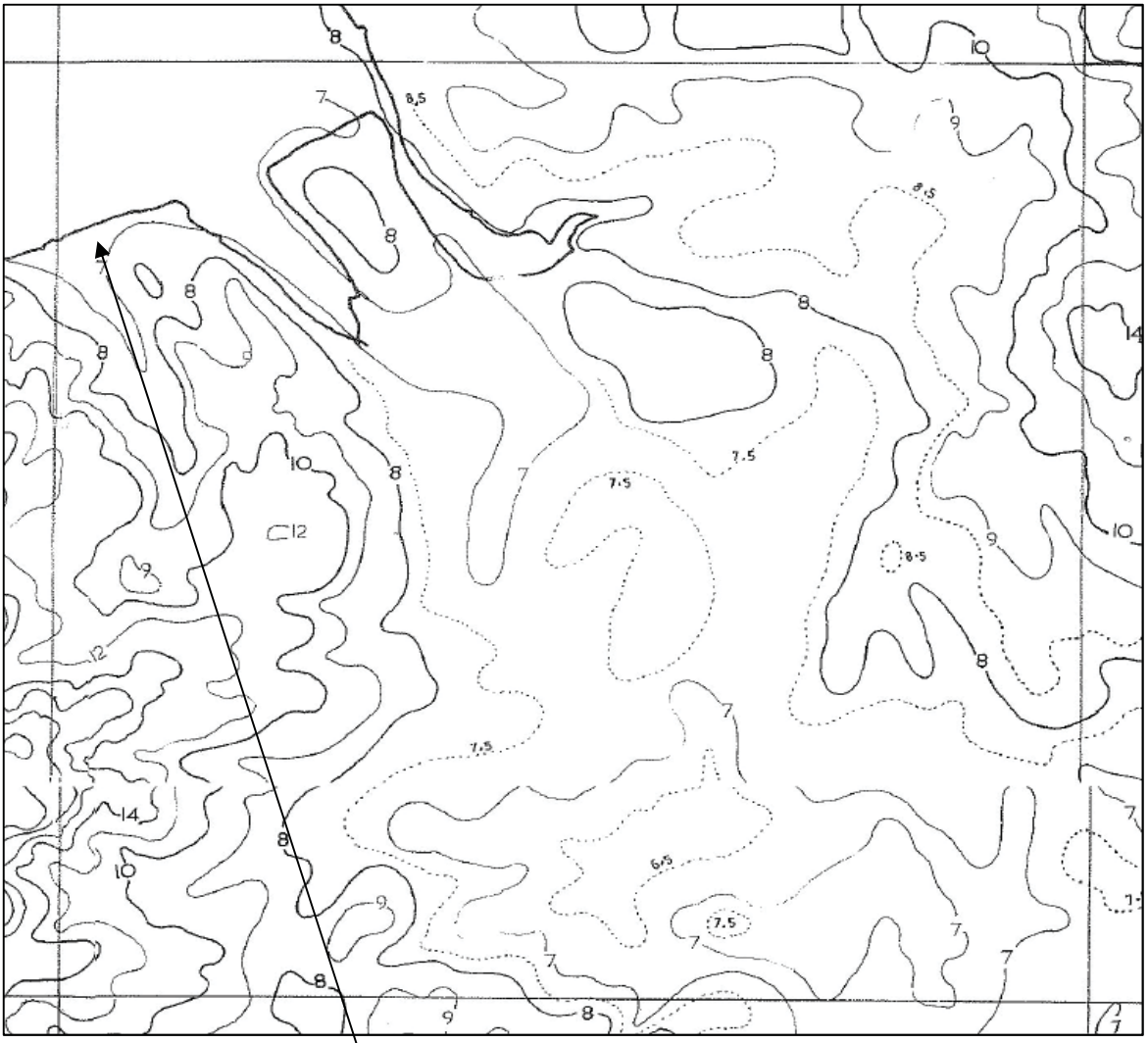


Grid Ref: - 306694E 382876N - Soil Classification = 4

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR9
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Standard Annual Average Rainfall (SAAR) Chart



Grid Ref: - 306694E 382876N - SAAR = 700mm

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

M5-60min Rainfall + r (From Defra / EA R&D Tech Report W5-074/A Rev D)

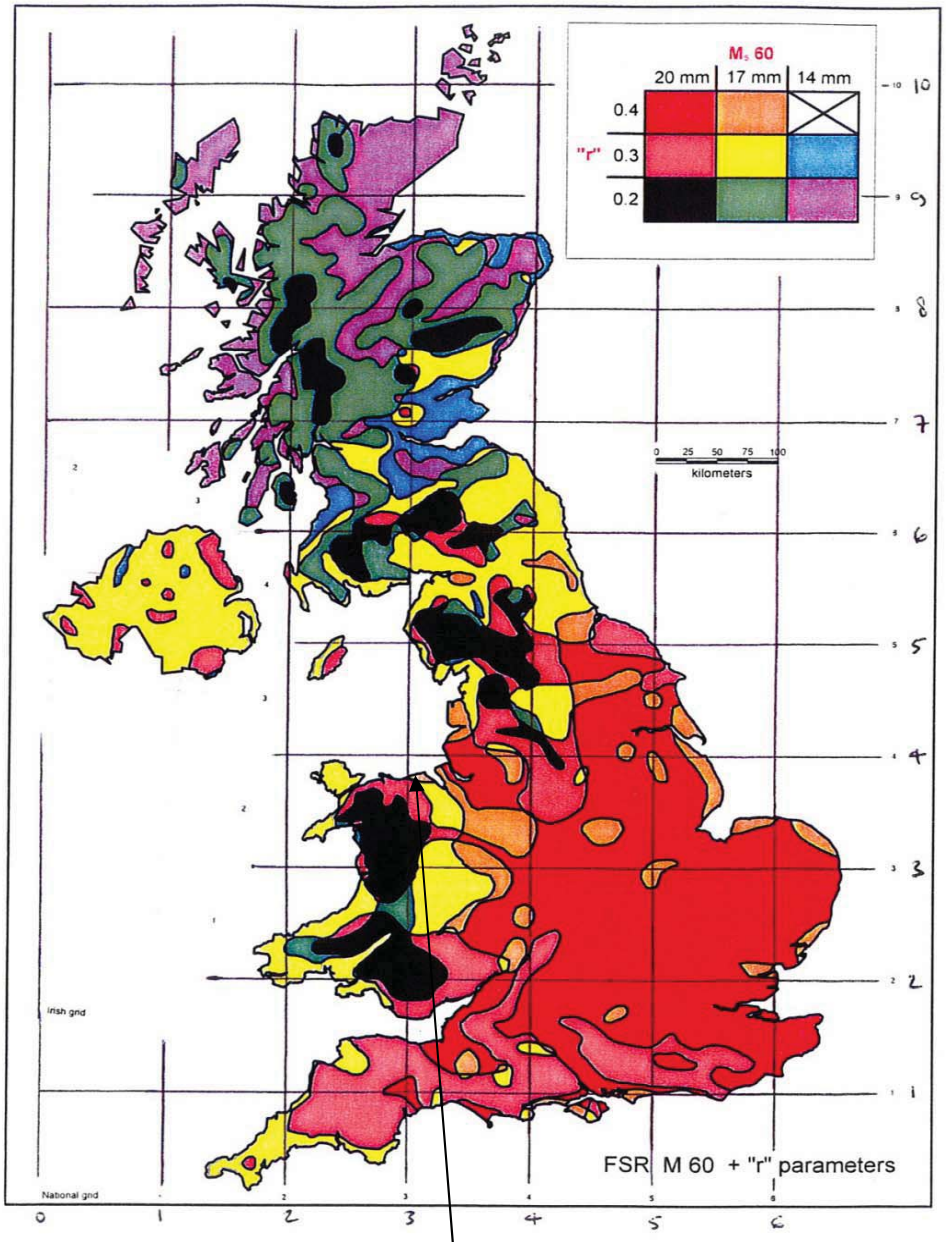


Figure 2 Hydrological rainfall zones of UK

Grid Ref: - 306694E 382876N - M5-60 = 17mm, 'r' = 0.4

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

M100 6hr Rainfall (From Defra / EA R&D Tech Report W5-074/A Rev D)

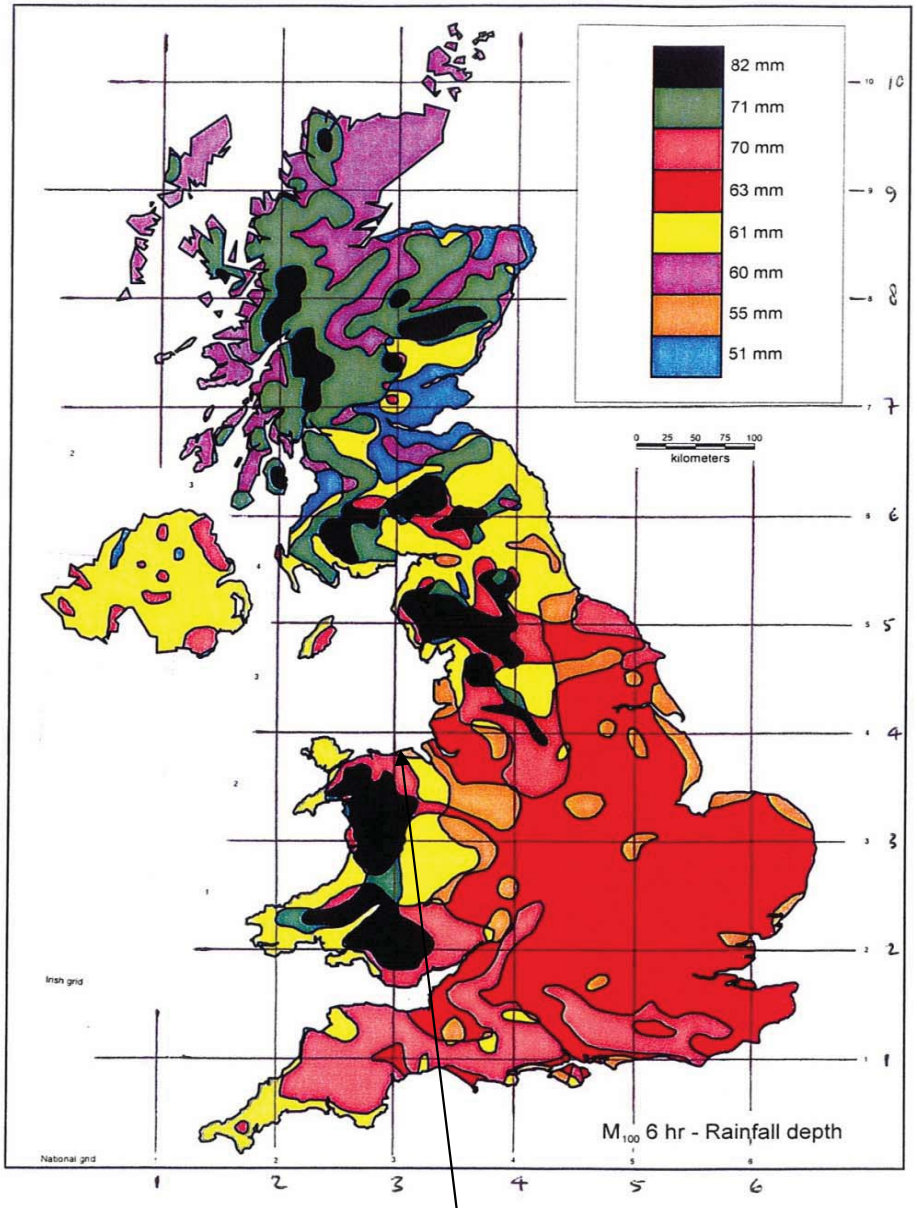


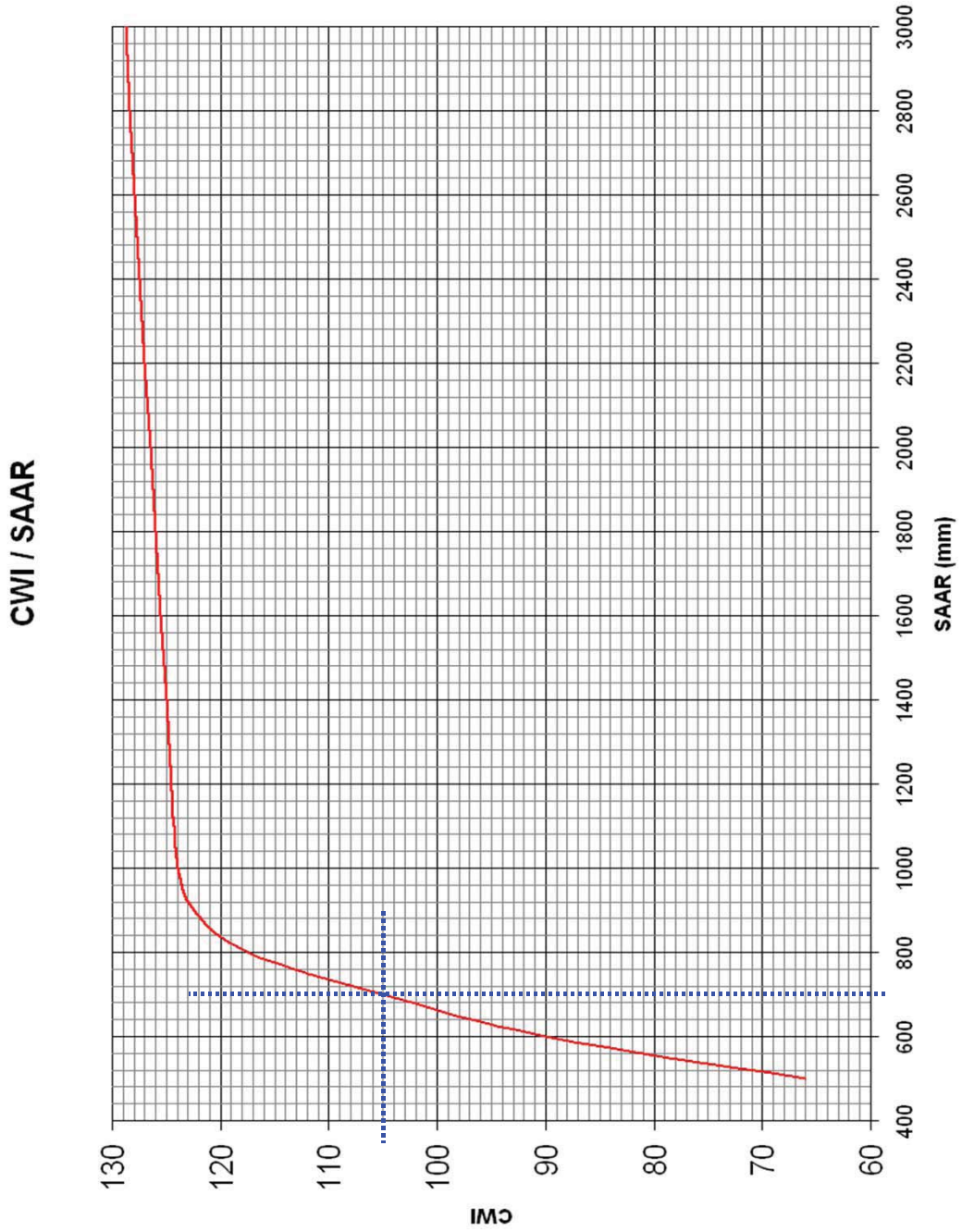
Figure 3.1 100 year 6 hour rainfall depths of UK

Grid Ref: - 306694E 382876N - M100-6hr Rainfall = 55mm

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR12
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

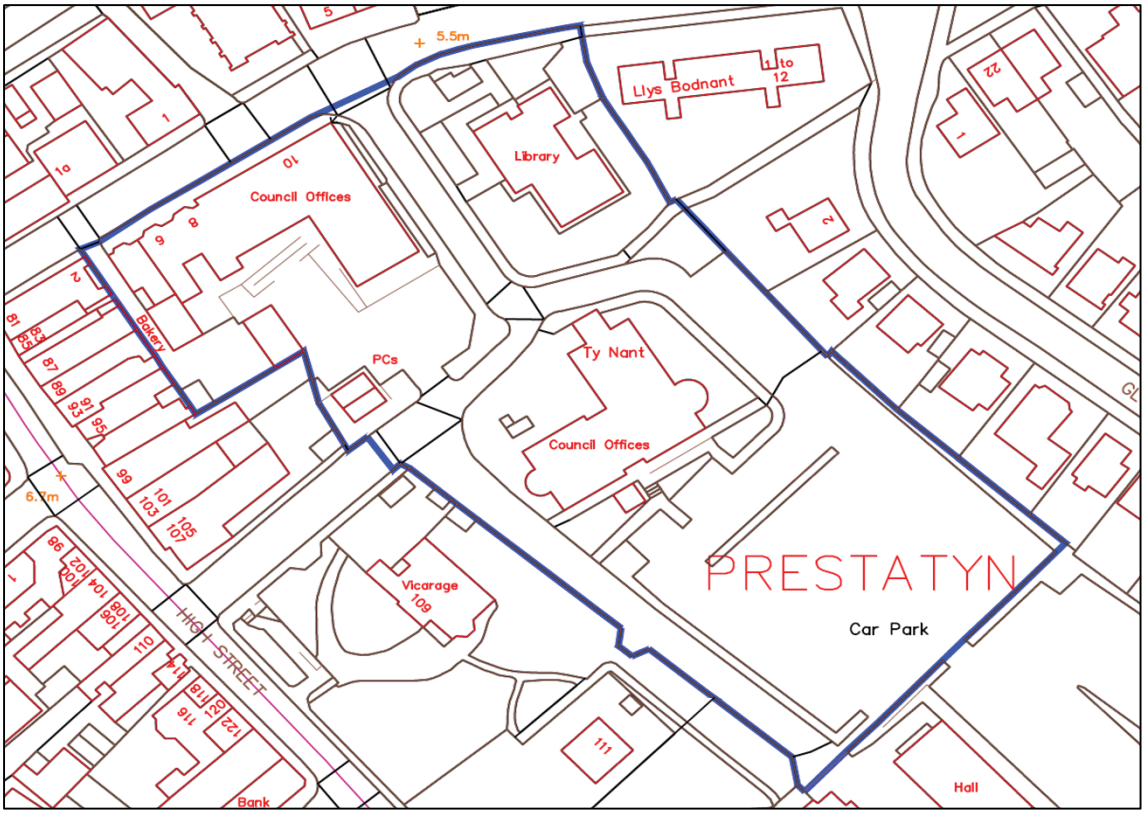
Catchment Wetness Index (CWI) vs Standard Annual Average Rainfall (SAAR)



N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR13
Scheme :	Ty Nant, Prestatyn		dated : 05/11/2014
Section :	Surface Water Run-off		

Pre-development Area



Total Area = 9340m²
Permeable Area = 5% = 467m²
Impermeable Area = 95% = 8873m²

= Site Boundary

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.

File Ref:w042-CT-04-03-F-SW Run-off-CSH 20101
Form Ref: w042-CT-04-03-F

waterco consultants	Eden Court, Lon Parcwr, Ruthin, 01824 702220	Calculations	ref : **w1697**
			prefix - page no. SWR14
Scheme :	Ty Nant, Prestatyn		dated :
Section :	Surface Water Run-off		05/11/2014

Post-development Area

Total Area = 9340m²
Permeable Area = 50% = 4670m²
Impermeable Area = 50% = 4670m²

N.B. These calculations are for planning purposes only and will need to be reviewed at the detailed design stage.