Whitland Green Park Ltd

WHITLAND CREAMERY

Flood Consequences Assessment

7007-1713-C-RP-002-00
NOVEMBER 2022

CONFIDENTIAL

Whitland Green Park Ltd

WHITLAND CREAMERY

Flood Consequences Assessment

TYPE OF DOCUMENT (VERSION) CONFIDENTIAL

PROJECT NO. 70071713

OUR REF. NO. 7007-1713-C-RP-002-00

DATE: NOVEMBER 2022

WSP

1 Capital Quarter
Tyndall Street
Cardiff
CF10 4BZ

Phone: +44 2920 769 200

WSP.com

QUALITY CONTROL

Issue/revision	First issue	Revision 1	Revision 2	Revision 3
Remarks	First Issue			
Date	November 2022			
Prepared by	Richard Curtis			
Signature				
Checked by	Andrew Wilkinson			
Signature				
Authorised by	Andrew Wilkinson			
Signature				
Project number	70071713			
Report number	7007-1713-C-RP-002-00			
File reference	\\central data\Projects\700717xx\70071713 - Whitland - St Mary Street\03 WIP\EI EIA and Flood Risk\05 Reports\FCA			

CONTENTS

TABLES

FIGURES

APPENDICES

1. INTRODUCTION AND BACKGROUND

1.1. ACKNOWLEDGEMENTS

WSP would like to acknowledge NRW for licencing their existing model of Whitland and for advice communicated through their Discretionary Planning Advice Service (Appendix A).

1.2. INTRODUCTION

WSP was commissioned to undertake a flood study at the old Whitland Creamery, Whitland, Carmarthenshire. This report comprises an FCA based on the results from the model study.

This FCA has been undertaken in accordance with Technical Advice Note 15 (TAN15) and is based on data sets provided by the client and licensed from Natural Resources Wales (NRW). TAN15 advises on development and flood risk by providing a framework within which risks arising from river flooding, coastal flooding and runoff from development can be assessed.

The Construction Industry Research and Information Association (CIRIA) has defined a tiered three-level approach to flood risk assessment (C624)[1] which will be used to identify the level of detail required for this FCA proportionate to the degree of flood risk. The three levels defined are as follows:

- Level 1 Screening study to identify whether there are any flooding issues related to a development site which may warrant further consideration;
- Level 2 Scoping study to be undertaken for each potential flood risk issue that is identified as being associated with a site during a Level 1 FCA. A Level 2 FCA involves a qualitative assessment of the flood risk to the site, and the impact of the site on flood risk elsewhere; and
- Level 3 Detailed study to be undertaken if the Level 2 study concludes that quantitative analysis is required to assess flood risk issues related to the development site.

Given the magnitude of the Scheme and the changes that are proposed within and adjacent to the floodplain it was deemed appropriate to undertake a Level 3 FCA to provide a robust evidence base to support the planning application.

This FCA should be read alongside the Hydraulic Modelling Report (7007-1713-C-RP-001-00) describing the modelling exercise undertaken and detailed consideration of modelling results.

1.3. LOCATION

The Old Whitland Creamery Site is a 1.7 ha site located between St Mary's Street, the Afon Gronw, the B4328 (Market Street) and the railway line as it approaches Whitland Station in the town of Whitland Carmarthenshire SA34 0PY. Site levels are understood to be around 18 and 19 m AOD and are generally higher in the north. Figure 1-1 below[2] shows the site location.

[1] Lancaster J.W. , Preene, M. & Marshall, C.T. (2004) *Development and flood risk - guidance for the construction industry* CIRIA C624 ISBN 0-86017-624-X

[2] CONTAINS OS DATA © CROWN COPYRIGHT AND DATABASE RIGHT 2020 – https://www.ordnancesurvey.co.uk/business-and-government/licensing/using-creating-data-with-os-products/os-opendata.html

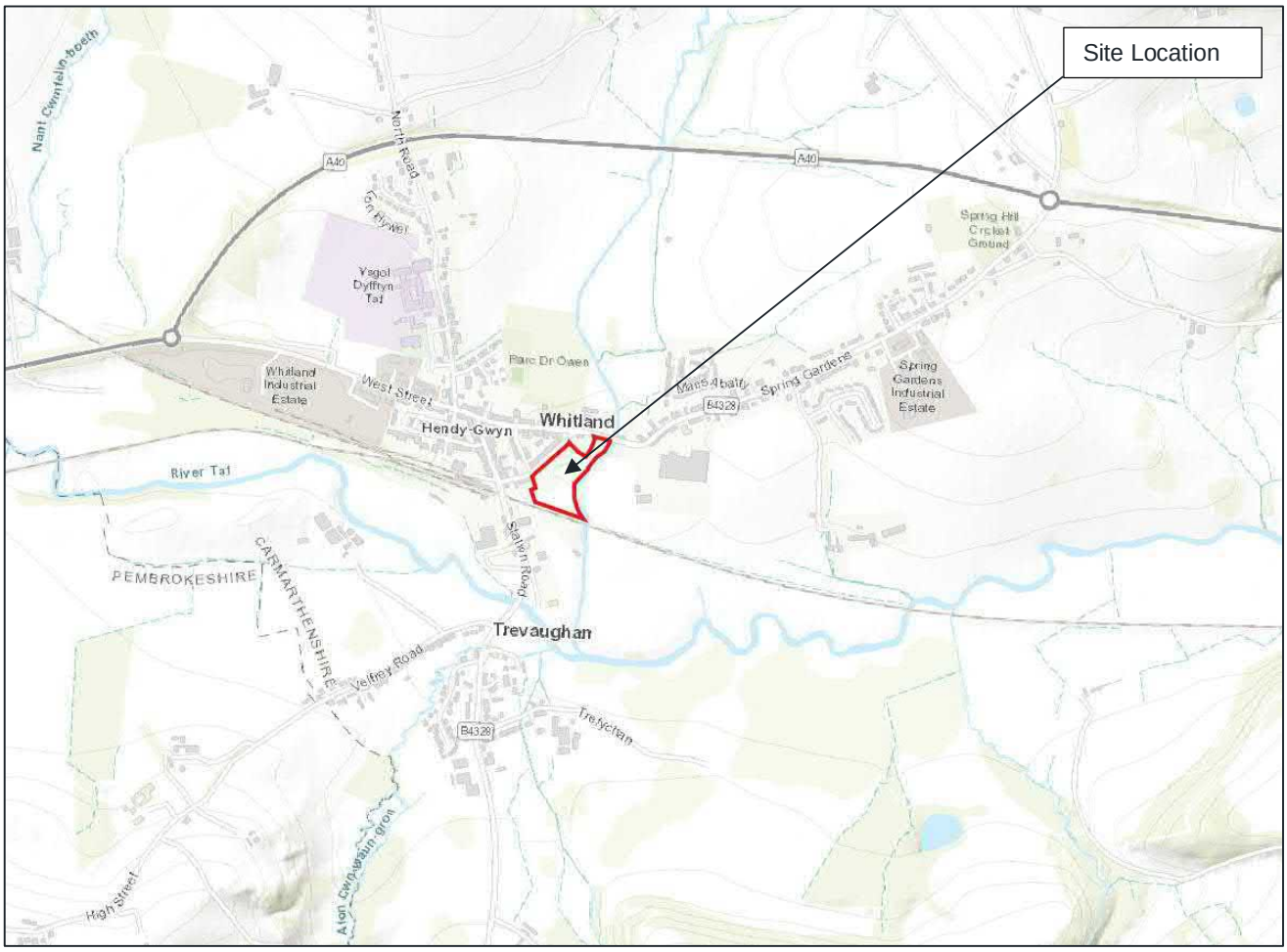


Figure 1-1: Site Location

1.3.1. HYDROLOGICAL ENVIRONMENT

The site is adjacent to approximately 220 m of reach alongside the right (western) bank of the Afon Gronw some 330 m from its confluence with the Afon Tâf. This short reach includes 5 structures of interest from upstream to downstream:

1. At its upstream (northern) end the river is crossed by the Market Street (B4328) road bridge, which comprises of two spans; a box culvert on the right and a parallel arch (within a short segment of box culvert) on the left.
2. A flood defence wall follows the right hand bank of the river parallel to the site, it extends for the full 220 m length between the two bridges and the defence feature continues upstream of Market Street in the form of an earthen bund.
3. A single span steel footbridge crosses the Afon Gronw approximately 125 m downstream of Market Street, but does not appear to be associated with a public right of way.
4. Approximately 70 m downstream of the footbridge is a semi demolished sluice structure with walkway which once diverted waters for the creamery. It is understood that the sluices have been removed but the concrete formation and parallel channel remain.

5. At the downstream (southern) end the river is spanned by a flat soffit railway bridge with two supporting piers.

Figure 1-2 to Figure 1-5 show these structures which were obtained to inform the 2010 NRW model study licenced for this project.

Figure 1-2: Market Street Bridge[3]

[3] Maltby Land Surveyors Ltd (27/05/2010) *GRON01_0600_USF3* [Photograph; taken at 07:42]. In possession of: Natural Resources Wales.

Figure 1-3: Site Footbridge (showing defence wall, right bank)[4]

[4] Maltby Land Surveyors Ltd (28/05/2010) *GRON01_0453_USF2* [Photograph; taken at 10:15]. In possession of: Natural Resources Wales.

Figure 1-4: Site sluice structure (showing overflow channel, left bank)[5]

N.B. Sluice gates have been removed since this photograph was taken.

[5] Maltby Land Surveyors Ltd (28/05/2010) *GRON01_0385_USF3* [Photograph; taken at 09:18]. In possession of: Natural Resources Wales.

Figure 1-5: Railway Crossing[6]

1.3.2. GEOLOGICAL ENVIRONMENT

According to the British Geological Society maps, the known superficial deposits within the redline boundary are alluvial deposits of clay, silt, sand and gravel overlying Didymograptus Bifidus Mudstone Beds with soil textures expected to be a clay to sandy loam associated with the river.

1.4. PROPOSED DEVELOPMENT SUMMARY

The site is under consideration for a residential development along with associated public open space and amenities. The development comprises a number of residential units and a public car park with vehicular access off St Mary's Street. It has been proposed to raise the development site above the

[6] Maltby Land Surveyors Ltd (28/05/2010) *GRON01_0347_USF2* [Photograph; taken at 07:29]. In possession of: Natural Resources Wales.

design flood level to reduce the risk of onsite flooding and direct waters safely towards the lower southern portion of the site.

1.5. FLOOD EVENT DEFINITION

There are a number of ways in which the likelihood or probability of a flood can be described. It is standard practice within the UK to refer to a flood in terms of its Return Period (RP), which is the average interval in years between consecutive events exceeding a specified magnitude. It is also possible to express an event in terms of its Annual Exceedance Probability (AEP). The AEP is the percentage chance that a flood of a specified magnitude or greater may occur in any given year. The equivalence between the two methods of describing the rarity of events is shown in Table 1-1 below.

Table 1-1: Annual Exceedance Probability - Return Period Equivalence

AEP (%)	50	20	10	4	3.3	2	1	0.1
RP (1 in *X* years)	2	5	10	25	30	50	100	1000

The equivalence[7] reported in the above table holds for return periods substantially greater than one year.

For fluvial simulations there are two key events of interest, the 1%CE AEP event is the design event, the CE denotes the central estimate uplift for climate change over the anticipated lifespan of the development, it is equivalent to the 1 in 100 year return period with the aforementioned climate change allowance. The second event of interest is the 0.1% AEP event or extreme event which is equivalent to the 1 in 1000 year return period.

[7] The equivalence $AEP \approx \left(\frac{1}{RP}\right) * 100$ as reported in table can be more accurately derived as $AEP = \left(1 - e^{(-1/RP)}\right) * 100$

2. EXISTING FLOOD RISK

This section outlines the existing understanding of flood risk at the site, it first considers the key online flood maps (S2.1) with a full set provided in Appendix B, followed by relevant local policies (S2.2) before concluding with historic flood data (S2.3).

2.1. NATURAL RESOURCES WALES FLOOD MAPS

Developments which include residences are classified as Highly Vulnerable Developments in accordance with Technical Advice Note 15 (TAN15). The Natural Resources Wales (NRW) flood maps show that the majority of the site is located within Development Advice Map (DAM) Zone C1. There is a small area of Zone B, this may correspond to a temporary spoil heap no longer extant which may have affected the delineation of DAM Zones. DAM Zone C1 is the area defined by NRW as served by significant infrastructure, including flood defences. According to TAN15, Highly Vulnerable Developments may be permissible in Zone C1, subject to: the Justification Test, acceptability of consequences and surface water requirements. Figure 2-1 below shows an extract from the DAM.

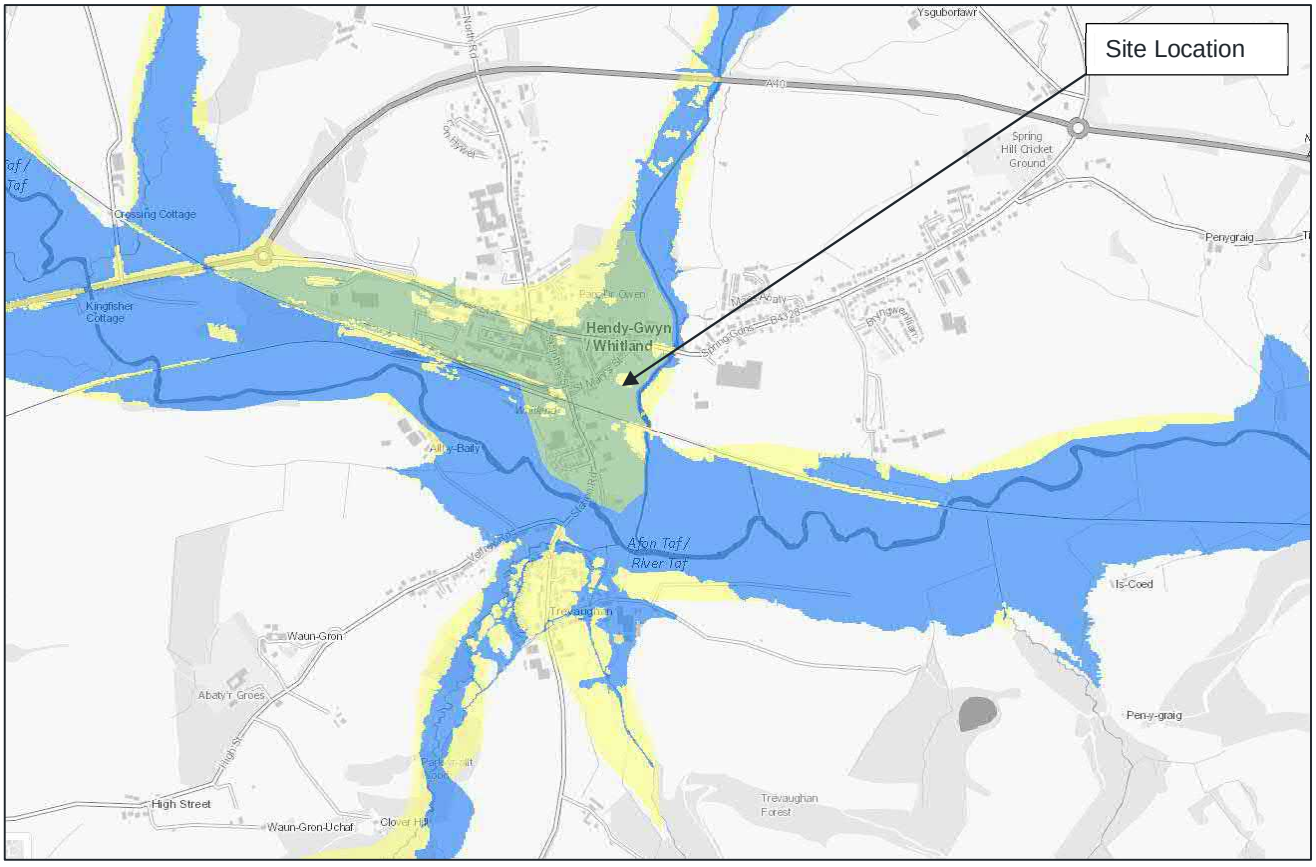


Figure 2-1: Development Advice Map

The map shows that the site is within an area benefitting from flood defences but is otherwise predominantly within area of Low Risk of flooding from rivers. Low Risk is the area NRW predict would flood with a probability of greater than 0.1% Annual Exceedance Probability (AEP) or on average more than once every thousand years from fluvial sources.

Additionally, of note are the flood defences present along the right bank of the Afon Gronw adjacent to the site. A review of the NRW data set indicates that this is assessed as protecting up to the 1% AEP and is in good to fair condition. It does not necessarily follow that the Afon Gronw will flood the site, only that the onset of flooding to the river's floodplain is likely to commence from an event of this magnitude.

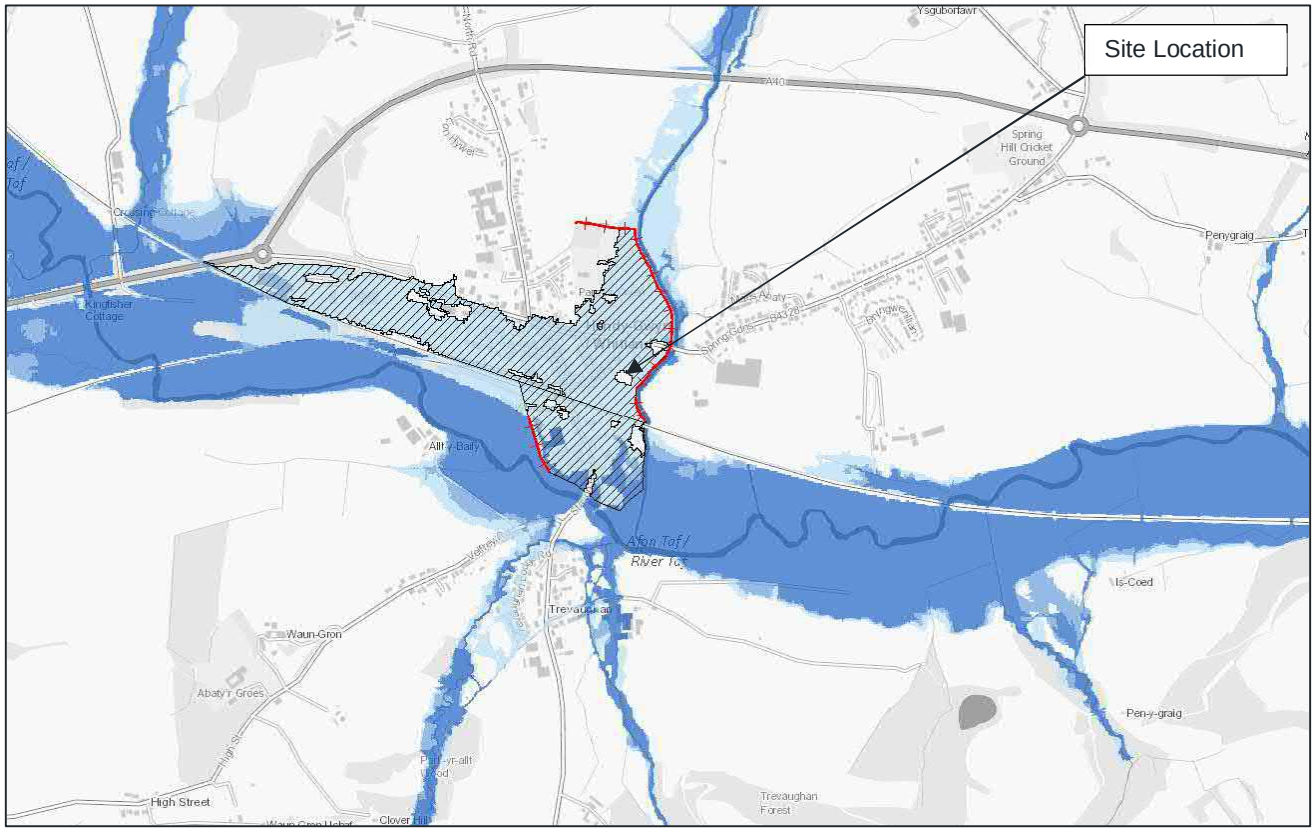


Figure 2-2: NRW Flood Zone Map

The NRW surface water flood map shown in Figure 2-3 below shows that the majority of the site is not in an area considered to be at high risk of flooding from surface water, however isolated low spots on site are considered to be at risk. Local drainage systems are often not explicitly considered in the studies which generate these maps and the level of risk is likely over-estimated.

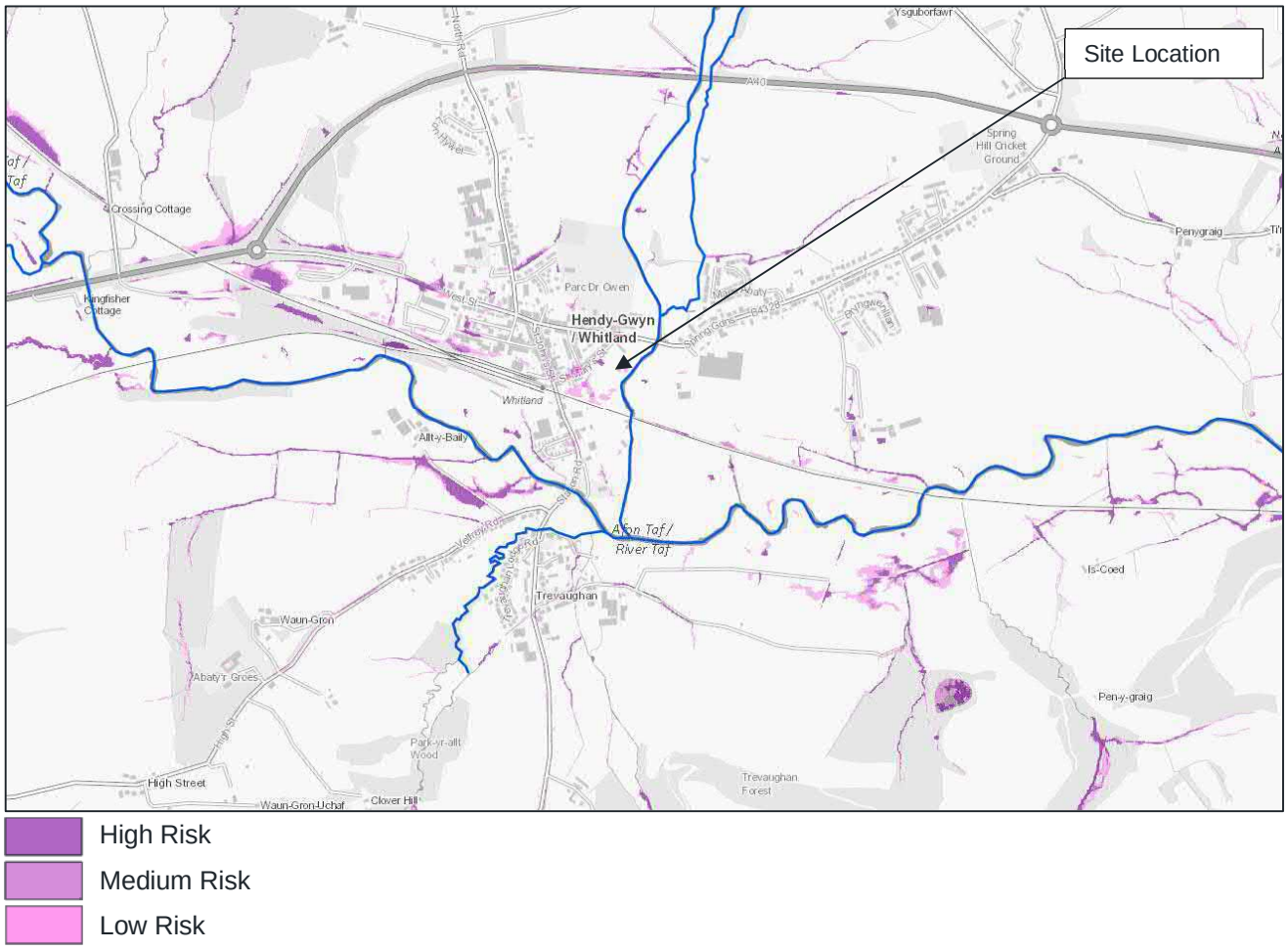


Figure 2-3: NRW Flood Risk from Surface Water & Small Watercourses Map

Figure 2-4 below shows an extract from the NRW Flood Map for Planning, which shows flood risk that includes an allowance for climate change. The recently published mapping is intended to support the new TAN15 guidance and whilst the implementation of this guidance has been suspended until June 2023, the mapping will be treated as a material consideration in planning applications prior to this date. The map shows that the site is predominantly within Flood Zone 3 but falls within an area benefitting from flood defences (rivers). Flood Zone 3 is the area NRW predict would flood either with a probability of greater than 1% Annual Exceedance Probability (AEP) from fluvial sources or 0.5% AEP from tidal or with those probabilities from both sources. Areas considered to be benefiting from defences indicates those areas that benefit from the presence of defences in a 1 in 100 (1%) chance of flooding each year from rivers.

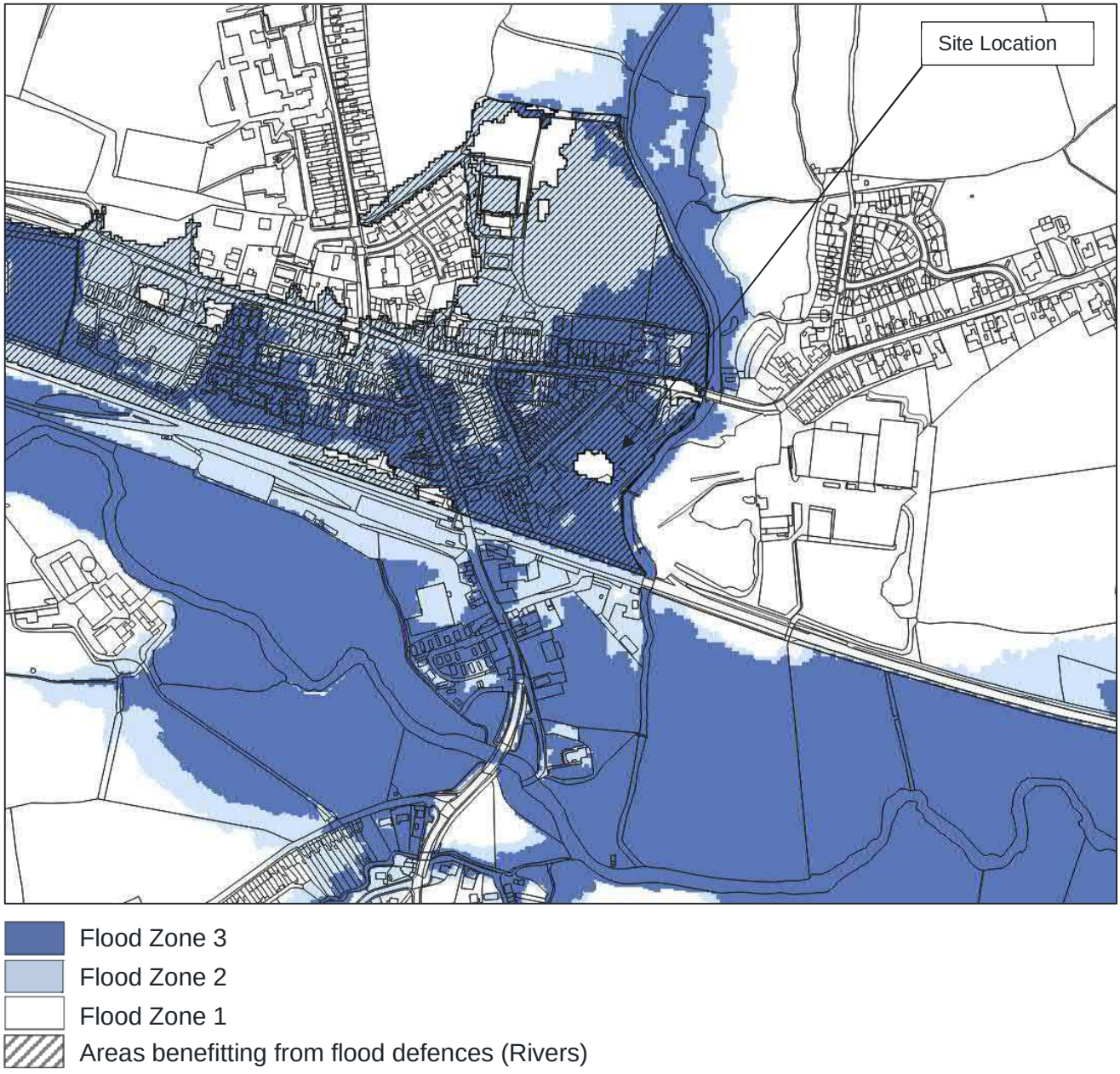


Figure 2-4: NRW Flood Map for Planning

The set of NRW flood maps online and those in Appendix B also illustrate that:

- The site is **not** predicted to be at risk of flooding from the sea.
- The site is **not** predicted to be at risk of flooding from an assessed reservoir breach
- The site *is* within a flood warning area
- A recorded historic flood outline is centred on St Mary's Street and encroaches onto the site access.
- The site is **not** within a source protection zone
- The site *is* situated within a Low productivity aquifer zone.

2.2. RELEVENT LOCAL POLICIES

2.2.1. STRATEGIC FLOOD CONSEQUENCES ASSESSMENT

Carmarthenshire and Pembrokeshire Councils have a joint Level 1 Strategic Flood Consequence Assessment (SFCA).

The site is noted as a potential candidate site for the Carmarthenshire Local Development Plan, with reference SR/163/007. The site is identified as a "Red" site, that is, a site considered at high risk of flooding[8]. According to the SFCA, 90% of the site is within NRW's Flood Zone 2, 45% is at risk of surface water flooding, and that none of the site is considered at risk from sea level rise. The SFCA states that further analysis is required to assess suitability for development and eligibility for inclusion within the LDP.

The SFCA also notes that, at the time of its writing, no data was available regarding flood risk from groundwater. It also does not comment on any known instances of sewer flooding.

2.2.2. OTHER STUDIES OF INTEREST

There are several other reports that are of interest to this document, which although not specific to Whitland, are of relevance concerning the more general hydrological environment. These include:

- The Shoreline Management Plan 2 (SMP2)[9]
- Sea Level Rise Data and User Guide (SC060064/TR7)
- CCC Flood Risk Management Plan: Part 1[10]
- Local Flood Risk Management Strategy[11]

The Flood Risk Management Plan for Whitland notes issues of surface water flooding around the areas of North Road and Llangan Road. It also notes that the wider area of Whitland is served by defences constructed circa 1985 in response to flooding from the Main Rivers Tâf, Gronw and Cwm

[8] Atkins, 2019. *Carmarthenshire & Pembrokeshire Stage 1 Strategic Flood Consequence Assessment*. Carmarthen: Carmarthenshire County Council.

[9] Halcrow, 2012. *Lavernock Point to St. Ann's Head Shoreline Management Plan Review SMP2*. Swansea and Carmarthen Bay Engineering Group.

[10] Carmarthenshire County Council, 2019. *Flood Risk Management Plan Part 1*. Carmarthen: Carmarthenshire County Council.

[11] Arup, 2013. *Local Flood Risk Management Strategy*. Carmarthen: Carmarthenshire County Council.

Waun Gron. Furthermore, it states that Dwr Cymru Welsh Water note the areas of Llanghan Road, Market Street, Trevaughan and Velfrey Road as areas of flood risk.

Whitland is not analysed further as an area at particular risk within Part 2[12] of the CCC Flood Risk Management Plan.

2.3. HISTORIC FLOOD DATA

A search of the Chronology of British Hydrological Events[13] for the terms 'Whitland', 'Hendy-Gwyn', 'Taf', 'Gronw' and "Cwm Waun Gron" returned no results of relevance to the area or site.

The SFCA notes significant flooding around 1985 from the Tâf, Gronw and Cwm Waun Gron, as well as surface water flooding issues around the area of North Road and Llagan Road.

Review of NRW's historic flood mapping reveals recorded flood events in the direct vicinity in 1979, and 1981, originating from fluvial sources. The flood extents of both the 1979 and 1981 events appear to incur into the site at the western edge. Additional flood events in the wider Whitland area are noted to have occurred in 1977 and 1993, also from fluvial sources.

The client does not have knowledge of any historic flood events at the site.

[12] Carmarthenshire County Council, 2019. *Flood Risk Management Plan Part 2*. Carmarthen: Carmarthenshire County Council.

[13] CBHE, 2020. Chronology of British Hydrological Events. Available at: http://www.cbhe.hydrology.org.uk/. [Accessed 7th December 2020].

3. CONSIDERATION OF SUSTAINABLE DRAINAGE

This section advises on options for the drainage strategy to comply with Sustainable Drainage System (SuDs) requirements, these will require further consideration in a drainage strategy report. Despite being a previously developed (brownfield) site, runoff should be limited to as close to Greenfield rates as practical; although this is not always achievable, especially at previously developed sites. Furthermore, we advise that, as the proposed development's construction area with drainage implications, including external areas, exceeds 100 m^2, acceptance from the SuDS Approving Body (SAB) will be required.

3.1. PROPOSED FOUL WATER DRAINAGE STRATEGY

This document does not contain a foul drainage strategy however it is understood that the area is currently served by Dŵr Cymru Welsh Water (DCWW). DCWW should be contacted as part of the foul drainage design process to confirm that they have capacity for any additional loading from the proposed development. When this has been agreed to the satisfaction of the sewerage undertaker the risk of flooding from this source can be considered residual.

3.2. SURFACE WATER DRAINAGE PROPOSAL

This section provides a summary of the proposed method of management and disposal of surface water runoff from the site to ensure that the hydrological impact of the development is minimised and to comply with both local and national policy requirements for the management of surface water. The discharge hierarchy should be given due consideration with the destination in order of preference as:

- Collection for Reuse
- Infiltration to Ground
- Discharge to a Surface Water Body
- Discharge to a Surface Water Sewer
- Discharge to a combined Sewer

As part of the design process sustainable drainage methods should be considered from the start of the project and included where practicable, as summarised in Table 3-1.

Table 3-1: SuDS Options Overview

SuDS Option	Suitability	Comments
Soakaways (infiltration)	*	Local knowledge suggests the ground conditions within the site may not be suitable for soakaways. Further investigation would however be required to confirm.
Porous Paving (storage/treatment)	*	The functionality of porous surfaces will depend on the composition of the substrates, but if considered suitable will provide benefit.
Rainwater Harvesting	*X*	Rainwater harvesting can be used as 'greywater' for use in the operation of developments. This not likely to be viable for the proposed residential development.
Attenuation Ponds (above ground storage/detention basin)	*	Whilst the proposed site lies within the floodplain attenuation basins/ponds may be appropriate. SAB requirements should be carefully considered as the design progresses.
Below Ground storage (tank / cellular systems)	*	Cellular storage systems or tanks could be suitable for this site, however this would be a less preferred option.
Flow Control Device(s)	*	The peak flow rates from attenuation basins/tanks (if included) would need to be limited, this is typically via an orifice or vortex control. Ideally discharge should be to greenfield rates if possible.
Green Roof, Brown Roof or Blue Roof	*X*	A green roof is not likely to be suitable for the residential development.

Key:

✓ *Suitable for use and included in the scheme*

* *Recommended for consideration – The suitability for this will be considered further as the design progresses*

X *Not recommended.*

In summary, there should be opportunity for SuDS given the nature of the development and consideration should be given to including SuDS measures where possible to the satisfaction of the SAB and within the constraints of the scheme.

The recommended drainage strategy is to treat and reduce runoff where viable. There are a number of potentially suitable methods for achieving this and it is recommended that these are given serious consideration through the detailed design process.

3.3. SURFACE WATER ATTENUATION ESTIMATE

Whilst this information will be superseded by a more detailed drainage strategy as the design progresses, initial guidance on runoff rates has been provided. Assuming a 1.7 hectare site with a soil classification value of 2 and a Standard Annual Average Rainfall 1,330 mm then the resulting Qbar value to which the runoff rate from the development should ideally be targeted is 6.57 l/s. This means that when assuming 60% of the proposed development will be impermeable and allowing for both a 40% uplift for climate change and urban creep, an estimate of the total required attenuation volume of approximately 966 m^3 results.

It should be noted that these default values and estimates are not suitably accurate for a design and require further consideration. These estimates of attenuation and runoff are subject to change as the design of the drainage systems progresses. Specific details not considered include:

- The effects on the drainage system of any 'locking' due to hydraulic head;
- Verified site geology;
- Finalised design site impermeable coverage;
- Any available infiltration;
- The draw down duration of attenuation feature(s), their locations, capacities and configuration;
- The implementation of complex controls for the discharge;
- Potentially, targeting brownfield betterment rather than greenfield, and;
- The distribution of the attenuation volume within the network.

We recommend that the SuDS hierarchy should be followed preferring soft engineered features over hard engineered where practicable and that due consideration must be given to the treatment train in order to result in the runoff achieving a water quality that is satisfactory to the Local Authority's SAB.

In summary, although there are restrictions associated with the site there are opportunities for the development to provide a drainage scheme which provides betterment over the existing situation.

3.4. MAINTENANCE

The site drainage, extending beyond a single curtilage, is likely to be eligible for adoption by either DCWW or Carmarthenshire Council (as the SAB). As the construction of the drainage infrastructure progresses, the requirements for regular routine inspection and maintenance will need to be incorporated into the overall site operation procedures in order to minimise the residual risks of flooding associated with surface water/sewers.

Continued regular inspection and maintenance of off-site adjacent public / combined sewers and highway drainage by DCWW and Carmarthenshire Council respectively will be required to minimise the risk of residual flood risks associated with off-site drainage infrastructure.

3.5. WATER QUALITY

Appropriate pollution control measures will need to be included as the design progresses, in line with the latest SuDS manual (C753) and best practice to the satisfaction of DCWW and Carmarthenshire Council.

4. HYDRAULIC MODELLING RESULTS

Hydraulic modelling results have been used to inform this FCA and the Hydraulic Modelling Report (HMR) (7007-1713-C-RP-001-00) should be read alongside this report. A full set of mapped results is included in Appendix C. This section firstly summarises the key results in the Existing (Baseline) Scenario before considering the Proposed Scenario (Variation D1) and the sensitivity tests. In reference to this project the key results are from the 1%CE event (1% AEP or 100 year return period with the Central Estimate for climate change allowance). The extreme event (0.1% AEP) as well as the blockage and breach scenarios are also of interest.

There are two storm durations modelled for this study, the Critical Storm for the Tâf (CST) and the Critical Storm for the Gronw (CSG). The two flood mechanisms are subtly different depending on the critical storm. The CST results in higher water levels in the Tâf and more overtopping of the railway line with waters routing to the site from the west through the town. The CSG results in higher water levels in the Gronw and more overtopping of the upstream soft defences in the playing fields routing to the site from the north over Market Street (B4328).

"Plot Outputs", or "POs" are referenced these refer to specific locations where more detailed results from hydraulic modelling have been recorded as detailed in the HMR.

4.1. BASELINE (EXISTING) SCENARIO

This section of the report outlines the key results for the Baseline Scenario, it first discusses the results for the Critical Storm on the Tâf, then the Critical Storm for the Gronw, before discussing the blockage scenarios and the breach scenario.

4.1.1. CRITICAL STORM TÂF (CST – 13HR)

The flood mechanism identified by the modelling suggests that by 8 hours into the simulation both the Tâf and Gronw have filled low lying areas of the floodplain and the Tâf starts to overtop the South Wales Main Line by the auction site (JJ Morris). At 12 hours the floodwaters peak. The waters overtopping the railway continue to fill the area around the auction site and reach Cross Street some 16 hours into the simulation, and reach the site an hour afterwards, gradually flooding most of the site. Depths onsite as recorded in PO 'Site_17' peak under 0.5 m at 22 hours into the simulation without overtopping the adjacent railway line before drawing down. Floodwaters from the Gronw do not reach the site due to the presence of the existing defences.

This description of the flood mechanism is for the key event of interest (1%CE) Existing Scenario which includes no blockages or breaches.

4.1.2. CRITICAL STORM GRONW (CSG – 7HR)

The design event for the CSG is not predicted to flood the site, the waters in the Tâf peak at a lower level due to the reduced storm duration and thus overtopping of the railway is significantly reduced; starting later, peaking lower and ending earlier. Floodwaters are higher in the Gronw but in the design event (sans breach) have not increased sufficiently to overtop the defences. In the extreme event the Tâf does overtop the railway and result in flooding to the site; however, the defences alongside the Gronw still do not overtop. It is important to note however, that they do reach depths sufficient to trigger the requirement for a breach analysis in the soft defences alongside the playing field but not in the hard defences alongside the site.

A full set of flood maps are shown in Appendix C, however, Figure 4-1 below shows an equivalent of the current flood zone map as generated by the model study. Noting that the current Flood Zone maps do not include climate change.

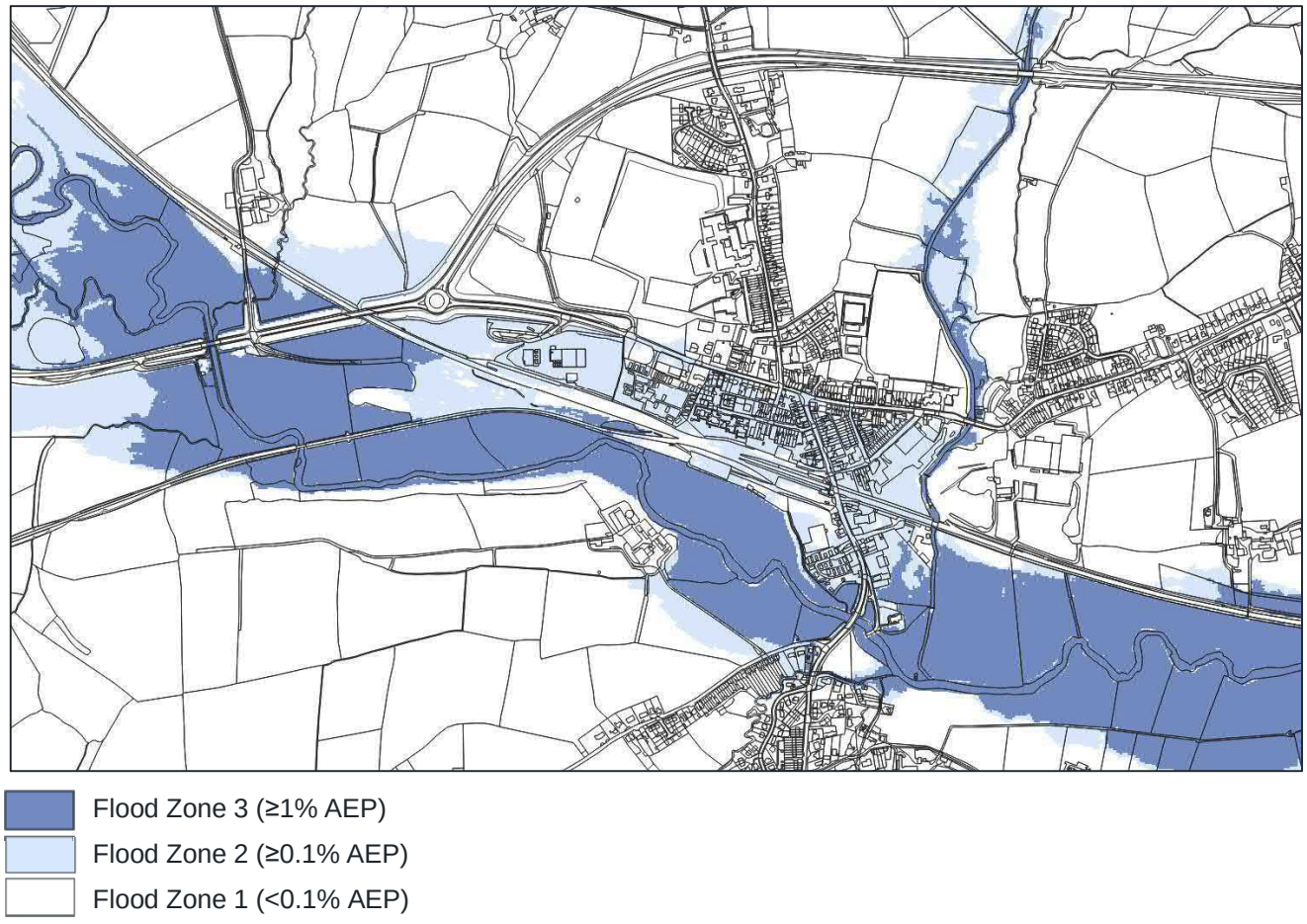


Figure 4-1: Predicted Flood Zone Map (Baseline, 7hr Intact Clear)

The above extract has been created by overlaying the 1% AEP (100 year) flood extents (dark blue) approximate to the current Flood Zone 3 on top of the 0.1% (1000 year, Morris) flood extents (light blue) approximate to current Flood Zone 2 (as well as DAM Zone C2).

4.1.3. BASELINE BLOCKAGE SCENARIOS

As described in the HMR these blockage scenarios had no significant effects for the site.

4.1.4. BASELINE BREACH SCENARIO

This subsection reports the simulated effects of a breach at a location on the Gronw, with particular consideration made of the 1%CE event. Flood waters affect large parts of Whitland, including the site, as illustrated in Figure 4-2.

The breach configuration is described in the HMR. Water spills through the breach and route to the site over Market Street and via St Mary's Street. A maximum level of approximately 19.18 m AOD is observed, with depths varying from around 10 cm at the north of the site, to 120 cm in the lower the south-east of the site.

Within the channel, the maximum modelled water levels along the reach of interest are reduced compared to the defended scenario, as would be expected, and are on average 6 cm lower.

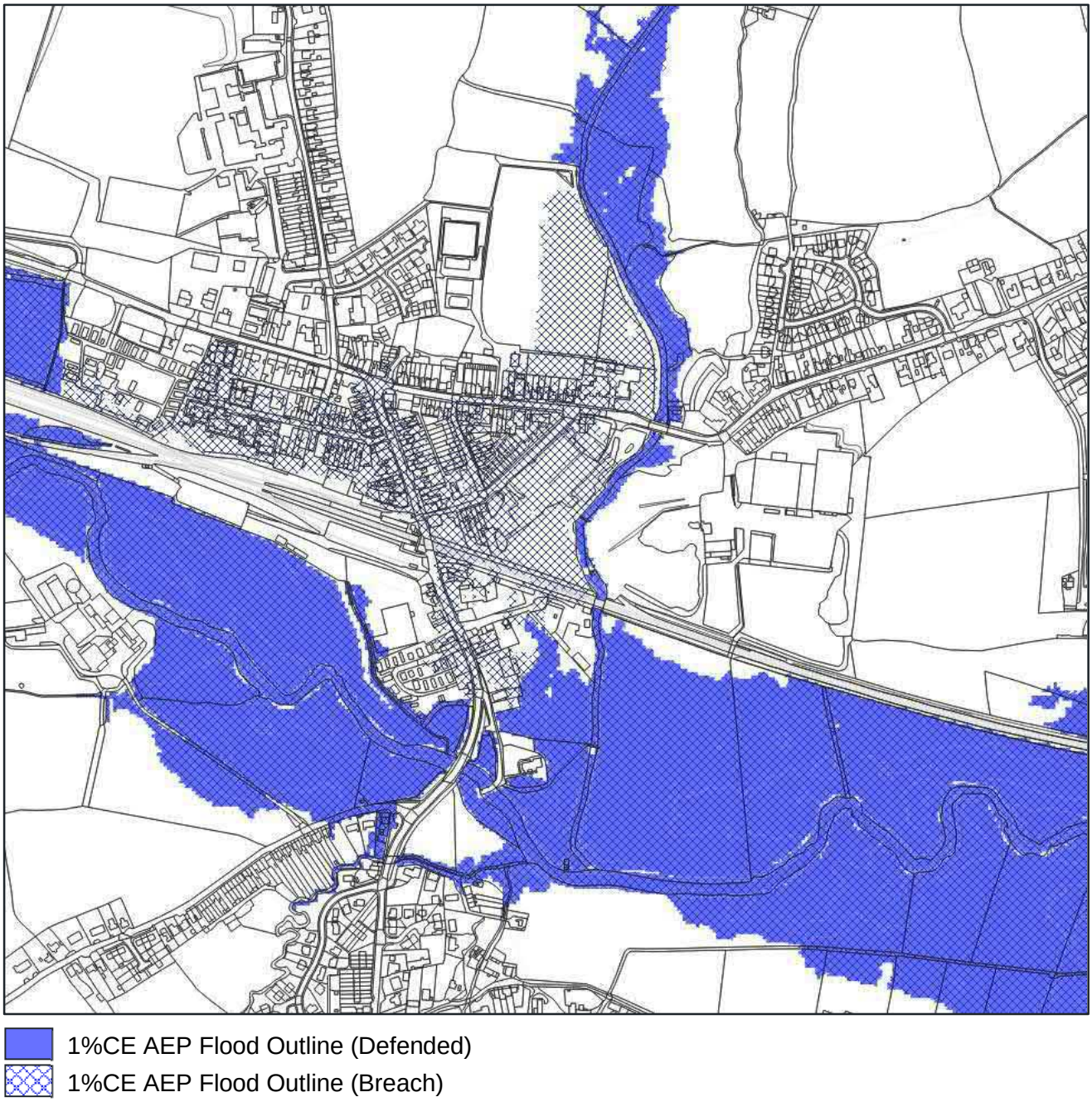


Figure 4-2: Existing 7hr 1%CE AEP Intact and Breach Scenarios

4.2. PROPOSED SCENARIO

The Proposed development scheme consists of a residential development, in addition to associated public open space and amenities. It is proposed to raise the development plots above the flood level to reduce the risk of onsite flooding whilst conveying floodwaters which do reach the site in extreme events safely to the flood storage area in the low point of the site (SE corner).

Flood maps showing the maximum extents and depths for the key design (1%CE) and extreme (0.1%) events have been produced, which are contained in Appendix C.

4.2.1. CRITICAL STORM TÂF (CST – 13HR)

The flood mechanism identified in the baseline section (S 4.1.1) is essentially unchanged until the floodwaters reach the site at 16 hours into the simulation; instead of flooding the majority of the site, flood waters are drawn through the designated flow routes through the site to the flood storage area. Depths onsite peak under 0.4 m without overtopping the adjacent railway line before drawing down. As before this describes the 1%CE AEP event.

From the model results and as shown in Figure 4-3 and Figure 4-4 below in the design event for the CST.

- Maximum flood depths in the carpark are < 20 cm with a low hazard classification
- Maximum flood depths in the SE flood storage area is < 100 cm with a significant hazard classification
- Maximum flood depths along the flow routes are < 70 cm with a significant hazard classification
- Maximum flood depths to driveways and parking is < 20 cm with a low hazard classification
- Gardens are predicted to remain dry
- Residences are predicted to remain dry
- There is a predicted reduction in maximum water level for the area Around St Mary's Street and St John Street of 10 cm

From the model results and as shown in Figure 4-5 and Figure 4-6 below in the extreme event for the CST.

- Maximum flood depths in the carpark are < 45 cm with a significant hazard classification
- Maximum flood depths in the SE flood storage area is 120 cm with a significant hazard classification
- Maximum flood depths along the flow routes are 90 cm with a significant hazard classification
- Maximum flood depths to driveways and parking is < 45 cm with a moderate hazard classification
- Gardens are predicted to flood to a maximum depths of circa 14 cm with a low hazard classification
- Residences are predicted to flood to flood to a maximum depth of < 5 cm with a low hazard classification with some plots in the north remaining dry
- There is a very small (circa 5 mm) predicted reduction in maximum water level for the immediate vicinity of the site

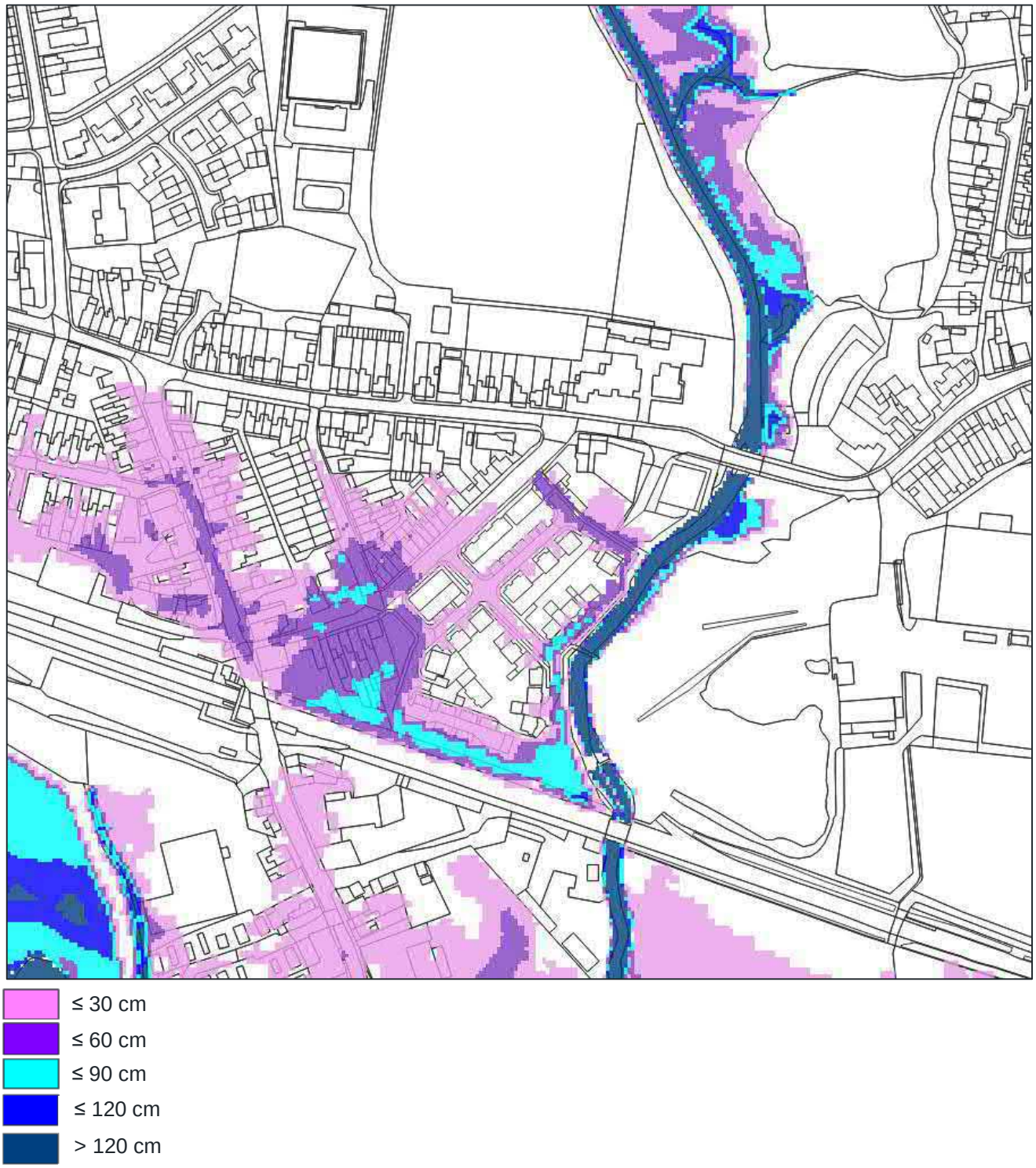


Figure 4-3: Proposed 13hr 1%CE AEP Intact Clear Max Depths

	≥100cm reduction		Less than 0.5 cm change		≥ 0.5 cm increase
	≥ 30 cm reduction		Was Dry Now Wet		≥ 30 cm increase
	≥ 0.5 cm reduction		Was Wet Now Dry		≥ 100 cm increase

Figure 4-4: Proposed 13hr 1%CE AEP Intact Clear Max Stage Comparison

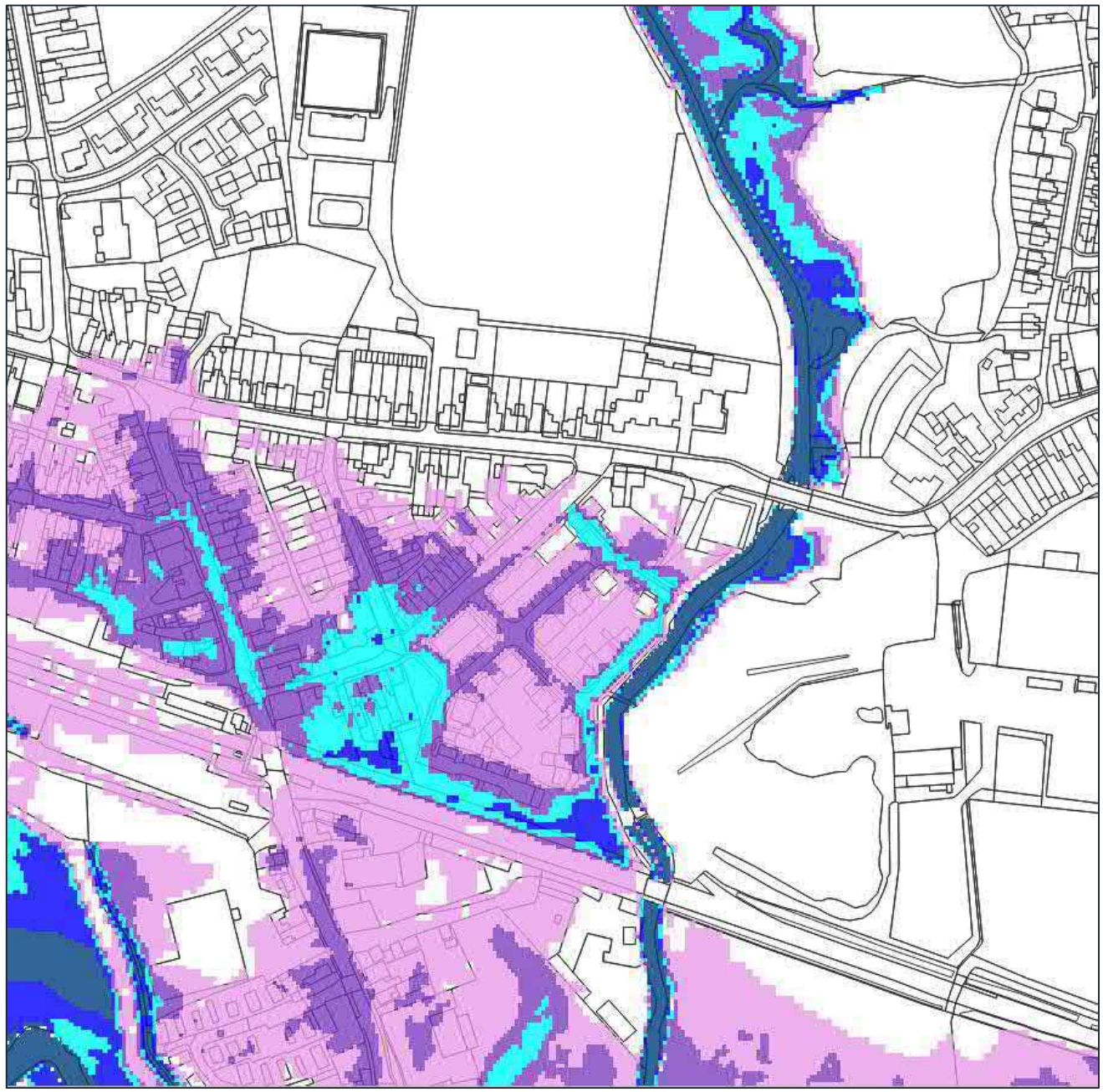
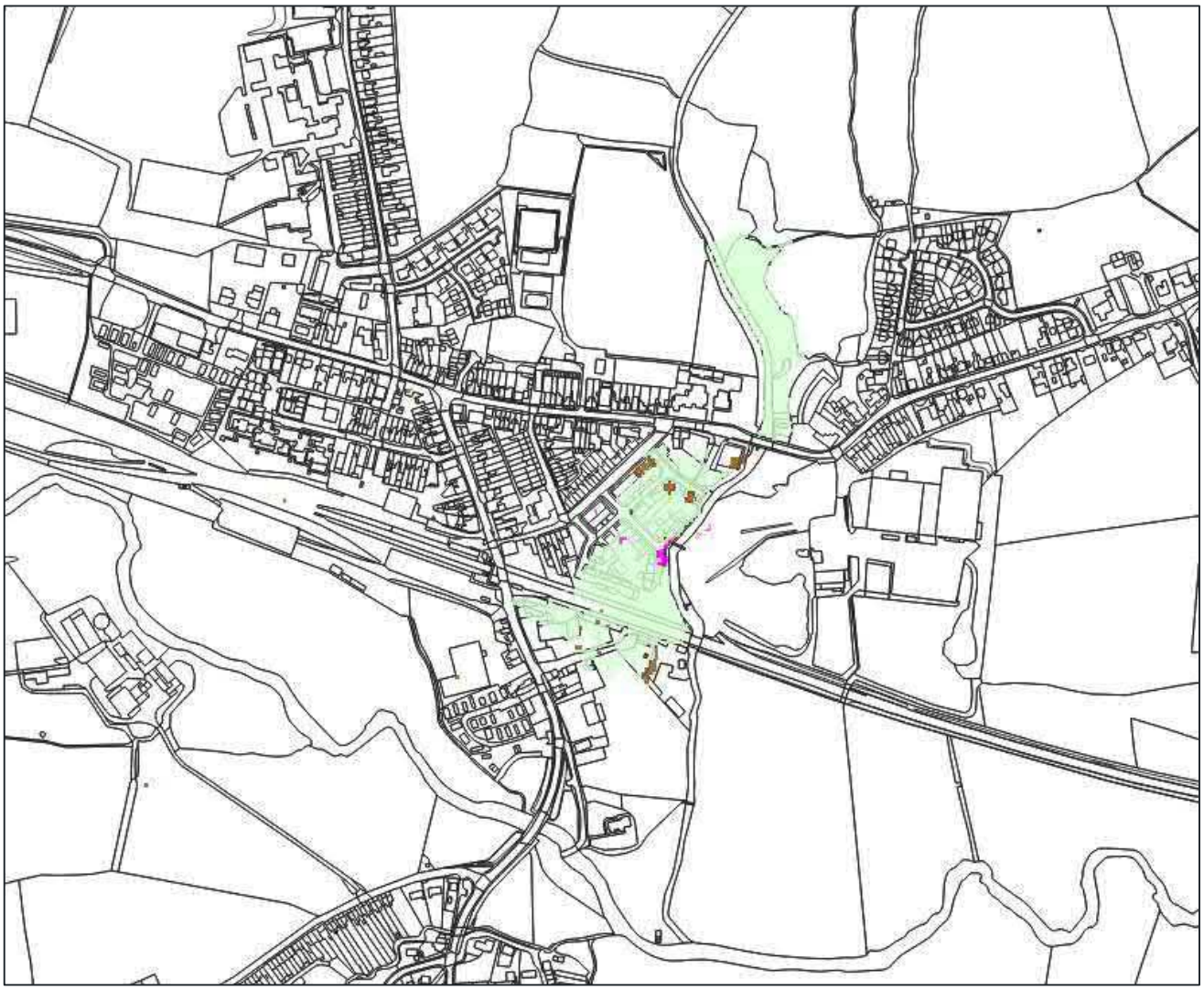


Figure 4-5: Proposed 13hr 0.1% AEP Intact Clear Max Depths



	≥100cm reduction		Less than 0.5 cm change		≥ 0.5 cm increase
	≥ 30 cm reduction		Was Dry Now Wet		≥ 30 cm increase
	≥ 0.5 cm reduction		Was Wet Now Dry		≥ 100 cm increase

Figure 4-6: Proposed 13hr 0.1% AEP Intact Clear Max Stage Comparison

4.2.2. CRITICAL STORM GRONW (CSG – 7HR)

From the model results in the design event for the CSG.

- As per the baseline scenario, the site is predicted to remain dry and thus there are no maximum depths or hazards to report nor does the site effect flooding to the vicinity.

From the model results and as shown in Figure 4-7 and Figure 4-8 below in the extreme event for the CSG results are similar to those for the CST given the primary flood mechanism is overtopping of the railway from the Tâf, however given the reduction in storm duration for the Tâf, depths on site tend to be a couple of millimetres lower than the CST.

- Maximum flood depths in the carpark are < 45 cm with a significant hazard classification
- Maximum flood depths in the SE flood storage area are 120 cm with a significant hazard classification
- Maximum flood depths along the flow routes are 90 cm with a significant hazard classification
- Maximum flood depths to driveways and parking is < 45 cm with a moderate hazard classification
- Gardens are predicted to flood to a maximum depths of circa 14 cm with a low hazard classification
- Residences are predicted to flood to flood to a maximum depth of < 5 cm with a low hazard classification with some plots in the north remaining dry
- There is a small predicted reduction (circa 5-8 mm) in maximum water level for the immediate vicinity of the site however there is also a negligible increase in flood stage in-channel at the upstream face of the railway bridge of 5-6 mm, and downstream of the bridge in the fields on the left bank there is also a small area indicating a negligible increase of 6 mm. This marginal increase in undeveloped land should be considered alongside the reduction in flood depths throughout Whitland, as discussed in Section 5.5.

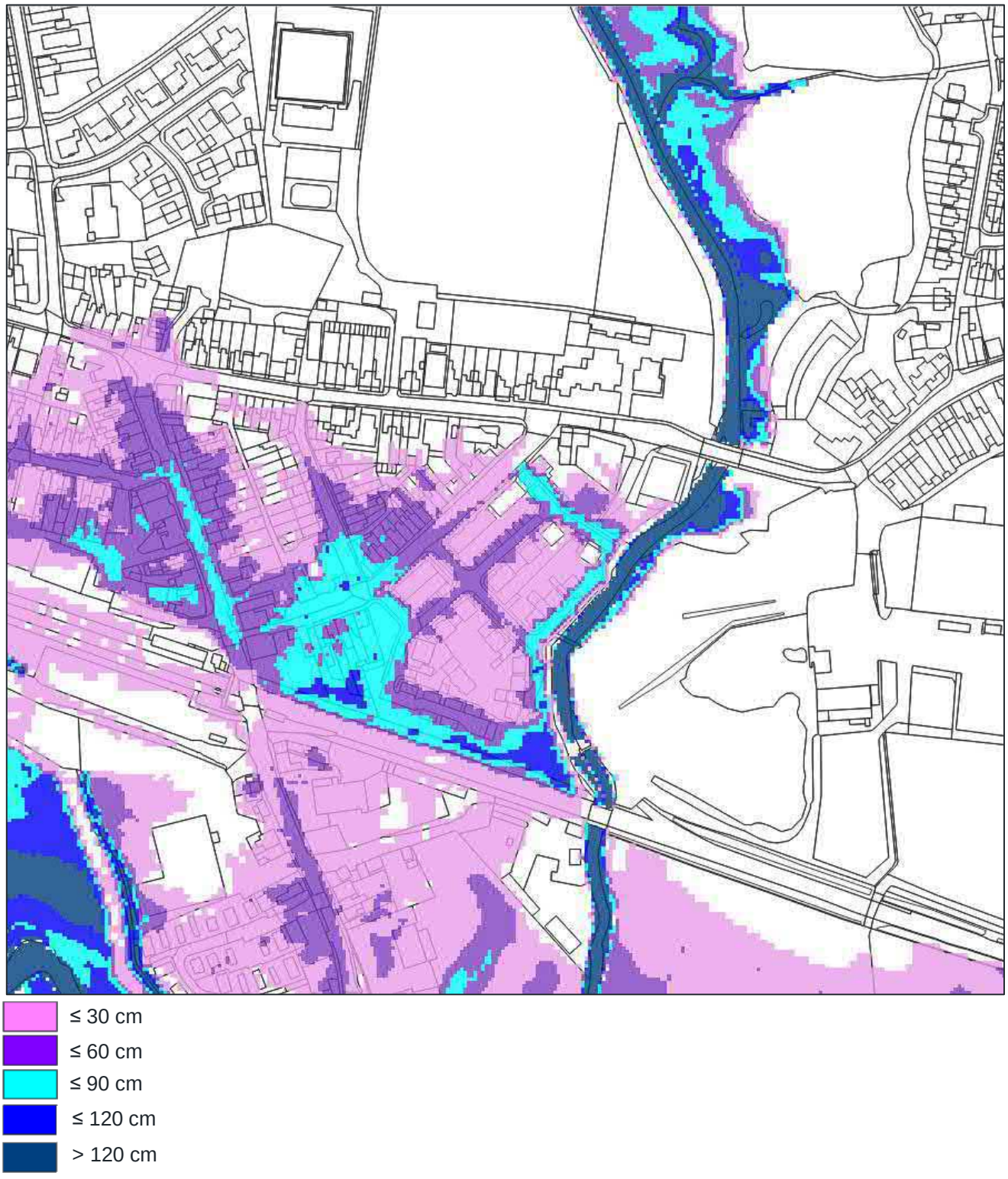
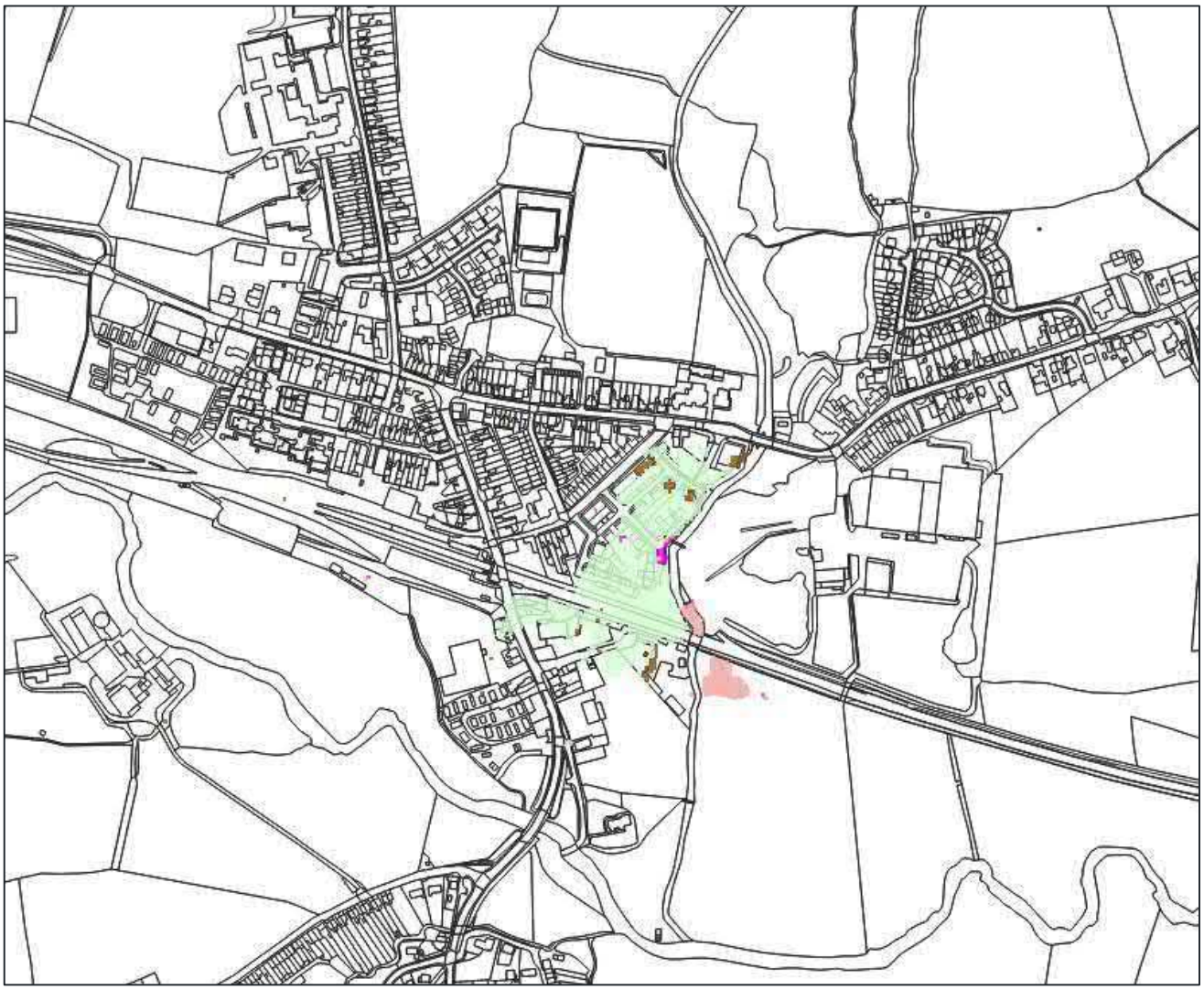


Figure 4-7: Proposed 7hr 0.1% AEP Intact Clear Max Depths



	≥100cm reduction		Less than 0.5 cm change		≥ 0.5 cm increase
	≥ 30 cm reduction		Was Dry Now Wet		≥ 30 cm increase
	≥ 0.5 cm reduction		Was Wet Now Dry		≥ 100 cm increase

Figure 4-8: Proposed 7hr 0.1% AEP Intact Clear Max Stage Comparison

4.2.3. PROPOSED BLOCKAGES SCENARIO

As noted in the above section (S 4.1.3), the presence of the blockages does not cause the design event to flood the site. Therefore, the proposed development cannot affect the Flood Consequences and as such the analysis set out in the above section is sufficient for the assessment of this FCA.

4.2.4. PROPOSED BREACH SCENARIO

The flood mechanism described in the baseline section (S 4.1.4) is essentially unchanged until the floodwaters reach the site at 7 hours into the simulation; instead of flooding the majority of the site, flood waters are drawn through the designated flow routes through the site to the flood storage area, leaving the buildings dry. Depths onsite peak under 0.57 m before drawing down. As before this describes the design event (1%CE AEP).

From the model results and as shown in Figure 4-9 and Figure 4-10 below in the design event for the CST.

- Maximum flood depths in the carpark are < 37 cm with a moderate hazard classification
- Maximum flood depths in the SE flood storage area are 100 cm with a significant hazard classification
- Maximum flood depths along the flow routes are < 80 cm with a significant hazard classification
- Maximum flood depths to driveways and parking is < 36 cm with a moderate hazard classification
- Gardens are predicted to flood to depths of between 5 and 7 cm with a low hazard classification
- Residences are predicted to remain dry
- There is a predicted reduction in maximum water level for the area Around St Mary's Street and St John Street of 1 cm with a small patch on the St Mary's Street showing an increase of 4 cm (on the public highway) and an in-channel increase in water level at the upstream face of the railway bridge adjacent to the site of 0.7 cm.

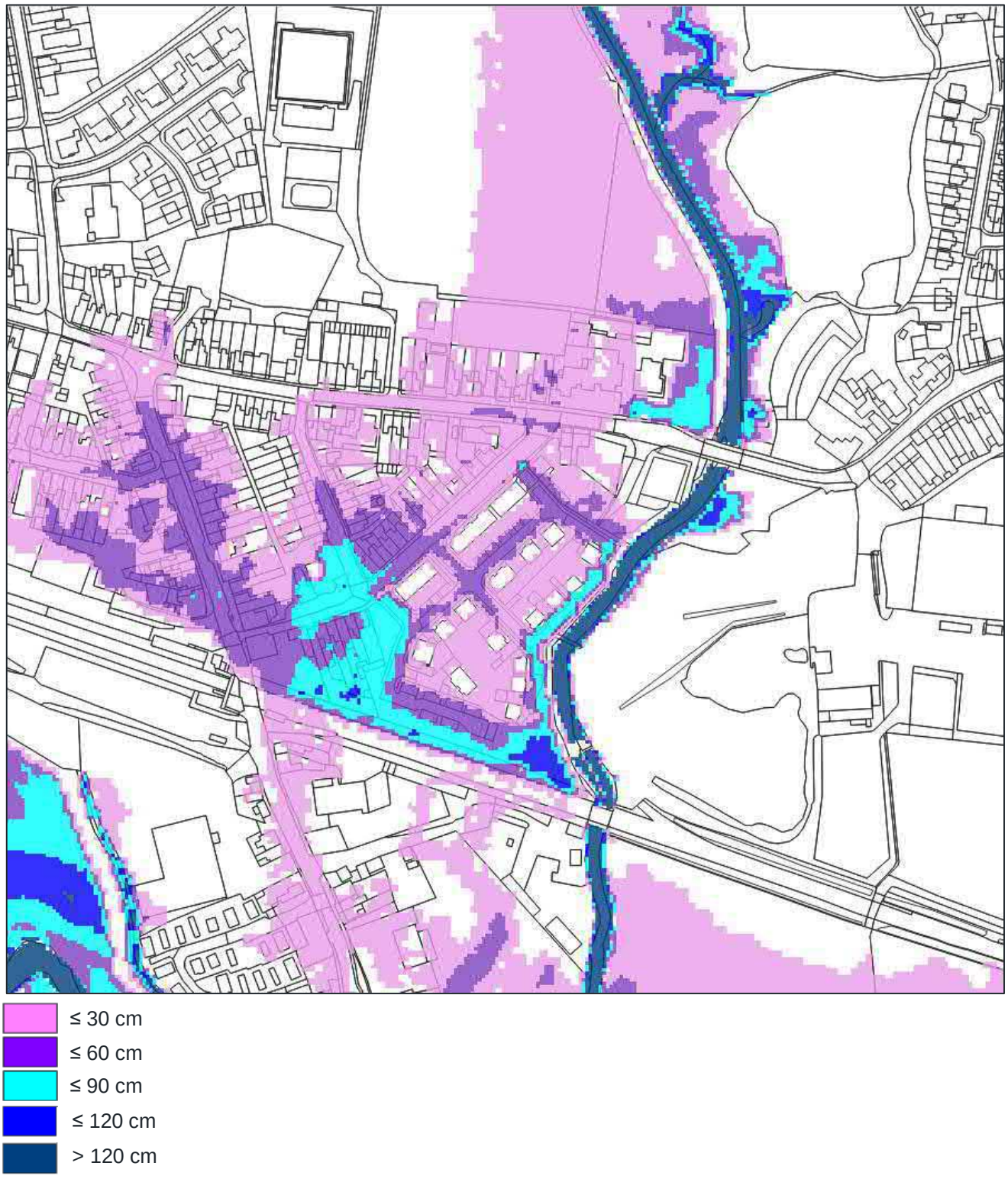


Figure 4-9: Proposed 7hr 1%CE AEP Breach Clear Max Depths

	≥100cm reduction		Less than 0.5 cm change		≥ 0.5 cm increase
	≥ 30 cm reduction		Was Dry Now Wet		≥ 30 cm increase
	≥ 0.5 cm reduction		Was Wet Now Dry		≥ 100 cm increase

Figure 4-10: Proposed 7hr 1%CE AEP Breach Clear Max Stage Comparison

4.3. SENSITIVITY TESTS

The results from the Sensitivity Tests suggest that the sensitivity of the model at this location may be amplified by the constriction at the two bridge structures in proximity to the site, particularly to variations in flow. The variations in average water level in response to the sensitivity testing are of similar magnitude to the opposite variation thus improving confidence in model robustness and performance

Sensitivity tests adjusting the model boundary conditions (+/-20%) were undertaken and showed no or negligible changes to maximum water levels within the reach of interest, indicating that the model boundaries are sufficiently distant from the site to have no significant impact on water levels at the site.

4.3.1. MANNING'S SENSITIVITY BASELINE

This subsection reports the sensitivity test on the Baseline Scenario for a +/- 20% change in Manning's roughness values in the model. The results suggest that the model is as sensitive to an increase in roughness as a decrease, with an average increase in water level through the reach of interest between +9 cm and -9 cm, with a percentage change in predicted water depth averaging between 4.4 and 4.5% respectively. These values help with the understanding of uncertainty in the results and should be given due consideration when determining suitable freeboard allowances.

4.3.2. FLOW SENSITIVITY BASELINE

This subsection reports the sensitivity test on the Baseline Scenario for a +/- 20% change in the peak flow applied to the model. The results suggest that the model is more sensitive to a decrease in flow than a decrease, with an average change in water level through the reach of interest between +16 cm and -18 cm which is a modest percentage change in predicted water depth (8 and 9 % respectively). These values help with the understanding of uncertainty in the results and should be given due consideration when determining suitable freeboard allowances.

It is noted that there is a significant change in water level at the upstream face of Market Street Bridge corresponding in both the increase and decrease flow events. This suggests that this structure has increased sensitivity to this change in flow levels with the model finding that the 1% AEP event is at the level where this drowns the box culvert (soffit 19.25 m AOD) and approaches the soffit of the arch (20.08 m AOD) and as such a small change in water level increases the wetted perimeter and associated friction losses.

5. REQUIREMENTS OF TECHNICAL ADVICE NOTE 15

The aim of this report is to provide an assessment of the suitability of the proposed development against the requirements of TAN15. This section outlines the flood risks that have been identified in this report and suggests mitigative measures to enable the site to improve compliance with the current legislation.

Section 2 of this report references the different flood maps for the site provided by NRW, from Figure 2-1 the site lies predominantly within the DAM Zone C1 region with a small spot of Zone B in the location of an old spoil heap. As the site is intended to be developed for residential purposes it is classified as Highly Vulnerable by TAN15 which in Section 9 states that Highly Vulnerable developments may be permissible Zone C1, subject to: the Justification Test, acceptability of consequences and surface water requirements. Given the level of risk it is considered that mitigative measures to reduce the level of risk and the consequences of flooding will need to be incorporated into the design.

5.1. FLUVIAL FLOOD RISK

5.1.1. MAIN RIVERS

The main source of flood risk to the site is the risk of flooding from main rivers, a fluvial source. It is currently understood that in the lower return period events the site remains dry. The site is at risk of flooding from two Main Rivers, with two separate critical storms, the Afon Tâf and the Afon Gronw.

5.1.1.1. Afon Gronw

Hydraulic modelling undertaken and reported above (S 4.2.2), demonstrates that the site is not expected to flood in the design event (1%CE AEP), therefore the site remains dry in this event in line with TAN15 requirements. In the extreme event (0.1% AEP) the site is predicted to flood. In such events depths are generally within those suggested by A1.15 in the TAN15 guidance of 0.6 m for residences and access as the properties, driveways and gardens flood to less than 0.6 m, although the access does exceed this limit, this is described further in Section 5.4 below. Whilst A.15 is not prescriptive, it does provide guidance on what it considers, as tolerable conditions for extreme events. The other guidance within A1.15 of TAN15 is considered for the extreme event in turn in the following points.

- The rate of rise of flood water has a suggested limit of 0.1 m/hr for residences. The data suggests the rate of rise on site averaged over the automatic PO points from initial wetting to peak stage is 0.11 m/hr, although the steepest part of the rising limb is in excess of this.
- The maximum speed of inundation of flood water has suggested limits of 4 hours for residences. The data suggests the onset of flooding when waters reach the site is 11 hours. For reference, widespread flooding within the Tâf floodplain commences between 5 and 6 hours into the simulation with the railway by the auction site overtopped at 8.33 hours into the simulation.
- The velocity of flood water has suggested limits of 0.15 m/s for property itself and 0.3 m/s for access, the data suggests the maximum velocity remains less than 0.15 m/s within the residential buildings and gardens with parking at the 0.3 m/s limit but exceeds this on the access.

The results suggest that the flooding predicted to the site is within or at the recommended criteria. Additional mitigation such as safe refuge on the upper floors and flood resistance and resilience measures are worth exploring for this site.

5.1.1.2. Afon Tâf

The modelling undertaken to date, and reported above (S 4.2.1), demonstrates that the site may flood in the design event (1%CE AEP), but properties and gardens remain dry arguably in line with TAN15 requirements. In the extreme event (0.1% AEP) the site is predicted to flood. In such events depths are generally within those suggested by A1.15 in the TAN15 guidance of 0.6 m for residences and access as the properties, driveways and gardens flood to less than 0.6 m, although the access does exceed this limit, this is described further in Section 5.4 below. Whilst A.15 is not prescriptive, it does provide guidance on what it considers, as tolerable conditions for extreme events. The other guidance within A1.15 of TAN15 is considered for the extreme event in turn in the following points.

- The rate of rise of flood water has a suggested limit of 0.1 m/hr for residences. The data suggests the rate of rise on site averaged over the automatic PO points from initial wetting to peak stage is 0.11 m/hr although the steepest part of the rising limb is in excess of this.
- The maximum speed of inundation of flood water has suggested limits of 4 hours for residences. The data suggests the onset of flooding when waters reach the site is 11.5 hours. For reference widespread flooding within the Tâf floodplain commences at 5 into the simulation with the railway by the auction site overtopped after 7 hours into the simulation.
- The velocity of flood water has suggested limits of 0.15 m/s for property itself and 0.3 m/s for access, the data suggests the maximum velocity remains less than 0.15 m/s within the residential buildings and gardens with parking at the 0.3 m/s limit but exceeds this on the access.

The results suggest that the flooding predicted to the site is within or at the recommended criteria. Additional mitigation such as safe refuge on the upper floors and flood resistance and resilience measures are worth exploring for this site.

5.1.2. BLOCKAGES

The batch of models simulated consider the effects of a blockage on both Market Street roadbridge and the railway bridge by the site. As reported previously (S 4.1.3), the predicted effects are negligible when considering flood consequences for the site including the probability of a breach.

5.1.3. BREACHES

The modelling undertaken to date considers the consequences of a breaches in the soft defences upstream of the site in the playing fields. Given the freeboard in the site adjacent hard defences a breach model was not considered necessary. As reported above, (S 4.2.4) the site is anticipated to flood in the event of a breach; however, the dwellings are predicted to remain dry with shallow flooding to gardens. In such events depths are generally within those suggested by A1.15 in the TAN15 guidance of 0.6 m for residences and access as the properties, driveways and gardens flood to less than 0.6 m, although the access does exceed this limit, this is described further in Section 5.4 below. Whilst A.15 is not prescriptive, it does provide guidance on what it considers, as tolerable conditions for extreme events. The other guidance within A1.15 of TAN15 is considered for the extreme event in turn in the following points.

- The rate of rise of flood water has a suggested limit of 0.1 m/hr for residences. The data suggests the rate of rise on site averaged over the automatic PO points from initial wetting to peak stage is 0.18 m/hr although the steepest part of the rising limb is in excess of this.
- The maximum speed of inundation of flood water has suggested limits of 4 hours for residences. The data suggests the onset of flooding when waters reach the site is 7 hours. For reference as the breach is in place from the start of the simulation this is only 1 hour after waters spill through the breach. Given that these defences are not predicted to overtop from static water levels in the design event, it is more likely that were the defence would fail to fail, the breach would establish around the 9 hour peak water level, though in that representation the waters may route to the site sooner following the peak given the increase in driving head.
- The velocity of flood water has suggested limits of 0.15 m/s for property itself and 0.3 m/s for access, the data suggests the maximum velocity remains less than 0.15 m/s within the residential buildings (dry) and gardens with parking at the 0.3 m/s limit but exceeds this on the access.

The results suggest that the flooding predicted to the site is within or at the recommended criteria. Additional mitigation such as safe refuge on the upper floors and flood resistance and resilience measures are worth exploring for this site.

5.1.4. ORDINARY WATERCOURSES

There are no Ordinary Watercourses known on site or in the immediate vicinity of the site. Flood risk from this source is not explicitly modelled but will be considered in Section 5.3.1.

5.1.5. FLOOD LEVELS, UNCERTAINTY & FREEBOARD

The predicted flood levels vary across the site, design flood level in the Proposed Scenario (Variation D1) as currently configured is generally 18.90 to 19.00 m AOD (CST 1%CE Defended Clear). With a breach this level increases to 19.18 m AOD (CSG 1%CE Breach Clear). In the extreme event this level is 19.23 to 19.24 m AOD (CST 0.1% Defended Clear).

There is an unavoidable level of uncertainty associated with the results of any model. For this particular model, as discussed in the HMR, the primary source of uncertainty is the general uncertainty which arises from simulating any complex system. It is considered, however, that for the purposes of this study there is sufficient understanding of the flood mechanisms, risks and consequences at this site. Given the uncertainty inherent in predicted model levels the inclusion of a freeboard allowance is suggested to account for the uncertainty. Sensitivity testing undertaken for this study (within 9 to 18 cm in-channel), should be considered when accounting for this freeboard allowance.

The levels stated at the start of this subsection provide a robust estimate for the minimum property levels and it is noted that thresholds are modelled as higher than. Based on the above data however, it is recommended that flood resistance and resilience measures are considered up to the extreme flood level plus 200 mm freeboard minimum (i.e. 19.44 m AOD).

5.2. TIDAL & OVERTOPPING RISK

The site is understood to not be at risk of flooding from the sea as would be expected given the location's elevation and situation, this is illustrated in the relevant NRW flood map pack Appendix B.

Overtopping of the site adjacent defences is unlikely given the predicted freeboard.

Overtopping of the railway is considered within the fluvial models simulated, additional overtopping from wave action is unlikely to significantly compound this risk.

Overtopping of the defences in the playing field upstream may occur in an extreme event; however, the simulation of the breach model suggests that this is not of significant concern to the proposed development as tested in the model.

5.3. PLUVIAL & SURFACE WATER RISK

The site is identified as predominantly outside of the areas considered to be at risk of flooding from surface water (Figure 2-3), however, isolated low spots on site are considered to be at risk. Local drainage systems are often not explicitly considered in the study which generated these maps and the level of risk is likely over-estimated. Furthermore, as these waters appear to be locally arising, they can be accommodated for within the proposed drainage system, which will be designed to current standards. A surface water drainage strategy will be required to outline how runoff is to be managed across the site to ensure that there is no increased risk to users of the site or third parties. Therefore, assuming the acceptability of the drainage strategy report and noting the pluvial and surface water risk is separate from surface water features (S 5.3.1), the risk from this source may be considered suitable for the proposed development.

5.3.1. SURFACE WATER FEATURES

As noted in Section 5.1.4 there are no surface water features known on site. Features of particular interest would be expected to be identified in the surface water flood map. There are Ordinary Watercourses of interest in the vicinity such as Nant Coil and the unnamed watercourse which flows past the Livestock Market, however, neither of these are anticipated to pose a risk of flooding directly to the site.

5.4. ACCESS & EGRESS

Safe access and egress are typically required for developments, with Section A1.15 of TAN15 giving descriptive guidance on what is considered acceptable for standard development types. In order to consider access, this development would be classed under A1.15 as ‘residential’. Therefore, the recommendations of A1.15 are: a maximum depth of 600 mm and a maximum velocity of floodwater of 0.15 to 0.3 m/s. It is noted that in the reported events which flood the site depths, hazards and velocities remain low across the development plots (buildings and gardens) and with the use of rear accesses the evacuation route selected for analysis is the primary “east-west” road, north along St Mary’s Street and over Market Street Bridge, noting that in a breach event this route may be less traversable than an alternative route away from the main flow (e.g. Park Street then west on Market Street). The descriptive guidance set out in TAN15 of 600 m depth and 0.3 m/s velocity has been analysed for the route described. Appendix D provides an illustration of this in 10 minute intervals extracted from the model results. It is noted that depths are not exceeded on this access route. In summary, for the 4 events of interest:

- 1%CE AEP, CSG (7hr), Breach, Clear:
  The results suggest that, barring a 20 minute interval, the velocity criterion is exceeded from 7 hours to 12.17 hours of the simulation. i.e. 5:10 hours (or 4:50 hours if subtracting the interval).

- 0.1% AEP, CSG (7hr), Intact, Clear:
  The results suggest that, the velocity criterion is exceeded for 0.5 hours from 11:50 to 12:10 in the simulation along this access route.
- 1%CE AEP, CST (13hr), Intact, Clear:
  The results suggest that, the velocity criterion is not exceeded in the simulation along this access route.
- 0.1% AEP, CST (13hr), Intact, Clear:
  The results suggest that, the velocity criterion is exceeded for 0.5 hours from 11:50 to 12:10 in the simulation along this access route. After this there is a single instance with waters draining off St Mary's Street recorded at 31:20 in the model which also exceeds the velocity criterion.

The Local Authority will need to determine what is considered acceptable access, which scenarios are of particular relevance to access (e.g. breach or intact) and which events are vital to the access considerations. The Local Authority will make their determination as advised by TAN15, NRW and this FCA. Nevertheless, this report suggests that a policy of safe refuge avoiding flood waters is suitable for this development.

5.5. FLOOD COMPENSATION & THIRD-PARTY EFFECTS

The current design includes minimal ground raising within the defended floodplain. Altering ground levels may result in third party effects; however, the modelling undertaken to date suggests that, for the events of interest, these when combined with the proposed flood routes and compensatory areas, would have a beneficial effect on Whitland with negative effects confined generally to the Afon Gronw itself. There are two instances of detriment otherwise noted: firstly, in the CSG extreme event to a small area in the undeveloped floodplain fields downstream of the railway bridge which are at the measurable and reportable limits of the model (6 mm). Secondly, in the breach scenario a small area on St Mary's Street of circa 1 cm noting that this remains constrained to the development side of the road and does not affect any properties. These two instances of potential detriment should be carefully considered against the predicted improvements from the development; not only a predicted reduction in flood consequences to the surrounding environment in these events and others, but also from a holistic planning perspective.

5.6. GROUNDWATER FLOOD RISK

The site is not within a groundwater source protection zone. The SFCA notes that no data is available regarding flood risk from groundwater. The groundwater level at this location would be anticipated to be dominated by the Afon Gronw. As there is no known elevated risk of flooding from this source and noting that groundwater tends to emerge slowly and typically follows drainage networks and flowpaths, thus is unlikely to pose an emergency and the risk would remain limited once a suitable drainage design is in place. Should ground investigations undertaken as part of the development of this design contradict this then this assessment of risk should be revisited.

5.7. AWARENESS OF FLOOD RISK

Whilst the site is generally at a low risk of flooding in the present day, the developer should be aware that the site is not immune from the impacts of flooding, due to predicted climate change, both flooding to the site itself or to the surrounding area. The site is located in a Flood Warning Area and it is recommended that anyone responsible for the site is encouraged to sign up to the service[14]. The developer may consider it appropriate to prepare a Flood Action Plan for a potential flood event, as well as welcome packs or signs adjacent to fire notices, describing the level of flood risk and evacuation routes, if appropriate for the type of development. It would also be expected that the maintenance plan section of the full SAB application would consider an appropriate response to flood events.

5.8. RESERVOIR & INFRASTRUCTURE FLOOD RISK

A review of NRW's reservoir flood risk map indicates that the site lies outside the areas predicted to flood in the event of an uncontrolled release of water from a reservoir. There are no known canals in Whitland. Blockages on fluvial structures have been considered in Section 5.1.2. Although there are significant waterbodies in the catchment such as the lakes at Cwm Cedni, Glandwr, Lampeter Vale and by Whitland Station, none are expected to introduce a significant risk to the site based on the available data reviewed and therefore, unless there are known issues with any lakes or reservoirs within the catchment, this risk may be considered residual.

Having considered the flood risk from lakes, reservoirs and canals, three principal infrastructure sources remain: a burst water main, a surcharging sewer and an outfall failure. A burst water main would likely have a similar effect as a sizable rainfall event to which the proposed development is not considered especially vulnerable (Section 5.3). Similarly, any overland flow generated by a surcharging foul (or combined) sewer would likely follow a flowpath external to the proposed development and away from the site, the drainage strategy should attempt to divert exceedance flows away from sensitive receptors. Therefore, once the foul drainage strategy has been agreed with the sewerage undertaker, the risk of flooding from these two sources can be considered as residual and should not forestall development.

5.9. COMPLIANCE WITH TAN15

Section 9 of TAN15 summarises: the planning requirements, acceptability criteria and development advice for a Highly Vulnerable development in DAM Zone C1. This summary is replicated in this section and discussed for completeness.

5.9.1. JUSTIFICATION

For developments in DAM Zone C1 the planning requirements are: that the Justification Test is applied, the consequences are acceptable and that surface water requirements are met.

Section 6 of TAN15 outlines the Justification Test, it states:

[14] https://naturalresources.wales/flooding/sign-up-to-receive-flood-warnings/?lang=en [Accessed May 2020]

'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.

And:

iii. It concurs with the aims of PPW and meets the definition of previously developed land (PPW fig 4.1); 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 found to be acceptable.'

Each point is addressed in turn:

i. As the site is a 'windfall' site it is not included within the Local Development Plan (LDP); however, it is opposite a site which is in the LDP (SeC19/h2) which was considered favourably. Furthermore, this site is a currently a relatively large vacant Brownfield site in the centre of Whitland and should be carefully considered as part of any regeneration initiative.

ii. The proposed development, does not contribute to longer term employment opportunities under point ii, albeit the construction of the residential scheme will generate a demand for trades in the short term. Notwithstanding this, the development does meet point i as argued above and points i and ii are stated as 'or' and not in a 'and/both' clause, unlike points iii and iv.

iii. The presence of the existing ground slabs suggests that the site meets the definition of previously developed land

iv. The earlier sections of this report and the maps in Appendix C demonstrate whether the development and its impacts as currently understood are acceptable.

5.9.2. ACCEPTABILITY

Section 7 of Tan15 outlines the acceptability of consequences:

5.9.2.1. TAN15 Section 7.2

Under Section 7.2 of TAN15 the three key criteria of acceptability are whether:

- the consequence of flooding can be managed down to an acceptable level including its effects on existing development,
- safe access can be achieved, and
- timely flood warnings can be provided.

The consequence of flooding can be made acceptable provided a site layout in line with that set out in this report and with the mitigation identified will meet the guidance of TAN15 as discussed throughout Section 5 of this report. An assessment of the access suitability has been undertaken for key events of interest as set out in Section 5.4 and it is a matter for the Local Authority whether the access arrangements are acceptable. The site is in a flood warning and alert area and so timely flood warnings should be available from NRW. The recommendations set out within this report will assist in meeting the intent of these three criteria.

5.9.2.2. TAN15 Section 7.3

Section 7.3 of TAN15 notes that if a development is justified, mitigation measures should be incorporated into the design to make it as safe as possible (Section 6.2) and that there is:

- Minimal risk to life;
  Risk to life may be minimised by raising the structures and gardens above the design event flood event, by creating designated flood flow routes and compensation areas, by incorporating flood resilience and resistance measures into the design.
- Minimal disruption to people living and working in the area;
  Disruption to people living and working in the area may be minimised by ensuring safe access and egress, by reducing the extents and depths of flooding on site, by including flood resilience and resistance measures and by reducing the predicted effect to third parties.
- Minimal potential damage to property;
  Potential damage to property may be minimised by incorporating flood resilience and resistance measures into the design, by reducing the extents and depths of flooding on site and by reducing the predicted effect to third parties.
- Minimal impact of the proposed development on flood risk generally, and;
  The modelling undertaken has identified a proposal whereby the site can be developed without incurring detrimental impacts and whilst improving the wider flood risk generally.
- Minimal disruption to natural heritage.
  Disruption to natural heritage can be minimised by making space for water in flood compensation areas, by reducing the extents and depths of flooding on site, by including flood resilience and resistance measures, by developing a flood action plan and by reducing the predicted effect to third parties.

This report provides sufficient information to judge whether the above criteria are met.

5.10. TAN15 UPDATE

The current version of TAN15, is due to be superseded 1st June 2023, and that the existing guidance and Development Advice Map will be replaced by new guidance and the Flood Map for Planning. The revised guidance on flood risk is understood to follow a more risk-based approach. This scheme has only been assessed under the TAN15 (2004) which is current at time of writing.

6. SUMMARY & RECOMMENDATIONS

The aim of the model, the configuration and results of which are summarised in this report, is to determine the potential impacts of the development in key flood events and scenarios; as well as how these risks may be reduced or otherwise altered by the implementation of mitigative measures. This section outlines the summary and recommendations.

6.1. SUMMARY

This report has outlined the configuration and results of a flood model study at St Mary's Street, Whitland, Carmarthenshire. Outputs from the model suggest that it is performing satisfactorily and the outputs should be suitable to understand the potential impact of the proposed development.

This Flood Consequences Assessment has been compiled to set out the proposed scheme's general compliance with TAN15. The findings to date suggest the effects of the proposal on flood risk can be mitigated and brought into general compliance with the requirements set out in TAN15. This report sets out a number of suggestions to mitigate against the risks and consequences of flooding.

6.2. RECOMMENDATIONS

The recommendations discussed in this subsection are limited to the proposed development only.

- Ground Levels should be set in line with those modelled (Variation D1), these are specified in the modelling and include:
  - Finished Floor Levels of residences 19.2 m AOD (and higher in the north) in order to ensure that there is no internal flooding in the 1%CE Breach event.
  - Gardens and other external areas should be set at 19.1 m AOD minimum to keep them dry in the design event (1%CE, no breach) and ensure acceptable depths in the extreme event (0.1%).
  - The internal roads need to route flood waters to the flood storage area but the spine roads are set to 18.8 m AOD.
  - The carpark area should be set at 18.8 m AOD to ensure that depths do not exceed 0.3 m in the design event (1%CE, no breach).
  - The flood compensation area should be lowered to 18.30 sloping to 18.25 m AOD falling towards the Afon Gronw / southeast.
  - Floodwater diversion channels should be routed to safely convey water to the flood compensation area.
  - The flood compensation area should be drained by twin 450 mm diameter pipes with suitable intake grillage and arrangement at 18.25 m AOD on the upstream (development) side and flapped on the downstream side.
- Flood Resistance and Resilience measures should be considered for inclusion within the design. Ideally these should be incorporated, where applicable, up to the extreme flood level plus freeboard allowances (i.e. 19.44 m AOD minimum) and may include, but are not limited to:
  - Flood-proof doors should be considered for incorporation into the buildings in addition to inbuilt demountable defences,

- Ventilation should be either sealable or above the extreme flood level plus freeboard,
- Non-return valves fitted to drains and water in/outlet pipes as appropriate,
- Consideration should be given to tiled or hard flooring on the ground floors as opposed to fitted carpets,
- Awareness of flood risk should be raised; this could be achieved by welcome packs or flood advice notices displayed next to fire safety notices as appropriate for the type of development.
- Any external amenity and ancillary areas (e.g. the parking area) at risk of flooding should be designed to passively accommodate flood waters, with readily accessible egress to safety, prevent floating debris being carried by floodwater (e.g. vehicles) as well as be sufficiently drainable post flood event, and
- Consideration should be given to raising electrical sockets on the ground floors.

- In order to ensure suitable access rear access (at a minimum equal to the level of gardens) should be set out for buildings such that every resident has access to either St Mary's Street or the main East-West or North-South internal spine roads.
- The surface water drainage strategy should be developed to the satisfaction of the SAB and should ensure that surface waters are accommodated without increasing risk.
- The foul water strategy should be developed to the satisfaction of DCWW and should ensure that there is no undue risk of flooding from this source.
- A Flood Action Plan should be developed for the proposal, if suitable for the nature of the development, and the level of risk to the site. This plan should include clear responsibilities and chain of command as well as procedures for confirming actions and coping with absences. This plan should be developed to the satisfaction of the Local Authority.
- It is recommended that the site is not appropriate for storing or processing hazardous materials, for emergency services, for basement dwellings or essential infrastructure or for other more vulnerable uses even on a temporary basis. Unless supported by a separate site specific FCA.
- Whilst not a matter of flood risk or consequence per-se, it is apparent that a number of consents and permits will be required from NRW, the SAB and the Lead Local Flood Authority. These include but are not limited to the proposed outfalls to and the easement associated with the flood defence wall along the Afon Gronw.
- These recommendations should be revisited and revised as necessary should the proposals alter significantly from those assessed in this report.

7. CONCLUSIONS

The proposed development featured in this report is considered to have a low risk of flooding from most sources but has an elevated risk of flooding from fluvial sources with the existing site at risk from the design flood event. From the results presented in this document an assessment can be made as to whether the level of risk and consequences are acceptable when assessed against the requirements of TAN15. This report makes a number of suggestions as to how the risks and consequences can be mitigated against. TAN15 considers Highly Vulnerable (residential) sites to be potentially permissible within DAM Zone C1, subject to additional criteria. The results as presented within this document enable an assessment to be made as to whether the proposal is in accordance with the requirements associated with this DAM Zone.

This document provides sufficient evidence to determine that the level of risk associated with this site may be considered commensurate with the aims and intent of the proposed development.

8. DRAWING LIST

This section provides a table detailing the drawings included in Appendix C.

Table 8-1: List of Appended Map Outputs

Drawing Name	Drawing Number
Existing Defended Clear 1%CE Maximum Depths	1713-WSP-DR-C-900
Existing Defended Clear 1%CE Maximum Velocities	1713-WSP-DR-C-901
Existing Defended Clear 1%CE Maximum Hazards	1713-WSP-DR-C-902
Existing Defended Clear 0.1% Maximum Depths	1713-WSP-DR-C-903
Existing Defended Clear 0.1% Maximum Velocities	1713-WSP-DR-C-904
Existing Defended Clear 0.1% Maximum Hazards	1713-WSP-DR-C-905
VarD1 Defended Clear 1%CE Maximum Depths	1713-WSP-DR-C-906
VarD1 Defended Clear 1%CE Maximum Velocities	1713-WSP-DR-C-907
VarD1 Defended Clear 1%CE Maximum Hazards	1713-WSP-DR-C-908
VarD1 Defended Clear 0.1% Maximum Depths	1713-WSP-DR-C-909
VarD1 Defended Clear 0.1% Maximum Velocities	1713-WSP-DR-C-910
VarD1 Defended Clear 0.1% Maximum Hazards	1713-WSP-DR-C-911
Existing-VarD1 Defended Clear 1%CE Maximum Depth Comparison	1713-WSP-DR-C-912
Existing-VarD1 Defended Clear 0.1% Maximum Depth Comparison	1713-WSP-DR-C-913

Appendix A

NRW DAS MEETING SUMMARY

Curtis, Richard

From:	SW Planning <swplanning@cyfoethnaturiolcymru.gov.uk>
Sent:	22 July 2021 09:57
To:	Curtis, Richard; Wilkinson, Andrew
Cc:	Jones, Daniel
Subject:	Old Whitland Creamery (Pre-app Charged) - Meeting Summary - NRW Response NRW:01272604

Good Morning,

Following the meeting held between NRW (Hannah Roberts, Daniel Jones) and WSP (Richard Curtis, Andrew Wilkinson) on Wednesday 14th July at 2-3.15pm, please find a summary below of the technical discussions and actions to take forward to progress with this development. It was good to put faces to the names at the meeting and we hope the meeting was of benefit to you.

- As previously advised and agreed as part of this charged pre-application review service request, NRW have only reviewed the model results provided by WSP. The model, hydrology and topography have not been reviewed as this was not requested and therefore our comments on the provided results and site's risk may change. If the application was received as a planning application, we would undertake a full detailed review of modelling, hydrology and all scenarios due to the scale and number of units proposed.
- We have not been provided with the full suite of model scenarios including the 1% Annual Probability of flooding including an allowance for climate change and thus we cannot comment on the application's compliance with TAN 15.
- Additionally, no blockage scenarios have been provided. A copy of NRW's Modelling Blockage and Breach Scenarios guidance note can be found here: https://cdn.cyfoethnaturiol.cymru/media/692247/gn43-modelling-for-breach-and-blockage-scenarios-accessible.pdf?mode=pad&rnd=131909171450000000
- In certain scenarios the site will always flood, however measures have been taken to minimise flooding to property thresholds, while acknowledging that gardens and access roads will flood.
- The consultant has undertaken measures to mitigate against the flood risk and manage any displacement.
- One of the mitigation measures proposed was a change/improvements in flood relief culvert in the existing defence wall. A new culvert that is proposed through NRW's flood defence wall would need a Flood Risk Activity Permit (FRAP) (further information on this can be found here: Natural Resources Wales / Flood risk activity permits) . Additionally, this will require careful discussion with NRW's Asset Performance Teams who manage these areas. Any removal of in channel structures must also be discussed with NRW. The South West Asset Performance Team can be contacted via their central email address at: APSouth@cyfoethnaturiolcymru.gov.uk
- For any mitigation measures, the management, maintenance and enforceability of retaining these to be unobstructed and functional should be assessed.
- You mentioned that the application may be submitted as a hybrid/mixed use application which could include a supermarket at the northern end of the site. This wasn't discussed in depth in relation to flood risk and we will be able to provide our comments on this when consulted on the planning application.

In summary, from reviewing the provided model results only, while the site will flood, there may be opportunities for the development to comply with TAN 15. The level of detail at current stage is encouraging however until a full review of modelling and further scenarios are provided is undertaken, we cannot confirm compliance with TAN 15.

I hope this provides a summary of our discussions, however if you have any additions or amendments, please send a copy back for our record. I will now commence with the invoicing which WSP should receive in due course. Please get in touch if you need anything further.

Kind Regards
Hannah Roberts

Tîm Cynllunio Datblygu / Development Planning Team
Cyfoeth Naturiol Cymru / Natural Resources Wales

Ffôn / Tel: 03000 653358
www.cyfoethnaturiolcymru.gov.uk / www.naturalresourceswales.gov.uk

Yn falch o arwain y ffordd at ddyfodol gwell i Gymru trwy reoli'r amgylchedd ac adnoddau naturiol yn gynaliadwy / Proud to be leading the way to a better future for Wales by managing the environment and natural resources sustainably.

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

Appendix B

FLOOD MAP PACK

FLOOD RISK PACK

Client:
Whitland Green Park Ltd

Project Reference:
70071713 - Whitland

Site Reference:
Old Whitland Creamery

Site Location
220113, 216505

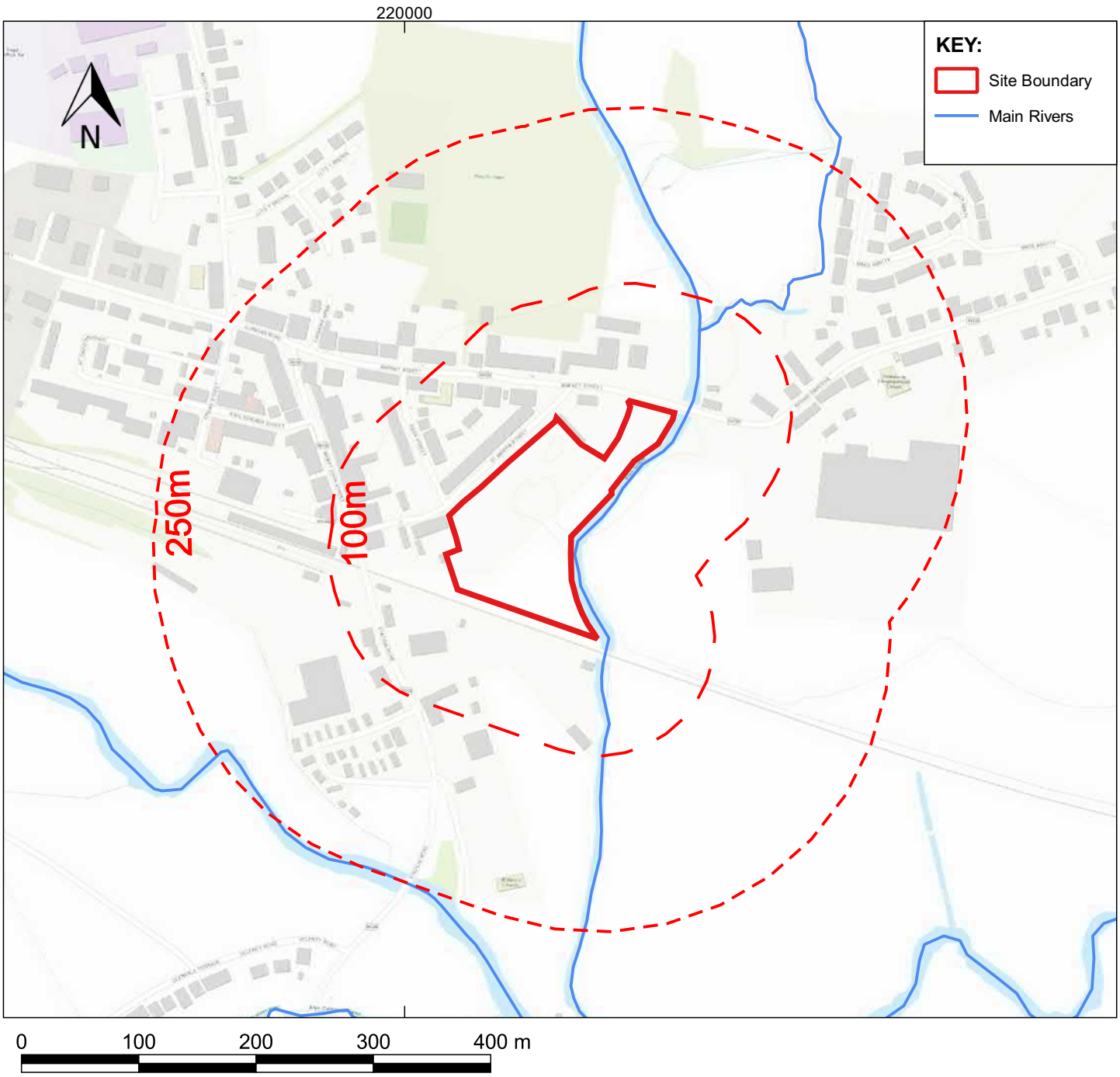
Site Area:
1.69 hectares

Map Scale:
1:5000

CONTENTS:

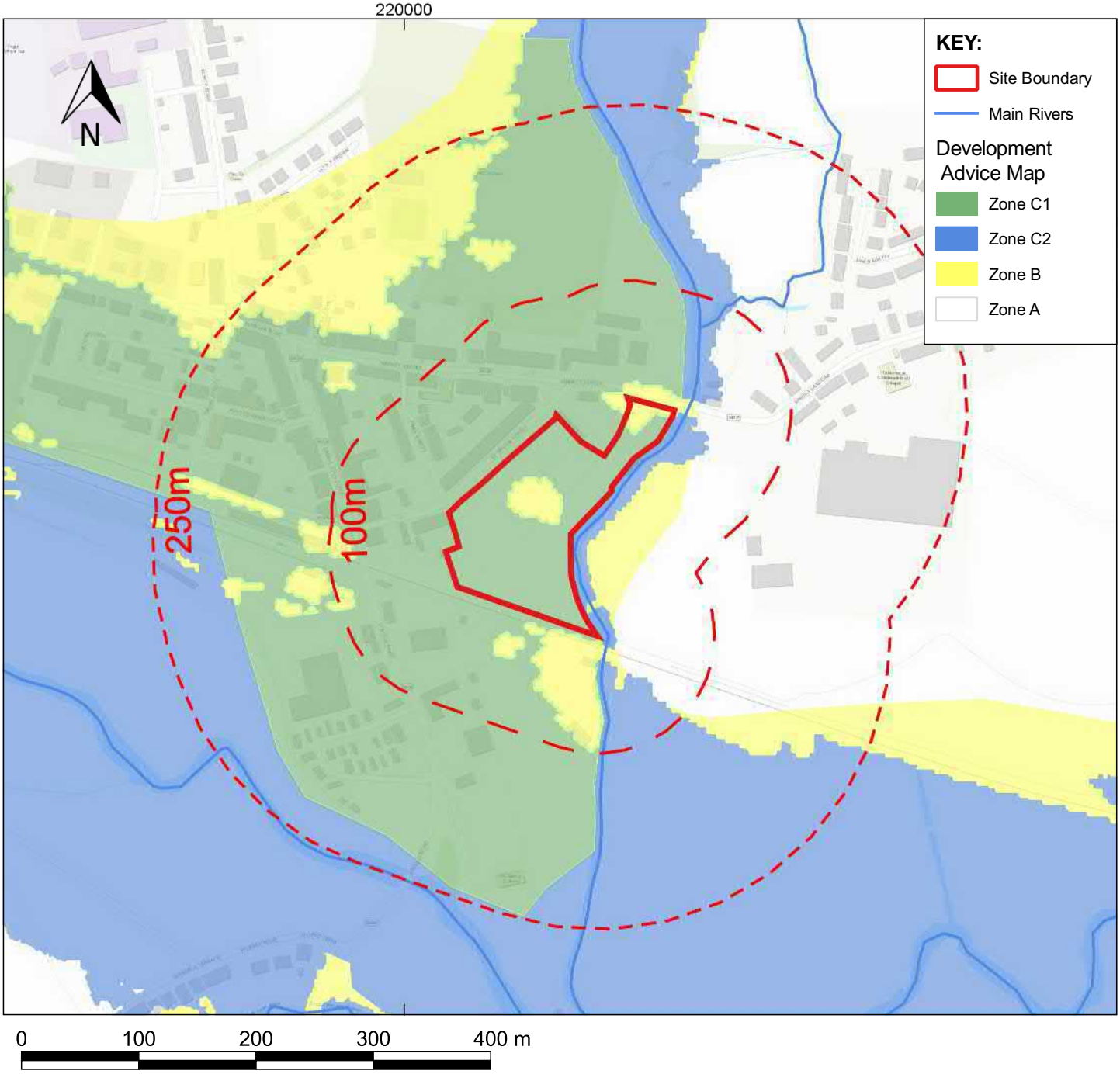
Created by: UKRGC400 - 2020-10-16 15:40:55
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

SITE LOCATION



In Wales main rivers are legally designated by Natural Resources Wales, they are typically larger streams and rivers but do include some smaller watercourses. Where works, either temporary or permanent, are proposed: in or near a main river, or in a flood plain or flood defence (including a sea defence), an application for a Flood Risk Activity Permit (FRAP) will usually be required.
All other watercourses in Wales are known as ordinary watercourses and are the responsibility of the Lead Local Flood Authority or Internal Drainage District. Where works, either temporary or permanent, are proposed on or near an ordinary watercourse either an ordinary watercourse consent (LLFA) or land drainage consent (IDD) may be required from the relevant authority.

NATURAL RESOURCES WALES (NRW) DEVELOPMENT ADVICE MAP



The Development Advice Map (DAM) shows areas at risk of flooding for the purposes of land-use planning. The DAM should be used to guide developments away flood risk areas. The maps should be considered as a trigger for following policy advice in TAN15.

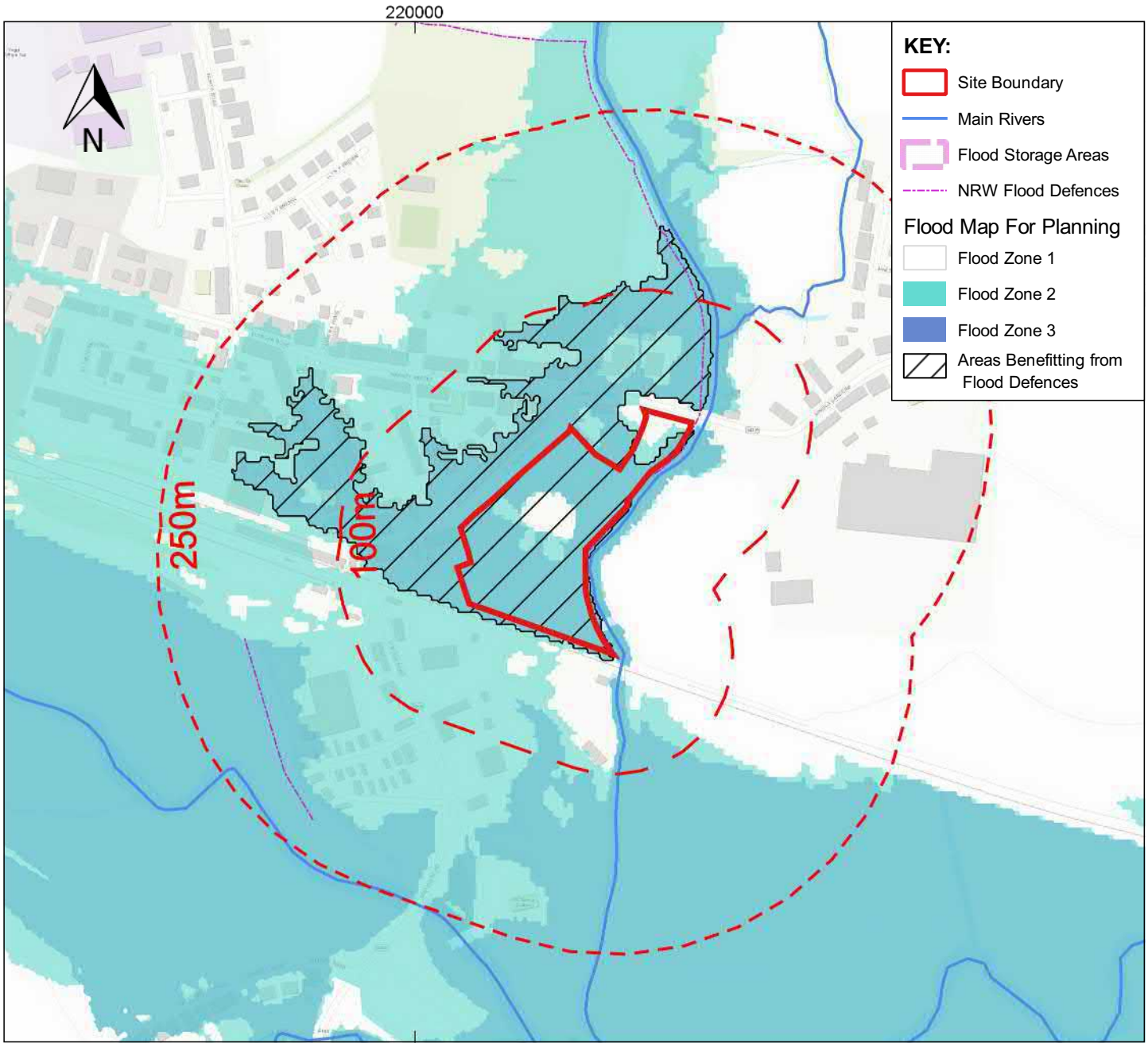
DAM Zone A is the area considered to be at little or no risk of fluvial or tidal flooding.

DAM Zone B is the area considered as known to have flooded in the past, evidenced by sedimentary deposits. It is based on BGS 10k superficial geology published 2004, revised 2017.

DAM Zone C is updated quarterly and is divided in two, it is based on the extreme flood outline, a 0.1% probability of flooding in any year from rivers or tides.
DAM Zone C1 is considered as areas of the floodplain which are developed and served by significant infrasturcture, including defences.
DAM Zone C2 is considered as areas of the floodplain without significant flood defence infrastructure.

Created by: UKRGC400 - 2020-10-16 15:40:58
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

NRW FLOOD MAP FOR PLANNING



Flood zone maps are modelled using local and national river and sea data. This information provides an indication of the likelihood of flooding and is intended for planning use only.

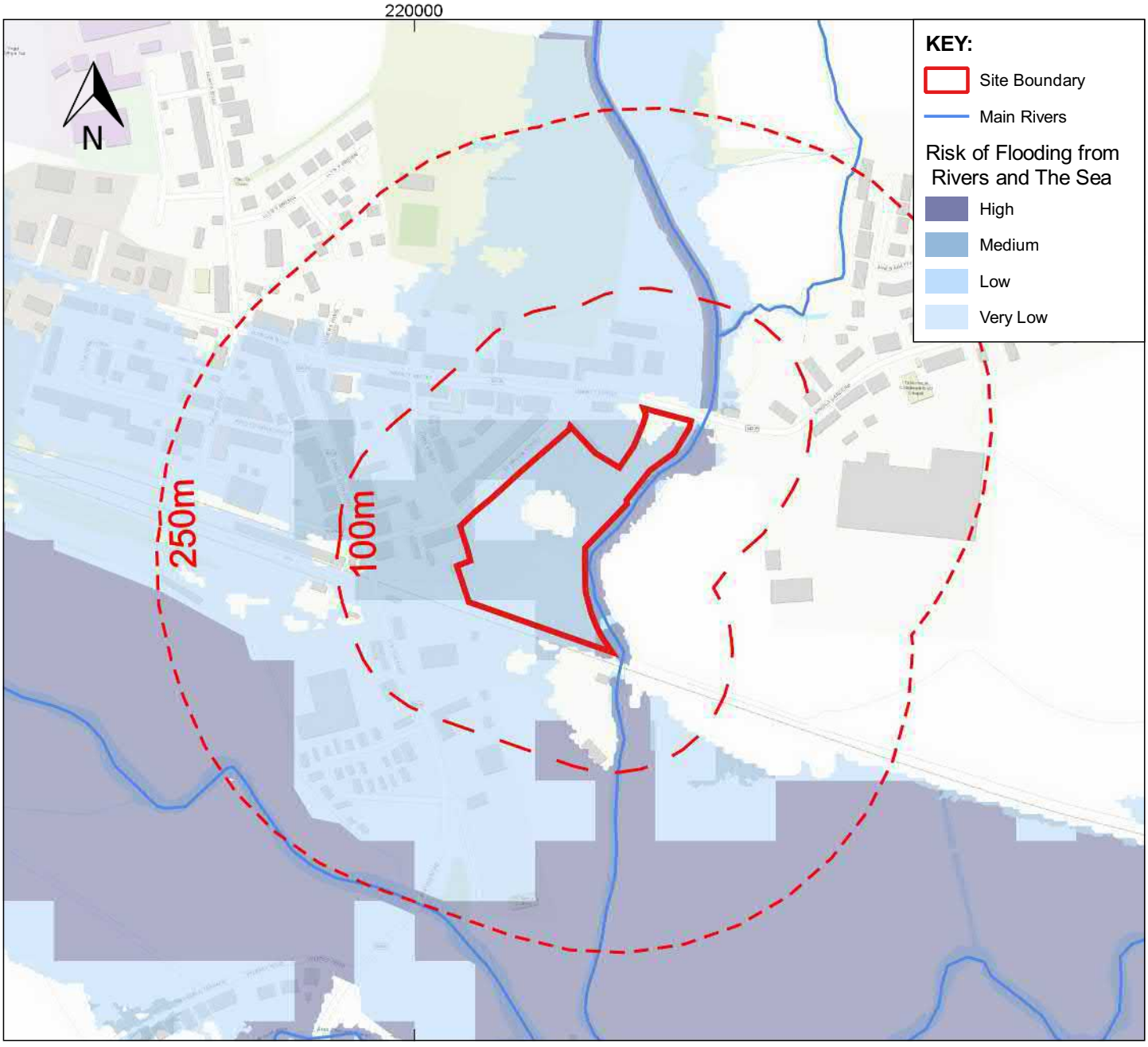
Flood Zone 1 - Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3).

Flood Zone 2 - Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)

Flood Zone 3 - Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)

Created by: UKRGC400 - 2020-10-16 15:41:07
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

NRW RISK OF FLOODING FROM RIVERS AND THE SEA



High risk means that each year this area has a chance of flooding of greater than 3.3%.

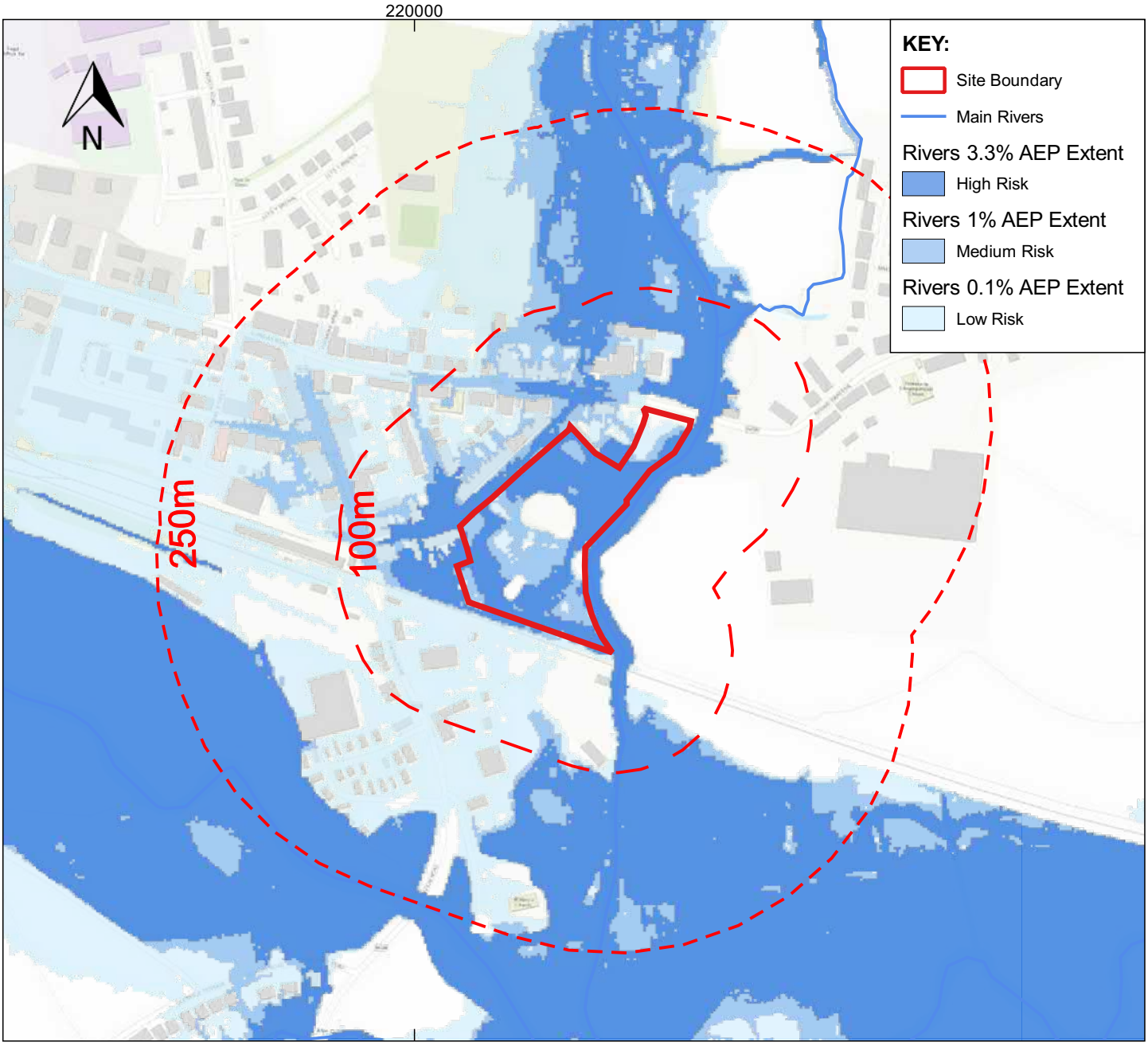
Medium risk means that each year this area has a chance of flooding of between 1% and 3.3%.

Low risk means that each year this area has a chance of flooding of between 0.1% and 1%.

Very low risk means that each year this area has a chance of flooding of less than 0.1%.

This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

NRW RISK OF FLOODING FROM RIVERS



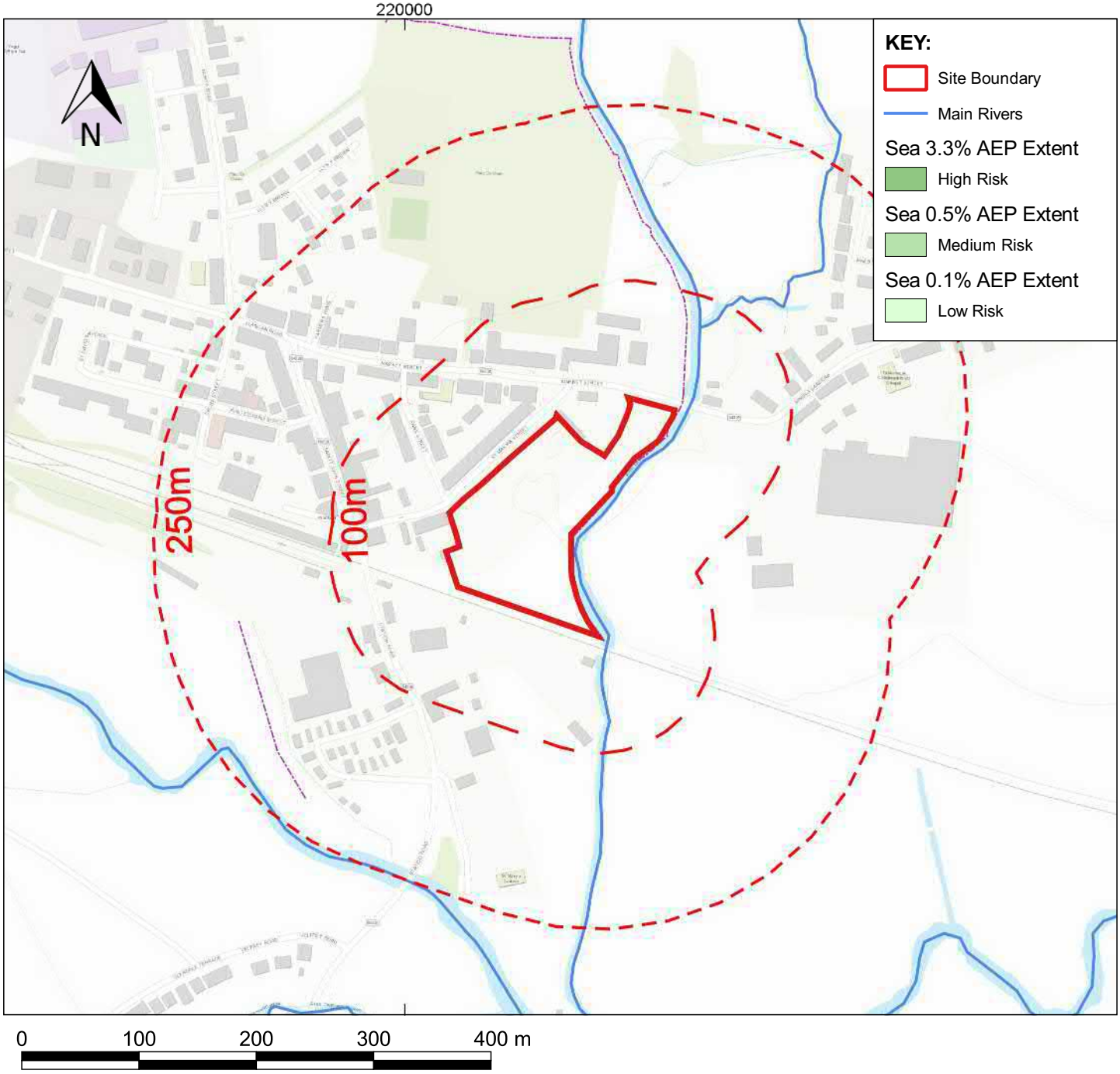
High risk means that each year this area has a chance of flooding of greater than 3.3%.

Medium risk means that each year this area has a chance of flooding of between 1% and 3.3%.

Low risk means that each year this area has a chance of flooding of between 0.1% and 1%.

This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

NRW RISK OF FLOODING FROM THE SEA



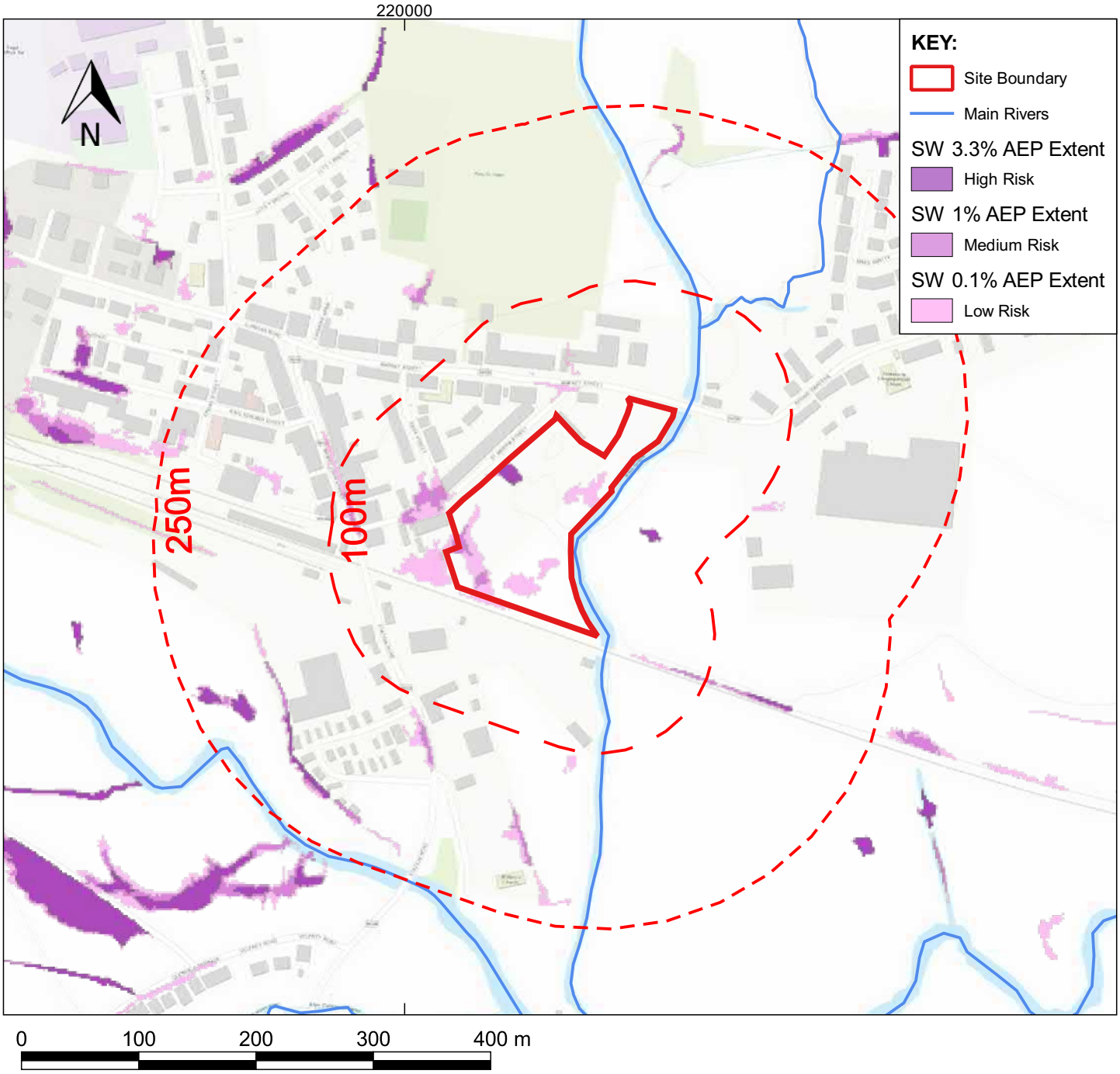
High risk means that each year this area has a chance of flooding of greater than 3.3%.

Medium risk means that each year this area has a chance of flooding of between 0.5% and 3.3%.

Low risk means that each year this area has a chance of flooding of between 0.1% and 0.5%.

This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

NRW RISK OF FLOODING FROM SURFACE WATER & SMALL WATERCOURSES



High risk means that each year this area has a chance of flooding of greater than 3.3%.

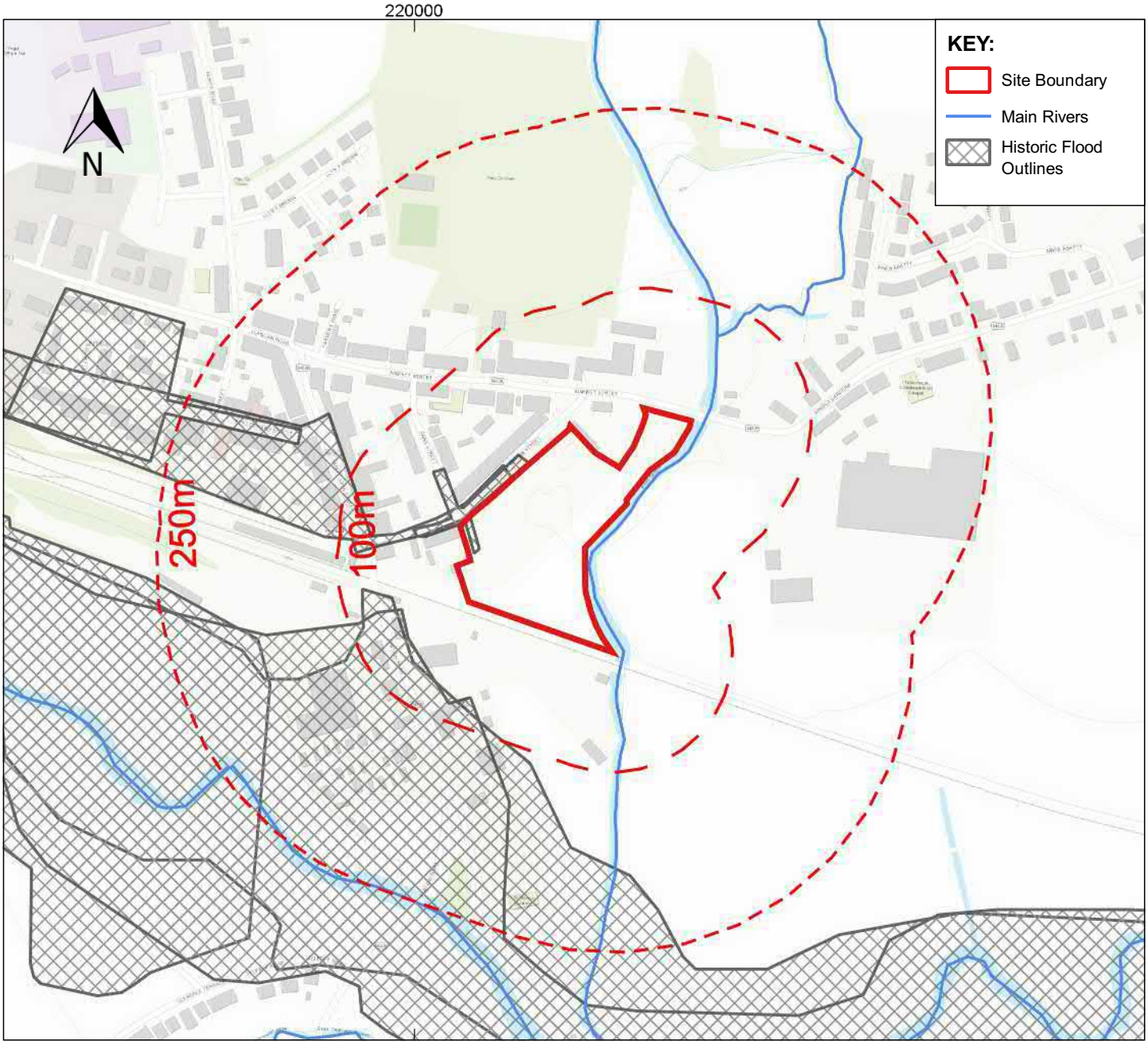
Medium risk means that each year this area has a chance of flooding of between 1% and 3.3%.

Low risk means that each year this area has a chance of flooding of between 0.1% and 1%.

Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.

Created by: UKRGC400 - 2020-10-16 15:41:16
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

NRW HISTORIC FLOOD MAP

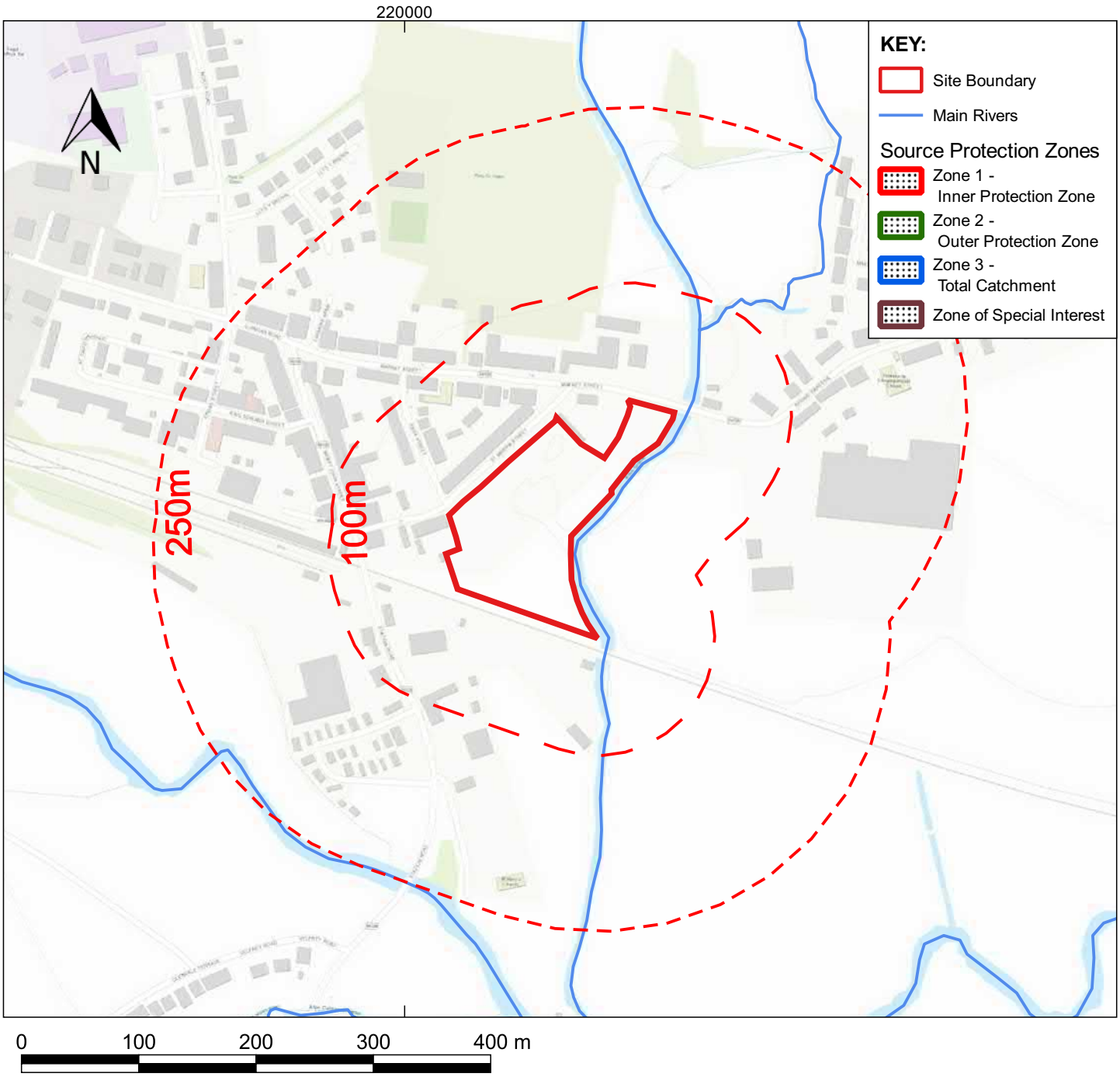


The hatched areas are those that have been recorded to have flooded in the past. The records come from a number of evidence sources including Natural Resources Wales, its predecessors or other Risk Management Authorities.
They may show flooding from rivers, the sea or surface water. Where they show flooding from rivers or the sea, and deemed of an appropriate quality they form part of Flood Zone 2.

The absence of coverage by the Historic Flood Map for an area does not mean that the area has never flooded, only that we do not currently have records of flooding in this area. It is also possible that the pattern of flooding in this area has changed and that this area would now flood under different circumstances. The Historic Flood Map will take into account of the presence of defences, structures, and other infrastructure where they existed at the time of flooding. It will include flood extents that may have been affected by overtopping, breaches or blockages. Flooding shown to the land and does not necessarily indicate that properties were flooded internally.

Created by: UKRGC400 - 2020-10-16 15:41:17
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

NRW SOURCE PROTECTION ZONES



Inner zone (Zone 1) - Defined as the 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres;

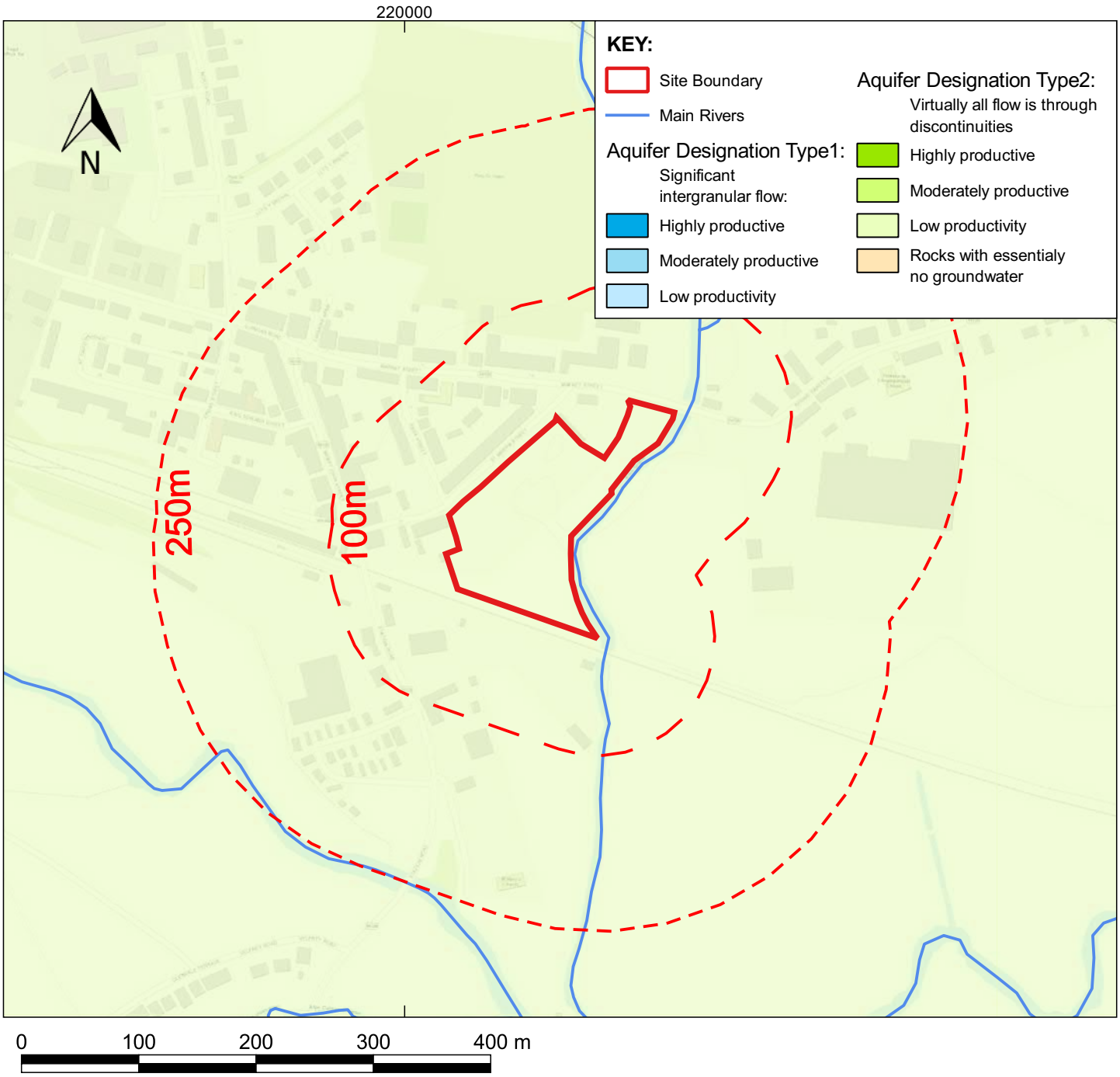
Outer zone (Zone 2) - Defined by a 400 day travel time from a point below the water table. The previous methodology gave an option to define SPZ2 as the minimum recharge area required to support 25 per cent of the protected yield. This option is no longer available in defining new SPZs and instead this zone has a minimum radius of 250 or 500 metres around the source, depending on the size of the abstraction;

Total catchment (Zone 3) - Defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

Special interest (Zone 4) - A fourth zone SPZ4 or 'Zone of Special Interest' was previously defined for some sources. SPZ4 usually represented a surface water catchment which drains into the aquifer feeding the groundwater supply (i.e. catchment draining to a disappearing stream).

Created by: UKRGC400 - 2020-10-16 15:41:18
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

BRITISH GEOLOGICAL SURVEY 1:625,000 SCALE AQUIFER DESIGNATION



The hydrogeological map indicates aquifer potential in generalised terms using a threefold division of geological formations:

1. those in which intergranular flow in the saturated zone is dominant
2. those in which flow is controlled by fissures or discontinuities
3. less permeable formations including aquifers concealed at depth beneath covering layers

Highly productive aquifers are distinguished from those that are only of local importance or have no significant groundwater. Within each of these classes the strata are grouped together according to age or lithology.

The 1:625 000 scale data may be used as a guide to the aquifers at a regional or national level, but should not be relied on for local information.

Created by: UKRGC400 - 2020-10-16 15:41:19
C:\Users\UKRGC400\Desktop\Whitland\SINGLE - SITE - Wales Aug2020\70071713 - Whitland.qgs

Appendix C

FLOOD MODEL RESULTS (MAPPED)

Appendix D

ILLUSTRATIVE ACCESS VIABILITY

Time	CSC (1Hz) Brch_Chr	CSC (1Hz) Int_Chr	CST (1Hz) 1%CE	CST (1Hz) Int_Chr	CST (1Hz) 0.1% Int_Chr
00:00					
00:10					
00:20					
00:30					
00:40					
00:50					
01:00					
01:10					
01:20					
01:30					
01:40					
01:50					
02:00					
02:10					
02:20					
02:30					
02:40					
02:50					
03:00					
03:10					
03:20					
03:30					
03:40					
03:50					
04:00					
04:10					
04:20					
04:30					
04:40					
04:50					
05:00					
05:10					
05:20					
05:30					
05:40					
05:50					
06:00					
06:10					
06:20					
06:30					
06:40					
06:50					
07:00					
07:10					
07:20					
07:30					
07:40					
07:50					
08:00					
08:10					
08:20					
08:30					
08:40					
08:50					
09:00					
09:10					
09:20					
09:30					
09:40					
09:50					
10:00					
10:10					
10:20					
10:30					
10:40					
10:50					
11:00					
11:10					
11:20					
11:30					
11:40					
11:50					
12:00					
12:10					
12:20					
12:30					
12:40					
12:50					
13:00					
13:10					
13:20					
13:30					
13:40					
13:50					
14:00					
14:10					
14:20					
14:30					
14:40					
14:50					
15:00					
15:10					
15:20					
15:30					
15:40					
15:50					
16:00					
16:10					
16:20					
16:30					
16:40					
16:50					
17:00					
17:10					
17:20					
17:30					
17:40					
17:50					
18:00					
18:10					
18:20					
18:30					
18:40					
18:50					
19:00					
19:10					
19:20					
19:30					
19:40					
19:50					
20:00					
20:10					
20:20					
20:30					
20:40					
20:50					
21:00					
21:10					
21:20					
21:30					
21:40					
21:50					
22:00					
22:10					
22:20					
22:30					
22:40					
22:50					
23:00					
23:10					
23:20					
23:30					
23:40					
23:50					
24:00					
24:10					
24:20					
24:30					
24:40					
24:50					
25:00					
25:10					
25:20					
25:30					
25:40					
25:50					
26:00					
26:10					
26:20					
26:30					
26:40					
26:50					
27:00					
27:10					
27:20					
27:30					
27:40					
27:50					
28:00					
28:10					
28:20					
28:30					
28:40					
28:50					
29:00					
29:10					
29:20					
29:30					
29:40					
29:50					
30:00					
30:10					
30:20					
30:30					
30:40					
30:50					
31:00					
31:10					
31:20					
31:30					
31:40					
31:50					
32:00					
32:10					
32:20					
32:30					
32:40					
32:50					
33:00					
33:10					
33:20					
33:30					
33:40					
33:50					
34:00					
34:10					
34:20					
34:30					
34:40					
34:50					
35:00					

1 Capital Quarter
Tyndall Street
Cardiff
CF10 4BZ

wsp.com