



North Wiltshire School

Flood Risk Assessment and Hydraulic Modelling Report

For Wilmott Dixon

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Appendices

Appendix A – Site Information

Appendix B – Hydraulic Modelling

1. INTRODUCTION

This Flood Risk Assessment (FRA) report has been prepared by Hydrock on behalf of Wilmott Dixon in support of a planning application for the proposed re-development of Rowdeford School site in Rowde, Devizes. The FRA has been prepared as the site is over 1ha in size and the eastern and southern boundaries are within Flood Zone 3.

The report addresses the requirements of the National Planning Policy Framework (NPPF) and associated National Planning Practice Guidance for flood risk and coastal change (NPPG), through:

- Assessing whether the site is likely to be affected by flooding.
- Assessing whether the proposed development is appropriate in the suggested location.
- Presenting any flood risk mitigation measures necessary to ensure that the proposed development and occupants will be safe from flooding, whilst ensuring flood risk is not increased elsewhere.

2. SITE INFORMATION

2.1 Site Location and Description

Rowdeford School is located in a rural area between the villages of Rowde and St. Edith's Marsh. Table 1 provides a summary of the location reference and Figure 1 shows the approximate site redline boundary.

The school grounds are bound to the south by Rowde Ford Stream, to the west by woodland off the A342 and to the north and east by agricultural land. There is an unnamed watercourse that runs southwards in the west of the site which is referred to hereafter as St. Edith's Marsh Drain. This joins the Rowde Ford Stream by the south-west corner of the site. There are also unnamed field ditches within the centre and east of the site which drain southwards and also outfall to the Rowde Forde Stream.

Table 1: Site Referencing Information

Site Referencing Information	
Site Address	Rowdeford School, Rowde, Devizes, SN10 2QQ
Grid Reference	ST 97725 63378
X (Easting), Y (Northing)	397725, 163378

Figure 1: Site Location



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2.2 Proposed Development

A Planning Application is to be submitted for the proposed redevelopment of the existing Rowdeford School site, with new / improved buildings, outdoor facilities, parking and access arrangements.

The latest layout also proposes the culverting of the existing ditch that flows through the centre of the site. This ditch is to be culverted along its current route before then flowing in a southerly direction and into the Rowde Ford Stream. At this stage this is 'in principle' only and discussions are on going with Wiltshire Council in their role as the Lead Local Flood Authority (LLFA)

The proposed landscape plan is included in Appendix A.

2.3 Topography

Appendix A includes topographical survey plans from August 2020. This shows the ground falls generally from north to south towards Rowde Ford Stream along the southern boundary. There are also shallow valleys within the site where the ground locally falls towards the tributaries and field ditches.

The highest ground level is in the north-west of the school grounds at approximately 71m AOD. Lowest ground levels along the river at the southern boundary are between 62-63m AOD. The lowest ground level recorded around the southern extent of the existing built development is approximately 66m AOD.

3. ASSESSMENT OF FLOOD RISK

3.1 Fluvial, Tidal and Coastal Flooding

3.1.1 Design Flood Event

New development should be flood resistant and resilient, including safe access and escape routes, for the following extreme flood events, also known as the 'design flood':

- 1 in 100 (1%) fluvial flood accounting for climate change
- 1 in 200 (0.5%) tidal/coastal flood accounting for climate change

Climate change is projected to increase the likelihood of flooding from most flood sources and therefore an assessment of the effects of climate change should be considered over the estimated development lifetime. The assumed lifetime of a building serving a school is not specifically noted in any policy or guidance documents, but general non-residential development has an accepted lifetime of no greater than 75 years.

3.1.2 Hydrological Setting

The site is located inland in the upper reaches of the River Avon basin. The site is within the sub-catchment of the Rowde Ford Stream which is classified as 'ordinary watercourse' with a catchment of 14.8km² upstream of the site, as indicated by the Flood Estimation Handbook (FEH) Web Service (see Figure 2).

Figure 2: Rowde Ford Stream Catchment Upstream of Site



The river flows in a south-westerly direction, joining the Summerham Brook which subsequently flows to the Semmington Brook, the River Avon, and finally the River Severn. The smaller ditches within the

site have only small, localised drainage catchments which are therefore not separately differentiated from the wider Rowde Ford Stream catchment in FEH.

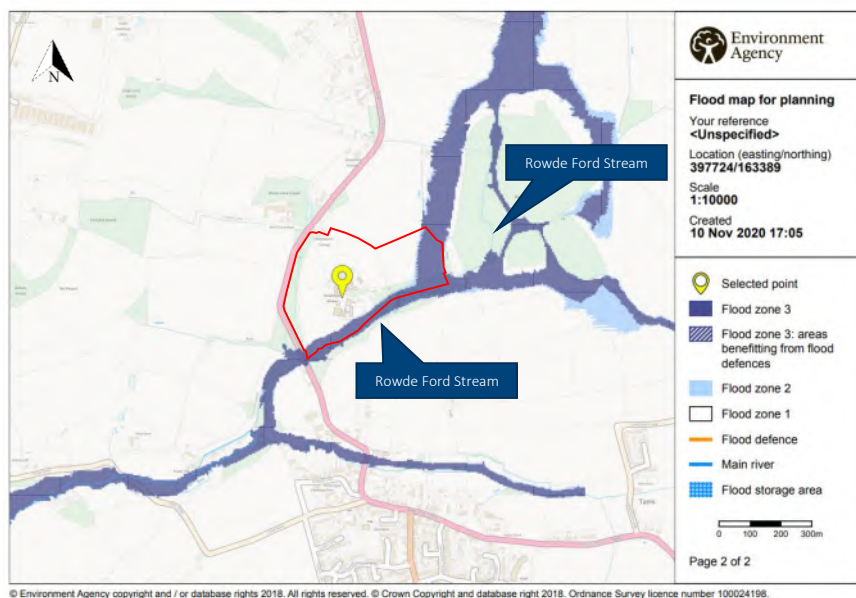
3.1.3 Coastal / Tidal Flooding

The risk of coastal and tidal flooding is concluded to be 'negligible' as the site is far inland, with a minimum elevation of 62m AOD.

3.1.4 Fluvial Flooding

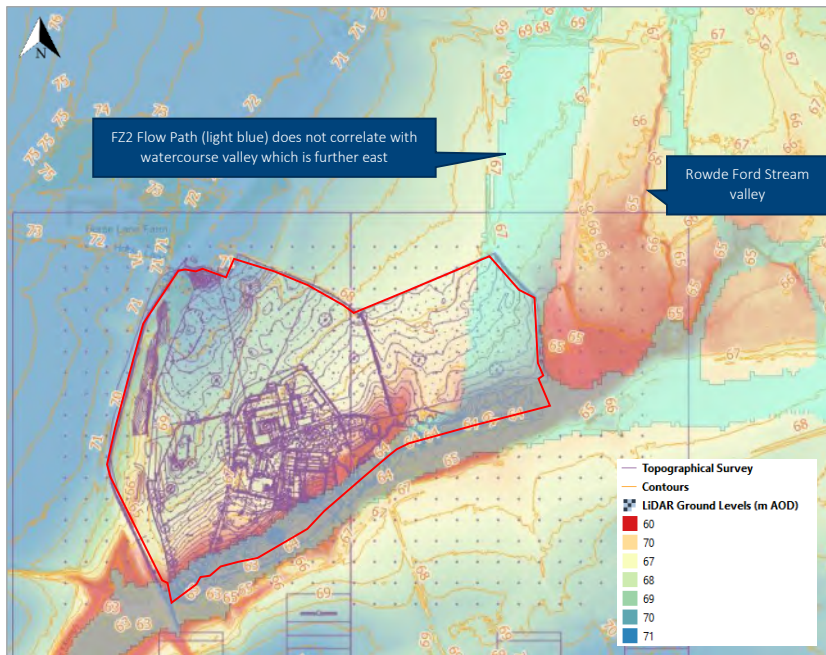
Figure 3 shows the EA's 'Flood Map for Planning' which indicates the combined coastal, tidal and fluvial floodplain in the present-day scenario (not accounting for climate change). The flood extent shown is associated with the Rowde Ford Stream which is a fluvial watercourse. The maps indicate that the southern and eastern boundaries are within Flood Zone 3 which is the 'high' risk flood zone where there is predicted to be a 1% or greater chance of fluvial flooding or 0.5% or greater chance of tidal flooding.

Figure 3: Flood Map for Planning



The flood extent shown in the east of the site is not considered to be representative of the actual risk, as the flow path does not match the location of the watercourse (which is further east), nor does it match the natural valleys as shown in the LiDAR data (demonstrated in Figure 4). The EA have confirmed that the flood maps in this area are based on JFlow data which is a broad-scale modelling approach and should not be used to inform detailed site-specific assessments of flood risk (see correspondence in Appendix B). Therefore, Hydrock have undertaken detailed flood modelling to confirm the risk to the site from fluvial sources (see Sections 4 and 5).

Figure 4: Comparing Flood Zone 2 Extent with LiDAR



3.2 Groundwater Flooding

The Wiltshire Local Flood Risk Management Strategy¹ and the Wiltshire Level 1 Strategic Flood Risk Assessment (SFRA)² reports were reviewed and the wider area of Devizes was not reported as experiencing issues with groundwater flooding.

The British Geological Survey (BGS) Geology of Britain viewer³ indicates the site is underlain by sandstone bedrock of 'Lower Greensand Group'. Superficial deposits of 'Alluvium', comprising clay, silt, sand and gravel are also indicated to be present along the river corridors.

The sandstone bedrock is classified as a 'Secondary A' aquifer which has potential to hold groundwater of significance at the local scale, but the quantity and movement of groundwater would not be expected to result in significant groundwater flooding. Ordnance Survey (OS) maps were reviewed and there are no springs shown in the area.

Given the presence of the adjacent Rowde Ford Stream, the groundwater table beneath the site will likely be influenced by water levels within the River. As such, the flood risk indicated at the site posed by the watercourse (as assessed in Sections 4 and 5) is considered to be representative of the 'worst-case' groundwater flooding scenario at the site.

¹ Wiltshire Council (2014) Wiltshire Local Flood Risk Management Strategy

² Scott Wilson (2009) Strategic Flood Risk Assessment High Level Executive Summary Final Report

³ Available on the BGS website at: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

Based on the above, whilst groundwater will play a role in the flow regime of the watercourses on site, there is concluded to be a 'low' risk of groundwater flooding occurring outside of the identified watercourse corridors.

3.3 Surface Water Flooding

The EA's surface water flood risk map highlights the low-lying areas and valleys where there is an increased risk of surface water flooding (see Figure 6). This map shows the majority of the school site is at a 'very low' risk from surface water, including the new areas of proposed development. Areas at 'very low' risk are predicted to be flood free in the 1 in 1000 year storm event.

The floodplain shown along the southern and eastern boundaries is a fluvial flood risk associated with the Rowde Ford Stream rather than a surface water risk, and is covered under the detailed assessment of fluvial flooding in Sections 4 and 5. A narrow floodplain is shown along St. Edith's Marsh Drain along the western boundary, which is of a 'low' risk indicating flooding is anticipated only in the 1 in 1000 year storm. Again, given the identified watercourse, this is actually considered a fluvial risk rather than surface water and is assessed further in Sections 4 and 5.

The short section of ditch through the centre of the site is not identified as being at an increased risk of surface water flooding in the EA flood mapping, however the topographical survey identifies upstream land drainage entering the head of the ditch which suggests the ditch provides a flow path that serves land further upstream that needs to be maintained. Similarly, there is a ditch along the eastern boundary which has an associated surface water flow path which needs to be maintained. Proposed mitigation to address this is detailed in Section 6.

Figure 5: Surface Water Flood Risk Mapping



3.4 Infrastructure Failure Flooding

There is no significant urban development upslope of the site so the risk of flooding as a result of sewer surcharge is concluded to be low.

No other potential sources of infrastructure failure flooding, such as artificially raised waterbodies, reservoirs or canal, are located within the immediate vicinity or uphill of the site. This is confirmed from review of OS maps and the EA's reservoir flood risk map. Therefore, the site is concluded to be at 'low' risk of flooding from artificial infrastructure failure.

4. HYDROLOGICAL MODELLING

4.1 Overview

Detailed hydrological and hydraulic modelling has been undertaken for the Rowde Ford and the small watercourse to the west of the site referred to as St. Edith's Marsh Drain. The drainage catchment of St. Edith's Marsh Drain is relatively minor and is not a defined watercourse catchment, forming part of the wider Rowde Ford catchment. However, the decision was made to model this as a separate watercourse catchment as there is a small culvert on site that restricts flows and it was considered important to represent this in the modelling.

4.2 Peak Flow Calculation Methods

Peak flows for the following return periods were calculated for the Rowde Ford and St. Edith's Marsh Drain for input into the hydraulic model:

- » 1 in 2 year.
- » 1 in 20 year.
- » 1 in 100 year.
- » 1 in 100 year + 35% climate change (Severn Basin 'central' allowance).
- » 1 in 100 year + 70% climate change (Severn Basin 'upper end' allowance).
- » 1 in 1,000 year.

A review of the Flood Estimation Handbook (FEH) web service shows that there are no gauging stations on either watercourse and, as such, no suitable observed data is available. As a result, the Enhanced Single Site analysis / Single Site analysis methods cannot be used for calculating flows.

Flows have been calculated using the FEH Statistical method and REF2 rainfall-runoff method for both catchments, as discussed in the following sections.

4.3 Catchment Characteristics

The Flood Estimation Handbook (FEH) Web Service was used to ascertain the catchment descriptors for the Rowde Ford Stream catchment. The catchment outlet (study node) was located at grid reference 397550, 163150. This is just downstream of the study site where the river crosses under the St. Edith's Marsh road. Table 2 shows the catchment descriptors for this node obtained from the FEH Web Service.

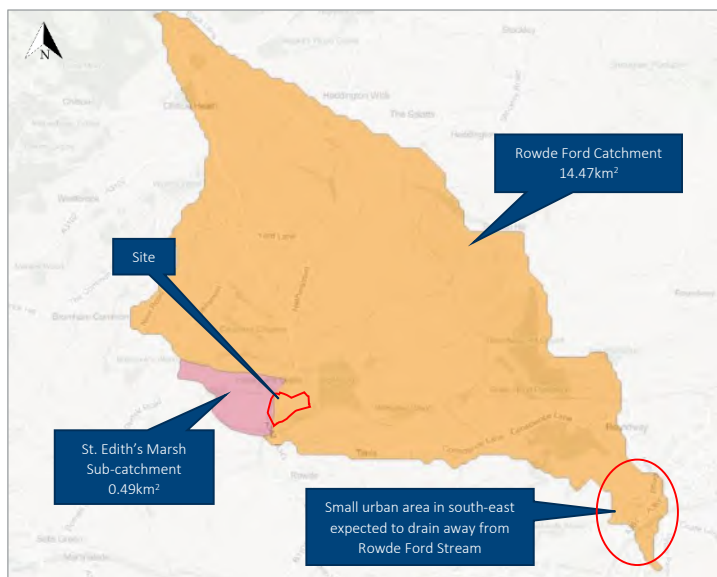
Table 2 Catchment Descriptors (FEH Web Service)

Descriptor	Value	Descriptor	Value
AREA	14.7975	FPEXT	0.1072
ALTBAR	101	FPDBAR	0.58
ASPBAR	184	LDP	6.3
ASPVAR	0.36	PROPWET	0.34
BFIHOST	0.663	SAAR	703
BFIHOST19	0.635	SAAR4170	770
DPLBAR	3.17	SPRHOST	27.58
DPSBAR	49	URBEXT1990	0.0253
FARL	0.991	URBEXT2000	0.0176

A check on key descriptors was undertaken to ensure that the values adopted were appropriate for use. This included the following checks:

- » **AREA** – Figure 6 shows the calculated watershed boundaries. The FEH Web Service does not recognise the sub-catchment of St. Edith's Marsh Drain within the wider Rowde Ford catchment and so the catchment area was calculated as 0.49km² using the 'r.watershed' module in Grass QGIS, which was refined through reviewing the LiDAR contour lines at 1m resolution. The catchment area of the remaining Rowde Ford catchment (i.e. minus the calculated sub-catchment) was measured as 14.47km². This catchment area was reviewed against 1m LiDAR contours and found to be largely representative of the likely catchment area from that data, apart from a small area in the south-east of the catchment which would be expected to drain southwards into the canal. Given the relatively small size of this area, it was decided that this would have little impact on flows and the catchment boundary was kept as shown by FEH, this being a conservative approach.

Figure 6: Catchment Drainage Basins



- » **Impermeable Land Cover (URBEXT2000)** of 0.0176. Urban extent values of greater than 0.03 are considered 'urban' catchments. There are a few small built-up areas within the catchment but it is largely rural land. Historical aerial mapping was reviewed and this did not identify any recent development that has occurred within the catchment since the year 2000. The urban areas adjacent to the catchment boundary were also reviewed and it is evident from the LiDAR that these areas would drain away from the catchment rather than into it. Therefore, the urban extent value is considered appropriate, if not slightly conservative due to the included urban area in the south-east of the catchment. That said, the Urban Adjustment Factor is to be included within any calculations to ensure it is in line with current guidance.

- » Average annual rainfall (SAAR) of 703 mm. This is relatively low in a UK context where typical values range from 500 to 3000 mm. This is, however, considered appropriate given the site's inland location.
- » Standard percentage run-off (SPRHOST) of 27.58% and Baseflow index (BFIHOST19) of 0.635. Both are considered to indicate moderately permeable geology in a UK context (where SPRHOST values range from less than 10% for catchments on permeable geology to over 50% in clay catchments, and the BFIHOST values typically range between 0.2 for highly impermeable and 0.6 for highly permeable, e.g. chalk catchments). The British Geology Survey mapping indicates the underlying bedrock to comprise chalk and sandstones in the upper catchment, mudstones in the middle catchment and sandstone in the lower catchment and therefore the moderate permeability is considered representative (see Figure 7). Similarly, the Soilsmap website indicates the upper reaches of the catchment as have freely draining soils, with the soils above the mudstone bedrock classified as having impeded drainage. Upon review, the SPRHOST and BFIHOST values are considered to be reflective of the expected ground permeability.

Figure 7: Bedrock Geology in the Catchment



The catchment descriptors identified for the wider catchment were directly transferred to both the Rowde Ford Stream catchment and St. Edith's Marsh Drain catchment, apart from the area values as discussed above. To assess the impact of these assumptions on the hydrology calculations, sensitivity testing has been carried out to confirm that the model is not sensitive to higher or lower flows. The sensitivity testing is discussed in Section 5.

4.4 Rowde Ford Stream Peak Flow Estimates

4.4.1 FEH Statistical Method

A pooled analysis was undertaken in WINFAP 4 using the latest NFRA peak flow dataset (Version 9). The initial pooling group was generated from stations which were suitable for pooling (see Figure 8). The following stations were removed from the dataset:

- » 33032 = Outlier in dataset removed for high BFIHOST value of 0.968
- » 26802 = Outlier in dataset removed for high BFIHOST of 0.959
- » 26014 = Outlier in dataset removed for high BFIHOST of 0.949
- » 33054 = Outlier in dataset removed for high BFIHOST of 0.906
- » 27073 = Outlier in dataset removed for high BFIHOST of 0.887
- » 44008 = Outlier in dataset removed for high BFIHOST of 0.811
- » 25011 = Outlier in dataset removed for low BFIHOST of 0.237
- » 48007 = Outlier in dataset removed for low FARL of 0.867

This left a final pooling group as shown in Figure 9 which was classified by WINFAP as being homogenous and therefore acceptable for use in pooling, and also has greater than 500 years of flow data.

Figure 8 WINFAP Initial Pooling Group

AM Data	Catchment Descriptors						
	Station	Distance	Years of data	QMED AM	L/OV	L/SKEW	Discrepancy
1	25802 (Gypsy Place @ Kirby Grindalby)	0.880	15	0.109	0.309	0.153	0.457
2	25019 (Leven @ Easby)	1.034	40	5.384	0.343	0.378	1.105
3	36010 (Bumpstead Brook @ Broad Gree	1.192	51	7.500	0.372	0.184	2.018
4	27010 (Hodge Beck @ Bransdale Weir)	1.324	41	9.420	0.224	0.293	0.360
5	44008 (South Waterbourne @ Winterbo	1.329	39	0.448	0.411	0.328	2.514
6	27051 (Cimple @ Burn Bridge)	1.372	46	4.539	0.219	0.148	0.241
7	41020 (Beven Stream @ Clappers Bridg	1.375	49	13.660	0.203	0.181	0.670
8	72014 (Conder @ Galgate)	1.422	50	16.465	0.233	0.162	0.080
9	73015 (Keer @ High Keer Weir)	1.448	27	12.330	0.205	0.281	0.495
10	26014 (Water Forlornes @ Driffield)	1.523	20	0.431	0.297	0.127	0.890
11	47022 (Toy Brook @ Newnham Park)	1.653	25	6.180	0.273	0.148	0.699
12	27073 (Brompton Beck @ Swanton Ings	1.670	37	0.620	0.200	0.047	0.944
13	26058 (Henmore Brook @ Ashbourne)	1.682	13	8.838	0.188	-0.109	2.765
14	33054 (Babingley @ Castle Rising)	1.722	42	1.132	0.201	0.080	0.955
15	28041 (Hamps @ Waterhouses)	1.763	33	26.126	0.223	0.291	1.320
16	25011 (Langdon Beck @ Langdon)	1.766	32	15.533	0.235	0.334	2.438
17	45003 (de Lank @ de Lank)	1.768	52	13.365	0.223	0.209	0.166
18	72007 (Beck @ Upstream of a/c)	1.774	40	28.964	0.199	0.218	0.816
19	27032 (Hebden Beck @ Hebden)	1.776	52	3.923	0.207	0.244	0.593
20	48004 (Waleggen @ Trengolle)	1.778	49	9.983	0.255	0.257	0.310
21	53017 (Boyd @ Bilton)	1.801	45	13.870	0.241	0.088	0.419
22	38033 (Winterbourne Stream @ Bagnor)	1.802	56	0.401	0.342	0.388	2.130
23	45816 (Haddo @ Upton)	1.827	25	3.456	0.306	0.399	1.111
24	36004 (Chad Brook @ Long Melford)	1.837	51	5.186	0.294	0.182	0.946
25	76811 (Dacre Beck @ Dacre Bridge)	1.847	18	35.000	0.197	0.240	1.303
26	48009 (at Neot @ Craighill Wood)	1.858	12	8.469	0.245	0.373	1.115
27	24006 (Rookhope Burn @ Eastgate)	1.869	20	24.620	0.152	0.117	1.028
28	28033 (Dove @ Hollinscough)	1.870	43	4.205	0.221	0.369	0.961
29	43004 (Gannet @ Gwills)	1.875	49	15.022	0.257	0.104	0.954
30	48007 (Kannel @ Ponsanooth)	1.885	50	4.236	0.194	0.222	0.516
31	33032 (Heascham @ Heascham)	1.889	50	0.442	0.304	0.124	0.750
32	Total		1176				
33	Weighted means		1176		0.253	0.215	

Figure 9 WINFAP Final Pooling Group

AM Data Catchment Descriptors							
	Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
1	25019 (Leven @ Easby)	1.034	40	5.384	0.343	0.378	1.361
2	36010 (Bumpstead Brook @ Broad Gree	1.192	51	7.500	0.372	0.184	2.622
3	27010 (Hodge Beck @ Bransdale Weir)	1.324	41	9.420	0.224	0.293	0.273
4	27051 (Cimple @ Burn Bridge)	1.372	46	4.539	0.219	0.148	0.308
5	41020 (Bevern Stream @ Clappers Bridg	1.375	49	13.660	0.203	0.181	0.623
6	72014 (Conder @ Galgate)	1.422	50	16.465	0.233	0.162	0.124
7	73015 (Keer @ High Keer Weir)	1.448	27	12.330	0.205	0.281	0.433
8	47022 (Troy Brook @ Newrham Park)	1.653	25	6.190	0.273	0.149	1.094
9	28059 (Hennore Brook @ Aulbourne)	1.692	13	8.638	0.188	-0.109	2.883
10	28041 (Hamps @ Waleshouses)	1.763	33	26.126	0.223	0.291	1.115
11	49003 (de Lank @ de Lank)	1.769	52	13.985	0.223	0.209	0.212
12	72007 (Brook @ Upstream of a6)	1.774	40	28.964	0.199	0.218	0.951
13	27032 (Hebden Beck @ Hebden)	1.776	52	3.923	0.207	0.244	0.488
14	48004 (Waleggen @ Trengolfe)	1.778	49	9.983	0.255	0.257	0.186
15	53017 (Boyd @ Bilton)	1.801	45	13.870	0.241	0.088	0.513
16	39033 (Winterbourne Stream @ Bagnor)	1.802	56	0.401	0.342	0.388	1.879
17	45815 (Haddoe @ Upton)	1.827	25	3.456	0.306	0.399	1.335
18	36004 (Chad Brook @ Long Melford)	1.837	51	5.186	0.294	0.182	0.963
19	76811 (Dacre Beck @ Dacre Bridge)	1.847	18	35.000	0.197	0.240	1.222
20	48009 (at Nest @ Craighill Wood)	1.858	12	8.469	0.245	0.373	1.220
21	24006 (Rookhope Burn @ Eastgate)	1.869	20	24.620	0.152	0.117	1.107
22	28033 (Dove @ Hollinsclough)	1.870	43	4.205	0.231	0.369	0.759
23	49004 (Gannel @ Gwills)	1.875	49	15.022	0.257	0.104	1.309
24							
25	Total		887				
26	Weighted means		887		0.247	0.226	

The estimated QMED value from catchment descriptors was 1.574m³/s. Various donor gauging stations were reviewed for scaling the QMED, and the most suitable identified was 43017 (West Avon @ Upavon based on the area of catchment (84.63km²) and distance (9.17m) being closest to the study site. The adjusted QMED value increased to 2.052 m³/s. The Urban Adjustment Factor was then applied, increasing the final QMED calculation to 2.108m³/s.

The 'Generalised Logistic' distribution was shown to offer the best fit for the pooled growth curve and so this was adopted and then scaled by the estimated QMED value of 2.108m³/s. The calculated peak flow estimates are shown in Table 3 below.

Table 3 Statistical Peak Flow Estimates (FEH Statistical Method)

Return Period (years)	Flow Estimate (m ³ /s)
1 in 20	4.290
1 in 100	6.335
1 in 100 + 35%	8.552
1 in 100 + 70%	10.770
1 in 1000	10.873

4.4.2 ReFH 2 Method

ReFH 2 was used to generate peak flows, with all default values in the software selected. Relevant outputs are included in Appendix B, and the calculated flows summarised in Table 4 below.

Table 4 ReFH 2 Peak Flow Estimates

Return Period (years)	Flow Estimate (m ³ /s)
1 in 20	3.44
1 in 100	5.01
1 in 100 + 35%	6.764
1 in 100 + 70%	8.517
1 in 1000	9.33

4.4.3 Peak Flows Selected for Model

The FEH Statistical method is generally the preferred method of flow calculation, particularly for a catchment of this size (14.47km²). Therefore, the FEH peak flows shown in Table 3 have been applied to the model hydrographs for Rowde Ford Stream. This is also in line with a conservative approach.

4.5 Edith's Marsh Drain Peak Flow Estimates

4.5.1 FEH Statistical Method

The initial pooling group for Edith's Marsh Drain is shown in Figure 10. The following stations were removed from the dataset:

- » 26802 = Outlier in dataset removed for high BFIHOST of 0.959
- » 26014 = Outlier in dataset removed for high BFIHOST of 0.949
- » 27073 = Outlier in dataset removed for high BFIHOST of 0.887
- » 44008 = Outlier in dataset removed for high BFIHOST of 0.811
- » 47022 = Outlier in dataset removed for low FARL of 0.942
- » 48007 = Outlier in dataset removed for low FARL of 0.867

This left a final pooling group as shown in Figure 11 which was classified by WINFAP as being homogenous and therefore acceptable for use in pooling, and also has greater than 500 years of flow data.

Figure 10 WINFAP Initial Pooling Group

AM Data	Catchment Descriptors						
	Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
3	27051 (Crimple @ Burn Bridge)	4.088	46	4.539	0.219	0.148	0.216
4	27073 (Brompton Beck @ Strainton Ings)	4.176	37	0.820	0.200	0.047	0.944
5	28033 (Dove @ Hollinscough)	4.232	43	4.205	0.231	0.369	0.847
6	91802 (All Leachdach @ Intake)	4.533	34	6.350	0.153	0.257	0.726
7	71003 (Croasdale Beck @ Croasdale Flu)	4.813	37	10.900	0.212	0.323	0.466
8	54022 (Severn @ Plymlmon Flume)	4.819	38	14.988	0.156	0.171	1.105
9	25003 (Trout Beck @ Moor House)	4.850	45	15.120	0.167	0.302	0.709
10	25011 (Langdon Beck @ Langdon)	4.886	32	15.533	0.235	0.334	1.555
11	25019 (Leven @ Earby)	4.900	40	5.384	0.343	0.378	0.684
12	47022 (Tory Brook @ Newnham Park)	4.912	25	6.180	0.273	0.149	0.513
13	26802 (Gypsey Race @ Kirby Grindalys)	4.936	19	0.109	0.309	0.183	0.374
14	49006 (Bolingey Stream @ Bolingey Coc)	5.026	8	6.511	0.262	0.049	4.112
15	206006 (Annalong @ Recorder)	5.110	48	15.330	0.189	0.052	2.488
16	27010 (Hodge Beck @ Bransdale Weir)	5.255	41	9.420	0.224	0.293	0.229
17	44008 (South Winterton @ Winterton)	5.343	39	0.448	0.411	0.328	0.997
18	49003 (de Lank @ de Lank)	5.551	52	13.985	0.223	0.209	0.056
19	57017 (Rhondra Fawr @ Tynnewydd)	5.580	17	24.060	0.136	0.018	1.359
20	27032 (Hebden Beck @ Hebden)	5.588	52	3.923	0.207	0.244	0.411
21	48009 (at Neol @ Craigshill Wood)	5.652	12	8.469	0.245	0.373	0.746
22	36010 (Bumpstead Brook @ Broad Gree)	5.686	51	7.500	0.372	0.184	1.757
23	48004 (Waleggan @ Trengolfe)	5.737	49	9.983	0.255	0.257	0.402
24	25012 (Harwood Beck @ Harwood)	5.766	49	33.265	0.190	0.225	0.749
25	46005 (East Dart @ Believer)	5.774	54	38.967	0.158	0.066	0.773
26	72014 (Conder @ Galgate)	5.796	50	16.465	0.233	0.162	0.128
27	48007 (Kernal @ Ponsanooth)	5.842	50	4.236	0.194	0.222	0.216
28	73015 (Keer @ High Keer Weir)	5.843	27	12.330	0.205	0.281	0.256
29	26014 (Water Forlones @ Driftfield)	5.948	20	0.431	0.297	0.127	0.717
30	72007 (Brock @ Upstream of ab)	5.985	40	28.964	0.199	0.218	0.455
31	41020 (Revern Stream @ Clappers Bridg)	6.011	49	13.660	0.203	0.181	0.508
32	44013 (Piddle @ Little Piddle)	6.055	26	0.895	0.494	0.276	2.498
33	7011 (Black Burn @ Plusscarden Abbey)	6.071	6	4.156	0.578	0.561	4.431
34							
35	Total		1202				
36	Weighted means				0.245	0.229	

Figure 11 WINFAP Final Pooling Group

AM Data	Catchment Descriptors						
	Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
1	76011 (Coal Burn @ Coalburn)	1.920	41	1.840	0.165	0.315	1.476
2	45816 (Haddes @ Upton)	3.969	25	3.456	0.306	0.399	1.381
3	27051 (Crimple @ Burn Bridge)	4.088	46	4.539	0.219	0.148	0.877
4	28033 (Dove @ Hollinscough)	4.232	43	4.205	0.231	0.369	0.917
5	91802 (All Leachdach @ Intake)	4.533	34	6.350	0.153	0.257	1.055
6	71003 (Croasdale Beck @ Croasdale Flu)	4.813	37	10.900	0.212	0.323	0.366
7	54022 (Severn @ Plymlmon Flume)	4.819	38	14.988	0.156	0.171	1.241
8	25003 (Trout Beck @ Moor House)	4.850	45	15.120	0.167	0.302	0.993
9	25011 (Langdon Beck @ Langdon)	4.886	32	15.533	0.235	0.334	1.625
10	25019 (Leven @ Earby)	4.900	40	5.384	0.343	0.378	2.779
11	206006 (Annalong @ Recorder)	5.110	48	15.330	0.189	0.052	2.325
12	27010 (Hodge Beck @ Bransdale Weir)	5.255	41	9.420	0.224	0.293	0.114
13	49003 (de Lank @ de Lank)	5.551	52	13.985	0.223	0.209	0.293
14	57017 (Rhondra Fawr @ Tynnewydd)	5.580	17	24.060	0.136	0.018	1.600
15	27032 (Hebden Beck @ Hebden)	5.588	52	3.923	0.207	0.244	0.308
16	48009 (at Neol @ Craigshill Wood)	5.652	12	8.469	0.245	0.373	0.582
17	48004 (Waleggan @ Trengolfe)	5.737	49	9.983	0.255	0.257	0.666
18	25012 (Harwood Beck @ Harwood)	5.766	49	33.265	0.190	0.225	0.995
19	46005 (East Dart @ Believer)	5.774	54	38.967	0.158	0.066	1.451
20	72014 (Conder @ Galgate)	5.796	50	16.465	0.233	0.162	0.769
21	73015 (Keer @ High Keer Weir)	5.843	27	12.330	0.205	0.281	0.124
22	72007 (Brock @ Upstream of ab)	5.985	40	28.964	0.199	0.218	0.666
23	41020 (Revern Stream @ Clappers Bridg)	6.011	49	13.660	0.203	0.181	0.397
24							
25	Total		921				
26	Weighted means		921		0.211	0.240	

The estimated QMED value from catchment descriptors was $0.088\text{m}^3/\text{s}$. No donor stations were considered suitable for data transfer. The Urban Adjustment Factor was applied, increasing the final QMED calculation to $0.091\text{m}^3/\text{s}$.

The 'Generalised Logistic' distribution was shown to offer the best fit for the pooled growth curve and so this was accordingly adopted and then scaled by the estimated QMED value of $0.091\text{m}^3/\text{s}$. The calculated peak flow estimates are shown in Table 5 below.

Table 5 Statistical Peak Flow Estimates (FEH Statistical Method)

Return Period (years)	Flow Estimate (m ³ /s)
1 in 20	0.171
1 in 100	0.248
1 in 100 + 35%	0.335
1 in 100 + 70%	0.422
1 in 1000	0.425

4.5.2 ReFH 2 Method

ReFH 2 was used to generate peak flows, with all default values in the software selected. Relevant outputs are included in Appendix B and the calculated flows summarised in Table 6 below.

Table 6 ReFH 2 Peak Flow Estimates

Return Period (years)	Flow Estimate (m ³ /s)
1 in 20	0.100
1 in 100	0.150
1 in 100 + 35%	0.203
1 in 100 + 70%	0.255
1 in 1000	0.260

4.5.3 Peak Flows Selected for Model

The REFH2 method is often preferred for calculating flows in smaller catchments such as Edith's Marsh Drain (0.49km²). However, given the higher predicted flows in the FEH Statistical method, and the relative uncertainty for calculating flows in smaller catchments, the FEH peak flows shown in Table 5 have been applied to the model hydrographs for Edith's Marsh Drain on the basis that this will be a conservative approach.

5. HYDRAULIC MODELLING

5.1 Model Approach and Summary

Based on the potential for overland flow routes during out of bank flows, a linked 1D-2D model (Flood Modeller / TUFLOW) has been developed to assess the fluvial flood risk to the site using the following software versions:

- » Flood Modeller (FM) v4.6
- » TUFLOW 2020-01-AB

A 1D-2D model log is included in Appendix B, and further discussion of the model build and outputs is outlined in the following sections.

5.2 1D Model Build

5.2.1 Overview

The 1D model was constructed using surveyed levels undertaken on 16th February using Leica GPS and dumpy level survey equipment. Long and cross sections can be reviewed within the 1D model '.dat' files. The river units were de-activated to top of banks for most sections, or up to a bank level and width consistent with the 2D model to ensure smooth linking between 1D and 2D domains. A summary of the surveyed extents for both watercourses is as follows:

Rowde Ford Stream (ROWD):

- » Total channel length of 594.0m with an upstream limit just downstream of a watercourse crossing and beyond the upstream extent of the site at 398089, 163452 (FM node ROWD5940), and a downstream limit approximately 30m downstream of where St. Edith's Marsh road crosses the Rowde Ford Stream at 397585, 163170 (FM node ROWD_0000). Photographs are included in Table 7.
- » Number of River Units – 16
- » Structures – Two bridges, one wall and one weir. See Section 5.2.5 for details on how these were represented in the model.

St. Edith's Marsh Drain (EDTH):

- » Total channel length of 461.2m with an upstream limit where the watercourse enters the site through a 600mm diameter culvert below St. Edith's Marsh Road at 397607, 163588 (FM node EDTH_4612), and a downstream limit where the watercourse joins the Rowde Ford Stream at 397593, 163176 (FM node EDTH_0000). Photographs are included in Table 7. It was decided that the upstream culvert would not be included in the model, which assumes no restriction on flows from this culvert into the site.
- » Number of River Units – 12
- » Structures – Two culverts. See Section 5.2.5 for details on how these were represented in the model.

Table 7 Photographs of Upstream and Downstream Model Extents



Photo 1 – Rowde Ford Stream Upstream Extent



Photo 2 – Rowde Ford Stream Downstream Extent



Photo 3 – St. Edith's Marsh Drain Upstream Extent



Photo 4 – St. Edith's Marsh Drain Downstream Extent

Figure 12 Modelled Reach and Node Locations

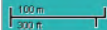
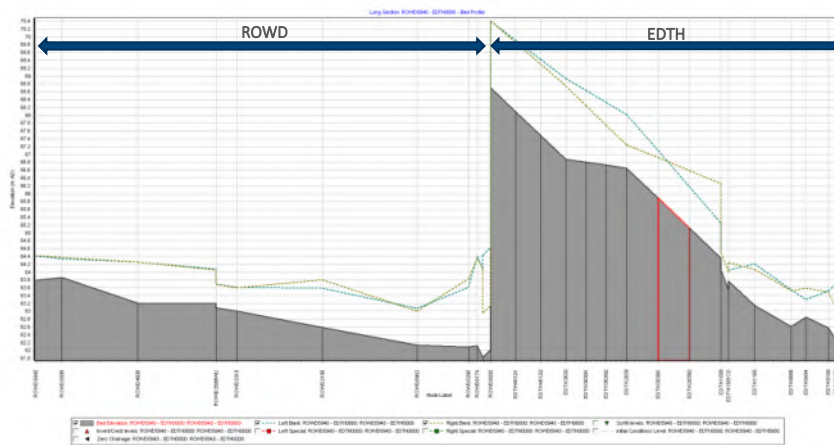


Figure 13 Modelled Long Section



5.2.2 1D Roughness

Manning's 'n' (roughness) values within the channel were assigned as 0.03, which represents option 1a. (main channels - clean, straight, full stage, no rifts or deep pools) in the reference table '*Manning's n for Channels (Chow 1959)*'. This was based on observation from the site survey. Sensitivity analysis has also been undertaken to assess the effects of assumed channel roughness on the modelling.

5.2.3 1D Conveyance

A check of the conveyance was undertaken for each cross section. Where conveyance values were outside the normally acceptable ratios additional panel markers were added to the river units. These were only used where there were sudden or large changes in geometry and/or roughness. This process resulted in all cross sections being shown to have suitable conveyance.

5.2.4 1D Boundary Conditions

An FEH hydrograph was specified for both watercourses which was scaled to the peak flows calculated for each return period event as outlined. A storm duration of 6.5 hours and a timestep of 30 minutes was specified for the Rowde Ford Stream based on the estimated values from the ReFH2, which resulted in a hydrograph covering a period of around 16 hours (see 'UK Design Flood Estimation' in Appendix B). A shorter duration of 3.5 hours was specified for the St. Edith's Marsh Drain catchment based on the small catchment size, resulting in a hydrograph of around 14 hours.

A minimum flow of $0.2\text{m}^3/\text{s}$ was specified in order to prime the model in the initial timestep. This is below the top of bank levels and the peak flows for both watercourses in the 1 in 100-year event and so would not impact the peak flood outlines.

The downstream boundary condition was an assumed 'normal depth' with the default average gradient of 1:1000 applied. This is considered conservative.

5.2.5 1D Structure

Table 8 shows the 1D structures on both watercourses and details of how they were represented in the model.

Table 8 1D Structures

Photo	Details
	Footpath over Rowde Ford Stream with brick culvert, located near the upstream extent of the model and the Rowdeford School site. Included in model as node ROWD5598. Due to its size and short downstream length, the structure was modelled as an Orifice Unit. Spill was represented in the 1D domain. Width = 1.00m Height = 1.20m Soffit Level = 64.20m AOD Spill Level = 64.65m AOD
	Trapezoidal weir located on Rowde Ford Stream to the south of Rowdeford School buildings. Included in the model as a Spill Unit 'ROWD3586WU'. Cross-sections were also taken immediately upstream and downstream of the weir to represent the drop in bed levels. Total Width = 4.14m Invert level = 63.078m AOD Top of Wall level = Slightly varies but maximum level of 64.055m AOD
No image	Wall extending into channel on the Rowde Ford Stream. Included in the model as a Spill Unit 'ROWD0962'. Top of wall level = 62.612m AOD Bottom of wall level = 61.132m AOD Width = 2.2m
	Arched bridge with twin overspill culverts where St. Edith's Marsh road crosses the Rowde Ford Stream. Included in the model as a Bridge Arch Unit 'ROWD0290BU' given the shape of the opening and relatively short downstream width of approximately 10m. The bridge dimensions and channel cross-section are based on the levels measured at the upstream end of the bridge. Spill was represented in the 2D domain given the potential for out of bank flow paths along St. Edith's Marsh Road. Main arch soffit level = 63.437m AOD Channel invert level = 62.087m AOD Bridge spill level = 64.40m AOD

	Culvert below St. Edith's Marsh Road. Photograph is of the culvert outlet where St. Edith's Marsh Drain enters the Rowdeford School site. The upstream extent of the model was started at the downstream end of this culvert and this structure was not included in the model to prevent model instability and backwater effect as a result of the culvert at the upstream extent of the model. This is conservative as it assumes all flows reach the watercourse without being restricted by this culvert, which is considered a fair assumption given the small catchment area and culvert size of 600mm. Pipe diameter = 600mm Pipe outlet invert = 69.19m AOD Headwall Height = 1.7m Headwall Invert = 4.11m AOD
	Culvert on St. Edith's Marsh Drain below St. Edith's Marsh Road. Included in the model as a Conduit Unit 'EDTH1599' given the downstream length and level difference surveyed between culvert inlet and outlet. The culvert was submerged below top water level and is considered one of the main flow restriction on this watercourse, with a high likelihood of blockage risk. Sensitivity testing has been undertaken to understand the effect of blockage on the flood risk to the site. Pipe diameter = 450mm Pipe inlet invert = 64.047m AOD Pipe outlet invert = 63.557m AOD Downstream length = 9.8m
	Culvert on St. Edith's Marsh Drain below access road off St. Edith's Marsh Road. Included in model as node EDTH0199. Due to its size and short downstream length, the structure was modelled as an Orifice Unit. Spill was represented in the 1D domain. Culvert Pipe diameter = 450mm Pipe inlet invert = 62.534m AOD Pipe outlet invert = 62.394m AOD

5.2.6 1D Run Parameters

The linked model was run with a 1D timestep of 0.5 seconds and the default dflood of 3m. Automated preissmann slots for river sections were selected under the options tab (as a default) to help prevent the watercourses from running dry and to avoid instabilities in the early timesteps. Initial conditions were generated from the steady-state model and were saved into the network (.dat) file. The model log folder in Appendix B outlines the various run files which were undertaken.

included on both the left and right banks with gradients set as 1:1000 (0.001) and 1:200 (0.05) respectively, based on the observed average gradient of the land around the downstream boundary from LiDAR. '2d_bc_hxi_ROW_D_001_L' includes the HX and CN lines which link the 1D and 2D domain.

5.3.3 2D Roughness

The 2D roughness values are represented within the 'Materials.csv' file referenced in the 2D control file (.TCF) which links to the model shapefile '2d_mat_ROW_D_001_R' as shown in Figure 15. Within the 2D code, land uses included woodlands, roads, buildings and open water, all other space was assumed as 'grassland' with a manning's n value of 0.06, which follows a standard modelling approach (see Table 9 below for reference).

The materials file is based on OS Open Map Local vector files. Buffers were applied to the OS Open Map roads layer, so the access road had a width of 5m and St. Edith's Marsh Lane a width of 8m. This was checked against aerial photography and found to be appropriate.

Figure 15 – TUFLOW Materials File



Table 9: Manning's n roughness coefficients for floodplain

Feature	Code	Manning's n
Pasture	1	0.06
Roads	2	0.022
Buildings	3	0.3
Ponds and other water	4	0.03
Woodland	5	0.07
Stability	10	0.9

5.3.4 2D Structures

No structures are present within the 2D domain.

5.3.5 2D Run Parameters

A 2D timestep of 1 second was specified which is considered suitable for a model grid resolution of 1m (and twice the 1D timestep). The default Single Precision TUFLOW was specified.

5.4 Model Outputs

Maps of the modelled outputs for all return period events have been included in Appendix B. These are subject to EA approval following a review of the model.

The flood extents have been plotted against the masterplan layout and the modelling shows the proposed development is outside of the floodplain in all events modelled, with little difference in floodplain extent predicted between the 1 in 100 year and 1 in 1000 year events. The 1 in 1000 year floodplain is the most extreme event modelled, but there is negligible difference between this event and the 1 in 100 year plus 70% climate change event.

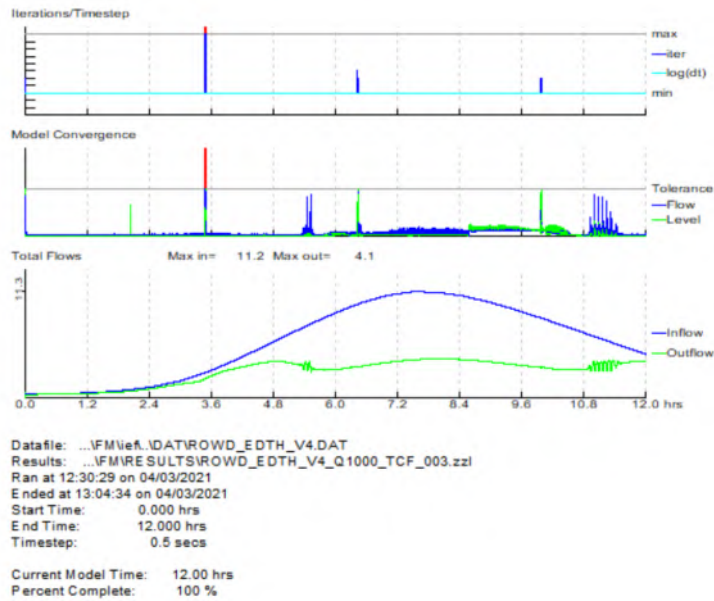
The nearest proposed building to the floodplain is the 'Orchard Block' where minimum recorded ground levels are at 65.75m AOD. Flood levels adjacent to this development, and just upstream, are predicted to be 64.05m AOD in the 1 in 1000 year event, which is 1.7m below existing ground levels by the development.

5.5 Model Stability

5.5.1 1D Model Stability

A review of the 1D model outputs (ZZD) shows no errors/comments or warnings of concern that require attention or are considered to have the potential impact upon the predicted flood levels or extents generated. The convergence plots show poor model convergence at the beginning of the rising limb (between 3.5 to 4 hours into the flood event) in all flood events, which exceeds the tolerance levels. However, the model stabilises within the peak of the flood event (at between 7.2 and 8.4 hours) with convergence below tolerance levels and so this is not considered to impact final peak flood extents and levels (see Figure 16).

Figure 16: 1D Summary for 1000 year event



Time series plots were reviewed and found to have a smooth flow curve throughout the length of both modelled watercourses. Some fluctuation in the time series plots can be observed at the location of structures in the rising and falling limbs where the structures surcharge and as flows recede. This is demonstrated in Figure 17 which is taken from the cross-section 'ROWD0174' in the downstream extent of the model, just downstream of the arch bridge over Rowde Ford Stream. This fluctuation is to be expected and it is noted there is still a smooth curve at the peak of the flood.

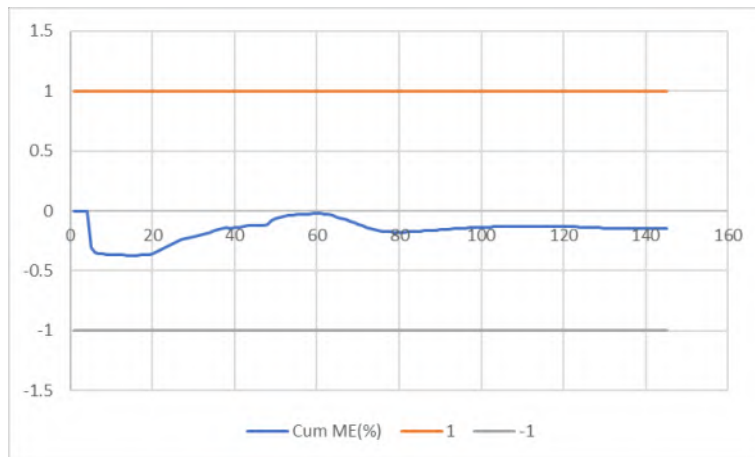
Figure 17: Time Series in Downstream Extent of Model at X-Section ROWD0174 in 1000 year event



5.5.2 2D Model Stability

From a review of the 2D results (MBD2.csv) for all events, the cumulative Mass Balance Error was within the EA's preferred range between -1% and 1% which indicates good stability within the 2D element (see Figure 18 for example in 1000 year).

Figure 18: Mass Balance in 1 in 1000 year Flood



5.6 Sensitivity Testing

Sensitivity testing has been undertaken to determine the robustness of the model and the effects of changing key design parameters on the peak flood levels and extents for the 1 in 100 year plus 35% climate change event.

5.6.1 Roughness

Given that there is an element of professional judgement required when assigning roughness coefficients, it was considered appropriate to undertake a sensitivity check applying a 20% global increase in roughness within the 1D cross-section and 2D materials file. The flood depth maps for increased roughness are included in Appendix B.

The increased roughness resulted in a slight increase in flood extent, and increases in flood depths of up to 100mm where the floodplain is nearest to the development. However, this change has not resulted in any development on site, existing or proposed, being brought into the floodplain.

5.6.2 Blockage

Two blockage assessments were undertaken on the key structures which would be considered to pose a potential flood risk to the site if a blockage were to occur. This includes one blockage on the 450mm diameter culvert on St. Edith's Marsh Ditch at cross-section 'EDTH1599' and one on the arch bridge over Rowde Ford Stream at cross-section 'ROWD0290'. The flood depth maps for both scenarios are included in Appendix B.

The blockage at 'EDTH1599' was modelled given that it was observed to be submerged below the normal water levels with a high blockage potential, and due to its location downstream of the site. A blockage unit was added in FM, with a 50% blockage applied after 3 hours, increasing to 90% after 4 hours (i.e. prior to the flood peak at around 7.8 hours) and for the remainder of the flood event. A 90% blockage was applied as the bore area was less than 1m², as standard EA guidance. This blockage resulted in flows shown to spill onto St. Edith's Marsh Road and flow southwards, ponding at the entrance to the site where the road is lowest. Flood depths on the road were indicated to be relatively shallow at no greater than 100mm. The hazard of this floodplain is assessed further in Section 6.

A 50% blockage was modelled at 'ROWD0290' given the larger opening in the arch bridge, which is far greater than 1m², again in accordance with standard EA guidance. This was applied by increasing the invert level of the cross-section to 62.70m AOD, with a narrow (0.1m) section in the centre to maintain the bed elevation. This resulted in increased flood extents and depths, particularly immediately upstream of the bridge structure, as well as across the site access road. However, the flood extents are still far from any proposed or existing buildings on site. This risk is considered to be residual, and from reviewing the structure the actual likelihood of a 50% blockage occurring at this location are considered quite low as the bridge has a wide opening and there is suitable access to ensure the bridge remains clear.

5.6.3 Peak Flows

The outputs from the baseline modelling already demonstrated that the model is not sensitive to changes in peak flows, with little change in flood levels and extents observed between the events. Given that the proposed development is far from the proposed maximum flood extent (i.e. the 1 in 1000 year event), further sensitivity testing of flows is not considered necessary.

6. SITE SUITABILITY AND PROPOSED MITIGATION

6.1 Summary of Flood Risk and Mitigation Requirements

Table 10 provides a summary of the flood risk to the site from the various sources and the implications for mitigation.

Table 10: Summary of Potential Sources of Flood Risk

Flood Source	Risk	Mitigation Requirements
Tidal	Negligible	None
Fluvial	Majority of site and proposed buildings in Flood Zone 1 and at a 'low' risk from fluvial flooding. Detailed flood modelling of the watercourses on site indicates there is an area of flood risk at the site entrance / access road into the site.	Refer to Section 6.3.
Surface Water	Majority of site at a 'low' risk from surface water flooding. There are existing land drainage ditches; one through the centre of the site and one along the eastern boundary, which provide an overland flow path which needs to be maintained.	Refer to Section 6.3.
Groundwater	Low	None
Artificial Infrastructure Failure	Low	None

6.2 Sequential Test and Development Vulnerability

The overarching aim of the Sequential Test is to ensure inappropriate development in areas at risk of flooding is avoided. This test aims to steer new development to areas at lowest probability of flooding (Flood Zone 1), but if the location of the low risk area is not suitable due to wider sustainability objectives then progressively higher risk areas (Flood Zone 2/Flood Zone 3) can be considered provided the development will be suitably safe from flooding and does not increase flood risk to other areas.

As the proposed development is for additional buildings serving the school, which is the current approved use of the site, the Sequential Test is not considered to apply. Adopting a 'sequential' approach within the site boundary, i.e. avoidance of the floodplain, is considered a pragmatic approach which allows expansion of the school whilst ensuring a 'low' flood risk is maintained at the site. This is subject to confirmation with the Local Planning Authority which stipulates the requirements for the Sequential Test.

An assessment has been made of the proposed development's flood risk vulnerability (Paragraph 066 of NPPG) and the suitability of each part within the flood zones in which they are proposed (see Table 11, taken from Paragraph 067 of NPPG). The school is considered 'more vulnerable' development in accordance with Paragraph 066 of NPPG. The detailed flood modelling has confirmed that the proposed development is located outside of the fluvial 'design flood' extent (i.e. accounting for climate change), and within Flood Zone 1. As such, the development is considered to be suitably located, meeting the requirements of the Sequential Test, with no requirement for an Exception Test.

Table 11: Flood Risk Vulnerability and Flood Zone 'Compatibility'

Flood Risk Vulnerability Classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception Test required	✓	✓
Flood Zone 3a	Exception Test required	✓	X	Exception Test required	✓
Flood Zone 3b	Exception Test required	✓	X	X	X

Where ✓ means development is appropriate and X means development should not be permitted

6.3 Mitigation Requirements

Whilst a full Exception Test is not required, the development must still be designed to ensure buildings and occupants are safe and flood risk is not increased elsewhere, akin to the requirements of the second part of the Exception Test. The proposed mitigation strategy is discussed below.

6.3.1 Building Protection

All built development is to be located outside the fluvial floodplain, with suitable freeboard. The only proposed building within close proximity to the floodplain is the Orchard Block in the south of the site. The flood levels adjacent to this development, and just upstream, are predicted to be 63.95m AOD in the 1 in 100 year plus 35% climate change event and 64.05m AOD in the 1 in 1000 year event.

In accordance with EA guidance, the development should be at least 600mm above the 1 in 100 year plus 35% climate change level at 64.55m AOD. The development is located on ground raised far above this level at 65.75m AOD and so will be located well above this minimum required level.

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6.3.2 Field Ditches

The existing ditch along the eastern boundary will remain as existing, with the east of the site allocated for open space. The LLFA normally stipulate an easement of no built development within 5-8m of an 'ordinary watercourse' and the proposed built development is well outside of this easement.

The dry ditch within the centre of the site is proposed to be culverted. Whilst the EA's surface water mapping does not identify any upstream surface water flow paths into the ditch, connections into the head of the ditch were identified in the topographical survey and these will need to be catered for within any culverting works. The proposals include for culverting of the existing ditch and conversations with Wiltshire Council on this are on-going. Any culverting will be undertaken to ensure that suitable capacity is provided for all events up to and including the 1 in 100 year plus climate change with freeboard to ensure any culverting has maintains the existing conditions and poses no increase in flood risk to third party land or within the site.

6.3.3 Safe Access / Egress

The existing entrance to the school is proposed to be maintained, with access at the south-western corner of the site from St. Edith's Marsh road. The detailed fluvial modelling indicates that the route into the site is flood free in the design flood event, which is in accordance with planning policy (1 in 100

year plus 35% climate change) (see flood maps in Appendix B). Flooding of the access route is predicted in the following modelled flood events:

- » 1 in 1000 year fluvial flood
- » Sensitivity Test - Blockage of culvert 1599 on St. Edith's Marsh Drain
- » Sensitivity Test - Blockage of bridge 0290 on Rowde Ford Stream
- » Sensitivity Test - Increased roughness

These events are considered to be a 'residual' risk as they are accepted as a risk that remains beyond the required design standard. The hazard associated with the floodplain for these events was reviewed and observed to be 'Very Low Hazard' in accordance with Defra classifications due to very low flood depths / velocities. The route would therefore still be classified as suitable for access and egress in the peak of the flood. The two 'worst-case' scenarios were the blockage scenarios, which are shown in the maps included in Appendix B.

6.3.4 Flood Risk within Catchment

All development is located outside the fluvial floodplain with suitable easements maintained alongside the watercourse. There will therefore be no increase in flood risk within the catchment through a loss of floodplain storage or conveyance.

There will be an increase in impermeable surfacing post development, but a sustainable drainage strategy is proposed to manage runoff from the new development. The surface water drainage is detailed in a separate report by Hydrock included within the planning submission.

7. CONCLUSIONS

A Planning Application is to be submitted for the proposed redevelopment of the existing Rowdeford School site. The land use is allocated as 'more vulnerable' in respect of flood risk.

The FRA concluded that the majority of the site is at a 'low' risk of flooding from all sources, but there are localised areas at risk from fluvial and surface water flooding.

The fluvial risk is associated with the Rowde Ford Stream along the southern boundary and with a minor unnamed watercourse along the western site boundary, referred to as St. Edith's Marsh Drain.

Environment Agency flood mapping is based on JFLOW data and so detailed hydraulic modelling has been undertaken to confirm the flood risk from these two watercourses. This modelling indicates that the proposed development is suitably located outside of the floodplain on ground raised well above the modelled 1 in 100 year plus 35% climate change flood event.

The development has safe access and egress in all flood events modelled, including the 1 in 1000-year event and when accounting for the residual risk of blockage. The development will also not increase flood risk elsewhere as a result of a loss of floodplain storage or conveyance.

There are ditches through the centre and eastern boundaries of the site which provide an overland flow path which needs to be maintained. The central ditch is proposed to be culverted with exact to be agreed at detailed design stage. No built development (or land raising) is proposed within at least 5m of the existing eastern ditch and proposed culverted central ditch.

As the proposed development is for additional buildings serving the school, which is the current approved use of the site, the Sequential Test is not considered to apply. Adopting a 'sequential' approach within the site boundary, i.e. avoidance of the floodplain, is considered a pragmatic approach which allows expansion of the school whilst ensuring a 'low' flood risk is maintained at the site. Given the proposed buildings are located outside the floodplain of the most extreme flood event modelled (the 1 in 1000 year), the proposed development is considered suitably located with no requirement for an Exception Test.

With the proposed sustainable drainage strategy, the development is concluded to be safe from flooding and will not increase flood risk elsewhere, therefore, meeting the requirements of the NPPF.

Appendix A – Site Information

Document Type - Source	Reference	Title
Drawing - AHR Architects	NWS-AHR-V4-ZZ-DR-L-000011-S2	Landscape GA
Drawing - South West Surveys	NWS-SWS-XX-XX-SU-X-0002	Topographical Survey
Drawing - Hydrock	NWS-HYD-00-ZZ-SK-C-7000	Drainage Strategy

Appendix B – Hydraulic Modelling

Document Type - Source	Reference	Title
Letter and Map - Environment Agency	189442-WX	-
REFH2 Hydrology Outputs - Hydrock	-	UK Design Flood Estimation
Model Log - Hydrock	-	Rowdeford School 1d/2d Model Log
Drawing – Hydrock	15011-HYD-XX-XX-DR-FR-0001	Modelled Flood Zone Extents
	15011-HYD-XX-XX-DR-FR-2001	1 in 100 year plus 35% climate change flood depths
	15011-HYD-XX-XX-DR-FR-3001	Sensitivity Test – Increased Roughness
	15011-HYD-XX-XX-DR-FR-3002	Sensitivity Test – Blockage on St. Edith's Marsh Drain Culvert 1599
	15011-HYD-XX-XX-DR-FR-3003	Sensitivity Test – Blockage on Rowde Ford Stream Bridge 0290
	15011-HYD-XX-XX-DR-FR-4001	Hazard Mapping – Blockage on St. Edith's Marsh Drain Culvert 1599
	15011-HYD-XX-XX-DR-FR-4002	Hazard Mapping – Blockage on Rowde Ford Stream Bridge 0290

