# Issue 2 Flood Risk Day1-2

NAS/RL/09213/

December 2011

**Hignett Family Trust Ref: 276** 

Addendum 2 to PS

**B&NES Core Strategy** 

Review of WYG Engineering Bath Compensatory Storage Study Phase 1 – Final Report dated November 2011 (CD4/FR35)

## **Background**

B&NES Core Strategy for provision of residential and employment relies on use of existing Flood Zone 3 land being infilled or defences raised to defend new development against flooding.

The strategy suggested by B&NES to replace the flood conveyance and storage volumes lost during the redevelopments is to create upstream storage areas to intercept the flows that cause the flooding through the centre of Bath. The strategy consists of lowering ground levels in existing Flood Zone 3 areas. To date no details of how the flows will be attenuated or throttled back have been presented.

## **Compensation Storage**

PPS25 (CD2/20) and CIRIA C624 – Development and flood risk – guidance for the construction industry prescribe how flood compensation storage should be provided:-

"Compensatory flood storage must become effective at the same point in a flood event as the lost storage would have done"

If the storage is provided at a different level or location it may fill prior to the same effective point in a flood event. Issues such as tributary watercourses joining the main watercourse, structures including weirs or bridges between the compensation storage and the development site locations can make it difficult to calculate exactly when remote flood storage should become effective.

There are two types of compensatory storage, Direct Storage, commonly known as "level for level" and Indirect Storage where the flood storage is provided at a different level but should be designed to provide the storage at the same return period design storm and flow.

The B&NES strategy is based on Indirect compensation storage as the proposed location of the storage is remote from the development sites. When indirect storage is provided it can only be delivered as stored volumes behind raised features such as embankments or walls otherwise flows will continue downstream unchecked, the figure below shows how direct, "level for level" compensation should work:



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Figure 1 - Direct or "level for level" Flood Plain Compensatory Storage

DESIGN FLOOD

THIS VOLUME NEEDS TO BE EXCAVATED FOR GROUND STABILITY BUT DOES NOT FORM PART OF THE COMPENSATION WORKS

RIVER SECTION

COMPENSATION FOR MADE-UP GROUND OR BUILDING (HYPOTHETICAL SLICES)
TAKING THE FORM OF
REDUCTION OF SITE LEVELS

Any loss of flood storage must be compensated for by the reduction in level of nearby ground, such that the same volume is available at every flood level before and after the works and it can freely fill and drain. In other words, in order to mirror the existing situation for a particular flood, each stage (or level) is provided with the same storage volume, cut and fill must equate on a level for level basis, ie at each level (say at 0.2 metre vertical intervals for example) the excavated and filled volumes are equal.

The timing at which the storage effect comes into operation is significant. If this volume is reduced for any stage of a flood then the lost storage results in flood waters being diverted elsewhere, leading to third party detriment. The detriment caused by a small encroachment may not be significant, or even measurable, when taken in isolation but the cumulative effect of many such encroachments along a length of river will be significant.

It is not adequate compensation to provide indirect compensation storage by means of :

- > excavating holes in the existing floodplain as these fill early in any flood event.
- > provide low level compensation volumes to replace high level floodplain and vice-versa as the river flows do not necessarily fill these compensation areas at the same time as the development site would have filled prior to being raised.

## Core Strategy documents available to Robson Liddle

- FRMS Appendix I The Atkins Site Specific Report (CD/FR22) detailing flood levels, return periods of each site flooding and the initial compensatory storage volumes – Document 1
- 2) The B&NES FRMS Note on Reviewed Flood Storage Volume (CD4/FR36) used as the basis for the WYG Bath Compensatory Storage Study Phase 1 (November 2011) - Document 2
- 3) The WYG Engineering Bath Compensatory Storage Study Phase 1 Final Report (CD4/FR35) Document 3

## Provision of flood compensation against return period

Each of the development sites requires replacement flood storage or conveyance to be provided at a certain point in the design storm hydrograph. Document 1 indicates the approximate return period flow when each site floods, these range between the less than 10 year, 25, 50, 75, 100 and climate change events. The volumes of replacement flood storage need to be designed to fill in a controlled manner so that they provide the like for like volume at the equivalent design flow based on the recalculated volumes including climate change and "cut off" areas.

Site B3a, the REC floods first at less than a 10 year flow event and needs flood compensation storage very early on with 10,155m³ at the 10 year design flow and 52,776m³ in the climate change event. Site B13f, Brassmill requires 16,285m³ between the 25 year and climate change events, whilst site B9a, South Quay needs 10,855m³ to be provided between the 50 year and climate change events and site B4, Manvers Street requires 7,911m³ to be provided between the 75 year and climate change events. It can therefore be seen that designing any storage area will need full 3D hydraulic modelling to be carried out to determine actual rather than theoretical volumes prior to any compensation design commencing. As the storage proposed is indirect rather than direct, only flows stored behind raised embankments can deliver such a range of timescales when replacement storage is required.

### Flood compensation storage strategy

WYG have been commissioned to undertake a study into the potential upstream storage sites and the compensation volumes that could be achieved. We have obtained a copy of the flood level data used in the WYG study from the Environment Agency (EA) to assess the potential storage sites in more detail and whether they will impact on third parties that lie adjacent to them.

The full EA data set includes a range of flood levels between the 2 year and 100 year + climate change scenarios at various points along the River Avon. It is therefore possible to determine when the potential storage sites would be available relative to the return period storm and whether the correct mix of flood compensation can be delivered at the right point in the design storm hydrograph.

A copy of the EA spreadsheet with level and flow information at the various return periods is included in the Appendix 1.

Based on the WYG report two of the three sites, Kensington Meadows and Bathampton have the capability to deliver fully controlled filling of flood compensation storage behind raised embankments. Detailed below is our assessment of each of the three sites and the potential volumes available for compensation storage:

BATHEASTON - At Batheaston, the volume of earthworks required in creating embankments to impound storage and the range of existing site and potential storage levels, make the site too small to be viable, but instead ground levels could be lowered. The 2 year flood level is 20.49m, the 10 year flood level is 21.42m and the 25 year flood level is 21.92m. The maximum ground level available for reducing is 21.60m although at this height it is a very small area with most of the land available up to 21.45m. It can therefore be seen that flood compensation storage is only available between the 2 year and 15 year storms, after that the land is under water during the existing flood regime. If compensation storage is proposed at this location, a low level bowl could be created by lowering the higher land (21.00 – 21.45m) to 20.49m south of the 21m contour level. This would create a flood compensation storage bowl with a rim level of 21.0m and up to 0.51m deep where water could be impounded. The land below this level equates to approximately 11,800m<sup>2</sup> or 6000m<sup>3</sup> of potential storage which would be available between the 2 year and 10 year return period flows. Any embankments raised in the existing flood plain at this location would need their volumes and any volumes cut off behind, adding to the total development site compensation figure at the appropriate return period design flow.

At the return period when compensation can be delivered at this site, just over 10% of the total volume of 52,776m³ required at the REC Site B3a could be offset, no other development sites would benefit or are suitable to offset flood storage against at this low level return period flood.

KENSINGTON MEADOWS - At this location the existing part of the site with potential to be lowered, floods around the 50 year event. Any potential compensation storage would only therefore be available between the 2 year and 50 year events. The existing site frontage to the Avon lies below the 2 year flood level of 19.21, further into the site the land rises to a maximum of 21.8m before dropping back down to below 19.60m on the northwest boundary.

This site lends itself to retaining the higher frontage level of 19.6 – 21.0m and excavating behind to create a controlled filling of the created void. The front bank (weir) controlling the flows into the storage will need to be 2 - 3m crest top width to maintain the structural integrity against the head of water on the Avon side with 1 in 3 side slopes as WYG have suggested.

The 2 year flood level is 19.21m, the 10 year is 20.18m, the 25 year is 20.65m, the 50 year is 21.15m and the 75 year flood level is 21.61m. Water would pass over Kensington Meadows at approximately 21.2m affecting property to the north as the land and housing to the north of Kensington Meadows, in London Road and Ringswell Gardens, is lower than Kensington Meadows itself and is also located in Flood Zone 3. The lowering of any frontage of Kensington Meadows to the Avon or the excavation of a new flood storage area would create an increased flood risk to any properties in that area. Without providing any enhanced defence to the properties to the north, the maximum compensatory storage level of Kensington Meadows is therefore approximately 21.0m, where existing site levels would retain any flood water from inundating existing

properties. An alternative would be to raise an earth embankment on the northwest boundary to a higher level, to create more storage at Kensington Meadows, but the volume of flood plain lost to the north and the embankment volume itself would need to be taken into account, in any detailed cut / fill flood compensation design.

Excavating to 19.21m and with water filling to 21.0m, we calculate that up to 59,620m<sup>3</sup> flood compensation storage could be provided, however this volume makes no allowances for the sterilised area mentioned by WYG, where an existing public sewer runs across the site.

If water was stored to a higher level of 21.2m with raised defences on the northwest area of the site, then the volume of potential storage would drop to 50,536m³ excluding any allowances for the loss of floodplain in Ringswell Gardens and London Road.

It can therefore be seen that flood compensation storage is only available between the 2 Year and 50 Year storms, after that the Kensington Meadows site is under water during the existing flood regime. If measures are taken to protect properties put at risk, to the north then the site will have a net compensatory storage of less than 14,500m³ as the area in Flood Zone 3 to the north is over 2.6ha with water levels up to 2.2m deep adjacent to Kensington Meadows.

This site has been used for landfill in the past and WYG correctly identify that the material deposited will need be tested and then removed to a suitable off site location based on any contamination found. Landfill tax alone on a volume of 59,620m³ will be in excess of £8.5m.

Drawings 9213-SK3 and SK4 included in Appendix 1 show the typical sections of the two options at Kensington Meadows.

BATHAMPTON – The previous two sites have offered potential flood compensation storage at return periods between the 2 year and 50 year event. The volumes offered (6,000 + average of 55,000m³) do not compensate for the total volumes required at all of the sites in Appendix A of document 2. Neither the Kensington Meadows or Batheaston sites have offered any potential storage beyond a 50 year event as they are already flooding in the existing flood regime at this return period however Bathampton may have some potential to offer some storage between the 50yr and climate change events. Based on our assessed requirement of 270,000m³ of flood compensation storage there is a shortfall of 209,000m³. At the Bathampton site, the WYG report offers a maximum potential storage volume of 210,600m³ above the 2 year level in an area of 148,714m².

The type of flood compensation storage provided at Bathampton needs to be the same as that shown on Drawing 9213-SK3A prepared for Kensington Meadows or no benefit will be provided downstream.

At Bathampton the 2 year flood level is 21.21m, the 10 year is 22.09m, the 25 year is 22.64m, the 50 year is 23.08m, the 75 year is 23.42m, the 100 year is 23.57m and the climate change flood level is 24.33m.

This site relies on excavating into the valley sides and creating bunded areas at a set level into which flood flows will enter via controlled overtopping. As most of the remaining storage required relates to return periods greater than a 50 year event the spill level into the storage areas will need to be around the 23.08m (50 year level). The

only realistic land available above the 23.00 contour is defined by the yellow and red areas on Figure 5.4 in Document 3. The area which can be cut down to lower storage levels equates to at best 66,000m² of the site area offered or 118,140m³ between the 23.00m and 21.21m level where impounding would occur.. Additional cut slopes from the higher ground above 24.33 climate change level will eat into the available land. The red band on Figure 5.4 includes land above 24.2m so may contain land above the 24.33m level which will not provide any compensation as it will need cutting down to create stability of the earthworks as shown in Figure 1 earlier in this report.

Overall we estimate that less than 115,000m<sup>3</sup> will be available at the Bathampton site between the 50 Year and the climate change flood event after taking cut slopes into account leaving a shortfall of nearly 94,000m<sup>3</sup> of flood compensation storage.

## **Other Flood Storage Options**

WYG have suggested further flood compensation volumes may be available below the current 2 year flood level. This is only a suggestion and has not been agreed with the EA as solution. This would not be in accordance with PPS25 and CIRIA C624 which do not advise holes to be excavated in the existing floodplain as compensatory storage because they will fill early on in any storm and not necessarily be available at the correct point in time relative to the development site flooding. If the filling of the low areas is controlled by raised embankments or structures constructed in the existing flood plain then any volumes lost due to the earthworks or existing flood plain cut off behind the embankments will need to be added to the overall flood compensation storage strategy.

Any water impounded below the 2 year flood level will be stored until after the river level subsides below the lowered area level and if the land is lowered too far it will fill with ground water rather than flood compensation storage flows.

## **Summary**

The three sites considered by WYG do not have the potential to deliver the flood compensation storage required at the correct point in the hydrograph of the various return period storms being considered.

At Kensington Meadows a volume of 50,536m³ is available for storms below the 50 year flow. At Batheaston a volume of 6,000m³ is available for storms below the 10 year flow. At Bathampton a volume of 115,000m³ is available between the 50 and climate change events.

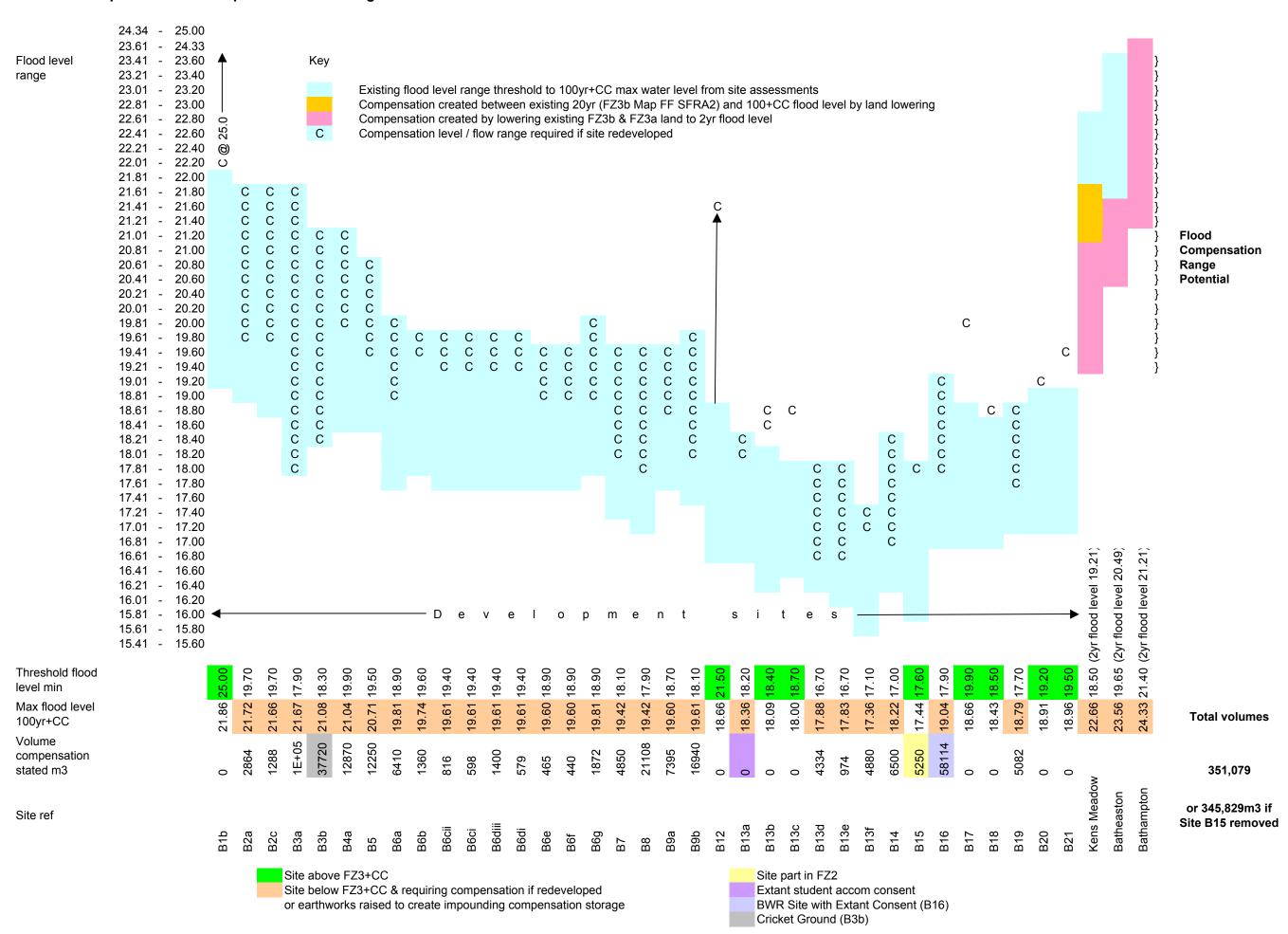
At Kensington Meadows and Batheaston the lower return period storm compensation volumes can be balanced quite closely with the lost volumes in the development sites. Above the 50 year return period however there is insufficient high level land at Bathampton that can be lowered to provide the necessary flood compensation storage right through to the climate change event.

At Kensington Meadows, the increased risk of flooding to properties alongside from the proposed flood storage, means that the added protection works will be required. The potential impact of these protection works will reduce the net flood storage at Kensington Meadows to as low as 14500m3.

The strategy cannot rely on any flood storage capacity in the floor of the floodplain below the 2 Year event.

## Flood level compensation and return period requirements

To demonstrate the range of flood levels, return periods and volumes involved the following table has been generated to show the relationship between the three potential upstream storage sites at Kensington Meadows, Batheaston and Bathampton and each of the development sites in Document 2. This shows that the range of volumes and levels (flows) at which compensation storage would be required.



## **APPENDIX 1**

EA flood level and flow data from River Avon ISIS model

Drawing 9213-SK3A Typical Sections at Kensington Meadows

Drawing 9213-SK4 – EA Flood Zone s and Typical Section Location at Kensington Meadows

NODE WATERCOURSE SCENARIO TYPE SOFTWARE LEVEL 2YR FLOW 2YR LEVEL 10YR FLOW 10YR LEVEL 25YR FLOW 25YR LEVEL 50YR FLOW 50YR LEVEL75YR FLOW 75YR LEVEL100YR FLOW100YR LEVEL100CC FLOW 100CC Easting Northing NODE River Avon Bath Flood Defence Scheme, Black & Veatch 2005

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RC001	Avon	Defended 1D	ISIS	14.74	163.90	15.46	235.20	15.74	270.70	16.00	309.80	16.23	346.20	16.33	362.90	16.71	431.10	371522	166029 RC001
RC002	Avon	Defended 1D		14.81	163.90	15.50	235.30	15.77	270.80	16.03	309.90	16.26	346.30	16.36	363.00	16.74	431.20	371618	165961 RC002
RC003	Avon	Defended 1D		14.82	163.90	15.50	235.30	15.76	270.80	16.02	309.90	16.25	346.30	16.34	363.00	16.72	431.20	371652	165868 RC003
RC003	Avon	Defended 1D		14.81	163.90	15.46	235.30	15.70	270.80	15.93	310.00	16.12	346.30	16.21	363.00	16.53	431.20	371678	165785 RC004ds
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RC004us	Avon	Defended 1D		14.81	163.90	15.47	235.30	15.72	270.80	15.96	310.00	16.17	346.30	16.26	363.00	16.61	431.20	371679	165778 RC004us
RC004	Avon	Defended 1D		14.86	163.90	15.56	235.30	15.83	270.80	16.10	310.00	16.34	346.30	16.44	363.00	16.86	431.30	371693	165745 RC004
RC005	Avon	Defended 1D		14.87	164.00	15.58	235.30	15.86	270.80	16.13	310.00	16.37	346.30	16.48	363.00	16.90	431.30	371747	165664 RC005
RC006	Avon	Defended 1D		14.91	164.00	15.63	235.30	15.91	270.90	16.18	310.00	16.42	346.40	16.53	363.10	16.94	431.30	371813	165598 RC006
RC007	Avon	Defended 1D	ISIS	14.94	164.00	15.65	235.30	15.92	270.90	16.18	310.00	16.42	346.40	16.52	363.10	16.92	431.30	371856	165528 RC007
RC008ds	Avon	Defended 1D	ISIS	14.93	164.00	15.63	235.30	15.90	270.90	16.16	310.00	16.39	346.40	16.49	363.10	16.89	431.30	371866	165500 RC008ds
RC008us	Avon	Defended 1D	ISIS	14.95	164.00	15.67	235.30	15.94	270.90	16.21	310.00	16.44	346.40	16.54	363.10	16.95	431.30	371871	165486 RC008us
RC008	Avon	Defended 1D	ISIS	14.98	164.00	15.70	235.30	15.98	270.90	16.25	310.00	16.48	346.40	16.59	363.10	16.99	431.30	371885	165454 RC008
RC009	Avon	Defended 1D		15.02	164.00	15.75	235.30	16.03	270.90	16.31	310.00	16.55	346.40	16.66	363.10	17.07	431.30	371941	165367 RC009
RC010	Avon	Defended 1D		15.05	164.00	15.79	235.40	16.08	270.90	16.36	310.00	16.60	346.40	16.71	363.10	17.13	431.30	371996	165280 RC010
RC010	Avon	Defended 1D		15.08	164.00	15.83	235.40	16.12	270.90	16.41	310.10	16.66	346.40	16.77	363.10	17.13	431.30	372054	165206 RC011
				15.11												17.20		372110	165136 RC012
RC012	Avon				164.00	15.86	235.40	16.16	270.90	16.45	310.10	16.71	346.40	16.82	363.10		431.30		
RC013	Avon	Defended 1D		15.15	164.00	15.92	235.40	16.22	270.90	16.51	310.10	16.77	346.40	16.89	363.10	17.33	431.40	372187	165056 RC013
RC014	Avon	Defended 1D		15.17	164.00	15.93	235.40	16.24	270.90	16.54	310.10	16.80	346.40	16.91	363.10	17.36	431.40	372265	164987 RC014
RC015	Avon	Defended 1D		15.22	164.00	15.99	235.40	16.30	270.90	16.60	310.10	16.87	346.40	16.99	363.10	17.44	431.40	372352	164933 RC015
RC016DS	Avon	Defended 1D	ISIS	15.25	164.10	16.03	235.40	16.34	270.90	16.65	310.10	16.92	346.50	17.04	363.10	17.50	431.40	372438	164863 RC016DS
RC016	Avon	Defended 1D	ISIS	15.52	164.10	16.12	235.00	16.43	265.40	16.75	296.70	17.02	324.50	17.15	337.20	17.66	388.80	372443	164860 RC016
RC017	Avon	Defended 1D	ISIS	15.57	164.10	16.18	235.00	16.50	265.40	16.82	296.70	17.10	324.50	17.22	337.20	17.74	388.80	372566	164808 RC017
RC018	Avon	Defended 1D	ISIS	15.62	164.10	16.25	235.00	16.58	265.40	16.90	296.70	17.18	324.50	17.30	337.20	17.83	388.80	372652	164790 RC018
RC019	Avon	Defended 1D		15.67	164.10	16.31	235.00	16.64	265.40	16.96	296.70	17.24	324.50	17.36	337.20	17.88	388.80	372732	164780 RC019
RC020	Avon	Defended 1D		15.73	164.10	16.40	235.00	16.73	265.40	17.05	296.70	17.34	324.50	17.46	337.20	17.98	388.80	372835	164772 RC020
RC021	Avon	Defended 1D		15.76	164.10	16.42	235.40	16.75	270.90	17.07	310.10	17.35	346.50	17.48	363.10	18.00	431.40	372955	164793 RC021
RC022	Avon	Defended 1D		15.73	164.10	16.37	235.40	16.68	270.90	16.99	310.10	17.27	346.50	17.39	363.10	17.90	431.50	373043	164803 RC022
RC023	Avon	Defended 1D		15.78	164.10	16.43	235.40	16.76	270.90	17.07	310.10	17.35	346.50	17.48	363.10	17.99	431.50	373126	164822 RC023
RC024	Avon	Defended 1D		15.85	164.10	16.52	235.40	16.85	270.90	17.17	310.10	17.45	346.50	17.57	363.10	18.09	431.50	373219	164854 RC024
RC025	Avon	Defended 1D	ISIS	15.90	164.10	16.58	235.40	16.91	270.90	17.24	310.10	17.52	346.50	17.64	363.10	18.16	431.50	373308	164901 RC025
RC026	Avon	Defended 1D	ISIS	15.94	164.10	16.63	235.40	16.96	270.90	17.29	310.10	17.58	346.50	17.70	363.10	18.22	431.50	373428	164946 RC026
RC026us	Avon	Defended 1D	ISIS	15.99	164.10	16.70	235.40	17.04	270.90	17.37	310.10	17.66	346.50	17.78	363.10	18.30	431.50	373458	164968 RC026us
RC027	Avon	Defended 1D	ISIS	16.04	164.10	16.75	235.40	17.09	270.90	17.42	310.10	17.71	346.50	17.84	363.20	18.36	431.50	373532	165051 RC027
RC028	Avon	Defended 1D	ISIS	16.10	164.10	16.82	235.40	17.16	270.90	17.50	310.10	17.79	346.50	17.91	363.20	18.43	431.50	373597	165086 RC028
RC029	Avon	Defended 1D		16.16	164.10	16.91	235.40	17.25	270.90	17.60	310.10	17.90	346.50	18.03	363.20	18.57	431.50	373709	165133 RC029
RC030	Avon	Defended 1D		16.22	164.10	16.98	235.40	17.33	270.90	17.68	310.10	17.99	346.50	18.12	363.20	18.66	431.50	373812	165121 RC030
RC031	Avon	Defended 1D		16.25	164.10	17.02	235.40	17.38	270.90	17.73	310.10	18.03	346.50	18.17	363.20	18.71	431.60	373902	
RC032	Avon	Defended 1D		16.30	164.10	17.08	235.40	17.45	270.90	17.81	310.10	18.11	346.50	18.25	363.20	18.79	431.60	374019	165076 RC032
RC033	Avon	Defended 1D		16.35	164.10	17.16	235.40	17.53	270.90	17.90	310.10	18.22	346.50	18.36	363.20	18.91	431.60	374096	165024 RC033
RC034	Avon	Defended 1D		16.38	164.10	17.19	235.40	17.56	270.90	17.93	310.10	18.25	346.50	18.39	363.20	18.96	431.60	374169	164980 RC034
RC035	Avon	Defended 1D	ISIS	16.39	164.10	17.20	235.40	17.58	270.90	17.95	310.10	18.28	346.50	18.43	363.20	19.04	431.60	374229	164943 RC035
RC036	Avon	Defended 1D	ISIS	16.45	164.10	17.27	235.40	17.65	270.90	18.02	310.10	18.34	346.50	18.48	363.20	19.04	431.60	374292	164867 RC036
RC037	Avon	Defended 1D	ISIS	16.55	164.10	17.39	235.40	17.77	270.90	18.15	310.10	18.47	346.50	18.61	363.20	19.16	431.60	374363	164789 RC037
RC037ds	Avon	Defended 1D	ISIS	16.57	164.10	17.41	235.40	17.79	270.90	18.17	310.10	18.49	346.50	18.63	363.20	19.19	431.60	374368	164768 RC037ds
RC037us	Avon	Defended 1D		16.63	164.10	17.51	235.40	17.91	270.90	18.30	310.10	18.64	346.50	18.79	363.20	19.38	431.60	374369	164760 RC037us
RC038ds	Avon	Defended 1D		16.68	164.10	17.57	235.40	17.97	271.00	18.36	310.10	18.69	346.50	18.84	363.20	19.42	431.60	374384	164676 RC038ds
RC038	Avon	Defended 1D		16.68	164.10	17.57	235.40	17.97	271.00	18.36	310.10	18.69	346.50	18.84	363.20	19.42	431.60	374395	164653 RC038
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RC039B	Avon	Defended 1D		16.74	164.10	17.64	235.40	18.05	271.00	18.46	310.10	18.82	346.50	18.97	363.20	19.59	431.70	374455	164590 RC039B
RC040	Avon	Defended 1D		16.75	164.10	17.65	235.40	18.06	271.00	18.47	310.10	18.83	346.50	18.99	363.20	19.61	431.70	374551	164551 RC040
RC041	Avon	Defended 1D		16.83	164.10	17.73	235.40	18.14	271.00	18.52	310.10	18.86	346.50	19.01	363.20	19.60	431.80	374647	164535 RC041
RC042	Avon	Defended 1D		16.88	164.10	17.78	235.40	18.19	271.00	18.58	310.20	18.92	346.60	19.07	363.20	19.68	431.80	374710	164481 RC042
RC043	Avon	Defended 1D	ISIS	16.93	164.10	17.84	235.40	18.25	271.00	18.64	310.20	18.98	346.60	19.13	363.30	19.74	431.90	374800	164423 RC043
RC044	Avon	Defended 1D	ISIS	16.98	164.10	17.89	235.40	18.30	271.00	18.70	310.20	19.05	346.60	19.20	363.30	19.81	431.90	374894	164380 RC044
RC045	Avon	Defended 1D	ISIS	17.04	164.10	17.95	235.40	18.36	271.00	18.76	310.20	19.10	346.60	19.25	363.30	19.84	432.00	374982	164351 RC045
RC045us	Avon	Defended 1D	ISIS	17.05	164.10	17.97	235.40	18.39	271.00	18.80	310.20	19.17	346.60	19.33	363.30	19.99	432.00	375015	164344 RC045us
RC046ds	Avon	Defended 1D	ISIS	17.08	164.10	18.00	235.40	18.42	271.00	18.84	310.20	19.21	346.60	19.37	363.30	20.04	432.00	375065	164333 RC046ds
RC046	Avon	Defended 1D	ISIS	17.08	164.10	18.00	235.40	18.42	271.00	18.85	310.20	19.23	346.60	19.40	363.30	20.10	432.00	375070	164331 RC046
RC047ds	Avon	Defended 1D		17.06	164.10	17.96	235.40	18.37	271.00	18.77	310.20	19.14	346.60	19.31	363.30	19.99	432.00	375136	164310 RC047ds
RC047	Avon	Defended 1D		17.18	164.10	18.13	235.40	18.56	271.00	18.99	310.20	19.38	346.60	19.55	363.30	20.27	432.00	375165	164301 RC047
RC048	_			17.10	164.10	18.36	235.40	18.81	271.00		310.20	19.68	346.60	19.86	363.30	20.62	432.10	375272	164281 RC048
	Avon									19.26								375380	
RC049	Avon	Defended 1D		17.46	164.10	18.45	235.50	18.91	271.00	19.37	310.20	19.78	346.60	19.96	363.30	20.71	432.10		
RC050ds	Avon	Defended 1D		17.52	164.10	18.53	235.50	18.99	271.00	19.45	310.20	19.87	346.60	20.06	363.30	20.81	432.10	375395	164416 RC050ds
RC050	Avon	Defended 1D		17.56	164.10	18.60	235.50	19.07	271.00	19.55	310.20	19.98	346.60	20.17	363.30	20.99	432.10	375391	164441 RC050
RC051	Avon	Defended 1D		17.57	164.10	18.61	235.50	19.07	271.00	19.55	310.20	19.98	346.70	20.17	363.30	20.99	432.20	375386	164532 RC051
RC052	Avon	Defended 1D	ISIS	17.60	164.10	18.64	235.50	19.11	271.00	19.60	310.20	20.03	346.70	20.22	363.40	21.04	432.30	375404	164621 RC052
RC053ds	Avon	Defended 1D	ISIS	17.64	164.10	18.68	235.50	19.15	271.00	19.63	310.30	20.07	346.80	20.26	363.40	21.08	432.50	375371	164700 RC053ds
RC053	Avon	Defended 1D		17.71	164.10	18.79	235.50	19.32	271.00	19.87	310.30	20.37	346.80	20.60	363.40	21.56	432.50	375356	164725 RC053
XS05	Avon	Defended 1D		17.75	164.10	18.84	235.50	19.37	271.10	19.92	310.40	20.43	346.90	20.66	363.60	21.62	432.80	375299	164812 XS05
XS07	Avon	Defended 1D		17.79	164.10	18.89	235.50	19.42	271.10	19.97	310.40	20.47	347.00	20.70	363.60	21.66	432.90	375279	164847 XS07
XS09_w	Avon	Defended 1D		17.79	123.40	18.90	190.50	19.42	217.00	19.97	254.20	20.47	292.40	20.70	309.60	21.67	381.20	375249	164871 XS09_w
	_																		
XS13	Avon	Defended 1D		18.02	164.10	18.98	235.60	19.50	271.10	20.04	310.40	20.54	347.00	20.77	363.60	21.72	433.00	375202	164929 XS13
XSEL02c	Avon	Defended 1D		18.03	164.10	18.99	235.60	19.50	271.10	20.04	310.40	20.54	347.00	20.76	363.60	21.72	433.00	375192	164940 XSEL02c
XSEL02	Avon	Defended 1D		18.04	164.10	19.01	235.60	19.53	271.10	20.07	310.40	20.58	347.00	20.80	363.60	21.76	433.00	375186	164961 XSEL02
XS15	Avon	Defended 1D		18.06	164.10	19.01	235.60	19.53	271.10	20.07	310.50	20.57	347.00	20.79	363.60	21.75	433.00	375169	164989 XS15
RC056	Avon	Defended 1D		18.06	164.10	19.00	235.60	19.51	271.10	20.05	310.50	20.55	347.00	20.78	363.70	21.74	433.00	375158	165011 RC056
RC057	Avon	Defended 1D	ISIS	18.14	164.10	19.09	235.60	19.60	271.10	20.14	310.50	20.63	347.10	20.85	363.70	21.80	433.10	375147	165096 RC057

WATERCOURSE SCENARIO TYPE SOFTWARE LEVEL 2YR FLOW 2YR LEVEL 10YR FLOW 10YR LEVEL 25YR FLOW 25YR LEVEL 50YR FLOW 50YR LEVEL75YR FLOW 75YR LEVEL100YR FLOW100YR LEVEL100CC FLOW 100CC Easting Northing NODE NODE River Avon Bath Flood Defence Scheme, Black & Veatch 2005 RC058 164 10 347 10 21.86 375155 165175 RC058 Avon Defended 1D 18.20 19 14 235 60 19 64 271 10 20.17 310.50 20.68 20.90 363.70 433 10 RC059 Defended 1D 18.38 164.10 19.30 271.20 20.29 310.50 20.76 347.20 363.80 21.90 433.30 375170 165283 RC059 Avon ISIS 235.60 19.78 20.98 RC060 Avon Defended 1D ISIS 18 61 164 10 19 55 235 60 20.03 271 20 20.55 310 50 21.02 347 30 21.24 363 80 22.14 433 60 375196 165414 RC060 RC061 Defended 18.65 164.10 271.20 20.60 21.07 347.40 21.28 363.90 22.18 433.80 375224 165479 RC061 1D ISIS 19.60 235.60 20.09 310.60 Avon RC062 Avon Defended 1D ISIS 18.72 164.10 19.67 235.60 20.15 271.20 20.66 310.60 21.13 347.50 21.34 364.00 22.23 434.00 375260 165540 RC062 RC063 Defended 1D ISIS 18.69 164.10 19.63 235.60 20.11 271.20 20.62 310.70 21.09 347.50 21.30 364.10 22.21 434.10 375306 165611 RC063 Avon RC064 Defended 1D ISIS 18.83 164.10 19.77 235.60 20.24 271.20 20.74 310.70 21.20 347.60 21.41 364.10 22.29 434.30 375384 165694 RC064 Avon RC065 Defended 1D ISIS 18 90 164 10 19 85 235 60 20.32 271 20 20.82 310 70 21 27 347 60 21 48 364 10 22 35 434 50 375465 165748 RC065 Avon RC066 Avon Defended 1D ISIS 18 94 164 10 19 90 235 60 20.37 271 20 20.87 310 70 21 33 347 70 21 53 364 20 22.41 434 70 375571 165782 RC066 RC067 Defended ISIS 19.00 164.10 19.95 235.60 20.42 271.20 20.92 310.80 21.37 347.70 21.57 364.30 22.44 434.90 375674 165794 Kensington Meadows downstream Avon 1D RC067 RC068 Defended 1D ISIS 19.04 164.10 19.99 235.60 20.47 271.30 20.96 310.80 21.42 347.90 21.62 364.40 22.49 435.30 375784 165795 RC068 Avon RC069 Defended 1D ISIS 19.10 164.10 20.05 235.70 20.52 271.30 21.02 310.90 21.50 348.00 21.71 364.50 22.59 435.60 375882 165835 RC069 Avon 22.60 RC070 Avon Defended 1D ISIS 19.14 164 10 20.08 235.70 20.55 271.30 21.04 310.90 21.52 348 10 21.73 364 60 435.80 375949 165873 RC070 RC071 Defended ISIS 19.20 164.10 20.18 235.70 20.65 271.40 21.15 311.00 21.61 348.30 21.81 364.80 22.66 436.20 376057 165920 RC071 WYG levels 2yr 19.21, CC 22.66 Avon 1D RC072 Defended 1D ISIS 19.24 164 10 20.22 235.70 20.69 271.40 21.18 311.10 21.64 348 40 21.84 364.90 22.69 436.40 376134 165939 RC072 Avon 20.73 21.22 21.68 376208 RC073 Defended ISIS 19.32 164.10 20.27 235.70 271.40 348.50 21.87 365.00 22.71 436.60 165959 RC073 1D 311.10 Avon RC074 Avon Defended 1D ISIS 19.28 164.10 20.27 235.80 20.73 271.40 21.22 311.20 21.68 348.60 21.87 365.00 22.71 436.80 376255 166088 RC074 Kensington Meadows upstream Grosds1 Avon Defended 1D ISIS 19.36 164.10 20.32 235.80 20.77 271.40 21.26 311.20 21.71 348.60 21.90 365.10 22.73 436.90 376273 166112 Grosds1 Grosus1 Avon Defended 1D ISIS 19.49 164.10 20.51 235.80 21.01 271.40 21.52 311.20 22.01 348.60 22.22 365.10 23.02 436.90 376275 166115 Grosus1 RC075 Defended 1D ISIS 19.51 164.10 20.53 235.80 21.02 271.50 21.53 311.30 22.02 348.70 22.23 365.10 23.02 437.00 376300 166133 RC075 Avon RC076 Avon Defended 1D ISIS 19 55 164 20 20.55 235 80 21 04 271 50 21 54 311 30 22 03 348 70 22 24 365 20 23 03 437 20 376381 166122 RC076 RC077 Avon Defended 1D ISIS 19.58 164.20 20.58 235.90 21.06 271.50 21.56 311.40 22.05 348.90 22.26 365.40 23.05 437.50 376449 166141 RC077 RC078 Avon Defended 1D ISIS 19.62 164.20 20.61 235.90 21.09 271.60 21.58 311.60 22.07 349.10 22.27 365.60 23.06 437.90 376513 166213 RC078 21.59 RC079 Avon Defended 1D ISIS 19.62 164.20 20.61 236.00 21.09 271.70 311.60 22.07 349.30 22.28 365.70 23.07 438.00 376528 166267 RC079 RC080 Avon Defended 1D ISIS 19.66 164 30 20.63 236.10 21.11 271 80 21 60 311 80 22.08 349 50 22.29 365.90 23.07 438.30 376560 166344 RC080 RC081 Defended 1D ISIS 19.68 164.30 20.65 236.10 21.12 271.90 21.61 311.90 22.09 349.70 22.30 366.20 23.08 438.70 376614 166427 RC081 Avon RC082 Avon Defended 1D ISIS 19 73 164 40 20.67 236.20 21.14 272 00 21.63 312 10 22 10 349 90 22.31 366 40 23 09 439 00 376681 166469 RC082 RC083 Defended 1D ISIS 19.73 164.50 236.30 21.14 272.10 21.62 312.20 22.10 350.10 22.30 366.60 23.08 439.30 376775 166487 RC083 20.67 Avon RC084 Avon Defended 1D ISIS 19 78 No Result 20.72 No Result 21.18 No Result 21 66 No Result 22 13 No Result 22 34 No Result 23 11 No Result 376907 166568 RC084 RC085 Avon Defended 1D ISIS 19.83 No Result 20.75 No Result 21.20 No Result 21.68 No Result 22.14 No Result 22.34 No Result 23.12 No Result 376964 166617 RC085 RC086 Avon Defended ISIS 19.85 No Result 20.76 No Result 21.21 No Result 21.69 No Result 22.16 No Result 22.35 No Result 23.13 No Result 377041 166658 RC086 RC089 Defended ISIS 19.94 21.74 RC089 1D No Result 20.83 No Result 21.27 No Result No Result 22.20 No Result 22.40 No Result 23.16 No Result 377322 166764 Avon **Bathwds** Avon Defended 1D ISIS 20.00 No Result 20.88 No Result 21 31 No Result 21 78 No Result 22 23 No Result 22 42 No Result 23 18 No Result 377396 166902 Bathwds Bathwus Defended 1D ISIS No Result 20.99 No Result 21.41 No Result 21.86 No Result 22.31 No Result 22.50 No Result No Result 377441 166965 Bathwus Avon 20.15 23.25 21.89 377448 RC091 Avon Defended 1D ISIS 20.17 No Result 21.01 No Result 21.43 No Result No Result 22.33 No Result 22.52 No Result 23.27 No Result 166978 RC091 Bathus1 Defended 1D ISIS 20.23 No Result 21.20 No Result 21.74 No Result 22.22 No Result 22.62 No Result 22.81 No Result 23.53 No Result 377482 167011 Bathus1 Batheaston downstream Avon RC092 Avon Defended 1D ISIS 20.33 No Result 21.33 No Result 21.86 No Result 22.32 No Result 22.70 No Result 22.89 No Result 23.59 No Result 377567 167081 RC092 RC096 Avon Defended 1D ISIS 20.50 No Result 21.42 No Result 21.92 No Result 22.37 No Result 22.75 No Result 22.93 No Result 23.63 No Result 377823 167344 RC096 WYG levels 2yr 20.49, CC 23.56 RC098 Defended 1D ISIS 20.59 No Result 21.46 No Result 21.94 No Result 22.38 No Result 22.76 No Result 22 94 No Result 23 64 No Result 377995 167353 RC098 Avon 21.97 22.40 RC101 Defended 1D ISIS 20.67 No Result 21.49 No Result No Result No Result No Result 22.96 No Result 23.65 No Result 378285 RC101 Avon 22.78 167223 RC103 Avon Defended 1D ISIS 20.70 No Result 21.49 No Result 21.95 No Result 22.38 No Result 22.75 No Result 22.93 No Result 23.61 No Result 378493 167072 RC103 Batheaston upstream RC103us Avon Defended 1D ISIS 20.73 No Result 21.52 No Result 21.98 No Result 22.41 No Result 22.78 No Result 22.96 No Result 23.70 No Result 378499 167053 RC103us AV2298\_11935

No Result

22.89

23.33

23 34

23.35

23.42

23.51

23.65

23.83

No Result

23.06

23.49

23 50

23.51

23.57

23.66

23.79

23.97

No Result

23.80

24.29

24 29

24.30

24.41

24.51

24.66

No Result

378512

378521

378539

378562

378483

378440

378282

378361

167030

166808

AV2298\_11935

AV2320 12214

Bathampton downstream

Bathampton upstream

WYG levels 2yr 21.21, CC 24.33

167018 AV2299 119.5

166992 AV2310\_12015

166449 AV2330\_12599

166140 AV2340 12923

165761 AV2350 13334

165362 AV2360\_13744

Avon

Avon

Avon

Avon

Avon

Avon

Avon

AV2299 119.5

AV2310 12015

AV2320 12214

AV2330\_12599

AV2340 12923

AV2350\_13334

AV2360\_13744

Defended

Defended

Defended

Defended

Defended

Defended

Defended

Defended

1D

1D

1D

1D

1D

1D

1D

1D

ISIS

ISIS

ISIS

ISIS

ISIS

ISIS

ISIS

ISIS

20.77

20.88

20.92

20.97

21.13

21.38

21.61

22.01

No Result

21.61

21.92

21 93

21.97

22.09

22.26

22.46

22.74

No Result

22.08

22.51

22.53

22.55

22.64

22.76

22.92

23.14

No Result

22.52

22.98

22.98

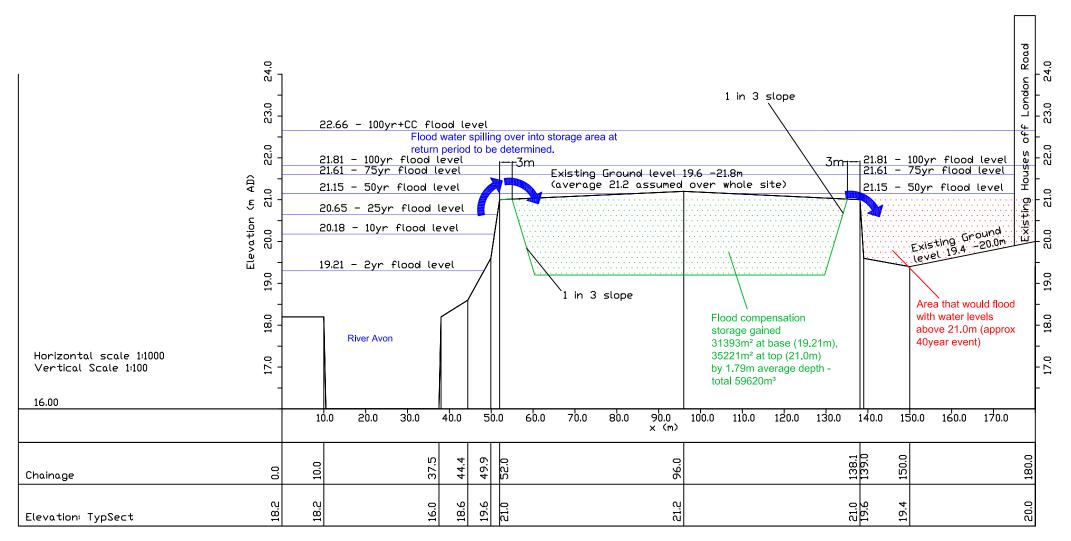
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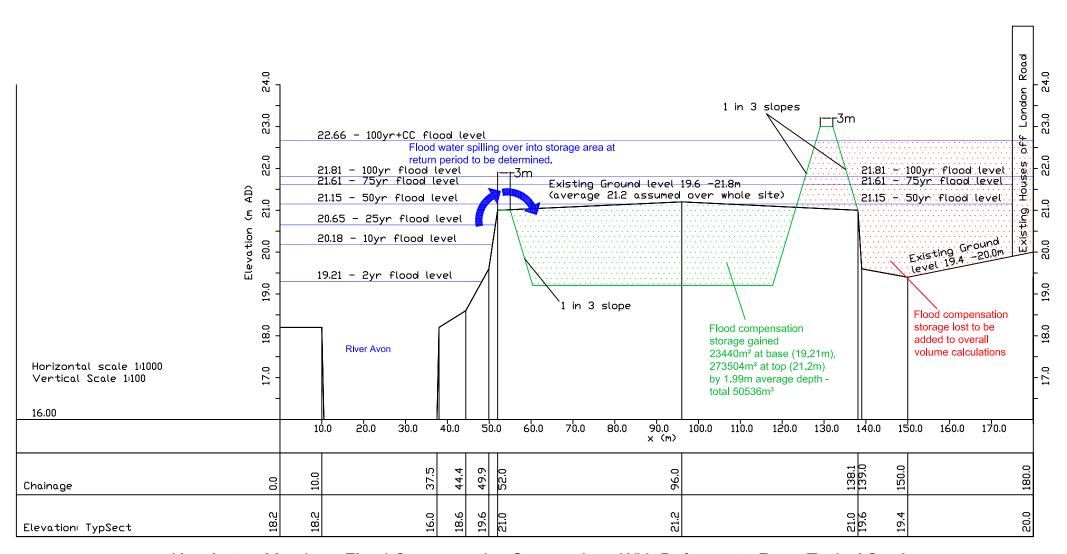
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23.32

23.52



Kensington Meadows Flood Compensation Storage Area Without Defences To Rear - Typical Section



Kensington Meadows Flood Compensation Storage Area With Defences to Rear-Typical Section

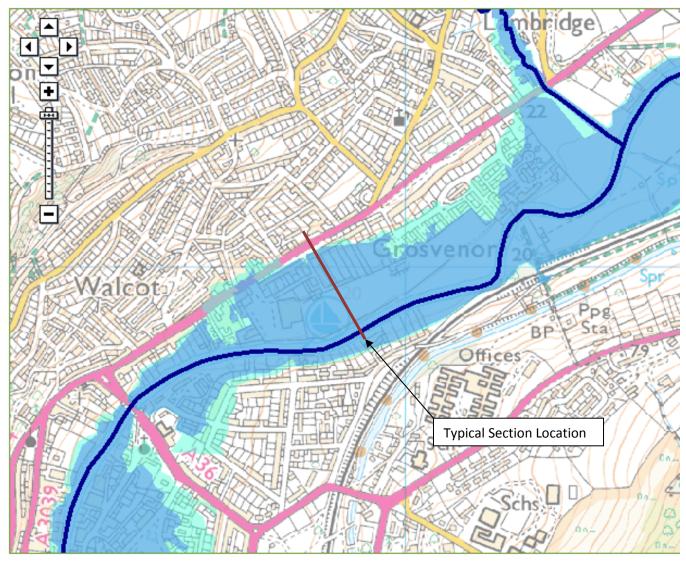
09213-SK3A - Kensington Meadows Flood Compensation Storage Area - Typical Sections

## Map legend

Click on the map to see what is the Risk of Flooding at a particular location.

- □ Flood Maps (1)
- Flooding from rivers or sea without defences
- Extent of extreme flood
- Flood defences
- Areas benefiting from flood defences
- Main rivers

X: 376,035;Y: 165,963 at scale 1:10,000



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