WYG Engineering
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Bath Compensatory Storage study

Phase 1 – Final Report

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The conclusions reached are those which can reasonably be determined from the sources of information referred to in the report and from our knowledge of current professional practice and standards. Any limitations resulting from the data are identified where possible but both these and our conclusions may require amendment should additional information become available. The report is only intended for use in the stated context and should not be used otherwise.

Contents

1 Introduction

The Bath Compensatory Storage Study has been commissioned by Bath and North East Somerset Council (B&NES) to investigate the provision of compensatory storage upstream of Bath city centre to balance future loss of flood storage volume when planned developments take place. This is understood to be necessary to achieve effective and flexible delivery of brownfield regeneration sites as part of its Core Strategy.

It is proposed that the study is undertaken in four phases as described below:

1. Identification of technically feasible upstream sites to identify preferred site(s);
2. Assessment of preferred site(s), based on deliverability;
3. Detailed design and costing of the preferred site(s);
4. Preparation of a costed maintenance regime for the preferred site(s).

This report covers Phase 1 of the study and comprises a preliminary investigation into potential sites for compensatory storage upstream of the city centre.

2 Data Gathering

The Flood Risk Management Strategy Report (FRMS) produced by Atkins in June 2010 has been reviewed. It identified that the preferred strategic solution to allow development of allocated sites within Bath, that lie below the 1% AEP (1 in 100 year) +20% (climate change allowance) flood level, would be to provide a compensatory storage area upstream of Bath.

The provision of a storage area upstream of Bath would offset the volume of water that would theoretically be displaced by the combined footprint of the development sites. The Atkins FRMS estimated that approximately 345,000m^3 of upstream compensatory storage would be required to offset the volume of water displaced by raising the full footprint of all the development sites above the 1% Annual Exceedance Probability (AEP) +20% flood level (i.e. 1 in 100 year + CC flood level). In providing the compensatory storage it is understood that the development strategy would meet the requirements of PPS25. Furthermore, it is assumed that the Environment Agency have approved the basic strategy and recommendation of the FRMS to provide compensatory storage upstream of Bath.

The required volume of upstream compensatory storage would ultimately be dependent on the sites that proceed with development and the resulting displacement of flood water for each site.

It is understood that B&NES has undertaken a separate more detailed assessment to review the compensatory storage volume requirements for the loss of flood capacity based on the 1% AEP 1 in 100 year plus climate change flood level at the development sites. The Council has obtained more refined site specific flood level predictions from the Environment Agency which were not available when the FRMS was finalised. The Council has also reviewed and revised the potential development sites including removing such sites with extant planning permissions. The results of the study indicate that approximately 205,000m^3 of flood storage volume will be required to compensate for the storage volume lost at the development sites. This reflects discussions with the Environment Agency. So for the

purposes of this study and as a basis for the identification of potentially feasible storage sites the figure of 205,000m^3 is being used.

The current River Avon hydraulic model has been obtained from the Environment Agency. The River Avon ISIS hydraulic model provides predicted flood levels along the reach of the River Avon for the 1 in 1 year up to the 1 in 100 year + climate change return period event.

LiDAR (ground terrain mapping data) has been obtained from the Environment Agency for areas alongside the River Avon upstream of Bath. The data obtained comprised 1m resolution DTM LiDAR data.

The LiDAR in conjunction with the River Avon hydraulic model will enable an assessment of ground terrain in conjunction with predicted flood levels to be undertaken in order to identify potentially suitable compensatory storage sites.

The Atkins FRMS identifies the site at Kensington Meadows as a potential upstream compensatory storage area and suggests that re-profiling of ground levels could achieve approximately 300,000m^3 of flood storage. The feasibility of the site at Kensington Meadows is further considered as part of this study (see sections 3 and 4). It is understood that a Combined Sewer Overflow (CSO) crosses the Kensington Meadows site and this has the potential to reduce the compensatory volume that is available.

A second site identified in the Atkins FRMS for potential compensatory storage is the area in Batheaston, but it is stated that this site would be unable to provide enough storage to offset flood storage lost at all the development sites, although it could be used in conjunction with another site to provide the total required volume. This area is considered further in section 4. The area considered for Mill Lane Park and Ride site lies immediately to the south of the Batheaston site (see section 3), but in view of its intended use as a park and ride facility for Bath it is not considered appropriate for use as an upstream compensatory storage area.

In addition to the compensatory storage for the development sites, the Atkins FRMS suggests that upstream storage capacity could be provided to offset any loss of flood storage due to protection works to Lower Bristol Road. According to the FRMS, the Lower Bristol Road is assessed to have a 1 in 20 year standard of protection and is reported to be impassable during times of flood. As a result protection works are likely to lie below the 1 in 100 year +20% flood level and as such would potentially require the provision of compensatory storage. The capacity of 205,000m^2 compensatory storage includes offsetting the loss of flood storage due to such protection works.

3 Assessment of potential sites

A preliminary investigation into potential sites for compensatory storage upstream of the city centre to balance future loss of storage volume when planned developments take place has been undertaken.

The provision of compensatory storage via ground re-profiling would provide mitigatory storage to offset the loss of flood storage on development sites within Bath.

The compensatory storage areas would mostly be located within Flood Risk Zone 3, as it will be necessary to provide the compensatory volume at similar levels (in respect to the flood levels) to the volumes that are displaced on the development sites. In addition, normal EA requirements are that compensatory storage should be provided for displacement of flood storage below the 1 in 100 year + CC level.

The minimum level that it is considered appropriate to reduce ground levels to, in order to provide the compensatory volume, is the 1 in 2 year flood level, although it may be feasible to provide storage below this level should site conditions permit. Ground levels below the 1 in 2 year level would inundate on a more frequent basis so may restrict the future usage of the land. Furthermore, the "top of bank" level is generally close to the 1 in 2 year level, although in some cases the bank top is lower and the flood plain beyond the bank is lower than the 1 in 2 year level.

The compensatory storage volume will be created by excavating ground above the 1 in 2 year level, but the removal of ground above the 1 in 100 year +CC level would not contribute to the overall volume recommended in the Atkins Flood Risk Management Strategy as this level is assumed to be the upper limit used for estimation of the displaced flood volume.

Greater storage volumes could be achieved by reducing ground levels below the 1 in 2 year level, if an agreement could be reached on the frequency of inundation, having regard to land use, footpath access, safety etc. In addition, it would be necessary to confirm that this method to provide contained flood compensatory storage below the 1 in 2 year is acceptable to the EA. Furthermore, the River Avon water level during normal flow conditions would need to be sufficiently below the lowest storage level in order to permit free drainage of flood water back to the river. At this stage, we do not have EA predicted flood levels for events more frequent than the 1 in 2 year return period.

The compensatory storage area should be designed to fill and drain freely and it is envisaged that this could be achieved via excavation and re-profiling of land within the 1 in 2 year to 1 in 100 year + CC level band. It may be necessary to create some earth bunding in order to contain water within the storage area. The use of over spill weirs could be considered to ensure that areas fill in a controlled manner and any water surplus to capacity is spilled back into the channel for effective flood management.

Excavation of low lying areas within the flood plain that would not freely drain back to the river channel will not be undertaken, although we would not wish to rule out the provision of channels or culverts as a means for draining a portion of the water back to the channel. The use of these measures would better enable the continued use of the land for other purposes as it would not be inundated on as frequent a basis and therefore is less likely to become waterlogged for longer periods.

The compensatory volumes have initially been estimated via comparison of the flood levels with ground level digital terrain mapping, hence the topography of the existing ground has been taken into account. Along the boundaries of

the areas it will be necessary to consider how ground levels would tie into existing levels and as such a small reduction in volume would potentially result to cater for embankments, accesses etc.

At this first stage of the study we have undertaken an initial consideration of these suggested effects, but until the sites have been assessed further in respect of their viability, a detailed assessment will not be undertaken until a later stage.

Based on the extents of the upstream waterways within the District a total of eight sites have been screened as shown on drawing A067660-04 (see Appendix A). The sites are listed in Table 3.1 as follows:

Site	Location	Area
1.	Kensington Meadows Kensington Meadows is upstream of Bath city centre on the right bank of the River Avon.	4.6 ha
2.	Batheaston Site to the south of Batheaston on the River Avon left bank.	22.2 ha
3.	Bathampton Site to the east of Bathampton on both the left and right banks of the River Avon, just upstream of the confluence with the By Brook.	27.4 ha
4.	Batheaston (extra) Located upstream of the A4 road bridge on both left and right banks of the River Avon.	3.4 ha
5.	Kensington (extra) Located downstream of the A4 bridge on both left and right banks of the River Avon.	4.1 ha
6.	Claverton Site to north of Claverton located approximately 2km upstream of the confluence with the By Brook. The majority of the site lies between the Kennet and Avon Canal and the railway line.	8.4 ha
7.	Warleigh Wood Site to north west of Warleigh Wood on the left bank of the River Avon, between the watercourse and the railway line.	4.3 ha
8.	Shockerwick On the right bank of the By Brook approximately 1.5km upstream of the confluence with the River Avon.	6.9 ha

Table 3.1 – Initial Sites

Five of the sites (4, 5, 6, 7, 8) have been discounted at this stage as being of too little value in terms of storage provision versus the cost and potential planning issues. These sites appear to be unable to offer a significant proportion of the required 205,000m^3 and as a result a number of these sites would be required to make up the total volume. It would be preferable to provide the compensatory volume at one or two sites. Should a greater number of sites be progressed then costs of delivering the scheme would increase proportionally due to the increased number of planning applications, associated studies, etc. that would be required for each site.

The potential technical constraints at sites 4, 5, 6, 7 & 8 have been considered in outline as follows and these constraints would potentially further restrict the viability of each of the sites.

Site 4 – Batheaston (extra)

This site is located immediately upstream of the A4 Batheaston bypass road bridge across the River Avon and occupies land on both the left and right bank of the river. The land on the left bank is shown to lie below the 20m AOD contour and the 1 in 2 yr flood level at this location is approximately 19.5m AOD. As a result this area would only offer minimal compensatory storage volume above the 1 in 2 year flood level.

The area of land on the right bank, similarly to the left bank area, is currently open grassland. The western portion of the site is shown to be at or below the 20m contour so would offer minimal compensatory volume. The eastern part of the site rises above the 20m contour and covers an area of approximately 1.5 ha so would only offer a small portion of the total required compensatory volume.

There is no direct access to the site from the local highway network. At this stage, a potential route along a farm access track would appear to be available from Mill Lane to the east, however this would be dependent on consultations with the land owner.

Mature trees and hedgerows are present along the river bank adjacent to the site and are likely to have potential to support bats and other protected species.

Site 5 – Kensington (extra)

This site is located upstream of the Kensington Meadows site (site 1.) and immediately downstream of the A4 Batheaston bypass road bridge across the River Avon. It occupies land on both the left and right bank of the river.

The land on the left bank comprises open grassland which is currently used for livestock. A number of overhead electricity lines cross the site including National Grid transmission lines which would potentially reduce the area of land available. The only apparent vehicular access to this part of the site would be via a narrow lane from the village of Bathampton to the south, which crosses the Kennet and Avon Canal and the mainline railway, so there is a risk that it may not be suitable for construction traffic.

The majority of the site on the right bank of the River Avon comprises the southern part of the Bath Rugby Lambridge Training Ground, however the southern end of the site closest the river does not appear to hold any formal rugby pitches and is just open grassland.

Both areas of the site on the left and right banks of the River Avon lie below the 20m contour, so the potential compensatory storage depth available above the 1 in2 yr flood level of approximately 19.5m AOD would be limited.

Site 6 - Claverton

The potential site located to the north of lies on the left bank of the River Avon. The majority of the site lies between the Kennet and Avon Canal to the west and the Bath to Bradford-on-Avon railway line to the east. The remaining small portion of the site lies to the east of the railway line. The site levels are generally between 20m and 25m AOD so in principal it is at the right levels for provision of compensatory storage, however the majority of the site lies to the west of the railway line and is therefore somewhat cut off from the River Avon due to the railway being higher than the surrounding farmland. This poses a significant constraint to the use of the site for compensatory storage.

The principal drainage route for flood water to the west of the railway to flow back to the river would be via the underpass beneath the railway. The lowering of ground levels to create the compensatory storage would require the modification and potential lowering of the underpass in order to maintain the flood flow route back to the river. Consultation with Network Rail would be required to investigate the feasibility of this. In addition, additional drainage culvert routes beneath the railway line may also be required to provide further flood flow routes back to the River Avon which would add further complexity to the scheme.

Vehicular access to the site would be from the A36 main road to the west and across intervening farmland. The existing farm access route crosses the Kennet and Avon Canal via an existing over-bridge, but this is unlikely to be suitable for construction traffic so a new temporary bridge across the canal would be required should this site be pursued.

Access to the small part of the site to the east of the railway is via an underpass beneath the railway line and this would require assessment of its suitability for construction traffic.

Site 7 – Warleigh Wood

This site is located on the left bank of the River Avon with the Bath to Bradford-on-Avon railway line running along the western boundary. The site is accessed via Ferry Lane off the A36 Warminster Road to the west. Ferry Lane crosses the Kennet and Avon via a narrow bridge and the railway line via a level crossing, both of which are unlikely to be suitable for construction traffic. An alternative route to the site which avoids the level crossing is via an underpass beneath the railway line, but similarly this route also appears unsuitable for construction traffic.

The site ground levels are below the 25m AOD contour so only a shallow depth would be available for the provision of compensatory storage which would limit the overall volume available.

Site 8 - Shockerwick

The site lies to the north of the By Brook adjacent to its right bank, approximately 1.5km upstream of the confluence with the River Avon. The northern and eastern parts of the site comprise open grassland, however the strip of land adjacent the River Avon comprises a thick belt of trees and hedgerows. Further ecological investigation of this area would be required as some removal of vegetation / hedgerows would be required in order to provide a route for flood water to and from the By Brook.

The 1:25,000 Ordnance Survey map indicates a disused pit within the site which potentially would have been some form of mineral extraction site. It appears that the site has been filled in so a geo-environmental assessment of the

site would be required to determine whether any contamination or other geo-technical constraints to the excavation of material exist.

Access to the site would be from the A4 at its southern end or the country lane along the northern boundary which joins the A4 just to the north east of the site and as such no apparent constraints to vehicular access appear to exist.

If at a later stage any of the above sites are considered in any more detail than it is recommended that ecological walkover surveys are conducted in order to identify and clarify any potential ecological constraints.

The three remaining sites (Kensington Meadows, Batheaston and Bathampton) have been considered in more detail and indicative volumes assessed.

It was found that the Kensington Meadows site (1) (favoured in the Atkins FRMS report) is still of value, but has nowhere near the capacity originally indicated. At present the storage volume above the 1 in 2 year level is estimated at 80,000m³ whereas the earlier suggestion was that there was some 300,000m³ capacity at this site. In addition the site is understood to be a former tip and services are understood to cross the site, both of which have the potential to reduce the available storage volume.

The Batheaston site (2) has the greatest area but as it is already a functional flood plain (being below the 1 in 2 yr event level). However, the area could be extended up to the edge of the proposed park and ride site to include higher ground in the south west corner. There may also be scope for a two stage flood plain, utilising storage volume below the 1 in 2 year flood level, with a dividing bund and flow control structure; in which case a capacity in excess of 100,000m³ may be achievable.

The Bathampton site (3) upstream of the A4 trunk road represents a good storage volume and warrants further investigation.

Sites 1, 2 and 3 are considered further in section 5 below.

An enquiry has been undertaken with the local Environment Agency development control department in order to confirm that the proposed approach to identify suitable sites is acceptable, as the EA will ultimately be responsible for the approval and consent for the proposed compensatory storage scheme.

The EA in its response dated 15 March 2011 confirmed that it would have no objections in principle to the proposals to provide compensatory storage above the 1 in 2 year flood level, as the approach is fundamentally the same as was agreed during the Atkins FRMS, however, the proposed solution to provide contained storage below the 1 in 2 year flood level has not yet been confirmed with the EA.

The EA confirmed that it would need to see further engineering details before confirming any acceptance to specific details and volumes which may affect its interests e.g. within the main river floodplain, near to existing flood risk management infrastructure, etc.

4 Further assessment of selected sites

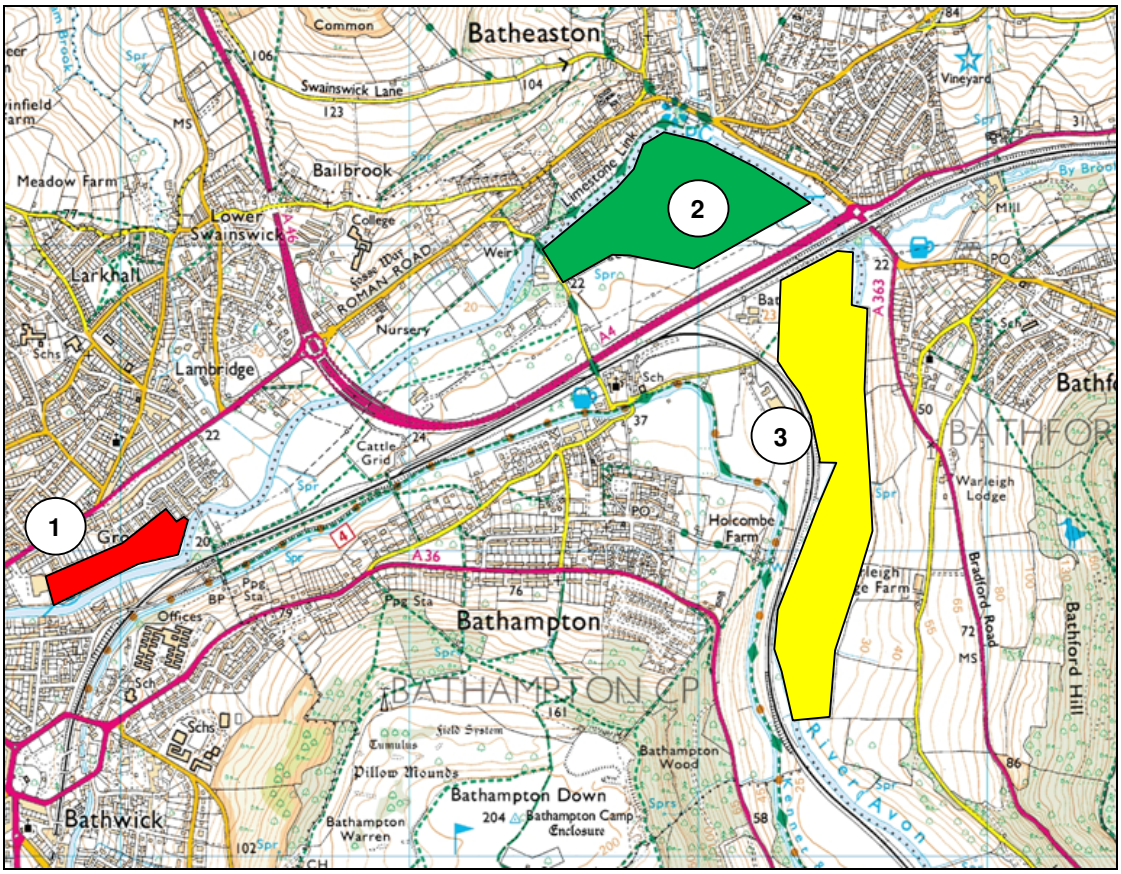
Having reviewed all existing information, three areas have been identified as possible suitable locations for compensatory storage:

1. Kensington Meadows;
2. Batheaston;
3. Bathampton

Using existing simulated water level prediction in combination with 1m resolution DTM LiDAR data the predicted maximum available compensatory storage volumes has been calculated at each site.

The principle compensatory storage volume has been taken as the volume lying between the average 2yr and 100yr + climate change predicted water levels taken from the existing ISIS model of the River Avon, however at specific locations it may be feasible to provide storage below the 2yr level.

Figure 5.1 - Site Locations



(1) Kensington Meadows

Ground levels across the Kensington Meadows site largely vary between 20.0m AOD and 21.8m AOD. The River Avon average 1 in 2 year flood level at the site is 19.21m AOD and the average 1 in 100 year + CC flood level is 22.66m AOD. Therefore, excavation of material down to the 1 in 2 year flood level would provide a compensatory volume within the band between the 1 in 2 year and 1 in 100 year + CC levels.

- 100yr + CC level: 22.66 mAOD
- 2yr level: 19.21 mAOD
- Max area above 2yr level: 47,659 m²
- Max Volume above 2yr level: 83,832 m³

Figure 5.2 – Kensington Meadows

The compensatory volume that would be provided at Kensington Meadows is in the lower half of the level band between the 1 in 2 year and 1 in 100 year + CC flood levels (i.e. closer to the 1 in 2 year flood level). The appropriateness of this will need further consideration and also discussion and approval with the Environment Agency.

Additionally, in order to connect the compensatory area to the River Avon and allow flood water to spill from the river into the site, the wooded zone along the top of the river bank will require clearance and ground level lowering in a number of areas. The extent of the tree and vegetation clearance and ground level lowering, would be

determined, via hydraulic modelling, in the second phase of the study should the Kensington Meadows site be chosen as the preferred site.

The Kensington Meadows site is understood to be a local nature reserve, therefore the removal or alteration of any habitat areas along side the river bank will require ecological assessment. Display boards at the site indicate the presence of bats and otters. A preliminary phase 1 ecological assessment for the preferred site would be undertaken in the second phase of this study. As a general principle, it would be necessary to replace any areas of lost habitat with new areas, but this will be considered further at a later stage.

An initial ecological walkover survey found that the area proposed for the provision of compensatory storage is of low ecological value and mainly comprises amenity grassland. A small area of riverside woodland would also be affected by the works. However, the trees in this area are all young to semi-mature and dominated by sycamore. The only protected species which could potentially be affected by the work are nesting birds.

Access into the site would be from London Road to the north and the aerial view shows a number entry points. During the next phase of the study it would be necessary to review whether the existing accesses would be suitable for construction traffic.

A further potential constraint to the use of the site as a compensatory storage area is that it appears that in the past it has been used as a tip. Apparently the tip has been restored to the grassland playing fields that are present today. Excavation of the former tip and disturbance of this ground could lead to contamination issues and disposal of excavated material would potentially be mostly costly than for previously undisturbed ground. A desktop assessment of geo-environmental issues would be undertaken for the preferred site during the second phase of this study.

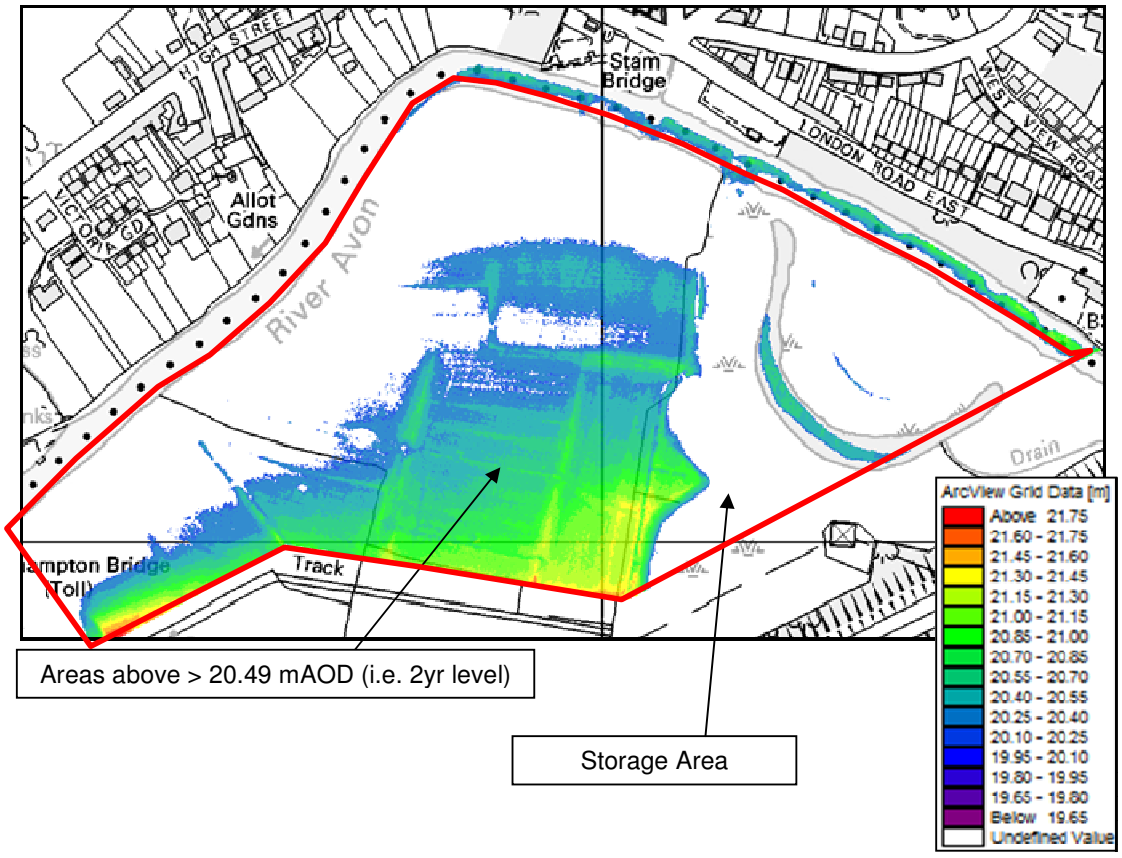
In addition, it is understood that a combined sewer overflow (CSO) crosses the Kensington Meadows site. The route has not yet been established, but it would potentially reduce the compensatory storage volume available at the site.

(2) Batheaston

Ground levels across the Batheaston site largely vary between 20.4m AOD and 21.6m AOD. The River Avon average 1 in 2 year flood level at the site is 20.49m AOD and the average 1 in 100 year + CC flood level is 23.56m AOD. Therefore, excavation of material down to the 1 in 2 year flood level would provide a compensatory volume within the band between the 1 in 2 year and 1 in 100 year + CC levels, although, similarly to the Kensington Meadows, the site at Batheaston would provide a compensatory volume in the lower half of the level band between the 1 in 2 year and 1 in 100 year + CC flood levels.

- 100yr + CC level: 23.56 mAOD
- 2yr level: 20.49 mAOD
- Max area above 2yr level: 62,000 m²
- Max Volume above 2yr level: 61,500 m³

Figure 5.3 - Batheaston



The Batheaston site currently comprises open grassland which is used for grazing livestock. Hedgerows were observed around the site boundary and isolated trees are present across the site. A number of water features can be seen on the aerial view of the site in eastern parts of the site, but these areas are below the 1 in 2 year flood level so are unavailable for use as compensatory storage areas.

The areas that would be considered suitable for provision of the compensatory storage are the open grassland areas towards the southern boundary. An access track crosses the southern part of the site and is bounded by an intermittent hedgerow with odd trees along its length.

The Council has confirmed it is committed to providing a Park & Ride to the east of the City. While the current proposal to use the site A4 P&R (Bathampton Meadows) was removed from the transport package, the area across the two fields to the south of the site adjacent to the A4 Batheaston Bypass is excluded from the capacity work. Therefore it is possible that the remaining northern areas closest to the potential compensatory storage site could be included within the compensatory storage site. This would potentially offer a further compensatory storage volume.

A potential access route into the site is from Mill Lane to the west, but this would require further investigation regarding its suitability for construction traffic.

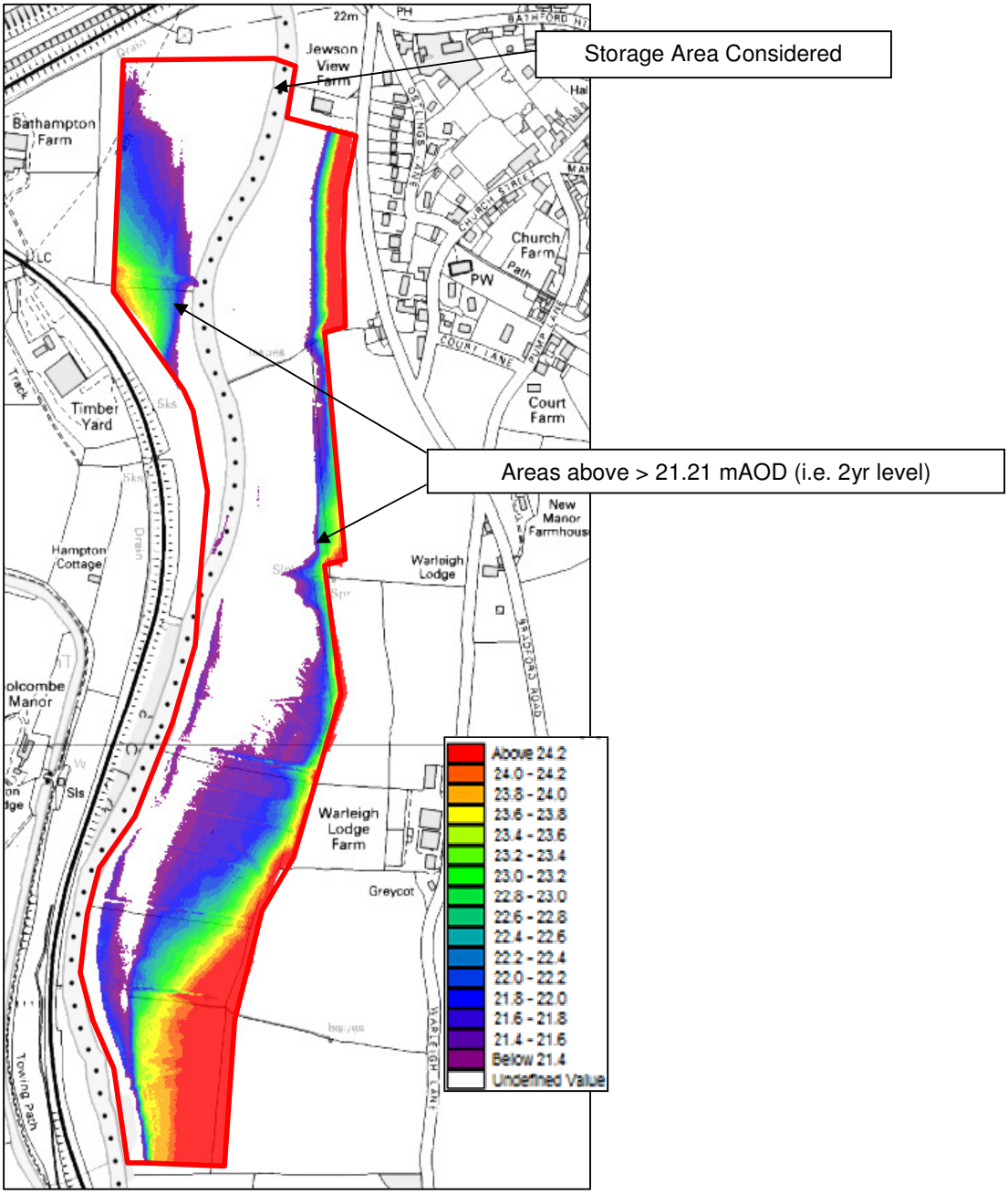
The Batheaston site lies adjacent to Bathampton Meadow Wildlife Trust Reserve. This reserve was created in 1996 to provide additional flood relief for the A46 Bathampton by-pass and the wet meadows and the oxbow lake of the site are important for a wide variety of migrant birds.

The area proposed for the provision of compensatory storage to the west of the Wildlife Reserve is of low ecological value and mainly comprises improved grassland, as well as some species-poor hedgerows. A few mature trees are present within the hedgerow and the site is considered to have some, albeit limited, potential for supporting badgers, dormice, roosting bats, nesting birds and reptiles.

(3) Bathampton

Ground levels across the Bathampton site largely vary between 21.4m AOD and 24.2m AOD. The River Avon average 1 in 2 year flood level at the site is 21.21m AOD and the average 1 in 100 year + CC flood level is 24.33m AOD. Therefore, excavation of material down to the 1 in 2 year flood level would provide a compensatory volume within the band between the 1 in 2 year and 1 in 100 year + CC levels.

Figure 5.4 - Bathampton



- 100yr + CC level: 24.33 mAOD
- 2yr level: 21.21 mAOD
- Max area above 2yr level: 148,714 m²
- Max Volume above 2yr level: 222,599 m³

The Bathampton site currently comprises open grassland gently sloping towards the River Avon. Hedgerows and isolated trees can been seen on the aerial view of the site along field boundaries. Access to the part of the site on the east bank of the River Avon would be from the A363 Bradford Road to the east. An access route across the farmland between the road and the proposed compensatory area would be required.

Potential access routes to the site to the west of the River Avon would require further investigation due to the railway line that runs along the northern and western boundaries.

The site at Bathampton would potentially provide a compensatory volume across the full range of levels between the 1 in 2 year and 1 in 100 year + CC flood levels. Furthermore, beyond the eastern boundary of the site ground levels rise above the 1 in 100 year + CC level, so potential for further compensatory volume creation at the flood risk zone 2/3 boundary is available.

In summary the Bathampton site would appear to offer potential compensatory storage across the full range of levels. The other two sites offer volumes closer to the 1 in 2 year level so may not be considered as suitable. It is noted that this is purely a hydraulic assessment of the sites and other constraints may affect the overall viability of each site.

Summary of selected sites

The compensatory volumes have initially been estimated via comparison of the flood levels with ground level digital terrain mapping, hence the topography of the existing ground has been taken into account. Along the boundaries of the areas it will be necessary to consider how ground levels would tie into existing levels and as such a small reduction in volume would potentially result to cater for embankments, accesses etc.

For example, at the Kensington Meadows site, the embankment that would be created around the perimeter of the site would take up a significant portion of the total estimated volume. The embankment is anticipated to comprise a 1 in 3 slope from the site perimeter down to the excavated base level for the compensatory area.

In addition, it is understood that a CSO crosses the Kensington Meadows site. The route has not yet been established, but for the purposes of this initial assessment it is assumed that it crosses the site from the London Road side to a discharge on the opposite River Avon side. It is assumed that ground levels over a 5m wide easement along the sewer length could not be reduced and a 1 in 3 slope at each side down to the base level has been assumed.

At this first stage of the study we will undertake an initial consideration of these suggested effects, but until the sites have been assessed further in respect of their viability, a detailed assessment will not be undertaken until a later stage.

A summary of the compensatory storage volumes considered to be potentially available based on the initial investigations are provided in Table 5.1 below. The estimated volumes take account of embankments that would be required around the site perimeters in order to allow ground levels to slope down to the base level within the compensatory areas.

At the Bathampton site it is not considered feasible to provide compensatory storage below the 1 in 2 year flood level due to the limited depth above the normal water level in the River Avon.

Table 5.1 – Summary of potential compensatory storage volumes

Site	Estimated Volume (m^3)		Estimated Total Volume (m3)
	Between 2yr and 100yr + CC flood levels	Additional 1m storage depth below 2 yr flood level	
1) Kensington Meadows	68,170	31,430	99,600
2) Batheaston	58,810	112,840	171,650
3) Bathampton	210,600	-	210,600
TOTAL	**337,580**	**144,270**	**481,850**

The Kensington Meadows and Batheaston sites are understood to be under the ownership of B&NES, but the site at Bathampton is assumed to be under third party ownership.

The Kensington Meadows and Batheaston sites would potentially offer approximately 271,250m^3 of compensatory storage which is in excess of the required 205,000m^3.

5 Conclusions

This study has been commissioned by Bath and North East Somerset Council to investigate the provision of compensatory storage upstream of Bath city centre to balance future loss of flood storage volume when planned developments take place.

B&NES has undertaken an assessment to review the compensatory storage volume requirements for each Bath development site. The results of the study indicate that approximately 205,000m^3 of flood storage volume will be required to compensate for the storage volume lost at the development sites.

Using the River Avon hydraulic model and ground terrain data a total of eight potential storage sites have been identified as potentially being able to provide compensatory storage, but only three of these are considered to have serious potential for development.

Based on the extents of the upstream waterways within the County a total of eight sites have been screened as shown. Five of these (4, 5, 6, 7, 8) have been discounted as being of too little value in terms of storage vs cost and potential planning issues. In addition a number of other constraints including access, flood flow routing and utility restrictions have been identified which further limit the compensatory storage provision potential of the sites. The three remaining sites have been considered in more detail and indicative volumes assessed.

The three sites that have been identified for further consideration are the sites at Kensington Meadows, Batheaston and Bathampton. It estimated that a total compensatory storage volume of approximately 337,580m^3 could be provided across the three sites. A further volume of approximately 144,270m^3 is potentially available at the Kensington Meadows and Batheaston sites should the storage volume be extended up to 1m depth below the 1 in 2 year flood level. The estimated total volumes takes account of embankments that would be required around the site perimeters in order to allow ground levels to slope down to the base level within the compensatory areas.

There is, however, potential for further constraints to exist such as underground infrastructure which would serve to reduce the total volume. An existing CSO at the Kensington Meadows site has been identified and the requirement to retain current ground levels in the vicinity of this service has been incorporated in the overall figure. The presence of a former tip at the site may also affect the feasibility of the site to be used for compensatory storage.

The Kensington Meadows and Batheaston sites are understood to be under the ownership of B&NES, but the site at Bathampton is assumed to be under third party ownership and potentially a number of different owners will be involved. The Kensington Meadows and Batheaston sites alone would potentially offer approximately 271,250m^3 of compensatory storage which is in excess of the required 205,000m^3.

6 Recommendations

It is recommended that the three sites are now discussed further with Bath and North East Somerset Council and the Environment Agency in order to determine whether the sites, at this stage, are considered suitable for further investigation.

Following consultation with stakeholders it will be necessary to identify a preferred site that can be progressed to the next phase of this study. The next phase will include further investigation of the potentially suitable site and will look to confirm whether the sites are technically feasible and logistically viable and would include the following items;

- Land owner engagement;
- Land contamination;
- Topography;
- Geology and underlying soils;
- Underground infrastructure;
- Ecology impacts;
- Sustainability and biodiversity.

A more detailed simulation of design flood flow across the area would be undertaken in order to confirm the hydraulic suitability of the site.