4.16 ORLETON

4.16.1 Flood History and Flood Dynamics

Orleton lies on the upper reaches of Brimfield Brook, some 4.0km upstream of Brimfield. Flood alleviation solutions for Orleton must have due regard for the downstream village. The village has a significant history of flooding. Pre 1965 there were only four properties close to Brimfield Brook, and the floodplain extended as far as the War Memorial in the 1963 flood (which is considerably further than the current 1% AEP (Q100) event floodplain map issued by the Environment Agency).

The earlier ford was later bridged over at low level (Millbrook Bridge, point A of Figure 4-18), and residents at that time were sceptical that it was sufficient to take flood flows. The Parish Council had the intention to undertake significant channel improvement works pre-1965, but these plans were shelved when land on the right bank was sold to build the Estate served by Millbrook Close and Mortimer Drive.

[redacted]

[redacted] The original SFRA Flood Reports Database makes general reference to 6 flooded properties in Millbrook Way and 10 properties in Mortimer Drive. Property flooding in Mortimer Drive could not be established, so this may be a report of garden flooding.

The site visit of 7th January and flood reports have confirmed direct flooding to 10 properties in July 2007. We suspect that this is an under-estimate.

Properties adjacent to Millbrook Bridge were particularly affected. Flood depth in Mill Lane was reported as 0.45m approximately, [redacted]

Residents have reported that runoff from the B4361 down into Millbrook Way (point B) is a significant part of the problem, and at least two properties on Millbrook Way have reported flooding due to the surface water from the highway. Millbrook Way itself receives overland surface water from numerous lanes in central Orleton, not least Green Lane west of the B4361.

Following the 2007 floods Herefordshire Council cleared the brook upstream and downstream of Millbrook Bridge in the centre of the village, and this has alleviated flood risk to some extent. There was no flooding in November 2009 for example.

Photograph 4-49 – Millbrook Bridge from south, 20 July 2007

Photograph courtesy of [redacted]

Photograph 4-50 – Millbrook Way from north, 20 July 2007

Photograph courtesy of [redacted]

There are persistent reports of inadequate highway drainage and lack of drain maintenance in Millbrook Way exacerbating the problem. We suspect that the drains (although quite possibly silted and below optimum) are being surcharged by the tailwater levels in the watercourse, but generally are simply overwhelmed by the excessive quantities of surface water from the lanes within the village, none of which have gullies.

Following the 2000 and 2002 floods, local residents have reported that Herefordshire Council undertook to clear the silt and debris at Millbrook Bridge on a regular basis, but that this has only been done twice since 2002.

There is a particular recurring problem on the B4361 south of the Maidenhead Inn, point C. The highway is heavily flooded during periods of heavy rain, typically once every 2 to 3 years, see Photograph 4-51.

Photograph 4-51 – B4361 flooded at Maidenhead Inn, 20 July 2007

The highway is only just passable, but the predominant problem is that all of this surface water, itself sourced from the large hillside west of the B4361, is funnelled into Millbrook Way at point B of Figure 4-18.

Bizarrely although there is a new 225mm Ø surface drain running in the north kerb from the cross-roads down Millbrook Way towards Brimfield Brook, it has only one inlet gully at the top of Millbrook Way, and possibly three gullies on the B4361. These are wholly inadequate to deal with the quantities that arrive at the Maidenhead Inn cross-roads.

We inspected the main bridge carrying Brimfield Brook under the B4361 170m north of Townsend Farm, point D. The hydraulic condition of this bridge is a travesty of land drainage. The downstream exit from the bridge and the channel were noted to be massively silted, to a depth of at least 0.4m, see Photograph 4-52.

Photograph 4-52 – Silted condition of B4361 Bridge, Orleton

15m downstream of the bridge a large tree cutting was found wedged across the channel, which had blocked the watercourse to the extent that the upstream water level was some 0.5m higher than the downstream. Some clearance work was undertaken here post-2007, but was not completed.

In its current 2010 condition, this blockage clearly has reduced the hydraulic gradient through the upstream bridge to a significant degree, as evidenced by the large silt deposits within and downstream of the bridge.

Photograph 4-52 clearly indicates that there is standing water within the bridge barrel caused by the large degree of siltation downstream. We estimate that the downstream channel has at least 0.4m of silt deposited that is directly affecting the hydraulic performance of the bridge. This requires urgent clearance.

A second even more significant problem exists upstream. It is clear that originally the watercourse was in open channel as far as the bridge but incorporated two right angle bends. Some years previously, Hereford and Worcester County Council realigned and culverted the watercourse to take a more direct route to the bridge, thus avoiding erosion of the highway at the bridge at point E. There is a manhole sited on the upstream entrance to the bridge which was not inspected.

It is anecdotally reported that following 2007 the local farmer removed very substantial quantities of debris from the culvert entrance. We suspect that considerably more material is contained within the culvert barrel. It is not surprising therefore that frequent flooding of the B4361 occurs largely due to the possibly blocked condition of this bridge. Desirable though the works may have been from the point of view of the highway, the entire arrangement is wholly unsatisfactory with regard to proper operation of the watercourse and urgently requires remedial work.

Elimination of this problem should alleviate the flooding onto the B4361 and also reduce significantly the surface runoff passing down Millbrook Way from the B4361. It may not fully resolve the fundamental problem of the massive flooding that arises from the main watercourse, which on the current frequency is occurring every 10 years on average. However, it is conceivable that the blocked bridge on the B4361 is exacerbating the situation as follows:

- Feasibly, steady runoff from the catchment to the west that would otherwise drain through the bridge for a long period is stored on the upstream side of the B4361. This is potentially a very large volume.
- A 'dam-break' situation is reached when the large volume of stored water suddenly then overtops onto the highway, and finds it way rapidly down to Millbrook Way via the B4361.

Hence, clearance of the bridge may actually serve to maintain a more constant and efficient conveyance of runoff within the watercourse, and possibly reduce the stored quantities upstream that emerge in an uncontrolled way.

4.16.2 Hydrology and Hydraulics

Orleton has a particular topography that makes it highly vulnerable to flash flooding. It lies less than 2km east of high hills to the west, which rise to a height of 275m. The upstream soil associations are comprised of Munslow (541i), well drained silt over siltstone, and Yeld (572a), silty soils with slowly permeable subsoils and seasonal waterlogging. This latter association underlies the source areas of the Brimfield Brook at elevations above 165 mAOD. Hence there is a rapid response soil a short distance above Orleton. The full catchment is 6.33 km^2 in area, and the catchment slope is particularly steep at 140 m/km. Surprisingly for a catchment with such a frequent flooding problem, the Standard Percentage runoff is very low at 16%. The Base Flow Index is high at 0.708, suggestive of a dominance of groundwater (i.e. spring based) flows.

Orleton is something of a hydrological anomaly. The hydrological assessment of Volume 2, Appendix R-02 shows that the flood magnitudes are relatively small, due to the low SPR of the catchment. For example, the 2% AEP (Q50) event peak flow is only 2.0 m^3/s. Millbrook Bridge and adjacent channel capacities appear to be well capable of accommodating this flow. This suggests that flooding is arising not so much because of the large potential upstream inflow, but because of downstream blockage and/or a relatively disproportionate increase in the Time to Peak of the catchment due to artificial influences.

We surmise that whilst fluvial flows should typically be no more than a constant steady spring fed regime, possibly improved agricultural drainage west of the B4361 may have increased flood risk over the years. We note also the presence of a large caravan park at the head of Green Lane which must discharge large quantities of surface runoff.

The Time to Peak of the watercourse at Millbrook Bridge is 2.6 hours. Hence floods will rise very rapidly.

We have carried out a detailed inspection of the surface water drainage routes within Orleton. It is remarkable how over a very large area all of the highways and fields drain to a single focused point, namely Millbrook Bridge in the centre of the village. From the Caravan Site off Millbrook Way to the north, the B4361 to the west and south as far as Townsend Farm, and Orleton Manor in the south-east, all highways and impermeable surfaces drain with minimal under-ground drainage provision, in the direction of Millbrook Way, see Figure 4-18. Residents report that most of the lanes in the centre of the village are awash with water at least once every year.

4.16.3 Baseline Flood Damage Assessment

There are at least 31 properties vulnerable to flooding in Orleton upto and including the 1% AEP (Q100) event. With the evident frequency of significant flooding in the village, we have nominally attributed a 3.3% AEP (Q30) event to the 2007 flooding, and assessed flood damages accordingly.

The Annual Average Damage cost at Orleton is £38 K/year, or £729 K over 30 years. This relatively large cost derives from the fact that there are a significant number of properties located within the 1% AEP (Q100) event floodplain. Additionally, there are a core of properties that have significant internal flooding with a frequency of 5% AEP (Q20) or greater.

4.16.4 Feasible Flood Alleviation Measures

Channel clearance works have been undertaken downstream of Millbrook Bridge since 2007, and this may have reduced the risk of flooding to some degree. However, this improvement will pass on the flood-peak more rapidly and with less attenuation to properties downstream, most notably [redacted] Kings Road, and ultimately to Brimfield, where there is already a significant flooding problem.

Further capacity improvement works are probably not desirable, because downstream flood risk will be exacerbated further.

It will be particular difficult to regulate or lessen the surface water runoff routes from the south side of the village (Church Lane and Kitchen Hill Road), as even if highway drainage is provided, the natural fall is towards Millbrook Way in any case, where below ground discharges will simply re-emerge at surface.

It will also be extremely difficult to provide flood defences to properties around Millbrook Bridge, and probably not-cost effective to provide defences to the rear of properties along Millbrook Close and Mortimer Drive.

Fundamentally, the only feasible large scale effective measure for Orleton is to provide attenuation upstream of Orleton to intercept the runoff volumes.

As an interim scheme, it is wholly necessary to restore the open channel upstream of the B4361 bridge at D, and rehabilitate the bridge to its optimum hydraulic condition. Many residents have reported that it is surface water flowing down Millbrook Way off the B4361 that is the more immediate problem, and we have identified the current condition of this bridge as the cause of this.

Scheme 0 – Do Nothing

We consider that Do Nothing is not a feasible option for Orleton. Flooding is both frequent and significant, with several properties having been flooded at least three times since 2000. Furthermore, because of the general lack of highway drainage in the area, and the steepness of the local terrain, the village is particularly vulnerable to flash flooding. The village appears to have a high proportion of elderly residents, and consequently emergency and evacuation costs are likely to be high.

Irrespective of the Do Nothing scenario, it is evident that the village centre has a high propensity to flood, and it is essential that riparian maintenance duties are enforced by Herefordshire Council, particularly in the vicinity of Millbrook Bridge and downstream as far as the weir to the rear of [redacted] Herefordshire Council may have to undertake occasional de-silting of Millbrook Bridge as part of its maintenance schedule. Regular jetting of highway gullies is also essential.

Scheme 1 – Restore B4361 Bridge to Optimum Hydraulic Condition

A priority scheme will be to remove the upstream culverting at the B4361, which will allow proper de-silting and clearance of the approach channel. Over a period of years the downstream channel has been allowed to overgrow and accumulate silt, and this also requires clearance.

We have assumed that 50m of culvert from the upstream face will have to be broken out and the channel restored. A timber access bridge may have to be provided as a replacement access.

On the downstream side we have assumed that the channel will require clearance and de-silting for 50m.

These works should optimise the capacity of the bridge, and prevent the build up if surface water on the upstream side, which we suspect then bursts rapidly onto the B4361 and passes on a significant and sudden enlarged volume downstream towards the village.

A second component of the scheme is to provide new gullies on both north and south sides of the highway from B to A in Millbrook Lane. Although flooding of the B4361 should be dramatically reduced as a result of the channel improvement at E, there is still likely to be some residual highway flooding in Millbrook Lane, emanating from Green Lane directly opposite. Currently there is a 225mm Ø sewer running in the north kerb, but there are no gullies to drain the highway.

Assuming kerb-gullies placed at 50m intervals on both sides, a total of 8 gullies should be provided in the 215m run down to the bridge.

We emphasise that the highway drainage improvements will not reduce flooding at Millbrook Bridge, but they are an integral part of alleviating flooding on the B4361.

Flood Alleviation Assumptions:

Subject to hydrological and hydraulic analysis, we have assumed that clearance of the B4361 bridge will be beneficial to downstream Orleton because early runoff is allowed to pass through the bridge, and thus does not accumulate upstream of B4361, which we suspect is the case at present. These benefits should not be over-stated however, as the runoff quantities that arrive at Millbrook Bridge (whether by the river corridor or via Millbrook Way) are so substantial that drainage improvements alone will be insufficient to markedly reduce flood levels.

We have assumed that flooding on the B4361 will be reduced by one depth category for all events upto and including the 0.5% AEP (Q200) event to the benefit of at least two properties, including the Maidenhead Inn, and that it will reduce flood depths by 0.1m for the four properties in Mill Lane and/or adjacent to Millbrook Bridge for all events upto and including the 2% AEP (Q50) event. Larger events are unchanged in terms of flood depths for these properties, and all other properties in Ashley Walk, Millbrook Close and Mortimer Close have flood depths unchanged from the baseline assessment.

With this scheme AAD reduces to £28.7 K/year (down from £37.1 K), and the 30 year Present Value cost is £545 K (thereby avoiding £161 K of flood damage over 30 years).

Scheme 2 - Attenuation Reservoir to 2% Standard at Townsend Farm

We are firmly of the belief that the most effective scheme for flood alleviation is one based on attenuation. Downstream capacity improvements will pass on more flow to Brimfield, which is not desirable. Raised defences are not practical in the confined areas around Millbrook Bridge.

Conversely, there exist two ideal locations west of the B4361 in the upstream catchment that could serve as attenuation areas. The most convenient is that at G, immediately adjacent to the B4361. In theory, substantial flows to this point would be intercepted and diverted to storage in the field south of the watercourse. Relatively simple inlet and outlet culvert controls would be required.

The required storage volume has been assessed based on the hydrographs shown in Volume 2, Appendix R - Hydrology.

For a 2% AEP (Q50) standard, the peak flow is assessed as 2.0 m^3/s. Since this flow rate should not be creating flooding problems at Millbrook Bridge, and we are unable to ascertain why it is, we have arbitrarily assumed that the peak flow through the village should be reduced to 1.0 m^3/s. Halving of the flood peak should be sufficient to eliminate most of the flood risk problems.

In the Q50, the Brimfield Brook exceeds 1.0 m^3/s for 5.25 hours with an average peak flow of 1.53 m^3/s. Hence an average 0.53 m^3/s needs to be diverted to storage over this period. This equates to 10,017 m^3, which is the active storage requirement. Assuming that a 0.3m bund around the reservoir perimeter can be gained from the spoil, and assuming the active storage depth to be 1.2m, this will require a plan area of say 50m x 166m. This can be feasibly accommodated in the field area at point G.

Flood Alleviation Assumptions:

We have assumed that the attenuation reservoir would be effective in eliminating all property flooding in all events upto and including the 2% AEP (Q50) event. This is taken to be a maximum flood level at -0.3m below threshold. Since the more extreme events (1.3%, 1% and 0.5% AEP) will also be significantly attenuated by the reservoir, we can assume that flood depths for all properties will be reduced by one depth category for these events.

We have assumed that Scheme 2 is independent of Scheme 1, and therefore provides an alternative scheme. In practice however, we suspect that the reservoir storage volumes might be reduced if the downstream restrictive bridge is removed (Scheme 1), because more throughput would be allowed earlier in the hydrograph, which is of course desirable.

After Scheme 2, Annual Average Damage reduces to £15.6 K/year (down from £37 K), and the 30 year Present Value is £297 K, thereby avoiding £409 K of flood damages.

Scheme 3 - Attenuation Reservoir to 1% Standard at Townsend Farm

For comparison with a higher standard scheme, we have also derived the necessary storage volume based on providing a 1% AEP (Q100) standard of protection. Again we have assumed that the Q100 peak flow will be reduced to a maximum of 1.0 m^3/s through the village. This peak is 2.3 m^3/s. In the Q100 event 1.0 m^3/s is exceeded for a period of 6.25 hours. The average flow in this time period is 1.71 m^3/s. Hence the volume to be stored is (1.71 – 1.0) x 6.25 hours = 15,975 m^3.

Assuming that the freeboard is provided by a 0.3m bund gained from spoil, and that the excavation depth is now 1.5m, this gives a plan area of 70m x 152m.

This can be feasibly accommodated in the field area at point G.

Flood Alleviation Assumptions:

We have assumed that the attenuation reservoir would be effective in eliminating all property flooding in all events upto and including the 1% AEP (Q100) event. This is taken to be a maximum flood level at -0.3m below threshold. Since the more extreme events of the 0.5% (Q200) will also be significantly attenuated by the reservoir, we have assumed that flood depths for all properties will be reduced by two depth categories for this event.

After Scheme 3, Annual Average Damage reduces to £8.0 K/year (down from £37 K baseline), and the 30 year Present Value is £152 K, thereby avoiding £555 K of flood damages.

4.16.5 Compliance with High Level Policy Objectives

The Brimfield Brook is part of the wider Teme catchment, and thus falls under the requirements of the River Severn Catchment Flood Management Plan, Teme sub-catchment, for which the Environment Agency Policy is Policy 3 - 'Manage flood risk at current level'. The overall objectives are:

Policy Option 3 – "*Areas of low to moderate flood risk where we are generally managing existing flood risk effectively. We have selected this policy because the risks are currently managed appropriately and the risk of flooding is not expected to increase significantly in the long term. We may need to review whether what we are doing currently is the best way of managing the risk in the longer term, but we are confident that the risks do need managing. This policy may lead to reviewing the flood warning services and/or how we manage assets that may be in place*".

Hence, active intervention is required to maintain flood risk levels at the current level.

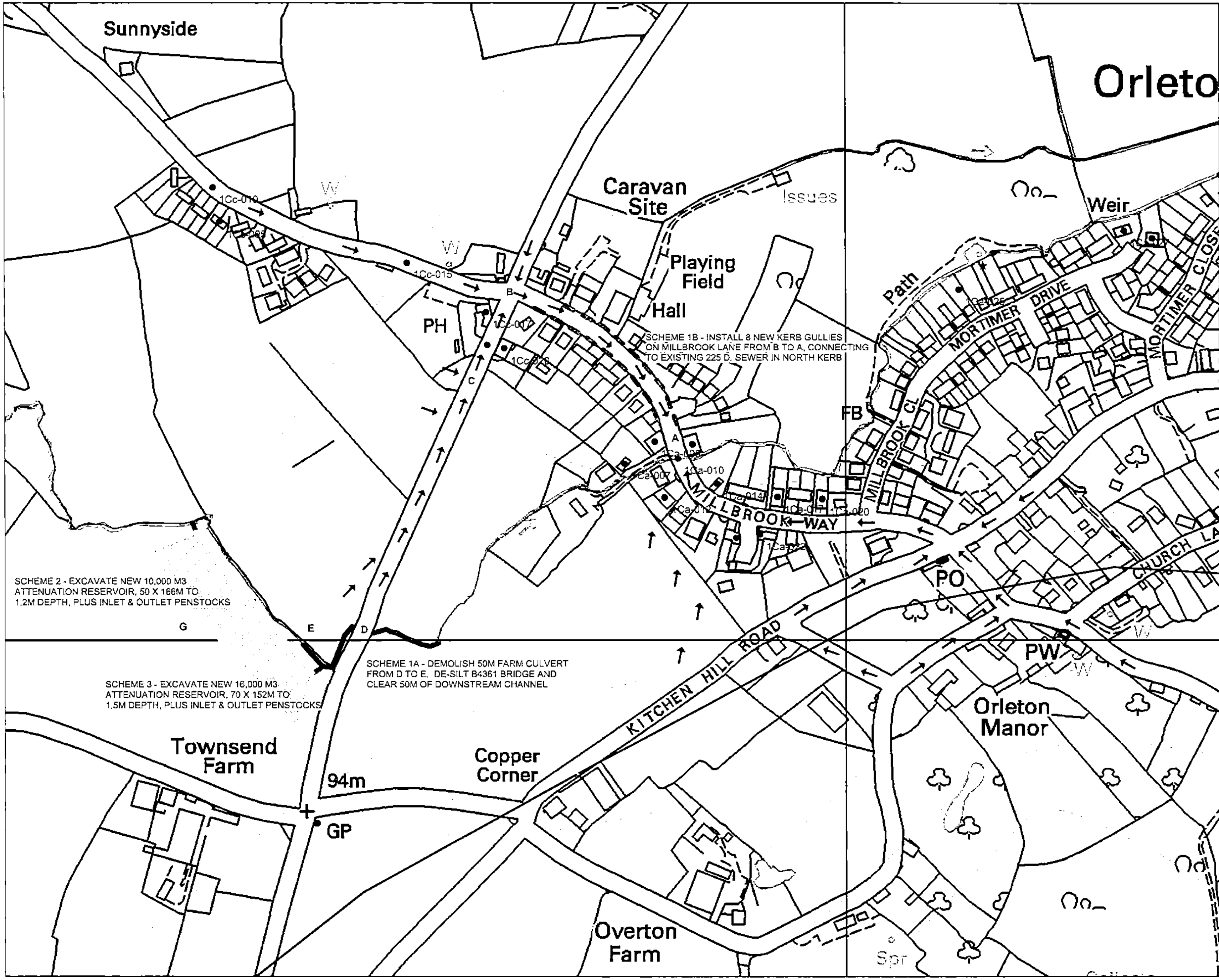
The Herefordshire SFRA policies for the Teme sub-catchments including Brimfield Brook are wide ranging because of the range of sub-catchments within it. For the Brimfield Brook (catchment 1C) the preferred strategies are FR1, FR2, FR5, FR6 or FR7.

The recommended attenuation scheme for Orleton is covered under Strategy FR3, which is not listed as a preferred strategy. However, it is entirely clear that for Orleton, being a headwater catchment, and upstream of further complex flooding problems at Brimfield, local attenuation is by far the most appropriate scheme.

Strategy FR3 – Local Attenuation Upstream

Provide or contribute to a centralised strategic attenuation facility on receiving or adjacent watercourse. Site discharges at residual maximum safe runoff rate, storing balance on-site as necessary.

Figure 4-17 – Scheme Proposals at Orleton



KEY

- Improved or cleared channel
- New channel or excavation line
- New culvert or structure
- New earth embankment
- New storage area
- Main routes of overland flow
- A Point of interest in text
- Property at risk of flooding

Drawn :	For Comment	✓
Design :	For tender	
Chkd :	For Construction	
Appd :	As Constructed	
Date :	Other	

File ref Amey: g:\000 Project Files\001\Structures\551460
File ref: water consultant: G:\water\1000\1120\

amey

Client
[redacted]
DIRECTOR OF REGENERATION
Planning & Transportation

Herefordshire Council

Project Name
HEREFORDSHIRE FLOOD ALLEVIATION STRATEGY

Drawing Title
Figure 4-17 Scheme Proposals at Orleton

Original Drawing Size : A3

Scale : NTS | Dimensions : -

Drawing No
551460-I-01-002

Rev

Table 4-16 - Summary of Potential Flood Alleviation Schemes – Orleton

Scheme Option	Design Details	Flood Alleviation Assumptions	AAD (£K)	PVd (£K) Damage	Scheme PV Cost	NPV	B/C Ratio
0	None	None	37	707	-	-707	-
1a	Demolish 50m of farm culvert from E to D, restore to open channel. De-silt bridge and de-silt and clear 50m of downstream channel.	Flood depths reduced by 1 category for all events at Maidenhead junction. Flood depths reduced for 6 properties at Millbrook Bridge by 0.1m for all events upto 2% AEP (Q50) event.	29	546	22	139	7.45
1b	Install 8 new kerb-gullies north-south sides of Millbrook Lane from B to A, connecting into existing 225 Ø highway drain.	Integral part of above scheme to eliminate flooding in Millbrook Lane.					
2	Excavate new 10,000 m^3 attenuation reservoir west of B4361 at G, plan area of 50 x 166m, to 1.2m depth. Retain some spoil to form 0.3m high bund as freeboard. Inlet and outlet controls formed by headwalls + 1.0m^2 penstocks.	Flooding to all properties reduced to -0.3m for all events upto and including 2% AEP (Q50) event. Flooding in 1.3%, 1%, 0.5% events reduced by one depth category	16	312	392	17	1.04
3	Excavate new 16,000 m^3 attenuation reservoir west of B4361 at G, plan area of 70 x 152m, to 1.5m depth. Retain some spoil to form 0.3m high bund as freeboard. Inlet and outlet controls formed by headwalls + 1.0m^2 penstocks.	Flooding to all properties reduced to -0.3m for all events upto and including 1% AEP (Q100) event. Flooding in 0.5% event reduced by two depth categories.	8	158	535	20	1.04

** PVd assumes 30 year scheme life