Appendix 8

National Landscape Character Assessment Area 97 Arden (ref EB 05/03)

National Character Area profile:

97. Arden

Supporting documents

Introduction & Summary | Description | Opportunities | Key facts and data | Landscape change | Analysis

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Introduction

As part of Natural England's responsibilities as set out in the Natural Environment White Paper[1], Biodiversity 2020[2] and the European Landscape Convention[3], we are revising profiles for England's 159 National Character Areas (NCAs). These are areas that share similar landscape characteristics, and which follow natural lines in the landscape rather than administrative boundaries, making them a good decision-making framework for the natural environment.

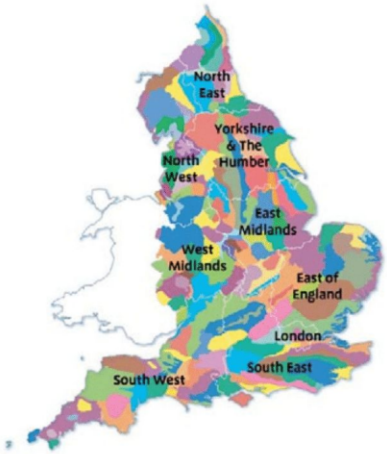
NCA profiles are guidance documents which can help communities to inform their decision-making about the places that they live in and care for. The information they contain will support the planning of conservation initiatives at a landscape scale, inform the delivery of Nature Improvement Areas and encourage broader partnership working through Local Nature Partnerships. The profiles will also help to inform choices about how land is managed and can change.

Each profile includes a description of the natural and cultural features that shape our landscapes, how the landscape has changed over time, the current key drivers for ongoing change, and a broad analysis of each area's characteristics and ecosystem services. Statements of Environmental Opportunity (SEOs) are suggested, which draw on this integrated information. The SEOs offer guidance on the critical issues, which could help to achieve sustainable growth and a more secure environmental future.

NCA profiles are working documents which draw on current evidence and knowledge. We will aim to refresh and update them periodically as new information becomes available to us.

We would like to hear how useful the NCA profiles are to you. You can contact the NCA team by emailing ncaprofiles@naturalengland.org.uk

National Character Areas map



[1] The Natural Choice: Securing the Value of Nature, Defra (2011; URL: www.official-documents.gov.uk/document/cm80/8082/8082.pdf)
[2] Biodiversity 2020: A Strategy for England's Wildlife and Ecosystem Services, Defra (2011; URL: www.defra.gov.uk/publications/files/pb13583-biodiversity-strategy-2020-111111.pdf)
[3] European Landscape Convention, Council of Europe (2000; URL: http://conventions.coe.int/Treaty/en/Treaties/Html/176.htm)

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Summary

Arden comprises farmland and former wood-pasture lying to the south and east of Birmingham, including part of the West Midlands conurbation. Traditionally regarded as the land lying between the River Tame and the River Avon in Warwickshire, the Arden landscape also extends into north Worcestershire to abut the Severn and Avon Vales. To the north and north-east it drops down to the open landscape of the Mease/Sence Lowlands. The eastern part of the NCA abuts and surrounds Coventry, with the fringes of Warwick and Stratford-upon-Avon to the south. This NCA has higher ground to the west, the Clent and Lickey Hills and to the east, the Nuneaton ridge. The landscape of the lower lying central area is gently rolling with small fragmented semi-natural and ancient woodlands. Mature oaks set in hedgerows, distinctive field boundaries, historic parklands and narrow river corridors are key features, all on the doorstep of a heavily urbanised area.

Land use throughout the area is mainly, residential, agricultural and industrial including coal mining, which is still active in the north-east of the NCA. Numerous transport corridors; road, rail, air and canal run through the area. There is likely to be increased development and greater pressure upon the existing infrastructure, particularly around Birmingham, Coventry and the main towns. This pressure could lead to the creation of new green infrastructure linking the urban areas out into the more rural areas. This NCA is among the most geologically diverse. This has had a strong impact on the landscape's character and development and is further reflected in the range of locally and nationally important geological assets across the NCA. There are also many local biodiversity assets and strong cultural links with William Shakespeare and his 'Forest of Arden'.

Statements of Environmental Opportunity

- **SEO 1:** Manage and enhance the valuable woodlands, hedgerows, heaths, distinctive field boundaries and enclosure patterns throughout the NCA, retaining the historic contrast between different areas while balancing the needs for timber, biomass production, climate regulation, biodiversity and recreation.
- **SEO 2:** Create new networks of woodlands, heaths and green infrastructure, linking urban areas like Birmingham and Coventry with the wider countryside to increase biodiversity, recreation and the potential for biomass and the regulation of climate.

Click map to enlarge; click again to reduce.

- **SEO 3:** Conserve and enhance Arden's strong geological, industrial, and cultural resource, to increase public access, enjoyment, recreation and to retain a sense of place and history.
- **SEO 4:** Enhance the value of Arden's aquatic features such as the characteristic river valleys, meadows and standing water areas like Bittell Reservoirs, to increase resource protection such as regulating soil erosion, soil quality and water quality.

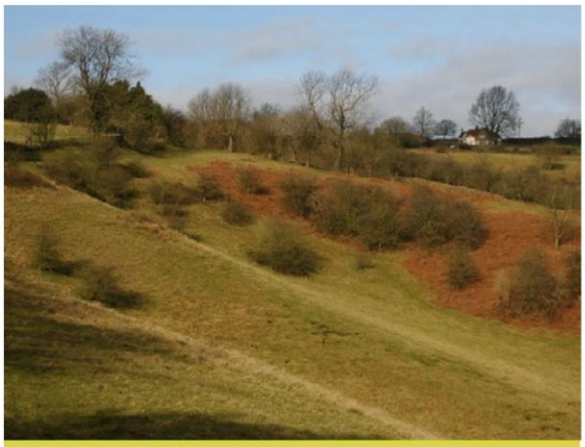
Description

Physical and functional links to other National Character Areas

To the north-west of Arden is the Mid Severn Sandstone Plateau NCA on the edges of Hagley Park. The Birmingham conurbation then links Arden with Cannock Chase and Cank Wood NCA. These National Character Areas, along with Arden, form the Natural Area referred to as 'The Midlands Plateau'.

In the north-east, the M42 transport corridor links the Mease/Sence Lowlands NCA and a sliver of the Trent Valley Washlands with Arden along the edge of Tamworth. On the eastern edge, the Warwickshire landscape flows into the Leicestershire Vales. In the central section of Arden the River Arrow starts its journey south and then merges into the River Avon near Bidford on Avon in the Severn and Avon Vales. Moving south, the River Avon flows into Dunsmore and Feldon then on into Severn and Avon Vales in the south-west.

From the highest point in Arden (Walton Hill, in the Clent Hill range), there are views from the summit looking south-west into the Shropshire Hills, Malvern Hills, Teme Valley and south into the Cotswolds. There are also views across the NCA taking in the southern fringes of Birmingham from the Heart of England Way near Meriden.

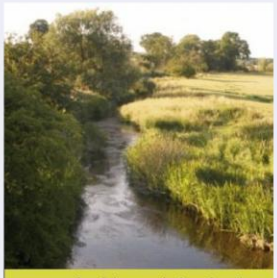


The eastern slopes of Walton Hill, the highest point in the NCA.

Key characteristics

- Well-wooded farmland landscape with rolling landform.
- Geologically diverse with rocks ranging from the Precambrian to the Jurassic and overlain by superficial Quaternary deposits.
- Mature oaks, mostly found within hedgerows, together with ancient woodlands, and plantation woodlands that often date from the time of enclosure. Woodlands include historic coppice bounded by woodbanks.
- Narrow, meandering clay river valleys with long river meadows; the River Blythe SSSI lying between the cities of Coventry and Birmingham is a good example of this.
- Numerous areas of former wood-pasture with large, old, oak trees often associated with isolated remnants of more extensive heathlands. Village greens/commons have a strong association with remnant lowland heath. Fragmented heathland persists on poorer soils in central and northern areas.
- Diverse field patterns, ranging from well hedged, irregular fields and small woodlands that contrast with larger semi regular fields on former deer park estates, such as, Packington Hall and Stoneleigh Park.
- Complex and contrasting settlement pattern with some densely populated where traditional settlements have amalgamated to form the major West Midlands conurbation while some settlements remain distinct and relatively well dispersed.
- North-eastern industrial area based around former Warwickshire coalfield, with distinctive colliery settlements. North-western area dominated by urban development and associated urban edge landscapes such as managed greenspace, for example allotments, gardens, parks, golf courses (rough areas) and public open spaces; playing fields, churchyards, cemeteries and institutional grounds (schools, hospitals).
- Transport infrastructure, the M42, M40, M6 and M5 are major transport corridors that sit within the landscape of this NCA.
- Shakespeare's 'Forest of Arden', featured in 'As You Like It', is still reflected through the woodland cover, mature oaks, small ancient woodlands and former wood pasture.

Demonstrating the undulating landscape between Coventry and Birmingham - looking west along A45, near to Meriden.



An example of the meadering clay river valleys with long river meadows typical of the Arden landscape.

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Arden today

Arden is a true mix of urban and rural with the heavily urbanised centres of Birmingham, Coventry, Redditch, Nuneaton and Tamworth set within and around a landscape of farmland, parkland and former wood pasture. Traditionally known as the land lying between the River Tame, Birmingham and the River Avon in Warwickshire, it also extends into north Worcestershire where some of the highest ground can be found. Mining and post industrial urbanisation is prominent in the landscape to the north-east between Nuneaton and Tamworth.

This is Shakespeare's 'Forest of Arden', historically a region of woodlands and heaths, which today remains one of the more wooded parts of the region. There are many mature hedgerow oaks, numerous patches of ancient woodland and parks containing remnants of wood-pasture. The association with former common and heathland also imparts a strong unity, reflected by the widespread occurrence of heathland vegetation and roadside bracken. The larger commons have been enclosed within a rectilinear pattern of larger fields, straight roads and hedges, but there are still smaller commons as well as extensive areas of farmland, characterised by small, irregular fields, dense, thick hedges, winding lanes and trackways. Brick and timber are common building materials throughout the area. Common oaks are still the dominant tree species and can be found both within towns and villages and as part of the hedgerow systems. The woods themselves range from 20th century plantations to species-rich ancient woodlands. Some of the woodlands contain important populations of lichens and fungi. Oak and ash wood with bracken, bramble and dog's mercury are also particularly distinctive.

Many of the modern towns and cities in Arden still retain a historic core.

Light, sandy soils predominate in the north of the NCA. Heavier clay soils and loams occur extensively in central and southern Arden. The poorer sandy soils are acidic and, when cleared of woodland, often became leached, giving rise to heathland vegetation. The area is drained to the south by the rivers Arrow, Alne and Avon, and to the north by the rivers Tame/Blythe and Anker. The River Tame joins with the River Rea to create a wide, shallow valley to the east of Birmingham. Threading through the landscape, the river valleys are more fertile and enclosed. They are typically rather narrow and meandering water bodies, with long river meadows on the floodplain, riverside trees such as alder are frequently pollarded, and blocks of scrub as well as the remains of mills, pools and leats remain as features within the landscape. Arable farmland extends into the more fertile southern river valleys. Purple moor grass, meadowsweet and soft rush are some of the plant species that dominate the marshy grassland. Heron and yellow wagtail are among the bird species that can often be seen here. Relatively abundant surface water in the NCA has been managed through the creation of dammed fishponds and millponds and their leats.

Many of Arden's parklands are studded with ancient oaks .

The heartland of the area is made up of a landscape of hedged, irregular fields and small woodlands. Narrow, often sunken lanes link scattered farms and there is a real sense of being closed in with restricted views. This contrasts with the more open views, gentle rolling pasture and regular, rectilinear fields around the southern edge of Birmingham. Deer parks were once common in the area and there is still an ancient wooded appearance to these sites. Veteran trees provide valuable habitats for invertebrates, noble chafer (green beetle) lichens and bats. Areas with a distinct parkland character can be found between Wroxall and Stoneleigh.

The landscape through time

Arden is on the south-easterly portion of the Midlands plateau and is geologically diverse possessing rocks from the Precambrian to the Jurassic periods. Physically and geologically, Arden has three constituent parts. The largest area, the Knowle basin, is relatively low lying and separates the higher ground of the Warwickshire coalfield in the east and the eastern edge of the South Staffordshire (Black Country) coalfield to the west.

The predominant bedrock of the Knowle basin is the Triassic Mercia Mudstone Group, which has been extensively used as a source of brickclay. This is overlain by extensive superficial deposits of till and glacio-fluvial sands and gravels from the last ice age. It is an area of gently rolling country with the only features arising from thin intermittent sandstone layers, within the mudstones, known as 'skerries'. In the upper part of the sequence, the Arden Sandstone gives rise to the higher ground between Warwick, Redditch and Solihull and around Inkberrow and Alcester.

Lower members of the Triassic, the Sherwood Sandstone Group, comprise predominantly hard sandstones and conglomerates and give rise to prominent ridges and hills on the north-western side of Birmingham and between Hagley and Bromsgrove. The Bromsgrove Formation has been used for building stone locally and is found in very characteristic churches, walls and older houses.

The western side of Arden is elevated by faulting and is an extension of the South Staffordshire coalfield which dominates the adjoining Cannock Chase and Cank Wood NCA. Complex folding and faulting has produced the striking series of hills including the Lickey Hills and Clent Hills, dominated by late Carboniferous and Permian rocks with small, but important, elements of Silurian, Ordovician and Precambrian.

The Warwickshire coalfield in the east creates a distinct high ground and pronounced edge to the Knowle basin and is characterised by harder red sandstones (locally used for building) of Carboniferous - Permian age overlying the productive coal seams of the Warwickshire coalfield. Folding and faulting has given rise to a complex sequence of older Cambrian sediments with Ordovician and Precambrian igneous rocks which form the Nuneaton ridge.

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Ice age deposits are found over most of the area but are mostly concentrated in the Knowle basin where they have been extensively worked for sands and gravel. Alluvium and river terrace deposits as well as the harder Silurian, Ordovician, Cambrian and Precambrian rocks found in the west and east (around Nuneaton) have also provided important sources of aggregates.

Arden holds a number of prehistoric sites. Many of these are buried remains but there are some visible prehistoric features including several burnt mounds, Hob Ditch earthwork and hillforts such as Barnmoor (Claverdon).

Roman roads whose lines are followed by modern roads are also a prominent feature. Roman field systems are evident in places like Kings Norton where hedges still follow the old roman boundaries. Livestock rearing was important in the Roman period along with the woodland resource being used for the tile and pottery industries.

The 10th century saw the development of market towns such as Warwick with its medieval castle, sitting on the River Avon. Kenilworth Castle, one of the great ruinous castles of England, was established around 1125.

Extensive woodland cover probably remained over the area into the Anglo-Saxon period perhaps as late as the 11th century. Many manorial deer parks were established in the 12th and 14th centuries and this continued into the 15th century, the remains of which can be seen as ancient wood pasture landscape today.

Enclosure began in the south of the area in the 18th century. In the Blythe Valley, which traditionally had open fields, enclosure was not completed until the 19th century. Extensive tracts of planned enclosure can be found in areas that were until this time common or heath. It can also be found on the plateau summits where the heavy clay soils made cultivation difficult.

Kenilworth Castle, built using local stone.

Arden has an extensive canal network that makes a link between the urban and rural areas of this NCA.

Birmingham and Coventry started out as medieval towns that, due to the presence of the raw materials in the natural resources such as the coal of the Warwickshire coalfields as well as the associated Carboniferous ironstones, developed to be at the centre of the Industrial Revolution. Birmingham had a broad economic base with a variety of highly skilled trades such as glass making, jewellery, gun smiths, pin making and car industries. Coventry also became famed for its car industries and its earlier ribbon making, watch, clock, bicycle and sewing machine manufacturing.

The 19th century also saw growth in the coal mining industries. The north-eastern side of the area saw the landscape impact of this industry with the development of mining villages, which continued into the 20th century. There was also great change in the landscape with the urban development of Birmingham and extensively the canal network. Birmingham developed in a fairly compact way from its original medieval centre and small-scale medieval industries. A ring of encircling suburbs began to emerge after the arrival of the railways and this pattern of concentric development continued through the 20th century. The result is a rich variety of suburban types from the model village of Bournville to tower blocks.

Today there are a number of changes in the character of the area with many historic Arden farmsteads converted into wealthy residences and the land being used for grazing, hobby farming and equestrian use. The pressure of development also continues with new transport schemes continuing to impact upon the landscape, along with the expansion of smaller villages, towns, Birmingham and Coventry.

Ecosystem services

The following section seeks to identify the services offered by the landscape. A more expansive list of ecosystem services associated with this NCA is included in the Analysis section.

The Arden NCA provides a wide range of benefits to society. Each are derived from the attributes and processes (both natural and cultural features) within the area. These benefits are known collectively as 'ecosystem services'. The predominant services are summarised below (under the constituent headings) Further information on ecosystem services provided in the Arden NCA is contained in the 'Analysis' section of this document.

Provisioning services (food, fibre and water supply)

- **Food provision:** Light, sandy soils predominate in the north with heavier clay soils and loams occurring extensively in central and southern Arden. The majority of the soil is grade 3. In 2009, over 30 per cent of Arden's holdings were lowland grazing livestock. Farms classified as 'other' (which will include smallholdings) 27 per cent; cereal farms 20 per cent; mixed farms 6.9 per cent.The area produces dairy and arable food crops alongside vegetables, pork, poultry and eggs but not on a large scale.
- **Timber provision:** The NCA contains 11,876 ha of woodland (8 per cent of the total area). 3,770 ha (3 per cent of the NCA) is broadleaved woodland.
- **Water availability:** Water provision comes from three sources in this NCA, reservoirs, major aquifers and rivers. One of the two main aquifers is currently over abstracted and the other is over licensed and has no further water available for abstraction. The River Arrow and River Avon have no water available for further abstraction and the River Sowe and the River Blythe are over licensed. However, the River Cole has water available.

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Regulating services (water purification, air quality maintenance and climate regulation)

- **Climate regulation:** The majority of the NCA has a low soil carbon content of 0 to 5 per cent; however, around Birmingham, carbon content increases to 5 to 10 per cent. Carbon content is likely to be higher under the more than 11,800 ha of woodland within the NCA, as well as under the more than 1,000 ha of grazing marsh, grassland, fen, reedbeds, and heathland.
- **Regulating water quality:** In the south of the NCA, surface water is generally of 'moderate' ecological status although there are some reaches of 'poor' quality around Birmingham and Coventry. Also in the south of the NCA there are some river lengths with 'good' chemical status. The chemical status of the groundwater sources is 'good' in the south but 'poor' again around Birmingham and Coventry.

There is an opportunity at the old mine and quarry sites to develop them for nature conservation and recreational use.

- **Regulating water flow:** Tamworth is at risk of flooding from the rivers Tame, Anker and Bourne Brook. In Birmingham, flood risk from the rivers Tame and Rea is high. In Coventry there is a relatively high risk of flooding from the rivers Sowe and Sherbourne.
- **Regulating soil quality:** The slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils (36 per cent) of the NCA may suffer compaction and or capping as they are easily damaged when wet. Also the slightly acid loamy and clayey soils with impeded drainage (26 per cent) of the NCA are easily poached by livestock and compacted by machinery when wet.
- **Regulating soil erosion:** Nearly 60 per cent of the NCA is considered to be at low risk of soil erosion. About 14 per cent of the NCA has high risk of soil erosion; this is associated with the moderately or steeply sloping land where cultivated or bare soil is exposed and where organic matter levels are low following continuous arable cultivation or where soils have become compacted.

Cultural services (inspiration, education and wellbeing)

- **Recreation:** Most of the recreational opportunity in Arden is formalised with numerous urban parks and golf courses. There is less than 1 per cent of open access land and a network of rights of way density of 1.35 per km. There is public access to numerous small woodlands and the canals, rivers and reservoirs offer opportunities for walking, cycling and water sports. The network of lanes is frequently used by horseriders and cyclists.
- **Sense of place/inspiration:** Associations with Shakespeare's 'Forest of Arden', featured in 'As You Like It' are still notable through the woodland cover, hedgerow oaks, small ancient woodlands and former wood pasture. The Elizabethan connection has been emphasised by Sir Walter Scott's novel

Kenilworth. In a more recent period, at the western edge of the area, Hagley and Leasowes at Halesowen are historic parks which have formed a focus for writers and designers, such as William Shenstone at Leasowes and James Thompson at Hagley. North Arden features strongly in George Eliot's novels. Tolkien's home at Hall Green is reflected in the fantasy landscape of his books.

- **Tranquillity:** Despite the major road and motorway network, a sense of tranquillity can still be found in the woodlands, sunken lanes, narrow river valleys and enclosed urban landscapes.
- **Sense of history:** Manorial deer parks, remnants of wood pasture, ancient oak woodland, historic field patterns, historic farm buildings, medieval moated sites, parkland landscapes, distinctive mining villages and former colliery sites all reflect the history of the landscape. Warwick Castle and Kenilworth Castle are also dominate features, built using locally found building materials, in the south of the NCA.
- **Biodiversity:** The internationally designated site in the NCA, Ensor's Pool SAC (4 ha) in Nuneaton, is designated for supporting a very large population of white-clawed crayfish. There are 56 SSSI, totalling less than 1 per cent of the NCA area. The majority of these (87 per cent) are in favourable or recovering condition; 12 per cent are in unfavourable condition. There are 1,126 Local Wildlife Sites in Arden, covering 10,863 ha, which is 7.6 per cent of the NCA.
- **Geodiversity:** There are 15 nationally designated geological sites within the NCA and 68 local sites, which are of great value for education and research. Many of the nationally designated sites are quarry or gravel pits. The geological diversity of this NCA gives a strong sense of place (higher ground to the west (Lickey and Clent) and east (Nuneaton)) and the rolling landscape of the central basin which is dominated by Triassic rocks.

Over hedge and cornfield with Daw Mill Colliery in the background.

Statements of Environmental Opportunity

SEO 1: Manage and enhance the valuable woodlands, hedgerows, heathlands, distinctive field boundaries and enclosure patterns throughout the NCA, retaining the historic contrast between different areas while balancing the needs for timber, biomass production, climate regulation, biodiversity and recreation.

For example, by:

- Managing small woodlands, semi-natural woodland and ancient woodland to maintain pockets of tranquillity and enhance biodiversity value and where appropriate re-plant new locally characteristic woodlands for wood fuel/biomass.
- Managing and maintaining the existing resource of 'big historic trees' in urban areas and support schemes to expand urban tree planting to support urban biodiversity and increase sense of place and history.
- Managing hedgerows in traditional local style to enhance landscape character and improve biodiversity value.
- Improving existing fragmented heathlands in southern Arden and Arden Parklands.

SEO 2: Create new networks of woodlands, heathlands and green infrastructure, linking urban areas like Birmingham and Coventry with the wider countryside to increase biodiversity, recreation and the potential for biomass and the regulation of climate.

For example, by:

- Expansion of urban tree planting to support urban biodiversity, landscape character and sense of place and history.
- Targeting expansion of woodland for the benefit of biodiversity and landscape, particularly where it can link isolated woodland blocks and increase habitat connectivity.
- Ensuring that the right type of tree is planted in the right location to maximise the benefits for water quality, climate regulation, soil erosion control, tranquillity and sense of place.
- Planting new hedgerows, especially in the north-eastern part of the NCA, using species of local provenance, planting standard hedgerow trees primarily oak, to maintain the distinctive character of the area. Maintain associated grassland buffer strips and improve habitat connectivity, particularly where this can assist in regulating soil erosion.
- Planning and creating new and improved links between urban areas, green belt and the wider countryside or major open spaces within and/or near the conurbation especially in and around Birmingham, Coventry and north Solihull.
- Enhance urban areas and fringes through sympathetic building and landscape design.
- Creating new green infrastructure with associated habitat creation and new public access especially around old mining and quarry sites in the central and north-east areas of the NCA.
- Maintaining and improving the existing rights of way network such as the Heart of England Way, cycle routes and access land.
- Improving links to or within the wider network of canal towpaths such as the Grand Union and Avon Canal walks and cycle routes.

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SEO 3: Conserve and enhance Arden's strong geological, industrial, and cultural resource, to increase public access, enjoyment, recreation and to retain a sense of place and history.

For example, by:

- Conserving, enhancing and making accessible the network of geological sites, ensuring the importance of the man-made sites such as disused quarries, road, rail and canal cuttings.
- Widening the understanding of the role of geodiversity in the NCA, in particular, its connection with biodiversity, landscape character, industrial and cultural heritage.
- Conserving and enhancing archaeological features such as moated sites and archaeology associated with the manufacturing and mining industries particularly in relation to the Warwickshire coalfield and the canal network; promote access and awareness.
- Protecting and managing historic wood pasture, parklands and urban parks to conserve significant historic landscapes and important features and habitats such as veteran and urban trees and the associated invertebrate populations.
- Conserving historic farmsteads, the buildings and their surrounding landscapes particularly where new uses are being considered.
- Capitalising on the links made in literature to the Arden landscape, such as links with Shakespear, using this as a tool to promote the conservation and enhancement of the landscape described.

SEO 4: Enhance the value of Arden's aquatic features such as the characteristic river valleys, meadows and standing water areas like Bittell Reservoirs to increase resource protection, such as regulating soil erosion, soil quality and water quality.

For example, by:

- Managing and restoring habitats including floodplain grazing marsh associated with river valleys, particularly the Tame, Blyth and Arrow.
- Reducing sources of diffuse pollution into rivers, particularly in catchments of the Trent, Tame and Blythe and standing open water habitats such as Bittell Reservoirs.
- Continuing to develop the growing nature conservation and recreational resource of old mine and quarry sites such as Hartshill and Alvecote wetlands.

Supporting document 1: Key facts and data

Total area: 143,425 ha

1. Landscape and nature conservation designations

There are no National Parks or Areas of Outstanding Natural Beauty in this NCA.

Source: Natural England (2011)

1.1 Designated nature conservation sites

The NCA includes the following statutory nature conservation designations:

Tier	Designation	Name	Area (ha)	Percentage of NCA
International	n/a	n/a	0	0
European	Special Protection Area (SPA)	n/a	0	0
	Special Area of Conservation (SAC)	Ensors Pool	4	<1
National	National Nature Reserve (NNR)	Chaddesley Woods	60	<1
National	Site of Special Scientific Interest (SSSI)	A total of 56 sites wholly or partly within the NCA	1,115	1

Source: Natural England (2011)

Please note: (i) Designated areas may overlap (ii) all figures are cut to Mean High Water Line, designations that span coastal areas/views below this line will not be included.

All of the Ensors Pool SAC is within a SSSI.

There are 1,126 Local sites in Arden NCA covering 10,863 ha which is 8 per cent of the NCA.

Source: Natural England (2011)

- Details of individual Sites of Special Scientific Interest can be searched at: http://www.sssi.naturalengland.org.uk/Special/sssi/search.cfm
- Details of Local Nature Reserves (LNR) can be searched: http://www.lnr.naturalengland.org.uk/Special/lnr/lnr_search.asp
- Maps showing locations of Statutory sites can be found at: http://magic.defra.gov.uk – select 'Designations/Land-Based Designations/ Statutory'

1.2 Condition of designated sites

A breakdown of SSSI condition as of March 2011 is as follows:

SSSI condition category	Area (ha)	Percentage of SSSI in category condition
Unfavourable declining	3	<1
Favourable	835	76
Unfavourable no change	123	11
Unfavourable recovering	141	13

Source: Natural England (March 2011)

Details of SSSI condition can be searched at:
http://www.sssi.naturalengland.org.uk/Special/sssi/reportIndex.cfm

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2. Landform, geology and soils

2.1 Elevation

Land within the NCA ranges from 31 m above sea level to a maximum of 315 m. The mean average elevation is 114m.

Source: Natural England (2010)

2.2 Landform and process

Arden is a well wooded landscape with a rolling landform. The northern and central parts of the area lie across the eastern part of the Birmingham plateau, which comprises two uplifted blocks of older Palaeozoic strata, the south Staffordshire and the Warwickshire coalfields. The central area (Knowle Basin) is lower lying than the adjacent Palaeozoic area and is largely underlain by Mercia Mudstones and covered by glacial sands, gravels or till. The southern part of the area is underlain by Mercia Mudstones, with outcrops of Arden Sandstone forming prominent escarpments.

Source: Arden Countryside Character Area Description

2.3 Bedrock geology

Lower members of the Triassic rocks, the Sherwood Group, which are predominantly sandstones and conglomerates, outcrop on the north-western side of Birmingham and between Hagley and Bromsgrove in the south-western part of the area where they give rise to more marked ridges and hills. The elevated landform of the Warwickshire coalfield is controlled by the harder mostly red sandstones of Carboniferous age (Upper Coal Measures) and Permian age. To the west the coalfield rocks form a pronounced edge to the Knowle basin. The Nuneaton ridge rocks form a steep scarp to the neighbouring NCA. They are scientifically important and the Cambrian shales in particular have a distinctive trilobite fauna.

Source: Geological Narrative West Midlands Geodiversity Partnership

Looking towards Walton Hill, near Clent, the highest point in the NCA.

2.4 Superficial deposits

Ice-age deposits are found over most of the area but are particularly concentrated in the Knowle basin where they have been extensively worked for sands and gravel. Alluvium and river terrace deposits have also been important sources of aggregates. Scientifically these drift deposits have played a major contribution into our current understanding of ice-age chronology and environments.

Source: Geological Narrative West Midlands Geodiversity Partnership

2.5 Designated geological sites

Tier	Designation	Number
National	Geological Site of Special Scientific Interest (SSSI)	16
National	Mixed Interest SSSI	0
Local	Local Geological Sites	68

Source: Natural England (2011)

Details of individual Sites of Special Scientific Interest can be searched at:
http://www.sssi.naturalengland.org.uk/Special/sssi/search.cfm

2.6 Soils and Agricultural Land Classification

Light, sandy soils predominate in the north. Heavier clay soils and loams occur extensively in central and southern Arden. The poorer sandy soils are acidic, and when cleared of woodland, often become leached, giving rise to heathland vegetation. On the heavier soils, woodland clearances were usually succeeded by the development of pasture grasslands and wood pasture.

Source: Arden Countryside Character Area Description

The main grades of agricultural land in the NCA are broken down as follows (as a proportion of total land area):

Agricultural Land Classification	Area (ha)	Percentage of NCA
Grade 1	427	<1
Grade 2	9,492	7
Grade 3	80,827	56
Grade 4	10,982	8
Grade 5	n/a	n/a
Non-agricultural	1,884	1
Urban	39,813	28

Source: Natural England (2010)

Maps showing locations of sites can be found at: http://magic.defra.gov.uk – select 'Landscape' (shows ALC and 27 types of soils).

3. Key waterbodies and catchments

3.1 Major rivers/canals

The following major rivers/canals (by length) have been identified in this NCA.

River Name	Length in NCA (km)
River Blythe	32
River Cole	31
River Avon	20
River Alne	19
River Arrow	17
River Sowe	14
River Tame	13

Source: Natural England (2010)

Please note: other significant rivers (by volume) may also occur. These are not listed where the length within the NCA is short.

This area is drained to the south by the rivers Arrow and Alne. Lying within the River Severn catchment area these rivers flow into the River Avon. Draining to the north, the rivers Tame, Blythe and Anker sit within the River Humber catchment. The River Tame joins with the River Rea to create a wide, shallow valley to the east of Birmingham. The extensive canal network (including Grand Union, Coventry Canal and Worcester and Birmingham Canal) is a notable feature of the NCA, and contributes significantly to the drainage of the urban area.

3.2 Water quality

The total area of Nitrate Vulnerable Zone is 100 per cent of NCA.

Source: Natural England (2010)

3.3 Water Framework Directive

Maps are available from the Environment Agency showing current and projected future status of water bodies http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

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4. Trees and woodlands

4.1 Total Woodland cover

The NCA contains 11,876 ha of woodland (8 per cent of the total area), of which 3 per cent is ancient woodland.

Source: Natural England (2010)

4.2 Distribution and size of woodland and trees in the landscape

This ancient woodland resource can often be found in significant pockets across the whole NCA, such as at the scarp south of Atherstone, west of Redditch, Lickey Hills. Mature hedgerow oaks scatter the area along with small ancient and plantation woodland sites. Manorial deer parks such as Stoneleigh Abbey and Packington Hall and Maxstoke park contain significant areas of wood pasture.

Source:Arden Countryside Character Area Description

4.3 Woodland types

A statistical breakdown of the area and type of woodland found across the NCA is detailed in the following table.

Area and proportion of different woodland types in the NCA (over 2 ha):

Woodland type	Area (ha)	Percentage of NCA
Broadleaved	9,804	7
Coniferous	1,399	1
Mixed	238	<1
Other	435	<1

Source: Forestry Commission (2011)

Area and proportion of ancient woodland and planted ancient woodland sites (PAWS) within the NCA.

Woodland type	Area (ha)	Percentage of NCA
Ancient semi-natural woodland	2,141	1
Ancient re-planted woodland (PAWS)	1,629	1

Source: Natural England (2004)

5. Boundary features and patterns

5.1 Boundary features

An ancient landscape pattern of hedgerows forms the traditional field boundaries. Within hedgerows mature hedgerow oaks form distinctive features.

Source: Arden Countryside Character Area description; Countryside Quality Counts (2003)

5.2 Field patterns

There are varied field patterns across this NCA. Smaller scale irregular fields derived from medieval woodlands clearance can be found close by to some of the high density dispersed settlements. The largest fields can be found in the broad river valleys and in the south which is dominated by big estates from Warwick to the east of Birmingham.

Source: Natural Area Profile, Countryside Character Area description

6. Agriculture

The following data has been taken from the Agricultural Census linked to this NCA.

6.1 Farm type

In 2009, 366 lowland grazing livestock holdings (31 per cent); Farms classified as' other' (which will include smallholdings) number 313 (27 per cent); 239 cereal farms (20 per cent); 81 mixed farms (7 per cent). Trends between 2000 and 2009 show a decrease in the total number of holdings from 1,898 to 1,577 (a 17 per cent decrease). Trends also show a significant decrease in dairy farms (down from 112 to 56 – a decrease of 50 per cent), and mixed farming (down from 124 to 81 a decrease of 35 per cent). Lowland grazing livestock has increased slightly (9 per cent).

Source: Agricultural Census, Defra (2010)

6.2 Farm size

Farms of size 5 – 20 ha, are the most common, accounting for 32 per cent of holdings; followed by farms of size 20 – 50 ha, accounting for 22 per cent of holdings. Trends between 2000 and 2009 show a decrease in the numbers of all farm sizes except for holdings over 100 ha. This category made up 17 per cent of the total in 2009 – up from 14 per cent in 2000.

Source: Agricultural Census, Defra (2010)

6.3 Farm ownership

In 2009 total farm area within the NCA was 65,922 ha and owned land coverage was 7,064 ha. In 2000 total farm area was 67,587 ha and owned land was 42,072 ha.

Source: Agricultural Census, Defra (2010)

6.4 Land use

The dominant land use is grass and uncropped land, accounting for 34,490 hectares (52 per cent of farmed area). This is followed by cereals (19,467 or 29 per cent) and oilseed and other arable crops account for much of the remainder (approximately 7 per cent and 5 per cent each).

Source: Agricultural Census, Defra (2010)

6.5 Livestock numbers

Sheep are the most numerous livestock type (a total of 119,500 animals) followed by cattle (38,000) and pigs (12,700). In every case there has been a significant decrease in overall numbers between 2000 and 2009.

Source: Agricultural Census, Defra (2010)

6.6 Farm labour

The figures suggest that many of holdings are run by dedicated farmers or managers. These comprise some 60 per cent of the total work force. The total workforce has decreased by 19 per cent between 2000 (3,444) and 2009 (2,787). There has been a decrease of 31 per cent in the number of full time employees, and 9 per cent in part time employees between 2000 and 2009. Casual workers have also decreased by 61 per cent.

Source: Agricultural Census, Defra (2010)

Please note: (i) Some of the Census data is estimated by Defra so will not be accurate for every holding (ii) Data refers to Commercial Holdings only (iii) Data includes land outside of the NCA belonging to holdings whose centre point is within the NCA listed.

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7. Key habitats and species

7.1 Habitat distribution/coverage

Remnant ancient woodland is a key feature in the NCA. Some of the woodlands contain important populations of small mammals such as Dormouse and Invertebrates such as 'false mocha' a rare moth, the larva of which feeds on oak leaves, lichens, bryophytes and fungi. There are several distinct areas of floodplain grazing marsh within Arden NCA. A priority species known to be present in this habitat is the 'mud snail', a species that is localised in its range. Bittell Reservoirs lie in the Upper Arrow Valley of north Worcestershire. These reservoirs form the largest area of open water in the county and represent one of the most important sites in the West Midlands for passage and wintering waders as well as other waterfowl, with over 200 species recorded. Post-industrial sites also provide a wide range of habitats. Derelict land provides opportunities for specialised plant and animal communities. Birmingham is known to be a stronghold for the black redstart, while the network of waterways provides a stronghold for the water vole.

Source: Midland Plateau Natural Area Profile

7.2 Priority habitats

The NCA contains the following areas of mapped priority habitats (as mapped by National Inventories). Footnotes denote local/expert interpretation. This will be used to inform future national inventory updates.

Priority habitat	Area (ha)	Percentage of NCA
Broadleaved mixed & yew woodland (Broad Habitat)	4,157	3
Coastal & floodplain grazing marsh	592	<1
Lowland Meadows	401	<1
Fens	82	<1
Purple moor grass & rush pasture	52	<1
Reedbeds	45	<1
Lowland dry acid grassland	44	<1
Lowland heathland	10	<1

Source: Natural England (2011)

- Maps showing locations of priority habitats are available at: http://magic.defra.gov.uk – Select 'Habitats and Species/Habitats'

7.3 Key species and assemblages of species

- Maps showing locations of some key species are available at: http://magic.defra.gov.uk – Select 'Habitats and Species/Habitats'
- Maps showing locations of S41 species are available at http://data.nbn.org.uk/

8. Settlement and development patterns

8.1 Settlement pattern

Thirty-two per cent of the area is urban. Total population of the area is 1,799,222. Birmingham dominates the north-west of the NCA, developing from a medieval centre with small-scale industries to concentric development with a range of surburban types through the 20th century. The north-east is an industrial area with distinctive colliery settlements. Elsewhere the pattern of settlement is scattered and dispersed. Major settlement populations can be found in the south-east of the area around Coventry, Kenilworth and Warwick and in the west, Redditch, Bromsgrove and Halesowen.

Source: Arden Countryside Character Area description; Countryside Quality Counts (2003)

8.2 Main settlements

The main settlements are: Birmingham; Coventry; Nuneaton Bromsgrove; Redditch; Tamworth; Warwick; Kenilworth. The total estimated population for this NCA (derived from ONS 2001 census data) is: 1,924,737.

Source: Arden Countryside Character Area description; Countryside Quality Counts (2003)

8.3 Local vernacular and building materials

Brick and timber is the material of many of the older buildings. The mining villages tend to be modern terraced housing situated on hill tops. In Birmingham many terracota bricks are present in 19th-century buildings. The Bromsgrove Formation (sandstone) has been used for building stone locally and is found in local churches, walls and older houses.

Source: Arden Countryside Character Area description; Countryside Quality Counts (2003)

9. Key historic sites and features

9.1 Origin of historic features

The town of Alcester in the south-west tip of the NCA was of some importance in Roman times. Strategically located at a junction between the Ryknild Street (Roman road) and the ancient Saltway from Droitwich and the Roman road from Stratford upon Avon, the Fosse Way. The 10th century saw the development of the market towns such as Warwick with the medieval castle, sitting on a bend in the River Avon, built as a wooden motte and bailey castle in 1068. The now familiar stone castle was built in the 12th century. The extensive woodland cover remained over the area in the Anglo-Saxon period as late as the 11th century. There was then a period of clearance and enclosure for arable and stock. The 12th and 14th centuries saw the establishment of manorial deer parks such as Stoneleigh Park and Packington Hall and this trend continued into the 15th century with formal houses and parklands for example Coughton Court and Baddesley Clinton.

Industrialisation of the Arrow Valley and Redditch in the 18th and 19th century was focused on the needle industry making use of the earlier water-powered corn mills. In the north-east of the NCA coal mining quickly developed in the 19th century. This was largely based on the location of canals and led to the development of coking and smelting industries and the development of other associated infrastructure (roads, rail).

Source: Draft Historic Profile, Countryside Quality Counts , Arden Countryside Character Area description

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9.2 Designated historic assets

This NCA has the following historic designations:

- 37 Registered Parks and Gardens covering 2,448 ha.
- 0 Registered Battlefield/s covering 0 ha.
- 155 Scheduled Monuments.
- 4,932 Listed Buildings.

Source: Natural England (2010)

- More information is available at the following address: http://www.english-heritage.org.uk/caring/heritage-at-risk/
- http://www.english-heritage.org.uk/professional/protection/process/national-heritage-list-for-england/

10. Recreation and access

10.1 Public access

- 21 per cent of the NCA 3,166 ha is classified as being publically accessible.
- There are 1,929 km of Public Rights of Way at a density of 1.3 per km2.
- There are 0 National Trails within the NCA.

Sources: Natural England (2010)

The table below shows the breakdown of land which is publically accessible in perpetuity:

Access designation	Area (ha)	Percentage of NCA
National Trust (Accessible all year)	145	<1
Common Land	179	<1
Country Parks	1,297	1
CROW Access Land (Section 4 and 16)	478	<1
CROW Section 15	326	<1
Village Greens	15	<1
Doorstep Greens	4	<1
Forestry Commission Walkers Welcome Grants	668	<1
Local Nature Reserves (LNR)	688	<1
Millennium Greens	17	<1
Accessible National Nature Reserves (NNR)	60	<1
Agri-environment Scheme Access	14	<1
Woods for People	1,553	1

Sources: Natural England (2011)

Please note: Common Land refers to land included in the 1965 commons register; CROW = Countryside and Rights of Way Act 2000; OC and RCL = Open Country and Registered Common Land.

11. Experiential qualities

11.1 Tranquillity

Based on the CPRE map of tranquillity (2006) the highest scores for tranquillity are in very small areas to the north-east and south-west of the NCA in very rural areas. The lowest scores for tranquillity are the major conurbations for example Birmingham and Coventry. However, the majority of this NCA falls within areas considered to be least tranquil.

A breakdown of tranquillity values for this NCA are detailed in the table below:

Tranquillity	Score
Highest Value within NCA	26
Lowest Value within NCA	-132
Mean Value within NCA	-36

Sources: CPRE (2006)

- More information is available at the following address: http://www.cpre.org.uk/resources/countryside/tranquil-places

11.2 Intrusion

The 2007 Intrusion Map (CPRE) shows the extent to which rural landscapes are 'intruded on' from urban development, noise (primarily traffic noise), and other sources of visual and auditory intrusion. This shows that the intrusion results are similar to the tranquillity results with a high percentage of the disturbed land being the urban areas of Birmingham and Coventry and the substantial road network across the area particularly the M6 and M42. A breakdown of intrusion values for this NCA are detailed in the table below.

Intrusion category	1960s (%)	1990s (%)	2007 (%)	Percentage change (1960s-2007)
Disturbed	40	58	60	+20
Undisturbed	34	16	10	-24
Urban	26	26	30	+4

Sources: CPRE (2007)

Notable trends from the 1960s to 2007 are a significant decrease of 24 per cent in the proportion of undisturbed or intruded land during the 1960s to 2007 period matched by increases in urban and disturbed land

- More information is available at the following address: http://www.cpre.org.uk/resources/countryside/tranquil-places

12. Data sources

- British Geological Survey (2006)
- Natural Area Profiles, Natural England (published by English Nature 1993-1998)
- Countryside Character Descriptions, Natural England (regional volumes published by Countryside Commission/Countryside Agency 1998/1999)
- Joint Character Area GIS boundaries, Natural England (data created 2001)
- National Parks and AONBs GIS boundaries, Natural England (2006)
- Heritage Coast Boundaries, Natural England (2006)
- Agricultural Census June Survey, Defra (2000,2009)
- National Inventory of Woodland & Trees, Forestry Commission (2003)
- Countryside Quality Counts Draft Historic Profiles, English Heritage (2004)*
- Ancient Woodland Inventory, Natural England (2003)
- Priority Habitats GIS data, Natural England (March 2011)
- Special Areas of Conservation data, Natural England (data accessed in March 2011)
- Special Protection Areas data, Natural England (data accessed in March 2011)
- Ramsar sites data, Natural England (data accessed in March 2011)
- Sites of Special Scientific Interest, Natural England (data accessed in March 2011)
- Detailed River Network, Environment Agency (2008)
- Source protection zones, Environment Agency (2005)
- Registered Common Land GIS data, Natural England (2004)
- Open Country GIS data, Natural England (2004)
- Public Rights of Way Density, Defra (2011)
- National Trails, Natural England (2006)
- National Tranquillity Mapping data, CPRE (2007)
- Intrusion map data, CPRE (2007)
- Registered Battlefields, English Heritage (2005)
- Record of Scheduled Monuments, English Heritage (2006)
- Registered Parks and Gardens, English Heritage (2006)
- World Heritage Sites, English Heritage (2006)
- Incorporates Historic Landscape Characterisation and work for preliminary Historic Farmstead Character Statements (English Heritage/Countryside Agency 2006)

Please note all figures contained within the report have been rounded to the nearest unit. For this reason proportion figures will not (in all) cases add up to 100 per cent. The convention <1 has been used to denote values less than a whole unit.

Supporting document 2: Landscape change

Recent changes and trends

Trees and woodlands

- The character of the resource has been maintained, or is strengthening slowly but there has been a general lack of woodland management in many places.
- Across rural parts of this NCA and into neighbouring NCAs, there is an ambitious, programme to purchase land and create an extensive forest landscape, the "Forest of Dennis". This project has created over 400 ha of new woodland and aims to eventually create a further 4 to 8,000 ha.

Boundary features

- There has been loss and deterioration of hedges and hedgerow trees, the former particularly as a result of field amalgamation. Many hedgerows have fallen into disrepair through poor and or lack of management. The number of hedgerow trees has declined and there has been a failure to nurture new generations. However, recent stewardship schemes have led to some positive management of hedgerows and improvement in hedgerow quality.

Agriculture

- In 2009, over 30 per cent of farms were lowland grazing livestock holdings; Farms classified as 'other' (which include smallholdings) 27 per cent; cereal farms 20 per cent; mixed farms (7 per cent). Trends between 2000 and 2009 show a decrease in the total number of holdings from 1,898 to 1,577 (a 17 per cent decrease). Trends also show a significant decrease in dairy farms (down from 112 to 56, a decrease of 50 per cent), and mixed farming (down from 124 to 81, a decrease of 35 per cent). Lowland grazing livestock has increased slightly (9 per cent).

Settlement and development

- There is development pressure throughout the area. The majority of the NCA falls within the southern half of the West Midlands Green Belt, which extends around Coventry and Redditch and south to Stratford. Growth proposals seem to be focussed around the east of Birmingham and north Solihull. Coventry is an area previously designated as a growth point and there has been consideration of sustainable urban extensions into the green belt.

Semi-natural habitat

- Semi-natural habitats are limited in this NCA with less than 1 per cent designated for nature conservation. There is little evidence to show that there are agri-environment agreements for heathland management and restoration. The most extensive annual agri-environment agreements in 2003 were for lowland pastures on neutral/acid soils (487 ha) and regeneration of grassland/semi-natural vegetation (236 ha). Given the size of the area, this suggests the resource remains weakened.

Historic features

- In 1918 about 3 per cent of the Arden area was historic parkland, but by 1995 it is estimated that 54 per cent of that had been lost. Less than half of the remaining parkland is covered by a Historic Parkland Grant and only 12 per cent is included within an agri-environmental scheme. This suggests some neglect of an important resource.

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- It should also be noted that only about 58 per cent of historic farm buildings remain unconverted of which the majority are intact structurally.

Rivers

- This area is drained to the south by the rivers Arrow and Alne. Laying within the River Severn catchment area, these rivers flow into the River Avon. Draining to the north, the rivers Tame, Blythe and Anker sit within the River Humber catchment. The River Tame joins with the River Rea to create a wide, shallow valley to the east of Birmingham.

Drivers of change

Climate change

Climate change is likely to result in:

- Periods of heavy rain that may destabilise slopes and adversely affect riparian habitats.
- Species migration out of Arden and loss of small or isolated habitats.
- Changes to the way the landscape looks, eg. different tree species/crops.
- Increased demand for renewable energy installations and cropping.
- Summer droughts leading to continued over abstraction from local rivers and the potential loss of the iconic hedgerow and mature oak trees.
- Increased risk of localised flooding.
- Agricultural change with the potential for new crops.

Other key drivers

- There is likely to be increased demand for food production in the future as a result of a national drive for greater self-sufficiency in food.
- Continuing development pressure in and around the Birmingham and Coventry conurbations and outlying towns. Opportunities for good, sustainable design reflecting local settlement patterns, green infrastructure and local character reflected in design and materials.
- Potential for new transport infrastructure including railways. There may be an opportunity to manage proposals to ensure best outcomes for the environment.
- Associated potential for new green infrastructure building upon the network of sites in the urban fringe.
- Continued demand for sand and clay from existing quarries, and possible planning applications for expansion.
- Increased demand for waste disposal and recreational facilities around the edge of the conurbation.
- Further agriculture change with the possibility of increased area under intense arable production to meet food production needs.
- Potential for an increase in biomass production.

Supporting document 3: Analysis supporting Statements of Environmental Opportunity

The following analysis section focuses on a selection of the key provisioning, regulating and cultural ecosystem goods and services for this NCA. These are underpinned by supporting services such as photosynthesis, nutrient cycling, soil formation and evapo-transpiration. Supporting services perform an essential role in ensuring the availability of all ecosystem services.

Biodiversity and geodiversity are crucial in supporting the full range of ecosystem services provided by this landscape. Wildlife and geologically-rich landscapes are also of cultural value and are included in this section of the analysis. This analysis shows the projected impact of Statements of Environmental Opportunity on the value of nominated ecosystem services within this landscape.

An example of the meadering clay river valleys with long river meadows typical of the Arden landscape.

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Statement of Environmental Opportunity	Ecosystem service: Food provision	Timber provision	Water availability	Genetic diversity	Biomass energy	Climate regulation	Regulating water quality	Regulating water flow	Regulating soil quality	Regulating soil erosion	Pollination	Pest regulation	Regulating coastal erosion	Sense of place / inspiration	Sense of history	Tranquillity	Recreation	Biodiversity	Geodiversity
SEO 1: Manage and enhance the valuable woodlands, hedgerows, heathlands, distinctive field boundaries and enclosure patterns throughout the NCA, retaining the historic contrast between different areas while balancing the needs for timber, biomass production, climate regulation, biodiversity and recreation.	↘ **	↑ **	↔ *	↗ *	↑ **	↑ **	↗ *	○ *	↗ *	↗ **	↑ *	↗ *	n/a	↑ **	↑ **	↗ **	↗ **	↑ **	○ *
SEO 2: Create new networks of woodlands, heathlands and green infrastructure, linking urban areas like Birmingham and Coventry with the wider countryside to increase biodiversity, recreation and the potential for biomass and the regulation of climate.	↘ *	↑ *	○ *	↗ *	↑ *	↑ **	↗ *	○ *	↗ *	↗ *	↑ *	↗ *	n/a	↑ **	↔ *	↗ *	↗ **	↗ **	○ *
SEO 3: Conserve and enhance Arden's cultural and geological resource, the links to Shakespeare and the geological designated sites, to increase public access, enjoyment and recreation.	↔ *	↔ *	↔ *	↔ *	↔ *	↔ *	↔ *	○ *	↔ *	↔ *	↔ *	↔ *	n/a	↑ **	↑ **	↔ *	↗ *	↗ **	↗ **
SEO 4: Enhance the value of Arden's aquatic features such as the characteristic river valleys, meadows and standing water areas like Bittell Reservoirs to increase resource protection, such as soil erosion, soil quality and water quality.	↘ *	↔ *	↗ *	↗ *	↗ *	↑ *	↗ **	↗ **	↗ *	↗ **	↗ *	↗ *	n/a	↗ **	↔ **	↗ *	↗ *	↑ **	○ *

Note: Arrows shown in the table above indicate anticipated effect on service delivery ↑ = Increase ↗ = Slight Increase ↔ = No change ↘ = Slight Decrease ↓ = Decrease.
Asterisks denote confidence in projection (*low **medium ***high) ○ = symbol denotes where insufficient information on the likely effect is available .
Dark plum = national importance; mid plum = regional importance; light plum = local importance

Landscape attributes

Landscape attribute	Justification for selection
Mature hedgerow oaks and hedgerows that mark many of the field boundaries.	■ Evidence to suggest loss and deterioration of oak trees and hedgerows. Many have fallen into disrepair through poor management or abandonment. Numbers on the decline and failure to nurture new generations. ■ Veteran oak trees with obvious cavities, splits or holes may provide important roost sites for bats such as Soprano pipistrelle bats and potential nest sites for birds. ■ Mature oak trees provide important food plant for rare priority species such as false mocha moths that feed on oak leaves. ■ Defining feature across whole area.
Ancient and plantation woodlands scattered throughout the area including ancient coppice with woodbanks.	■ This National Character Area (NCA) has woodland covering 8 per cent of the NCA and ancient woodland covering 3 per cent, making up nearly half of all woodland cover. ■ Woodland is primarily found in small isolated pockets well dispersed throughout the area. ■ Broadleaved woodlands support a range of priority plant species such as the narrow leaved helleborine and spreading bellflower. Records show that the there are two main populations for these two species in the UK; in the West Midlands with very good numbers in Arden, and on the Welsh borders. This priority species is regarded as threatened and consideration should be given to expansion of habitat.
The river valleys and associated narrow alluvial floodplains of the rivers and their habitats of grazing marsh and lowland meadows.	■ The river valleys cut through the rolling landscape, providing distinctive local landscapes and hosting remnant areas of important wetland habitat. ■ Priority habitats include wet woodlands, floodplain grazing marsh and lowland meadows.

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Landscape attribute	Justification for selection
Complex and contrasting settlement pattern with densely populated urban areas such as Birmingham and Coventry. Others relatively dispersed.	■ 32 per cent of the area is urban. Main urban settlements are located around the edge of NCA. 83 per cent of NCA is green belt. ■ Villages are mainly found along river valleys. ■ Farmsteads are mainly isolated. ■ Transport infrastructure of M42, M5, M6 and M40 motorways. ■ Former and existing mining settlements, red brick terraced housing.
Contrasting with the smaller, well hedged fields are the larger more regular fields of the former deer parks and estates.	■ Large country houses and mature parkland estates such as Packington Hall, Stoneleigh Abbey and Arbury.
Heathland remnants particularly on the poorer soils.	■ Heathland remnants found in roadside hedgerows particularly in southern Arden. ■ Small, fragmented heathland found in urban, central and northern areas.

Landscape opportunities

- Conserve, enhance and restore the area's ancient landscape pattern of field boundaries, historic (including farm) buildings, moated sites, parkland and pasture and reinforce its well wooded character.
- Protect and manage woodlands particularly ancient woodlands and wood pasture to maintain the character of Arden.
- Manage and restore hedgerows especially in the north-eastern part of the area (enclosure patterns) and restore parkland, ancient trees and stream side trees plus manage and replace in–field trees and hedgerow trees.
- Maintain and restore areas of heathland particularly in southern Arden, Arden Parklands and Birmingham Hills, lowland meadows and pastures and floodplain grazing marshes.
- Manage arable cultivation to encourage rare arable plants and range-restricted farmland birds and mammals, following appropriate management options under Entry Level Stewardship.
- Restore habitats associated with river valleys particularly the Blythe and Tame.
- Create new green infrastructure with associated habitat creation and new public access on former mining sites and close to urban populations in the West Midlands Green Belt.

Frequent hedgerow oaks are a typical feature of the Arden landscape.

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Ecosystem Service analysis

The following section shows the analysis used to determine key Ecosystem Service opportunities within the area. These opportunities have been combined with the analysis of landscape opportunities to create Statements of Environmental Opportunity.

Please note that the following analysis is based upon available data and current understanding of ecosystem services. It does not represent a comprehensive local assessment. Quality and quantity of data for each service is variable locally and many of the services listed are not yet fully researched or understood. Therefore analysis and opportunities may change upon publication of further evidence and better understanding of the inter-relationship between services at a local level.

Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Food provision	Soils Livestock Mixed and cereal farms	Light, sandy soils predominate in the north with heavier clay soils and loams occurring extensively in central and southern Arden the majority of the soil is grade 3. In 2009, over 30 per cent of Arden's holdings were lowland grazing livestock. Farms classified as 'other' (which will include smallholdings) 27 per cent; cereal farms 20 per cent; mixed farms 6.9 per cent. The area produces dairy and arable food crops alongside vegetables, pork, poultry, eggs but not on a large scale.	Local	Expansion of food provision within the NCA could lead to increased production but could lead to less biodiversity and pollination sources, increase pressure on water availability (required for irrigation). It may also possibly have a huge impact on the character/sense of place of the landscape with uncultivated land being put into production.	There is scope to increase food provision but balance needs to be struck to ensure biodiversity/ water availability and other services do not suffer negative impacts.	**Food provision**
Timber provision	Small woodlands Mature timber Ancient woodlands	The NCA contains 11,876 ha of woodland (8 per cent of the total area). 3 per cent of that resource is ancient woodland.	Local	Provision is currently low but it could be increased if new sites are planted or existing sites come into management. This would also increase climate regulation through carbon sequestration and local heating effects. It could provide increased opportunities for biodiversity and recreation if planted in appropriate locations. Woodland is a very strong key feature of Arden and new planting would enhance this sense of place.	Opportunity to manage the many under-managed broadleaved woodlands in this NCA to provide timber and to encourage new woodlands in appropriate areas to provide biodiversity connectivity and increase recreation provision.	**Timber provision** **Biodiversity** **Recreation** **Climate regulation** **Sense of place/ inspiration** **Sense of history**

Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Biomass energy	Small woodlands Existing woodland cover (8 per cent of NCA)	There is currently limited potential for the provision of biomass through bringing unmanaged woodland under management. There is generally a high potential yield for miscanthus, and a medium or high potential yield for short rotation coppice (SRC) in the NCA.[4] For information on the potential landscape impacts of biomass plantings within the NCA, refer to the tables on the Natural England website. http://www.naturalengland.org.uk/ourwork/farming/funding/ecs/sitings/default.aspx	Local	Biomass potential is currently low. However the area has medium or high potential for SRC. Increased provision of SRC for fuel has the potential to increase climate regulation, but could decrease provision of future food if placed on farmed areas or on biodiversity if placed on areas of non-agricultural production. Major expansion could also affect sense of place.	There is an opportunity to increase production of biomass through introducing management in currently unmanaged woodlands. There is also an opportunity for small-scale biomass production through planting on sites including, for example, small parcels of land isolated by development and closed quarry or mining sites. There is also an opportunity to plant new broadleaf woodland or short rotation coppice where extension or introduction of woodland character would be desirable, avoiding other priority habitats and historical features.	**Biomass energy** **Climate regulation** **Biodiversity**

[4]Environment Agency, NSRI National Soils Map for England and Wales, January 2009.

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Water availability	Reservoirs, aquifers and rivers	The major metropolitan areas of Birmingham, Coventry and Redditch places considerable pressure on water resources. The Bartley, Frankley and Bittel reservoirs in south-west Birmingham provide drinking water for Birmingham. The major sandstone aquifers underlying the south of the NCA are the Triassic Sandstone Aquifer, over-abstracted and the Avon Confirmed Aquifer, which is over licensed and no water available for abstraction.	Regional	Increasing water availability (through greater capture/infiltration) and further management of abstraction is likely to increase wetland biodiversity and improve quality. Greater water availability could also increase agricultural outputs at times when water for irrigation is limited, for example, during droughts.	There is an opportunity to manage water within the NCA to slow runoff to increase infiltration to the aquifer. There is also an opportunity to manage over-abstraction from the aquifer and rivers through careful and efficient use of water and through use of alternative more sustainable sources of water supply where possible.	**Water availability** **Biodiversity** **Regulating water quality** **Food provision**

Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Climate regulation	Woodlands Grazing marsh Grassland Fen Reedbeds Heathland	The majority of the NCA has a low soil carbon content of 0-5 per cent. However, around Birmingham, carbon content increases to 5-10 per cent.[5] Carbon content is likely to be higher under the more than 11,876 ha of woodland within the NCA, as well as under the more than 1,000 ha of grazing marsh, grassland, fen, reedbeds, and heathland.	Regional	Carbon storage in the areas of woodland, grazing marsh, grassland, fen, reedbeds and heathland is likely to be higher, and this may be increased by the expansion of these areas. This may lead to a reduction in provisioning of food if planted on agricultural land. However, if created, there is good potential to increase biodiversity and increase recreational resource if publicly accessible. Creation may also increase the sense of place by enhancing the character of Arden.	There is an opportunity to increase the carbon storage potential of the area through the net expansion of new woodland, grazing marsh, grassland, fen, reedbeds and heathland in appropriate areas.	**Climate regulation** **Biodiversity** **Recreation** **Sense of place/ inspiration** **Regulating water quality**
Regulating soil erosion	Soils Woodlands Hedgerows .	Nearly 60 per cent of the NCA is not generally susceptible to soil erosion (associated with the slowly permeable clayey soils, loamy soils with naturally high groundwater, and the floodplain soils with naturally high groundwater). Of the remaining soils the slightly acid loamy and clayey soils with impeded drainage (covering 26 per cent of the NCA) are prone to compaction, capping/slaking, leading to increased risk of soil erosion by surface water run-off, especially on steeper slopes. By comparison, the light freely draining slightly acid loamy soils and the freely draining slightly acid sandy soils (together covering 14 per cent of the NCA) have enhanced risk of soil erosion on moderately or steeply sloping land where cultivated or bare soil is exposed. This is exacerbated where organic matter levels are low after continuous arable cultivation or where soils are compacted. There is the potential for wind erosion on some coarse textured cultivated variants.	Local	Not a major issue for this NCA with over 60 per cent of the area not susceptible to soil erosion. Addressing the issue of soil erosion would require taking small areas of land out of production in high risk areas to reduce compaction, trap sediment and improve soil health. This approach would lower food production very slightly in the short term but could offer benefits to biodiversity by reducing sedimentation in rivers. It may also help store limited amounts of carbon and could help maintain fertility in the longer term. Strengthening the hedgerow network would add to the sense of place as well as increasing biodiversity.	There is scope to reinstate and strengthen hedgerows and create grass buffer strips across steeper slopes under arable cultivation. Also to strengthen the hedgerow network and increase the population of hedgerow trees in the river valleys.	**Regulating soil erosion** **Biodiversity** **Sense of place/ inspiration** **Regulating soil quality**

[5] Joint Nature Conservation Committee website, Special Areas of Conservation, Ensor's Pool (accessed November 2010).

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Regulating soil quality	Soils Heathland Woodlands Hedgerows	This NCA has 7 main soilscape types: ■ Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils, covering 36 per cent of the NCA. ■ Slightly acid loamy and clayey soils with impeded drainage (26 per cent). ■ Freely draining slightly acid loamy soils (13 per cent). ■ Slowly permeable seasonally wet acid loamy and clayey soils (11 per cent). ■ Loamy soils with naturally high groundwater (9 per cent). ■ Loamy and clayey floodplain soils with naturally high groundwater (3 per cent). ■ Freely draining slightly acid sandy soils (1 per cent). Those covering 10 per cent or more of the NCA are described below. The slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils (36 per cent) and the slowly permeable, seasonally wet acid loamy and clayey soils (11 per cent) may suffer compaction and/ or capping as they are easily damaged when wet. In turn this may lead to increasingly poor water infiltration and diffuse pollution as a result of surface water run-off. Management measures that increase organic matter levels can help reduce these problems. Equally, the slightly acid loamy and clayey soils with impeded drainage (26 per cent) are easily poached by livestock and compacted by machinery when the soil is wet. Weak topsoil structures can easily be damaged. Careful timing of activities is required to reduce the likelihood of soil compaction. The freely draining slightly acid loamy soils (13 per cent) may be valuable in enabling the recharge of the aquifers that underlie this NCA, requiring the maintenance of good soil structure, improved by the addition of organic matter, to aid water infiltration and requiring the matching of nutrients to needs to prevent groundwater pollution.	Local	It is important to minimise compaction and / or capping risk on clayey soils, which can arise from over-grazing, trafficking or other mechanised activities. These will tend to exacerbate run-off problems as well as damaging soil structure. These soils may have limited potential for increasing organic matter levels by management interventions. This in turn should have enhanced benefits for biodiversity.	There is scope to employ minimal tillage and incorporate organic matter to increase levels of soil organic matter and relieve soil compaction.	**Regulating soil quality** **Regulating soil erosion** **Biodiversity** **Water availability**

Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Regulating water quality	Woodlands Wetland habitat/ reedbed	In the south of the NCA, surface water is generally of 'moderate' ecological status or ecological potential in the case of artificial or heavily modified waterbodies, although there are some reaches of poor quality in and around Birmingham and Coventry. The chemical status of surface waterbodies generally 'does not require assessment'; however in the south of the NCA there are some river lengths with 'good' chemical status. The chemical status of groundwater sources is 'good' in the south of the NCA, but 'poor' in the north of the NCA, around Birmingham and Coventry.[6,7]	Regional	Around Birmingham and Coventry groundwater chemical status is 'poor' so improvements are required to the water quality through selective reduction in inputs from point source pollution and diffuse pollution from for example, agricultural activities, through better land management and the buffering water courses, which should help address specific pollutant issues in water bodies in the north around the conurbations that fail standards.	Expansion of semi-natural wetland habitats adjacent to watercourses, including reedbeds and grazing marsh, plus creation of grassland buffer strips /restoration of hedgerows across slopes within river catchments.	**Regulating water quality** **Regulating soil erosion** **Biodiversity**
Regulating water flow	Rivers	Tamworth is at medium risk of flooding from the rivers Tame and Anker and Bourne Brook. In Birmingham the key source of flooding is from the River Tame and its main tributary the River Rea, and the risk of flooding is high. There is a relatively high level of flood risk in Coventry from the River Sowe and the River Sherbourne. There are approximately 2,200 properties at risk of fluvial flooding within Warwick from the River Avon and in Redditch there are between 250 and 500 homes at risk of flooding from the River Arrow.[8]	Local	Within the NCA flooding may be reduced through well designed natural flood alleviation schemes such as river restoration and creation of new wetlands to retain water in situ. River corridors will benefit from further wetland habitat creation, the reduction of intensive land uses and re-establishing the natural processes associated with watercourses, including naturally-functioning floodplains. This should also go hand-in-hand with improved public access, where appropriate.	Creation and extension of semi-natural floodplain habitats such as flood meadows, wet woodland and reedbed riparian margins, thick hedges in floodplain, which dissect the direction of peak flow. In particular, the existing wet meadows alongside the Blythe and Anker are areas where the river and its flooplain can function naturally, which in turn will help to reduce flood risk.	**Regulating water flow** **Biodiversity** **Water availability** **Recreation** **Regulating soil erosion** **Regulating soil quality**

[6]Environment Agency, Humber River Basin Management Plan, Annex A: Current state of waters, December 2009.
[7]Environment Agency, Severn River Basin Management Plan, Annex A: Current state of waters, December 2009.
[8]Environment Agency, River Severn Catchment Flood Management Plan, Summary Report, December 2009.

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Pollination	Grassland meadows Heathland Gardens and parks	Grassland, meadows and heathland, totalling less than 1 per cent of the NCA area, provide limited nectar sources for pollinating insects although lengths of hedgerow and the numerous gardens and parks of the major built up areas of the NCA are likely to provide important nectar sources.	Local	Increasing nectar sources, through creating and enhancing grassland, meadows, heathland and hedgerows may reduce the little food production that there is in the area, although, it would lead to a much needed increase in biodiversity.	Increase unimproved grassland, floodplain grazing marsh and woodland with a diverse ground flora, and plant and manage flowering hedgerows and nectar and forage mix areas (particularly in arable areas), to increase the diversity of flowering plants and increase the sustainability of local agricultural production.	**Pollination** **Biodiversity** **Sense of place/ inspiration**

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Sense of place/ inspiration	Woodland cover Hedgerows and hedgerow oaks Wood pasture Landforms such as low rounded hills, steep scarps and incised valleys Lane network linking scattered farms and hamlets Former coalfields and colliery settlements Parklands, canals and railways	Countryside Quality Counts data suggests that the character of the resource has probably been maintained or is strengthening slowly. However there has been a general lack of woodland management in many places. Loss and deterioration of hedges and hedgerow trees, the former particularly as a result of field amalgamation. Many hedgerows have fallen into disrepair through a lack of and/or poor management. Hedgerow trees numbers have declined.	Regional	Management to enforce sense of place is likely to increase sense of history. Conserving and enhancing the distinctive landscape features is also likely to benefit biodiversity by enhancing or expanding available habitat.	There is an opportunity to maintain a sense of place, valued by local people and visitors by conserving the variety of landscape features which give the NCA its distinctive character. There are opportunities to maintain the historic features that provide local distinctiveness within the different parts of the NCA such as the industrial coal mining heritage. There are opportunities to market the associations with Shakespeare's 'Forest of Arden' and ensure the landscape features associated with that are conserved and enhanced.	**Sense of place/ inspiration** **Biodiversity** **Recreation** **Sense of history**

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Sense of history	Wood pasture Deer parks Ancient oak woodland Historic field pattern Mining and built heritage	1.7 per cent of NCA registered parks and gardens. 155 Scheduled monuments. 4,932 listed buildings. These contribute to a heritage of past coal mining and associated colliery villages as well as municipal and commercial buildings in Birmingham.	Local	Increasing sense of history has some potential to increase tourism. This could in turn lead to increasing recreational opportunities and sense of place by reinforcing the historic character of the landscape.	There is an opportunity to increase sense of history by protecting the character and historic resource of the large country houses and parklands. Also by increasing the protection and appropriate management of above and below ground archaeology, ancient trackways and the established vernacular of settlements.	**Sense of history** **Recreation** **Sense of place/ inspiration**

Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Tranquillity	Wooded landscape Sunken lanes Lack of visual and noise intrusion	Just 10 per cent of the NCA is classified as 'undisturbed' according to the CPRE Intrusion Map 2007, a decline from 34 per cent in the 1960s.	Local	Increasing tranquillity through expanding areas of woodland could also increase biodiversity and sense of place.	There is an opportunity to protect tranquillity in some core areas where intrusion is currently low such as in the sunken lanes with hedgerows. This will increase the opportunity for people to feel connected to nature and contribute to wellbeing and health. There is an opportunity to reduce where possible the impact of settlement and road infrastructure in the urban fringe areas by planting woodland shelter belts, strengthening the hedgerow pattern and ensuring new development on settlement fringes is sensitively designed.	**Tranquillity** **Sense of history**

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Recreation	Parklands Woodlands Formal parks Canals and rivers Wildlife reserves Reservoirs	Recreation is supported by 1,929 km of rights of way (at a density of 1.35 km per km^2), and just 238 ha of open access land (covering 0.2 per cent of the NCA). Numerous parks provide recreational opportunities within and surrounding Birmingham, such as Edgbaston Park adjacent to the university, while the reservoirs to the south-west of the city are well used for sailing, fishing and bird-watching. Parks, canals and rivers feature throughout the NCA and provide varying levels of recreational opportunity, while numerous golf courses are prevalent features offering more prescribed recreation.	Local	There is a strong resource here that could be utilised and increased without significant effects on other services. However, increased recreation may have minor negative effects on tranquillity, biodiversity through disturbance and potentially a small effect on food production through, for example, taking land out of production to produce paths in some areas.	Maintain and enhance the access throughout the area on public rights of way, on the long-distance route Heart of England Way, on canal towpaths and cycle and recreational sites. Open spaces should also be incorporated into well designed urban developments to provide recreational opportunities and potentially increase biodiversity.	**Recreation** **Sense of place/ inspiration**

Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Biodiversity	Priority habitats including species-rich grasslands, heathlands, wetlands and woodlands Reservoirs Canal network Ensors Pool	Internationally designated site in the NCA – Ensor's Pool SAC (4 ha) in Nuneaton, designated for supporting a very large population of white-clawed crayfish.[9] There are 56 SSSI, totalling less than 1 per cent of the NCA area. The majority of these (87 per cent) are in favourable or recovering condition; 12 per cent are in unfavourable condition.	Regional	The improvement in the condition, and expansion, of woodland and priority habitats will assist in climate regulation through the storage of carbon. Increases in habitat extent could also have a positive effect on increasing recreation, water quantity, water quality and regulating soil erosion but is likely to have a negative impact on agriculture.	There is an opportunity to integrate woodland management and potentially extend broadleaved woodland, where appropriate, for biodiversity with timber and biomass production. There is also an opportunity to protect, manage and extend the habitats within greenbelt and urban fringe to retain and increase biodiversity value and improve network connections. Opportunity to expand semi-natural wetland habitats adjacent to watercourses, including reedbeds and grazing marsh and manage and extend hedgerows.	**Biodiversity** **Recreation** **Water availability** **Regulating water quality** **Regulation soil erosion** **Climate regulation**

[9]Joint Nature Conservation Committee website, Special Areas of Conservation, Ensor's Pool (accessed November 2010).

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Service	Assets/attributes: main contributors to service	State	Main beneficiary	Analysis	Opportunities	Principal services offered by opportunities
Geodiversity	Exposed rock formations Designated geodiversity sites	There are 16 nationally designated geological sites within the NCA and 68 local sites. Many of the nationally designated sites are quarries or gravel pits.	National	Designated sites provide important and accessible sections of geology allowing the interpretation, understanding and continued research into the geodiversity of the NCA.	Promote the geodiversity of the NCA particularly for recreational and educational use, adding to the sense of place and sense of history. There is an opportunity to manage some of the geological sites to enhance biodiversity.	**Geodiversity** **Sense of place/ inspiration** **Sense of history** **Biodiversity**

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Appendix 9

Flood Alleviation Report 2010 (ref EB 08/06)

BOURNE BROOK CATCHMENT & FLOOD ALLEVIATION STUDY, FILLONGLEY, NORTH WARWICKSHIRE
July 2010

1 Introduction

The village of Fillongley is located towards the south east boundary of North Warwickshire Borough and 6.2 miles north west of Coventry city centre. The Bourne Brook runs from south to north through the village and is a tributary of the River Tame. For details of the catchment refer to Plan 1 in Appendix A.

The upstream catchment consists of two valleys which are approximately 95% rural. High up in the catchment there is dense woodland but agricultural farming is the most common type of land use with grazing land for live stock being the second. There are small hamlets and clusters of properties and farming units dotted around the catchment but besides a contribution from the M6 motorway there are no real significant built up urban areas.

The Bourne Brook is formed from smaller drainage ditches in two separate valleys upstream of Fillongley. The ditches form two main watercourse channels, one in each valley, and pick up runoff from the M6 motorway as well as contributions from the greenfield areas. The M6 discharges into the two watercourses at three different points, two directly into one of the two main watercourses and at a third point into drainage ditch which joins the main watercourse channel further downstream.

The two watercourses then flow directly to the Fillongley castle ruins which are 300m south of Fillongley village, flowing through the old moats of the castle before merging into one brook, the Bourne Brook on the north side of the castle. The watercourse then meanders into the village where it discharges to two 900 mm diameter brick culverts at the rear of the Manor House public house. The culvert then flows under the Coventry Road in a large s-bend shape curve and along Church Lane. The culvert issues in the rear of the gardens of the properties in Church Lane into an open channel which have been altered to suit residential requirements. The open watercourse flows though the remainder of the village where another tributary joins at Little London, before exiting the village under the Nuneaton Road Bridge and onwards into the fields downstream of Fillongley.

The watercourse then merges with the Didgley Brook and flows north west merging with several other watercourses before joining the River Tame.

The aim of this report is to greatly reduce the affects of flooding to the village of Fillongley. This will require a multi-agency response to fund aspects of the required works to be carried out in the near future.

2 Background

There is a long history of flooding in the centre of Fillongley Village from the Bourne Brook watercourse. Anecdotal evidence in the form of old photographs is available from some of the local residents and also in the local public house; The Manor House. However there is no detailed information of the dates of these events or supporting information of the duration and intensity of the accompanying rainfall.

More recently there have been two significant flooding events for which a greater amount of observational data can be obtained. These occurred on the 20th July 2007 and 13th December 2008. Evidence of the effects of flooding from these two events is contained in Appendix C.

2.1 Flooding Event - 20th July 2007

Analysis of the rainfall event from the Met Office indicates that between 50mm and 75mm of rainfall occurred. This heavy and prolonged rainfall event was caused by a slow moving area of low pressure and associated frontal system.

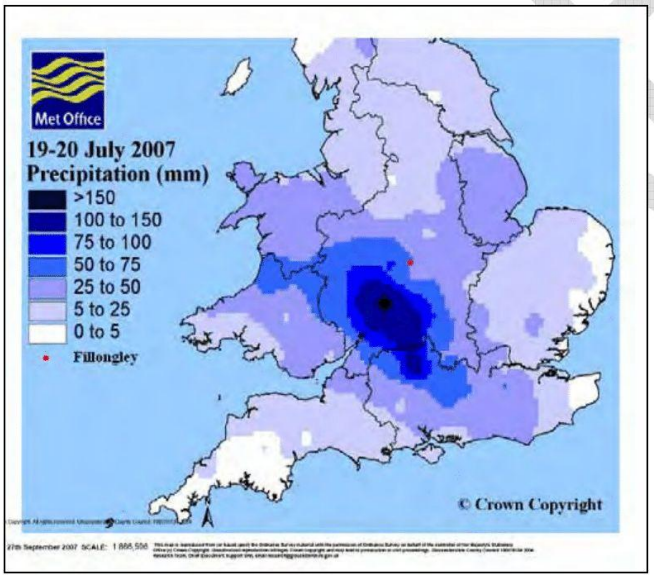


Figure 1 – Met Office Data for 20th July 2007

Whilst this level of rainfall is not entirely unusual it was coupled with extremely wet antecedent conditions. Further information from the Met Office indicates that during June and July 2007, the amount of rainfall was 200 to 250% higher than average in the North Warwickshire area. This is further confirmed by an analysis of the local Soil Moisture Deficit (SMD) during this period. This is a measure of the amount of rainfall required to be added to the soil to restore it to field capacity. An average value

for July is about 75mm – 100mm which indicates that this is the quantity of rainfall which can be absorbed in the soil. However, the SMD value for July 2007 was about 1mm which indicates that the ground was already saturated when the event occurred. These are the sort of antecedent conditions normally associated with winter rainfall events and it is unusual for them to occur in the summer.

The consequence of this rainfall event was to cause high surcharge at the culvert inlet in the village. Ultimately the pressure from the static head of water forced the brick wall around the culvert inlet to fail and the centre of the village was flooded. As the water levels continued to rise flood water was routed along Church Lane and flooded a number of low lying properties. Properties which are at risk of flooding are shown on Plan 2 in Appendix A.

2.2 Flooding Event - 13th December 2008

The effects of this rainfall event were recorded by one of the residents and are contained in Appendix C. It was also possible to obtain rainfall data for this event from a local rain gauge which had been deployed by a flow survey contractor.

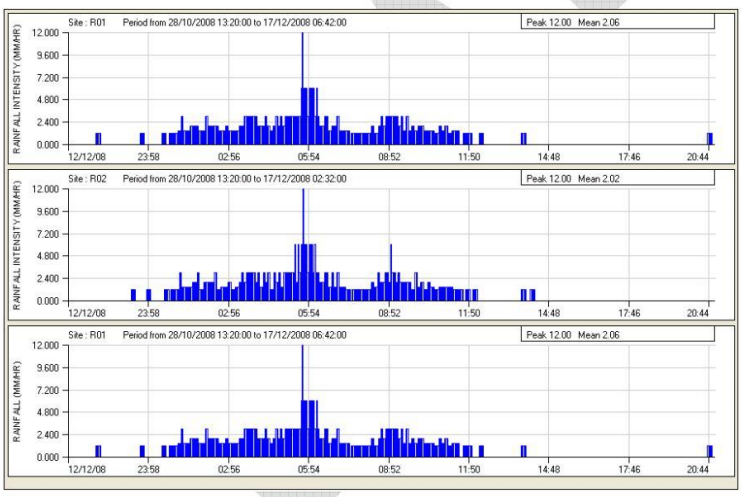


Figure 2 – Rainfall Intensities and durations for 13th December 2008.

This rain gauge indicated that 23 mm of rainfall occurred in approximately 12 hours on the 13th December. This is not particularly excessive rainfall and would equate to a return period of about 1 in 1 year (Flood Studies Report methodology). The SMD value for Warwickshire for December 2008 was again about 1 mm which compares to an average for this time of year of 10 mm. So again this indicates that the preceding conditions are critical to flooding as well as the depth and duration of rainfall.

2.3 Third Party Ownerships and Liaison

The Bourne Brook has the status of an ordinary watercourse. Whilst North Warwickshire Borough Council (NWBC) has permissive powers to carry out flood defence works, there are also a number of other parties that have responsibilities and contributions to the performance of the watercourse.

NWBC – have overall responsibility for the ordinary watercourses within the Council boundary.

Warwickshire County Council (WCC) – the highway authority responsible for the culverted section of the Bourne Brook which runs beneath the public highway and footpaths. They are also responsible for any highway drains which discharge to the Bourne Brook.

Highways Agency (HA) – responsible for the M6 motorway which discharges un-attenuated runoff to the head of the Bourne Brook.

Various riparian owners – where the Bourne Brook runs through privately owned land, the land owner has "riparian" ownership of the watercourse and is responsible for the maintenance of that section. These include Punch Taverns who own the Manor House PH and various private residences.

Severn Trent Water – are responsible for the public surface water sewers which discharge to the watercourse.

NWBC has contacted the Highways Agency (HA) with a view to include them in the problem solving process and to obtain the original drawings of the M6 drainage plans.

Severn Trent Water has been contacted to investigate the storm water and foul combined sewer system

WCC has been contacted to look at the surface water run off and as a riparian owner for a large section of culvert. An internal survey of the village culvert for its length within the public highway was commissioned by WCC any obstructions were removed at the time of the survey. A length of the culvert was also subsequently relined.

Other works which also been carried out include securing an eroded bank using a gabion retaining wall and the channel realigned to line up with the Nuneaton Road Bridge.

3 Modelling Methodology

3.1 Model Build

To provide a tool for the analysis of the Bourne Brook, a computer hydraulic model was required. Modelling was carried out using InfoWorks RS produced by Wallingford Software. As a basis for the model a topographical survey was carried out of the main watercourse channel and flood plain.

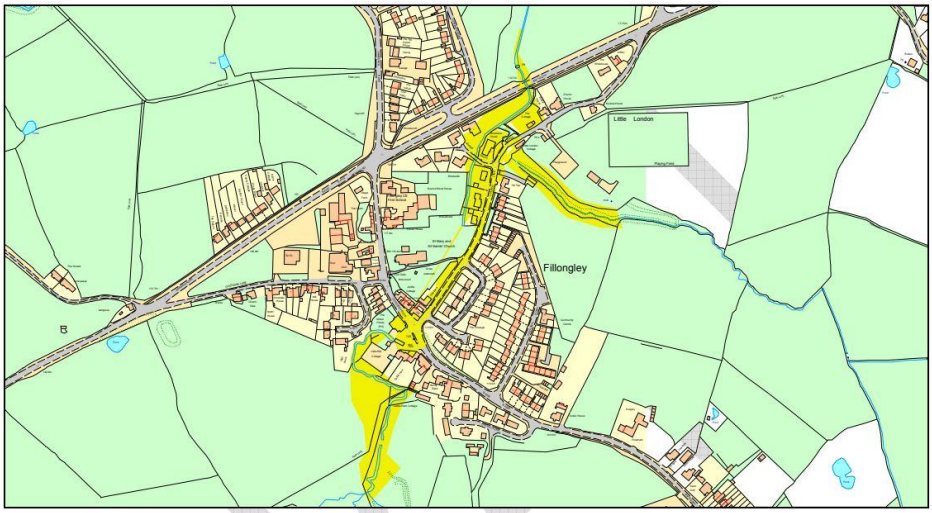


Figure 3 – Extent of Survey Work (Highlighted Yellow)

The model included a representation of the main watercourse channel from the Ancient Monument which is about 300m upstream of the village. The model includes the culverted section of the watercourse through the centre of the village. The culvert consists of a twin 900mm barrel circular pipe. The model also includes a representation of the known flooding mechanism in the centre of the village. The headwall around the culvert inlet is included as a weir which spills to a storage area in the centre of the village. The storage area can also spill to Church Lane which acts as a natural flood route. The above ground flood route along Church Lane discharges back into the main channel further downstream adjacent to the Little London tributary.

3.2 Model Hydrology

Inflows into the model have been generated using the Flood Estimation Handbook (FEH) and the revitalised Rainfall Runoff Method. The details of the calculation of flows for the 100 year event for the Bourne Brook and the Little London Tributary are contained in Appendix B.

	Catchment Inflows				
	100 Yr (m3/s)	**75 Yr (m3/s)**	**50 Yr (m3/s)**	**25 Yr (m3/s)**	**10 Yr (m3/s)**
Bourne Brook Inflows	3.3	3.1	2.8	2.4	1.9
Little London Tributary Inflows	0.9	0.9	0.8	0.7	0.5
Total Inflows	**4.2**	**4.0**	**3.6**	**3.1**	**2.4**

Table 1 – Catchment Hydrology

3.3 Model Flood Mechanisms

The pipe full capacity of the culvert through the village is 1.4 m^3/s, which is exceeded by all of the design events. The lack of capacity in the culvert is the primary cause of flooding in the catchment. The flooding mechanisms are shown on Plan 3 in Appendix A.

The flooding mechanisms included in the model are:

- Culvert capacity is exceeded and water levels rise at the culvert entrance. The top of the wall around the culvert inlet is at a level of 115.1mAOD. This has been modelled as a weir which directly to the centre of the village. In reality (and also in the model) it is unlikely that the wall will over top at this location because there are a number of other mechanisms which will relieve the system first.

- The lowest gulley in the village is outside of the Post Office and has a level of 113.3mAOD. This has been represented in the model to allow water to back-up the gulley connection and flood the road. The level of this gulley is only 0.65m above the culvert invert although it does require additional head to pressurise the system. Although this is the first location to flood there are a number of other gulley connections in the village which will also flood if the water level continues to rise. **(Flood Mechanism A)**

Flood Mechanism A

- The brickwork around the headwall is in a poor condition. Water can therefore escape through the gaps in the mortar. This has been modelled but the extent to which it occurs has been estimated. This can occur when the water level rises above the external ground level at 114.0mAOD which is 1.6m above the culvert invert. **(Flood Mechanism B).**

Flood Mechanism B Flood Mechanism C

- Further upstream from the culvert inlet in the rear garden of the Manor House PH the wall protecting the surrounding areas drops to a lower level of 114.75mAOD which is 2.3m above the culvert invert. This has been modelled as a weir which spills directly to the centre of the village. **(Flood Mechanism C).**

- It also known that the event on the 20th July 2007 caused the wall around the culvert entrance to collapse. This process has not been represented in the model. However assuming that this does not normally occur, the final flooding mechanism will be the wall being breached at a level of 115.1mAOD. **(Flood Mechanism D).**

Flood Mechanism D

3.4 Model Results

The model has been simulated using a range of design return period rainfall events (10yr, 25yr, 50yr, 75yr and 100yr). The critical duration for the catchment was found to be 14 hours in accordance with the FEH procedure.

The model shows that flooding is predicted to occur for all events which have been simulated. The lowest property threshold level is 113.4 mAOD at the Post Office. This is exceeded by the 10 year event where a water level of 113.799 mAOD is predicted. For the 100 year event a water level of 113.975 mAOD is predicted.

This is corroborated by the known flooding history. In section 2.2 it was shown that the event was in the region of a 1 year event. The observed flood levels for this event are less than the predicted flood levels for the 10 year event. To provide further confirmation of the performance of the model it is intended to simulate a 1 year design event and compare the predicted levels with the observed levels taken from photographs for the 13th December 2008.

4 Impact of the M6 Motorway

As built construction drawings of the M6 were provided to NWBC by the Highways Agency, Management Agency Contractor for Area 9 (MAC9). At the time of request Optima were the MAC 9 agent, who has since been replaced by Amey Highways. This information has enabled more concise analysis to be undertaken of the contributing area of the M6 to the catchment.

An analysis has been carried out of the contribution to the overall catchment runoff of the M6 motorway.

	Catchment Inflows				
	100 Yr (m3/s)	**75 Yr (m3/s)**	**50 Yr (m3/s)**	**25 Yr (m3/s)**	**10 Yr (m3/s)**
Total Inflows	4.2	4	3.6	3.1	2.4
Motorway Runoff Contribution	0.76	0.7	0.62	0.5	0.37
Percentage Contribution from Motorway	18%	18%	17%	16%	15%

Table 2 – Percentage runoff contribution from M6 motorway

This table shows that the contribution from the M6 motorway is significant but it is not the main source of runoff in the catchment. The model has been simulated with a 100 year event with all of the motorway contribution removed. This was not sufficient to prevent flooding from occurring but did reduce the impact.

Recommended Action: - flood routing from the M6 should be examined in more detail. A possible solution would be to ascertain if there was sufficient space within the confines of the M6 boundary to provide a swale or pond storage system to attenuate the flows.

As an alternative, negotiations should take place with the MAC 9 agent to provide a percentage of the costs towards flood alleviation works elsewhere. There is currently no legal obligation for the Highways Agency to make a contribution for motorway runoff and the right of connection to the watercourse cannot be removed.

5 Proposals to Alleviate Flooding

The information compiled in the first sections of the report has formed the basis for the various scheme options. An estimated cost of constructing the schemes has also been determined. **These costs do not allow for feasibility, design, contract preparation, or supervision costs, or any works proposed to the various organisations or private individuals involved.**

A summary of the effects of each of the options is given in the following table followed by a more detailed discussion of each of the options and the advantages and disadvantages of each.

	Flood Volume m^3								
		Option A	Option B	Option C	Option D	Option E1	Option E2	Option E3	Option E4
Event	Existing	Fit Non-Return Valves to highway and private gullies	As Option A with 5,200m3 balancing pond upstream	As Option A with reconstruction of 35m of headwall	As Option C with 6,700m3 balancing pond upstream	Temporary flood barrier around Bell Cottages (36m)	Temporary flood barrier around Manor House Pub (47m)	Temporary flood barrier around Post Office (60m)	Temporary flood barrier around Church Lane (82m)
10yr	457 m^3	30 m^3	30 m^3	0	0	0	0	0	0
25yr	1,936 m^3	1,292 m^3	1,052 m^3	0	0	0	0	0	0
50yr	4,584 m^3	3,777 m^3	2,497 m^3	0	0	0	0	0	0
75yr	6,767 m^3	5,911 m^3	3,553 m^3	1,334 m^3	0	0	0	0	0
100yr	8,703 m^3	7,947 m^3	4,109 m^3	3,127 m^3	0	0	0	0	0
Cost		**£63,100**	**£640,821**	**£170,000**	**£918,064**	**£14,700**	**£8,500**	**£24,500**	**£14,800**

Table 3 Comparison of the Effects of Each Option on Predicted Flood Volume (m^3)

As a comparison of where the events recorded over the last couple of years would equate to these events. The event on 20th July 2007 would be between the 25 year and 50 year event. The event on the 13th December 2008 would be less than the 10 year event.

5.1 Option A – Gulley Isolation

This option proposes to alleviate the flooding from flooding mechanism A which was identified in section 3.3. The first cause of flooding in the village occurs when water backs up through the highway gullies and floods the highway. This option involves fitting non-return valves to all of the surface water sewers and highway drains which discharge directly to the brook. This will prevent flows from backing up and flooding out of the highway gullies.

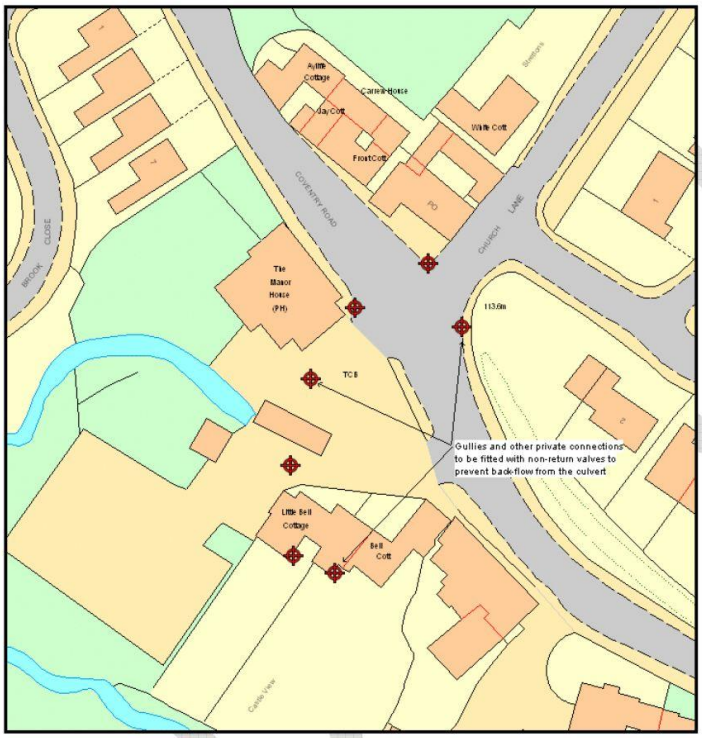


Figure 4 – Option A

As shown in Table 3 this option does not prevent flooding for any of the design events but it does reduce the volumes significantly.

5.1.1 Environmental Impact

The works are all within the existing highway and non highway areas. There will be some low level excavations within the highway but the environmental impact of these will not be significant.

5.1.2 Advantages

- Relatively low construction cost.

- Good level of protection for events of less than 50 year return period.

5.1.3 Disadvantages

- Detailed surveys will be required to discover where all the gulley connections are. The option has been based on five new manholes with non-return valves and connecting pipe work. The assumption has also been made that the location of existing utility services will allow sufficient space for these proposals. As part of the feasibility works it will be necessary to investigate utility and gulley locations to ensure that this option can be constructed. It should therefore be noted that the cost of this option may be subject to change.

- This option relies on being to identify every direct connection to the culvert. It is known that some of the properties have private surface water connections onto the watercourse. There is a risk that if any connections are missed then they will continue to flood despite all the measures taken elsewhere.

- There is a risk that the culvert pressurising will cause damage to road surface or manhole covers under surcharge conditions. It will therefore be necessary to carry out a structural assessment of the carriageway construction. This would be carried out at the feasibility stage and could potentially prevent the scheme from going ahead.

- There is a residual risk with this option that flooding will continue to take place. The non-return valves will prevent back flows from the watercourse from flooding out through the road gullies onto the highway and surrounding areas. However, when the valves close off to prevent back flows they will also prevent runoff from the highway from draining away. The volume of highway runoff will be significantly less than the back flows from the water course. This effect will therefore need to be fully quantified and considered during the feasibility stage. It may be possible to mitigate the effect by providing some localised storage on the surface water system.

- There will be some disruption to village traffic during works.

- It will be necessary to obtain third party permission (STW, highway authority or residents). There is no reason why this permission would be withheld but this could potentially affect the progress of the scheme.

5.2 Option B – Gulley Isolation with Storage (5,200m³)

This option includes the details of Option A (gulley isolation) but also has the provision of storage in the fields upstream of Fillongley to attenuate the flows.

A storage area of approximately 5,200m3 to be excavated in the fields up stream of Fillongley and the gully connections are to be retro fitted with non-return valves to isolate them from the culvert structure in the event of a surcharge state.

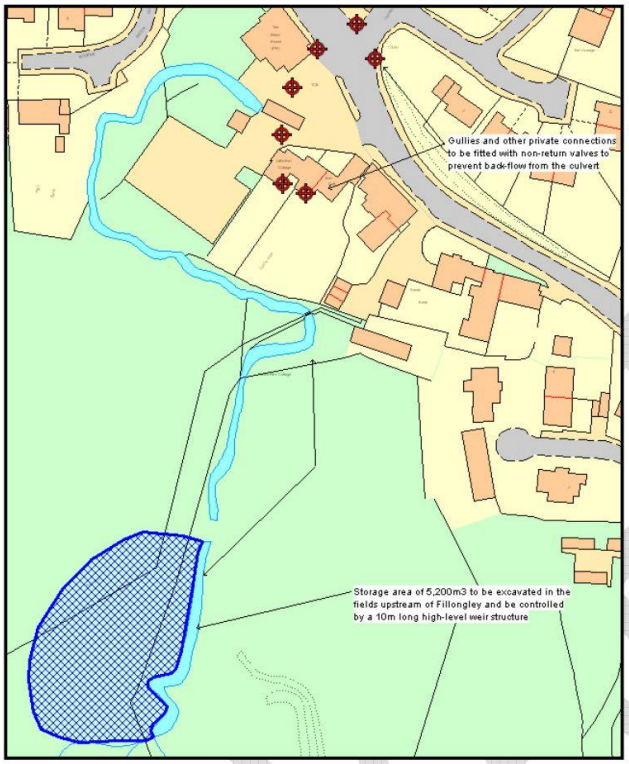


Figure 5 – Option B

5.2.1 Environmental Impact

As this option requires significant ground excavations in the vicinity of the watercourse, an Environmental Impact Assessment is likely to be required.

5.2.2 Advantages

- Significantly reduction in the flooding for all events.

5.2.3 Disadvantages

- This option has the same disadvantages as Option A as well as some others.
- Despite the cost this option does not fully mitigate the flooding for any storm event.
- There are possible land acquisition issues for the storage pond. For the purposes of this assessment the location of the storage pond has not been explored in detail. It would be beneficial to locate the storage area upstream of the ancient monument site as this will mitigate exposures to planning delays. A check on the land upstream of the ancient monument has

revealed that there is “no registered estate”. This may therefore delay proceedings whilst due process is followed to establish if there is a land owner.

- Agreement with land owners will also be necessary for access during the construction phase and for maintenance. This may well delay or potentially stop the proposals being implemented.

5.3 Option C – Gulley Isolation and Headwall Reconstruction

This option contains all the elements of option A but additionally the wall surrounding the watercourse adjacent to the manor house public house is to be demolished and reconstructed, using waterproofing and retaining measures. This will effectively protect the village from flooding mechanisms A, B and C which were discussed in Section 3.3. This will increase the head on the system and increase the pressurising of the culvert.

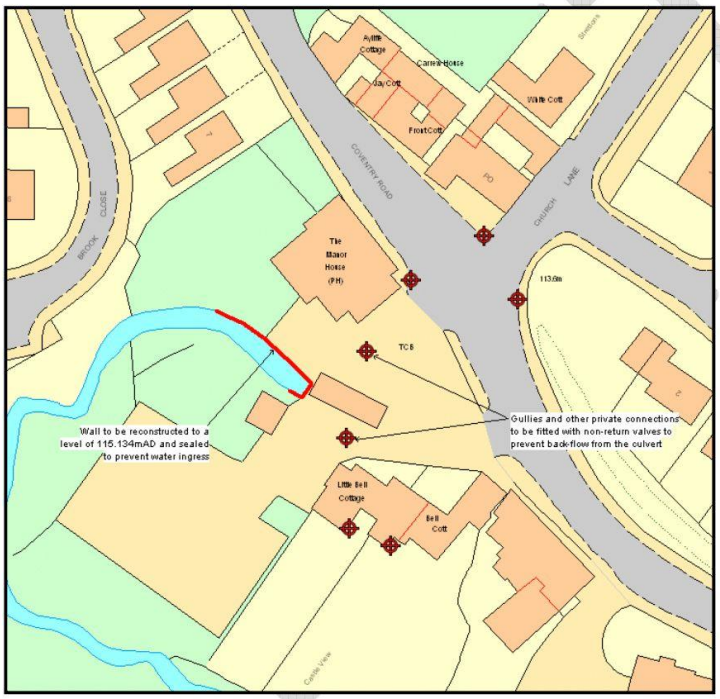


Figure 6 – Option C

5.3.1 Environmental Impact

As this option requires construction work directly over the watercourse an Environmental Impact Assessment is likely to be required.

5.3.2 Advantages

- Predicted flooding prevented for up to 50 year flood periods.

- Relatively low construction cost.

5.3.3 Disadvantages

- This option has the same disadvantages as Option A but also has some additional ones to be considered.
- Work on the wall would require third party agreement with the Brewery (Punch Taverns). There is no foreseeable reason why this would be withheld but the negotiations may delay the process.
- A foot bridge in the pub garden would need to be removed or altered to make allowance for the retaining wall.

5.4 Option D - Gulley Isolation and Headwall Reconstruction with Balancing Pond (6,700m³)

This option includes the details of Option C (gulley isolation and wall reconstruction) but also has the provision of storage in the fields upstream of Fillongley to attenuate the flows.

This option would require a two pond system. The favoured location for the two pond system would be upstream of the castle. This would be constructed by excavating and using the excavated material to construct a small embankment. At its base would be a 1250m diameter culvert with a penstock flow control device that can be adjusted to control the depth of water in the pond. There would be the need to provide an overtopping spillway which could be constructed using reinforced grass so that should flows exceed the design storm event of 1 in 100 years the flows can flood route on at this location.

Access roads can be constructed from high ground to allow for maintenance and inspections to be carried out when required in flooding periods.

The sites are currently are not agriculturally cropped and appear to be set aside for grazing land or for natural and wild flow meadow that could transform into a holding area with improved habitat area and could become a location of special scientific interest home to many species of wildlife with a dipping platform that can be used by local schools.

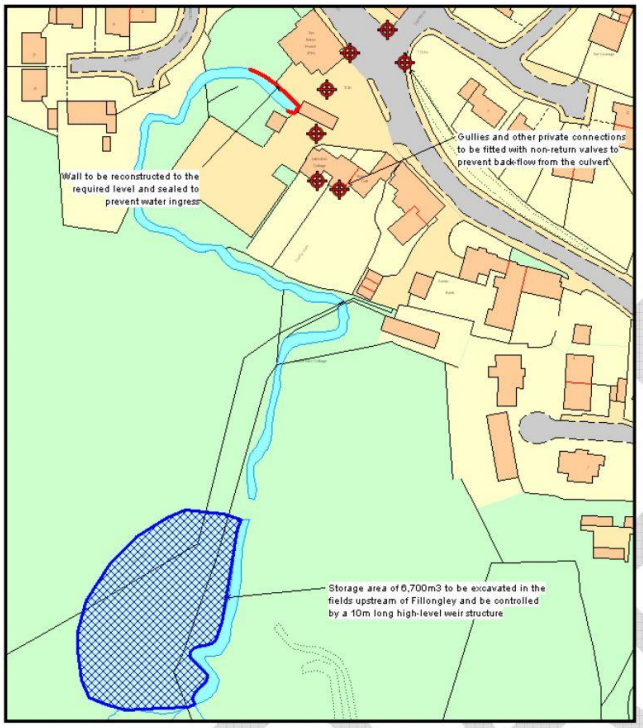


Figure 7 – Option D

5.4.1 Environmental Impact

As this option requires construction work directly over and adjacent to the watercourse an Environmental Impact Assessment is likely to be required.

5.4.2 Advantages

- The construction of the balancing pond area may offer an opportunity to encourage wild life and plants. This could be used for the local schools to visit to see a habitat area.
- Predicted flooding is prevented for events up to 100 year return periods.

5.4.3 Disadvantages

- This option has the same disadvantages as Option C but also has some additional ones to be considered.
- There are possible land acquisition issues for the storage pond. For the purposes of this assessment the location of the storage pond has not been explored in detail. It would be beneficial to locate the storage area upstream of the ancient monument site as this will mitigate exposures to planning delays. A check on the land upstream of the ancient monument has

revealed that there is “no registered estate”. This may therefore delay proceedings whilst due process is followed to establish if there is land owner.

- There would be a long term inspection and maintenance issue for the balancing ponds.
- Significant construction cost to construct flood storage area.

5.5 Option E – Temporary Flood Barriers

This option includes the provision of demountable flood barriers at four separate locations. Each of these locations could be promoted in isolation from the other, for this reason sub-options have been designated for each location. The flood barrier would have to be manually deployed when a flood is imminent. As they are dependent on manual intervention there is a risk of failure if a sudden flood occurs overnight.

There are a multitude of flood barrier products available on the market. For the purposes of this assessment the costs are based on a simple self-weighting barrier. These require the weight of the incoming flood water to provide ballast and are at the low-cost end of the market.

Figure 8 – Typical Self-Weighting Flood Barrier

Other types of products are available, including self-closing flood barriers, but the costs vary considerably. A full assessment of the different products should be undertaken and the relative advantages and disadvantages of each considered.

NWBC has secured funding from the Department of Environment, Food and Rural Affairs (Defra) for property-level flood protection measures to be implemented at the 14 properties which are at risk of flooding. This is provided so that each property can be provided with flood protection measures at the point that water enters the property. From initial discussions with Defra’s representatives it does not appear that this funding could be used to contribute to Option E solutions as these options protect groups of properties and not individual properties.

This type of solution relies on the intervention of a local flood warden or the local residents to be effectively deployed. As the response time of the watercourse to rainfall is likely to be less than an hour, it will be necessary to act quickly to ensure that the flood barriers can be deployed in time. As the water course is not a Main River it will not be part of the flood warning system operated by the Environment Agency. The only currently available warning system would be to use the Met Office severe weather warnings. However, these are indicative of weather only and not an indication that flooding is likely to occur. To provide adequate warning of an imminent flood it is recommended that a flood warning system is utilised in the village. Initial discussions with a manufacturer have identified a mechanism for doing this. It is proposed to use two wall mounted water sensors fitted to the headwall around the culvert inlet. The height of the monitors would be set so that one gave an early warning of the rising water levels and the second a final warning of impending flood. They would be linked to a modem and mobile phone sim card so that a text message could be sent to a number of pre-set mobile phone numbers. The cost of the flood warning system has still to be finalised so it has not been included in these option costs but it will be explored in more detail if this option is promoted.

5.5.1 Option E1 – Temporary Flood Barriers at Bell Cottages

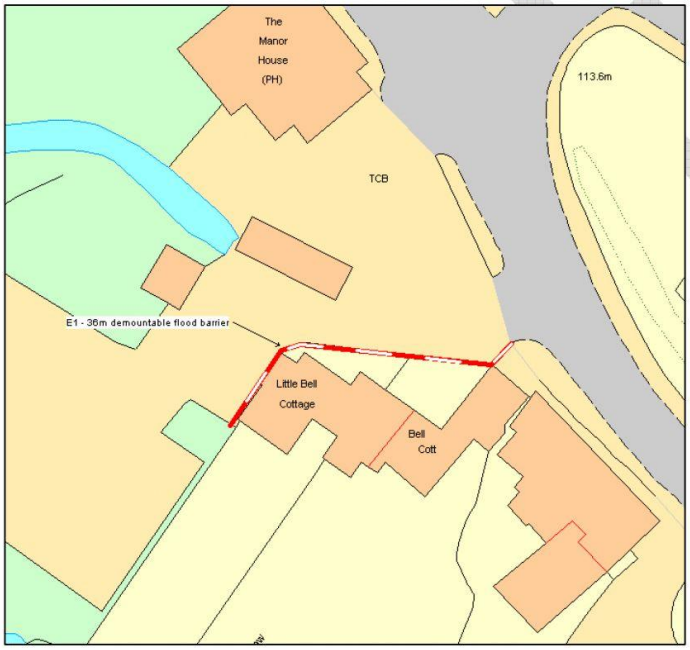


Figure 9 – Option E1

This option would effectively isolate Little Bell Cottage and Bell Cottage from the flood water. Due to the topography of the surrounding ground the properties cannot flood from the rear. When deployed this barrier would block the footpath on the south side of Coventry Road. It would therefore need to be agreed with the Highway Authority so that it can be deployed in an emergency. From discussions with

the Environment Agency it is understood that permission has been granted by other Highway Authorities for such measures.

5.5.2 Option E2 – Temporary Flood Barriers at Manor House PH

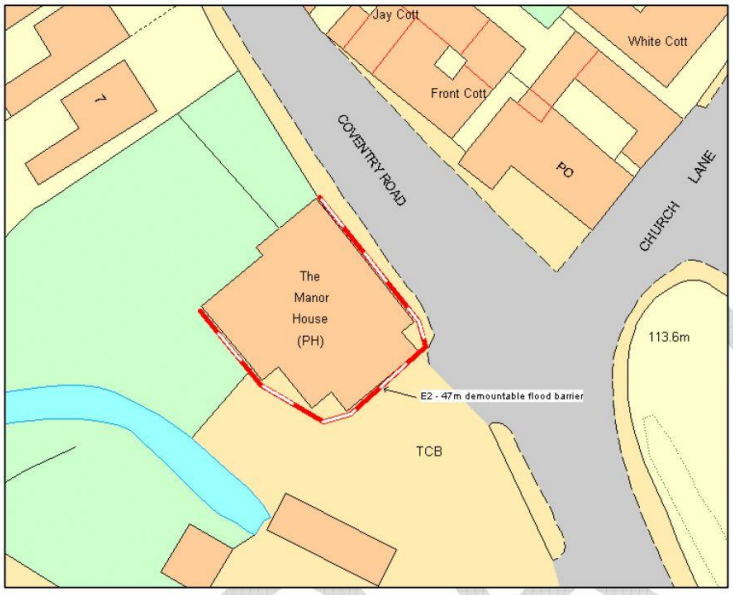


Figure 10 – Option E2

This option provides a temporary flood barrier to protect The Manor House PH in isolation from all other properties. Due to the topography of the ground The Manor House will not be subject to flooding from the north west side. The Manor House is also used as a private residence by the landlord so this barrier will not just be protecting a commercial property.

5.5.3 Option E3 – Temporary Flood Barriers at Post Office

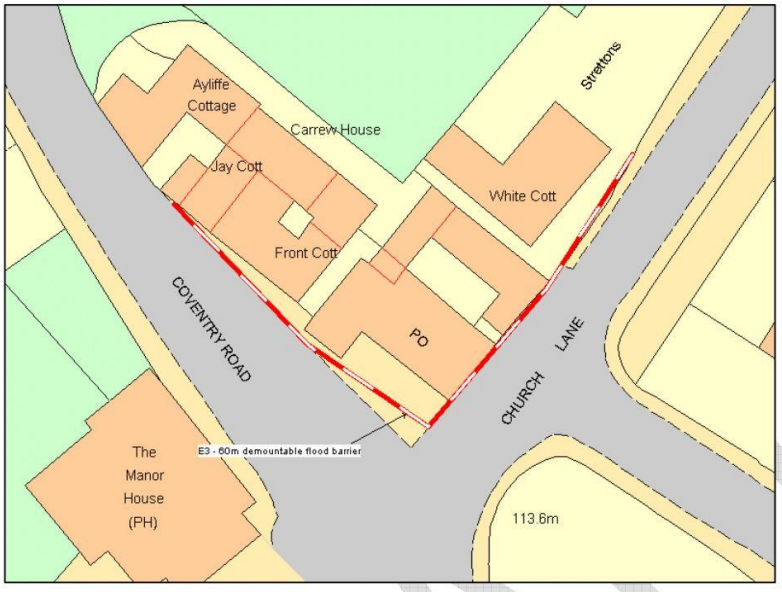


Figure 11 – Option E3

This option provides a temporary flood barrier to protect the cluster of properties at risk of flooding around the Post Office. When deployed this barrier would block part of the footpath on the north side of Coventry Road. It would therefore need to be agreed with the Highway Authority so that it can be deployed in an emergency. From discussions with the Environment Agency it is understood that permission has been granted by other Highway Authorities for such measures.

5.5.4 Option E4 – Temporary Flood Barriers at Church Lane

Figure 12 – Option E4

This option provides a temporary flood barrier to protect the three properties at risk of flooding along Church Lane. The flood barrier would protect the properties from flood waters which have been routed along Church Lane from the centre of the village. It would not protect the properties from flood water directly from the watercourse in the rear gardens. From the analysis carried out the greater flood risk comes from the centre of the village as the culvert is the main restriction. When deployed this barrier would block part of the footpath and highway around Church Lane and Adkins Croft. It would therefore need to be agreed with the Highway Authority so that it can be deployed in an emergency. From discussions with the Environment Agency it is understood that permission has been granted by other Highway Authorities for such measures.

5.5.5 Environmental Impact

As these are temporary demountable barriers no Environmental Impact Assessment would be required.

5.5.6 Advantages

- These options are relatively inexpensive compared to other flood mitigation measures.
- The flood barriers could be used for other purposes such as traffic delineation.

- They are relatively easy to store and deploy.

5.5.7 Disadvantages

- As this system requires manual deployment there is a risk of failure if there is insufficient time to respond to an event. An integral part of this system would therefore be to fit a high level alarm at the culvert to give warning of imminent flooding.
- The flood barriers would need to be stored somewhere locally.
- They would not be easy for elderly residents to deploy. It would therefore be beneficial to encourage a community flood group to take responsibility for deployment.
- Permission would be required from the Highway Authority so that they can be deployed in an emergency (i.e without referring to the Highway Authority).

6 Maintenance Issues

6.1 The Fillongley village culvert and downstream watercourse

Trash screens should be constructed at the entrances to the culverted sections of watercourse within the village of Fillongley and on any proposed inlets to control structures within the flood storage areas upstream of the village. This is to safe guard the culverted sections from becoming blocked with debris. Although there are costs associated with the maintenance of the screens this would minimal compared to the costs involved in removing blockages from culverts as this will require specialist contractors and machinery.

The screens should be constructed from suitable materials so that vandalism has minimal effect on them and so that they are structurally sound enough to take the weight of the debris and the water loading.

The screen should be designed so that maintenance crews can use the structures in a safe manner but members of the public are prevented from accessing. Suitable safety fencing, gates and signage should be provided around the site of the screen along with tie off points for the crew. There should be a standing deck and the front face of the screen should be rack able. The screen should stop large debris entering the culvert but should still allow water to flow through the structure even when partly blocked. The structure should include a lockable access point so that the screen does not need to be removed in its entirety when maintenance staffs are checking the culvert for debris and sediment build up. Suitable access ways should be provided to the structures so that maintenance equipments can be brought to the structure by vehicle and then by hand. Access steps should also be provided to gain access to the channel bed in front of the screen. A temporary storage area for debris should be provided out of the area where the debris could be dragged back into the flow, so that material can dry off before transporting it to tip.

The proposed construction of trash screens will require a cleansing and structural inspection regime to be set up overseen by the local authority. Inspections should be carried out to monitor the build-up of debris on the screens and clearance works carried out as required. Failure to undertake inspections and clearance works will ultimately see the screens being blocked and the filling of the watercourse channel upstream before the overtopping of the structure.

The Fillongley catchment is very rural therefore it is envisaged that agricultural and natural waste will form the bulk of the debris collected on the trash screen with a small percentage of urban waste from potential fly tipping. The clearance works should be monitored and recorded on a suitable database with before and after pictures of the works carried out. Any issues arising from the debris collected should be taken up with upstream land owners and with Environmental Health should dangerous material be found.

It is advised that inspections are carried out initially on a high frequency before during and after storm events on an ad-hoc basis and once weekly on a routine basis over the first year. This is so that a history database can be set up of the recorded findings. Once the frequency of blockages is ascertained then

the regime can be a tailored to suit the area. Screens that block more frequently than others can be inspected and cleared on a 4 to 8 weekly basis.

7 Conclusions and Recommendations

This report has demonstrated that there is a risk of flooding to 14 properties in Fillongley. The catchment would appear to be particularly sensitive to flooding during periods when the catchment greenfield areas are saturated prior to a rainfall event. Under such circumstances the village is susceptible to flooding for rainfall events of 1 year return period and greater.

Anecdotal evidence indicates that there is a long history of flooding in the village. The two most recent events in 2007 and 2008 have a reasonable amount of supporting information available.

A hydraulic model has been built of the catchment and watercourse to examine the efficacy of flood prevention options. Each of these options is discussed in more detail in Section 5.

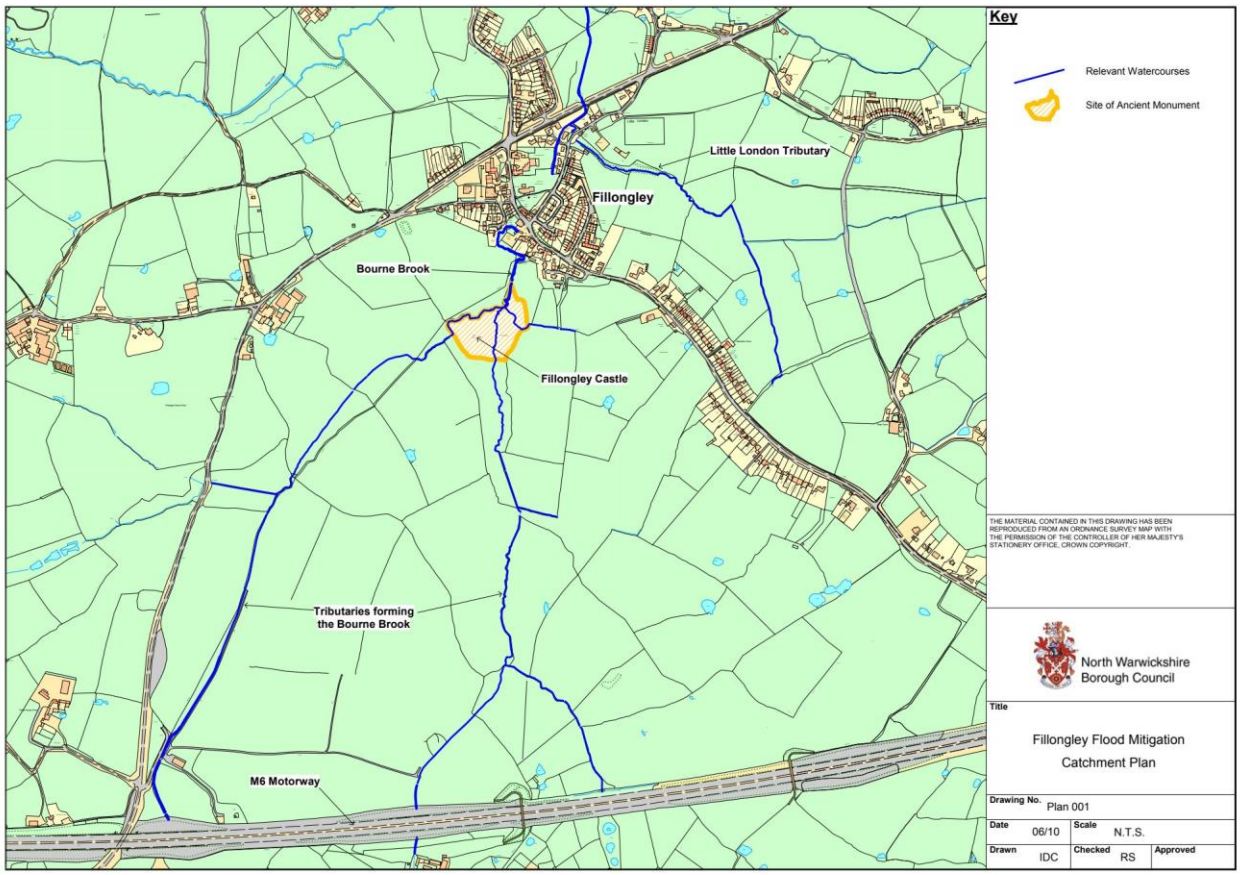
The recommended option is Option C which has a cost of **£170,000** and could be constructed in phases. The first phase would be the gulley isolation which is effectively Option A and has a cost of **£63,100**. The second phase would be to carry out the reconstruction of the headwall and has an additional cost of **£106,900**. When completed the model indicates that these measures would protect the village from flooding up to a 50 year event. There are a number of risks associated with this option which are explained in detail in Section 5.

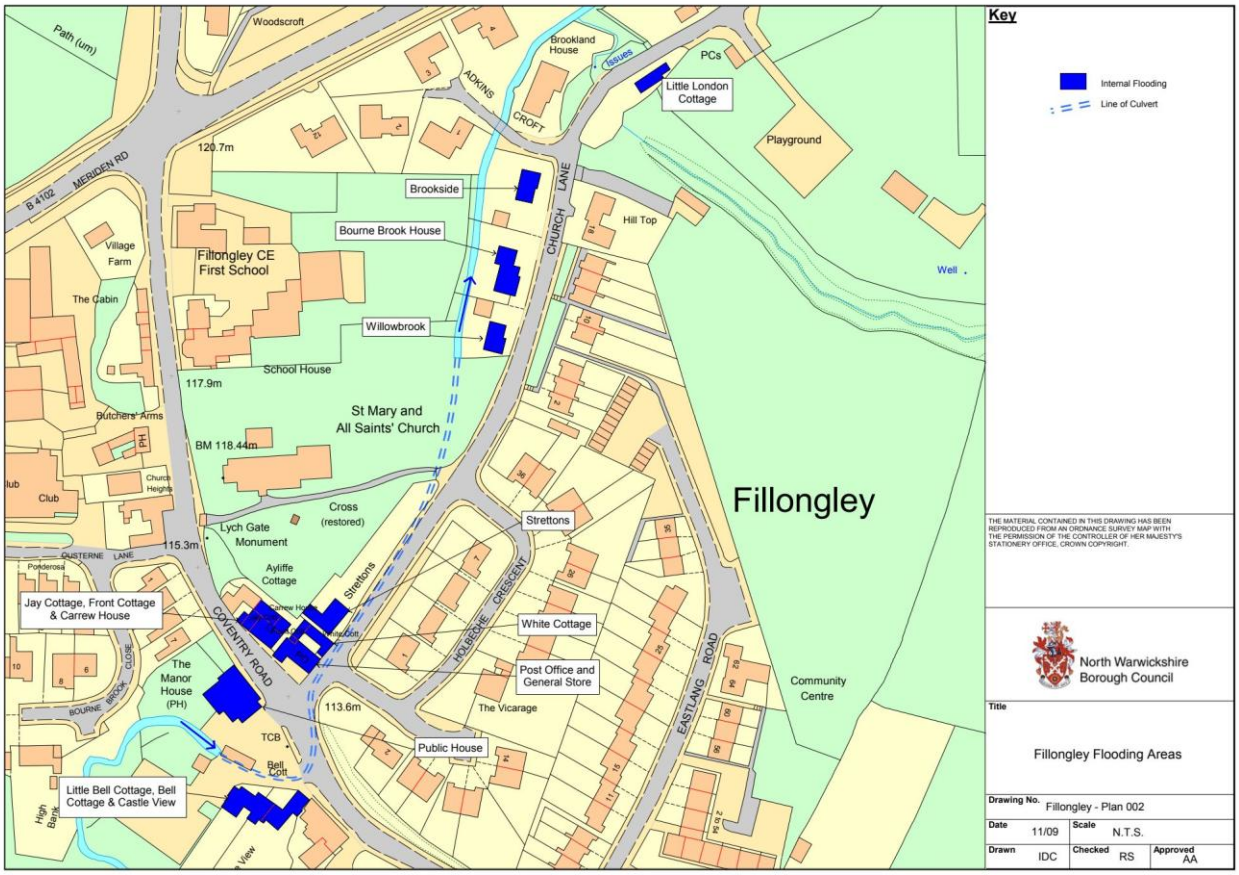
These costs do not allow for feasibility, design, contract preparation, or supervision costs, or any works proposed to the various organisations or private individuals involved.

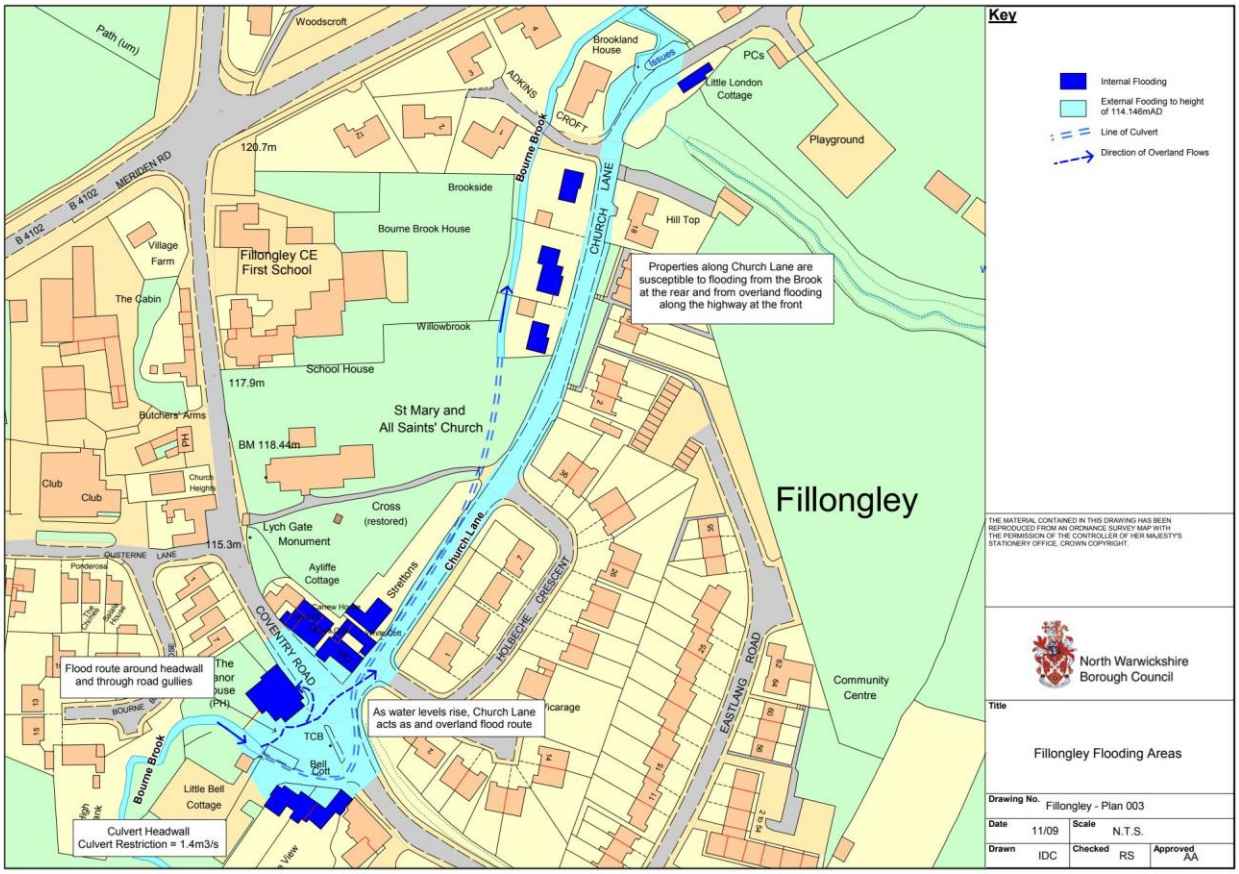
It is recommended that negotiations take place with the other stakeholders with a view to obtaining a contribution from them for the preferred option. It would seem to be reasonable that the cost of mitigating the effects of flooding are shared amongst the various agencies which contribute toward the problem. Negotiations should therefore take place with Severn Trent Water, Warwickshire County Council and the Highways Agency.

8 Appendices

Appendix A – Plans


Key
Relevant Watercourses
Site of Ancient Monument
Little London Tributary
Fillongley
Bourne Brook
Fillongley Castle
Tributaries forming the Bourne Brook
M6 Motorway
THE MATERIAL CONTAINED IN THIS DRAWING HAS BEEN REPRODUCED FROM AN ORDNANCE SURVEY MAP WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE, CROWN COPYRIGHT.
North Warwickshire Borough Council
Title
Fillongley Flood Mitigation Catchment Plan
Drawing No. Plan 001
Date 06/10
Scale N.T.S.
Drawn IDC
Checked RS
Approved


Key
Internal Flooding
Line of Culvert
Fillongley
Woodscroft
Path (um)
Brookland House
Issues
PCs
Little London Cottage
ADKINS CROFT
Playground
B 4102
MERIDEN RD
120.7m
Brookside
Bourne Brook House
CHURCH LANE
Hill Top
Village Farm
Fillongley CE First School
The Cabin
Willowbrook
School House
117.9m
St Mary and All Saints' Church
BM 118.44m
Butchers' Arms
Church Heights
Cross (restored)
Lych Gate Monument
115.3m
CUSTERNE LANE
Ayliffe Cottage
Strettons
Jay Cottage, Front Cottage & Carrew House
COVENTRY ROAD
HOLBERNE CRESCENT
White Cottage
The Manor House (PH)
BOURNE BROOK CLOSE
Post Office and General Store
The Vicarage
113.6m
EASTLANG ROAD
Community Centre
TCB
Public House
Bell Cott
Little Bell Cottage, Bell Cottage & Castle View
High Bank
Well
THE MATERIAL CONTAINED IN THIS DRAWING HAS BEEN REPRODUCED FROM AN ORDNANCE SURVEY MAP WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE, CROWN COPYRIGHT.
North Warwickshire Borough Council
Title
Fillongley Flooding Areas
Drawing No. Fillongley - Plan 002
Date 11/09
Scale N.T.S.
Drawn IDC
Checked RS
Approved AA


Key
Internal Flooding
External Fooding to height of 114.146mAD
Line of Culvert
Direction of Overland Flows
Properties along Church Lane are susceptible to flooding from the Brook at the rear and from overland flooding along the highway at the front
Flood route around headwall and through road gullies
As water levels rise, Church Lane acts as and overland flood route
Culvert Headwall
Culvert Restriction = 1.4m3/s
Fillongley
Woodscroft
Brookland House
PCs
Little London Cottage
Playground
Brookside
Bourne Brook House
Hill Top
Village Farm
Fillongley CE First School
The Gabin
Willowbrook
School House
117.9m
St Mary and All Saints' Church
BM 118.44m
Butchers' Arms
Club
Lych Gate Monument
Cross (restored)
115.3m
Ayliffe Cottage
Strefons
Church Lane
COVENTRY ROAD
HOLBEACHE CRESCENT
EASTLANG ROAD
Community Centre
The Manor House (PH)
TCB
Bell Loft
Little Bell Cottage
Bourne Brook
MERIDEN RD
B 4102
CHURCH LANE
CROFT
ADKINS
120.7m
THE MATERIAL CONTAINED IN THIS DRAWING HAS BEEN REPRODUCED FROM AN ORDNANCE SURVEY MAP WITH THE PERMISSION OF THE CONTROLLER OF HER MAJESTY'S STATIONERY OFFICE, CROWN COPYRIGHT.
North Warwickshire Borough Council
Title
Fillongley Flooding Areas
Drawing No. Fillongley - Plan 003
Date 11/09
Scale N.T.S.
Drawn IDC
Checked RS
Approved AA

Appendix B – Calculations

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application version 1.3

Catchment sheet

Catchment name: Bourne Brook at junction of Little London

Catchment Descriptors (Descriptors in bold are used within model)

File name: C:\SDA Projects\Fillongley\Fillongley\FEH Data\ds Fillongley.csv — Import Catchment Descriptors

FEH CD ROM version	1	Exported on		
Easting	428150	Northing	287300	
Area	5.87			
FARL	1	RMED-1H	10.8	
PROPWET	0.3	RMED-1D	32.6	
ALTBAR	148	RMED-2D	40.7	
ASPBAR	21	**SAAR**	709	
ASPVAR	0.33	SAAR4170	704	
BFIHOST	0.577	SPRHOST	32.7	
DPLBAR	2.23	URBCONC	0.483	
DPSBAR	44.3	**URBEXT1990**	0.018	essentially rural
LDP	4.19	URBLOC	0.706	
C	-0.027	C(1km)	-0.027	
D1	0.364	D1(1km)	0.365	
D2	0.323	D2(1km)	0.326	
D3	0.254	D3(1km)	0.257	
E	0.306	E(1km)	0.308	
F	2.377	F(1km)	2.373	

Catchment Comment:

Catchment Comment list: User comments

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application version 1.3

Rainfall sheet

Catchment name: Bourne Brook at junction of Little London

Specify design rainfall

Time Step (hr): 0.25
Duration (hr): 5.25

Return Period (yr): 100

Season: Winter (Recommended Season is Winter as URBEXT is less than 0.125)

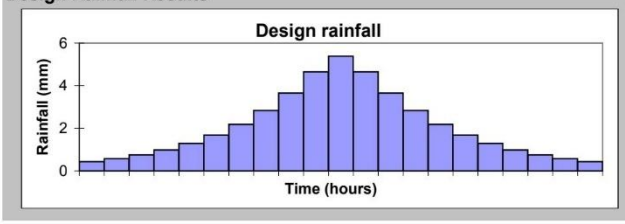
Seasonal Correction Factor
SCF method: ReFH Design Standard SCF: 0.69

Areal Reduction Factor
ARF method: ReFH Design Standard ARF: 0.96

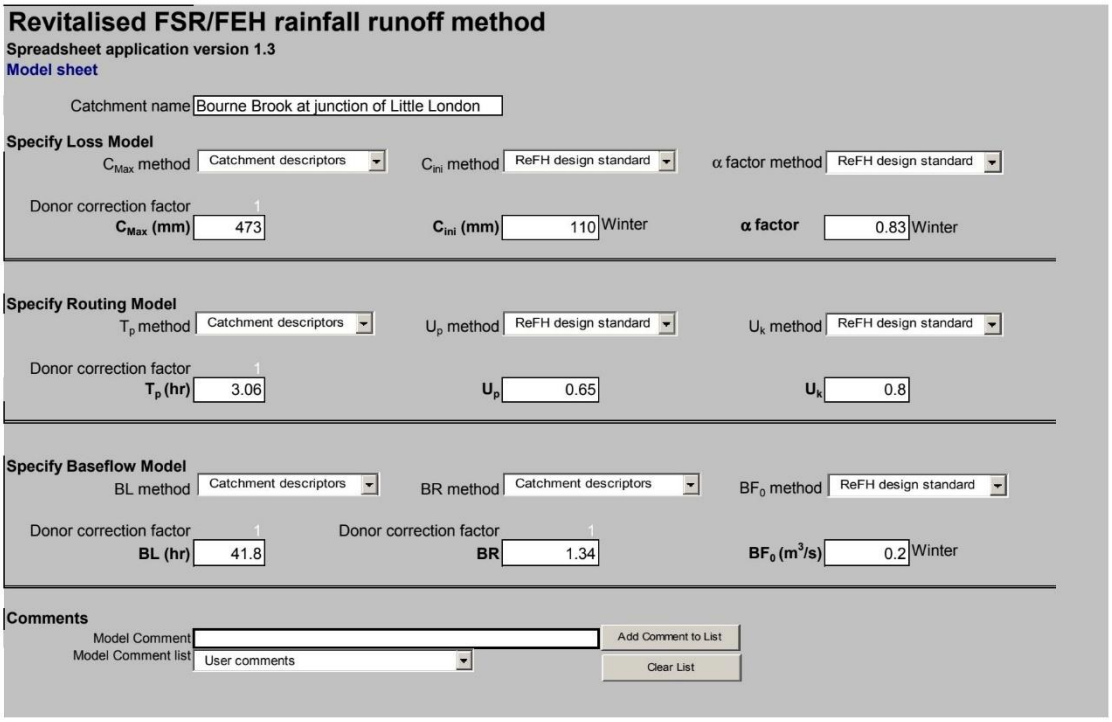
Rainfall Comment:
Rainfall Comment list: User comments

Add Comment to List
Clear List

Design Rainfall Results



FEH DDF Model rainfall (mm): 65.5
Design rainfall (mm): 43.5
Peak rainfall (mm): 5.4


Revitalised FSR/FEH rainfall runoff method
Spreadsheet application version 1.3
Model sheet
Catchment name Bourne Brook at junction of Little London
Specify Loss Model
C_{Max} method Catchment descriptors
C_{ini} method ReFH design standard
α factor method ReFH design standard
Donor correction factor 1
C_{Max} (mm) 473
C_{ini} (mm) 110 Winter
α factor 0.83 Winter
Specify Routing Model
T_p method Catchment descriptors
U_p method ReFH design standard
U_k method ReFH design standard
Donor correction factor 1
T_p (hr) 3.06
U_p 0.65
U_k 0.8
Specify Baseflow Model
BL method Catchment descriptors
BR method Catchment descriptors
BF_0 method ReFH design standard
Donor correction factor 1
BL (hr) 41.8
Donor correction factor 1
BR 1.34
BF_0 (m^3/s) 0.2 Winter
Comments
Model Comment
Model Comment list User comments
Add Comment to List
Clear List

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application version 1.3

Results sheet

Catchment name: Bourne Brook at junction of Little Londor

Easting 428150
Northing 287300

Model Parameters

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters		Catchment descriptors	
Return period (yr)	100	C_{max} (mm)	473	T_p (hr)	3.06	BL (hr)	41.8	URBEXT	0.018
Duration (hr)	5.25	C_{ini} (mm)	110	U_p	0.65	BR	1.34		
Timestep (hr)	0.25	α factor	0.83	U_k	0.8	BF_0 (m^3/s)	0.2		
Season	Winter								

Run Model

Generate Audit Report

Summary

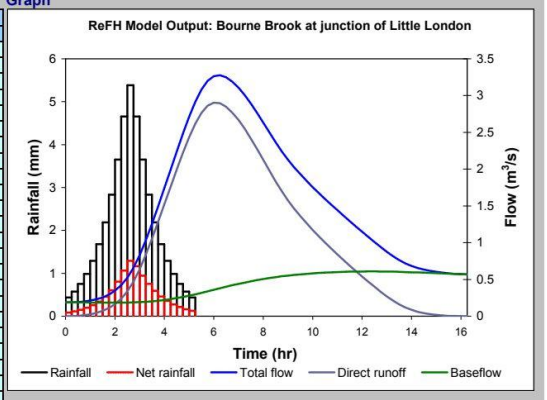
FEH DDF rainfall (mm)	65.5	Peak rainfall (mm)	5.4
Design rainfall (mm)	43.5	Peak flow (m^3/s)	3.3

Progress: Complete

Data

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Units	mm	mm	m3/s	m3/s	m3/s
0.00	0.4	0.1	0.0	0.2	0.2
0.25	0.6	0.1	0.0	0.2	0.2
0.50	0.8	0.1	0.0	0.2	0.2
0.75	1.0	0.2	0.0	0.2	0.2
1.00	1.3	0.3	0.0	0.2	0.2
1.25	1.7	0.3	0.0	0.2	0.2
1.50	2.2	0.5	0.1	0.2	0.3
1.75	2.8	0.6	0.1	0.2	0.3
2.00	3.7	0.8	0.2	0.2	0.3
2.25	4.7	1.1	0.2	0.2	0.4
2.50	5.4	1.3	0.3	0.2	0.5
2.75	4.7	1.2	0.5	0.2	0.7
3.00	3.7	0.9	0.6	0.2	0.8
3.25	2.8	0.8	0.8	0.2	1.0
3.50	2.2	0.6	1.1	0.2	1.3
3.75	1.7	0.5	1.3	0.2	1.5
4.00	1.3	0.4	1.5	0.2	1.7
4.25	1.0	0.3	1.8	0.2	2.0
4.50	0.8	0.2	2.0	0.2	2.2
4.75	0.6	0.2	2.2	0.3	2.5
5.00	0.4	0.1	2.4	0.3	2.7
5.25	0.0	0.0	2.6	0.3	2.9
5.50	0.0	0.0	2.8	0.3	3.1
5.75	0.0	0.0	2.9	0.3	3.2
6.00	0.0	0.0	2.9	0.4	3.3
6.25	0.0	0.0	2.9	0.4	3.3
6.50	0.0	0.0	2.8	0.4	3.2
6.75	0.0	0.0	2.8	0.4	3.2
7.00	0.0	0.0	2.7	0.4	3.1
7.25	0.0	0.0	2.5	0.5	3.0
7.50	0.0	0.0	2.4	0.5	2.9
7.75	0.0	0.0	2.3	0.5	2.8
8.00	0.0	0.0	2.1	0.5	2.6
8.25	0.0	0.0	2.0	0.5	2.5
8.50	0.0	0.0	1.8	0.5	2.4
8.75	0.0	0.0	1.7	0.5	2.2
9.00	0.0	0.0	1.6	0.6	2.1
9.25	0.0	0.0	1.5	0.6	2.0
9.50	0.0	0.0	1.4	0.6	1.9
9.75	0.0	0.0	1.3	0.6	1.8
10.00	0.0	0.0	1.2	0.6	1.8
10.25	0.0	0.0	1.1	0.6	1.7
10.50	0.0	0.0	1.0	0.6	1.6
10.75	0.0	0.0	0.9	0.6	1.5
11.00	0.0	0.0	0.8	0.6	1.4
11.25	0.0	0.0	0.8	0.6	1.4
11.50	0.0	0.0	0.7	0.6	1.3
11.75	0.0	0.0	0.6	0.6	1.2
12.00	0.0	0.0	0.5	0.6	1.1
12.25	0.0	0.0	0.5	0.6	1.1
12.50	0.0	0.0	0.4	0.6	1.0
12.75	0.0	0.0	0.3	0.6	0.9
13.00	0.0	0.0	0.3	0.6	0.9
13.25	0.0	0.0	0.2	0.6	0.8
13.50	0.0	0.0	0.2	0.6	0.8
13.75	0.0	0.0	0.1	0.6	0.7
14.00	0.0	0.0	0.1	0.6	0.7
14.25	0.0	0.0	0.1	0.6	0.7
14.50	0.0	0.0	0.0	0.6	0.6
14.75	0.0	0.0	0.0	0.6	0.6
15.00	0.0	0.0	0.0	0.6	0.6
15.25	0.0	0.0	0.0	0.6	0.6
15.50	0.0	0.0	0.0	0.6	0.6
15.75	0.0	0.0	0.0	0.6	0.6
16.00	0.0	0.0	0.0	0.6	0.6
16.25	0.0	0.0	0.0	0.6	0.6
Totals	43.5	10.4	10.4	4.4	14.8

Graph



Revitalised FSR/FEH rainfall runoff method

Spreadsheet application version 1.3

Catchment sheet

Catchment name: Little london Tributary

Catchment Descriptors (Descriptors in bold are used within model)

File name: C:\SDA Projects\Fillongley\Fillongley\FEH Data\Little London.csv — Import Catchment Descriptors

FEH CD ROM version	1	Exported on		
Easting	428200	Northing	287300	
Area	0.76			
FARL	1	RMED-1H	10.7	
PROPWET	0.3	RMED-1D	32.6	
ALTBAR	137	RMED-2D	40.6	
ASPBAR	300	**SAAR**	704	
ASPVAR	0.62	SAAR4170	704	
BFIHOST	0.419	SPRHOST	40.1	
DPLBAR	0.89	URBCONC	0.7	
DPSBAR	41.2	**URBEXT1990**	0.02	essentially rural
LDP	1.53	URBLOC	0.706	
C	-0.027	C(1km)	-0.027	
D1	0.362	D1(1km)	0.365	
D2	0.328	D2(1km)	0.326	
D3	0.253	D3(1km)	0.257	
E	0.306	E(1km)	0.308	
F	2.384	F(1km)	2.373	

Catchment Comment:

Catchment Comment list: User comments

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application version 1.3

Rainfall sheet

Catchment name: Little london Tributary

Specify design rainfall

Time Step (hr): 0.25
Duration (hr): 4.75

Return Period (yr): 100

Season: Winter (Recommended Season is Winter as URBEXT is less than 0.125)

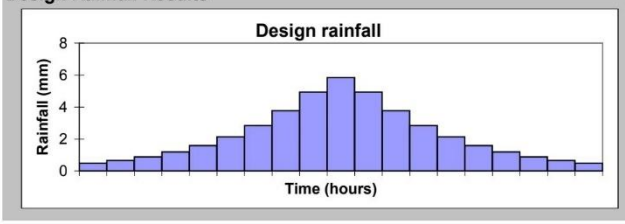
Seasonal Correction Factor
SCF method: ReFH Design Standard SCF: 0.68

Areal Reduction Factor
ARF method: ReFH Design Standard ARF: 0.98

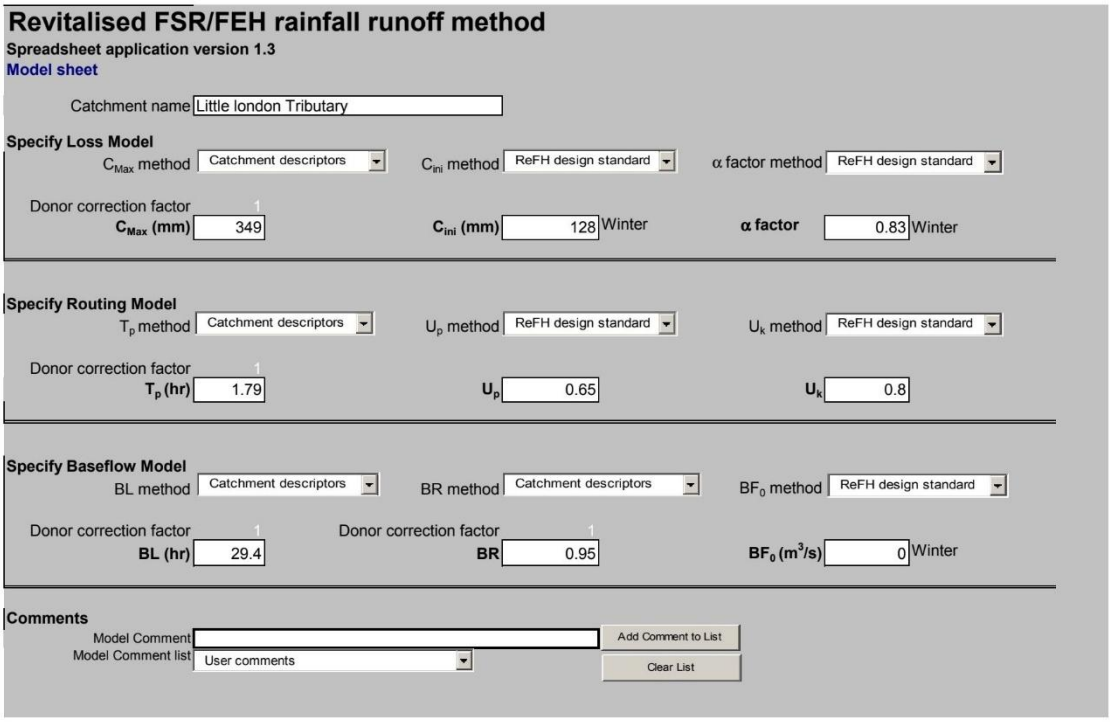
Rainfall Comment:
Rainfall Comment list: User comments

Add Comment to List
Clear List

Design Rainfall Results



FEH DDF Model rainfall (mm): 64.2
Design rainfall (mm): 42.8
Peak rainfall (mm): 5.8


Revitalised FSR/FEH rainfall runoff method
Spreadsheet application version 1.3
Model sheet
Catchment name Little london Tributary
Specify Loss Model
C_{Max} method Catchment descriptors
C_{ini} method ReFH design standard
α factor method ReFH design standard
Donor correction factor 1
C_{Max} (mm) 349
C_{ini} (mm) 128 Winter
α factor 0.83 Winter
Specify Routing Model
T_p method Catchment descriptors
U_p method ReFH design standard
U_k method ReFH design standard
Donor correction factor 1
T_p (hr) 1.79
U_p 0.65
U_k 0.8
Specify Baseflow Model
BL method Catchment descriptors
BR method Catchment descriptors
BF_0 method ReFH design standard
Donor correction factor 1
BL (hr) 29.4
Donor correction factor 1
BR 0.95
BF_0 (m^3/s) 0 Winter
Comments
Model Comment
Model Comment list User comments
Add Comment to List
Clear List

Revitalised FSR/FEH rainfall runoff method

Spreadsheet application version 1.3

Results sheet

Catchment name: Little london Tributary

Easting 428200
Northing 287300

Model Parameters

Design rainfall parameters		Loss model parameters		Routing model parameters		Baseflow model parameters		Catchment descriptors	
Return period (yr)	100	C_{max} (mm)	349	T_p (hr)	1.79	BL (hr)	29.4	URBEXT	0.02
Duration (hr)	4.75	C_{ini} (mm)	128	U_p	0.65	BR	0.95		
Timestep (hr)	0.25	α factor	0.83	U_k	0.8	BF_0 (m^3/s)	0		
Season	Winter								

Run Model

Generate Audit Report

Summary

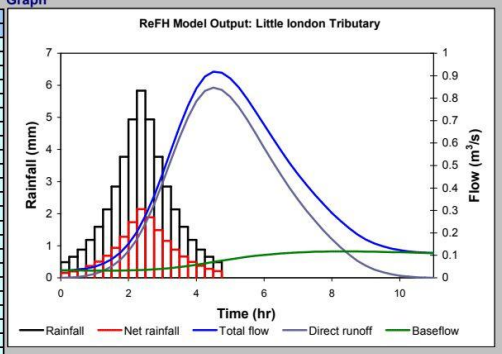
FEH DDF rainfall (mm)	64.2	Peak rainfall (mm)	5.8
Design rainfall (mm)	42.8	Peak flow (m^3/s)	0.9

Progress: Complete

Data

Series	Design Rainfall	Net rainfall	Direct runoff	Baseflow	Total flow
Units	mm	mm	m3/s	m3/s	m3/s
0.00	0.5	0.1	0.0	0.0	0.0
0.25	0.7	0.2	0.0	0.0	0.0
0.50	0.9	0.3	0.0	0.0	0.0
0.75	1.2	0.4	0.0	0.0	0.0
1.00	1.6	0.5	0.0	0.0	0.0
1.25	2.1	0.7	0.0	0.0	0.1
1.50	2.8	0.9	0.1	0.0	0.1
1.75	3.8	1.3	0.1	0.0	0.1
2.00	4.9	1.7	0.1	0.0	0.2
2.25	5.8	2.1	0.2	0.0	0.2
2.50	4.9	1.9	0.2	0.0	0.3
2.75	3.8	1.5	0.3	0.0	0.4
3.00	2.8	1.1	0.4	0.0	0.5
3.25	2.1	0.9	0.5	0.0	0.6
3.50	1.6	0.7	0.6	0.0	0.7
3.75	1.2	0.5	0.7	0.1	0.8
4.00	0.9	0.4	0.8	0.1	0.8
4.25	0.7	0.3	0.8	0.1	0.9
4.50	0.5	0.2	0.8	0.1	0.9
4.75	0.0	0.0	0.8	0.1	0.9
5.00	0.0	0.0	0.8	0.1	0.9
5.25	0.0	0.0	0.8	0.1	0.8
5.50	0.0	0.0	0.7	0.1	0.8
5.75	0.0	0.0	0.6	0.1	0.7
6.00	0.0	0.0	0.6	0.1	0.7
6.25	0.0	0.0	0.5	0.1	0.6
6.50	0.0	0.0	0.5	0.1	0.6
6.75	0.0	0.0	0.4	0.1	0.5
7.00	0.0	0.0	0.3	0.1	0.5
7.25	0.0	0.0	0.3	0.1	0.4
7.50	0.0	0.0	0.3	0.1	0.4
7.75	0.0	0.0	0.2	0.1	0.3
8.00	0.0	0.0	0.2	0.1	0.3
8.25	0.0	0.0	0.1	0.1	0.3
8.50	0.0	0.0	0.1	0.1	0.2
8.75	0.0	0.0	0.1	0.1	0.2
9.00	0.0	0.0	0.1	0.1	0.2
9.25	0.0	0.0	0.0	0.1	0.2
9.50	0.0	0.0	0.0	0.1	0.1
9.75	0.0	0.0	0.0	0.1	0.1
10.00	0.0	0.0	0.0	0.1	0.1
10.25	0.0	0.0	0.0	0.1	0.1
10.50	0.0	0.0	0.0	0.1	0.1
10.75	0.0	0.0	0.0	0.1	0.1
11.00	0.0	0.0	0.0	0.1	0.1
Totals	42.8	15.7	15.7	4.3	19.9

Graph



Appendix C – Photographs and Flooding History

Photographs of flooding – 20th July 2007


CAR PA

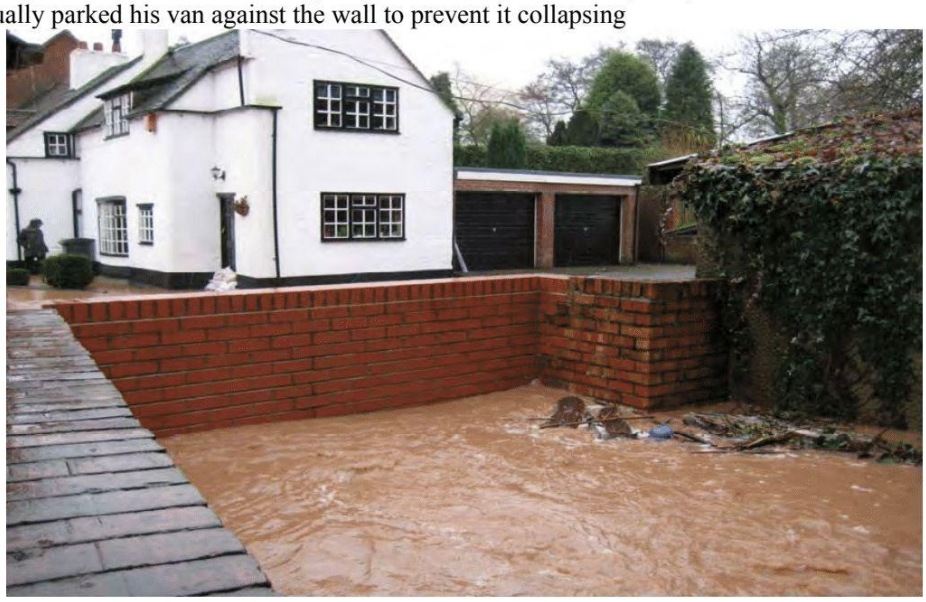

CAR PARK


THE MANOR HOUSE

Flooding 13th December 2008
Note of issues with photographs
All Photographs taken between 12.00 and 13.00 on Saturday the 13th December. After 13.00 hours the flood waters subsided.

Location 1 Post Office, Manor House Pub and Culvert.

The culvert could not cope with the water, which fell overnight and during the morning of 13th December. The Culvert was submerged and the water held back by the pub head wall. The landlord eventually parked his van against the wall to prevent it collapsing



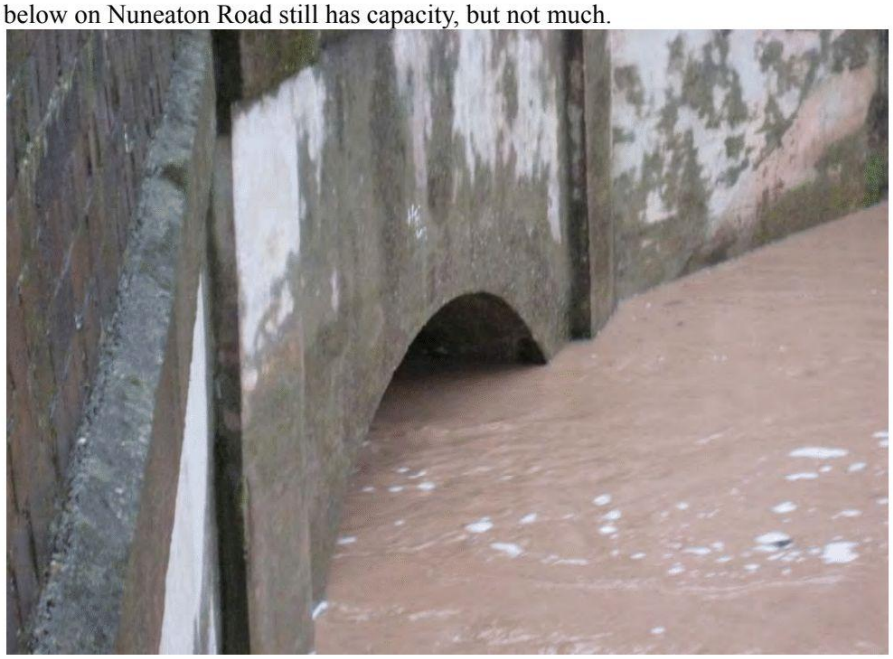
Water flowed around the wall through the car park to submerge the centre of the village. The police closed the road. The fire brigade pumped out the water to further down church lane to bypass the culvert.

Location 2 Little London Gulley on Church Lane
The gulley opposite Little London, which was reported as blocked did not function water ran down from Little London to the gulley at the entrance to Atkins Croft. It could not cope and there was local flooding preventing pedestrian access to the Croft.
Gulley being bypassed by water at Little London. Difference in Levels shows that there is still capacity on Brook if gulley was working

Location 3
Junction of Atkins Croft and Church Lane

Location 4 Nuneaton Road
Nuneaton Road flooded over the top of the Culvert as gulleys were blocked or could not cope. Police allowed vehicles through with care.

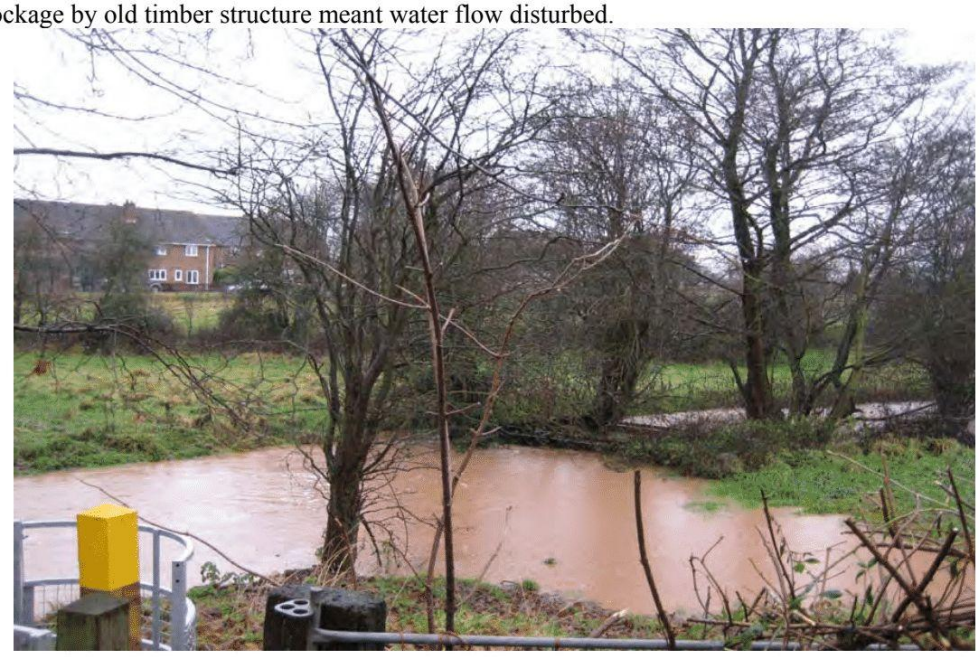
Culvert below on Nuneaton Road still has capacity, but not much.



Location 5 The Brook at Nuneaton Road end
Photographs show the new footpath is over topped and that it will tale capacity when flood events occur. This event was not as bad as July 2007.

Location 6 Major Trees blocking flow of Brook

Location 7 Water meadow beyond Nuneaton Road
Blockage by old timber structure meant water flow disturbed.



Issues to be arising from this flood.

- Head Wall at public house needs to be strengthened
- The new culvert under the road at the Manor did not have enough capacity.
- Gulleys in Church Lane, which were reported in correspondence to the county council as blocked, had not been cleaned causing local flooding at Atkins Croft.
- Gulleys in Nuneaton Road above the culvert did not cope and were blocked. This has been reported at every meeting
- Sand bags ran out. Aqua Sacs which had been promised at the last meeting were not delivered. The cottage behind the post office, which was supposed to have them did not. This requires immediate action.

Appendix D – Option Costs

Option A - Cost Breakdown

	Should gully be located directly on culvert then grout up gully - Assume 2				
2/600/39	Backfilling of disused gullies, 450 mm diameter with in-situ 4N foamed concrete	no.	2	178.04	356.08

	Cut back intrucding connections within the culvert flush with cuvert wall & make good			est.	£2,950.00
	To trace the location of drainage system's with the Manor pub car park & church land Including CCTV van and Jet Vac on site for 3 days.			est.	£3,825.00
				Total	£7,131.08

Traffic Safety and Management

1/100/08	3 way Traffic safety and management inc associated Chapter 8 signing	item		
	Site set up		£450	
	Maintain per day estimated 2weeks on site	14	£120	£1,680
	Remove from site on completion		£250	

Post Office Area

total £2,380

Breakout existing Gullys - Remove to tip
Grout up existing connections to culverts
Place new gullys and back fill
Construct new manhole with 150mm Forge non return Valve
Excavate new drainage pipes and connect to existing gullys & culvert & manhole
Back fill with Granular Material
Relay kebs with backing and bed
Reinstate full highway construction

2/200/21	Take up or down and remove to Contractor's tip off site precast concrete kerbing including bed and backing	**m**	4	£34.46	£137.84
2/200/32	Take up or down and remove to Contractor's tip off site gulley grating and frame	**no.**	4	£63.18	£252.72
2/600/38	Backfilling of disused sewer or drain 150 mm internal diameter with 1 metre or less of cover to formation	**no.**	1	£114.86	£114.86
2/600/11	Extra over excavation for excavation in hard material **(For New manhole & drainage)**	**m^3**	0.18	£45.95	£8.27
2/600/21	Disposal of unacceptable material class U1 **(For New manhole & drainage)**	**m^3**	0.18	£57.43	£10.34
2/500/173	Precast concrete manhole Type 11b with Class A cover and frame depth to invert exceeding 1 metre but not exceeding 2 metres	**no.**	1	£1,378.38	£1,378.38
2/500/183	Precast concrete trapped gulley (450 x 900 mm) with GA1-450 grating and frame	**no.**	4	£459.46	£1,837.84
2/500/19	150 mm internal diameter drain specified design group Z1 in trench depth to invert not exceeding 2.0 metres, average depth to invert 1.35 metres	**m**	10	£103.38	£1,033.80
2/500/20	Adjustment on last item for variation greater than 150 mm above or below the average depth of 1.35 metres per 25 mm of variation in excess of 150 mm	**Rate only required**		£0.46	£0.00
2/500/139	Connection of 150 mm diameter pipe to existing 450 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	**no.**	9	£183.78	£1,654.02
	Non return valve - **(Supply & Fit)**	**no.**	1	£817.40	£817.40
2/500/143	Connection of 150 mm diameter pipe to existing 900 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding	**no.**	1	£229.73	£229.73

	4 metres				
2/1100/01	Precast concrete kerbs Type HB2 laid straight or curved exceeding 12 m radius	**m**	4	£28.72	£114.88
2/1100/24	Additional in-situ concrete mix ST4 for precast concrete kerbs	**m^3**	0.36	£103.38	£37.22
2/700/09	Reinstate paved area with 55/10 stone asphalt Surface Course, 40 mm thick	**m^2**	4.5	£10.11	£45.50
2/700/08	Reinstate paved area with 20 mm aggregate Dense Macadam Binder Course, 60 mm thick	**m^2**	4.5	£12.35	£55.58
2/700/10	Reinstate paved area with 28 mm aggregate Dense Macadam Base, 125 mm thick	**m^2**	4.5	£25.85	£116.33
2/700/01	Granular Type 1 sub-base in carriageway, hard shoulder, hard strip and all other trafficked areas	**m^3**	4.5	£51.69	£232.61
				Total	£8,077.30

Little Bell Cottage Area

Breakout existing Gullys - Remove to tip
Grout up existing connections to culverts
Place new gullys and back fill
Construct new manhole with 150mm Forge non return Valve
Excavate new drainage pipes and connect to existing gullys & culvert & manhole
Back fill with Granular Material
Relay kebs with backing and bed
Reinstate full highway construction

2/200/21	Take up or down and remove to Contractor's tip off site precast concrete kerbing including bed and backing	**m**	4	£34.46	£137.84
2/200/32	Take up or down and remove to Contractor's tip off site gulley grating and frame	**no.**	4	£63.18	£252.72
2/600/38	Backfilling of disused sewer or drain 150 mm internal diameter with 1 metre or less of cover to formation	**no.**	1	£114.86	£114.86
2/600/11	Extra over excavation for excavation in hard material **(For New manhole & drainage)**	**m^3**	0.54	£45.95	£24.81
2/600/21	Disposal of unacceptable material class U1 **(For New manhole & drainage)**	**m^3**	0.54	£57.43	£31.01
2/500/173	Precast concrete manhole Type 11b with Class A cover and frame depth to invert exceeding 1 metre but not exceeding 2 metres	no.	1	£1,378.38	£1,378.38
2/500/183	Precast concrete trapped gulley (450 x 900 mm) with GA1-450 grating and frame	**no.**	4	£459.46	£1,837.84
2/500/19	150 mm internal diameter drain specified design group Z1 in trench depth to invert not exceeding 2.0 metres, average depth to invert 1.35 metres	m	30	£103.38	£3,101.40
2/500/20	Adjustment on last item for variation greater than 150 mm above or below the average depth of 1.35 metres per 25 mm of variation in excess of 150 mm	Rate only required		£0.46	£0.00
2/500/139	Connection of 150 mm diameter pipe to existing 450 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	no.	8	£183.78	£1,470.24
	Non return valve - (Supply & Fit)	no.	1	£817.40	£817.40
2/500/143	Connection of 150 mm diameter pipe to existing 900 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	no.	1	£229.73	£229.73

2/700/09	Reinstate paved area with 55/10 stone asphalt Surface Course, 40 mm thick	**m²**	13.5	£10.11	£136.49
2/700/08	Reinstate paved area with 20 mm aggregate Dense Macadam Binder Course, 60 mm thick	**m²**	13.5	£12.35	£166.73
2/700/10	Reinstate paved area with 28 mm aggregate Dense Macadam Base, 125 mm thick	**m²**	13.5	£25.85	£348.98
2/700/01	Granular Type 1 sub-base in carriageway, hard shoulder, hard strip and all other trafficked areas	**m³**	13.5	£51.69	£697.82
				total	£10,746.24

Manor House Area

Breakout existing Gullys - Remove to tip
Grout up existing connections to culverts
Place new gullys and back fill
Construct new manhole with 150mm Forge non return Valve
Excavate new drainage pipes and connect to existing gullys & culvert & manhole
Back fill with Granular Material
Relay kebs with backing and bed
Reinstate full highway construction

2/200/21	Take up or down and remove to Contractor's tip off site precast concrete kerbing including bed and backing	**m**	4	£34.46	£137.84
2/200/32	Take up or down and remove to Contractor's tip off site gulley grating and frame	**no.**	4	£63.18	£252.72
2/600/38	Backfilling of disused sewer or drain 150 mm internal diameter with 1 metre or less of cover to formation	**no.**	1	£114.86	£114.86
2/600/11	Extra over excavation for excavation in hard material **(For New manhole & drainage)**	**m³**	1.26	£45.95	£57.90
2/600/21	Disposal of unacceptable material class U1 **(For New manhole & drainage)**	**m³**	1.26	£57.43	£72.36
2/500/173	Precast concrete manhole Type 11b with Class A cover and frame depth to invert exceeding 1 metre but not exceeding 2 metres	no.	1	£1,378.38	£1,378.38
2/500/183	Precast concrete trapped gulley (450 x 900 mm) with GA1-450 grating and frame	**no.**	4	£459.46	£1,837.84
2/500/19	150 mm internal diameter drain specified design group Z1 in trench depth to invert not exceeding 2.0 metres, average depth to invert 1.35 metres	m	70	£103.38	£7,236.60
2/500/20	Adjustment on last item for variation greater than 150 mm above or below the average depth of 1.35 metres per 25 mm of variation in excess of 150 mm	Rate only required		£0.46	£0.00
2/500/139	Connection of 150 mm diameter pipe to existing 450 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	no.	8	£183.78	£1,470.24
	Non return valve - (Supply & Fit)	no.	1	£817.40	£817.40
2/500/143	Connection of 150 mm diameter pipe to existing 900 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	no.	1	£229.73	£229.73
2/700/09	Reinstate paved area with 55/10 stone asphalt Surface Course, 40 mm thick	**m²**	31.5	£10.11	£318.47
2/700/08	Reinstate paved area with 20 mm aggregate Dense Macadam Binder Course, 60 mm thick	**m²**	31.5	£12.35	£389.03
2/700/10	Reinstate paved area with 28 mm aggregate Dense Macadam Base, 125 mm thick	**m²**	31.5	£25.85	£814.28

2/700/01	Granular Type 1 sub-base in carriageway, hard shoulder, hard strip and all other trafficked areas	**m^3**	31.5	£51.69	£1,628.24

total £16,755.87

Church Lane

Breakout existing Gullys - Remove to tip
Grout up existing connections to culverts
Place new gullys and back fill
Construct new manhole with 150mm Forge non return Valve
Excavate new drainage pipes and connect to existing gullys & culvert & manhole
Back fill with Granular Material
Relay kebs with backing and bed
Reinstate full highway construction

2/200/21	Take up or down and remove to Contractor's tip off site precast concrete kerbing including bed and backing	**m**	2	£34.46	£68.92
2/200/32	Take up or down and remove to Contractor's tip off site gulley grating and frame	**no.**	5	£63.18	£315.90
2/600/38	Backfilling of disused sewer or drain 150 mm internal diameter with 1 metre or less of cover to formation	**no.**	16	£114.86	£1,837.76
2/600/11	Extra over excavation for excavation in hard material **(For New manhole & drainage)**	**m^3**	0.774	£45.95	£35.57
2/600/21	Disposal of unacceptable material class U1 **(For New manhole & drainage)**	**m^3**	0.774	£57.43	£44.45
2/500/173	Precast concrete manhole Type 11b with Class A cover and frame depth to invert exceeding 1 metre but not exceeding 2 metres	no.	2	£1,378.38	£2,756.76
2/500/183	Precast concrete trapped gulley (450 x 900 mm) with GA1-450 grating and frame	**no.**	5	£459.46	£2,297.30
2/500/19	150 mm internal diameter drain specified design group Z1 in trench depth to invert not exceeding 2.0 metres, average depth to invert 1.35 metres	m	43	£103.38	£4,445.34
2/500/20	Adjustment on last item for variation greater than 150 mm above or below the average depth of 1.35 metres per 25 mm of variation in excess of 150 mm	Rate only required		£0.46	£0.00
2/500/139	Connection of 150 mm diameter pipe to existing 450 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	no.	12	£183.78	£2,205.36
	Non return valve - (Supply & Fit)	no.	2	£817.40	£1,634.80
2/500/143	Connection of 150 mm diameter pipe to existing 900 mm diameter drain or existing piped culvert depth to invert exceeding 2 metres but not exceeding 4 metres	no.	2	£229.73	£459.46
2/700/09	Reinstate paved area with 55/10 stone asphalt Surface Course, 40 mm thick	**m^2**	19.35	£10.11	£195.63
2/700/08	Reinstate paved area with 20 mm aggregate Dense Macadam Binder Course, 60 mm thick	**m^2**	19.35	£12.35	£238.97
2/700/10	Reinstate paved area with 28 mm aggregate Dense Macadam Base, 125 mm thick	**m^2**	19.35	£25.85	£500.20
2/700/01	Granular Type 1 sub-base in carriageway, hard shoulder, hard strip and all other trafficked areas	**m^3**	19.35	£51.69	£1,000.20

total £18,036.62

Grand Total £63,127.10

Option B Costs - Balancing Pond Only

Series		Amount	
		£	p
100	Preliminaries	£0.00	
200	Site Clearance	£6,424.40	
300	Fencing, Gates and Stiles	£24,663.36	
500	Drainage and Service Ducts	£2,182.40	
600	Earthworks	£349,358.28	
700	Pavements	£74,869.33	
1200	Traffic Signs, Road Markings and Ancillaries	£1,527.70	
1700	Structural Concrete	£2,908.58	
1800	Steelwork for Structures	£5,000.00	
2400	Brickwork, Blockwork and Stonework	£0.00	
2700	Provisional Sums and Prime Cost Items	£11,216.00	
3000	Landscape and Ecology	£72,060.40	
	Sub-Total	£550,210.46	
	Add 5% for Contingencies	£27,510.52	
	TENDER TOTAL Carried to Form of Tender	£577,720.99	

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and ……... (Signature)

Date ……

The prices are based on possible 5300m3 and 6700m3 flood storage areas. , it is assumed that the land is completely flat and ground conditions are ideal to construct on. We would require a full topographic survey to be taken of the proposed sites along with trail holes and core samples taken. Planning permission would be required and agreement and funding from land owners for the adoption of the land. Land owners would have to be consulted to ascertain how much material could be spread onsite as this will reduce tipping costs.

I have therefore allowed for the following:

Generally site clearance
Take up existing cattle fencing

Construct unbound access road with turning head/parking:
200mm 6G material
150mm type 1 layer
100mm type 1 to dust layer

Erection of access gates for pedestrians & vehicles to safe guard site.

Construct headwalls from concrete and surround with keyclamp fencing, construct control structure in watercourse
Excavate out 1.1m deep storage area including 0.100 topsoil, to be stored onsite and resited in storage area to vegetate.
Excavate 1m acceptable material
Form bund approx 18m3 in section by 100m in length, cover with 100mm of topsoil. All other material to go off site.
Take up 4 – 8 existing land drains to the sides of the storage area, and construct new headwall on them.

Surround flood storage area with cattle fencing
Along sections of roadway over control structure construct 3 rail wooden fencing to stop undesired access.
Erect safety rings and deep water signs

Grass seed all areas
Plant up pond and wetland

Option C - Headwall Reconstruction

Demolish & Reconstruct wall

Remove tree and exavate out stump
Take up brige for reuse
Take down existing collaping wall - Assume 35m in length
Reconstuct using reinforced concrete filled hollow concret blocks
Waterproof Concrete face with Bitium, filter drain, Filtram membram
Resite footbridge
Face concrete wall with red brick to tie in with conservation area, use stainless steel ties
Construct trash Screen

Large Tree

	Remove Tree and route mass				£600.00

Raise Footbride

	Prep footings for removal, two day Crane Hire, Prep footings & reset				£10,000.00

Garage

	Demolish existing garage & reconstruct garage 5.4m x 3.6m in size with 0.600 x 0.600 concrete footings				£10,000.00

Total £20,600.00

Headwall

2/200/01	General Site Clearance	ha	0.023	########	£261.89
2/200/29	Take up or down and remove to Contractor's tip off site brickwall, 230 mm thick	m²	60	£57.43	£3,445.80
2/600/10	Extra over excavation for excavation in hard material in cuttings and other excavation	m³	2	£45.95	£91.90
2/600/07	Excavation of unacceptable material Class U1	m³	175	£22.97	£4,019.75
2/600/33	Excavation of soft spots and other voids below cuttings or under embankments	m³	4	£57.43	£229.72
2/600/34	Filling of soft spots and other voids below cuttings or under embankments with granular type 1	m³	4	£57.43	£229.72
2/600/21	Disposal of unacceptable material class U1	m³	181	£57.43	£10,394.83
2/1700/11	High yield steel for reinforcement nominal 16 mm and under of 12 metres length or less	tonne	2.1	£1,435.81	£3,015.20
2/1700/03	In situ concrete RC30	m³	32.55	£201.01	£6,542.88
2/1700/06	Formwork Class F1 vertical more than 300 mm wide	m²	271.5	£45.95	£12,475.43
2/2000/02	Waterproofing with two coats of bitumen sprayed or brushed to surfaces more than 300 mm wide or less at any inclination	m²	151	£28.72	£4,336.72
2/2400/03	Brickwork in Engineering Class B bricks in cement mortar designation type (i) one and a half brick thick in any bond in wall	m²	126	£137.84	£17,367.84
	Stainless steel ties spaced 5 per square m	no.	525	£3.90	£2,047.50
2/500/125	150 mm single diameter filter drain specified design group Type H1 in trench	m	35	£45.95	£1,608.25

	depth to invert not exceeding 2 metres, average depth to invert 1.0 metre				
	Filtram	m^2	129	£5.00	£645.00
2/600/23	Imported acceptable material Class 6F2 in embankments and other areas of fill	m^3	119	£51.69	£6,151.11
2/700/01	Granular Type 1 sub-base in carriageway, hard shoulder, hard strip and all other trafficked areas 200mm thick	m^3	19.32	£51.69	£998.65
2/700/11	Reinstate paved area (footway) with 20 mm aggregate Dense Macadam Binder Course, 50 mm thick	m^2	84	£11.49	£965.16
2/700/12	Reinstate paved area (footway) with 45/6 stone asphalt Surface Course, 25 mm thick	m^2	84	8.27	694.68
2/400/07	Kee Klamp Type 90º galvanised 50 mm diameter tube handrails, 1 m high inclusive of posts and fittings, or similar approved	m	35	£57.43	£2,010.05
2/1200/01	"Danger Deep Water" yellow signage 400mm x 600mm PVC on backing boards mounted on 4 m long 75 mm diamter plastic coated tubular steel posts	no.	2	£252.70	£505.40
2/1200/02	Life rings - 600 mm "Glasdon" lifebouy	no.	1	£258.45	£258.45

	Trash Screen				£8,000.00

total ##########

Option D - Balancing Pond Only

Series		Amount	
		£	p
100	Preliminaries	£0.00	
200	Site Clearance	£3,802.02	
300	Fencing, Gates and Stiles	£36,181.68	
500	Drainage and Service Ducts	£0.00	
600	Earthworks	£488,189.72	
700	Pavements	£74,869.33	
1200	Traffic Signs, Road Markings and Ancillaries	£1,527.70	
1700	Structural Concrete	£2,908.58	
1800	Steelwork for Structures	£5,000.00	
2400	Brickwork, Blockwork and Stonework	£0.00	
2700	Provisional Sums and Prime Cost Items	£11,216.00	
3000	Landscape and Ecology	£88,747.16	
	Sub-Total	£712,442.20	
	Add 5% for Contingencies	£35,622.11	
	TENDER TOTAL Carried to Form of Tender	£748,064.31	

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and …….. (Signature)

Date ……

The prices are based on possible 5300m3 and 6700m3 flood storage areas. , it is assumed that the land is completely flat and ground conditions are ideal to construct on. We would require a full topographic survey to be taken of the proposed sites along with trail holes and core samples taken. Planning permission would be required and agreement and funding from land owners for the adoption of the land. Land owners would have to be consulted to ascertain how much material could be spread onsite as this will reduce tipping costs.

I have therefore allowed for the following:

Generally site clearance
Take up existing cattle fencing

Construct unbound access road with turning head/parking:
200mm 6G material
150mm type 1 layer
100mm type 1 to dust layer

Erection of access gates for pedestrians & vehicles to safe guard site.

Construct headwalls from concrete and surround with keyclamp fencing, construct control structure in watercourse
Excavate out 1.1m deep storage area including 0.100 topsoil, to be stored onsite and resited in storage area to vegetate.
Excavate 1m acceptable material
Form bund approx 18m3 in section by 100m in length, cover with 100mm of topsoil. All other material to go off site.
Take up 4 – 8 existing land drains to the sides of the storage area, and construct new headwall on them.

Surround flood storage area with cattle fencing
Along sections of roadway over control structure construct 3 rail wooden fencing to stop undesired access.
Erect safety rings and deep water signs

Grass seed all areas
Plant up pond and wetland

Option E - Cost Estimate

Option	Length of Barrier	Height of Barrier	Cost £/m	Cost £	Uplift for Price Inflation (20%) £
E1	36	0.9m	340	12240	14688
E2	47	0.5m	150	7050	8460
E3	60	0.9m	340	20400	24480
E4	82	0.5m	150	12300	14760

Costs are based on fluvial solutions "Floodstop" barrier. Data obtained in January 2010.

Appendix E – Maintenance Costs

Maintenance Costs

Screen Clearance estimated Costs

Prices Based on approx meterage of debris cleared per visit		Estimated to be cleared 1x a every month		Adhoc clearances		annually	Over 5 years
Little London Tributity Screen	£11.99	12	£143.91	8	£95.94	£239.85	£1,199.25
Manor House Public House Screen	£22.14	12	£265.68	8	£177.12	£442.80	£2,214.00
Flood storage area 1 screen	£27.68	12	£332.10	8	£221.40	£553.50	£2,767.50
Flood storage area 2 screen	£27.68	12	£332.10	8	£221.40	£553.50	£2,767.50
	Total		£1,073.79		£715.86	£1,789.65	£8,948.25

Estimated costs to visit operate, cleans, and grease Forge valve's

		Approx number of valves:-	Cost per valve	1x visit annually	2x visits annually	over 5 years based on 2x visit annually
Surface water drainage to watercourse culvert		5	£65.00	£325.00	£650.00	£3,250.00
Properties to Severn trent foul System		14	£65.00	£910.00	£1,820.00	£9,100.00
	Total	19		£1,235.00	£2,470.00	£12,350.00

CCTV Survey & Culvert cleansing

Based on 1 x survey & culvert cleans every 5 years

CCTV Van per day	est. time onsite in days	
£600	1	£600
Jet Vac & Gully Suck		
£675	2	£1,350