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Ecological Assessment for the Shipley – Canal Road Corridor & Bradford City Centre Area Action Plans

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August 2014

Commissioned by: City of Bradford Metropolitan District Council

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1.0 Introduction

This Ecological Assessment covers the land within both the Shipley – Canal Road Corridor and Bradford City Centre Area Action Plan areas (referred to as the 'AAP areas' in this report). Figure 1 shows the boundaries of each AAP area. The AAP areas have been identified in the Core Strategy as priorities for regeneration, through to 2028. The council is keen to ensure adverse effects on the local natural environment and biodiversity are minimised. This requires a strategic approach to plan making and a sound up-to-date evidence base.

This conforms with the National Planning Policy Framework for sustainable development, where paragraph 9 requires positive improvements to the quality of the natural environment, "moving from a net loss of biodiversity to achieving net gains for nature". It goes on to expand on this in paragraph 109, recognising the wider benefits of ecosystem services and identifying the need for establishing coherent ecological networks, more resilient to current and future pressures. Paragraph 110 requires plans to minimise adverse effects on the local and natural environment.

This report provides guidance on how future re-development of the AAP areas can meet these requirements and incorporate a green network which benefits wildlife and provides an attractive and engaging setting for local residents and businesses. It is based on a robust understanding of the ecology and biodiversity of the AAP areas. This has been achieved by:

- Carrying out an ecological assessment of the existing biodiversity resource
- Identifying key habitats, species and wildlife corridors and promoting them through targeted ecological recommendations
- Providing potential target locations, standard prescriptions and species lists to guide quality design, habitat creation and ongoing ecological management

The AAP Areas have been subject to many decades of development which has resulted in wildlife being pushed to the margins and habitats degraded across much of the area. On a wider scale Bradford district has a wealth of wildlife habitats which provide context and inspiration for this report and with well planned development can point towards significant improvements in the future. A few key sites are listed below.

- South Pennine Moors – with broad expanses of internationally important heather moorlands and breeding bird populations including: dunlin *Calidris alpina schinzii*, golden plover *Pluvialis apricaria* and merlin *Falco columbariu*

- Heaton & Northcliffe Woods – a locally designated ancient woodland site carpeted with native bluebell *Hyacinthoides non-scripta*

- Trench Meadows – a nationally important flower-rich meadow site, supporting orchids and a range of butterfly species

- Leeds – Liverpool Canal – a nationally and locally designated waterway, important for aquatic plants and invertebrates and host to otters *Lutra lutra* and a range of fish species

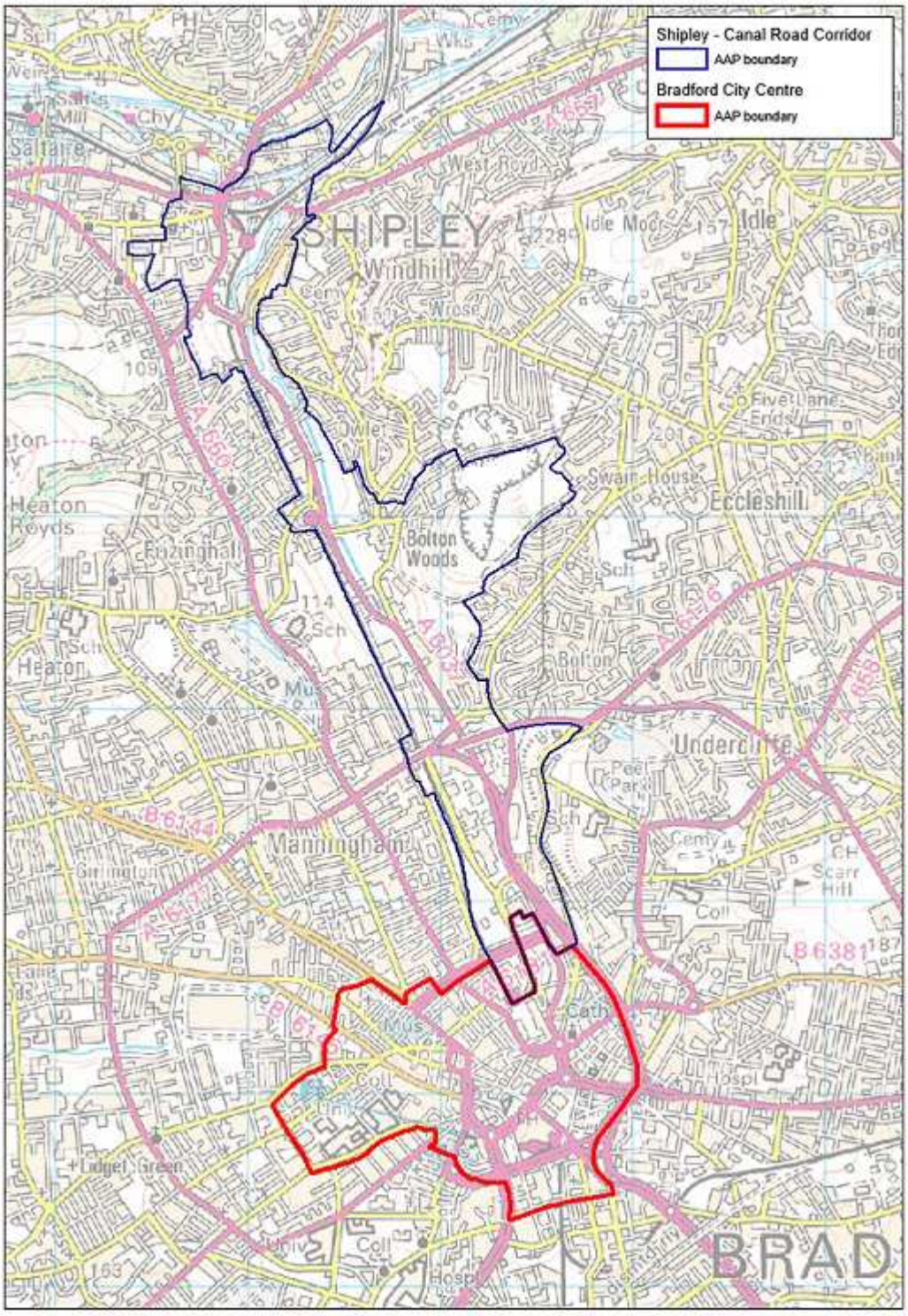

Figure 1 - Shipley – Canal Road Corridor and Bradford City Centre AAP area boundaries

The Wildlife Habitat Network (WHN) for Bradford district was created by West Yorkshire Ecology in 2012. It incorporates important ecological links between heathland, grassland, woodland, wetland and other habitats shown in Figure 2. The AAP areas offer an opportunity to extend this network in to the heart of the city.

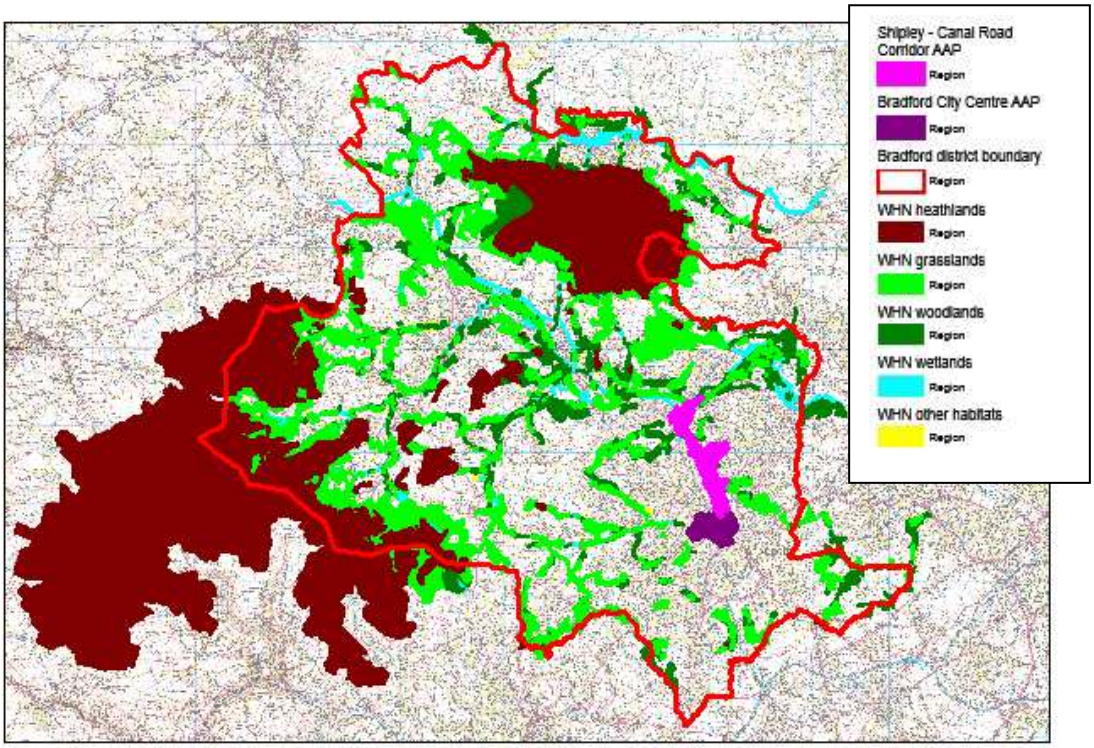

Figure 2 - Wildlife Habitat Network for Bradford district (with AAP areas displayed)

2.0 Methodology

An ecological database search was undertaken at West Yorkshire Ecology, using existing records and those provided by local environmental groups. This covered the AAP areas and a 1km buffer zone. The data was assessed and gap analysis was carried out to inform the scope for ecological field work.

The field work took place between March and early June 2014 and included:

- Phase 1 Habitat survey
- Invasive species survey
- Breeding bird survey
- Otter & water vole survey
- Bat roost potential survey

Details of the methodology followed for each survey can be found in Appendix 1 and maps of the Breeding Bird Survey transects are available in Appendix 2. Casual records were also captured during the surveys and target notes were made of potential opportunities for ecological enhancements. Target notes were made of areas of interest and for potential opportunities for ecological enhancements.

Wider reading and research was carried out throughout the project and the final ecological findings, concepts and guidance are consolidated in this report.

3.0 Results

3.1 Species Records

Protected species are those under national or international legal protection owing to their rarity or significant declines in populations. Protected species that have been recorded in the AAP areas and a 1km buffer are listed below in Table 1. Notable species are those with conservation designations but no legal protection. The table in Appendix 3 lists all the notable and protected species recorded within the AAP areas and a 1km buffer with locations provided. A full list of all species records held for each AAP area can be found in Appendices 4 and 5, with the most recently recorded date, protected/ notable species highlighted and conservation designation/ status provided. Appendix 6 provides a definition of the different types of species conservation designations. Appendix 7 is a series of maps displaying all the notable and protected species in the AAP areas, classified by taxon group. Appendices 8 - 12 showing the distribution of notable and protected mammal, bird, invertebrate, amphibian and plant species within the AAP areas (excluding Himalayan balsam and Japanese knotweed which are displayed on separate maps). These maps show individual species names.

Table 1 – all protected species records within the AAP areas and a 1km buffer

Species	**Locations Recorded**
bluebell *Hyacinthoides non-scripta* (Sch8, Bradford BAP) 2014	• Brow Wood & adjacent acid grassland slope • Bolton Woods Quarry surrounds, acid grassland • On acid grassland slope to eastern side of Powell Road, just before Gray Avenue • Boar's Well Urban Nature Reserve BWA • Small fenced off grassland by Vicar Lane/ Bridge Road intersection, Bradford city centre • Poplars Park BWA • Fairbank Wood BWA • Heaton/ Northcliffe/ Old Spring Woods BWA • Renold's Wood BWA & pasture • Shipley - Thackley Disused Railway BWA • Lister Park • Undercliffe Cemetery BWA • Wrose Hillside BWA
sanfoin *Onobrychis viciifolia* (RDB:Post 2001) 2008	• Boar's Well Urban Nature Reserve BWA
freshwater crayfish *Austropotamobius pallipes* (Sch5, UK BAP)	• Leeds – Liverpool Canal about 100m east of AAP area • Leeds – Liverpool Canal, 5km west of AAP area
white-letter hairstreak *Satyrium w-album* (Sch5, UK, W. Yorks & Bradford BAP) 2006	• field east of Shipley Station • grassland adjacent to Bolton Woods quarry • junction of Stanley Road/ Poplars Park Road • Brow Wood BWA • Kings Drive & Drovers Way Bolton Woods

bat records, casual & 1 roost (Sch5, W. Yorks & Bradford BAP) 2013	• Field records including Daubenton's *Myotis daubentonii* and pipistrelle *Pipistrellus* along the Bradford Beck and one non-breeding roost site for common pipistrelle *Pipistrellus pipistrellus*
otter *Lutra lutra* (Sch5, UK, W. Yorks & Bradford BAP) 2014	• Leeds – Liverpool Canal spraint at Salts Mill Road bridge & spraint on rock in L – L Canal at north-eastern tip of AAP area alongside Dockfield Road • River Aire spraint by north-eastern end of Dockfield Road • Bradford Beck spraint under Briggate A-road & Briggate B-road bridges
common frog *Rana temoraria* (Sch5, W. Yorks BAP) 1991	• Boar's Well Urban Nature Reserve BWA • Red Beck Mill Pond BWA • Thackley Woods BWA • Renold's Wood BWA
common toad *Bufo bufo* (Sch5, UK & W. Yorks BAP) 2014	• Toadspawn in Leeds – Liverpool Canal off Dock Lane & just to east of AAP area at swingbrige • Thackley Woods BWA • Shipley – Thackley Disused Railway BWA
black redstart *Phoenicurus ochrorus* (Sch1, Amber list - declining) 2008	• Bradford city centre (one pair sighted on one occasion. Recorded by Bradford Ornithology Group (BOG) but spoke with Shaun Radcliffe and this species has not been recorded since however this is not a key location for BOG member activity)
kingfisher *Alcedo atthis* (UK specially protected, Amber list - European Conservation Concern) 2013	• Leeds - Liverpool Canal by swing bridge just east of AAP area • Salts Mill footbridge about 800m west of AAP area • Red Beck Mill Pond BWA

BWA = Bradford Wildlife Area

3.2 Phase 1 Habitat Survey

Within Bradford City Centre 79% of the land is developed and 15% is green cover (with 6% undistinguished) while in Shipley – Canal Road Corridor 41% of the land is developed and 54% is green cover (with 5% undistinguished). The Phase 1 habitats recorded during the field survey are presented on a map in Appendix 13 while Appendix 14 is a table showing area covered by each habitat and percentage coverage for each AAP area. Table 2 below highlights key features of interest and Figures 3 and 4 display two important habitat features, one within each AAP area. See Appendix 15 for further information on findings.

Table 2 - the highlights and key findings from the Phase 1 Habitat survey.

Bradford City Centre AAP area	Shipley – Canal Road Corridor AAP area
• 4 green roofs & 1 green balcony • University Campus – pond, wildflower strips, young orchard, edible shrubs • Partially re-vegetated brownfield sites • Scattered young – medium aged trees across grassland • Hanging baskets in Little Germany • A few patches of un-cut grass with wildflowers/ daffodils • A few lines of trees • Little standing water, native shrubs & species-rich grassland	• Species-rich grasslands, scattered scrub and mature trees in Bolton Woods quarry surrounds • Good broad-leaved woodland link on eastern side – Boar's Well UNR, Brow Wood, Poplar Park Woods & Bolton Wood quarry surrounds (to Peel Park) • Some dense areas of native scrub offer good wildlife habitat • Good continuity of green corridors along Bradford Beck & railway margins • River Aire & Leeds – Liverpool Canal corridor • Little standing water, fen, wet woodland & heathland

Figure 3 – a pond on Bradford university campus, planted with native species including branched bur-reed *Sparganium erectum* and soft rush.

Figure 4 - species-rich grassland and scrub/ woodland on quarry margins overlooking Bolton Woods.

3.3 Ecological Enhancement Opportunities

Potential locations for a range of ecological enhancements were target noted during field work. These cover potential sites for the creation of green roofs, living walls, native hedgerows, orchards, wildlife ponds, Sustainable Urban Drainage Systems (SUDS) wetlands, perennial and annual wildlife meadows, grassland enhancements, woodland enhancements/ creation, bird/ bat/ bug boxes, log piles and the planting of bulbs and bee friendly flower beds and heathland creation. Locations are shown in maps included in Appendices 16 to 28.

3.4 Invasive Species

Japanese knotweed *Fallopia japonica* was recorded at 55 locations. Stands were particularly notable along the railway margins, and to a lesser extent, along the Bradford Beck. There were also scattered stands on road margins and wasteland, as well as three small stands in Boar's Well Urban Nature Reserve. See the maps in Appendix 29 for all locations and Appendix 31 for further information on findings.

Himalayan balsam *Impatiens glandulifera* was recorded at 30 locations. These were concentrated predominantly along the margins of the Bradford Beck. There was also a dense stand along the margin of King's Road, bordering the Boar's Well woodland. See the maps in Appendix 30 for all locations.

No giant hogweed *Heracleum mantegazzianum* was recorded within the AAP areas but it was identified at one location within a 1km radius of the AAP Areas boundary (at this grid reference: SE1529,3210).

3.5 Breeding Bird Survey

The bird species recorded and number of records made during the Breeding Bird Survey are shown in Appendix 31 with conservation status. See Appendix 9 for distribution maps showing all notable bird species records within the AAP areas. The location where the highest density of bird activity was recorded is along the woodland, scrub and grassland corridor from Boar's Well Urban Nature Reserve up through Brow Wood, Poplars Farm Woodlands and the Bolton Woods quarry surrounds. See Appendix 15 for further details on findings.

3.6 Otter and Water Vole Survey

Fresh otter spraint was found at one point along the River Aire, at two points along the Leeds - Liverpool Canal and at two locations along the Bradford Beck. See Appendix 8 for a distribution map. No otter holts or lying-up sites were identified in the survey area but they are often extremely well concealed.

No water vole activity was recorded within the AAP areas and suitable habitat was limited. Mink have been recorded in the area and can heavily predate water vole. See Appendix 15 for further details on findings.

3.7 Bat Roost Habitat Potential Survey

Features of high and medium bat roost potential that were identified during the survey are listed below in Table 3. The distribution of these features are shown on the maps in Appendices 32 - 34. There were few mature trees and little dead wood habitat throughout the Shipley – Canal Road Corridor AAP area and none recorded in the City Centre AAP area. Further information on findings is available in Appendix 15. The areas with the greatest density of high and medium features of bat roost potential were within Brow Wood and Bolton Woods quarry surrounds.

Table 3 - features of high or medium potential for bat roosting habitat within the AAP Areas.

AAP Area	High Priority Trees	High Priority Buildings	Medium Priority Trees	Medium Priority Buildings	Other Features
Shipley Canal Road Corridor AAP area	10	55	41	74	Revetment walls Beck bridges Rock faces Stone wall stretches
Bradford City Centre AAP area	0	27	11	175	None recorded

4.0 Discussion - Ecological Enhancement Concepts and Opportunities

4.1 General Concepts

This section details the key ecological enhancement concepts that were established through the intensive ecological survey work (see Sections 2.0 and 3.0 above) and extensive research carried out as part of this Ecological Assessment. Ecological enhancement opportunity maps are available in Appendices 16 - 28 and they show locations within the AAP areas with the potential for: green roofs, living walls, perennial meadows, annual meadows, grassland diversity enhancements, woodland structure and diversity enhancements, log piles, nest boxes, wildlife and SUDS ponds, native hedgerows, traditional orchards, heather planting, bee friendly herb beds and planting bulbs and associates. Suggested species lists for use in the creation of these habitats are provided in Appendix 35 and Appendices 36 - 45 provide guidance on the creation and management of these habitats. This guidance can be used to sustain and enhance the ecological value within the AAP areas, to protect species present and to create more resilient wildlife networks and ecological corridors.

4.1.1 The Value of Invertebrates

Many of the ecological enhancement measures discussed below are aimed at increasing the area of wildflower-rich habitat as a nectar source for invertebrates. The reason for this is:

- 65% of invertebrate species are currently declining in population, mainly due to habitat loss.
- 97% of wildflower-rich meadows in the UK have been lost since the 1940's.
- Pollinating species such as bees, hoverflies, butterflies and moths save the modern agriculture industry around £510 million per annum.
- Invertebrates pollinate many UK wildflowers, supporting habitats
- Invertebrates are an integral part of food chain. They are prey for many groups of species: fish, bats, mice, voles, shrews, hedgehogs, badgers and other invertebrate species (Buglife, 2014).

The Royal Horticultural Society supports an initiative to promote the use of flowering plants of high benefit for pollinators through the 'Perfect for Pollinators' labelling scheme (The Royal Horticultural Society, 2014).

4.1.2 Structural Diversity

Structural diversity is of high importance for supporting healthy faunal populations, particularly invertebrates. Pollinating species such as butterflies and moths require food plants for their larval stage. Common food plants include nettle *Urtica dioica* and thistles *Cirsium*. These are often found in tall herb and rank grass habitats and offer egg laying opportunities, a food source for larvae and primary nectar source for many species (Butterfly Conservation, 2014b).

It is not the intention to encourage the creation of tall herb/ rank grass habitats as part of this assessment, as they often form naturally on unmanaged green space and were found to be present as a mosaic within grassland, scrub and woodland habitats throughout the AAP areas. It is essential that a mosaic of these habitats is retained or enabled to establish (in less conspicuous locations as they often look untidy).

4.1.3 Native Versus Non-native Planting

The benefits of selecting native plant species or non-invasive non-native flora choices depends on many factors including the location, habitat type, species already in-situ and desired ecological and visual outputs. Suggested species lists for a range of habitat types discussed below are provided in Appendix 35.

For semi-natural habitats such as woodlands, meadows and heathlands it is generally best to utilise native species, as they offer both high wildlife value and visual benefits. Native species have evolved together over a longer time-period and the English oak *Quercus robur,* for example, provides niches for hundreds of different species (Royal Forest Society, 2014). Within urban centres there is often more scope for utilising certain non-invasive, non-native species such as lavender *Lavendula*, which is low maintenance, relatively low-cost and yet produces attractive swathes of nectar-rich flowers that benefit invertebrates and look attractive to the passing public.

4.2 'The Butterfly Express'

The railway network is a key green corridor within the AAP areas. A conceptual map highlighting this area can be found in Appendix 49. The railway enables species mobility and linkage of habitats. The limited public access reduces disturbance and is beneficial for many species and yet the corridor is highly visible to rail passengers. It is a prominent feature within the landscape and is one of the 'green fingers' that links the city centre to the wider area.

Railway margins are on display to passing rail passengers throughout the year and by creating an attractive and engaging natural backdrop, using the plants lists in Appendix 35, it is possible to promote a sense of mental wellbeing as well as creating a valuable wildlife habitat (CABE, 2006).

Ecological enhancement opportunities along the railway corridor include:

- Establishment of dwarf-shrub ground cover along the railway banks
- Creation of perennial meadows at the railway stations
- Maintenance of the living wall at St. Blaise Square
- Woodland enhancements to improve structure and floral diversity
- Use of native hedgerows to prevent waste dumping
- Control of invasive species, which are prevalent along some stretches

4.2.1 Railway woodland enhancements

Many stretches of the railway banks within the AAP areas are heavily managed and generally consist of young birch *Betula* and willow *Salix* woodland with little shrub or ground flora cover (see Figure 5 below). The ecological and visual interest can be enhanced through establishing a dwarf-shrub ground cover of heather *Calluna vulgaris* and bilberry *Vaccinium myrtillus*, mixed with some saplings of alder buckthorn *Frangula alnus* and species such as foxglove *Digitalis purpurea*, wood sage *Teucrium scorodonia* and tormentil *Potentilla erecta.* See Appendix 35 for a wider list of suitable species.

Heather *Calluna vulgaris* is a food source for many moth caterpillars and a nectar source for butterfly species such as the small tortoiseshell *Aglais urticae* and painted lady *Vanessa cardui* (Butterfly Conservation, 2014b). Bilberry is a food source for the green hairstreak *Callophrys rubi* butterfly and bilberry bumblebee *Bombus monticola.* Alder buckthorn is the primary food plant for the brimstone butterfly and tormentil is a nectar source for the small heath *Coenonympha pamphilus* butterfly (Butterfly Conservation, 2014a).

Figure 5 - young wooded habitat along railway margins in the Frizinghall area.

The more mature woodland strips along the railway have a canopy of sycamore *Acer pseudoplatanus* with some oak *Quercus* and birch *Betula.* These wooded sections have little shrub layer and a fairly species-poor ground flora (see Figure 6 below). They can be enhanced through the thinning of some sycamore *Acer pseudoplatanus* (avoiding clear felling wherever possible). Sycamore is a non-native species with low biodiversity that has large leaves which can become a nuisance on the rail-tracks. Planting whips of native tree species and introducing shrub and ground flora species such as native bluebell is recommended (see Appendix 35 for species lists).

Native bluebell *Hyacinthoides non-scripta* is a nectar source for species including brimstone *Gonepteryx rhamni,* green-veined white *Pieris napi*, orange tip *Anthocharis cardamines* and peacock *Aglais io* butterflies, while primrose is a nectar source for the small tortoiseshell *Aglais urticae* and brimstone (Butterfly Conservation, 2014b). An example of an attractive native bluebell wood is shown in Figure 7.

Figure 6 – northern side of railway, woodland stretch south of Queen's Road, by Midland Road recycling site, providing opportunities for woodland enhancements

Figure 7 - bluebell *Hyacinthoides non-scripta* clad woodland slope that illustrates the attraction of dense native ground flora cover.

There are opportunities for installing bird and bat nest boxes and log piles within the more developed woodland stretches of the railway, which offer more sheltered conditions. Log piles provide useful niches for many species including small mammals, invertebrates, amphibians and reptiles. They could be made using tree brash cut down by railway maintenance contractors. See Appendices 21 and 22 for potential locations.

Crossley-Evans manages a recycling site adjacent to the railway. They host educational visits and are keen to enable children to connect with nature. The use of bird nest boxes with installed cameras to provide close-up views of wildlife without causing disturbance would enhance such experiences.

4.2.2 Station Meadows

There is a small butterfly meadow at Shipley Station, managed by Bradford Urban Wildlife Group. It supports a range of plant and invertebrate species including the common blue *Polyommatus icarus* butterfly - a Local Biodiversity Action Plan (LBAP) species. An interpretation board is in place to inform passers-by of its wildlife interest, and open days are held for community engagement. This is a unique and inspiring concept and following this model at Frizinghall and Forster Square stations would provide valuable wildlife features and create interest for local commuters and visitors. See Figures 8, 9 and 10 for proposed meadow locations.

Figure 8 – this area at Frizinghall Station (westbound platform) has the potential for perennial wildflower meadow creation.

Figure 9 – this area at Frizinghall Station (eastbound platform) has the potential for perennial wildflower meadow creation.

Figure 10 – this area at Bradford Forster Square station has the potential for perennial wildflower creation.

For the station meadows, the use of native perennial wildflowers such as ox-eye daisy *Leucanthemum vulgare*, black knapweed *Centaurea nigra*, field scabious *Knautia arvensis* and common bird's-foot trefoil *Lotus corniculatus* would be suitable. These species have particularly striking blooms (see Figures 11 & 12). A number of fine grasses are used in perennial meadow creation, to compliment the wildflower mix. See Appendix 35 for a more expansive list of suitable species and Appendix 38 for guidance on perennial meadow creation/ management.

Figure 11 - ox-eye daisy *Leucanthemum vulgare*; one of the most showy species of perenial wildflower meadows.

Yellow rattle *Rhinanthus minor* is a semi-parasite of grasses and is a useful tool in a wildflower meadow, preventing the grasses from outcompeting and dominating other wildflowers. It should be included in seed mixes for meadow creation in the AAP areas. It can also be seeded or plug planted into existing meadows. It is an annual species and should be allowed to set seed in July before cutting. It is also a visually attractive feature of meadows (see Figure 13).

Figure 12 (left) - black knapweed *Centaurea nigra* with a Burnet moth *Zygaena* &
Figure 13 (right) - yellow rattle *Rhinanthus minor* in flower (courtesy of Ann Hanson)

Perennial wildflower meadows are **NOT** established by just leaving an existing area of grassland to grow wild. There is a prescriptive preparation necessary (see Appendix 38) and ongoing management of these sites is required (which should be low maintenance once established). The species discussed above all grow on a neutral soil pH with low nutrient inputs. Keeping problem weeds such as dock *Rumex*, thistle *Cirsium* and nettle *Urtica* under control will retain a more tidy appearance and enable the attractive wildflowers to be well appreciated. Figure 14 below shows how Bradford University have used interpretation boards to convey the importance of wildflower strips for pollinator species. This is a useful tool for public engagement.

Figure 14 - use of interpretation boards on Bradford University grounds explaining the link between wildflowers and pollinator species. This strip had just been sown.

Wildflower meadows provide nectar and food sources for a wide range of butterflies including: common blue *Polyommatus icarus*, small tortoiseshell *Aglais urticae*, brimstone *Gonepteryx rhamni*, peacock *Aglais io*, small heath *Coenonympha pamphilus,* meadow brown *Maniola jurtina* and wall *Lasiommata megera,* as well as many other pollinating invertebrates (Butterfly Conservation, 2014a). Figure 15 shows common bird's-foot trefoil *Lotus corniculatus*, a popular nectar source.

Figure 15 - burnet moth *Zygaena* on common bird's-foot trefoil *Lotus corniculatus* in Shipley Station Butterfly Meadow.

4.2.3 Grassland Enhancements; Railway Margins

The gravelly margins of the rail-tracks are largely kept clear of vegetation under railway management but there are some broader strips that are host to fine grasses and low growing vetches and clovers, including red fescue *Festuca rubra*, red clover *Trifolium pratense*, common vetch *Vicia sativa* and black medick *Medicago lupulina*.

The ecological linkage along the railway could be enhanced further through seeding suitable open stretches with a range of species tolerant to this nutrient-poor substrate. These include: common bird's-foot trefoil *Lotus corniculatus,* mouse-ear hawkweed *Pilosella officinarum*, common poppy *Papaver* rhoeas, scented mayweed *Matricaria recutita* and perforate St John's-wort *Hypericum perforatum*. This would provide an enhanced mosaic of nectar-rich habitats as well as putting on a colourful display for rail users. A list of suitable species can be found in Appendix 35.

4.2.4 Hedgerow Barriers

Rubbish dumping can become an issue along railway embankments and can be difficult to clear from the slopes, presenting an un-kempt look that sometimes attracts further dumping. This could be mitigated by creating dense native hedgerows along the top of relevant stretches of railway banks (see Figure 16). Appendix 35 provides a list of suitable native species.

Species-rich hedgerows are a UK Biodiversity Action Plan (BAP) priority habitat. They provide shelter, food and nesting habitat for many species of birds, small mammals and invertebrates. The English elm *Ulmus procera* is the primary food source of the white-letter hairstreak *Satyrium w-album* butterfly. Hedges can also function as a wildlife corridor, assisting species movement and providing perches for singing males during the bird breeding season.

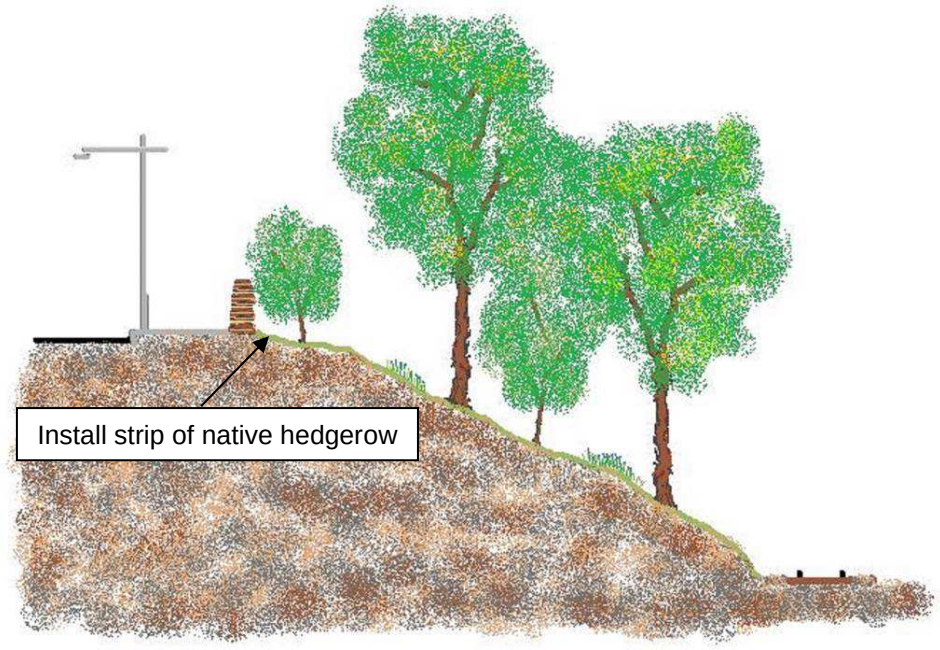

Figure 16 - illustrates the use of native hedgerows where roadsides border railway banks to prevent any dumping of rubbish being spilled down the banks (produced by Robert Masheder).

4.2.5 Living Wall; St. Blaise Square

A living wall of Persian ivy *Hedera colchica* '*Dentata variegata'* has formed on a revetment wall at St. Blaise Square, just outside Forster Square station (see Figure 17). Recommendations for and benefits of this feature are listed below:

- A prominent location with a high volume of footfall adjacent to the station
- Ivy walls offer shelter, food and nesting habitat for invertebrates
- Potential nesting opportunities for bird species such as blackbird
- Species of hoverfly, bumblebee and butterfly feed on the nectar of ivy flowers
- Thrushes feed on ivy berries that are produced late in the year when little other food is available
- The small tortoiseshell *Aglais urticae* butterfly can hibernate in dense ivy
- A low maintenance feature that can be kept tidy by cutting back to half the height of the revetment wall every 5 years
- The removal of buddleia shrubs at the top of the wall will create a tidier appearance (check for nesting birds first)
- Further enhancements are possible through installing a trellis on lower half of the wall and training in climbing species such as travellers joy *Clematis vitalba* and honeysuckle *Lonicera periclymenum* to provide further nectar sources, beautiful flowers and a lovely scent
- Low cost interpretation signage enables the public to engage with wildlife, learn to recognise their local wildlife and build a greater appreciation of it

Figure 18 shows an example of an attractive climbing clematis growing on a trellis. See Appendix 37 for guidance on creating and maintaining living walls and Appendix 35 for suitable species.

Figure 17 – living wall at St. Blaise Square by Forster Square station, with opportunities for ecological and visual enhancements.

Figure 18 - an attractive clematis growing up a trellis demonstrates the visual attributes of such species

4.2.6 Control of Invasive Species

The removal of Japanese knotweed should be a priority along the railway embankments. It was recorded at numerous locations and there were some very large, dense strips. This species spreads via underground rhizomes which extend up to 7m from the stand of the plants. It is a growing problem which will get worse with time and become more expensive to treat. See Appendix 46 for further information on Japanese knotweed, including control methods. The bare ground remaining after the cessation of treatment of Japanese knotweed may be sown with a mix of the species listed in Appendix 35, which should provide an attractive and nectar-rich cover swiftly.

4.3 'The Nectar Highway'

The road network offers a range of opportunities for ecological enhancement measures. A conceptual map highlighting this area can be found in Appendix 50. Potential enhancements are discussed below, including:

- Establishing perennial wildflower meadows and implementing grassland diversity enhancements along road verges and around apartment blocks
- Woodland enhancements to improve structural & floral diversity
- Creating drought tolerant herb beds
- Planting bulbs and associates in suitable grass covered areas
- Native hedgerow creation
- Controlling invasive species

4.3.1 Perennial Meadow Verges

Lowland meadows are a UK Biodiversity Action Plan (BAP) Priority Habitat owing to extensive losses. Creating wildflower meadows along road verges and around apartment blocks will give a real boost to local pollinating species, create interesting features that will enhance the appeal of living and working in Bradford and benefit local businesses (Greenspace, 2010).

The emphasis can be placed on creating a 'nectar highway' to provide food for a diverse range of invertebrates, including pollinators such as bumblebees *Bombus.* Most bumblebee species have declined dramatically over the past few decades and several are faced with national extinction. The loss of these pollinator species would have serious implications for the food production industry (Bumblebee ConservationTrust, no date A).

Buglife are currently running a project called B-lines with the aim of creating at least 150,000 hectares of flower-rich habitat in the shape of broad strips of perennial meadows. A pilot project in Yorkshire has mapped out potential routes for B-lines, which would create links between existing sites of importance for invertebrates (Buglife, 2014). The 'nectar highway' fits into this concept of linkage and species mobilisation.

There is the potential for creating a number of new flower-rich perennial meadow strips on highly prominent sites, such as the one shown below in Figure 19. They could also be established in the grounds of apartment blocks, as shown in Figure 21. See Appendix 35 for a list of suitable species and Appendix 38 for guidance on how to create successful perennial wildflower meadows. Guidance on visibility splays is provided in the Street Design Guide (Leeds City Council, 2009) and the safety of habitat management staff is paramount. Regular cutting of margins helps to define the feature, stops vegetation encroaching on the footpaths and roads and looks more cared for to the general public.

Some strips of road verge could be enhanced using a few key species such as black knapweed *Centaurea nigra,* ox-eye daisy *Leucanthemum vulgare* and field scabious *Knautia arvensis*. These can be planted as plugs (young plants) into an established grass sward, where wildflower seed would not be likely to germinate. Alternatively, manually created small areas of bare ground can be used for establishing wildflower seed, which is less costly.

Figure 19 - road verge off Canal Road (SE15845 35310) with opportunities for creating a perennial wildflower meadow

Knowsley Metropolitan Borough Council established an extremely successful project in partnership with the charity Landlife. The key points are listed below:

- They transformed prominent road corridors and land surrounding tower blocks into annual/ perennial meadows
- Used a seed mix containing annual and perennial species
- Created a particularly colourful spectacles in the first year that were maintained and enhanced as perennial meadows in following years
- Landlife provided training and ongoing guidance and may be able to work with Bradford Council on a similar project
- If new mechanical equipment was required for wildflower meadow management there may be funding available (see Appendix 47).
- The advantages of converting larger areas to wildflower meadow management were economic, ecological and visual
- The definition of specific management prescriptions was also easier with broader coverage
- Feedback from local residents was 97% positive and they said they would like more wildflower landscapes
- The local health practice wrote to thank the council as they felt the scheme had uplifted the whole community (CABE, 2006)

See Figures 20 and 21 which show images of habitats created through the wildflower initiative in Knowlsey. For more information on making contracts ‘work for wildlife’ and for local residents see the Landlife website and this document: http://www.lbp.org.uk/downloads/Publications/Management/making-contracts-work-for-wildlife.pdf

Figure 20 - perennial wildflower meadow on edge of amenity grassland (courtesy of Landlife)

Figure 21 - first year annual/ perennial wildflower meadow created as part of the Knowlsey project in partnership with Landlife (photo courtesy of Landlife)

4.3.2 Bulbs and Associates

Bulbs have been planted on a number of road verges in the town centre but these are predominantly daffodil, which have limited value for invertebrates. Options that have higher value for wildlife include: native bluebell *Hyacinthoides non-scripta*, autumn-flowering crocus *Crocus speciosus*, primrose *Primula vulgaris* and flowering onions *Alliums*. (Tayside Biodiversity Partnership, no date).

Figure 22 shows how small patches within a mown grass verge were seeded/ planted with flowering onions *Alliums* and ox-eye daisy *Leucanthemum vulgare* and left unmown during the flowering period. A cluster of bees and hoverflies were seen feeding on the flowers in these patches. See Appendix 35 for a list of suitable species and Appendix 28 for potential sites for this type of planting.

Figure 22 - uncut patches in a mown grass verge that offer nectar sources for invertebrates as well as being visually pleasing. The patch achieves a tidy appearance by defining the edges with the mowing regime.

4.3.3 Drought Tolerant Perennial Herb Beds

Heather *Calluna*, lavender *Lavendula* and cosmos have been used occasionally in roadside flowerbeds in Bradford City Centre AAP area. Their use is beneficial as they create an attractive visual display and are often alive with the humming of bees and other invertebrates. They require little management once established and have long flowering periods. Figure 23 shows urban lavender planting and Figure 24 shows the use of cosmos on a Shipley reservation. In Wakefield similar beds also have poppy *Papaver* scattered amongst lavender to add another colour dimension.

The creation of mixed, drought tolerant herb-beds using species such as rosemary *Rosmarius officinalis*, lavender *Lavendula angustifolia*, wild thyme *Thymus polytrichus*, borage *Borago officinalis* and chives *Allium scoenoprasm* would also be beneficial. These features provide mini-hubs for pollinators within more urbanised areas. If interpretation boards were erected with images of the species and their culinary uses then the herbs could be harvested by the local community. Strongly aromatic herbs can also be appreciated by visually impaired residents. See Appendix 35 for suitable species and Appendix 27 for potential locations.

Figure 23 - lavender planted in flower-bed in central Ossett

Figure 24 - cosmos flowers: great nectar source for pollinators. Sown in a central reservation flower bed in Kirkgate, Shipley.

4.3.4 Woodland Enhancements

The woodland margins along Canal Road are largely species-poor secondary or planted woodland. Selective thinning of some non-native canopy species, predominantly sycamore *Acer pseudoplatanus* (not clear felling) and the introduction of native whips such as oak *Quercus robur/ petraea* and birch *Betula pendula/ pubescens*, would be of greater value for native wildlife (Woodland Trust, no date). Appendix 35 lists suitable native tree, shrub and ground flora species. Installing bat and bird boxes and creating log piles in less visible locations would be valuable. A number of trees should be retained through to full maturity (well back from access routes) to benefit fungi and saproxylic (dead-wood feeding) beetles, roosting bats and nesting birds. Appendices 21 and 22 provide potential locations for bird/ bat boxes, log piles and structural/ floral diversity enhancements.

4.3.5 Native Hedgerow Creation

Many existing roadside stretches and some of the car parks within the city centre have dense, non-native shrub planting along the margins. Whilst this forms a type of hedging that can provide valuable nesting and feeding habitat for birds, greater benefits for wildlife could be achieved through the use of native hedgerows. There is the scope for installing a number of native hedgerows with standard trees within the AAP areas and potential locations are shown in Appendix 24. Species such as hazel *Corylus avellana*, guelder rose *Viburnum opulus* and rowan *Sorbus aucuparia* produce berries or nuts that provide food for birds and small mammals and are also visually appealing. Spiny species such as hawthorn *Crataegus monogyna* and blackthorn provide dense nectar-rich blooms (see Figure 24) but should be sited where they do not obstruct footpaths or cycleways.

Figure 25 – blackthorn *Prunus spinosa* in full bloom attracts species such as peacock butterfly *Inachis io* (courtesy of Sweffling).

4.3.6 Control of Invasive Species

There are some stands of Japanese knotweed along the road verges and before any works or enhancements are undertaken at these locations (or up to 7m from the plant) treatment should be implemented to prevent the spread of affected materials. See Appendix 46 for guidance on control methods.

4.4 'An Aquatic Haven'

The Leeds – Liverpool Canal is a focal watercourse within the Shipley – Canal Road Corridor AAP area, designated as a Local Wildlife Site for its aquatic communities. A conceptual map highlighting this area can be found in Appendix 41. Discussed below are some of the ways in which the ecological value of this key corridor can be enhanced, including:

- Increasing emergent vegetation and fen cover
- Creating reedbed habitat
- Meeting white-clawed crayfish requirements
- Enhancing grassland diversity along the towpath
- Controlling invasive species

4.4.1 Fen & Emergent Aquatic Habitat Enhancements

The Canal and the River Aire both flow through the Saltaire World Heritage Site and more visitors could be encouraged to visit Shipley by enhancing natural green links along waterways. The canal is used by otter *Lutra lutra*, mallard *Anas platyrhynchos*, mute swan *Cygnus olor* for feeding and nesting, kingfisher *Alcedo atthis*, toad *Bufo bufo* and fish for spawning. Little fen and emergent aquatic habitat was recorded during the Phase 1 survey and it was largely restricted to the Leeds – Liverpool Canal. The emergent aquatic habitat is dominated by arrowhead *Sagittaria sagittifolia* and the fen with reed sweet-grass *Glyceria maxima*, as well as some hemlock water-dropwort *Oenanthe crocata* and meadowsweet *Filipendula ulmaria.*

Fen and emergent aquatic habitats provide a haven for invertebrates (see Figure 26) and also offer shelter, feeding and spawning ground for fish species. Dragonflies and damselflies utilise submerged and emergent species, such as rushes, when they are pupating and for resting (Derbyshire Dragonflies, no date). These species capture the imagination of the public and can create further interest along the canal.

Figure 26 - golden-ringed dragonfly *Cordulegaster boltonii* feeding on a fly while perched on soft rush *Juncus effusus.* This is one of the species that could be attracted to the AAP areas with further fen (and heathland) creation.

The canal margins could be ecologically enhanced through planting with species such as: reed sweet-grass *Glyceria maxima*, branched bur-reed *Sparganium erectum*, soft rush *Juncus effusus*, meadowsweet *Filipendula ulmaria*, water mint *Mentha aquatica* and brooklime *Veronica beccabunga* to create further fen habitat. Figure 27 shows a stretch of the canal with emergent aquatic vegetation. This habitat can be expanded and enriched along the water's edge using arrowhead *Sagittaria sagittifolia*, water plantain *Alisma plantago-aquatica* and flowering rush *Butomus umbellatus*, to compliment the existing stretches of arrowhead and to provide longer stretches of continuous habitat and an appealing display for those using the canal and towpath. Planting needs to consider the movement of boats on the waterway. See Appendix 35 for lists of suitable species.

Figure 27 - emergent vegetation (including arrowhead *Sagittaria sagittifolia*) along the margin of Leeds – Liverpool Canal

4.4.2 Reedbed Creation

There is the opportunity for creating a small reedbed in the basin of the canal by Victoria Street (SE15333778 – see Figure 28). This would provide habitat for a range of birds on the opposite side from the towpath, so the feature would be visible to passers-by but with little disturbance to wildlife. Bradford Ornithological Group have attracted nesting reed warbler to a similar small reedbed on their reserve at Stocksbridge, approximately 5km to the west. Another local example is situated near Bingley and is a small Sustainable Urban Drainage Systems (SUDS) reedbed created as part of the A650 bypass development. It has been utilised by species including reed bunting *Emberiza schoeniclus* and water rail *Rallus aquaticus*. Moorhen *Gallinula chloropus* and coot *Fulica atra* also typically use reedbed habitat for nesting and shelter.

Figure 28 - site on Leeds – Liverpool Canal that may be suitable for the creation of a small reedbed habitat.

4.4.3 White-Clawed Crayfish

The white-clawed crayfish *Austropotamobius pallipes* has been recorded in the canal to the west and east of the AAP boundary and so is presumed to use the AAP stretch. This is the only native British species and is protected under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). The native species is at risk from non-native American signal crayfish *Pacifastacus leniusculus*, which are larger, more aggressive and can pass on a deadly virus to the native crayfish. They have not been recorded in this vicinity of the canal but any evidence in future recording should be drawn to the attention of the Environment Agency (Holdich, 2003).

Resilience against non-native crayfish can be sought by translocating a number of healthy native white-clawed crayfish from a stable population to a new receptor site. This should only be undertaken if it is not likely to compromise the original population. The receptor site may be a suitable pond or lake where there are no records of American signal crayfish and where they are not likely to be introduced.

White-clawed crayfish require clean water with a good abundance of aquatic invertebrates and habitat for creating burrows. This can be within bankside tree roots or revetment walls below the water. The measures discussed above for creating additional fen vegetation are likely to provide shelter, particularly in winter months (Environment Agency, 2013).

4.4.4 Grassland Enhancements

The grass margins of the Leeds – Liverpool Canal towpath are frequently cut and currently contain species such as white clover *Trifolium repens* and greater plantain *Plantago majus.* They can be enhanced by adding more floral diversity using species such as common bird's-foot trefoil *Lotus corniculatus*, selfheal *Prunella vulgaris* and black medick *Medicago lupulin*. These species tolerate a frequent cutting regime and are much more colourful and appealing than plain grass (University of Reading, 2013). The installation of benches on suitable stretches would encourage the public to stop and appreciate their surroundings. Figure 29 shows the cut grass of the towpath and Figure 30 shows an example of a short mown, herb-rich grass sward.

The grass margins away from the water's edge may be cut less frequently and plug planted (or small bare patches created to sow seed) using species such as black knapweed *Centaurea nigra*, field scabious *Knautia arvensis* and ox-eye daisy *Leucanthemum vulgare.* This would add further to the visual appeal of the towpath and provide nectar and food sources for invertebrates (Baines, 1986). See Appendix 35 for suitable species lists.

Figure 29 - recently cut grass margins of the Leeds – Liverpool Canal (taken on 27/07/2014).

Figure 30 - example of a low growing, frequently mown grassland with dense herb content including: selfheal *Prunella vulgaris*, black medick *Medicago lupulina* and yarrow *Achillea millefolium.*

4.4.5 Control of Invasive Species

Stands of Japanese knotweed should be controlled. It was recorded at two locations along the stretch of canal within the AAP area and at other points outside. Treatment should be done with care beside waterways using appropriately qualified contractors. Himalayan balsam was not recorded along the AAP stretch of the canal but it was recorded not far outside the AAP area and can travel easily along waterways to colonise new stretches (Yorkshire Wildlife Trust, 2012). See Appendix 46 for guidance.

4.5 'Big Fish Revival'

Just a short stretch of the River Aire lies within the Shipley – Canal Road Corridor AAP boundary but this is another key feature providing an ecological link to the wider countryside. A conceptual map highlighting this area can be found in Appendix 52. Restoring means of passage for the migration of fish species is a key priority under the Water Framework Directive (WFD). Measures for achieving this and other enhancements are discussed below, including:

- Shipley weir – safeguard land for fish pass
- Retaining natural river banks & setting back development
- Woodland enhancements for structural and floral diversity
- Controlling invasive species

4.5.1 Local Interest Groups/ Organisations

The Aire Rivers Trust have an in depth knowledge of this watercourse and its ecology. They work towards improving the River Aire and its tributaries and connecting people, places and nature (Aire Rivers Trust, 2014). The Leeds City Regions' Green Infrastructure Strategy identifies the Aire catchment as one of their flagship initiatives, Fresh Aire. They aim to encourage environmentally conscious development and environmental improvements (Leeds City Region, 2010). The Wildlife Trusts' Aire Valley Living Landscape project highlights the corridor along the River Aire as an important wildlife feature, which they aim to enhance through habitat creation and linkage to other important wildlife areas (The Wildlife Trusts, no date A). The Environment Agency recently released 3000 barbel at various locations along the River Aire to boost the natural ecosystem as well as benefitting the angling community (Aire Rivers Trust, 2014). It would be beneficial to work with these groups towards achieving the outcomes listed above.

4.5.2 Shipley Weir

Shipley weir is an obstacle to the movement upstream of some fish species and other aquatic species. A fish pass would resolve this issue and space should be safeguarded adjacent to the weir to allow for its installation. Funding will also need to be secured. The Environment Agency should be consulted as they are the authority on this waterway. The Shipley weir is shown below in Figure 31.

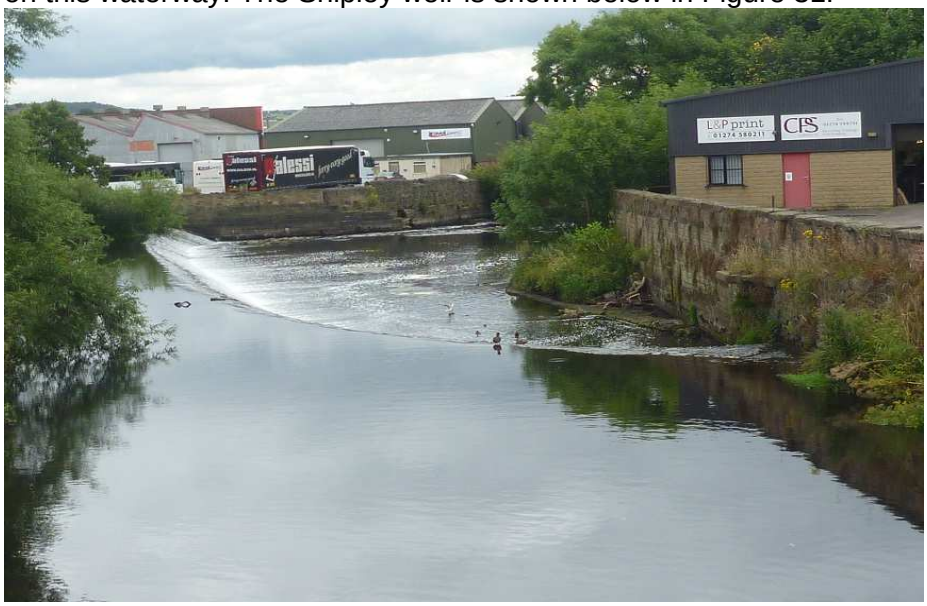

Figure 31 - Shipley weir on the River Aire (taken from Otley Road facing east).

4.5.4 Retain Natural Banks & Set-Back Developments

Natural banks should be retained or re-instated wherever possible, as they offer natural filtration of pollutants, burrowing habitat for a range of species, suitable sites for marginal fen to establish and are also more aesthetically pleasing (European Centre for River Restoration, 2013).

Any riverside development should always be set well back from the edge of the water, in order to retain the quality of the natural ecological corridor and to reduce the risk of flooding. The Environment Agency has a policy for critical ordinary watercourses and it requires development to be set back by at least 8 metres from the top of the bank. This allows access for maintenance. A significantly wider corridor should be left for wildlife wherever possible to establish a coherent ecological network that is more resilient to current and future pressures (National Planning Policy Framework, 2012).

4.5.5 Woodland Enhancement

The woodland bordering the River Aire is mostly dominated by sycamore *Acer pseudoplatanus* with little ground cover. There is also some young birch *Betula* and willow *Salix*. Steps can be taken to enhance the ground flora cover, through introducing species such as native bluebell *Hyacinthoides non-scripta*, wood anemone *Anemone nemorosa* (see Figure 32), greater wood-rush *Luzula sylvatica* and wild garlic *Allium ursinum*. Wild garlic should flourish on the lower slopes nearest to the water's edge. There is a footpath running along the northern margin of the River Aire and so the public will be able to appreciate the wildflower clad slopes on their way through. The woodland ground flora will also be beneficial for nectar feeding invertebrates such as bumblebees.

Figure 32 – wood anemone *Anemone nemorosa*; one of the attractive and nectar-rich woodland ground flora species proposed for use in woodland enhancement measures.

There is a stand of dense crack willow *Salix fragilis* on the margin of the River Aire, alongside the Otley Road bridge. There are also occasional sycamore *Acer pseudoplatanus* and ash *Fraxinus excelsior* trees. The ground cover contains some interest but could be enhanced using wet woodland species such as: meadowsweet *Filipendula ulmaria*, wild angelica *Angelica sylvestris*, common valerian *Valeriana officinalis*, marsh marigold *Caltha palustris* and rush *Juncus*. See Appendix 35 for a more extensive species list. Sycamore can be thinned and native alder *Alnus glutinosa* whips planted to form part of the wet woodland canopy.

Wet woodland is virtually absent from the AAP areas. It is a rich habitat that supports a diversity of species including: frogs, toads, newts, shrews, voles and many invertebrate species. The shrub/ canopy layer may be used by nesting birds and feeding bats. Overhanging branches provide fishing spots for kingfisher *Alcedo atthis*, which are known to use the area. The location discussed in the paragraph above (SE15041,37925) may also function as a secluded resting spot for otter *Lutra lutra*.

4.5.6 Control Invasive Species

None of the three key invasive species, Himalayan balsam, Japanese knotweed and giant hogweed, were recorded on the stretch of the River Aire within the AAP boundary but Japanese knotweed and Himalayan balsam were recorded on the watercourse not far outside the AAP area (see the maps in Appendices 29 and 30). See Appendix 46 for further information on control methods.

4.6 'The Otter's Domain'

The Bradford Beck is the key waterway that links the two AAP areas. A conceptual map highlighting this area can be found in Appendix 53. The beck flows south - north through the AAP areas, from Bradford city centre to Frizinghall and onwards to Shipley where it enters the River Aire. Throughout the city centre most reaches are under culverts, with just short open stretches. The northern stretches have a naturalised stony river bed, with stone or brick walled sides. They are generally between about 0.5 to 2m in height, although some sections are much higher including the section that flows under the Leeds – Liverpool Canal aqueduct. Small stretches have naturalised banks. Measures for enhancing this important ecological corridor are discussed below, including:

- Utilising concepts from the Bradford Beck Catchment Management Plan
- Retaining the green corridor along the beck
- Enabling species passage and enhancing diversity in the brick-lined stretch
- Increasing species mobility at gauging station & under Briggate A-road bridge
- Infilling the culvert and creating a new meandering stretch of beck
- Installing an artificial otter holt
- Re-naturalising some banks & set back development
- Monitoring & control pollution of misconnections & sewer systems
- Controlling invasive species

4.6.1 Bradford Beck Catchment Management Plan

The Friends of Bradford's Becks and the Aire Rivers Trust have a detailed knowledge of this aquatic habitat and the Bradford Beck River Restoration Catchment Management Plan encapsulates their aspirations for this watercourse (Friend's of Bradford's Becks, 2013a). The Catchment Management Plan was endorsed by Bradford's Environment and Waste Management Scrutiny Committee in 2013. It also has the support of the authors of this report and a couple of the concepts will be touched on below. For further information such as outline costs and a flood map see: http://bradford-beck.org/catchment-management-plan/

4.6.2 Retaining the Green Corridor

There is an important green corridor that runs along the margins of the Bradford Beck. It should be retained in order to preserve the ecological value and wildlife mobility it offers as well as the resource for quiet recreation. The corridor comprises a mix of woodland and grassland with some scrub and tall herb patches. There is currently good connectivity of green margins from Briggate A657 until the beck goes under culverts, just north of the Canal Road/ Stanley Road junction. The Canal Road Greenway follows much of this stretch (see Section 4.7 for further information). If development does take place within this green corridor then a reasonable sized width should be retained alongside the beck.

4.6.3 Brick-lined Barrier

There is a fully brick-lined stretch of Bradford Beck that runs from the Stanley Road/ Canal Road junction (SE15701,35456) up to Poplar Road (SE15254,36509), covering a length of about 1,170m. There are high vertical brick/ stone walls on both sides varying from approximately 2.5m to 5m in height. During the field work evidence of otter *Lutra lutra* activity was found as far upstream as Briggate B6149 (SE14974,36989) and it is likely that otter activity spans as far up the watercourse as the brick-lined stretch of the beck. This stretch was walked and no otter signs found. The brick lining forms a serious barrier to most fauna and flora species.

Figure 33 - part of the brick-lined stretch of the Bradford Beck, north of Gaisby Lane.

Figure 33 above shows the single obstruction to flow found while surveying the brick-lined stretch of the Bradford Beck. This small boulder is creating resistance to the fast flow of water over it. There is little vegetation in the water except lower plants. A few plants have colonised in the brick walls.

Figure 34 below shows indicative illustrations of the potential methods for increasing species access upstream. A high pressure gas mains pipe is located adjacent to the beck. Confirmation of its exact location must be sought. An indicative high water mark is shown in pale blue and low water mark in dark blue.

Figure 34a shows the current brick-lined stretch, which creates fast, laminar flowing water over the smooth, hard surface. This prevents most plant growth and provides no refuges for fish or invertebrates.

Figure 34b illustrates how the flow of water could be slowed by bolting clusters of boulders into the bed of the beck at intervals. This would create riffles and pools that would allow higher plant species to develop, invertebrate life to establish and fish species to migrate further upstream and utilise new spawning habitat. This would also provide a wider territory for otter as well as food for kingfisher *Althedo atthis* and grey heron *Ardea cinerea*. Increased capacity in the beck can be achieved by re-structuring and widening the eastern wall, which will create niches for plant growth. For a good example see the Burnley Urban River Enhancement Scheme: http://www.ures-burnley.org.uk/about_us.html

Figure 34c illustrates how the bed of the beck may be re-naturalised or partially re-naturalised. This would be the most costly but most ecologically beneficial method, providing all the benefits mentioned above for Figure 34b but at a much greater magnitude. A natural river system also has the benefit of acting as a natural filtration system. The option for removal of the eastern wall is illustrated and this would provide further space for a broader spectrum of habitats and diversity to establish. The amount of space available on the eastern bank will help to determine which option is most viable. See Appendix 35 for suitable native species lists for fen and emergent aquatic habitats, both of which were identified as scarce within the AAP areas.

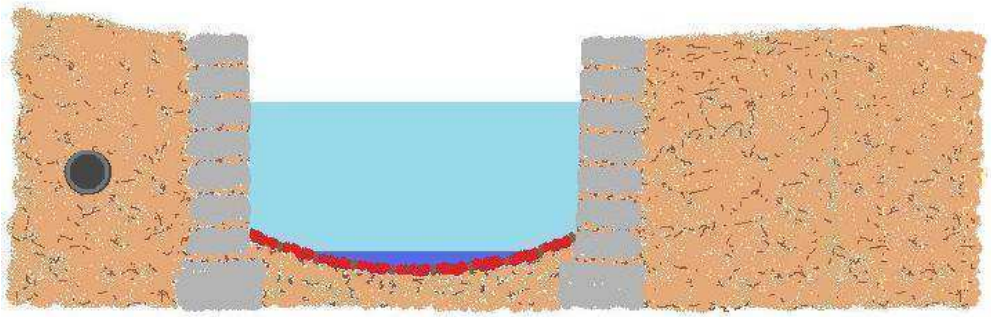

Figure 34a – current brick-lined stretch of Bradford Beck

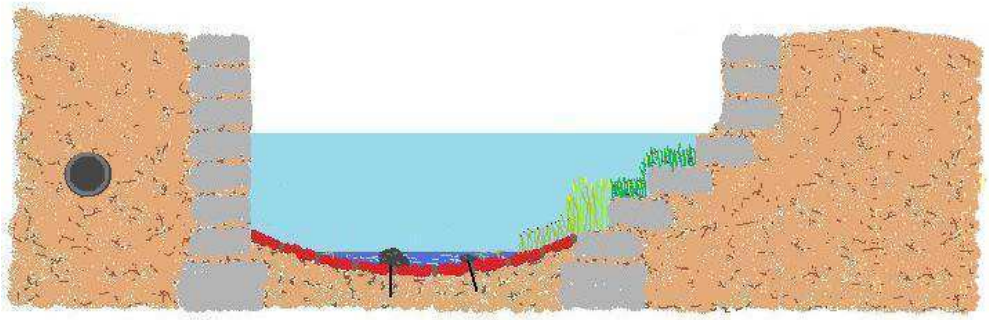

Figure 34b – boulders on bed to slow flow and re-grading of eastern bank

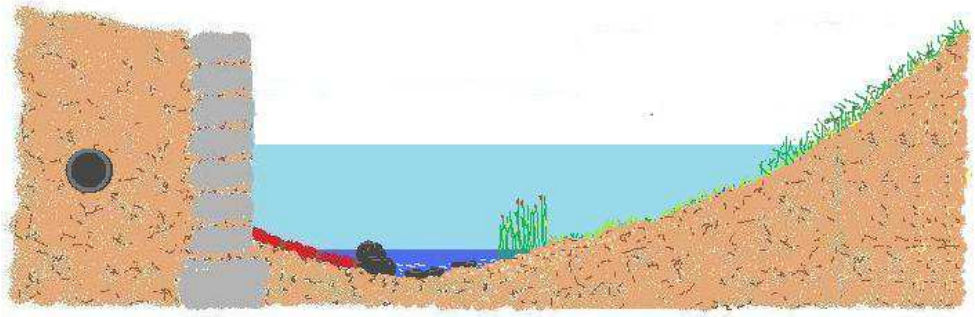

Figure 34c – re-naturalise bed & eastern bank

Figure 34 - options for increasing ecological quality along the brick-lined stretch of the Bradford Beck (produced by Robert Masheder).

4.6.4 Gauging Station

Shown in Figure 35 is a gauging station on Bradford Beck, to the east of Shipley Station (SE15129 37500). This also acts as barrier to the movement of some aquatic species, including brown trout *Salmo trutta*. The use of baffles or the replacement of the station with an electronic system would create a more easily accessible corridor for wildlife. This would need Environment Agency approval.

Figure 35 - gauging station on Bradford Beck is a barrier to migration of some fish species (courtesy of Friends of Bradford's Becks)

4.6.5 Briggate A657 Bridge

The Bradford Beck flows through double tunnels under the road bridge of Briggate A657 (SE15139,37613 – see Figures 36 and 37). The river-bed here is partially concrete and stone-lined and may act as a barrier to the movement of some fish and other aquatic species, particularly when the water level is low. The re-naturalising of the river bed would resolve this issue.

Figure 36 (left) - western tunnel & Figure 37 (right) eastern tunnel, both under Briggate A657 road-bridge with partial concrete and stone-lined beds

4.6.6 Infill Culvert and Realign the Beck

The beck is fairly inconspicuous along much of its path through the AAP areas. The Friends of Bradford Beck believe this has lead to it becoming a somewhat forgotten feature for many local people (Friends of Bradford's Becks, 2013). The green space between Briggate B6149 (SE15985 36979) and Poplar Road (SE15257 36504) is a key focal point for quiet recreation, particularly since the creation of the Greenway. The beck flows through this stretch and can be enhanced to support a richer diversity of wildlife and encourage the local population to engage with this natural resource.

Ecological and visual benefits can be achieved by realigning the beck on a new course to the east and infilling a culverted stretch covering about 75 – 80m (from SE15050 36720 to SE15106 36671). The culvert was installed between the late

1920's and mid 1930's but the original reason for its creation is unknown. Removal of the culvert would be a more expensive option and infilling will maintain the stability of retaining walls. A bay and backwater can be created by retaining short sections of the present beck at the entrance and exit of the culvert (Friends of Bradford's Becks, 2013). Figures 38 and 39 show the entrance and exit tunnels of the existing culvert.

Figure 38 (right) - southern (entrance) end of culvert & Figure 39 (left) – northern (exit) end of culvert & along Bradford Beck, Frizinghall.

Installing benches and an attractive footbridge overlooking the newly opened stretch of beck and erecting an interpretation sign would aid awareness of and public engagement with the beck and its ecological value. Waterways stimulate the human imagination and can be uplifting when the habitats present are healthy with an abundance of wildlife. Figure 40 shows an attractively painted bridge over Bradford Beck. Humpback bridges are often the most aesthetically pleasing.

Erecting a low fence or wall to encircle the newly created features would encourage the public to view from the bridge or top of the slopes, to avoiding potential injury or wildlife disturbance. There may be the possibility for closer contact with the beck through properly organised and responsibly led events.

Figure 40 - footbridge over Bradford Beck painted in an attractive colour (located just south of Poplar Road)

There would be the opportunity to create some marginal fen habitat along the newly created stretch of beck. Species may include: meadowsweet *Filipendula ulmaria*, wild angelica *Angelica sylvestris*, marsh marigold *Caltha palustris*, soft rush *Juncus effusus*, yellow-flag iris *Iris pseudacorus*, purple loosestrife *Lythrum salicaria*, water forget-me-not *Myosotis scoripiodes* and lesser spearwort *Ranunculus flammula*. This

would produce an attractive strip of colour and provide shelter and spawning ground for fish as well as perching places for dragonflies and damselflies.

The fresh banks along the new stretch of beck could be scattered with a dense concentration of seeds of native species that will provide a dense ground cover and prevent the growth of rank species such as nettle *Urtica* and thistle *Cirsium*. These may include species such as native bluebell *Hyacinthoides non-scripta*, wild garlic *Allium ursinum*, primrose *Primula vulgaris* and greater woodrush *Luzula sylvatica*. These species are visually appealing and offer a nectar source for invertebrates. See Figure 41 below that illustrates this overall concept.

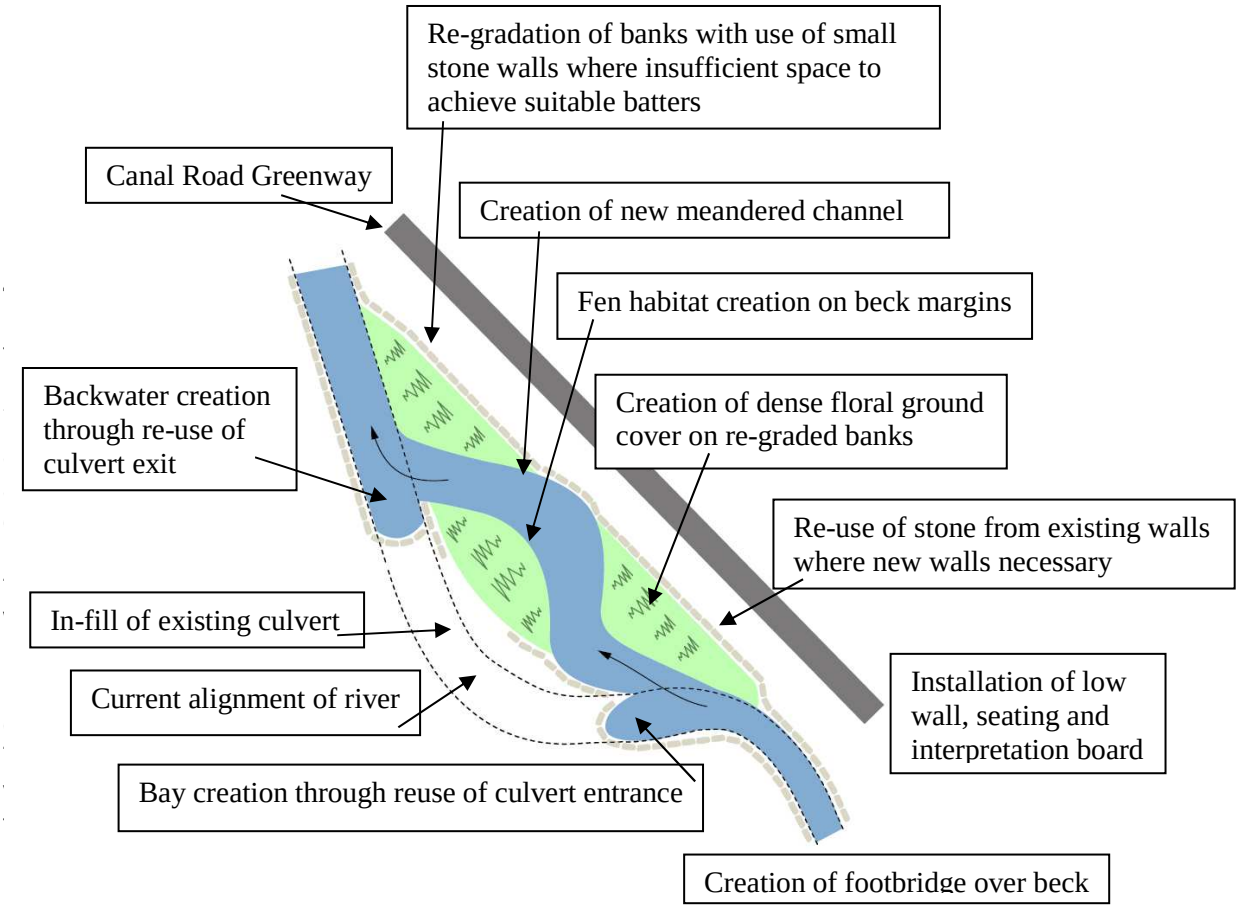

Figure 41 - overview of the concept to infill an existing stretch of culvert on the Bradford Beck and create a new meandering channel to the east. Improvement of ecological linkage, habitat creation and public engagement opportunities (courtesy of Friends of Bradford's Becks)

4.6.7 Otter Holt

No otter holts were located during the field survey work but this is not confirmation of their absence as they can be extremely hard to detect. Installation of an artificial otter holt along the Bradford Beck would ensure that suitable nesting space is available. Yorkshire Water should be informed before installation. Monitoring (ideally annually) to establish if a holt is in use provides valuable information. The surveyor will need a licence from Natural England and should aim to cause as little disturbance as possible to any occupied holt (Yorkshire Wildlife Trust, 2014). This may be achieved by installing a camera trap in the holt during erection.

Yorkshire Wildlife Trust installed twenty artificial otter holts along the River Aire as part of the Mid-Aire Otters and Rivers Project. These included a range of holt types: log pile and pipe and chamber (see Figures 42, 43 and 44 below). For sites where access is difficult a recycled plastic holt may be the best option as it can be flat-packed and is relatively light to transport. They can be partially buried then covered by turves/brash or can be fully buried if a ventilation pipe is installed (Yorkshire Wildlife Trust, 2014). Recycled plastic chamber holts and ventilation tubes are available from Filcris:
http://www.filcris.co.uk/products/wildlife-products/otter-holts

Figure 42 - recycled plastic chamber otter holt comes flat packed. Installed by Yorkshire Wildlife Trust and volunteers (courtesy of Don Vine)

Figure 43 - breeze block chamber type otter holt constructed by Yorkshire Wildlife Trust with volunteers (courtesy of Don Vine)

Figure 44 - temporary log pile and brash otter holt constructed by Yorkshire Wildlife Trust with volunteers (courtesy of Don Vine)

Otter holts should be sited where risk of disturbance is limited. Disturbance can be caused by people, and particularly dogs, passing frequently close-by or by regular maintenance of river banks. There should be a good source of food nearby as well as good cover such as willow scrub,fen or tall herbs. Otter holts should be sited above the highest winter flood level as the chamber must not be flooded. There should be two or three entrances, of about 20cm across, sited below or at water level (International Otter Survival Fund, no date). One potentially suitable site was noted during field survey work (SE1509,3738 and surrounding land). A suitability assessment will be required.

Otters are legally protected against disturbance in their breeding or resting spaces. The presence of otters should be flagged up for any developments or works that will affect the beck and banks. Holts should not be disturbed and any pipes or otter sized holes (20cm plus in diameter) should be checked by a competent otter surveyor during project planning. Figure 45 shows a potential otter resting site located on the Bradford Beck (SE15085,37341).

Figure 45 - potential resting site for otter *Lutra lutra* in the eastern bank of the Bradford Beck

4.6.8 Retaining Natural Banks & Setting Back Development

Natural banks along the watercourse should be retained or re-instated wherever possible, as they offer natural filtration of pollutants, burrowing habitat for a range of species, suitable sites for marginal fen to establish and are also more aesthetically pleasing (European Centre for River Restoration, 2013). The existing stone/ brick revetment walls are utilised by nesting birds such as great tit *Parus major* and potentially roosting bats. Suitable surveys for these species would be necessary prior to the re-structuring or removal of any stretch of revetment wall. Compensatory measures can be achieved by installing bird nest boxes and bat roost boxes in adjacent wooded sections. See Appendix 21 for potential locations.

Any riverside development should always be set well back from the edge of the water, in order to retain the quality of the natural ecological corridor and to reduce the risk of flooding. The Environment Agency has a policy for critical ordinary watercourses that states any development should be set back at least 8 metres from the top of the bank. This allows access for maintenance. Along much of the Bradford Beck this stand-off distance should be increased to take account of the artificial vertical walls on both sides of the beck.

4.6.9 Flood Risk & Contaminated Land Assessment

Modelling will be needed to see if such morphological improvements make a significant difference to flood capacity. Risk of contaminated land should also be assessed. The Land Contamination team carried out a Phase 1 survey of this area as part of the Canal Road Greenway project and suggested further investigations of some sections (CBMDC, 2014). Their advice should be sought before any works are carried out.

4.6.10 Water Quality & Pollution Control

Dipper were found to be nesting under two bridges along the Bradford Beck (SE15136,37614 and SE14989,36916) and grey wagtail were also seen collecting invertebrate food at various locations along the beck. The presence of dipper, grey wagtail and otter indicates that water quality is at a sufficient level to provide a food source for these species. However, pollution events can be extremely detrimental and vigilance is necessary to prevent excessive pollutant levels in the watercourse.

The misconnection of sewage pipes is thought to be a key issue regarding the pollution of the Bradford Beck. The Friend's of Bradford's Becks have initiated a monitoring project and are training volunteers who will record observations from 15 key monitoring points along the watercourse (Friend's of Bradford's Becks, 2014b). They will report findings to Yorkshire Water, Bradford Council and the Environment Agency, who should work together to tackle this issue.

Combined Sewage Overflows (CSOs) are in place along the Bradford Beck and, during a heavy storm event, will discharge untreated human sewage and wastewater into the beck, to prevent it flooding into houses (Yorkshire Water, 2014). Screens are in place at the discharge points of CSOs, to block debris and coarse solids from entering the river system. These should be maintained regularly to ensure that they are fully functioning, otherwise pollution in the beck may become severely detrimental to wildlife. The use of green roofs and Sustainable Urban Drainage Systems (SUDS) basins can help greatly in reducing the amount of runoff pressure being put on CSOs (see Section 4.9.3 below for further information on Green Roofs).

4.6.11 Control Invasive Species

There were a number of stands of Japanese knotweed and Himalayan balsam recorded along the stretch of the Bradford Beck that lies within the AAP areas (see maps in Appendices 29 and 30 for locations). The Friends of Bradford's Becks and Aire Rivers Trust are currently running a project which aims to control of these invasive species and they are currently focusing efforts on Japanese knotweed control (Friends of Bradford's Becks, 2014). The invasive species data from this project has been shared with these groups. See Appendix 46 for guidance on control methods, which must be done sympathetically beside waterways.

4.7 The Canal Road Greenway; 'The Greener Way'

The Canal Road Greenway offers opportunities for creating an improved green corridor through the AAP areas. A conceptual map highlighting this area can be found in Appendix 54. Measures for achieving ecological enhancements are discussed below, including:

- Creating large scale nectar-rich meadow habitat along the corridor
- Woodland enhancements for structural and floral diversity & increasing the abundance of habitat niches and nesting/ roosting opportunities
- Potentially utilising phytoremediation on disused allotments
- Controlling invasive species

4.7.1 Perennial Meadow Creation; Green Corridor

The Canal Road Greenway is a beneficial and welcome addition to the local area and, once complete, it will offer a healthier option for commuters and a leisure route for many to enjoy. The stretches of the Greenway that have already been established have been well received and praised by the local community. Individuals gave positive feedback directly to surveyors during field work for this report.

The Greenway runs parallel with the line of the Bradford Beck and forms part of an important green corridor. The grassland surrounds are used as public open space, which is kept close mown (see Figures 46 and 47 below). These grasslands could be transformed into wildflower-rich perennial meadows that can give a huge boost to local pollinator populations as well as small mammals. They can also provide enhanced visual interest along the Greenway. A strip of about 0.5 – 1m should be regularly mown along the margins of the Greenway to keep the pathway clear. Suitable areas for picnic and play may also be identified through consultation with the local community and mown more regularly.

A similar project is currently being implemented via a partnership between Stoke-on-Trent City Council and Staffordshire Wildlife Trust. It is being undertaken with funding from the SITA Trusts' Enriching Nature programme to transform a number of green open spaces into perennial meadows in consultation with the local community (City of Stoke-on-Trent, 2013).

Figure 46 - the recently established Canal Road Greenway is well used and appreciated by the local community and visitors to the area (looking north from SE1512,3668)

Figure 47 - stretch of Canal Road Greenway, looking south from Poplar Road

An example of an attractive, well managed perennial meadow that is rich in wildflowers is shown in Figure 48. Yellow rattle *Rhinanthus minor* is used in this meadow to control vigorous grass growth and maintain a high concentration of wildflowers. After sowing yellow rattle its seed was harvested annually and re-sown until it had established well across the whole site (Coton Manor Garden, 2014). See Appendix 18 for potential perennial meadow locations, Appendix 38 for guidance on creation and maintenance and Appendix 35 for suitable species.

Further seating should be installed at intervals along the Greenway to allow users to stop and rest. This has already been done at one point on the Greenway, using two wooden benches, a gravel surface and an arc of young tree saplings (see Figure 49 below). The Greenway acts as a defined pathway and during numerous survey visits, throughout spring and summer 2014, users were noted to be sticking to the pathway. Therefore the meadows would not be at high risk of trampling.

Figure 48 – a perennial wildflower meadow with an abundance of ox-eye daisy *Leucanthemum vulgare* and buttercup *Ranunculus* (courtesy of Coton Manor Garden, Nottinghamshire).

Figure 49 - seating created along the Canal Road Greenway (SE1525,3655). Benches should be attractive but also functional, with backs and arms for ease of use.

4.7.2 Greenway: Opportunities for Woodland Enhancements

Woodland habitat stretches along the eastern side of the Greenway, between Briggate B6149 and Poplar Road. Parts of the woodland can be enhanced by the periodical removal of some sycamore *Acer psedoplatanus* from the canopy (but leaving the most mature trees, as there are few throughout the AAP areas) and by planting oak *Quercus robur/ Quercus petraea* and birch *Betula pendula/ Betula pubescens* whips. A shrub layer of hazel *Corylus avellana*, holly *Ilex aquifolium* and hawthorn *Crataegus monogyna* could then be established and ground flora such as native bluebell *Hyacinthoides non-scripta* and foxglove *Digitalis purpurea* sown. See Figure 50 below for a potential location.

Figure 50 – Canal Road Greenway: opportunities for woodland enhancements including increased diversity and structure (photo location: SE1503,3694).

Other parts of the woodland may be retained with a dense canopy and understory to discourage public access. Boxes may be erected for birds as well as bats (see Figure 51). *Pipistrellus pipistrellus* and Daubenton's *Myotis daubentonii* bats use this stretch for feeding but there is little to no available roosting habitat in the woodland, although there are opportunities along the stone/ brick revetment walls and bridges of the beck. The Bat Conservation Trust can provide information on suitable boxes for tree installation that can host the pipistrelle bat *Pipistrellus pipistrellus* and other species. Schwegler market a range of bat roost boxes. The RSPB sell a wide range of bird

nesting boxes and can give advice on suitability. Woodcrete boxes are particularly durable. Log piles may also be created to support invertebrates and mammals such as bank vole *Clethrionomys glareolus* and hedgehogs *Erinaceus europaeus*.

Figure 51 - dense woodland on bank to the west of Cragg Road by Canal Road Greenway: potential for installing boxes for birds/ bats and creating log piles (photo location: SE1509,3680)

There are a couple of dense bracken *Pteridium aquilinum* stands on the slopes adjacent to the Greenway (SE1514,3671 & SE1522,3662). This offers additional ecological structure but is lacking in visual appeal (see Figure 52). It can be ecologically and visually enhanced through sowing with native bluebell *Hyacinthoides non-scripta* and foxglove *Digitalis purpurea* to provide attractive blooms and a nectar source for invertebrates such as bumblebees.

Figure 52 - dense bracken stand on Canal Road Greenway margin: opportunities for enhancements through use of native bluebell *Hyacinthoides non-scripta* and foxglove *Digitalis purpurea.*

4.7.3 Phytoremediation

The disused allotment site, north of Gaisby Lane, is subject to soil pollutants. There are current assessments being carried out in order to ascertain the type of pollutants, the extent and potential associated risks. Until this is known it is not possible to assign a suitable method for treatment but phytoremediation may be an option. Phytoremediation is the process of using specific plants to extract, sequester or detoxify pollutants from the soil or water (Centre for Novel Agricultural Improvements, 2014).

4.7.4 Control of Invasive Species

There are small stands of Japanese knotweed *Fallopia japonica* and Himalayan balsam *Impatiens gladulifera* along the Canal Road Greenway. These should be controlled to prevent a worsening situation. See Appendix 46 for advice on management.

4.8 'The Green Lungs of Bradford'

The high sides of the valley throughout the AAP areas support valuable wildlife habitat. A conceptual map highlighting this area can be found in Appendix 55. Measures for retaining and enhancing this resource are discussed below, including:

- Retaining green ridge as key area of ecological interest within AAP areas
- Enhancing linkages through woodland creation and increasing grassland diversity further
- Existing woodland enhancements for improved structure & floral diversity
- Creating heathland on former quarry land
- Controlling invasive species (notably Boar's Well)

4.8.1 Bolton Woods Quarry

The quarry at Bolton Woods has been in use since the 1950s and produces high-quality sandstone. The area it covers is around 60 acres (Hard York Quarries, no date). The minerals team at Bradford Council has original planning documentation that shows a low-level plan was submitted for the quarry to be in-filled following the cessation of works. No agreed ongoing land use has been identified as yet and the plan for complete levelling is subject to change if another viable plan is submitted and approved in advance.

The quarry surrounds are representative of the native flora and habitats of the district, which have become restricted in distribution within the AAP areas due to the pressures of development. The marginal slopes are covered by species-rich acid and neutral grasslands with scattered scrub, while broad-leaved woodland covers the northern and western parts. Figure 53 shows a section of this area which forms part of an important ecological corridor along the eastern side of the Shipley – Canal Road Corridor AAP area, reaching as far as the northern end of the Bradford City Centre AAP area. These habitats should be retained and enhanced wherever possible (see Section 4.8.2 below).

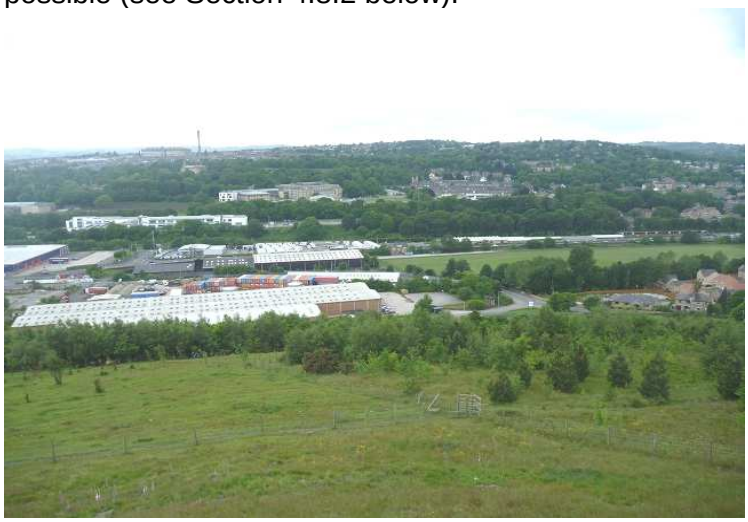

Figure 53 - overlooking Canal Road from the Bolton Woods quarry margins, host to acid grassland, scrub and woodland habitats (SE1604,3576)

4.8.2 Bolton Woods; Retention & Enhancement of Important Ecological Corridor

The important ecological corridor along the eastern side of the Shipley – Canal Road Corridor AAP area provides linkages to the wider area. It covers the quarry surrounds, Poplars Park woodlands, Brow Wood and the Boar's Well Urban Nature Reserve (see Figure 54). The dominant habitat is woodland and the species-rich acid and neutral grasslands and scattered scrub within the quarry surrounds provide a valuable habitat mosaic. This corridor was found to have the greatest concentration of ecological interest within the AAP Areas, with the most features of high to medium bat roost potential and the highest density of breeding bird activity. Retention and enhancement of this ecological corridor offers one of the primary ways in which to sustain the ecological resource within the AAP Area. This can be achieved through retention of existing habitats and creation of new habitats to strengthen linkages.

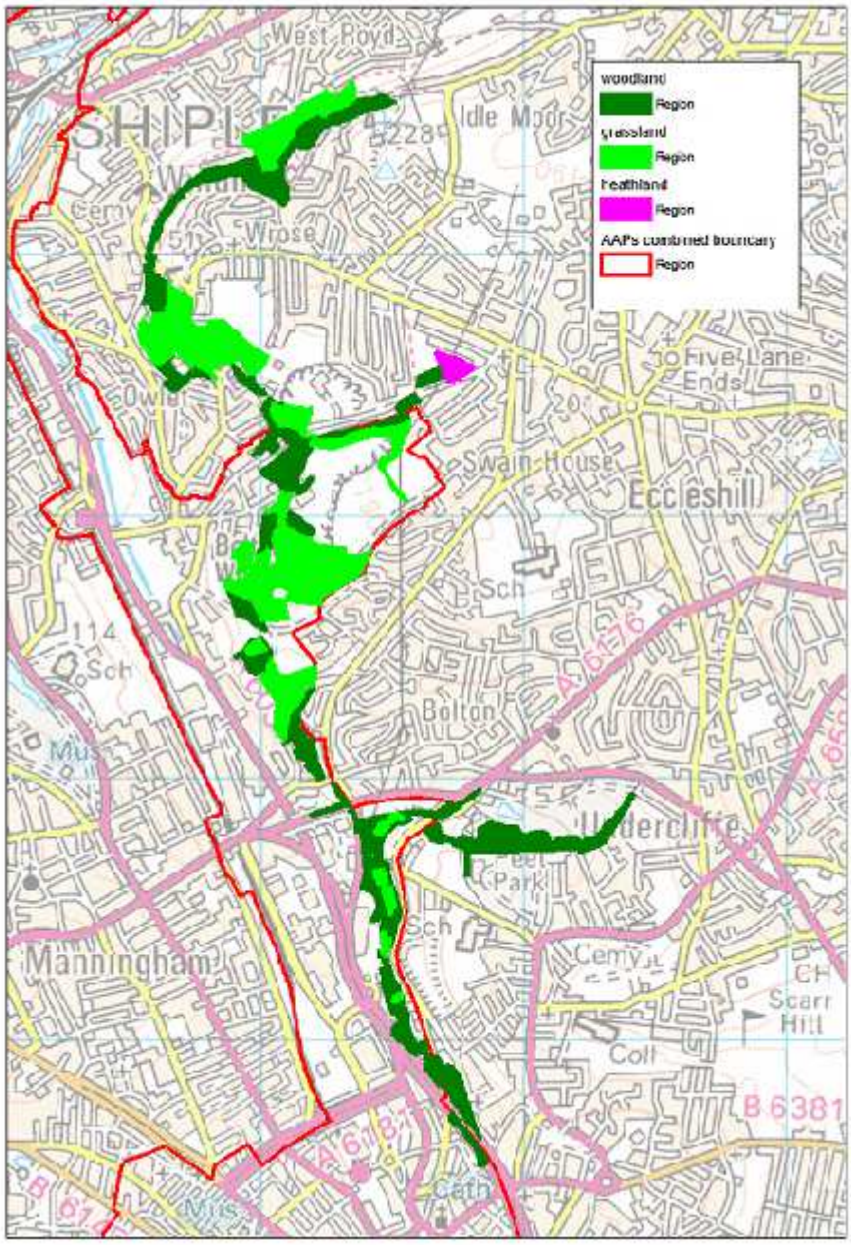

Figure 54 – an important ecological ridge runs down the eastern side of the AAP areas and links to the wider countryside.

Following cessation of quarrying, part of the quarry grounds may be used for the creation of a heathland and acid grassland mosaic (see Figure 54 for indicative area coverage). This would be of great benefit for wildlife, particularly invertebrates. Many moth species use heather *Calluna vulgaris* as a food plant and these species then provide food for feeding bats, such as common pipistrelle *Pipistrellus pipistrellus*. The heathland habitat could be mirrored by establishing mini-heathlands/ acid grasslands on the roofs of suitable new developments in this area. This would produce a real 'eco' development that would blend sympathetically with the surrounding natural areas and serve a dual-purpose by providing space for wildlife and for local residents. See Figure 55 below for an indicative illustration of this concept and see Appendix 35 for lists of suitable flora species. The RSPB have experience of wildlife habitat creation through quarry restoration projects and can be consulted.

Figure 55 - indicative illustration that displays the potential for Bolton Woods quarry to be utilised following cessation of quarrying works to strengthen an important ecological corridor and provide restful natural surroundings for local residents through the creation of heathland. Adjacent residential buildings are shown with heather green roofs to compliment the surrounding vegetation (Produced by Robert Masheder)

The woodland stretches within this ecological corridor can be enhanced through various measures. The woodlands on the steeper parts of the quarry surrounds are dominated by young birch *Betula* and willow *Salix*. These areas would be enhanced through the introduction of native oak *Quercus petraea/ robur* whips, as well as through seeding heather *Calluna vulgaris*, bilberry *Vaccinium myrtillus* and foxglove *Digitalis purpurea*. This would create a dense ground cover, providing both shelter and a food source for a wide range of wildlife, including roe deer *Capreolus capreolus*, fruit and seed feeding birds, small mammals and many moth species.

Many of the other woodland blocks along this ecological corridor are dominated by sycamore *Acer pseudoplatanus* with some oak *Quercus robur* and ash *Fraxinus excelsior*. Periodical thinning of some of the non-native sycamore (but retaining the most mature trees) and plantings of native oak *Quercus robur* and birch *Betula pendula/ B. pubescens* would be beneficial. Some of the felled wood can be utilised on-site in the form of log piles (placed in discreet spots to avoid vandalism). Ground flora such as native bluebell *Hyacinthoides non-scripta*, wood sorrel *Oxalis acetosella* and red campion *Silene dioica* can be sown in the newly created openings. Figure 54

and Appendices 21 and 22 indicate potential enhancement locations. Appendix 35 provides information for species choices.

Boar's Well Urban Nature Reserve lies at the southern end of this significant ecological corridor. It is host to a mosaic of scrub, tall herb and woodland habitat on a steep slope, as well as a small pond (one of only 3 recorded in the AAP areas during the field work). Bradford Environmental Education Service (BEES) has carried out valuable ecological works over recent years, such as dead-hedge creation, control of invasive species and pond maintenance. The control of invasive species on-site is of key concern to avoid spread through the valuable ecological corridor and should be a primary target. See Appendix 46 for further information on control methods.

4.8.3 Community Woodlands

There are opportunities for local community groups to take on responsibilities for maintaining natural resources such as woodlands. Heaton Woods Trust is a charity that was formed in 1978 by local residents in the Heaton area of Bradford with the aim of preserving and enhancing Heaton Woods. The woodland is a locally designated wildlife site and consists mostly of ancient semi-natural woodland (continuously wooded since at least AD 1600) and supports a great diversity of wildlife species. The site is well respected by the local community and is a popular location for quiet recreation (Heaton Wood Trust, no date). This is a good example of how community cohesion and long-term enthusiasm can provide a successful duel purpose space for the benefit of both wildlife and local people.

4.8.4 Traditional Orchard Creation

Traditional orchards are a UK BAP priority habitat. They support a wide range of invertebrates but 90% of this habitat has been lost since the 1950's (People's Trust for Endangered Species, 2014). There is the potential to create a number of small orchards (with meadow ground-cover) within the AAP areas and five potential sites are highlighted on the map in Appendix 25.

Through consultation, the orchards may be established and managed by groups of local residents, such as 'Friends of' Groups. Bradford Environmental Education Service (BEES) received funding for the creation of a traditional orchard covering six disused allotment plots at Bowling Green allotments, central Bradford. The orchard was planted in 2002 and is now well established. It is managed by the BEES volunteers and the 'Friends of' Bowling Park Community Orchard. Prior to the creation of the community orchard the disused allotment space was a target for rubbish dumping and anti-social behaviour but it has been transformed into a pleasant and valued local space (BEES, 2014c). See Figure 56 of the orchard in use.

Species suitable for use in orchards include wild cherry *Prunus avium*, domestic apple varieties *Malus pumila var.,* plum *Prunus domestica* and walnut *Juglans regia.* These fruits and nuts can be harvested by the local groups that manage them and surplus utilised by wildlife such as birds and invertebrates. The type of rootstock used determines the size and vigour of the tree. Suitable annual pruning will be necessary to encourage healthy blooms and to maintain a steady harvest.

Fruit trees are often self-sterile, which means at least two or three varieties are required to enable fertilisation (Building Conservation, 2011). No chemicals and little to no fertiliser should be used in a traditional orchard management system and the ground beneath can be managed as a meadow. The blooms of fruit trees are extremely attractive and also provide a brilliant nectar source for bees and other

pollinator species. See Appendix 35 for a list of potential species and Appendix 43 for guidance on creation and maintenance of traditional orchards.

Figure 56 – Bowling Park Community Orchard & allotment site during an event for local students and interested individuals (Bradford Environmental Education Service)

4.9 'Urban Oases'

There are many ways in which to incorporate features for wildlife into an urban centre. A conceptual map highlighting this area can be found in Appendix 56 and a range of key methods for enhancing ecological resource in the urban centre are discussed below, including:

- Enhancing brownfield space using annual meadows
- Creating green roofs & living walls
- Integrating nesting boxes & bat tubes in to new developments
- Increasing amount of urban tree lines
- Installing retention/ detention ponds & wildlife ponds
- Using stormwater planters widely in urban locations
- Installing a peregrine nesting platform
- Wider use of permeable paving
- Water butts on suitable new housing
- 'Ecoversity' - encouraging Bradford college to follow a good example
- Little Germany/ Bradford Cathedral Oases - small enhancements

4.9.1 Urban Greening

Modern urban centres are often deserts for wildlife, as they are largely covered by developed land with little green space. There are many creative, functional and visually appealing ways of transforming wildlife deserts and establishing more welcoming urban centres for wildlife, local residents and businesses.

Incorporating a range of ecological features into planning for new developments should be encouraged as the standard approach. It will often cost less than retro-fitting buildings and the long-term benefits often exceed the initial rise in cost (Dunnett & Kingsbury, 2008).

Sustainable Urban Drainage Schemes (SUDS) are recognized tools for managing runoff pressures created through development. They are used to meet National Planning Policy: paragraph 93 (deliver sustainable development) and paragraph 94 (reduce flood risk), as well as to comply with the Water Framework Directive (WFD). These features often provide benefits for wildlife and can provide important habitats. The key techniques are:

- Green roofs
- Living walls
- Stormwater planters
- Ponds/ wetland features
- Permeable paving
- Rain gardens/ swales
- Rain butts
- Incorporating green space

4.9.2 Brownfield Site Enhancements; Annual Wildflower Meadows

Incorporating and retaining green space in urban centres is an important measure for wildlife and reduces the volume of stormwater runoff. Annual flower meadows may be utilised, as a temporary measure, on existing areas of bare earth or brownfield land that is awaiting development. Disused brownfield sites often develop a patchy cover of low growing clovers and fine grasses spontaneously. This naturally colonised habitat mosaic is often good for wildlife and there is a UK BAP priority habitat for 'open mosaic on previously developed land'. However, the 'unloved' appearance of these sites can attract unwanted dumping of rubbish and anti-social behaviour, as was seen on some of the sites within the Bradford City Centre AAP area.

Annual plant species have a year long life-cycle and it is necessary to scarify the soil each spring to stimulate seeds from the previous year to germinate and to implement some top-up re-seeding annually. It is often best to sow annual meadow seed on areas with bare earth to aid success. See Appendix 39 for guidance on annual wildflower meadow creation and management and Appendix 35 for a list of suggested species. Figure 57 shows an attractive annual wildflower mix available from Landlife.

Scattering brownfield sites with annual wildflower seed, while awaiting development, would compliment existing self-colonised vegetation and provide a rich-source of nectar and food for many pollinator species, such as bees, butterflies and moths. It would also create a colourful and uplifting spectacle, which should not attract misuse. The use of interpretation boards to inform the local community of the temporary status of the habitats and reason for their use would be beneficial.

Figure 57 – an attractive annual wildflower meadow (courtesy of Landlife)

It may be possible to create a pollinator friendly land-use scheme that developers/ owners of the brownfield sites could join and receive an award for the wildlife friendly use of space prior to development. This would encourage the creation of this temporary meadow habitat and would hopefully lead to a sustainable, ongoing project with new sites becoming available for seeding as others are lost to development. Some potential sites have been highlighted in Appendix 19 (this map also includes non-brownfield annual meadow opportunity sites).

Development sites can sometimes remain vacant for a number of years and if a site is managed as a meadow for that length of time it is more likely to become a valuable resource for both wildlife and local residents. This may lead to resistance to development and in order to mitigate this, the scheme could encourage developers to include a green roof within their development proposals whenever possible to enable recreation (or possibly translocation) of meadow habitat on to new roof space.

This type of scheme was utilised by MEPC, who own land at Wellington Place in central Leeds and aim to develop a commercial and social hub there. In 2010 they established an urban garden with allotment space for their customers and local residents to make use of prior to development of the land (MEPC, no date). They also have a small orchard on site (MEPC, 2014).

4.9.3 Green Roofs

4.9.3.1 Green Roofs Benefits

Green roofs are a prominent method for greening urban space and can be extremely beneficial. The attributes offered through green roofs include:

- Wildlife habitat – notably plants, invertebrates and birds
- Creation of green stepping stones – linking urban centres to the wider area
- Interception of dust and air pollutants – improving air quality, asthma reduction
- Retention of stormwater by green roofs - reducing and slowing runoff
- Filtration of water prior to runoff
- Reduced energy consumption –regulating the building temperature
- Reduced urban heat island effect
- Prolonged life of roof
- Employment opportunities
- Visual pleasure – can contribute to stress reduction in humans
- Potential for amenity and food production
- Enhanced green credentials for developers

4.9.3.2 Green Roof Centre

The Green Roof Centre at the University of Sheffield is a demonstration centre that carries out research on and promotes this green technology. They can offer advice on structural elements, plant species options, ecological benefits and funding opportunities.

4.9.3.3 Green Roof Policies

Developers can be deterred from implementing green roofs due to the upfront cost often being higher than that of a standard roof. Understanding the full potential and benefits offered by green roof technology is vital and should be used as a valuable tool. Other methods for encouraging the wider use of green roofs include holding workshops and demonstration events. These could be held on top of an intensive green roof or include a site visit to view an extensive green roof.

There are a range of monetary incentives being implemented by local authorities worldwide (Green Roof Waterloo, 2004). The environmental assessment (BREEAM) rating can be greatly enhanced through incorporating measures such as green roofs into new developments and the publicity benefits from increased green credentials should be promoted to developers.

Local authorities also have the power to put policies in place that require developers to implement green roofs within certain developments. This approach is widely implemented throughout Germany, Austria, Switzerland, The Netherlands, Norway, Sweden, parts of the USA including Portland and Michigan, Toronto in Canada and Tokyo in Japan. It was slow to catch on in England but Greater London (Living Roofs.org, 2014) and Sheffield (Sheffield City Council, 2009) have adopted local green roof policies and this approach is likely to increase.

Where local authorities have introduced green roof policies, they have also created demonstration/ publically accessible roofs that allow engagement with developers and the public. The use of interpretation signs to highlight locally beneficial ecological interest points of green roofs can be useful. Air quality and water quality were found to be top priorities following a public outreach survey on green roof technology completed by local residents in Waterloo, Iowa (Green Roof Waterloo, 2004).

In Germany, many cities have had green roof policies integrated in to their legal development framework for many decades and subsidies for the voluntary creation of green roofs have helped reduce stormwater management costs (International Green Roof Association, 2014).

In Copenhagen all new developments topped by roofs with less than a 30 degree pitch must be built with green roofs (Livingroofs.org, 2010), while in Toronto all new buildings with a floor space of 2000 square feet or more must install a green roof that covers between 20 – 60% of its roof space (City of Toronto, 2014).

In the USA, the city of Portland promotes the use of green roofs to alleviate the overwhelming stresses put on the sewage system from stormwater runoff. Public events were held on top of intensive green roofs in order to enable local residents and developers to learn about the benefits they provide and to engage with the concept (International Green Roof Association, 2014).

4.9.3.4 Classes of Green Roof

Green roofs are generally classed as either intensive or extensive. Extensive roofs do not usually have access for amenity but, depending on where they are sited, can have high aesthetic benefits. The growing substrate will generally be thinner and less weight loading capacity required. This means retro-fitting of existing roofs may be a feasible option.

‘Biodiverse’ green roofs are a more recent concept that slots between an extensive and intensive roof type. They usually require a depth of at least 10cm of substrate and offer more diversity and ecological benefits than typical sedum roofs.

Intensive roofs are more likely to have amenity value, a deeper soil substrate and the ability to support larger plant species such as trees and shrubs. They need a greater capacity for weight loading built in to the roof and there are usually greater demands on maintenance but the capacity for runoff retention may be high. Figure 58 shows an intensive green roof at City Park, Bradford.

Figure 58 – an intensive green roof above the rangers office and public conveniences at City Park, Bradford

All buildings require a full assessment by an engineer to establish weight loading capacity and any other health and safety considerations. Buildings proposed for green roofs do not require flat roofs but there will usually be an enhanced cost for pitched roofs as additional structures are required. Green roofs need not be restricted to larger buildings and can also be installed on small surfaces such as sheds and garages. Increased public understanding and appreciation of green roofs is likely to lead to wider implementation.

While carrying out field work a number of (mainly flat roofed) buildings were target noted as potential sites for green roofs. These are shown in Appendix 16. Most of the buildings are office, commercial and residential buildings in the city centre. Public buildings such as educational blocks, hospitals, libraries and public offices can be displayed as promotional examples to industry of what can be achieved through utilising green roof technology. Local events and open days could be held to provide opportunities for local residents, businesses and developers to learn about the benefits of green roofs. Figure 59 shows a green roof covering part of a building on Bradford University campus grounds.

Figure 59 – a green roof on the health studies building on Bradford University campus grounds.

4.9.3.5 Green Roof Habitats

A wide range of different habitat types can be created using green roofs. These include: wildflower/ grass meadows, sedum mats, spontaneous colonisation, bulbs, culinary plants, trees, shrubs and gravel habitats for invertebrates (Dunnett & Kingsbury, 2010). It is thought that using assemblages of locally native species on green roofs can support the most biodiversity (Scientific American, 2013). See Appendix 36 for guidance on the key elements of green roof creation and maintenance and a diagram of the components of green roofs.

Lindum offer a range of green roof habitats including a perennial wildflower and sedum mat (see Figure 60) that is produced locally (in York) with low environmental impact and has a long flowering period (April – September). The minimum substrate depth of 10cm is required and Lindum can install a locally sourced growing substrate (this should equate to lower cost) and a drainage layer (Lindum Green Roofs, 2011) See Appendix 35 for more information on species compositions. Though a number of the species are not locally native they are known to be reliable and successful in a green roof habitat where the extremes of wind and drought are evident.


Figure 60 - Lindum wildflower and sedum mat incorporates attractive, long- flowering pollinator friendly flora that aids species such as the small tortoiseshell *Aglais urticae*

The creation of locally native heathland/ acid grassland habitats on green roofs is an interesting option within the AAP areas, which is touched on in Section 4.8.2. Creating a dwarf shrub/ acid grassland mosaic habitat would require substrate depth of roughly 20cm while creating a dry acid grassland habitat would require a substrate depth of at least 10cm. A mosaic habitat offers greater value for wildlife and may also be more aesthetically pleasing but there would be further maintenance requirements.

Green roofs can be established by leaving all or part of the substrate layer bare and allowing natural colonisation of local species. This may provide habitat that is highly beneficial to wildlife but would need ongoing monitoring to identify which species are establishing over time and to remove any undesirable species (Dunnett & Kingsbury, 2010).

The use of mixed herbaceous perennials, grasses and bulbs can create a visually stimulating and ecologically diverse green roof, which may be used for semi-extensive roofs with some public access. See Appendix 35 for suitable species lists for this and all the other types of green roof habitat discussed.

Pure sedum mats may be utilised on urban roof tops where reduction in weight-loading and maintenance requirements is essential. Sedum roofs are extremely drought tolerant and are lightweight but it is important to note that using thinner substrate reduces green roof capacity for water retention, filtration and aesthetic impact.

4.9.3.6 Greener Car Parks

There is a sizable demand for car parking space in city centres and during field work some of the green spaces in the Bradford City Centre AAP area had recently been replaced by open-air car parks with gravel or hardstanding. The loss of green space within this area is particularly notable as there are very few green patches present in some localities. If there is scope to create a multi-story car park, to avoid the piecemeal approach, then any loss of green space could be mitigated by utilising the roof/ part of the roof space as an intensive green roof. This could function as a roof-top amenity space for local residents and customers to enjoy.

4.9.3.7 Transforming Residential Blocks

A group of flat roofed residential blocks along the Canal Road corridor were flagged up during field work as being potentially suitable for green roof retro-fitting (see Figure 61). They are situated in a prominent place, just off Canal Road and opposite a popular green amenity space (SE1513 3656). They currently look dull and unattractive and by cultivating plant life on the roofs the visual interest can be greatly improved, as well as harnessing a range of ecological benefits (see list in Section 4.9.3.1).

Figure 61 - unattractive residential blocks in Frizinghall just off Canal Road could be enhanced by installing green roofs as well as creating traditional orchards & meadows on adjacent grassland.

4.9.3.8 Green Roofs and Bird Life

The use of green roofs as nesting habitat for birds has not been widely researched. Green roofs are known to support invertebrate populations and therefore supply an increased food source for urban birds (Fernandez-Canero & Gonzalez Redondo, 2010). Black redstart *Phoenicurus ochrurus* have been recorded nesting on green roofs in England (Fernandez-Canero & Gonzalez Redondo, 2010), notably on the London Olympic stadium where consultants GRC designed green roof space to provide habitat for this species (Lambert, 2013). A pair of black redstarts was sighted in Bradford City Centre within the last 10 years. This species may be attracted to green roofs through the inclusion of rubble patches for forage and sheltered nooks for cover and nesting (Lambert, 2013).

4.9.4 Urbanised Swifts

British Trust for Ornithology (BTO) records show that swift *Apus apus* numbers decreased by 39% in England between 1995 – 2011 (Baillie et al, 2014). They are now on the amber list for Birds of Conservation Concern (RSPB, 2009). Swift were recorded within the Shipley – Canal Road Corridor AAP area during field work. They remain aerial at all times and even sleep on the wing, except when they need to land to nest during the breeding season.

Swifts prefer to nest at a high elevation and buildings are often utilised as nesting sites by this species. New developments often have limited potential for swift nesting habitat but swift boxes can be built-in to new developments or fitted to existing buildings. A range of different types of internal nest boxes, such as the Ecosurv nest brick (shown in Figure 62) can be fitted in to the brick or stone walls of a building and blend in with the structure. See http://www.swift-conservation.org/Swift%20Bricks-V5.pdf for a list of swift boxes. Boxes must be fitted in shade or on the north/ north-west facing side of a building in an undisturbed location with uncluttered adjacent airspace for swifts to access and exit the nest. They should be sited a minimum of 5 metres from ground level but preferably higher (Swift Conservation, no date).

Figure 62 - Ecosurv swift nesting box that comes brick or stone fronted and can be fitted flush with the wall of a building.

Internal nest boxes are also available for starling *Sturnus vulgaris* and house sparrow *Passer domesticus,* which have both suffered steep population declines in recent years and are on the Birds of Conservation Concern red list (RSPB, 2009). See http://housesparrow.org/resources/ for more information.

4.9.5 Integral Bat Boxes

Bat roosting boxes can also be incorporated within new building structures. Schwegler bat tubes can be installed individually or fitted together to provide a larger roosting space (see Figure 63). These tubes can be used to offer roosting space for bats where there are little or no natural roost features present (see the maps in Appendices 32 - 34 for the locations of high and medium priority bat roost features within the AAP areas).

Bat roosting tubes can be sited on a south – south-easterly aspect but should not be installed in locations that are brightly lit at night because bats do not usually emerge to feed at night until the light levels are low enough (Jones, 2000). Feeding habitat should be available close to the roost installations, which will often consist of woodland margins or linear features such as hedgerows, lines of trees or watercourse margins. Pipistrelle *Pipistrellus* bats are the most common bat species in England and they will also feed in more open grassland habitats (Bat Conservation Trust, 2012).

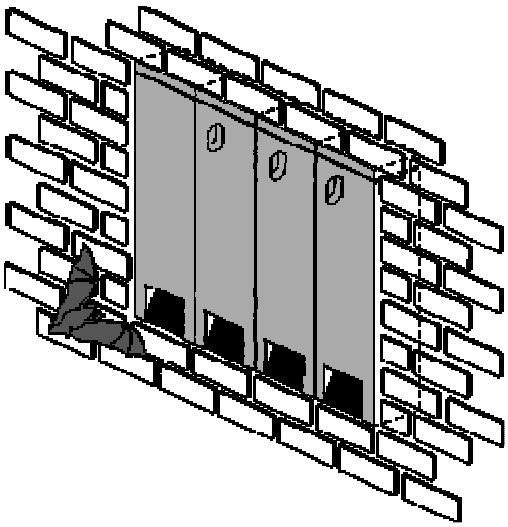

Figure 63 - four Schwegler bat tubes linked together within the wall of a building.

4.9.6 Urban Tree Lines

There are a limited number of lines of trees within Bradford City Centre AAP area, mostly consisting of short lines of young specimens. These should be retained and further tree lines planted where opportunities arise. These features are often utilised by bats as part of their network of flight paths (JNCC, 2001). Choice of tree species should be aimed at incorporating a variety of shallow rooted, drought tolerant species. There should not be too much reliance on an individual species or variety such as Himalayan birch *Betula utilis var. jacquemontii*, which is widely planted in the urban centre.

4.9.7 Living Walls

Living walls can be used to create visually striking features in prominent locations that offer habitat for wildlife, particularly invertebrates, in a dense urban centre. During the AAP field work there was an opportunity identified for creating a living wall opposite the new Westfield development (see Figure 64 below). Erection of a trellis and establishing species such as travellers' joy *Clematis vitalba*, honeysuckle *Lonicera periclymenum* and wisteria *Wisteria sinensis* on the façade would provide a colourful and attractive spectacle beside this important new development. It would also provide shelter and a nectar source for bees, butterflies and other pollinating species. See Appendix 37 for guidance on creation and management of living walls.

Figure 64 – a location identified for the potential creation a visually striking living wall opposite the new Westfield development.

4.9.8 SUDS Detention Ponds

Sustainable Urban Drainage Systems (SUDS) ponds are sometimes incorporated within new developments, to intercept, filter and enable infiltration of stormwater runoff. These features can be mutually beneficial, providing flood water management improvements and wildlife habitat. Figure 65 is an indicative illustration to show how retention of a permanent low-level of water within typical detention ponds would provide a habitat for plant communities, such as common reed *Phragmites australis,* which are able to sequester and eliminate some pollutants. This style of pond requires space and is more suitable for suburbs than the city centre. An appropriate assessment by a drainage engineer would be necessary. Maintenance would include clearance of inflow and outflow pipes, monitoring/ removal of sediment, invasive species and debris (Susdrain, 2012).

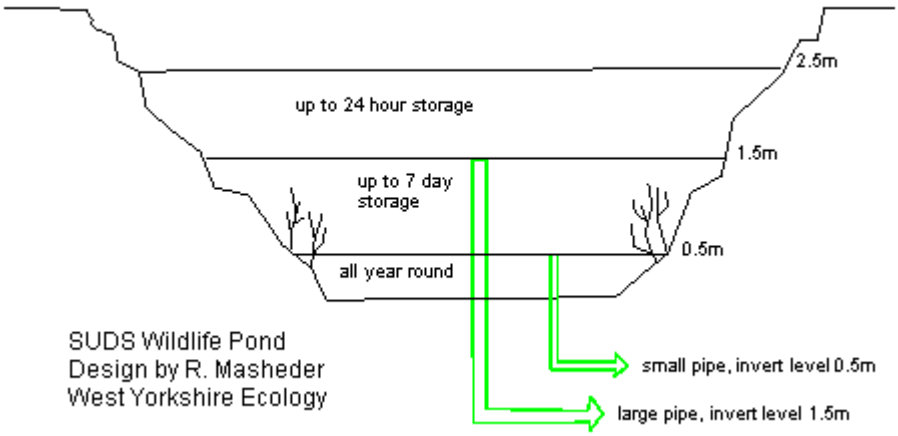

Figure 65 - an indicative design to demonstrate how a SUDS detention pond can be utilised for the dual purpose of wildlife pond habitat and as a receptor site for runoff from roofs

4.9.9 Stormwater Planters; Infiltration & Flow-through

Stormwater (Infiltration) planters are attractive features that are useful for stormwater runoff alleviation in urban locations where space availability is limited. They are constructed of durable materials such as concrete or plastic and intercept runoff, enable filtration through a layer of vegetation, soil and gravel and then infiltration in to the ground beneath. Surplus water is directed to the desired out-flow location. If the earth beneath planters is not freely-draining then flow-through planters may be used, which have impervious bases, which filter runoff and then direct it to a desired out-flow location. Management requirements are limited to occasional inspection of plants and structural components and removal of debris, litter and sediment from inflow pipes (Environmental Services City of Portland, 2006). A list of suitable stormwater planter species can be found in Appendix 35 and an example of a stormwater planter is shown below in Figure 66 and a cross section in Figure 67.

Figure 66 – infiltration stormwater planter in which intercepted rainwater will either filter down through the soil and infiltrate the ground beneath or spill over into the adjacent drain (photo by Tom Liptan).

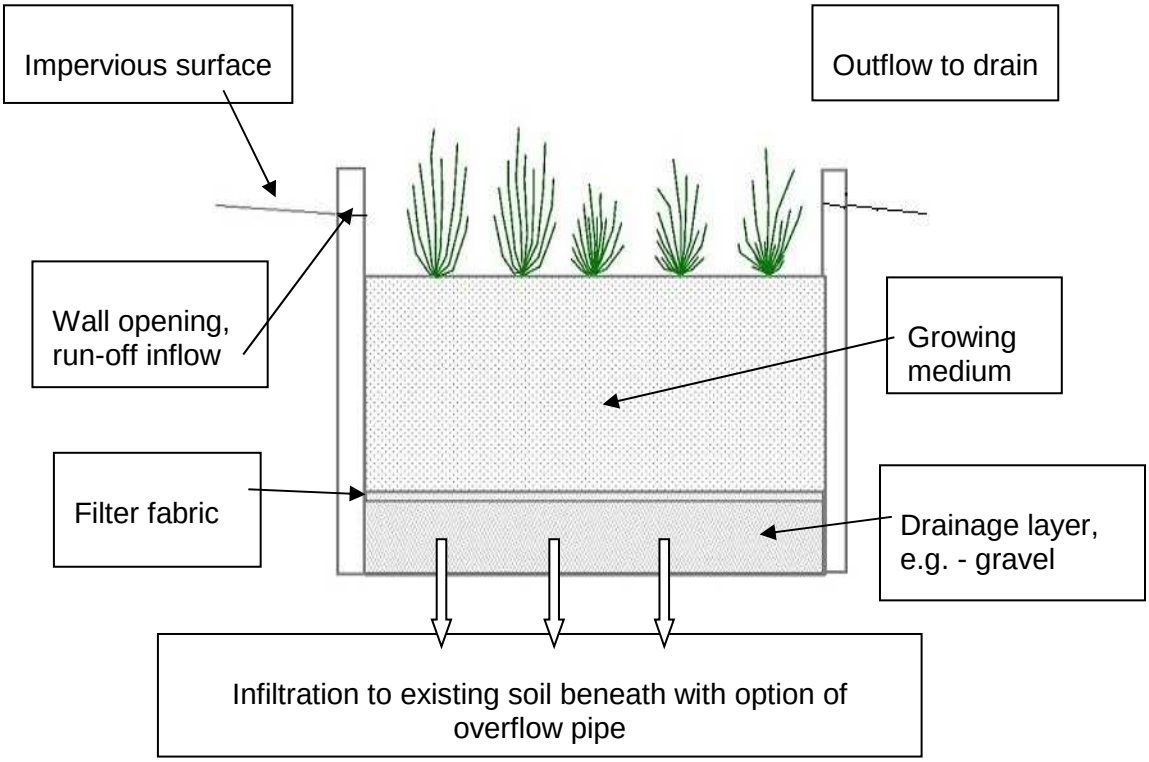

Figure 67 –side profile of an infiltration stormwater planter.

4.9.10 Wildlife Ponds

Standing water features such as wildlife ponds are currently lacking throughout the AAP areas. Ponds are hugely beneficial for wildlife and provide a vital source of drinking water as well as breeding and egg laying grounds for common frog *Rana temporaria*, common toad *Bufo bufo* and smooth newt *Lissotriton vulgaris* and invertebrates such as dragonflies and damselflies *Odonata*.

At least one side of a pond should have a gently sloping bank to allow species safe access to drink and to climb out of the water if they fall in. Species such as hedgehog *Erinaceus europaeus* frequently use urban ponds for drinking water and must be provided with a safe and easy access and exit route. This would also reduce the risk for young children. Figure 68 shows how a nature reserve in Leeds has implemented safety measures using signage and fencing. Ponds can be used as a wildlife education tool and events such as pond dipping enable young children to engage with the natural world (see Section 4.9.8 below). Appendix 41 provides advice on pond creation and maintenance and some potential locations are shown in Appendix 23.

A geotextile pond liner such as Rawmat is generally a suitable option as it will not have the issues of splitting or cracking that can be encountered with a hard liner and the material can re-seal if small holes occur. See their website for further information: http://www.rawell.co.uk/products_rawmat_hdb/introduction.php

Figure 68 – a wildlife pond at Rodley nature reserve, Leeds, created in a sympathetic manor with depth sign and natural wooden fencing.

4.9.11 School Involvement

Schools would benefit from on-site features such as wildlife ponds for pond dipping (health and safety must be provided for), orchards and herb/ wildflower-beds. This would enhance the ecological network across the AAP areas.

This approach has been adopted successfully at Lower Fields Primary School with the support of Bradford Council and Bradford Community Environment Project (BCEP), through their Environmental Schools Project. The school has allotments and has planted shrubs and trees to create woodland and scrub habitat, which is used by a range of bird species. Their wildlife pond is used by species such as smooth newt *Lissotriton vulgaris* and common frog *Rana temporaria*, as well as many invertebrates such as dragonflies and dragonflies *Odonata.* These habitats are well used and appreciated by the school pupils as part of their learning and recreation activities (Lower Fields Primary School, 2014).

4.9.12 Permeable Paving

There are various forms of permeable paving and it should be utilised in urban locations to enable stormwater to infiltrate, reduce the pressures caused by stormwater runoff and recharge groundwater. Concrete block permeable paving is a versatile tool that is widely used (Interpave, 2008). Legislation may be implemented to ensure a certain level of coverage of permeable surfaces is achieved. Some forms of paving support plant growth between gaps. Figure 69 shows an example of permeable paving in use on a driveway.

Permeable paving can be utilised in situations such as:

- Pavements
- Car parks
- Driveways
- Urban tree planting surrounds
- Trail paths

Figure 69 – an example of attractive permeable paving in use on a driveway (Luxury Paving, no date)

4.9.13 Water Butts

Incorporating water butts in appropriate new housing developments is another valuable ecological step that should be harnessed in development plans. Water butts can be linked to down-pipes and an overflow pipe can be fitted to the water butt that enables any excess water to be directed to the main drainage system (or to another stormwater feature). Water butts can also be fitted on to garden sheds, garages or greenhouses.

4.9.14 Peregrine Falcon

Peregrine falcon *Falco peregrinus* numbers have increased from a significant low in the 1960's owing to better control of pesticides and legal protection (RSPB, 2014). Popular nest sites for peregrines include natural cliffs and old quarries but they are also known to nest on tall buildings (RSPB, 2013).

The favourite food source of peregrines is pigeon and there was a good population of feral pigeon *Columba livia* recorded in the Bradford City Centre AAP area during field work. Peregrine falcons have been recorded nesting about 6 miles from the centre of Bradford and by creating an artificial nesting site in a suitable, undisturbed location it may be possible to attract them to the heart of the city.

During 2012, the first documented pair of urban breeding peregrines in Yorkshire was recorded nesting on an artificial nest platform on Saint George's church, in the Sheffield University grounds. The use of a web-cam created huge public interest, with over 53,500 visits to the website during the month of June 2014 (University of Sheffield, 2014). Perhaps the same thing could be achieved at the University of Bradford. The Hawk and Owl Trust installed a peregrine nest platform on Norwich Cathedral and may be consulted for advice on the creation of an artificial nesting platform (Hawk and Owl Trust, 2014).

4.9.15 University of Bradford; 'Ecoversity'

The University of Bradford has established a project called 'Ecoversity' with the aim of incorporating sustainable development within their core activities. Some student accommodation has been developed with solar panels and there are partial green roofs on two of their buildings (see Figure 59 above). There is the scope for establishing further green roofs across the campus, which would create a mosaic of flower-rich habitats. Further opportunities for ecological enhancements within the university grounds are the creation of a series of standing water features and native hedgerow planting along suitable margins. See the Appendices for guidance on habitat creation and management and for planting suggestions.

Bradford College can be encouraged to follow the positive example set by the University of Bradford. They could perhaps work in partnership to achieve more together. The college was developing new buildings while field work for this report was carried out and some green space had been lost. New developments should incorporate green measures to avoid habitat losses.

4.9.16 Little Germany; Hanging Baskets

The Little Germany Action group have established an extremely successful scheme for the use of hanging baskets across the Little Germany area (Bradford Property Forum, 2012). This is an intelligent and suitable manner of bringing some greenery in to a tightly developed space with historical interest and limited options for wildlife enhancements. The type of species used in the hanging baskets and the diversity present will determine the wildlife benefit. Species with high value for pollinators should be used (see RHS Plants for Pollinators). A variety of different assemblages could be created using species such as chives *Allium schoenoprasm*, trailing nasturtium *Tropaeolum* sp., trailing fuschia *Fuchsia* sp. , trailing lobelia *Lobelia* sp., dahlia *Dahlia* sp., sweet William *Dianthus barbatus* and common bird's-foot trefoil *Lotus corniculatus*. Single flowered varieties should be used as double flowered are sometimes sterile. Irrigation may be necessary to avoid the time required for hand watering, which would be necessary twice daily during a hot, sunny day. Figure 70 shows the scheme in action.

Figure 70 - hanging baskets on display in Little Germany, Bradford (June 2014).

4.9.17 Bradford Cathedral

The Bradford cathedral grounds function as a small wildlife haven and a quiet retreat for local people and visitors. It has the feel of a quiet village setting even though it is nestled in the urban heart of the city. There is a small wooded area as well as shrub and flower beds and regularly mown lawns (see Figure 72). This offers feeding and nesting habitat for birds and invertebrates. A welcome addition would be an above ground birdbath feature that would provide a source of drinking and bathing water for birds. It would be necessary to provide fresh water regularly and keep the bath clean.

5.0 Summary of Concepts; Implementation Methods

5.1 Summary of Ecological Concepts

There are many ideas for ecological enhancements provided throughout the text in Section 4.0 and Table 4 below lists those related to each AAP area.

Table 4 - a summary of the ecological concepts for Shipley – Canal Road Corridor and Bradford City Centre AAP areas

Ecological Enhancement Measure	**Relevant AAP area**
Control Japanese knotweed and Himalayan balsam throughout AAP areas	SCRC & BCC
Create perennial meadows, notably along the Greenway/ Bradford Beck corridor, at railway stations, along road-verges and around apartment blocks	SCRC & BCC
Woodland enhancements to improve structure and floral diversity	SCRC & BCC
Allow some trees to mature and provide dead wood habitat (well away from access routes)	SCRC & BCC
Erect bird/ bat boxes and create of log piles in less disturbed locations	SCRC & BCC
Establish dwarf-shrub heathland vegetation along the railway embankments	SCRC & BCC
Construct a number of ponds/ wetland features	SCRC & BCC
Increase amount of fen and emergent aquatic habitat, particularly along the Leeds – Liverpool Canal but also on the Bradford Beck	SCRC & BCC
Retain land for a fish pass at Shipley weir	SCRC
Retain and re-instate natural banks where possible	SCRC & BCC
Re-naturalise stretches of the Bradford Beck	SCRC & BCC
Install an artificial otter holt on the Bradford Beck	SCRC
Monitor water quality, control pollution from misconnections & sewer systems	SCRC & BCC
Use part of Bolton Woods Quarry (once inactive) to establish dry heathland/ acid grassland/ woodland mosaic	SCRC
Retain natural corridor along eastern side of AAP areas – Bolton Woods, Poplars Park, Brow Wood and Boar's Well	SCRC & BCC

& strengthen links through habitat creation and enhancements	
Utilise stormwater planters widely within urban locations	SCRC & BCC
Integrate or retro-fit swift nest boxes and bat tubes in urban buildings	SCRC & BCC
Explore the potential for phytoremediation on the disused allotment site	SCRC
Create green roofs on public buildings and implement legislation or incentives to encourage developers to incorporate them	BCC & SCRC
Create a number of living walls including a focal wall by Westfield	SCRC & BCC
Install a peregrine nesting platform	BCC
Maintain the living wall at St. Blaise Square	BCC
Encourage the selection of highly nectar-rich and visually attractive species for the hanging basket scheme in Little Germany	BCC
Plant more lines of trees in urban locations	SCRC & BCC
Use permeable paving wherever possible to address stormwater runoff at an early stage	SCRC & BCC
Plant native hedgerows in suitable locations	SCRC & BCC
Encourage schools to create a rich wildlife resource on their grounds that can be mutually beneficial for wildlife and children's education	SCRC & BCC
Encourage Bradford College to follow the good example set by the 'Ecoversity' initiative at the University of Bradford	BCC
Create drought tolerant herb beds in urban locations	SCRC & BCC
Plant various bulbs and associates instead of relying on daffodil	SCRC & BCC

5.2 Monitoring Habitat Gains/ Losses

In accordance with the National Planning Policy Framework (NPPF), the planning system should contribute to and enhance the natural and local environment by: "Minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to future pressures…"

In order to assess biodiversity gain/ loss within each AAP area, a series of monitoring protocols are recommended based on the Nature Improvement Area (NIA) Indicator Framework.

NIAs are large areas which are selected for enhancing wildlife resource and habitat connectivity. NIAs were introduced in the Natural Environment White Paper (HM Government, 2011) and stemmed, in part, from recommendations set forward by the Lawton Review, which argued for bigger, better, more connected sites and for the better protection of non-designated sites, in order to support a more coherent, resilient ecological network (Lawton et al, 2010).

The NIA indicator framework seeks to integrate monitoring and evaluation across a broad range of themes/subthemes. The biodiversity themed indicators are indicative of an integrated habitat and species management approach, which advocates monitoring the quality and extent of priority habitats on the assumption that most species' requirements will be met through priority habitat actions.

Species should be considered separately if they require bespoke management or are particularly important locally. In the AAP areas these may include: otter (monitoring water quality and usage of otter holt), freshwater crayfish (monitoring water quality, establishment of Ark sites: separate, new colonies, resistant to the risks posed by non-native crayfish) and swifts (number of nest boxes installed, monitoring of usage).

Relevant NIA biodiversity monitoring and evaluation indicators are:

- Extent of existing priority habitat managed to maintain and/or improve its condition
- Extent of areas managed to restore/ create habitat
- Total extent of existing priority habitat
- Extent of habitat managed to secure species-specific needs
- Status of focal species
- Control of invasive non-native species
- Local indicator of habitat connectivity

The details of the NIA biodiversity indicators can be found at: http://publications.naturalengland.org.uk/publication/5542385517854720?category=2430109

The total extent of existing priority habitat has been calculated for the 2014 Phase 1 Habitat Survey (see Appendix 14). If a subsequent Phase 1 Habitat survey were to be carried out in 10 years time then the total extent of priority habitat could be directly compared to that of the previous survey and any gains or losses determined. The aims should be:

- to increase the cover of priority habitats found to be lacking during the 2014 survey, including ponds, fen, wet woodland, heathland, species-rich grasslands and species-rich native hedgerows

and;

- to enhance the ecological network, by buffering core sites and creating stepping stones through the urban landscape. The Bradford Wildlife Habitat Network highlights links within the district that should be protected and enhanced.

The success of features such as bird nesting boxes, bat roosting boxes and otter holts could be measured by monitoring their use on an annual basis. This would need to be carried out by licensed professionals, avoiding any undue disturbance to wildlife. Resource demands on the time resources necessary for this monitoring may be a restrictive factor and the number of boxes checked or frequency of checks may be limited. Cameras can also be installed within boxes/ holts to measure usage.

Other monitoring methodologies, which could provide a useful approach to assessing biodiversity loss/ gain within the AAP areas include: Biodiversity 2020 (DEFRA, 2011).

Biodiversity Action Reporting System (BARS) is a government recommended, web-based information system on which the AAP areas can be flagged-up as locations delivering practical action for nature. It offers an efficient way for partners to contribute and share information about their biodiversity actions, and this shared intelligence helps national and local communities plan and better co-ordinate their conservation activities. It also helps to build a greater understanding of what is being done to halt overall biodiversity loss in line with international, UK and country commitments.

5.3 Bradford Wildlife Habitat Network

The Wildlife Habitat Network (WHN) for the Bradford district was created in 2012. A full overview map is shown in Section 1.0 (Figure 2). Figure 71 below shows a more detailed view of the WHN in relation to the AAP areas. The key links follow the main waterways within the Shipley – Canal Road Corridor AAP area: the River Aire, Leeds – Liverpool Canal and the Bradford Beck, while Bradford city centre does not currently feature in the WHN. The intensive ecological field work carried out as part of the Ecological Assessment of the AAP areas has highlighted new parcels of land that should be included within the WHN, such as the species-rich acid and neutral grasslands in the immediate surrounds of the Bolton Woods Quarry and potentially the green space within the Bradford University grounds. The wildlife corridors and ecological stepping stones within the AAP areas can be greatly enhanced within the AAP areas through implementing the ecological concepts set out within this report.

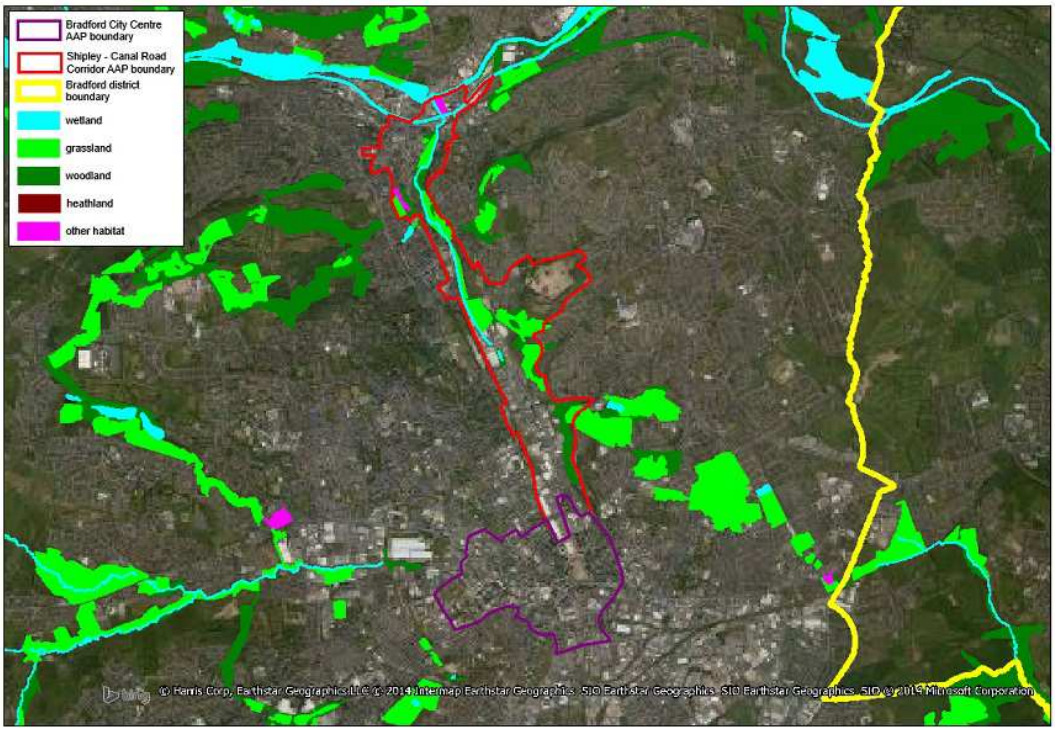

Figure 71 – Bradford Wildlife Habitat Network in relation to the AAP areas

5.4 Key Potential Partners and Funding Sources

Organisations that may work as key partners towards the realisation of the ecological concepts discussed in this report are listed in Appendix 48. Partnership working is often the most effective and efficient way to reach joint goals. Funding is available for community groups, non-profit organisations or partnership projects focused on achieving certain wildlife/ local community improvements. Relevant funding bodies and their current schemes are listed in Appendix 47.

5.5 Implementation of Concepts; Community Engagement

During field work, surveyors were approached on numerous occasions by local residents who were interested in the ideas for enhancing the local natural environment and were keen to be involved with community projects. There is much potential resource within the local community that may be harnessed through local interest groups such as 'Friends of' Groups. These may function as ambassadors and managers of features such as traditional orchards, wildflower meadows, wildlife ponds and woodlands. The scope of existing local nature interest groups may also be widened via involvement such as providing mentoring for habitat maintenance and community engagement events.

In order to implement the next stages of this project it will be necessary to secure funding for a position for an officer who would carry out community engagement, continue to engage with existing local nature conservation groups and initiate new ones, identify where partnerships can be formed and assist with/ formulate bids for funding opportunities.

5.6 Role of the Planning System in Nature Conservation

The planning system is responsible for playing a key role in protecting the integrity of the natural environment of both the local and wider area, in accordance with the National Planning Policy Framework. One of the main aims of the AAPs is to enable future re-generation to take place in a manner that minimises adverse effects on biodiversity. This Ecological Assessment provides guidance to support a strategic approach towards planning which aims to protect the natural resource within the AAP areas and to enhance it through the creation of new habitats and the strengthening of the wildlife network and key ecological corridors.