

# Broadland flood alleviation project



*Adele Dodgson, Bam Nuttall Ltd and Louise Clarke, CIRIA, examine the approach to biodiversity enhancement on the Broadland Flood Alleviation Project (BFAP)*

## Introduction

The Broadland Flood Alleviation Project (BFAP) is a unique 20 year scheme to improve and maintain 240 km of flood defences within the Norfolk Broads, one of Europe's most important wetland areas. A critical aspect of the project is to protect and enhance the sensitive wetland areas that are rich in biodiversity, while providing an improved service level in flood defence protection. A strategic approach to managing the flood defences has enabled several exemplary enhancement and mitigation activities to be implemented as part of the project. This briefing will explore what the project has achieved in the last 10 years, looking at its approach, and using several examples to show how the enhancement of biodiversity can be incorporated into a large scale civil engineering scheme.

## Background to the BFAP

The £150m BFAP contract was awarded by the Environment Agency in May 2001, as a Public Private Partnership scheme to BAM Nuttall Ltd and Halcrow Group Ltd who work together in a joint venture capacity as Broadland Environmental Services Ltd (BESL). The main purpose of the project is to provide a strategic approach to improving the level of flood protection in Broadland while engaging key stakeholders and the local community, which is fundamental to achieving this objective.

Project staff work closely with the Broadlands Authority (BA) to ensure that the works not only provide the required level of sustainable flood defence, but also meet the Authority's over-arching objectives to protect the Broadland environment, improve recreational facilities and maintain the navigable waterways. The project

also works closely with other key stakeholder groups (including Natural England, the RSPB, Norfolk and Suffolk Wildlife Trust's, the internal drainage boards (IDB), and county, district and parish councils), and attends topic groups that are tasked with seeking to co-ordinate the overall management of the Broadland area.

## BFAP area and its value

The project area is located wholly within the Norfolk Broads, which is an extensive area of wetland covering some 30 000ha, with a status equivalent to that of a National Park. The focus of the project is to improve and maintain the flood defences (mainly earth floodbanks), along the tidal reaches of the Rivers Yare, Bure, Waveney and their tributaries (eg Ant and Thurne) in Norfolk and North Suffolk (see Figure 1).

Within the aforementioned river valleys over 20 per cent of the project area is designated for its nature conservation value. There are 28 separate Sites of Special Scientific Interest (SSSI) combining to form the Broads Special Area of Conservation (SAC), Broadland Special Protection Area (SPA) and Broadland Ramsar sites. There are also County Wildlife Sites (CWS) and important biodiversity habitats include rivers, shallow lakes, reedbed, fen, grazing marshes and dykes, woodland and scrub, and estuary. Broadland is well-renowned for its variety of flora and fauna, with these sites providing a diverse range of ecological networks, offering fresh, brackish and saline habitats in both flowing and standing bodies of water.

The flood defences also protect 24 000ha of agricultural land, the



Figure 1 Map of the BFAP area

majority of which is managed with livestock as lowland grazing marsh, 1700 private properties of which more than 1000 are residential, 14 undefended communities, rail and road infrastructure systems, important archaeological and built heritage structural remains (eg former drainage mills), and several recreational facilities.

## The works

The project area is divided into 40 hydrologically discrete flood compartments with each compartment subject to a separate Environmental Impact Assessment (EIA), documented in the Environmental Statement (ES) and submitted with the planning application.

The improvements are achieved via strengthening of the existing flood defences, mainly earth banks, and restoring them to their height in 1995 (a level defined by the Environment Agency), while making further allowances for sea level rise and future settlement of the banks. Linear ditches, known as soke dykes are found behind the earth floodbanks. They provide many important functions such as a means of counterbalancing the weight of the bank, particularly since groundwater levels on the marsh are high throughout the year, a source of clay for use during the improvement works, an integral part of the marshland drainage system and they serve as excellent habitat for a range of aquatic species of flora and fauna. With the increase in height and footprint to many of the floodbanks, and the excavation of wider soke dykes, the overall proportion of habitats within the riparian corridor changes during the improvement works, providing an ideal opportunity to seek to enhance the biodiversity of the area while undertaking the works.

With such broad-ranging improvements proposed for an ecologically sensitive area, biodiversity is an important part of the project and is considered at both strategic and individual compartment levels. It is inevitable that the proposed works may have a

temporary but sometimes significant affect on protected or notable species of flora and fauna, and in particular those that are present within, feed, hibernate or seek refuge in the earth floodbanks or the nearby dykes. The main environmental receptors within each flood compartment are documented in the ES, along with the specific methods as to how the potential effects will be reduced or mitigated during each phase of the works. Before works start a mitigation strategy is developed and implemented by the BESL environment team who perform an ecological and environmental clerk of works role, co-ordinating the requirements of the strategy with the construction team.

## The enhancement of biodiversity

The mitigation strategy adopted by BESL to manage the biodiversity within a flood compartment is based on the proposed nature and extent of the engineered solution for the improvement works. It considers many different notable species groups including mammals (water vole, otter, and bats), reptiles (adder, common lizard, grass snake and slow worm), invertebrates (rare molluscs, dragonflies, eg Norfolk Hawker and butterflies, eg Swallowtail); both over-wintering and spring-nesting birds, as well the Schedule 1 species, bittern and marsh harrier, and least of all scarce plants, both aquatic and terrestrial types. As part of the pre-works public consultation period, BESL also work closely with stakeholder groups to identify enhancement opportunities that the project can help deliver while undertaking the flood defence works. An approach that reduces the effects of nuisance and disturbance to a site, but takes advantage of potential cost savings by avoiding the separate mobilisation of staff and machinery. Examples of enhancement are both varied and broad-ranging, including:

- new UK BAP quality wetland habitat created via re-aligned or “setback” flood defences (see section on *Setback* and Figures 2 to 4)

- material generated from the excavation of scapes, open water and reedbed habitat for bitterns and other wetland habitat (part of the Broadland Authority’s Bittern II Project on Buttle Marsh near Ludham, Norfolk) was used during the construction of re-aligned or “setback” earth floodbanks on the River Ant (see Figure 2)
- construction of large (see *Hibernacula* and Figures 5 to 7) and small scale hibernacula for reptiles but also widely used by small mammals and invertebrates
- re-routing of IDB main drains to improve the water level management within designated sites and nature reserves
- liaison between BESL, landowners and DEFRA farm advisors enabled former arable land to be reverted back to typical lowland grazing marsh. The associated network of drainage dykes acted as “wet” fence lines to manage the livestock and providing new aquatic habitat for a range of species
- bird and bat boxes erected at various locations along route corridors to replace nesting habitat lost during tree and scrub clearance
- marsh dykes re-profiled and water control structures installed to improve habitats and management control.

During the construction works, emphasis is placed on ensuring that aquatic and terrestrial habitats are rapidly re-established. Turves of reed, rhizomes and silts are transferred into new dykes before old/existing dykes are in-filled, topsoil is removed and stockpiled before the works, and it is replaced upon completion along with the application of a fast growing/ tussock forming grass seed mix. Following the works, all floodbanks are subject to regular grass cutting to develop a dense sward and there is an extensive programme of post-construction monitoring to record the success of the mitigation and re-establishment of the floodbank and dyke habitat.

Figure 2 shows earthworks are underway to re-align or “setback” the flood defences on the west bank of the River Ant, similar to those already established on the east bank. The former flood bank on the east bank has been reduced to a low level earth platform with the new “setback” lagoon immediately behind. The new flood bank (prominent green ridge) separates the lagoons from the new soke dykes, which are connected to the freshwater marshland drainage system.

Figure 3 shows material generated from the excavation of scapes, open water and reedbed habitat for bitterns and other wetland species (part of the Broadland Authority’s Bittern II Project on Buttle Marsh near Ludham, Norfolk) was used during the construction of re-aligned or “setback” earth flood banks on the River Ant. Disposal of dredged silt by the BA in the setback lagoons to create new BAP quality wetland habitat.

## Setback – a sustainable strategy to long-term flood defence protection

In some BFAP flood compartments, the defences are re-aligned or “setback” (up to 30 m) behind the existing bank via the construction of a new floodbank in the adjacent grazing marshes (see Figure 2). This technique results in a substantial increase in river width (the vegetated area between the flood embankment and the river). This delivers significant environmental enhancements including the provision of wetland habitat for protected and UK Biodiversity Action Plan (BAP) species, eg marsh harriers and reed buntings.

The main criteria for selecting setback as the preferred solution are where the existing reeded river on the river’s edge is particularly narrow, providing limited protection from tidal erosion and/or there is piling that has reached the end of its residual life. Other factors include the presence of a significant area of grazing marsh immediately behind the existing bank. Relevant landowners are satisfied to receive compensation payment for loss of grazing. Once the integrity of the new bank is established, the dilapidated erosion protection materials along the river front (usually sheet metal piles) are removed, and



Figure 2 View northwest, the confluence of the Rivers Ant and Bure in the northern area of the Norfolk Broads (courtesy Mike Page)



Figure 3 View east (courtesy Mike Page)

the old bank is reprofiled to a low level earth platform just above the height of mean high tide. The area in front of the new bank (a lagoon) is ideally suited to receive river dredgings (see Figure 3) with the platform divided by narrow channels to maintain connectivity with the river and reduce the risk of stagnation. Once dredging disposal has ceased, emergent vegetation (usually dominated by reed), quickly colonises the shallow aquatic margins and expands across the area where dredged silt has been placed, to produce a mosaic of reedbed and tidally controlled open water habitats (see Figure 4).

Where the water quality of the adjacent river is good, for example

the River Ant, the lagoons support a varied assemblage of aquatic and emergent plants, invertebrates and fish. In times of tidal surge, where significant amounts of salt water are forced through the river system, the lagoons have been designed to provide a refuge for fish.

The creation of natural reedbed habitat provides a sustainable, long-term means of erosion protection for the new floodbank offering an alternative to the installation of new sheet piles (expensive and unsustainable in most locations), and acts as a natural buffer to the damaging effects of boatwash and strong river flows. Setback also supports the Broadland Authority’s



**Figure 4** Emergent vegetation expands across the shallow aquatic margins of the setback lagoon following disposal of dredged silt by the Broadland Authority on the River Ant



**Figure 5** Adder basking in vegetation on the new reptile hibernacula, there are significant but localised populations in the Norfolk Broads

river dredging programme via the provision of disposal areas that then assist with the development of new BAP quality habitat.

## Construction of a large semi-permanent artificial reptile hibernacula

The proposed improvement works to some sections of BFAP floodbank in the Upper Thurne Valley necessitated a specific mitigation and enhancement strategy to consider a significant but localised population of adder (see Figure 5), with common lizard and grass snake also present. The site includes parts

of the Upper Thurne Broads and Marshes SSSI (included in the Broads European designated site), and the reptiles receive partial protection under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended). Meanwhile, the flood compartment provides typical habitat for the reptiles, ie earth embankments with a sloping south facing aspect and a predominantly tussocky grass sward. This gives the animals a suitable basking, feeding, refuge and often hibernation habitat.

With the improvement works requiring over 10 km of floodbank strengthening to the crest and rear of the existing bank, and limited capacity to avoid affects

on hibernation sites (often used by breeding female adders), it was necessary to identify where the reptiles could be relocated near to their existing habitat. There was little scope to use localised displacement techniques (eg vegetation management) and there were few receptor sites near to the proposed works that had the potential to accommodate significant numbers of relocated reptiles. So, engineers and ecologists selected an area of land, outside but adjacent to the works corridor, to construct a large scale semi-permanent reptile hibernacula in the form of a linear earth bank with a broad south facing aspect.

The bank was constructed in the summer preceding the improvement works, using alternating layers of locally sourced reed bundles and rush bales (from the field that it was built on), timber (logs and brash) from the pre-works floodbank tree clearance, and topsoil was derived from the excavation of a shallow dyke directly adjacent next to the bank (see Figure 6). Grass seed was applied to the bank to ensure a dense grass sward developed, while piles of brambles were placed on the outer surface of the bank to reduce the potential of predator attack to basking reptiles.

During the mitigation phase, emphasis was placed on translocating a significant number of female adders as well as males to the bank. This included a range of juveniles, sub-adults and adults to ensure the long-term viability of the reptile population and the suitability of the bank in providing an alternative site for adders (lizards and grass snakes) to give birth and/or to hibernate during the immediate period after the works have been undertaken and vegetation is re-establishing.

In total, about 125 adders were translocated to the new bank along with 100+ common lizards and grass snakes. Regular checks showed that the majority of animals stayed on the bank and displayed natural behaviour, eg basking, sloughing, and mating attempts. Meanwhile the presence of female adders on the bank in the summer immediately following

the mitigation period indicated that they were likely to give birth within the bank. Also, monitoring surveys (of the former works corridor) in the late summer/early autumn identified that reptiles, specifically adders were present within both terrestrial and marginal habitat that was starting to re-establish.

The creation of a new earth bank was a significant component of the mitigation strategy for the flood compartment, representing a temporary “holding” area for the reptiles during the improvement works. Now that the works have finished and the floodbank habitat has been re-established, the bank (see Figure 7) will continue to be available for use by animals (see Figure 5). This represents a significant net increase in suitable habitat for reptiles and in particular, adder. Following the completion of the works, spring monitoring surveys have shown that reptiles continue to use the bank to hibernate and give birth, with juvenile adders following their mothers to the hibernation site.

The “adder” bank is believed to be one of the largest purpose-built hibernacula in the UK as part of a large scale mitigation strategy with long-term enhancement for a translocated reptile population. Its use has avoided the potential detrimental effect on local reptile populations because of the proposed works and represents a nationally important, technically sound and innovative approach to adder mitigation.

## Conclusion

The success of the BFAP demonstrates that large scale improvement schemes that have a strategic approach to improving existing flood defences can be accomplished within a nationally and internationally important wetland area. Long-term PPP schemes that involve key stakeholder groups and landowners in detailed phases of public consultation can enable the



**Figure 6** *The new reptile hibernacula was specifically located outside but adjacent to the works corridor. It was constructed in layers of locally sourced brush, timber and reed bundles, with topsoil and grass seed applied to develop a dense sward*



**Figure 7** *The new earth bank will continue to be available for use by reptiles (as well as other small mammals and invertebrates). This represents a significant net increase in suitable habitat for the animals, particularly adders*

development of partnership projects. These schemes achieve the desired objectives for biodiversity while reducing disturbance to important and notable sites. Mitigation strategies that are both site specific but strategic in their nature can be developed for notable species, which are financially viable and provide real enhancement for biodiversity. Post construction monitoring surveys within former work areas have identified that notable species (both terrestrial and aquatic), have

re-colonised these areas and are thriving within three years of the works having been completed.

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