Babtie Brown & Root

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Upper Leven Flood Risk Management Strategy

Strategic Environmental Assessment - Scoping Report

Final

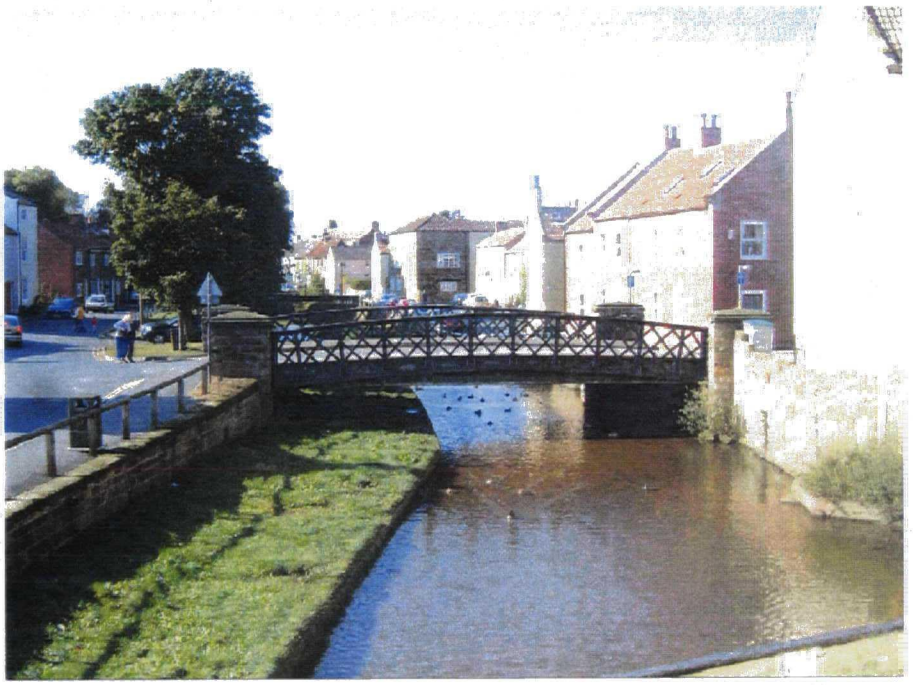

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Table of Contents

Abbreviations

AOD	Above Ordnance Datum
BAP	Biodiversity Action Plan
BBR	Babtie Brown and Root Limited
CSS	Countryside Stewardship Scheme
DEFRA	Department for Environment Food and Rural Affairs
EA	Environment Agency
EU	European Union
FDC	Flood Diversion Channel
GQA	General Quality Assessment
JBA	Jeremy Benn Associates
NGR	National Grid Reference
ODPM	Office of the Deputy Prime Minister
PAG	Project Appraisal Guidance
PPG	Planning Policy Guidance
SAC	Site Area Conservation
SAM	Scheduled (Ancient) Monument
SEA	Strategic Environmental Assessment
SPA	Special Protection Area
SSSI	Site Special Scientific Interest
SuDS	Sustainable (urban) Drainage System
UK	United Kingdom
UKCIP	United Kingdom Climate Impacts Programme

SUMMARY

The Environment Agency is developing a Flood Risk Management Strategy for the upper reaches of the River Leven to ensure that an integrated, catchment-wide approach is taken to managing the flooding issues affecting the communities of Great Ayton and Stokesley. Babtie Brown and Root has been commissioned by the EA to progress the Strategy and, in parallel, undertake a Strategic Environmental Assessment (SEA). This document comprises the findings of the scoping stage of the SEA which aims to ensure that the SEA process is focused upon the key issues.

This report provides an opportunity for you to comment on and influence the development of the flood risk management framework for the study area. Specific questions are within highlighted boxes within the report.

This Strategy follows the guidance set out in the Department for Environment, Food and Rural Affairs (DEFRA), *Flood and Coastal Defence Project Appraisal Guidance* (PAG) documents and the DEFRA Revised Flood Defence Grant Memorandum (2003). SEA is an integral aspect of a PAG2 Strategy as it will ensure the environmental acceptability of alternative options and enable opportunities for environmental enhancement to be considered at every stage. Further technical assessments are being undertaken in parallel to this, including hydraulic modelling and an economic assessment.

Both Stokesley and Great Ayton have a long history of flooding with, most recently, severe flooding affecting the communities in Autumn 2000. Existing measures such as the Stokesley Flood Diversion Channel (FDC), channel widening, ongoing maintenance and flood warning systems provide some protection, however further flood risk reduction measures are required in the long term.

The study area totals some 90 km^2, including a 20 km length of the River Leven from its headwaters in the Cleveland Hills down through the lowlands surrounding the settlements of Great Ayton and Stokesley, both designated as Conservation Areas. Moorland and rough pasture dominate the upland areas. The lowland areas are dominated by large scale arable cultivation interspersed with small scale settlements. Runoff from the upland areas is rapid and flows quickly into the flatter lowland areas resulting in very short times before peak river flow is reached during heavy rainfall. In many reaches the Leven is heavily modified having been straightened, deepened, and widened and the banks re-profiled preventing the river from behaving naturally.

SEA Objectives have been built upon the principles for flood risk management within the study area and constitute a series of markers against which flood risk

management options will be assessed. Often the complete fulfilment of these objectives and their associated key local issues will be outside of the Agency's remit, however they provide direction to the Strategy and may be achieved in partnership. The proposed SEA Objectives are:

Recreation and amenity
Maintain and improve access to and amenities for informal recreation
Biodiversity
Maintian and improve area, quality and distribution of BAP habitats
Improve BAP habitat with a view to aiding increase in local BAP species numbers and distribution.
Water quality
Maintain and improve chemical water quality
Maintain and improve biological water quality
Reduce presence of litter in water
Encourage uptake of SuDS and best farming practices
Geomorphology
Achieve good geomorphological diversity
Achieve good lateral connectivity with the floodplain where other factors allow
Achieve good river continuity
Landscape and visual amenity
Protect and enhance quality of landscape and townscape character
Protect and enhance visual amenity
Protect and enhance existing landscape features
Socio-economic conditions
Support farming practices which are beneficial in terms of flood alleviation
Reduce risks to local premises, businesses, rural economies and livelihoods from flooding
Avoid segregation of communities/social groups through flooding/flood risk management
Accommodate the flooding impacts of climate change
Cultural heritage
Protect and enhance features of archaeological and heritage interest
Transport and infrastructure
Maintain strategic communications and service links
Use of natural resources
Facilitate sustainable use of materials

Strategic flood risk management options are proposed:

1 Do nothing
2 Do minimum
3 Improve flood warning
4 Flood proofing
5 Increase channel maintenance
6 Channel modifications
7 Change flow regime associated with existing FDC
8 Increase the capacity of the existing FDC/Eller Beck
9 Construct new flood defence embankments/walls
10 New FDC around Great Ayton
11 Floodwater storage:

12 Land use management
13 Development control

These options shall be taken forward, assessed and developed at the next stage of the Strategy. The options will be assessed according to their economic, technical and environmental viability. Opportunities for environmental enhancement will be incorporated where possible. Once the strategic options have been developed, the Strategy will be put out to consultation and after any further modifications, a Strategy report incorporating the SEA will be produced.

1 INTRODUCTION

1.1 Purpose of the Document

The Environment Agency (Agency) has commissioned Babtie Brown and Root to develop a Flood Risk Management Strategy for upper River Leven catchment and, in parallel, undertake a Strategic Environmental Assessment (SEA) of the Strategy. This document comprises the findings of the scoping stage of the SEA that aims to ensure that the Strategy and the SEA process is focused upon the key issues. This report brings together information obtained so far and highlights the key issues, constraints and opportunities which will influence the remainder of the Strategy development. From this information, the principles and environmental objectives of the Strategy have been developed and potential flood risk management options have been identified.

The Strategy will provide a high level assessment of potential flood risk management options at a catchment level, providing a framework for future flood risk management at the sub-catchment and flood cell level.

This report has been developed through a process of desktop study, site visits and preliminary consultation with a wide range of local stakeholders. Many of the issues identified are at the early stage of investigation only and require further consideration, a number of gaps in availability of information have been identified.

Consultee feedback on the scope, content and nature of the Strategy is critical to its successful development and is welcomed.

1.2 The Study Area

The River Leven is a tributary of the River Tees and flows from its headwaters in the Cleveland Hills down through the lowlands south of Middlesbrough. The Strategy will focus on the Upper Leven catchment, identifying the causes and potential solutions to flooding. The study area covers the upper reaches of the river and its tributaries from its source (NGR NZ 618, 079) on the north western slopes of the North York Moors National Park to a point 1 km downstream of the market town of Stokesley at Leven Mouth (see Figure 1). The study area totals some 90 km^2, this includes a 20 km length of the River Leven, 9 km of which is in the highlands and 11 km in the lowlands.

A number of tributaries drain into the river, the larger of these are the Broughton Bridge Beck (which becomes Eller Beck), and the River Tame. Both join the Leven to the south of Stokesley near Broughton Bridge (NGR NZ 519, 077) and at Leven Mouth (NGR NZ 512, 073) respectively. During high flows, all water is diverted from the Leven into Broughton Bridge Beck via a

Flood Diversion Channel (FDC) upstream of Stokesley, while the river channel through Stokesley takes only local drainage. Otter Hills Burn also joins the Leven at Easby.

In much of the study area the river channel is heavily modified and is unable to behave naturally as the channel has been straightened and deepened in many reaches. Part of Eller Beck downstream of the confluence with Broughton Beck has also been significantly realigned. In other reaches the channel has been widened and the banks reprofiled and reinforced, such as through the centres of Great Ayton and Stokesley.

A more detailed description of the existing environmental baseline is given in section 4.

1.3 Nature of and Background to the Project

1.3.1 The Flooding Problem

Whilst flooding can have a direct physical impact on human health, it is often the associated mental stress that can have the most detrimental effects. Contributing factors include the loss of personal possessions, financial pressures through loss of income or the cost of repairs, the loss of pets, damage to property and the affect on its value, the trauma of finding temporary accommodation, and the fear of further flooding.

Both Stokesley and Great Ayton have a long history of flooding. The area drains a steep escarpment, as such the river responds very quickly to rainfall and it is difficult to give advance notice of the impending threat of flooding. Areas at risk of flooding within a 1 in 100 year flood event are identified in Figure 1.

Serious flooding occurred in Stokesley in October 1960, 1967 and 1968. To reduce the impact of further floods, the FDC was installed in 1978 such that high flows could by-pass Stokesley. The FDC was designed to provide a '1 in 40 year' protection standard.

Reports of 1978 recognise that flooding in Great Ayton was a major problem. The gradient of the riverbed has been greatly altered, over time, through the village by the construction of a series of weirs and fords. The channel has been broadened with reinforced banks throughout much of the village.

In autumn 2000 the communities of Great Ayton and Stokesley were again subject to severe flooding, including areas of land adjoining the FDC. The Agency's Preliminary Strategic Review for the River Tees Catchment in 2001 identified Stokesley and Great Ayton as principal areas of flooding concern in the Leven catchment and was the pre-cursor to this Strategy. The number of properties at risk of flooding is estimated to be (JBA, 2002):

Flood level:	Great Ayton	Stokesley
• 1 in 25 year	25	10
• 1 in 50 year	44	50
• 1 in 100 year	76	194

Have we identified all of the relevant flood issues?

Research into climate change indicates that the incidence of flooding will increase in the future. A report published by the UK Climate Impacts Programme (2002) indicates that in a worst case (high greenhouse gas emissions scenario), the UK could see a 20% increase in peak flows in rivers during high and extreme rainfall events over the next 50 years. Increased precipitation combined with an increase in the size of urban areas (increasing the rate of surface runoff) is likely to increase the risk of flooding. This is particularly important for winter floods where there could be 15% more rain in some regions by 2050, and for summer floods in the north of the UK, where it is expected that there will be a higher proportion of extreme summer rainfall (Environment Agency, 2001). Modelling undertaken within the Strategy shall incorporate these factors in order that the impacts of climate change are incorporated it into the development of the options.

1.3.2 **Statutory Framework**

The Agency is empowered, under Section 106 of the Water Resources Act 1991 to carry out flood defence functions through Regional Flood Defence Committees, and under Section 6(4) of the Environment Act 1995, it has a general supervisory role over all matters relating to flood defence. There is no statutory obligation for the Agency to undertake works to manage flood risk.

Guidance is provided in the Department for Environment, Food and Rural Affairs (DEFRA), *Flood and Coastal Defence Project Appraisal Guidance*[1] (PAG 1-5) documents and the DEFRA Revised Flood Defence Grant Memorandum. In particular, PAG2 provides guidance on, *Strategic Planning and Appraisal*. The Leven Strategy will follow this guidance.

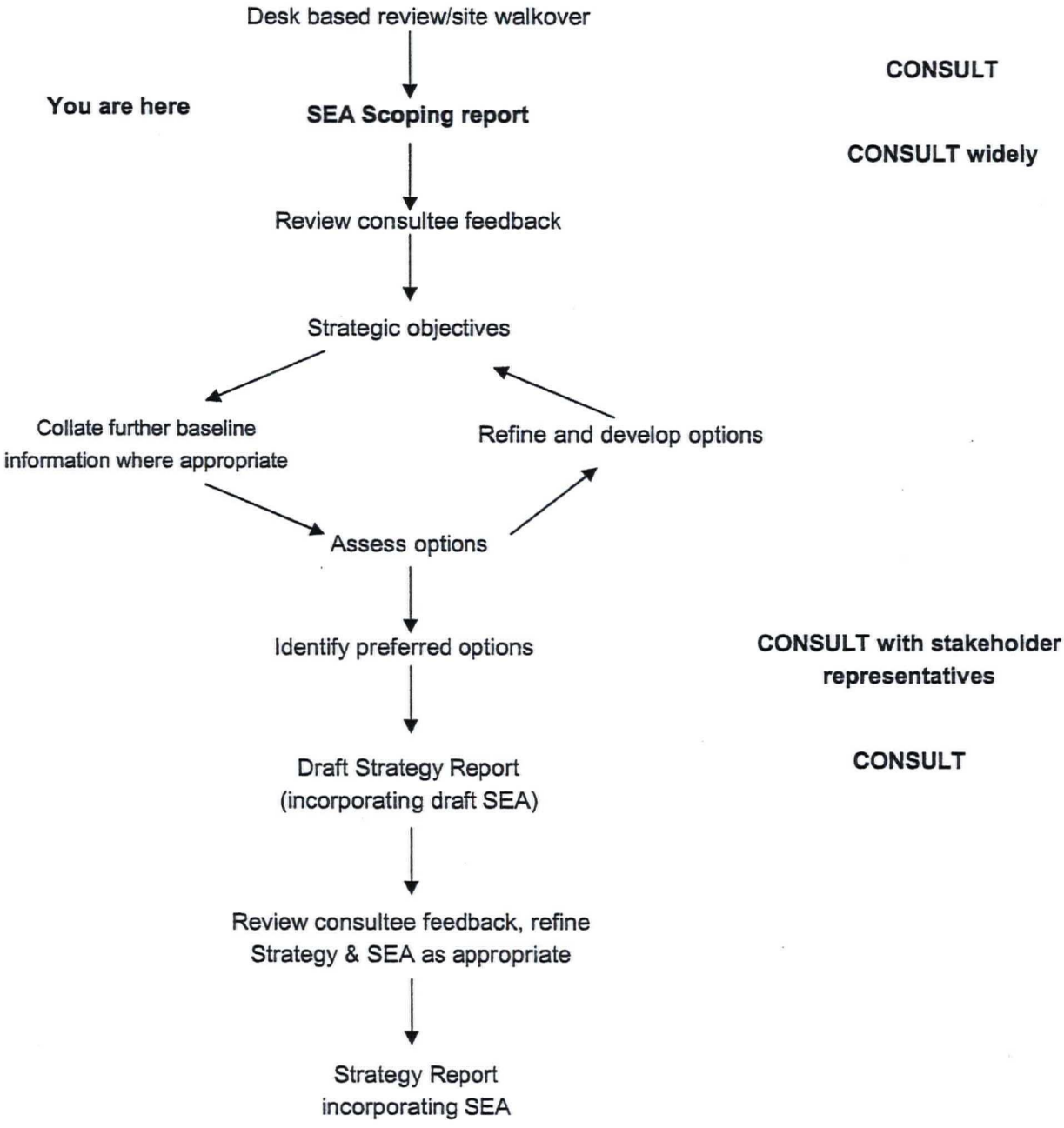
The guidance establishes the requirements for technical, environmental and economic appraisal of projects to establish which projects are acceptable for public funding. It is through these systems that an achievable level of protection can be determined.

[1] The *Flood and Coastal Defence Project Appraisal Guidance* documents are available at http://www.defra.gov.uk/corporate/publications/pubcat/env.htm

The EU Directive *2001/42/EC on the Assessment Of The Effects Of Certain Plans And Programmes On The Environment* – the 'SEA Directive' is to be implemented in the UK in June 2004. Whilst the Directive may not directly apply to flood risk management strategies, the Agency is integrating SEA into the Strategy as a good practice measure to ensure the environmental acceptability of proposed options and to enable integration of opportunities for environmental enhancement. In parallel, technical and economic assessments are being undertaken, these include hydraulic modelling to assess the level of protection that the options offer. In combination, technically, economically and environmentally acceptable flood risk management options should be identified.

1.4 Next Steps in the Strategy

The Strategy is being developed in two phases. This scoping report provides the output from the initial phase. During the following phase, the identified options will be developed to identify a preferred flood risk management option. The development of the Strategy shall be an iterative process as outlined below.



2 PRINCIPLES OF THE STRATEGY AND SEA OBJECTIVES

2.1 Principles of the Strategy

The aim of the strategy is to reduce flood risk by identifying sustainable measures for flood risk management in the upper River Leven catchment. This is to be achieved in line with the overarching principles of the Strategy:

- to take account of key issues, impacts and opportunities to encourage the provision of technically, environmentally and economically sound and sustainable flood defence measures to provide long term benefit and value;
- take an integrated approach for the whole catchment as well as to the flooding problems experienced in Stokesley and Great Ayton such that a common approach may be considered and any flood risk management options adopted are not of detriment elsewhere;
- to identify the optimum standard of protection and measures to provide this consistently across the study area;
- to identify improvements to flood risk management, for example through improved hydrometrics and flood forecasting; and
- work in partnership with, and encourage co-operation between, stakeholders at all levels, from Government agencies to local residents and landowners.

Please indicate and make any amendments to the principles of the Strategy you feel necessary.

Please outline any partnership opportunities you feel may be appropriate with your organisation.

Have you any projects in progress that it would be helpful for us to know about? If yes, please provide further details/references.

2.2 SEA Objectives

The SEA Objectives build upon the principles for flood risk management within the study area and constitute a series of markers against which the options will be assessed. They shall be applied to issues relevant at the local level by considering the key local issues when assessing the options. Often the

complete fulfilment of these objectives will be outside of the Agency's remit, however they provide direction for the Strategy and may be able to be achieved in partnership.

The proposed SEA objectives and the key local issues to be taken into account in their assessment are presented in Table 1. They build upon the Agency's statutory obligations and have been developed taking into consideration the existing environmental constraints and opportunities (see section 4), relevant plans and programmes, and stakeholder feedback from early consultation.

In the next stage of the SEA, environmental and flood defence specialists will assess each option against these objectives, presenting findings within an impact assessment matrix. Due to the strategic nature of the work, many of these assessments will be based on professional judgement and may be qualitative in nature. Based on this assessment, environmentally unacceptable and preferable options shall be identified. The assessment shall be an iterative process, with options being modified and developed according to the findings.

The compatibility of the objectives has been reviewed and it is apparent that there are some minor conflicts, however, careful consideration during the development of options and continued consultation with stakeholders will aim to resolve these issues. The minor conflicts in objectives that have been identified are:

- "Achieve good geomorphological diversity" encourages options to consider the naturalisation of the river channel and this may conflict with "protect and enhance visual amenity" or "protect and enhance quality of landscape and townscape character" should the latter be interpreted as meaning a 'tidy' channel.

- "Maintain and improve access to amenities for informal recreation" could potentially lead to an increase in the amount of litter, hence conflicting with, "reduce the presence of litter in the water", although these objectives are of a lower priority in terms of option development.

Table 1 Proposed SEA objectives

Objective	Key local issues to consider in applying objective
Recreation and amenity Maintain and improve access to and amenities for informal recreation	Maintain and enhance pedestrian, access where works are undertaken
	Maintain and enhance recreation opportunities
Biodiversity Maintian and improve area, quality and distribution of BAP habitats	Hambleton BAP includes the following habitats: • rivers and streams (broad habitat) • lakes and ponds (local habitat) • floodplain grazing marsh (priority habitat) • wet woodland (priority habitat) • an area of scrub • 1 manageable reedbed • a wildlife area in either Stokesley or Great Ayton
Improve BAP habitat with a view to aiding increase in local BAP species numbers and distribution.	Increase potential number and distribution of BAP species through: • maintain and increase connectivity between existing river corridor habitats • provision of bat roost boxes • maintain and increase connectivity between existing hedgerows • install artificial otter holts • create mammal ledges on bridges • manage lengths of river for water voles or otters • naturalising river and FDC (e.g. by addition of bays and meanders) • improve fish passage
Water quality Maintain and improve chemical water quality	Improve Chemical General Quality Assessment (GQA) standard
Maintain and improve biological water quality	Improve Biological GQA standard
Reduce presence of litter in water	Improve Aesthetic GQA standard
Encourage uptake of SuDS and best farming practices	Reduce run-off from escarpment, agricultural land and developed areas
Geomorphology Achieve good geomorphological diversity	Establish processes such as erosion, transfer and deposition and resultant forms such as riffles, pools, bars and flow diversity
Achieve good lateral connectivity with the floodplain where other factors allow	Allow lateral flow routes from channel to floodplain where other factors allow
Achieve good river continuity	Allow longitudinal sediment transfer (e.g. reduce obstacles in-channel)
Landscape and visual amenity Protect and enhance quality of landscape and townscape character	The river passes through the conservation areas of Stokesley and Great Ayton. The design of structures and engineering works should be appropriate in form and scale so as not to detract from the character of this designation. Improvements to poorer quality landscapes could be made through naturalisation of the river channel.
Protect and enhance visual amenity	The river forms a prominent visual feature within Great Ayton and locally within Stokesley. It has a strong recreational value. As such any works should aim to enhance this value and the river's visual prominence.

Objective	Key local issues to consider in applying objective
Protect and enhance existing landscape features	Hambleton Local Plan landscape policies for rivers and streams include for the protection of existing natural features, marginal vegetation and wildlife habitats encouraging their reinstatement when lost and requires the design of structures and engineering works to be appropriate in form and scale to their setting.
Socio-economic conditions Support farming practices which are beneficial in terms of flood alleviation	Increase in number of CSS schemes related to catchment management/flood defence
Reduce risks to local premises, businesses, rural economies and livelihoods from flooding	
Avoid segregation of communities/social groups through flooding/flood risk management	
Accommodate the flooding impacts of climate change	
Cultural heritage Protect and enhance features of archaeological and heritage interest	No designated sites put at risk by flooding/flood risk management
Transport and infrastructure Maintain strategic communications and service links	Access maintained to strategic road links around Stokesley and Great Ayton during manageable flood
Use of natural resources Facilitate sustainable use of materials	Use at least 20% recycled and secondary materials in place of primary aggregates during construction.

Are the objectives identified appropriate to the Strategy? Please suggest any amendments.

3 EXISTING ENVIRONMENT, CONSTRAINTS AND OPPORTUNITIES

This section provides an overview of the existing environmental conditions in the upper Leven catchment. For each environmental component, the baseline situation is described, with a focus on key issues, partnerships, constraints, and potential opportunities for enhancement which have been identified. The focus is to ensure that the most sustainable and holistic flood risk management measures are developed. Where appropriate, these components are mapped in Figure 2.

Does this represent the key baseline environmental features?

Have we correctly identified and interpreted the constraints identified, are there any further constraints that you are aware of either through your organisation or others?

Have we correctly identified the opportunities, are there any further opportunities that you are aware of either through your organisation or others?

3.1 Human Beings

The 2001 census identified a population of 4,710 within the ward of Great Ayton, a 1.9% decrease from the 1991 census; and a population of 5,520 in the Stokesley ward. The latter represents an increase from the 1991 survey of 16.5% and was mainly due to inward migration. Both wards have an above average proportion of older people: 28% of the population within Great Ayton and 22% of the population within Stokesley are over 60.

The census also identified unemployment in both wards as being a little under the national average. Within Hambleton District as a whole, there is a significantly higher proportion of the workforce employed within agriculture, forestry, and fishery compared to the national average, representing 6-7% of the employment within the wards. Levels of deprivation within the District are low, however the local economy is characterised by low wages and relatively restricted employment opportunities.

The study area has a thriving tourism industry through the presence of the North York Moors National Park. The village of Great Ayton has particular tourist interest due to its links with Captain Cook and its well preserved picturesque appearance. Great Ayton station is on the Esk Valley Railway, which also proves to be a popular tourist attraction as well as the only rail link

into the local vicinity. Stokesley is an historic market town and provides a popular base from which to visit the National Park.

The North York Moors National Park contains a number of moorland footpaths including the Cleveland Way which bounds the study area to the south and south-east. Places of interest include Roseberry Topping (National Trust) and Captain Cook's Monument. It is unlikely, that flood risk management works will adversely affect the National Park.

There are no existing SUSTRANS[2] routes, nor planned routes through the area, although the River Leven is well served by public rights of way which provide access to the riverside. Footpaths run along side the river through Stokesley centre. Further well-used footpaths follow the route of Eller Beck, the FDC, and along the north bank of the River Leven towards Great Ayton. In Great Ayton, a number of footpaths run close to and adjacent to the river and extend towards Little Ayton and Easby. A number of recreational facilities lie adjacent to the river including the Stokesley Show Ground that was flooded in Autumn 2000. Areas of recreational value are also adjacent to the river in Great Ayton, including tennis courts, small areas of public amenity land in the centre and playing fields. Whilst there is potential for recreational facilities to be adversely affected by flood risk management options, opportunities may exist to improve access to the river and enhance existing recreational facilities.

3.2 Fauna and Flora

Within the study area there are designated sites of international, national, regional, and local importance. At the perimeter of the study area, the North York Moors is designated a National Park, a Special Area of Conservation (SAC), a Special Protection Area (SPA), an Important Bird Area and a Site of Special Scientific Interest (SSSI). It sustains both the largest expanse of heather in England and populations of upland breeding birds. A further three SSSI's are present in the upper Leven catchment at Cliff Ridge, Langbaurgh and Kildale. Nine tracts of ancient woodland have also been identified within the catchment (Figure 2). The lowland areas contain important waterside grasslands alongside the Rivers Tame and Leven, which along with hedgerow restoration and small-scale tree planting which are targeted under the Countryside Stewardship Scheme (CSS)

Desk based research has identified that a number of protected species are present within the catchment including badger, bat, a range of breeding birds, kingfisher, water vole, otter, bullhead, and brook lamprey. White clawed crayfish may potentially be present in the study area. It is likely that a number

[2] Sustrans is a sustainable transport charity which works on practical projects to encourage people to walk, cycle and use public transport in order to reduce motor traffic and its adverse effects.

of bat species (including Noctule, Pipistrelle, Brown Long-eared and Brandts) utilise the riparian corridor as either foraging habitat or as a commuting corridor and potential bat roosts have been identified in the riparian trees. The lowland areas are also important for lowland farm birds, including the grey partridge and tree sparrow which are both in decline. Many of the fish species which have been identified in the study area, such as the brown trout, require clean gravels in which to spawn.

In view of the wide range of statutorily protected sites and species in the study area it is imperative that flood risk management options are carefully developed to avoid ecological impacts such as damaging gravel beds or other existing habitats, or impacting species which are present within the catchment.

Opportunities for environmental enhancement include:

- create new habitat sites such as wet grasslands, wet woodland, wildlife ponds and areas of scrubland and reedbeds which would help to contribute to the achievement of UK BAP targets;
- improve the in-channel aquatic habitat through the creation of bays and back waters, gravel beds, planting of emergent vegetation, and the creation of fish refuges and passages;
- naturalise the existing FDC as it is currently ecologically poor in terms of the number of species present and type of habitat; and
- improve bankside habitat through creation of earth banks for sand martin and kingfisher and creation of suitable habitat for otters and water voles.

3.3 Air Quality and Climate

Air quality with Stokesley and Great Ayton is categorised from moderate to good for all parameters with the exception of mean summer ozone that is categorised as moderate to poor[3]. The activities associated with the flood risk management options considered in this Strategy are not considered likely to result in significant adverse impacts on air quality. Consequently, impacts on air quality have not been considered further in this assessment.

3.4 Land use

The upland areas within the National Park are largely pastoral, with un-improved and semi-improved grazed pastures, and open, heather moorland. On the lighter lowland soils, a more mixed agriculture is favoured and a greater proportion of cultivated, arable fields are present, interspersed with small

[3] http://www.homecheck.co.uk

copses. The slopes of the Cleveland Hills escarpment and significant parts of the elevated moorland in the National Park are covered by ancient and semi-natural woodland.

Much of the catchment is designated poorer-quality Grade 3 land under the DEFRA Agricultural Land Classification for the North East Region. More versatile Grade 2 land is situated to the east and south-east of Stokesley, however, the area of arable agricultural land through which the FDC passes is Grade 3. The upland areas of the catchment in the south and east are largely poor quality Grades 4 and 5. The CSS Agreements have a good coverage across the study area, providing payments to agricultural land managers for managing their land in a less intensive way, often with corresponding environmental benefits.

Arable areas are interspersed with isolated farms , houses and settlements, ranging from small villages to larger market towns. Small nucleated villages in the lowlands include Kirkby, Great Broughton, Little Broughton and Ingleby Greenhow. Settlements in close proximity to the River Leven include the villages of Easby, Little Ayton, the larger settlements of Stokesley and Great Ayton, and the upland village of Kildale in the National Park.

3.5 Landscape & Visual Amenity

The landform of the study area is generally low lying and flat, with gently undulating topography that is fringed to the east by the steep escarpment of the Cleveland Hills. The study area falls within the Countryside Agency's 'North Yorkshire Moors and Cleveland Hills' and 'Tees Lowland' landscape character areas. Local landscape designations include Conservation Areas in Stokesley and Great Ayton.

Belts of woodland along the river bank characterise the course of the river, whilst scrubby vegetated field boundaries provide containment and structure in the local landscape. Catchment management options, such as restoration of field boundaries or increasing forestry coverage have potential landscape enhancement opportunities.

The River Leven lies within a narrow visual envelope within Stokesley. This effectively means that visual receptors are restricted largely to the users of the river, its adjacent footpaths, and to those who live or work immediately adjacent to the river. The river has a wider visual envelope within Great Ayton, forming a key feature within the centre of the village.

Flood risk management options along the river have a number of landscape and visual implications. The river corridor is an important recreational space within the townscape and therefore provides an opportunity to increase its

landscape amenity value and enhance access and usage. Parts of the river and the FDC are currently not aesthetically pleasing, therefore opportunities exist to create a more enjoyable experience for users of adjoining public rights of way, for example by naturalising the heavily engineered sections of the river and the FDC.

3.6 Geology, Soil & Hydrogeology

The upland areas of the Cleveland Hills to the south and east of the study area largely comprises hard Jurassic limestone. The lowland areas of the catchment are underlain by generally softer rocks of the Lower Jurassic Rhaetic and Permo-Triassic (Redcar Mudstone Formation and Mercia Mudstone Group), comprising shales and marls. Glacial drift covers much of the lowland area composed mainly of Till (Boulder Clay) with patches of glacial sand and gravel on the higher ground. River Terrace Gravels and Alluvium deposits are shown along the valleys of the River Leven and its principal tributaries.

The elevation of the floodplain rises from about 65m AOD downstream of Stokesley to around 80m AOD at Great Ayton. However, the headwaters of the River Leven and its tributaries rise steeply towards the moors to an average elevation of around 200m AOD.

The Soil Survey map of England and Wales indicates that the majority of the area beneath Stokesley and Great Ayton is underlain by soils derived from tills with Mesozoic sandstones and shales. These form slowly permeable, seasonally waterlogged, fine loamy, clayey soils. South of Stokesley the soils are described as petro-alluvial clay soils. These comprise of river alluvium and are stoneless clayey, fine silty and fine loamy soils affected by groundwater.

The 1:100 000 groundwater vulnerability map shows the River Leven and its tributaries to lie on minor aquifers (of variable permeability) surfaced by soils of both high and low leaching potential. Although they do not produce large quantities of water for abstraction, they can be of local importance and can supply base flow to rivers. The upstream areas are surrounded by non-aquifers of negligible permeability.

3.7 Water

The steep escarpment fringing the area results in rapid run off from the upland areas into the River Leven and Eller Beck. In contrast the River Tame follows more gently sloping ground for its entirety, thereby giving a more sluggish response to rainfall.

Routine water quality monitoring is carried out at five locations on the River Leven within the study area. Permanent monitoring stations are located at Bense Bridge and between Great Ayton and Stokesley downstream of the

wastewater works. This monitoring is used to establish the chemical and biological quality along the river and is expressed as an General Quality Assessment (GQA) grade as shown in Table 2.

Table 2 General Quality Assessment within the study area

Stretch of river	Chemical quality (1999-2001)	Biological quality (2000)
River source to Great Ayton wastewater treatment works	B (good)	C (fairly good)
Great Ayton wastewater treatment works to confluence with Broughton Bridge Beck	C (fairly good)	E (poor)

Drainage has been artificially modified through much of the catchment, increasing the run off and reducing the time to peak river flow during heavy rainfall. Agricultural areas are intensively drained in the lowlands (potentially increasing flood flows by up to 60%) (Nisbet, 2001); development has increased the area of impermeable surfacing; and grips (moorland drainage ditches) have been created within limited areas of the moorland in the upper catchment. The presence of woodland within the catchment may reduce the rate of runoff through interception of rainfall and its greater hydraulic roughness.

The implementation of flood risk management measures has the potential to indirectly improve water quality. The establishment of wetlands could help to attenuate particulates and pollutants from diffuse pollutant sources, thereby contribute to water quality improvements. Similarly, the adoption of more sustainable agricultural drainage systems, potentially with support from the Countryside Stewardship Scheme, can provide benefits both in terms of preservation of nutrients as well as reducing the rate of flow to rivers.

Within the River Leven, many structures are present that alter its flow regime and morphology. Weirs reduce the velocity of flow and impound the water upstream creating a ponding effect. This is particularly evident upstream of Great Ayton. Silt often builds up behind weirs, and this could further reduce the capacity of the channel. However upstream of Great Ayton the river shows fewer sign of modifications and has a more natural form.

The FDC was constructed to convey the floodwaters around Stokesley. This has had serious implications for the morphology (shape) of the channel by promoting the build up of fine sediment on the river bed which is not regularly flushed downstream. The natural readjustment of the river has resulted in silt accumulation on the margins of the channel, which has been colonised by vegetation (grasses, reeds) over time to create natural berms. Artificial berms have also been constructed in the centre of Stokesley for the purpose of increasing the depth and velocity of low flow.

Eller Beck displays a slightly sinuous form but lateral movement is restricted due to the restricted land take resulting in an unfavourable cross-section and a need for regular maintenance practices. The FDC is too narrow and too deep to accommodate significant morphological features such as side and point bars.

The bed material is predominantly cobbles and gravels. Riffles are evident in parts of the river, although there are generally very few bedforms and an overall lack of morphological diversity. The lateral connectivity of the channel to the floodplain is poor, especially where there are embankments. Embankments have been built both sides along the River Leven upstream of Stokesley, along the FDC and the entire length of Eller Beck. These reaches have also been straightened and deepened, and are regularly cleared of vegetation to maintain channel capacity.

The principal geomorphological issue relates to the lack of diversity. It would be possible to enhance the geomorphology and conservation value in a number of areas and create a more sustainable system which does not need regular maintenance and management. Improving the geomorphology and ecology are particularly important in view of the Water Framework Directive (WFD) which states that all Main Rivers that are categorised as heavily modified (as the Leven would be) must achieve at least good ecological potential by 2015. Whilst the poor geomorphological diversity within the Leven system does not appear to be directly contributing at a significant level to the flooding issues in Great Ayton and Stokesley at present, there is an opportunity to work towards fulfilling the wider WFD requirements within the Strategy. This may include improving the diversity of the river channel to benefit aquatic life thus moving towards achieving the status of good ecological potential in the future.

Possible geomorphological opportunities within the study area include:

- Enhancements to the diversity and river continuity by enhancing the channel planform, reinstating meanders and altering the geometry to create a more natural and stable cross-section.
- Allow for the periodic flushing of fine sediment downstream within all sections of the channel.
- Retention of the marginal channel vegetation to provide good river habitat.
- Modifications of weirs on the River Leven could improve the velocity, morphology and ecology of the river and also alleviate flooding. However, weirs are occasionally protected structures and therefore removal might not always be feasible

3.8 Cultural Heritage, Archaeology & Material Assets

Nearly 900 (897) sites or areas of cultural heritage interest have been identified within the overall study area of 89km². These comprise 31 Scheduled Ancient Monuments (SAM), two Conservation Areas, 376 Listed Buildings and 488 other archaeological sites, monuments or find-spots. The vast majority of the Listed Buildings lie within villages and their locations have not been mapped separately at this stage. The greatest concentration of sites is on the upper slopes of the North Yorkshire Moors escarpment.

A total of 14 archaeological sites have been identified within 100 m of the river and at least 30 Listed Buildings, which are for the most part located in the Conservation Areas of Stokesley and Great Ayton. These sites were assessed as being of Regional or Local Importance; none of them were of National Importance. The close proximity of the river to the historic cores of Great Ayton and Stokesley would necessitate the use of appropriate construction materials and sensitive designs to avoid any potential adverse impacts.

Buried archaeological deposits are associated with Broughton Grange in Great Ayton which is a site identified as being of Regional Importance. It is also possible that further below-ground archaeology exists which has yet to be discovered. Such remains are very sensitive to fluctuations in water levels and could, therefore be easily degraded by de-watering activities or alterations to water levels. Therefore, as the study progresses and specific options are considered, further archaeological evaluation will be conducted as appropriate.

3.9 Traffic & Transport

Flooding frequently disrupts transport routes resulting in the isolation of properties and limiting access to major transport links. This can lead to the isolation of properties, the division of communities, increased stress and perhaps most significantly reduces access for emergency response and operation.

The primary road through the study area is the A173 which runs from Stokesley through Great Ayton towards the town of Guisborough. This links to the A172 Stokesley Bypass which carries traffic north-westwards from the A19 in the south. The B1365 is the main route through the centre of Stokesley which also links to the B1257 main route to Great Broughton. A number of minor roads interconnect the settlements within the catchment traversing many of the Leven's tributaries.

The A173 crosses the FDC east of Stokesley and then runs alongside the River Leven towards Great Ayton where it crosses the river at Ayton Bridge before heading out of the village. The A172 and other routes cross Eller Beck between the sewage works south of Stokesley and the confluence with the

FDC. Within Stokesley, Levenside is a quiet residential road which runs adjacent to the river and was at risk from flooding before construction of the FDC. Similarly in Great Ayton, a number of local roads runs adjacent to the river and are afforded little flood protection. Historic fords cross the river at several locations in Stokesley.

The area is served by the Esk Valley Railway which runs from Middlesbrough to Whitby via Great Ayton, Battersby Junction and Kildale. This crosses tributaries of the Leven at numerous locations and crosses the main river at Low Easby and near Kildale.

Any flood risk management works which may affect these transport links, may have significant impacts upon traffic movement in these areas. The river is not considered to be navigable and as such this issue shall not be considered further.

3.10 Use of Natural Resources

Consideration should be given to the use of natural resources. The Agency has a target to use at least 20% recycled (e.g. crushed concrete, brick) and secondary materials (e.g. slate waste, quarry waste) where feasible, as a partial substitute for primary aggregates in construction projects. Opportunities should be sought to re-use material from operations such as other construction sites. Nonetheless, the choice of construction materials should also be determined by its sensitivity to the local landscape, visual amenity and consistency with the historic setting.

4 STRATEGIC OPTIONS

Flood risk management options have been identified which may prove beneficial in managing fluvial flooding. The development of options is a core component of the SEA process as it will ensure the environmental acceptability of alternative options, and enable opportunities for environmental enhancement to be considered. Strategic options are:

1. Do nothing
2. Do minimum
3. Improve flood warning
4. Flood proofing
5. Increase channel maintenance
6. Channel modifications:
   a) Removal or lowering of weirs
   b) Widening, with grading
   c) Removal of constrictions
7. Change flow regime associated with existing FDC:
   a) Flow from Leven to FDC
   b) Confluence of Leven and Eller Beck
8. Increase the capacity of the existing FDC/Eller Beck:
   a) Increase the length of FDC/Eller Beck
   b) Deepen FDC/Eller Beck
   c) Raise the existing flood banks along FDC/Eller Beck
   d) Increase cross section of FDC/Eller Beck
9. Construct new flood defence embankments/walls
10. New FDC around Great Ayton
11. Floodwater storage:
    a) Off-line – overbank flooding
    b) Off-line – dedicated storage area
    c) On-line
12. Land use management
13. Development control

Further details regarding these options are provided in Table 2. These options shall be taken forward, assessed and developed at the next stage of the Strategy, in accordance with the steps outlined in Section 2.4.

Are there any other flood risk management options you would like to suggest?

Do these options introduce constraints that we haven't already identified which may compromise their viability?

Table 2 Identified flood risk management options

Ref	Potential option	Key issues/comments
1	**Do nothing** Option involves stopping all existing flood risk management in the study area and carrying out no new works (i.e. stopping the maintenance of existing flood defences; providing no flood warnings; and providing no new flood defences).	This option is included as it forms the baseline for the study against which other options are assessed (in accordance with PAG2). Option likely to increase flooding due to lack of channel maintenance and management and effect of climate change resulting in greater damage to property and health.
2	**Do minimum** Continued operation and maintenance of existing flood risk management measures in the study area at their current level (i.e. continued operation of the flood warning system at Great Ayton and Stokesley; continued maintenance of the FDC; continued channel clearance). No new proposals would be implemented.	The do minimum option is always evaluated under PAG2. Option likely to see a long term increase in flooding due to the effect of climate change and development pressure (particularly within Stokesley).
3	**Improve flood warnings** Option would allow residents to mitigate impacts of flooding through early warning.	Effectiveness of this option is limited due to the rapid onset of flood events in the upper catchment however could be used in conjunction with other options.
4	**Flood proofing** Option involves the protection of individual properties against the effects of flooding using temporary features (e.g. door guards or portable flood barriers) and/or construction processes (e.g. tanking).	Option may be effective for a limited number of properties. Effectiveness of temporary measures is dependent of effective flood warnings (Option 3) in order to allow measures to be implemented/activated in time.
5	**Increase channel maintenance**: removal of sediments and vegetation Option increases the frequency of removal of sediments and vegetation from within the channel to increase the channel capacity.	Enhanced Channel maintenance encourages the conveyance of water and is important to sustain existing flood defence assets although in some instances it may not significantly reduce the water level at peak flow. A careful balance needs to be struck between the benefits of maintenance and the negative impact of impairing the natural behaviour of the river and ecological system.
6 6a	**Channel modification:** <u>Removal or lowering of weirs</u> Involves removal or lowering of weirs to reduce the water level relative to the bank during normal flow conditions, this would allow the channel to convey water faster.	Options would improve the flow velocity and reduce the area of ponding and sedimentation (increasing channel capacity) and could enhance ecology. Consideration is needed to the potential historic nature of the weirs and to erosion risks. Option is particularly relevant to Great Ayton. Consideration is needed as to aesthetic impact. Option would enhance fish migration.

Ref	Potential option	Key issues/comments
6b	Widening, with grading Option involves widening of river channel to increase channel capacity during high flows. Option requires grading of the channel to provide a 'two stage channel' where berms (a low level shelf or ledge) at the base of the bank restricts water flow to a narrow channel during low flow conditions (maintaining flow rates, reducing sediment deposition).	Channel is already over widened in many areas, therefore use of a two stage channel is key. The berms would provide valuable river habitat if a diversity of vegetation is established and sympathetically managed and improve flow velocity during low flow conditions. Riparian land uses will restrict ability to widen channel. Option would have to be used in conjunction with removal of constrictions (Option 6c). Occasional removal of silt from berms may be required to prevent them raising significantly above the water level.
6c	Removal of constrictions Option involves modifications to structures limiting water flow within the main channel (e.g. bridges).	Option will improve localised conveyance during high flow events. Care is needed to maintain structural integrity and conserve heritage.
7	**Change flow regime associated with existing FDC**	
7a	Flow from Leven to FDC Option involves changing arrangements for diversion of flows from the Leven to the FDC during peak flows. This may involve replacing the penstocks at the off-take, or changing the river levels at which they are opened/closed.	Ideally high yet controlled flow velocities would be occasionally provided through the town to provide flushing. Option may not be viable since it is understood that the Leven through Stokesley only has sufficient capacity to deal with drainage from Stokesley during flood events, may be viable in conjunction with other options (e.g. Options 7b, 12, 13). Problem exacerbated by low flows being very low.
7 b	Confluence of Leven and Eller Beck Option involves modifying the confluence of the Leven with Eller Beck. This may involve replacing the valves at the confluence.	Greater understanding is needed of the current hydrology at this confluence to assess this option, some consultees report water is currently locked in Stokesley during high flows. Option may be viable in conjunction with other options (e.g. Options 6b, 7a, 9)
8	**Increase the capacity of the existing FDC/Eller Beck**	
8a	Increase length of FDC/Eller Beck Option involves increasing the sinuosity in some sections to provide an increased channel capacity.	Option would provide a more natural form however its viability is likely to be constrained by land ownership.
8b	Deepen FDC/Eller Beck Option involves deepening the existing channel to increase capacity.	Option is likely to result in increased maintenance requirements (e.g. sediment removal) and offers few environmental enhancement opportunities. Operational and public health and safety implications would require careful consideration with a deeper channel.
8c	Raise flood banks along FDC/Eller Beck Option involves raising flood banks along the FDC to increase capacity.	Option offers few environmental enhancement opportunities, may impair visual amenity and impair recreational value of the well used footpath. Option likely to be constrained by land take

Ref	Potential option	Key issues/comments
8d	Increase cross-section of FDC/Eller Beck Option involves re-profiling the existing banks of these watercourses to increase channel capacity.	Option would only be viable in conjunction with the removal of constrictions (Option 6c). It provides opportunity for developing wetland areas in the channel for ecological benefit however is constricted by land take.
9	**Construct flood defence walls** Options would involve construction of flood defence walls within developed areas. The height of the walls would be dependent on the standard of protection to be provided.	Sympathetic design would be required such that the visual impact was acceptable within the Conservation Areas and in close proximity to properties. Consideration required to the maintenance of existing accesses. Increasing the conveyance of water downstream may generate greater bank erosion where reinforcement is not provided and may increase peak flows downstream.
10	**New FDC around Great Ayton** Option involves construction of an additional FDC taking peak flows from the River Leven at Little Ayton to discharge into Broughton Bridge Beck. Since a new FDC could be shorter than the existing river channel, a water storage facility may also be required in order to prevent increase in peak flows downstream.	Impact on land take, existing ecology, landscape, visual amenity, unidentified archaeology, and drainage. Opportunity exists to provide a more natural FDC design with ecological enhancement. Initial estimates suggest that this is not a cost-effective option.
11	**Floodwater storage**	
11a	Off-line – overbank flooding Involves allowing (or encouraging) overbank flooding (i.e. 'natural' flooding) in suitable areas by lowering existing defences. In consultation with landowners, it may be feasible to use agricultural land or recreational grounds for this purpose whereby these areas would be inundated with water for between several days to several weeks.	This may be viable upstream of either of the settlements or potentially downstream of Stokesley (to protect downstream settlements if conveyance of floodwaters were to be increased through Great Ayton and Stokesley by implementation of other options). Consideration required as to agricultural economy and availability of recreational facilities, option may be viable in conjunction with CSS scheme. Possible impacts on flora and fauna and to groundwater regime in flooded areas.
11b	Off-line – dedicated storage area Alternatively, floodwaters may be stored in dedicated flood storage area(s) away from the river, typically embankments would be required around the storage area(s). They may be subjected to either gradual changes in water level (e.g. wetlands) or sudden inundations during a flood event. Floodwater could then be released in a controlled way once the peak-flow has passed. For the majority of the time, these structures would remain empty or contain only low water levels.	Initial searches have not identified suitable storage areas that offer sufficient capacity to mitigate the flooding issues, however this option may be viable considered in combination with other options. This may be viable upstream of either of the settlements or potentially downstream of Stokesley (to protect downstream settlements if conveyance of floodwaters were to be increased through Great Ayton and Stokesley by implementation of other options). Possible impacts on flora and fauna and to groundwater regime in flooded areas. Option provides opportunity for recreational enhancement.

Ref	Potential option	Key issues/comments
11c	On-line Floodwaters may be stored in dedicated flood storage area(s) within the main river channel through use of a structure (e.g. dam). Floodwater could then be released in a controlled way once the peak-flow has passed. For the majority of the time, the dam would not be in use, resulting in normal water flows.	Initial searches have not identified suitable storage areas that offer sufficient capacity to mitigate flooding issues. Implications for hydraulic regime, hydraulic continuity, and ecology. Storage area could become a sediment sink.
12	**Land use management** Option involves changes to land use management to reduce runoff into the watercourses and therefore reduce the peak flow. This may be applied to all land uses within the catchment: • Moorland (blocking of moorland grips) • Forestry (increasing forested areas, reviewing current forestry drainage) • Agriculture (altering drainage and ploughing practices) • Wetlands (increase wetland areas) • Developed areas (implementation of Sustainable (urban) Drainage Systems, SuDS)	Rapid run off from the upper reaches of the catchment is key to the flooding processes. Working in partnership with landowners and tenants is key to success of this option. Other schemes are likely to be of assistance (e.g. CSS). Greater understanding is needed of the effects of these options on run off so that their effectiveness may be predicted. A change in the land management across significant areas of the catchment would be required for this option to be effective.
13	**Development control** Option involves restricting development within the floodplain such that no new development may occur, or where development is permitted it does not reduce floodplain storage, does not increase run-off and the property is protected from the effects of flooding.	The Environment Agency has a presumption against development on the floodplain. However, Local Authorities make the final decision on planning applications, PPG25 provides guidance on this.

5 CONCLUSIONS

In developing a strategy to manage the flooding risk at Stokesley and Great Ayton there is an opportunity to enhance the sustainability of the economy, the community and the environment.

By pursuing issues collectively, in partnership with the local community and in parallel with flood risk management, a wide range of objectives can be met. Furthermore, there is the potential for a broad spectrum of stakeholders to work together to improve the quality of life in these highly regarded, characteristic North Yorkshire settlements.

We welcome feedback on the scope of the Strategy such that your comments may be incorporated from the beginning in the development and assessment of the flood risk management options. We shall continue to consult with stakeholders through this process as appropriate and shall issue a draft Strategy Report for wider consultation once the preferred options have been identified.

6 REFERENCES

Preparing for Floods, ODPM 2002.

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Can Forestry Stem the Flood?, Forestry and British Timber, Tom Nisbet 2001.

Appendix 1: Plans and Drawings

Figure 1 Site Location Plan

Figure 2 Constraints Plan