Case study 22. Guisborough Flood Alleviation Scheme

Authors: Ted Thomas

Main driver: Flood risk management

Project stage: Appraisal

Photo 1: A dam that will be refurbished and made greener as part of the scheme (source: Environment Agency)

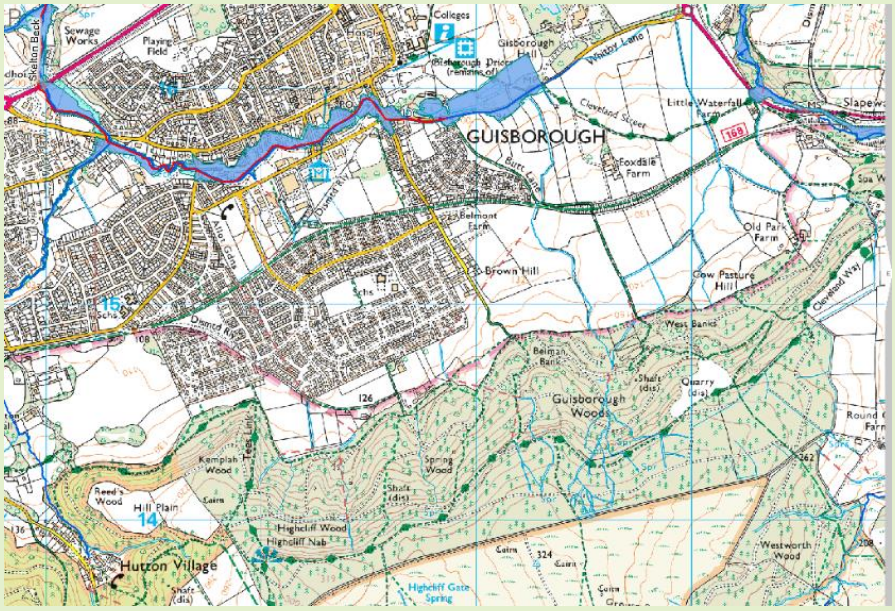
Project summary:

The Chapel Beck (main river) flows through Guisborough (Map 1) and is fed by a number of small tributaries (ordinary watercourses). There is significant modelled flood risk from the chapel beck but few instances of actual flooding, although the tributaries have caused flooding in the past. The project has so far determined that the reason for the lack of flooding from the beck is likely to be a large number of unaccounted for natural and unintentionally created attenuations upstream of the town. The project is seeking to formalise and improve these existing attenuations and to create further attenuations to reduce future flood risk, while creating 5ha of water dependent habitat.

Key facts:

Installing 15,000m^3 of flood water storage in the catchment could reduce the 100-year peak flow by 10.9% (2m^3s^{-1}).

The published flood map cannot take account of the man-made attenuations present in the catchment because there is no guarantee that these will perform this inadvertent flood water storage function in perpetuity. Only if the features are formalised as flood risk assets and maintained can they be considered when estimating the actual flood risk to homes in Guisborough.



Map 1: Guisborough with fluvial flood risk shown (source: Environment Agency and Ordnance Survey)

1. Contact details

Contact details	
Name:	Ted Thomas
Lead organisation:	Environment Agency
Partners:	Forestry Commission Redcar and Cleveland Borough Council
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2. Location and catchment description

Catchment summary	
National Grid Reference:	NZ6203815843
Town, County, Country:	Guisborough, North Yorkshire, UK
Regional Flood and Coastal Committee (RFCC) region:	Northumbria
Catchment name(s) and size (km^2):	Chapel Beck, 8.32km^2
River name(s) and typology:	Chapel Beck. Urban: modified urban watercourse Rural: inactive single thread channel
Water Framework Directive water body reference:	GB103025071970
Land use, soil type, geology, mean annual rainfall:	Urban, Agriculture, Forestry/Amenity

3. Background summary of the catchment

Socioeconomic/historic context

Chapel Beck rises on the northern scarp slope of the North York Moors. This slope was home to a number of mines until after the Second World War when it was turned over to forestry. Consequently, the upper reaches of the beck have been significantly modified by the forest road and drainage network as well as by the historic mining dams and railways. Further downstream the beck has been altered historically to serve the Guisborough Priory ponds and many of the smaller tributaries now flow into the surface water drainage networks of modern developments before entering Chapel Beck.

Flood risk problem(s)

The predominant historic flood risk in Guisborough is from small tributaries and surface water flooding, with recent instances in 2006 and 2012. Although there is a significant modelled flood risk from the main Chapel Beck, there is very little history of flooding. As part of this project, the existing hydraulic model and input hydrology have been reviewed. It has been concluded that it is the input hydrology that estimates greater flood flow rates than have historically been seen.

Other environmental problems

The catchment is heavily modified. The historic mine system has been known to bulk discharge iron-rich water, following what are thought to be underground collapses of the mine workings. Chapel Beck also suffers from diffuse pollution issues and intermittent discharges from combined sewer outfalls, and the channel through the town is prone to siltation, reducing channel capacity. The ecological and fisheries status are 'poor'.

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood risk problem(s) and solution(s)

A detailed review of the catchment discovered that many of the human interventions in the catchment are likely to be acting to slow down and attenuate flows. This is the likely cause of the discrepancy between historic flooding and modelled flood risk. The forest drainage network is very sinuous and often tracks across contours rather than heading down the steepest part of the slope. The historic mine dams and railway embankments act as online storage dams, with the discharge pipes acting as throttles. Tributaries of the beck syphon underneath the beck at points and flow through the Guisborough Priory pond network before discharging into the beck. However as these elements are not designed or maintained for this purpose, it cannot be assumed that they perform this function effectively and therefore the Environment Agency cannot reduce the published risk to homes within Guisborough. There are excellent opportunities to formalise these existing features and maintain them in perpetuity, as well as working with the Forestry Commission and other landowners to Work with Natural Processes (WWNP) to further reduce flood risk, create water-dependent habitat and incorporate other ecological benefits.

What was the design rationale?

Early appraisal of WWNP measures was conducted using a simplified modelling tool developed for the Lustrum Beck Flood Alleviation Scheme. This determined that the addition of WWNP features in the catchment could reduce flows through the town by up to 10.9% during a 1 in 100 year flood. This simplified modelling allowed a high level economic analysis to be completed in order to gain approval to carry out a more detailed appraisal.

AECOM is now undertaking detailed modelling and appraisal of WWNP and more traditional measures to determine a preferred option. Due to the small scale of the catchment, AECOM is developing a 2D

TUFLOW model of the entire catchment. Rainfall events will then be simulated over this domain using a direct to mesh methodology, meaning that the model will fully simulate rain falling onto the catchment. This will allow the incorporation of existing features into the model to understand their influence on downstream flood risk. It will be possible to modify these features to improve their performance, for example, to reduce the pipe size through existing embankments.

It will also be possible to add in new features such as field corner bunds, large woody debris, drain blocking and wetlands. These will be able to be modelled explicitly within the 2D domain rather than through a simplified representative approach, as was done early in the appraisal.

The 2D model will then be linked to a 1D-2D Isis-TUFLOW model of Chapel Beck through the centre of Guisborough, which will give a better understanding and representation of property by property flood risk. As this forms part of a typical flood and coastal risk management (FCRM) appraisal, traditional options such as flood walls and embankments cannot be excluded from the appraisal. Detailed economic analysis will then be completed to determine a preferred option.

Project summary	
Area of catchment (km^2) or length of river benefitting from the project:	8.2km^2
Types of measures/interventions proposed (both WWNP and traditional):	Online and offline flood storage, large woody debris, wetlands, drain blocking, naturalisation of engineered channel
Numbers of measures/interventions used (both WWNP and traditional):	Early indications are that 2 larger (~5,000m^3) online storage features could be created with one permanently wetted. In addition work may include: • 19 features that maximise existing floodplain storage • 22 features which disconnect run-off pathways • 6 reaches of large woody debris • 14 reaches of ditch management • 5 hectares of water-dependent habitat • 400m of naturalised urban watercourse
Standard of protection for project as a whole:	It is hoped the scheme will deliver a standard of protection of 1 in 75 years compared with the existing standard of protection of 1 in 5 years.
Estimated number of properties protected:	127

How effective has the project been?

To be completed following project completion

5. Project construction

How will individual measures constructed?

It is anticipated that smaller scale work, such as large woody debris construction, could be completed by the Forestry Commission on land in its ownership. In addition it is planned to work with the Forestry Commission to take opportunities to intervene in areas as felling takes place, given the machinery already onsite. Large-scale work such as formalising historic dams and embankments is likely to be completed by the Environment Agency. This work may involve reinforcing the embankments using piles so as to avoid needing to fully reconstruct them.

How long will measures be designed to last?

It is anticipated that larger structures will have a 100 year design life, while the softer measures may have a maximum 10 year design life.

Are there any landowner or legal requirements which need consideration?

The larger dams need to be considered with regards to reservoir safety as well as public access due to the amenity use of the sites.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed:	2015 to 2021
How was the project funded:	FCRM grant-in aid RFCC Local Levy external contributions (to be confirmed)
Total forecast cash cost of project (£):	£1.5 million
Overall cost and cost breakdown for WWNP/NFM measures (£):	To be confirmed
WWNP/NFM costs as a % of overall project costs:	To be confirmed
Unit breakdown of costs for WWNP/NFM measures:	To be confirmed
Cost–benefit ratio (and timescale in years over which it has been estimated):	2.94 over 100 years

7. Wider benefits

What wider benefits will the project achieve?

The proposed modelling will provide greater understanding of flooding from all sources, not simply the main river. This will allow the Environment Agency to tackle all sources of flood risk and, by carrying out work to slow flows in the catchment it will be possible to reduce flood risk from the main river, ordinary watercourses and surface water.

The scheme will also look to reduce erosion at current hotspots in the upper catchment. This will reduce the risk of damage to forest paths (including the Cleveland Way) and reduce the diffuse pollution and the sedimentation issues seen in the town centre.

The scheme is also taking an ecosystems services approach involving a range of local partners to highlight opportunities for wider benefits and to mitigate any potential negative impacts of the scheme.

How much habitat will be created, improved or restored?

It is currently hoped that a minimum of 5ha of water-dependent habitat can be created. The majority of this will be on former coniferous plantation sites.

It is also hoped to ecologically restore 400m of heavily modified channel through the central park in the town centre.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

It is to be confirmed how maintenance will be undertaken, but it is likely that larger structures will be regularly inspected and maintained by the Environment Agency. Smaller features will be monitored by the Forestry Commission as part of its routine monitoring. Who undertakes reactive maintenance and how will be determined on a case by case basis.

Is the project being monitored?

Monitoring equipment is currently in place in the town centre. This will remain to attempt to determine the actual impacts of the scheme.

Has adaptive management been needed?

To be confirmed

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

Recent developments in computational modelling and increased processor speed now allow detailed 2D modelling of whole catchments. This presents the opportunity to have a similar level of certainty during the appraisal process about the effectiveness of WWNP schemes as traditional schemes.

Hydraulic modelling is rarely fundamentally wrong and there are likely to be causes for discrepancies in modelled flood risk and actual flood risk. It is for project teams to determine the cause of the difference and whether work is required to ensure the discrepancy continues, so long as the discrepancy is in favour of reduced instances of flooding.

The Guisborough flood alleviation scheme has been used by the Environment Agency as an Area pilot of the ecosystems approach. This has involved the Environment Agency catchment partnership and external stakeholders in discussing the flood alleviation scheme and potential wider benefits from taking an integrated approach to project management. The learning from the ecosystems approach at Guisborough can be used to inform how multiple benefits can be incorporated into future NFM schemes.

10. Bibliography

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Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's Joint Flood and Coastal Erosion Risk Management Research and Development Programme.