Case study 13. Stroud Rural SuDS Project: Community Engagement in NFM

Authors: Brian Smith (Environment Agency), Chris Uttley (Stroud District Council)

Main driver: Flood risk management

Project stage: Construction/implementation, 2014 to 2020

Photo 1: Slad Brook flooding, July 2007 (source: Stroud District Council)

Project summary:

Stroud and small communities throughout the 250km^2 Stroud Frome catchment (Map 1) have suffered historic flooding: with recorded events in November 1875, December 1900, December 1929 and December 1965 causing prolonged flooding between Stroud and Saul (Lower Frome). Summer flooding was recorded in October 1882, July 1907 and August 1931, affecting Nailsworth Stream and Slad Brook. The two largest flood events on record occurred in 1965 and 1968. In July 2007 (Photo 1), the Upper Frome, Painswick Stream and Slad Brook flooded, affecting over 200 properties. In November and December 2012, 15 properties in Chalford flooded.

Initial flood risk management studies sought to achieve a contemporary storage scheme on the Slad Brook (a rapid response catchment), but this proved technically and economically unviable. Community Flood Action Groups, supported by Stroud District Council, promoted the Natural Flood Management (NFM) approach. Extensive scoping studies and site evaluation by the local community, with support from the Environment Agency's Area Flood and Coastal Risk Management (FCRM) team, identified the potential opportunities and benefits of this approach. The options were refined through a detailed scoping study, which provided the evidence to support a funding bid to the Regional Flood and Coastal Committee (RFCC).

In May 2014, a 3-year partnership between the Environment Agency and Stroud District Council was established with Local Levy funding from the English Severn and Wye RFCC. A full-time project officer was appointed in May 2014 and RFCC funding for the scheme has been extended to March 2020. The partnership's objective is to promote and implement Working with Natural Processes (WWNP) measures to reduce flows and flood risk and to contribute towards Water Framework Directive measures in the Frome catchment.

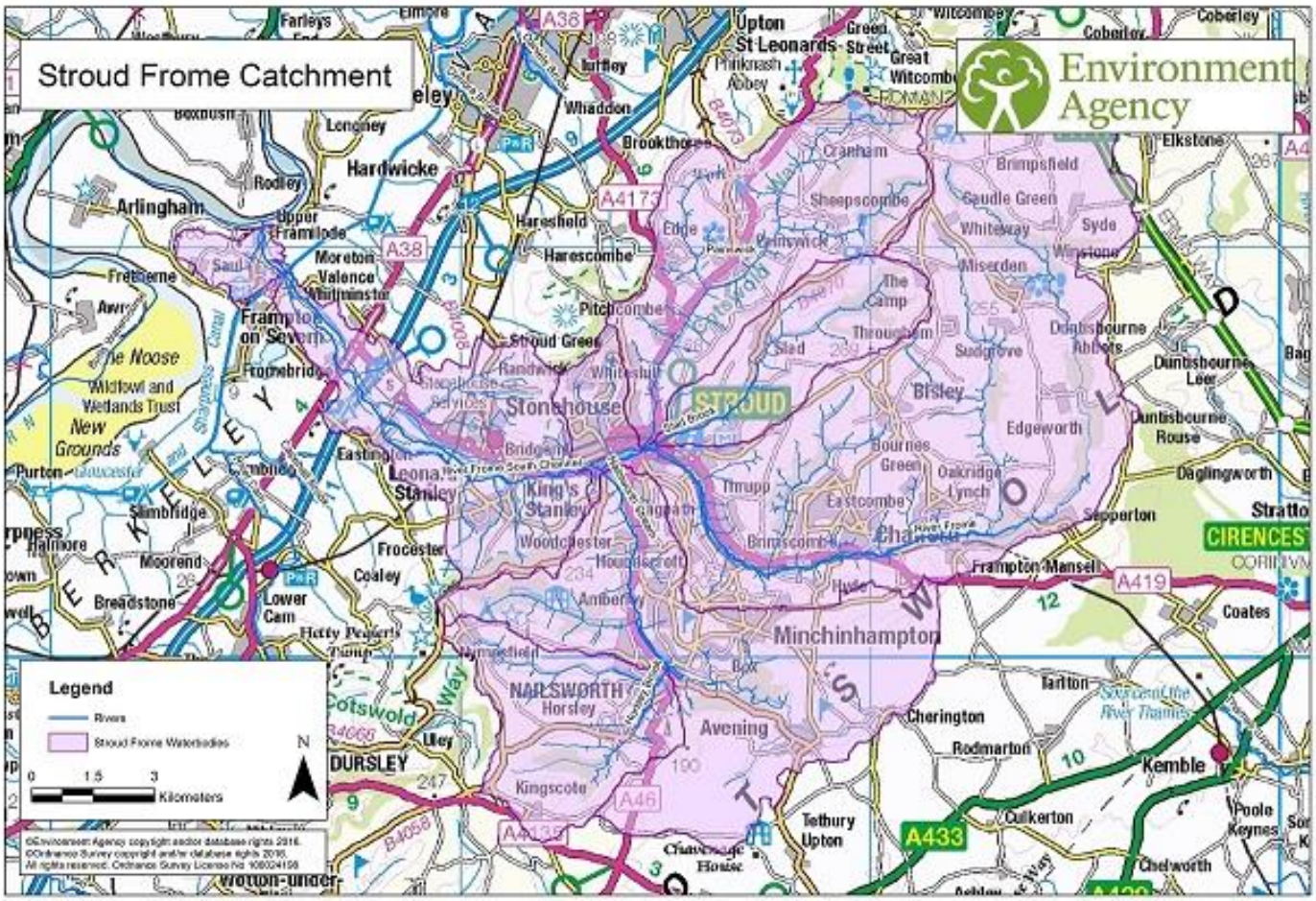
Key facts:

To date (October 2016), the project has worked with 16 land managers (12 private and 4 non-governmental organisations) to put in place 257 NFM interventions including: 162 large woody debris dams; 50 minor deflectors; 1 dry stone wall deflector; 3 spring-fed and 3 solar-fed cattle drinking troughs; 5 large earth bunds; 7 small earth bunds/check dams; 1.2km of streamside fencing; and 1 large dry pond.

An area of 52.5km^2 (21%) of the Stroud Frome catchment now drains through NFM structures. Comparing Environment Agency river gauge data for a rain event on 9 March 2016 (36mm in 12 hours) with similar a rainfall event in 2012 suggests that these measures reduced peak river levels in the Slad Brook by up to 1m. Some 53 properties are at 'Very Significant Flood Risk' but did not flood in this event.

Flood action groups in the Stroud valleys were crucial in the development of the project and a representative of the flood groups was on the interview panel for the selection of the project officer. To date, over 30 people from the Stroud and other flood action groups have visited, including members of the Calderdale community group called 'SlotheFlo'.

- Project Officer costs for the 6 years to March 2020: £315,000
- Capital project costs to date: £115,000, plus contributions in kind from landowners
- Average cost per structure to date: £1,670



Map 1: Stroud Frome catchment (source: Environment Agency)

1. Contact details

Contact details	
Names:	Chris Uttley (Project Officer) and Brian Smith (Environment Agency Technical Lead)
Lead organisations:	Stroud District Council Environment Agency (West Midlands Area)
Partners:	Community flood action groups, landowners, Gloucestershire Wildlife Trust, Gloucestershire County Council, National Trust, Forestry Commission, Natural England, Cotswold Area of Outstanding Natural Beauty, Severn Rivers Trust, Farming and Wildlife Advisory Group (FWAG)
e-mail address:	chris.uttley@stroud.gov.uk brian.smith@environment-agency.gov.uk

2. Location and catchment description

Catchment summary	
National Grid Reference:	SO8540504955 (Stroud)
Town, County, Country:	Stroud, Gloucestershire, UK
Regional Flood and Coastal Committee (RFCC) region:	English Severn and Wye
Catchment name(s) and size (km^2):	Frome catchment, 250km^2 (total catchment)
River name(s) and typology:	Painswick Stream, Slad Brook, River Frome & Nailsworth and Horsley Streams. All the main tributaries are steeply, fast flowing off the Cotswold Escarpment and spring feed from the Cotswold aquifer. All watercourses have extensive gravel reaches and in the lower valleys have numerous active and redundant mill pools. Typology transitions from step pool and bedrock channel through pool riffle and modified urban channel.
Water Framework Directive water body reference:	Frome (source to Ebley Mill) GB109054032470 Painswick Stream GB109054032460 Slad Brook GB109054032440 Horsley Stream GB109054026510 Nailsworth Stream GB109054026531 Frome (Ebley Mill to River Severn) GB109054032450
Land use, soil type, geology, mean annual rainfall:	Permanent pasture and broadleaved woodland in steep valleys; arable and pasture on upper plateau Thin calcareous clays and loams overlaying Jurassic Oolitic Limestone Mean annual rainfall: 679mm

3. Background summary of the catchment

Socioeconomic/historic context

For centuries, the Frome catchment has been used for drinking water, agricultural and industrial purposes. This has inevitably resulted in numerous modifications to manipulate and control flow. Derelict and operational buildings, leats, weirs and other features are commonplace in the catchment. Many of the storage ponds, pools and reservoirs remain in place, some off-line, where the river water needs to be abstracted or overtop to fill the pool.

The Lower Frome through Stroud and Stonehouse remains heavily industrialised, but water-driven systems are rarely still in use. There is increasing and ongoing residential development of former industrial sites and mill buildings.

The upper river valleys are narrow, with natural flat valley bottoms, which were historically adapted to provide storage pools or to hold up water up to provide for mills, dwellings and farms. The tributaries were also developed for water-powered industry and this is still evident with complex networks of mill leats and artificial channels, storage pools or pipes (for example, on Nailsworth Stream, Toadsmoor Stream and the lower Slad Brook). The functional retention of the numerous mill pool systems remains important from a heritage and aesthetic viewpoint.

Throughout the catchment, many spring outflows have been adapted and impounded to form pools for ornamental features and to create fisheries. In addition, many springs have provided private water supplies to remote dwellings and farm areas through the use of siphons and hydraulic rams – some of these still function.

There are many complex interactions between the Frome, its tributaries, springs and the Stroudwater Canal. The full extent of these is not fully understood, although studies are ongoing across the Severn–Thames groundwater catchments. Painswick Stream and Slad Brook enter the Stroudwater Canal before reaching the Frome, while many springs and overbank flows are intercepted by various sections of the canal.

The most important water use in the Frome today is for the supply of drinking water locally and for Bristol. Water quality is therefore of crucial to ensure it is safe for public supply.

Flood risk problem(s)

Records of historical fluvial flood events from the 1820 to the 1960s reveal that Nailsworth Stream and the Frome below its confluence flooded frequently. Painswick Stream rarely flooded as it remained mostly in open channel through Beeches Green (Stratford Mill) until the 1970s. Events in November 1875, December 1900, December 1929 and December 1965 caused prolonged flooding between Stroud and Saul (Lower Frome). Summer flooding was recorded in October 1882, July 1907 and August 1931, affecting Nailsworth Stream (one event reported it to have risen 10 feet in 15 minutes) and Slad Brook. The 2 largest flood events on record occurred in 1965 and 1968 when a large number of properties along the Frome valley were flooded. After this the Ebley Mill gauging station was installed but such events have not occurred since. The Upper Frome, Painswick Stream and Slad Brook flooded in July 2007, affecting over 200 properties; 15 properties in Chalford flooded in November and December 2012. The most widespread flooding occurs after sustained periods of rainfall, subsequent increased groundwater levels/flow causing increased baseflow combined with increased run-off response from land areas. The Slad Brook was designated as a rapid response catchment in 2012, with 112 properties at risk.

Other environmental problems

The Upper Frome and Slad Brook water bodies are classified as 'Good' and all the other water bodies as 'moderate' for fish. However, all watercourses suffer from substantial historical obstructions to fish passage and sedimentation from agricultural sources.

The upper Slad, Painswick and Frome catchments are within the Cotswold Beech Woodlands and Commons Special Area of Conservation (SAC). There are extensive areas of species-rich limestone grassland, with significant areas managed as nature reserves by the National Trust and Gloucestershire Wildlife Trust.

There are also many complex and varied interactions between the Frome, its tributaries, springs and the Stroudwater Canal. A joint flood and coastal risk management (FCRM) and water resources catchment study of groundwater and flood risk is planned by the Environment Agency for 2017.

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

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

Flood risk assessment and feasibility studies for contemporary flood defence schemes had been undertaken at various stages, including after the 2007 floods. Further modelling was carried out when the Slad Brook was designated as a rapid response catchment.

Following extensive community consultations on contemporary schemes, it was widely accepted that protection against major flood events is not viable and would have an unacceptable impact on the local environment and landscape. The local community proposed that Natural Flood Management (NFM) options should be investigated.

In 2010, working with the community through a local action group (Water 21), the Environment Agency undertook a series of catchment walkovers and informal discussions with landowners to establish the scope and potential locations for NFM measures. The outputs from the community walkovers were reviewed in the 'Rural SuDS – River Frome catchment (Stroud Valleys) scoping study' (Atkins 2013).

In May 2014, a 3-year partnership with Stroud District Council was established with Local Levy funding from the English Severn and Wye RFCC. A full-time project officer was appointed in May 2014 and RFCC funding for the scheme has been extended to March 2020. The project officer reports to a steering group chaired by members of the local community flood action groups.

What was the design rationale?

The primary driver from the local community was to see measures in place on the ground and not a period of protracted planning and evaluation. The project officer therefore focused on working with the National Trust and Gloucestershire Wildlife Trust in the Slad and Painswick catchments, developing and implementing a wide range of measures from woody structures in streams to soakaways on forest road culverts. The initial programme provided the basis for demonstrating and promoting the project approach to a wider landowning community, building confidence and promoting dialogue. The project now has an extensive network of supportive landowners either already undertaking or planning measures as part of the project. To date (October 2016), the project has worked with 16 land managers (12 private and 4 non-governmental organisations) and 257 NFM interventions have been put in place including:

- 162 large woody debris dams
- 50 minor deflectors
- 1 dry stone wall deflector
- 3 spring-fed and 3 solar-driven cattle drinking troughs
- 5 large earth bunds
- 7 small earth bunds/check dams
- 1.2km of streamside fencing
- 1 large dry pond

An important factor when developing measures is that they are installed in locations which the landowner considers appropriate and which minimise the potential impact on their farm practice. With experience, the landowners begin volunteering additional locations and, at most sites, the project has been invited back to install further measures. By working with landowners rather than imposing a decision on them, the project has had full cooperation and has not needed to offer financial compensation.

Project summary	
Area of catchment (km^2) or length of river benefitting from the project:	250km^2
Types of measures/interventions used (Working with Natural Processes and traditional):	Large woody check dams Earth bunds Retention pools
Numbers of measures/interventions used (Working with Natural Processes and traditional):	257 (as of October 2016)
Standard of protection for project as a whole:	No specified standard of protection has been set for the project – the aim is to reduce flood risk for those residents at Very Significant <5% annual equivalent rate (AER)
Estimated number of properties protected:	The Slad Brook is a rapid response catchment with 112 properties at flood risk. Of these: • 53 are at Very Significant risk (50% to 4% annual exceedance probability (AEP)) • 3 are at Significant risk (4% to 1.33%AEP) • 1 is at Moderate risk (1.33% to 0.5% AEP) • 55 are at Low risk (over 0.5% AEP)

How effective has the project been?

The project's most significant benefit to date is that the local community is now actively engaged in a positive partnership with local councils and the Environment Agency to constructively manage their flood risk while protecting and enhancing their local environment.

Evidence of measurable flood risk benefit is harder to demonstrate or quantify. The project has only been operational for 2 years during which time there have been very few high flow events. Observed evidence shows that, individually and collectively, the structures are having a positive effect (photos 2-3).

So far, monitoring has been based on comparing events at the Environment Agency's Slad Road gauge; available data are based on water levels and not flows.

Initial gauge data from the rain event on 9 March 2016 and observed evidence at various structures, has shown that the underlying limestone geology of the catchment has enabled large volumes of surface water to infiltrate to groundwater, reducing total surface flows and subsequent flood risk.

Comparing a 36mm rise in water level in a 12-hour rain event on 9 March 2016 with comparable events (taking into account many variables including antecedent conditions, intensity, duration and distribution of rain over the 24-hour period and seasonality), there is a clear indication that WWNP measures have reduced the peak level by up to 1m

Based on local information no properties reported flooding. Some 53 properties are in the Very Significant flood risk category and could potentially have flooded in this event, The FCRM partnership funding calculator estimates the economic benefits of protecting these 53 properties at £605,000, the property level resilience estimate of damages avoided is £1.59 million.

More comparable events are required before a clear trend can be determined and the level of benefit can be confidently assessed.

Photo 2: Large woody debris on Slad Brook, with water retained on the floodplain during a heavy rain event (source: Chris Uttley, Stroud District Council)

5. Project construction

How were individual measures constructed?

Measures are constructed in a wide variety of ways using a range of methods. In all cases, contracts for construction and installation are awarded on a hierarchy that favours:

1. Construction by the landowner or farmer as first option
2. Construction by landowner's favoured contactor (based on comparison with known best value prices)
3. Open tender

In all instances, works are closely supervised by the project officer.

Large woody debris

Three basic designs are used for the construction of large woody debris structures (Photo 3): very natural, semi-natural and structured. Landowner preference and location determines which of these is most suitable. Material is sourced from as close to site as possible, using trees coppiced or felled in the riparian area.

A tractor/winch system is used if machine access is available; if not, then a hand (Tufa) winch is preferred. Structures are built according to the following basic guidelines and criteria:

- Baseflow should be allowed to continue unimpeded wherever possible.
- Tree trunks and branches should be left as long as possible and with branching in place to reduce possibility of movement.
- Tree trunks should be pinned using reinforcing steel pins to create complex structures and ensure tree trunks do not float during high flow events. In some cases, wood may be left in situ without pinning.

Different species of tree (alder, ash, willow, hazel, poplar and oak) are all used. Soft wood is used if that is all that is available.

Photo 3: Large woody debris (source: Chris Uttley, Stroud District Council)

Earth bunds

Earth bunds (Photos 4 and 5) are constructed using material in situ rather than bringing additional clay to the site. Top soil and turf are removed first, then sub-soil is removed and the bund is reshaped using clays and sub-soil.

Photo 4: Earth bund in Winterbourne Valley on Ebworth Estate, April 2016 (source: Chris Uttley, Stroud District Council)

Photo 5: Earth bund retaining water during storm event, December 2015 (source: Chris Uttley, Stroud District Council)

Track works

Grips and culverts are constructed using traditional track management techniques, enhanced to ensure the water removed from the tracks is diverted into storage areas, with overland flow to increase infiltration soakaway. Culverts are built to include large catch pits at the inlet end and, if possible, large soakways at the discharge end (Photo 6).

Photo 6: Culvert and soakaway, Ebworth Estate, January 2015 (source: Chris Uttley, Stroud District Council)

Gully stuffing

Erosion gullies and ravines are filled with brash and logs to impede erosion and flow, and to increase infiltration (Photo 7).

Photo 7: Gulley stuffing, Ebworth Estate, October 2016 (source: Chris Uttley, Stroud District Council)

How long were measures designed to last?

Measures are designed with varying life expectancy.

Large woody debris has a natural lifespan determined by the rotting periods of wood. Alder, oak and so on are expected to have a life expectancy in-channel of between 5 and 10 years.

Earth bunds will require maintenance and repair if damaged, but their life expectancy is 5–10 years.

Culverts and track works require annual or biannual maintenance.

The project approach to NFM is that it will require a continuous programme of new projects and renewal.

Were there any landowner or legal requirements which needed consideration?

A variety of consenting issues require consideration during construction:

- Land Drainage Act 1991 consent on Ordinary watercourses
- Section 28 consent under Wildlife and Countryside Act for works on Sites of Special Scientific Interest
- Protected species licencing
- Felling consent from Forestry Commission for tree works above the limit allowed
- Derogation for works on land covered by agri-environment agreements

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures	
Year project was undertaken/completed:	2014 to 2020
How was the project funded:	The project officer post has been funded by the RFCC through the Local Levy. Project delivery has been funded through: • RFCC Local Levy • Gloucestershire County Council and Stroud District Council contributions • landowner contributions in kind

Total cash cost of project (£):	Project officer costs: £315,000
Overall cost and cost breakdown for WWNP/NFM measures (£):	Not applicable
WWNP/NFM costs as a % of overall project costs:	Not applicable
Unit breakdown of costs for WWNP/NFM measures:	Not applicable
Cost–benefit ratio (and timescale in years over which it has been estimated):	Not available – many of the benefits, such as community engagement, are not quantifiable; also the WWNP measures do not provide a specified flood risk benefit

7. Wider benefits

What wider benefits has the project achieved?

The most significant benefit to date has been that the project has enabled the local community to become actively engaged in a positive partnership with local councils and the Environment Agency to constructively manage their flood risk while protecting and enhancing their local environment.

All measures are designed to have multiple benefits, for instance:

- large woody debris improved in-stream habitat by cleaning downstream reaches of silt and impeding the progress of silt downstream
- woody debris itself creates habitat for invertebrates, fungi and lower plants
- coppicing of traditional coppice stools allows light to reach riparian areas, increasing plant diversity
- putting up fences to keep stock out of watercourses decreases silt pollution
- measures to reduce soil erosion reduce silt loads reaching watercourses

The project has received an award from the Campaign to Protect Rural England (CPRE) for its contribution to the landscape and amenity value of the catchment.

How much habitat has been created, improved or restored?

It is estimated that approximately 15km of stream habitat has been improved through the various measures introduced.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

- Maintenance activities are planned according to need.
- Track works will be maintained annually or bi-annually by landowners.
- Large woody debris structures will not be maintained. Works may be repeated at a timescale determined by need.
- Earthworks will be maintained as required.

Is the project being monitored?

Although no formal monitoring is taking place, a variety of measurements are being made to inform future monitoring or works.

- Volunteers and students from University of Gloucestershire are involved in a programme to measure and

geo-locate all structures.

- The infiltration levels of some works are being measured.
- Fine scale laser mapping of large woody debris is taking place to detect small-scale changes to structures.

Has adaptive management been needed?

Yes – a series of small earth bunds/check dams was damaged during the storms in winter 2015 to 2016. The bunds have been repaired and, because of increased movement of soils from the structures, now include a silt fence downslope to trap any soil or silts moving as a result of works being disturbed again in subsequent winters. The area is now being fenced off permanently from grazing animals and trees will be planted to reduce flow rates.

9. Lessons learnt

What was learnt and how could it be applied elsewhere?

- Keep it local and community led.
- Keep it local. Build capacity in local contractors and volunteer groups.
- Build small and many, rather than few and large.
- Start as upstream as possible and concentrate on ordinary watercourses.
- Do not wait for perfect data before building. Focus on low risk, certain wins to gain confidence.
- Geology and groundwater interactions are key factors in catchment responses to WwNP measures.
- Understanding the geology will enable partners to maximise the potential benefits of WwNP, install the most effective measures and manage community expectations of the effect and benefits of WwNP.

10. Bibliography

ATKINS, 2013. *Rural SuDS – River Frome Catchment (Stroud Valleys) scoping study.* Final report for the Environment Agency. Epsom: Atkins.

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.