European Commission

Natural Water Retention Measures

NWRM

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Case Study

Rain Garden Nottingham

ACTeon environment research & consultancy

Office International de l'Eau

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Environment

This report was prepared by the NWRM project, led by Office International de l'Eau (OIEau), in consortium with Actéon Environment (France), AMEC Foster Wheeler (United Kingdom), BEF (Baltic States), ENVECO (Sweden), IACO (Cyprus/Greece), IMDEA Water (Spain), REC (Hungary/Central & Eastern Europe), REKK inc. (Hungary), SLU (Sweden) and SRUC (UK) under contract 07.0330/2013/659147/SER/ENV.C1 for the Directorate-General for Environment of the European Commission. The information and views set out in this report represent NWRM project's views on the subject matter and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this report. Neither the Commission nor any person acting on the Commission's behalf may be held Key words: Biophysical impact, runoff, water retention, effectiveness - Please consult the NWRM glossary for more information.

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Table of content

I. Basic Information

Application ID	*United Kingdom_04*			
Application Name	Rain_Garden_Nottingham			
Application Location	Country:	United Kingdom	Country 2:	
	NUTS2 Code		*UKF1-Derbyshire and Nottinghamshire*	
	River Basin District Code		*UK04-Humber*	
	WFD Water Body Code		GB104028052860	
	Description		*The case study is located in a central part of the United Kingdom, in Nottingham city. It is in a heavily urbanised area, at an altitude of approximately 50m AOD.*	
Application Site Coordinates *(in ETRS89 or WGS84 the coordinate system)*	Latitude: 52.992004 - *ETRS89 or WGS84? Specify: WGS84*		Longitude: -1.142012 - *ETRS89 or WGS84? Specify: WGS84*	
Target Sector(s)	Primary:	Urban		
	Secondary:			
Implemented NWRM(s)	Measure #1:	*U9 – Rain Gardens*		
Application short description	A total of 21 linear rain gardens were constructed within the grass verge of Ribblesdale Road, to manage surface water run off within the catchment of Day Brook. Water contained within the gardens soaks away rather than entering the local surface water sewer which flows to the Day Brook. Construction was completed in May 2013.			

II. Policy context and design targets

Brief description of the problem to be tackled	Within the highly urbanised area of Nottingham City, a total of 972 properties fall within the Day Brook floodplain, with previous fluvial events leading to property flooding downstream. Ribblesdale Road is parallel to some of the upper reaches of Day Brook, a heavily modified watercourse that has poor water quality due in part to numerous sources of diffuse pollution from the extensive urban catchment. A pilot study was implemented that reduced the volume of surface water flowing to urban drainage systems from the existing highway setting, reducing the volume of surface water flowing to urban watercourses.		
What were the primary & secondary targets when designing this application?	Primary target #1:	Self-regulation of water by filtration / storage / accumulation by ecosystems	
	Secondary target #1:	Flood control and flood risk mitigation	
	Remarks	*The primary aim was to prove that a retro fitting project can work within an urban environment and that rain gardens can be effective in managing surface water from public highways.*	
Which specific types of pressures	Pressure #1:	WFD identified	*Diffuse - Urban runoff-*

did you aim at mitigating?		pressure	*Storm overflows and discharges in urbanized areas not identified as point sources*
	Pressure #2:	Floods Directive identified pressure	*Natural Exceedence - Flooding of land by waters exceeding the capacity of their carrying channel or the level of adjacent lands.*
Which specific types of adverse impacts did you aim at mitigating?	Impact #1:	Other non EU-Directive (specify)	*Property- Adverse consequences to property and businesses.*
	Impact #2:	WFD identified impact	*Waterbody Status - Adverse consequences to ecological or chemical status of surface water bodies as of concern under the WFD.*
Which EU requirements and EU Directives were aimed at being addressed?	Requirement #1:	Floods Directive-mitigating Flood Risk	*Address risk of flooding to local and downstream properties.*
	Requirement #2:	WFD-mitigation of significant pressure	*Address effects of diffuse pollution from urban catchment*
Which national and/or regional policy challenges and/or requirements aimed to be addressed?	Urban diffuse pollution programme across the region		

III. Site characteristics

Dominant Land Use type(s)	Dominant land use	*111 - Continuous urban fabric*
	Secondary land use	*122-Road and rail networks and associated land*
	Other important land use	
	Remarks	
Climate zone	cool temperate moist	
Soil type	Gleysols/ Luvisols	
Average Slope	very gentle (1-2%)	
Mean Annual Rainfall	600 - 900 mm	
Mean Annual Runoff		
Average Runoff coefficient (or % imperviousness on site)		> 80%
Characterization of water quality status (prior to the implementation of the NWRMs)	There was poor water quality within Day Brook, due in part to numerous sources of diffuse pollution from an extensive urban catchment. This was based on data available from the WFD monitoring programme for the Day Brook.	
Comment on any specific site characteristic that influences the	*Positive way:* The availability of the existing grass verge with occasional mature trees along the entire length of the road, allowed	

effectiveness of the applied NWRM(s) in a positive or negative way	the effective implementation and operation of the rain gardens.
	Negative way: Existing trees and underground services did not allow implementation along the full length of the road.

IV. Design & implementation parameters

Project scale	Small (e.g. farm, plot, building complex, block)	*Tributary catchment scale*	
Time frame	Date of installation/construction (MM.YYYY)	*Completed May 2013*	
	Expected average lifespan (life expectancy) of the application in years	Geotextile materials have an expected lifetime of over 100 years, therefore lifetime will be dependent on the filter performance and maintenance, which will be monitored over the coming years.	
Responsible authority and other stakeholders involved	*Name of responsible authority/ stakeholder*	*Role, responsibilities*	
	1.Environment Agency	Financial; guidance and ongoing evaluation	
	2. Nottingham City Council	Construction; Design and ongoing maintenance	
	3. Groundwork Greater Nottingham	Design; Implementation and community liaison	
	4. Severn Trent Water	Post construction modelling	
	5.		
The application was initiated and financed by	Environment Agency and Nottingham City Council		
What were specific principles that were followed in the design of this application?	The primary principle was to ensure effectiveness in managing downstream water quality and flooding. As part of this, aesthetic benefits were an important consideration, to ensure no loss of the green areas already limited within the urban environment. Part of the purpose of this pilot study was to understand the public perception and acceptability of rain gardens.		
Area (ha)	Number of hectares treated by the NWRM(s).	*0.55ha*	
	Drained from 0.55 ha of highway catchment area.		
Design capacity	A total of 21 linear rain gardens with a total volume capacity estimated to be approximately 15m^3, designed to capture runoff from 0.55 ha of highway.		
Reference to existing engineering standards, guidelines and manuals that have been used during the design phase		*Reference*	*URL*
	1.		
	2.		
	3.		

Main factors and/or constraints that influenced the selection and design of the NWRM(s) in this application?	The available space on the grass verges and budget available were key considerations in the selection of Rain Gardens over other schemes considered such as tree pits or permeable paving. Groundwork undertook a scoping/ feasibility study to consider the options but there is no available documented information. The original plan for this scheme was to collect runoff from a surface area of 7100 m^2, however only 5500m^2 was incorporated into the scheme due to underground services and a number of mature trees clustered in one section of Ribblesdale Road. Proprietary water attenuation cells were key to the initial design as they provide significantly higher void space capacity than clean stone. However, budget contraints meant that use of proprietary cells was reduced and replaced by stone fill in a number of gardens.

V. Biophysical impacts

Impact category (short name) Select from the **drop-down menu** below:	**Impact description** (Text, approx. 200 words)	**Impact quantification** (specifying units)	
		Parameter value; units	% change in parameter value as compared to the state prior to the implementation of the NWRM(s)
Runoff attenuation / control	*Increased water storage will provide additional capacity to retain and efficiently remove run off from highways, and infiltrate to ground. This will reduce the volume of water reaching the local sewer and Day Brook.*		Modelled 33% reduction in flow reaching the sewer for 1 in 1 year event
Peak flow rate reduction	*The storage capacity of the rain gardens will result in reduced peak flows reaching the local sewer, as water will be slowed and contained in the gardens.*		
Impact on groundwater	*Possible increases to infiltration to groundwater from rain gardens providing groundwater recharge and baseflows to the brook.*	*n/a*	
Impact on soil moisture and soil storage capacity		*n/a*	
Restoring hydraulic connection		*n/a*	
Water quality Improvements	*Rain gardens are designed to always intercept and treat the, often more polluted, first flush of highway runoff, ensuring this polluted water does not reach the Day Brook or the local sewer. There is no available data for the quality of water flowing into or within the rain gardens.*		
WFD Ecological		*n/a*	

Status and objectives			
Reducing flood risks (Floods Directive)	*Reducing the volume of water reaching the Day Brook in rainfall events will reduce flood risk to downstream homes and businesses. The reduction in flows reaching the sewer will reduce risk of localised sewer flooding.*		*Designed to manage surface water runoff from a 1:30 year event*
Mitigation of other biophysical impacts in relation to other EU Directives (e.g. Habitats, UWWT, etc.)	*Describe any other biophysical impacts related to pressures and objectives (the biophysical related ones) of other EU Directives, e.g. Habitats Directive, UWWT Directive, etc.*	*None*	
Soil Quality Improvements	*Has the NWRM impacted the overall soil quality? In which way? Please provide some explanatory text. Provide details on specific pollutants (N, P, soil carbon/organic matter, physical properties-bulk density, etc.)*	*No*	
Other		*None*	

VI. Socio-Economic Information

What are the benefits and co-benefits of NWRMs in this application?	The use of rain gardens in a predominantly urban landscape provides a cost effective and adaptable means to reduce flood risk, while providing aesthetic value to highly populated area.		
Financial costs	***Total:***	*€85,000*	This includes the kerbs, the aggregate/attenuation cells, the inlet, the liner, soil and plants for all rain gardens.
	Capital:		
	Land acquisition and value:	*€0*	*Land is owned by council.*
	Operational:		*No operational costs*
	Maintenance:		*Some maintenance will be required* (annual trim of vegetation, occasional mulching and clearing of the inlet) *but no costs provided.* The reduction of grass cutting costs(due to less grass verges) will off-set the cost of the new maintenance regime.
	Other:		
Were financial compensations required? What amount?	*Was financial compensation required: No*		
	Total amount of money paid (in €): N/A		
	Compensation schema: N/A		
	Comments / Remarks:		
Economic costs	*Actual income loss: None*		

	Additional costs: None
	Other opportunity costs: None
	Comments / Remarks:
Which link can be made to the ecosystem services approach?	Flood security and protection.

VII. Monitoring & maintenance requirements

Monitoring requirements	Data logger installed beneath two of the rain gardens, which allows continuous water depth recording. This monitoring has taken place between May 2013 and September 2014.
Maintenance requirements	Maintenance is undertaken by Nottingham City Council. Maintenance of the rain gardens will be limited to an annual trim of the vegetation, with occasional mulching and clearing of the inlets.
What are the administrative costs?	No information available

VIII. Performance metrics and assessment criteria

Which assessment methods and practices are used for assessing the biophysical impacts?	Continuous water level monitoring is allowing a short period of data to be collected post-implementation, and will allow future monitoring of any variation in rain garden performance. InfoWorks CS 2D modelling has been undertaken since implementation, to model the anticipated reduction in the flow reaching the sewer based on the data logger information.
Which methods are used to assess costs, benefits and cost-effectiveness of measures?	A Survey was undertaken of local residents following implementation to understand opinions and acceptance of rain gardens since construction.
How cost-effective are NWRM's compared to "traditional / structural" measures?	In this case, the 'traditional/structural' NWRM options were not considered as this was a specific SuDS retrofit project.
How do (if applicable) specific basin characteristics influence the effectiveness of measures?	There are no specific basin characteristics necessary for this type of measure. It could be widely applicable to urban catchments, but the detailed design would need to consider local factors. This needs to include both the rainfall-runoff characteristics, and the use of appropriate low-maintenance vegetation

	suitable for the local climate.
What is the standard time delay for measuring the effects of the measures?	The primary benefit of the measures, i.e. flood regulation, will have been achieved as soon as the measures were installed (i.e. no time delay). Monitoring at the rain garden will provide some evidence of effectiveness, although the effects are likely to be difficult to distinguish in the downstream watercourse. The hydraulic modeling that is being carried out will assist with this. Any benefits and improvements in water quality within Day Brook, seen as a result of the rain gardens, are likely to take longer to become established and must be considered within the context of the wider catchment.

IX. Main risks, implications, enabling factors and preconditions

What were the main implementation barriers?	The main implementation challenges were : - There was initial difficulty in getting the Council to accept a different and new approach. However once the approach was clearly explained, the council were fully supportive. - There was limited time and budget for design and construction of the scheme. - The implementation/construction of the gardens was more of a challenge than anticipated, due to lack of experience of contractors. The project has provided experience that can help to limit these barriers/challenges in future projects.
What were the main enabling and success factors?	The main factors included : - The partnership approach between all stakeholders was critical to the delivery of the retrofit scheme and was very effective. - The positive attitude of the local residents and their involvement in meetings as the project progressed ensured support. - The land was already owned by the council so there were no land ownership issues.
Financing	Funding for the majority of the works was provided by the Environment Agency (Government funding).
Flexibility & Adaptability	The scheme was implemented to increase the capacity to manage highway runoff, but was not specifically designed to consider climate change. However the new storage supports the existing highway drainage system to make

	it more resilient and effective in accommodating change.
Transferability	The approach seen with the Day Brook Catchment is suited to similar urban catchments and sites with limited space. However it should not be replicated without consideration of local factors.

X. Lessons learned

Key lessons	The purpose of this pilot study was to prove a retrofit design would work within an existing constrained urban area and will be accepted by both residents and experts. The specific design of these rain gardens and the site layout is shown to work, and could be replicated. Key lessons identified are that : - The measure provides proven surface water capture and infiltration, leading to reduced pressure on the local sewer and watercourse. - Active residents/ stakeholder engagement and involvement during design and construction helps ensure that concerns are being considered and that the scheme will be accepted and valued. - When delivered as a collaborative project, multiple benefits can be achieved such as knowledge transfer and local involvement and understanding. - It is important that all involved (from designers to the construction crew on the ground) are clear on what is to be achieved and how, before implementation/ construction begins.

XI. References

Source Type	*Project Report*		
Source Author(s)	*Environment Agency, Nottingham City Council and Groundwork*		
Source Title	Nottingham Green Streets – Retrofit Rain Garden Project		
Year of publication	*2013*		
Editor/Publisher	*Text*		
Source Weblink	*http://www.susdrain.org/case-studies/case_studies/nottingham_green_streets_retrofit_rain_garden_project.html*		
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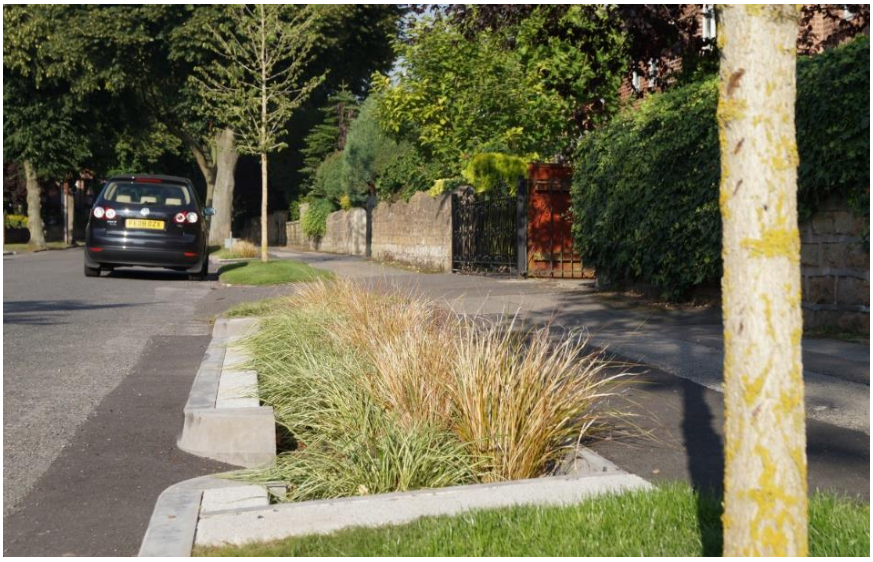
	3.		
	4.		

XII. Photos Gallery



Completed Rain Gardens on Ribblesdale Road. Photo provided by John Brewington, Environment Agency

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