Tracked Programme of Nature-based Solutions

Initial Testing of an Evidence Framework

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Contents

Acronyms & Abbreviations

Acronym	Meaning
A-WINEP	Advanced Water Industry National Environment Programme
CSO	Combined Sewer Overflow
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management
GRADE	Grading of Recommendations, Assessment, Development and Evaluation
iCASP	Yorkshire Integrated Catchment Solutions Programme
INCA	Integrated Natural Capital Assessment
MNbS	Mainstreaming Nature-based Solutions
NFM	Natural Flow Management
NbS	Nature-based Solutions
PR29	Price Review 2029
RPS	Regulatory Position Statement
RSPB	Royal Society for the Protection of Birds
SuDS	Sustainable Drainage Systems
UKWIR	UK Water Industry Research
WFD	Water Framework Directive
WINEP	Water Industry National Environment Programme
WWF	World Wide Fund for Nature

Executive Summary

The Mainstreaming Nature-based Solutions (MNbS) project, funded by the Ofwat Innovation Fund, is working to develop a Tracked Programme of Nature-based Solutions (NbS) to build a greater understanding of the evidence for NbS and support the evolution of evidence-led regulation. As part of this, a comprehensive Evidence Framework has been compiled which allows the evidence for different NbS delivering a range of benefits to be brought together.

This report sets out the activities undertaken by, and the findings of, an Environment Agency funded project to test the initial Evidence Framework and to support its continued development, with the aims of:

- Testing and refining the structure of the Evidence Framework and establishing a process for conducting future phases of evidence review.
- Informing further scoping of the Tracked Programme by helping define the links to regulation and how the programme can move from scoping to implementation.

The review focused on a limited priority set of NbS types and benefits, which were agreed by the project's Review Group, which included regulatory bodies, Defra, and Water UK, as well as MNbS project partners. The approach taken was "learning by doing", to undertake a rapid initial test of the Evidence Framework to demonstrate its applicability in principle and to inform refinement of the framework where necessary.

A call for evidence on the priority NbS types and benefit categories was made; 65 sources of evidence were received with a further 13 relevant sources extracted from these, totalling 78 new sources of evidence that were reviewed. These sources were supplemented by other existing sources, such as previous Environment Agency projects, as listed in this report. In parallel with the call for evidence, work was completed to update an existing Environment Agency evidence proforma, adapting it to make it suitable for determining the benefits provided by NbS as defined through the standard categorisation process developed by MNbS.

The NbS evidence sources for this project were then scored into the Evidence Framework by using the adapted proforma. This report presents the findings of this review work, summarised by NbS type, available evidence and evidence gaps. It should be noted that the review findings are based on the sources received through the call for evidence and the other existing sources identified above. Therefore, identified gaps and conclusions could reflect limitations in the evidence received rather than the absence of additional evidence more broadly.

This report also summarises the findings from workshops ran as part of the project process and makes recommendations for next steps in relation to the priority NbS types assessed, and the Evidence Framework more generally.

1. Introduction

The Mainstreaming Nature-based Solutions (MNbS) project, funded by the Ofwat Innovation Fund, is working to develop a Tracked Programme of Nature-based Solutions (NbS) to build a greater understanding of the evidence for NbS and support the evolution of evidence-led regulation. As part of this, a comprehensive Evidence Framework has been compiled which allows the evidence for different NbS delivering a range of benefits to be brought together. The ambition is that, over time (and beyond the scope of MNbS), this Evidence Framework will be populated to support the scale up of NbS delivery.

The initial structure and proposed content of the Evidence Framework was scoped under the MNbS project. To test the initial Evidence Framework, and to support its continued development and the further scoping of the Tracked Programme, the Environment Agency provided funding for a literature and evidence review under its Research, Development and Evidence Framework. This Environment Agency-funded project includes a first phase of evidence review focused on priority NbS types and benefit categories. The aim of this work was to:

- Test and refine the structure of the Evidence Framework and establish a process for conducting future phases of evidence review.
- Inform further scoping of the Tracked Programme by helping define the links to regulation and how the programme can move from scoping to implementation.

This report sets out the activities undertaken as part of the evidence review and the findings from this process.

2. Evidence collection

Priority NbS and benefits

The review focused on a limited set of NbS types and benefits, using a "learning by doing" approach to undertake a rapid initial test of the Evidence Framework to demonstrate its applicability in principle and to inform refinement of the framework where necessary. The NbS types chosen for this initial testing were selected by the project's Review Group[1]. This is an independent working group established to support the development of the Tracked Programme, with representatives from regulatory bodies, Defra, and Water UK, as well as MNbS project partners. The NbS type selection process included a questionnaire as well as follow up discussions with Review Group members. Prioritisation was based on which NbS applications have the most potential to deliver benefits to society and the environment if evidence and regulatory barriers are removed. NbS types and benefits that are not already being explored by other initiatives were also prioritised.

The priority NbS selected by the Review Group are presented in Table 1 and the selected benefits categories are:

- Low flow management and drought resilience
- Water quality (physical processes)
- Water quality (biological treatment)
- High flow management and flood resilience
- Biodiversity provision
- Carbon sequestration and storage

Table 1 Selected NbS Categories and Interventions

NbS Group	NbS Category	NbS Intervention
Sustainable Drainage Systems (SuDS)	Attenuation, infiltration, and treatment	• Rain gardens • Swales (wet & dry) • Filter strips • Bioretention systems
Natural Flow Management (NFM)[2]	Runoff management	• Vegetative barriers • Buffer strips • Short rotation coppice

[1] Note that the NbS types presented within this report are aligned to the NbS categories and interventions agreed prior to this scope of works rather than the final draft of the MNbS NbS Intervention categories which were issued in February 2026.

[2] NFM is defined as Natural Flow Management, not the more commonly used Natural Flood Management, to align with the definition established through the MNbS categorisation work, which recognises that NFM provides more than flood benefits, and we are focusing here on these other benefits, specifically low flow and water quality.

NbS Group	NbS Category	NbS Intervention
	Runoff storage	• Ponds • Scrapes (temporary ponds) • Bunds and earthen dams • Swales
	Woodland management	• Cross slope woodland • Riparian woodland • Floodplain woodland • Catchment woodland
	Leaky barriers	• Leaky barriers on watercourses • Engineered logjams • Leaky barriers on runoff pathways
	Offline storage	• Offline storage next to watercourses (e.g. ponds, wetlands, washland) • Offline storage adjacent to runoff pathways (e.g. infiltration basins field-edge ponds and scrapes)
	Floodplain reconnection	• Lower, fully or partially remove or set back existing embankments • Palaeochannel reconnection • In-channel features to push flow into floodplain • Floodplain wetland restoration

Call for evidence

In February 2026, this project made a call for evidence from projects in England and Wales (or from geographies with equivalent climates) on the priority NbS types and benefits categories. The call was issued to the Review Group and MNbS partners. Responses were received via email and Microsoft Forms, from the Environment Agency, Natural England, Defra, Ofwat, Dŵr Cymru Welsh Water, Northumbrian Water, Anglian Water, Yorkshire Water, United Utilities, Lincolnshire County Council, University of Exeter, Westcountry Rivers Trust, Ribble Rivers Trust, and the RSPB.

In some cases, responses to the call for evidence directed us towards existing databases e.g., case study directories, rather than providing evidence on specific projects. Where possible, relevant information was extracted from these sources.

Sixty-five sources of evidence were received, and a further 13 relevant sources were extracted from these, totalling 78 new sources which were reviewed following the call for evidence. A screening process was applied to identify those directly relevant to the priority NbS categories, interventions and benefits. This same screening process was used to identify the 13 additional sources. New sources not considered to be directly relevant to the priority NbS categories and benefits were still included within the evidence framework directory.

Identification (ID) numbers were assigned to the sources, as presented in Table 2. A breakdown of the number of source types received is provided in Table 3.

Table 2 New evidence ID numbers and sources

Evidence ID	Reference/Source name	Evidence ID	Reference/Source name
M2.1	Bagheri-Gavkosh *et al.*, 2025	**E5.3c**	Kavehei *et al.*, 2019
M3.1	Puttock *et al.*, 2020	**E5.3d**	Lucke *et al.*, 2014
M4.1	Puttock *et al.*, 2017	**E5.3e**	Shafique *et al.*, 2018
E.1	iCASP Unlocking Policy for Nature Based Solutions, 2026	**E5.3f**	Marcotte *et al.*, 2016
E2.1	River Restoration Centre UK Projects Map, 2026	**E5.3g**	Trowsdale et al., 2011
M6.1	West Country Rivers Trust, 2014	**E5.4**	Susdrain, 2026
E3.1	RESTORE Wiki, 2026	**E5.4a**	Susdrain, 2026
E3.2	Estuary Edges, 2026	**E5.4b**	Susdrain, 2026
E3.3	Estuarine & Coastal Sciences Association, 2026	**E5.4c**	Susdrain, 2026
E3.4	Engineering with Nature, 2026	**E6.1**	Northumbrian Water, 2026
E3.5a	Bond *et al.*, 2022.	**E6.1a**	Northumbrian Water, 2026
E3.5b	Goudarzi *et al.*, 2024	**E7.1**	Aberystwyth University, 2025
E3.5c	Shuttleworth *et al.*, 2019	**E7.2**	Dŵr Cymru/Welsh Water, 2022
E3.5d	Goudarzi *et al.*, 2021	**E7.3**	Dŵr Cymru/Welsh Water, 2023
M7.1	Van Leeuwen *et al.*, 2024	**E7.4**	Dŵr Cymru/Welsh Water, 2023
M7.2	Van Leeuwen *et al.*, 2024	**E8.1**	Environment Agency, 2025
M8.1	Green Finance Institute, 2026	**E8.3**	Natural England, 2014
M9.1	Norfolk Rivers Trust, 2026	**E8.4**	Natural England, 2023
M10.1	UKCEH/United Utilities, 2025	**E8.5**	Natural England, 2021
M10.2	UKCEH/United Utilities, 2024	**E8.6**	Natural England, 2020
M10.3	United Utilities, 2024	**E8.7**	Natural England, 2025
M11.1	Anglian Water, 2025	**E8.8**	Natural England, 2026
M11.2	Anglian Water, 2025	**E8.9**	Natural England, 2026
M13.1	UKWIR, 2024	**E8.10**	Natural England, 2024
M21.1	Osborne and McLelland, 2025	**E8.11**	Natural England, 2025
M22.1	Lincolnshire Chalk Streams, 2026	**E8.12**	Natural England, 2023
M23.1	Potter, 2004	**E9.1**	JBA, 2025
M23.2	Tobias, 1999	**E9.2**	Edenvale Young Associates, 2020
M23.3	The Institute of Asset Management, 2024	**E9.3**	Edenvale Young Associates, 2020
M23.4	Green Finance Institute, 2026	**E9.4**	Edenvale Young Associates, 2017
M23.5	Marches Forward Partnership, 2024	**E9.5**	Harrison, 2015
E4.1	Constructed Wetland Association, 2025	**E9.6**	Ribble Rivers Trust, 2018
E5.1	University of Oxford, 2026	**E9.7**	Ribble Rivers Trust, 2026
E5.1a	Filoso *et al.*, 2015	**E9.8**	Ribble Rivers Trust, 2025
E5.1b	Elosegi *et al.*, 2017	**E9.9**	Sherwood and Mason, 2023
E5.2	RSPB/WWF/Oxford University, 2026	**E9.10**	Ribble Rivers Trust, 2025
E5.3	University of Salford, 2026	**E9.11**	Forest Research, 2026
E5.3a	Bouchard *et al.*, 2013	**E9.12**	Willis, 2002

E5.3b	Taylor *et al.*, 2019	**E9.13**	Nisbet, 2008

Table 3 Source types received

Source type	Number of sources received
Peer-reviewed journal article	20
Review synthesis	2
Report	27
Interactive map/database	6
Guidance	2
Website	14
Citizen science	0
Other	7

In addition to the sources identified through the call for evidence, the following existing sources were included in the review:

- Multiple benefits of nature-based solutions: an evidence synthesis (Environment Agency, 2025a).
- Working with natural processes: Evidence directory update (Environment Agency, 2025b).
- Summary of evidence by Conservation Evidence (Conservation Evidence, 2026).
- SuDS-iQ collaboration and evaluation platform (HR Wallingford, 2026).
- Nature-based Solutions Water Resources Handbook (unpublished) (Environment Agency, 2025c).

The data sources within the multiple benefits of nature-based solutions evidence synthesis matrix (Environment Agency, 2025a) were screened for relevance. Fifty-four sources relevant to the priority NbS and benefits were identified (the EA sources). The EA sources are summarised in Table 4.

Table 4 Relevant Environment Agency evidence ID numbers and sources

Evidence ID	Reference/Source name	Evidence ID	Reference/Source name
EA2	Roberts *et al.*, 2023	**EA93**	Al-Zankana *et al.*, 2021
EA4	Anlanger et al., 2022	**EA99**	Harvey *et al.*, 2018
EA5	Fennell *et* al., 2022	**EA100**	Höckendorff *et al.*, 2017
EA16	Wilkinson *et al.*, 2010	**EA106**	Parker *et al.*, 2017
EA22	Golden *et al.*, 2018	**EA110**	Thompson *et al.*, 2018
EA24	Sprössig *et al.*, 2022	**EA112**	Ahilan *et al.*, 2019
EA34	Batson *et al.*, 2012	**EA119**	Deane *et al.*, 2021
EA36	Evrard *et al.*, 2008	**EA121**	Fahey *et al.*, 2017
EA38	Norbury *et al.*, 2021	**EA122**	Frankl *et al.*, 2021
EA40	Addy *et al.*, 2021	**EA125**	Lo *et al.*, 2022
EA45	Hutchins *et al.*, 2023	**EA127**	Murphy *et al.*, 2020
EA46	Cooper *et al.*, 2021	**EA130**	Richards *et al.*, 2020

Evidence ID	Reference/Source name	Evidence ID	Reference/Source name
EA50	Pennino *et al.*, 2016	**EA131**	Richet *et al.*, 2017
EA54	Sinclair *et al.*, 2022	**EA133**	Thomas *et al.*, 2018
EA56	Black *et al.*, 2021	**EA115a**	Howard *et al.*, 2023
EA57	Trill *et al.*, 2022	**EA118b**	Collins *et al.*, 2023
EA58	Tschikof et al., 2022	**EA11a**	Schulz-Zunkel *et al.*, 2022
EA66	Dietz *et al.*, 2005	**EA128a**	Barber *et al.*, 2012
EA71	Acreman *et al.*, 2003	**EA129a**	Pinto *et al.*, 2019
EA72	Buechel *et al.*, 2022	**EA134a**	Zak *et al.*, 2019
EA73	Allen *et al.*, 2001	**EA13a**	Dixon *et al.*, 2016
EA75	Clilverd *et al.*, 2013	**EA28b**	Robotham *et al.*, 2023
EA77	Green *et al.*, 2006	**EA47c**	Griffith *et al.*, 2020
EA82	Peskett *et al.*, 2023	**EA53b**	Adams *et al.*, 2018
EA85	Nicholson *et al.*, 2020	**EA62a**	Cole *et al.*, 2020
EA89	Thomas *et al.*, 2007	**EA70a**	Lockwood *et al.*, 2022
EA91	Zhang *et al.*, 2010	**EA8a**	Badjana *et al.*, 2023

3. Evidence Framework development

Evidence proforma

One of the key outcomes of the evidence review was to test and refine the Evidence Framework developed by the MNbS project. The framework is based on the matrix presented in the *Multiple benefits of nature-based solutions: an evidence synthesis* report (Environment Agency, 2025a). To populate the matrix, the Environment Agency developed an evidence proforma, "the EA proforma", to collate existing evidence and extract relevant information for drawing conclusions about the effects of NbS on a variety of outcomes, such as runoff generation, nutrient retention and removal, groundwater recharge, and habitat connectivity.

An "updated proforma" was adapted from the EA proforma to improve its suitability for determining the benefits provided by NbS, as defined in the standard categorisation developed by the MNbS project. A summary of the changes is shown in Table 5.

Table 5 Key differences between the EA proforma and the updated proforma

Area	EA proforma	Updated proforma	Reason for change and future recommendations
NbS classification	Multiple NbS groups repeated across columns e.g. river/floodplain restoration, wetlands/ponds/water storage features, soil/rural land management.	Clear hierarchy specific to NbS categories and interventions using drop-down selection options.	To align with the categorisation developed by the MNbS project.
Evidence type	Long list e.g. modelling, monitoring, lab experiment.	Consolidated evidence types and added new types e.g. citizen science, using drop-down selection options. Assigned a quality score to each evidence type.	The EA proforma considered peer reviewed journal articles only, whereas the updated proforma incorporates grey literature and citizen science. Quality scores (A: high, B: medium, C: low) were applied to source types to inform quality/quantity scores in the updated matrix. Due to limited scope, quality was assessed on the type of source rather than its contents. It is assumed peer-reviewed sources are of the highest quality and this approach may therefore under value other source types. We recommend this approach is adjusted based on content and reliability in the future.
Catchment information	Extensive metadata e.g. annual precipitation, temperature, soils, geology.	Streamlined to country, catchment/site name, description, and catchment type classification.	To remove the requirement for extensive catchment information, which is not always available in the new source types. While not possible due to limited scope, we recommend implementing a form of catchment typology into the final evidence framework. This may result in an additional unspecified category for sources which do not contain specific catchment details.

Area	EA proforma	Updated proforma	Reason for change and future recommendations
Outcomes	60+ process- and species-level outcome fields.	Simplified to three: Hydrological Extremes, Water Quality, Biodiversity & Habitat.	To streamline the approach and support the filtering of evidence depending on priority benefits. Efforts were focused on priority MNbS benefits. Outcome fields that sat outside of said benefits were not included due to the limited nature of the scope. We recommend creating a consolidated approach to process and species level outcome fields to aid in data and conclusion processing.
Impact assessment	Primary/Secondary/Tertiary benefits.	Updated to reflect NbS priority benefits categories with impact columns to record outcomes using drop-down options. Incorporated new fields e.g. disbenefits, confidence level.	To align with the priority NbS benefits categories and record impacts in a standardised way. The updated proforma enables the recording of multiple benefits via the primary, secondary and tertiary benefit fields.
Constraints	Absent or implicit.	New explicit field: Indication of constraints (regulatory, delivery, other).	To consider regulatory requirements and other factors influencing delivery of priority NbS when they explicitly highlight constraints in delivery.

Where the EA proforma was designed primarily for peer-reviewed studies, the updates broaden its applicability to a wider range of evidence types, such as grey literature and citizen science. They also streamline the process for assessing new data sources and allow users to easily filter the data due to the incorporation of drop-down selections for interventions and benefits.

Despite these benefits, project specific context is now captured in less detail than in the EA proforma. For example, detailed catchment descriptors such as annual precipitation and temperature are no longer explicitly recorded. This is because highly detailed information is typically only available in peer-reviewed studies and is less readily available in grey literature or citizen science data. Although this information is not explicitly captured in the updated proforma, relevant context can still be added in open fields, such as the catchment/site description.

Overall, the updated proforma is useful for comparability across evidence types, allowing users to draw high level conclusions from the data. It is also less resource intensive to populate than the EA proforma.

Scoring approach

The scoring method developed for this review builds directly on the approach used in the *Multiple benefits of nature-based solutions: an evidence synthesis report* (Environment Agency, 2025a) ("the EA matrix"). The EA matrix provides a clear and intuitive system for summarising evidence from peer reviewed literature using colour coded classifications that reflect both (i) the direction of effects and (ii) the quantity and quality of evidence. This approach has been valuable in shaping the development of the MNbS evidence framework. The scoring system is shown in Figure 1 and the full matrix is included in Appendix C.

Figure 1: EA Scoring

Effects of NbS	
	Mostly positive effects reported
	Mixed effects/contradictory evidence reported
	Mostly negative effects reported
	No effects observed/detected
	No evidence available

Quantity and quality of evidence	
H	2 or more studies with substantial evidence
M	At least 1 study with evidence or multiple studies with some evidence
L	Evidence is limited, inconclusive or only modelled/hypothesised

As part of the evidence review, the EA matrix was adapted to create an "updated matrix" that maps the evidence for priority NbS categories and interventions against priority benefit categories. This enabled identification of trends and evidence gaps in the data following the call for evidence. For this review, the EA scoring method was retained as the foundation for

assessing peer-reviewed journal articles. However, because we sought to broaden the evidence base to include additional source types (e.g., reports, guidance, databases, citizen science), some refinements were required to ensure consistent scoring across a wider evidence set. A description of the updates made is provided under the following subheadings within this section of the report.

The scoring approach relies on a "vote-counting" method, where findings from individual studies are tallied and each source of a similar type contributes equally to the evidence base. This provides a clear and transparent way of summarising the balance of findings across multiple sources, particularly where evidence varies in form and detail. As the Evidence Framework evolves, there is an opportunity to introduce additional layers of nuance for example, approaches that distinguish between shorter pilot studies and longer-term, multi-site research, so that the strength of conclusions reflects both the volume and depth of available evidence. Over time, incorporating effect-size metrics could help provide a more detailed understanding of the magnitude of benefits delivered by NbS and better support future regulatory assessments.

The GRADE framework (Grading of Recommendations, Assessment, Development and Evaluation) (Neumann, 2025) adapted from standard medical sector practice, offers a robust alternative. A cross-sector panel, equipped with a co-developed standardised operating protocol, appraises the reliability of diverse evidence sources — including peer-reviewed literature, grey literature, best-practice guidance, citizen science, and live data — supporting contextualised discussion rather than mechanical tallying. While full-scale systematic reviews with quantitative meta-analysis represent the gold standard, they are time-intensive and risk delivering outputs outside of the timeframes required for regulatory reform. The panel-based approach provides a pragmatic, outcome-focused alternative that can operate within those constraints.

Under the GRADE-based panel approach, evidence is categorised into actionable recommendation tiers. A proposed framework could operate as follows:

- **Strong:** Consensus in evidence is clear - results in updated regulatory guidance or Regulatory Position Statement (RPS) issuance.
- **Moderate:** Consensus exists but with weak quality components, or where evidence is mixed - supports adaptive permitting or regulatory sandbox arrangements with targeted monitoring.
- **Weak:** Identifies NbS-benefit combinations where targeted trials can be designed to generate the data needed to inform a future decision.

Where significant elevated risk is identified, independent academic institutes specialising in a specific NbS or benefit category can be engaged to conduct a full systematic review, providing greater assurance.

Critically, GRADE also identifies where quality components, such as risk of bias, geographic specificity, or data completeness, are limiting certainty of outcomes. These gaps can be directly engineered into targeted monitoring programmes, strengthening the evidence base over time. Consistency of appraisal logic across geographies, benefit categories, and scale, reduces evaluator bias and supports standardised decision-making across the Environment Agency and Defra.

Underpinning all of this, standardised data extraction processes are essential. The updates made to the proforma, matrix and scoring approach in the Evidence Framework intend to support this approach. The long-term ambition is to integrate these with the Natural Capital Metrics Catalogue being developed by the Environment Agency through the INCA project, and to establish a series of 'Living Reviews' – enabling new data to be continuously entered into a centralised extracted-data database, reducing the resource burden of future evidence framework iterations.

Further detail on the updates made to the scoring approach within the Evidence Framework are detailed below.

Quality and quantity of evidence

The EA matrix, designed primarily for assessing peer-reviewed articles, uses qualitative High, Medium and Low ratings to summarise the strength of evidence for each benefit, supported by a list of relevant sources. This provides a clear and accessible way of presenting how many studies contribute to each conclusion, while also indicating the overall confidence in the evidence.

For the MNbS evidence framework review, we adopted the same approach for peer-reviewed material. To enable the inclusion of a broader range of evidence types, the matrix was then expanded with a complementary scoring system that assigns numerical values reflecting both the number and indicative quality of sources supporting or refuting each benefit. Quality is determined by source type to ensure consistency across diverse evidence formats, acknowledging that different forms of evidence contribute in different ways to the overall understanding of NbS performance. When scoring the sources collected through the call for evidence, we sought to ensure consistency and replicability in our scoring approach. The scoring approach is informed by elements of the GRADE approach and the EA matrix scoring approach to evaluate the quality and quantity of evidence collected. Emphasis was placed on systematically weighting the quality of evidence. Weightings were applied by categorising sources by evidence type and assigning them with a letter classification (A, B, or C). To remove subjectivity from the assessment process, it was assumed that source type is directly reflective of quality, as shown in Table 6.

Table 6 Quality scores assigned to source types

Source type	Quality category	Quality score
Peer-reviewed journal article	A	4
Review synthesis	A	4
Report	B	2
Interactive map/database	B	2
Guidance	B	2
Website	B	2
Citizen science	C	1
Other	C	1

Peer-reviewed journal articles and review syntheses were assigned an A. Structured but non-peer-reviewed materials, such as reports, guidance, websites, and interactive databases, were classified as B. Informal or less validated sources, such as citizen science outputs, were categorised as C. These categories were converted into a logarithmic point scoring system (A = 4, B = 2, C = 1), allowing the quantity and quality of evidence for each NbS intervention and benefit to be aggregated in a consistent and replicable way.

The total score generated for each NbS intervention was used to assign an overall High, Medium or Low classification. The thresholds used to assign this classification are presented in Table 7.

Table 7 Quality and quantity classification thresholds

Quality and quantity classification	Thresholds
A	≥6 points e.g. 1 A source and 1 B source.
B	2 to 5 points e.g. 1 B source and 1 C source.
C	≤1 point e.g. 1 C source.

The scoring approach is based on the quantity and quality of studies that support or refute a benefit type, rather than reflecting the magnitude of the effects on an ecosystem service.

Assessment of effects

The GRADE approach also informed our method for evaluating the direction and strength of evidence in showing whether NbS delivered the intended effects. In the updated proforma, the effects were recorded using a drop-down list (positive, negative, neutral, or mixed) for each relevant benefit type. Then, each source was classified into one of six categories: strongly supports (++), weakly supports (+), mixed (+/-), weakly refutes (-), strongly refutes (--), or negligible, as shown in Table 8.

Table 8 Effect categories and assumptions

Effects of NbS	Scoring assumption
Strongly supports (++)	If 80% of sources are “strongly supports” then = “Strongly supports”
Weakly supports (+)	If greater than 1 "weakly supports" or "mixed support" drop "strongly supports" to "weakly supports".
Mixed support (+/-)	If greater than 2 "mixed support" or sources of opposite conclusions drop to mixed
Weakly refutes (-)	If greater than 1 "weakly refutes" or "mixed support" drop "strongly refutes" to "weakly refutes"
Strongly refutes (--)	If 80% of sources are "strongly refutes" then ="Strongly refutes"
Negligible	No effects reported in the evidence

Emphasis was placed ensuring certainty and accounting for sources of bias. Therefore, a small amount of contradictory evidence may still mean an NbS intervention does not ‘strongly support’ a particular benefit. For example, the presence of more than one weakly supportive or mixed source resulted in a reduced score from ‘strongly supports’ to ‘weakly supports’, and the presence of more than two mixed or conflicting findings resulted in classification as ‘mixed support’. Similarly, for refuting evidence, more than one weakly refuting or mixed finding reduced a ‘strongly refutes’ conclusion to ‘weakly refutes’. The significant impact of a single source on the final score reflects the limited amount of evidence available for each NbS application in this initial evidence review.

Ultimately, the updated scoring approach enables a transparent and proportionate evaluation of the effect, quantity, and quality of evidence provided, while enabling replicability and objectivity in the assessment of evidence.

Evidence Framework reflections

The evolution of the Evidence Framework reflects a shift to a policy-aligned framework that enables consistent scoring and strategic decision-making. This streamlining was essential given the scale and diversity of evidence encountered. The new approach, which consolidates dozens of hydrological, ecological, and chemical indicators into broader benefit categories, aims to preserve scientific defensibility while greatly improving usability. Simplifying the proforma improves comparability across evidence submissions and helps to ensure that the framework makes data aggregation more feasible for a variety of source material. The changes represent a maturation of the Evidence Framework from a data inventory into a strategic tool capable of supporting proportionate, robust, and regionally nuanced assessment of NbS.

In updating the framework, we prioritised creating an aggregated score for each NbS intervention that reflects the evidence across all catchment types. However, the next steps in developing the framework should include testing the ‘Catchment Mapper’ typology used in the EA matrix which assigns water bodies in England into nine groups that are broadly

representative of catchments in England (Lovett, 2024). Where new evidence falls outside the mapped area, it could be listed under a new catchment type (e.g. ‘other’ or ‘global’).

4. Review findings

The findings from the review are presented in Figure 2. The matrix brings together the Environment Agency’s original evidence base with the new sources identified through the call for evidence, showing an overall summary of evidence in the framework. Appendix A and B show a breakdown of findings from the original Environment Agency evidence and new evidence respectively.

The review findings are based on the sources received through the call for evidence and the other existing sources identified above. Although 78 sources were submitted not all were relevant to the scope or priority NbS and therefore excluded through an initial screening process described in the Call for Evidence section above. Identified gaps and conclusions could reflect limitations in the evidence received rather than the absence of additional evidence more broadly.

Figure 2: Summary of findings

All sources		SuDS				Natural Flow Management																			
	MNbS Category (Tier 1)	**Attenuation, infiltration, and treatment**				**Runoff management**			**Runoff storage**			**Woodland management**				**Leaky barriers**			**Offline storage**		**Floodplain reconnection**			
	MNbS Intervention (Tier 2)	Rain gardens	Swales (wet & dry)	Filter strips	Bioretention systems	Vegetative barriers	Buffer strips	Short rotation	Ponds	Scrapes (temporary ponds)	Bunds and earthen dams	Swales	Cross slope woodland	Riparian woodla	Floodplain woodlan	Catchment woodland	Leaky barriers on watercourses	Engineered logjams	Leaky barriers on runoff pathways	Offline storage next to watercourses	Offline storage adjacent to runoff pathways	Lower, remove or set back existing	Palaeochannel reconnectio	In-channel features to push flow into	Floodplain wetland restoration
MNbS Benefit Categorisation	High flow management & flood resilience	H EA22, EA50, EA66, M21.1	H EA22, EA50, M21.1, E5.3f, E5.4, E6.1a		H EA22, E5.3h, E5.4, E5.4b	M O6	M E7.1		H EA56, EA53b, EA70a, M2.1, O6, E9.6		H EA36		M O1	M E9.2, O1	H EA89, O1	H EA56, EA72, EA73, EA82, EA121, EA119b, EA8a, M2.1	H M2.1, M7.2, E7.2, E9.1, E9.3, O1	H EA38, EA13a		H EA2, EA57, O1	H EA16, EA85	M EA56	H EA40, EA71	L M22.1	H M2.1, E9.4, O1, M22.1
	Low flow management & drought resilience					M EA131										H EA72, EA73, EA77, EA82, EA91, EA121, EA127, M2.1, E9.12, O6		M EA38		M EA5			M EA40		
	Water quality (physical processes)	H EA22, EA50, EA66, E5.4a	H EA50, E5.3e, E5.3g, E5.4	M E5.4	H E5.3h, E5.4, E5.4b	H EA122, EA133	H EA134a, EA62a, M6.1		H EA28b, EA53b, O6		H EA36, EA128a		M O1	M O1	M O1	H EA45, EA46, EA73, E9.13, O1	H E5.1b, E7.2, O1, E9.8			M O1			M EA58		H E5.1a, O1
	Water quality (biological treatment)																M EA115a								M EA34
	Emerging contaminant retention																								
	Biodiversity provision		M E5.4, E6.1a	M E5.4	M E5.4, E5.4b		M EA62a		M O6				M O1	H EA47c, O1, E9.7	M O1	M O1	H EA4, EA99, EA100, EA106, EA110, EA119, EA125, EA11a, EA123a	M EA93				M EA24		M EA54	M O1, O2
	Carbon sequestration & storage		M E5.3b	M E5.3a	M E5.3d	M E8.5			H E5.3c, E8.5							M E8.5									M E8.5

Effects of NbS	
	Strongly supports (++)
	Weakly supports (+)
	Mixed support (+/-)
	Weakly refutes
	Strongly refutes (--)
	Negligible

Quantity and quality of	EA matrix	Updated matrix: points system
H	2 or more studies with substantial evidence	>6
M	At least 1 study with evidence or multiple studies with some evidence	2-5
L	Evidence is limited, inconclusive or only modelled/hypothesised	1

The matrices helped identify key strengths and weaknesses in the evidence, as detailed below in the findings associated with each priority NbS category and intervention. The findings are broken down as a summary of the Environment Agency evidence, the new evidence, and the remaining evidence gaps for each intervention type.

Sustainable drainage systems

Environment Agency evidence

- The EA's evidence showed a bias towards the high flow management and flood resilience benefits of SuDS. Evidence for this benefit type exists for all priority SuDS interventions (rain gardens, swales (wet & dry), and bioretention systems), except filter strips, and is of medium to high quantity and quality. The evidence is of mixed support for this benefit, though findings consistently indicate that the cumulative effects of SuDS reduce flashy hydrology by lowering peak flows and increasing lag times.
- Evidence relating to water quality benefits (both physical processes and biological treatment) is more limited and restricted to rain gardens and swales. Where available, the evidence quantity and quality is medium to high, although studies show high variability in pollutant attenuation potential.
- Catchment-scale research indicates overall water quality improvements where SuDS are implemented, while focused rain-garden studies suggest limited pollutant removal (e.g., organic nitrogen, total phosphorus).
- No evidence is provided on water quality (biological treatment), biodiversity provision, or carbon sequestration.

In summary, the EA sources show mixed support for the potential for high flow management and flood resilience, but offer a usable evidence base in this area. Whereas there are significant gaps in the Environment Agency's evidence for other priority benefits associated with SuDS interventions including low flow management and drought resilience, and water quality. Additional evidence gaps identified include the efficiency of SuDS to treat emerging pollutants, habitat creation and biodiversity benefits, and long term evaluation of SuDS over different temporal and spatial scales.

New evidence

The call for evidence helped to address several of the gaps identified in the EA source data related to SuDS.

- The evidence base for high flow management and flood resilience was strengthened, with high quality/quantity scores for rain gardens, swales, and bioretention systems. Many of the new sources are peer-reviewed journal articles, confirming with reasonable certainty that these interventions reduce peak flows and runoff volumes. Additional case studies from databases such as the University of Salford Green Infrastructure Evidence Base and Susdrain corroborate these findings.

- New sources also show that SuDS can deliver improvements in water quality alongside flow attenuation with evidence available for all SuDS intervention types. Evidence suggests that macrophyte planting in swales, particularly deep-rooted species, improves soil particle retention and reduces concentrations of trace elements. Embedding a variety of SuDS interventions can also help reduce the flow volumes entering combined sewer overflows (CSOs) with positive effects on water quality.
- Improvements in water quality in turn support biodiversity benefits, with evidence suggesting that biodiversity benefits improve as SuDS mature, with evidence available for all SuDS interventions except rain gardens.
- New evidence also highlights the potential for swales (wet & dry), filter strips and bioretention systems to sequester and store carbon. Wetland swales were found to have a higher carbon density than dry swales.

Remaining evidence gaps

- New evidence strengthened the existing understanding of high flow management and flood resilience, and water quality (physical processes) benefits associated with SuDS. However, there is still a distinct lack of evidence for low flow management and drought resilience, and water quality (biological treatment) benefits, with no new sources providing evidence of these applications.
- Despite new evidence supporting the potential for SuDS interventions to sequester and store carbon, this evidence base remains limited in comparison to high flow management and flood resilience, and water quality (physical processes) benefits. Further evidence is required to understand their full potential in this area.

Natural flow management

Runoff management

Environment Agency evidence

- The EA evidence base for vegetative barriers and buffer strips is relatively limited. Of the three EA sources on vegetative barriers, two primarily assess water quality (physical processes) benefits. These studies share the same findings, indicating that vegetative barriers, such as strips of straw or woodchip, and hedgerows, are effective at intercepting runoff and sediments.
- Hedgerows also contribute to microbial retention and denitrification.
- Despite these benefits, the EA evidence indicates that overall impacts are small at the catchment scale.
- No EA evidence is presented for short rotation coppice or for other priority benefits.

New evidence

- New evidence strengthens the understanding of water quality benefits from buffer strips.

- No new evidence was provided for vegetative barriers or short rotation coppice.
- For vegetative barriers, additional evidence is of mixed support for delivering carbon sequestration and storage benefits but strongly supports the potential for high flow management and flood resilience.
- Several sources suggest that hedgerows attenuate flows by obstructing and slowing water pathways and may increase infiltration due to high-permeability soils beneath them. The impact of this on low flows is uncertain due to a lack of clarify surrounding the relative contributions of infiltration versus evapotranspiration.

Remaining evidence gaps

- The overall evidence base for runoff management interventions remains limited for both vegetative barriers and buffer strips.
- Knowledge gaps persist, requiring increased quantity and quality of evidence across all priority benefits. No evidence is available for the water quality (biological processes) benefit, and only one source is available for low flow management and drought resilience.
- The new evidence has not filled the gap in evidence for short rotation coppice, of which there is currently no evidence for any of the priority benefits.

Runoff storage

Environment Agency evidence

- The EA evidence includes several sources for ponds delivering high flow management and flood resilience, and water quality (physical processes) benefits, but no evidence for other priority benefits.
- Evidence is limited for bunds and earthen dams, with one source strongly supporting high flow management and flood resilience, and two strongly supporting water quality (physical processes) benefits.
- No evidence is available for scrapes or swales.
- Across the EA sources, there is evidence that ponds and bunds and earthen dams interventions have strong potential to attenuate peak flows and reduce sediment loads, although their effectiveness is highly dependent on their configuration within the landscape.

New evidence

- New sources strengthen the existing understanding of runoff storage interventions by reinforcing findings that ponds offer high flow management and water quality benefits, improving confidence in their application for these purposes.
- New sources expand the evidence base by addressing impacts of ponds on biodiversity provision and carbon sequestration benefits which are of weak and strong support respectively.

- Evidence indicates that carbon burial rates in ponds can be 20 to 30 times higher than those estimated for other habitat types including woodland, grassland and natural wetlands. This suggests ponds are potentially valuable interventions for carbon mitigation supported by ease of creation and ability to be integrated within mixed land uses.
- The updated evidence base provides a more comprehensive understanding of the multiple priority benefits delivered by ponds. No new evidence was received for scrapes, bunds and earthen dams, or swales.

Remaining evidence gaps

- Significant gaps remain for other types of runoff storage interventions, notably scrapes and swales, and their ability to provide priority benefits. These features do not appear in either the EA database or in newly identified evidence sources, although it should be noted that swales are more often reported in the context of SuDS.
- Although evidence is available for bunds and earthen dams, this is limited to high flow management and flood resilience and water quality (physical processes) benefits. An increase in the quantity and quality of evidence across all priority benefits is required.

Woodland management

Environment Agency evidence

The evidence base is predominantly focused on catchment woodland interventions. There is strong emphasis on high flow management and flood resilience, but limited evidence for low flow management and drought resilience.

- Woodland interventions were shown to delay peak flows, increase floodplain storage and reduce peak flows. A modelling study of large-scale afforestation found that afforestation consistently decreases median and low stream flows but notes no consistent impact on extreme floods.
- Evidence suggests that to reduce large flood flows, afforestation of more than 75% of the catchment area is required, however this is highly dependent on other variables such as soils and geology, catchment slope, and tree species. The evidence also highlights high model uncertainties associated with these variables.
- Evidence highlights negative impacts on low flow management and drought resilience, such as reduced streamflow and water yield due to increased evapotranspiration and reduced groundwater recharge.
- Limited but noted negative effects on water quality. Evidence indicates that acidification and nitrification can be enhanced under forests, partly due to the dynamic interface between atmospheric pollutants and forest canopies, and due to greater deposition of high acidic leaf litter surrounding, although the evidence base is limited.
- Evidence is narrow in scope, with limited coverage of biodiversity impacts and carbon sequestration and storage.

New evidence

The new evidence reinforces the EA's conclusions whilst providing a broader evidence base covering all woodland intervention types and priority benefits.

- The new evidence extends to include water quality and biodiversity outcomes for all woodland interventions, although the evidence base is still limited in terms of the quantity of sources, often not exceeding one source for each benefit per intervention
- It reinforces EA conclusions on high flow management, confirming that catchment woodland reduces flood peaks and increases peak travel time.
- The new evidence allows comparison across interventions, for example cross-slope woodland works through similar mechanisms but with smaller impacts due to its limited spatial extent relative to catchment woodland.
- The new evidence indicates negative impacts on low flow management, particularly in relation to catchment woodland, such as mature forests increasing evapotranspiration, and reducing water yield, baseflows, and peak flows with implications for abstraction availability.
- The evidence highlights new positive outcomes for water quality and biodiversity provision:
    - Riparian woodland reduces summer stream temperatures, supporting salmonid species.
    - Converting agricultural land to woodland reduces nitrate, phosphate, sediment, and pesticide loads.
    - Cross-slope woodland improves soil structure, infiltration, and hydraulic conductivity.

Remaining evidence gaps

- Evidence gaps remain on the low flow management and drought resilience impacts across intervention types, as well as carbon sequestration and storage benefits.
- Further research is required on the long-term impacts of woodland interventions on low flows and water quality.

Leaky barriers

Environment Agency evidence

- The EA sources provide a strong foundation for understanding how leaky barriers contribute to biodiversity provision. Evidence consistently shows leaky barriers support habitat complexity and ecological functioning.
- Evidence indicates strong support for biodiversity provision, with fish abundance and macroinvertebrate diversity increasing significantly following installation of leaky barriers on watercourses.
- Leaky barriers on watercourses can increase morphological diversity by up to 800% and flow diversity by up to 120%. They often enhance macroinvertebrate density,

biomass, and taxonomic richness and provide important refugia and nursery habitat for brown trout.
- Evidence is more limited for other priority benefits, such as carbon sequestration, water quality, and low-flow management.
- Evidence for engineered logjams indicate similar benefits to leaky barriers on watercourses, leading to reduced storm peak discharge and increased baseflows and increased macroinvertebrate density, biomass and taxonomic richness.

Overall, the EA sources strongly support leaky barriers and weakly support engineered logjams for biodiversity provision benefits, but evidence for wider benefits is lacking. No evidence is available for leaky barriers on runoff pathways based on the sources received in the call for evidence.

New evidence

- New sources expand the evidence base for leaky barriers on watercourses with regards to high flow management and flood resilience. Evidence suggests strong support for this benefit, indicating significant reductions in flood peak magnitude after installation with an average reduction of 10% for events up to a one-year return period.
- The impact of leaky barriers on watercourses is typically reported as site-specific with localised flood risk reductions during smaller events due to increased hydraulic roughness, reduced flow velocities, and increased flood peak travel time.
- Despite significant benefits for high flow management flow attenuation varies significantly depending on event size and shape, highlighting the need for detailed understanding of catchment hydrology, and there is limited evidence for flood events larger than a 1 in 5-year return period flood event.
- Additional evidence reinforces biodiversity provision benefits, with evidence demonstrating that the creation of local velocity reductions and habitat diversification typically leads to positive macroinvertebrate responses. However, the evidence suggests that more monitoring is still needed to improve confidence in this area.

Remaining evidence gaps

- Evidence gaps remain related to the effects of all leaky barrier interventions on carbon sequestration and storage benefits.
- Further evidence is required to strengthen the evidence base for engineered logjams and leaky barriers on runoff pathways, of which there is no evidence for the latter.

Offline storage

EA evidence

- The EA evidence base for offline storage predominantly focuses on high flow management and flood resilience. Evidence is available for both offline storage next to watercourses and offline storage adjacent to runoff pathways interventions. However, the evidence base is limited with only two relevant sources for each intervention type.

- The EA sources indicate that offline storage adjacent to watercourses can support groundwater recharge and reduce high and mean river flows, although effectiveness depends on site-specific variables such as soil type and spatial scale.
- Greater hydrological impact is observed in freely draining soils, and distributed interventions across larger areas deliver greater benefits than localised ones.
- Based on the sources received limited evidence exists on biodiversity, low flow management, water quality, or carbon sequestration benefits for both offline storage interventions.
- Evidence gaps remain around long-term benefits, water quality impacts, and influence of site-specific conditions.

New evidence

- One new source partially addresses EA evidence gaps, but overall evidence for offline storage interventions remains limited.
- New evidence supports EA findings regarding hydrological impacts and the influence of soil type and spatial distribution. Offline storage areas can reduce flow velocities and create temporary storage which attenuates flood flows and can reduce flood risk locally for small events.
- New sources provide some evidence on water quality, suggesting that offline storage can improve water quality by trapping sediments but may also mobilise pollutants during flood events.

Remaining evidence gaps

- Evidence gaps persist around intervention design, site-specific variables, and variation in performance of offline storage interventions across different flood magnitudes.
- Despite benefits for high flow management, further research is required to understand performance across scales and conditions.
- There is a clear lack of evidence for water quality (physical processes) and carbon sequestration and storage benefits.

Floodplain reconnection

Environment Agency evidence

- The EA evidence covers a range or priority benefits categories but is more heavily skewed towards palaeochannel reconnection interventions, of which there is evidence for all benefits categories except biodiversity provision and carbon sequestration and storage.
- There is more scattered evidence available for lowering, removal or set back of existing embankments, in-channel features, and floodplain wetland restoration interventions.
- High flow management has the largest evidence base, but some sources address low flow management, water quality improvements, and biodiversity provision.

- The strongest evidence, based on the sources received, exists for high flow management. Evidence suggests that the removal of embankments can lead to significant changes in morphology that in turn improve hydrological connectivity with the floodplain, which results in more localised flooding, but lowers flood risk downstream.
- Evidence for biodiversity provision is somewhat mixed, with one long term study (10-years) concluding that floodplain reconnection had minimal effects on macroinvertebrate and macrophyte communities, and no effect on the fish community, although there was a notable increase in macroinvertebrate richness.
- There is some evidence to support low flow management, water quality improvements, and biodiversity provision benefits, but this is more limited than that for high flow management.

New evidence

- New sources expand the evidence base to include in-channel features and floodplain wetland restoration, where the EA sources had very little evidence in this area.
- There is evidence for floodplain wetland restoration for most priority benefits, although evidence is mixed for high flow management and water quality (physical processes).
- The new sources emphasise increased opportunities for water storage and peak flow reductions, and early monitoring results also demonstrate re-establishment of natural habitats, improved sediment regimes, and enhanced ecological conditions following floodplain reconnection interventions.
- Performance of interventions is shown to depend heavily on local hydrology, geology, and site configuration, highlighting the variability in performance across catchments/sites.

Remaining evidence gaps

Several evidence gaps remain, particularly around carbon storage potential and downstream water quality impacts. Further targeted research in these areas would help strengthen the evidence base and improve understanding of how floodplain reconnection can most effectively deliver multiple priority benefits. In addition, there is a notable absence of evidence on the role and importance of stakeholder buy-in. Addressing this gap is critical as stakeholder buy-in is likely to be a key enabling factor for implementation.

Evidence gaps

Overall, the evidence review filled several gaps, notably for SuDS, water quality (physical processes), high flow attenuation for several NFM interventions, and some woodland related benefits. However, there are still several remaining evidence gaps. These gaps reflect the limited availability of studies submitted/available that contain the required information across all priority intervention and benefit types.

For SuDS, although the evidence base for high-flow management and flood-resilience is strong, particularly for rain gardens, swales (wet and dry), and bioretention systems, there is

minimal evidence for low-flow management and drought-resilience benefits across all four priority SuDS types. Similarly, there remains no evidence relating to water-quality improvements via biological treatment processes for any of the SuDS interventions. Biodiversity provision and carbon sequestration benefits also remain unevidenced for rain gardens. Evidence on the benefits of filter strips for high-flow and flood-resilience benefits is also lacking. These findings reinforce the imbalance in the SuDS evidence base previously identified by the Environment Agency, where hydrological attenuation effects are well-represented, but biological water-quality processes, baseflow effects and longer-term ecosystem benefits remain largely unexamined.

For NFM interventions, a similar pattern of uneven evidence emerges:

- Runoff management measures display particularly significant gaps. There is no evidence for leaky barriers on runoff pathways across most benefit categories, including high and low flows, water quality (physical and biological), biodiversity provision, and carbon. Engineered logjams also lack evidence for water quality and carbon related benefits.
- For runoff storage interventions, scrapes and swales remain completely unevidenced in the storage context, while bunds and earthen dams lack biodiversity and carbon evidence. Although ponds show strong evidence across several benefit types, this does not extend to the rest of the runoff-storage interventions.
- Woodland management interventions also exhibit persistent gaps. Cross-slope, riparian and floodplain woodland all show no evidence for low-flow benefits, water-quality (biological) improvements or carbon-sequestration outcomes, even though these interventions are relatively well-supported in relation to high-flow attenuation.
- There is no evidence for offline storage measures providing biodiversity or carbon-sequestration outcomes.
- Floodplain reconnection interventions retain extensive gaps as well. Evidence remains low for lower or set-back embankments and in-channel features proving low-flow and water-quality benefits (both physical and biological) and based on the sources received through the call for evidence, there is limited evidence for palaeochannel reconnections providing biodiversity and biological water quality benefits. This absence could be due in part to limited nature of scope rather than the lack of benefit.

Overall, the evidence base remains highly uneven across both intervention categories and benefit types. This reflects not only the limited number of studies available through the call for evidence but also deeper, structural gaps in the existing literature, many of which mirror those previously identified by the Environment Agency.

Some of the gaps identified illustrate a pattern of missing evidence concerns slower, longer-term, and ecologically mediated processes. Low-flow dynamics, biological water-quality mechanisms, biodiversity outcomes and carbon pathways are consistently under-represented across SuDS and NFM, particularly for interventions whose performance

depends on geomorphology, soil development, vegetation succession, and broader catchment context. The evidence base is notably smaller for interventions that are diffuse, multifunctional, or whose benefits accumulate over decadal rather than event-scale timescales

While some evidence gaps are likely due to limited research, others reflect non-alignment between typical monitoring practices and the benefit types assessed. For example, leaky barriers on runoff pathways are not expected to deliver meaningful water-quality or carbon benefits; therefore, the absence of evidence does not necessarily imply a need for further investigation.

The remaining evidence gaps predominantly relate to low-flow processes, biological water-quality mechanisms, biodiversity outcomes and carbon pathways. These gaps also cluster around interventions whose benefits depend on catchment-scale interactions, long-term ecological development, or biogeochemical cycling, areas where short-duration studies or single-site monitoring are insufficient to capture meaningful effects. Targeted, multi-year monitoring and coordinated, catchment-scale trials will be essential to address these gaps.

5. Regulation

Regulatory constraints and enablers

Alongside collating and reviewing evidence on the efficacy of NbS, the Tracked Programme is also supporting the evolution of evidence-led regulation to scale up NbS delivery. To support this aim, we held a workshop with experts from the EA and Ofwat on 3rd February 2026 to explore regulatory constraints and possible enablers to the delivery of NFM in rural areas and SuDS in urban areas, for both water quality and water resources benefits. The aims of this workshop were to:

1. Identify key regulatory barriers to the delivery of NbS.
2. Understand if and how evidence could help overcome these barriers, including what level of evidence is sufficient for regulators.
3. Identify enablers to NbS and measures to manage risk while evidence is developed.

The key takeaways from this workshop were:

- NbS provide a range of benefits and support broader outcomes e.g., catchment resilience, but they work best when deployed as a coordinated mosaic of actions across a catchment, including in tandem with grey / engineered solutions to deliver a hybrid approach.
- There are limited drivers e.g., through the WINEP, for investment in broader outcomes like catchment resilience. Funding is typically for individual projects, focussed on specific assets that address specific issues, and aligning multiple funding pots to address multiple issues at scale is challenging.
- Quantitative evidence for the benefits of catchment-scale NbS remains limited, particularly for downstream benefits, as it is hard to model. The most useful evidence would come from looking at the cumulative effects of interventions at catchment scale, rather than linking specific actions to specific outcomes.
- Learning from NFM for drinking water and NFM for flood risk mitigation might help to overcome evidence limitations.
- Delivery of NbS, like all interventions, requires effective risk management, and will be more effective on some occasions than others. Attributing specific benefits to specific, individual interventions is difficult and unlikely to be entirely accurate. Some level of risk and uncertainty around delivery will always exist with NbS, and those implementing and regulating NbS will need to be comfortable with this. This risk is minimised when delivering at landscape scale and as a mosaic of interventions.
- The Polluter Pays principle is a fundamental challenge for NbS which typically provide benefits that go beyond a single actor's responsibility.
- The benefits of NbS take time to accrue and typically grow as they mature. Standard cost-benefit assessments fail to acknowledge this.

- Earlier engagement with regulators on permitting requirements and planning vs permitting needs, as well as improved guidance, would help improve applications, although permitting requirements are not always known and / or don't always exist.
- Often NbS require regulators to create new frameworks or adapt existing ones to fit, whilst continuing to ensure compliance with legal and regulatory frameworks and requirements.

Further information on the activities and outputs from the workshop are included in Appendix A.

Evidence framework reflections: Regulation

In the initial structure of the Evidence Framework, a tab was included to document regulatory and delivery constraints associated with each NbS intervention. However, the 3rd of February workshop highlighted how regulatory constraints are often specific to the context in which they are being used.

A different regulatory approach (and related evidence threshold) is required depending on whether an NbS intervention is being used to resolve acute or chronic pressures, as demonstrated in Figure 3.

Figure 3: Acute versus chronic pressures in a catchment

For now, the regulatory and delivery constraints tabs have been hidden in the Evidence Framework. This reflects a shift in focus in the Tracked Programme away from addressing regulatory constraints associated with acute pressures, towards developing a new regulatory approach that incentivises the use of NbS for resolving chronic and diffuse pressures in catchments. However, there is still space in the evidence proforma to capture information on specific regulatory and delivery constraints noted in the evidence.

Links to PR29 and regional systems planning

Following the 3rd February regulatory workshop, calls were set up with key stakeholders in the Environment Agency to discuss the opportunities for implementing the Tracked Programme of NbS within PR29 and the regional planning system as proposed by the Independent Water Commission. A meeting was held with the EA's PR29 team on 5th March. A second meeting

was also held on 13th March to discuss regional planning with the EA. The aim of these calls was to:

- Secure wider endorsement of the Tracked Programme within the EA.
- Explore routes to operationalisation within PR29 and the new regional water systems planning context.
- Identify funding and resource options for future Tracked Programme delivery.

The key takeaways from these meetings were:

- We should aim to drive the monitoring programme or regulatory sandbox through the existing PR29 framework.
- The independence of the Tracked Programme should be maintained when it comes to collating and reviewing evidence on NbS efficacy.
- The Advanced WINEP (A-WINEP) provides an opportunity to test and scale NbS to support wider catchment resilience.
- The EA is setting up a task and finish group to support the development of the A-WINEP over the next three to six months. The Tracked Programme should be represented, and we should continue working together to align the two programmes.
- While the A-WINEP is a key delivery route, other PR29 projects will provide useful evidence on NbS efficacy.
- Embedding the Tracked Programme within the emerging regional systems planning context should be explored further with Defra.

Further detail on the discussion in this call is provided in Appendix B.

6. Conclusions and next steps

The evidence review has strengthened the evidence base for our priority NbS and benefits, while highlighting key remaining evidence gaps. It has also helped test and refine the methodology for collating and reviewing evidence and identified opportunities for further development of the Evidence Framework.

The Tracked Programme sought to strengthen the evidence base for low flow management and drought resilience, and water quality priority benefits. While the call for evidence provided additional information on water quality benefits for SuDS, runoff management, runoff storage, and woodland management, there remains a notable lack of evidence for leaky barriers, offline storage, and floodplain reconnection. For these NbS categories, new sources were more heavily focused on high flow management and flood resilience, and biodiversity provision benefits.

Across all NbS categories, a significant evidence gap remains in relation to low flow management and drought resilience. Catchment woodland is the only intervention type for which new evidence was received through the call for evidence, with three sources providing overall mixed findings that reinforce the evidence presented in the EA matrix. No new evidence for water quality (biological treatment) was provided, and while evidence for water quality (physical processes) was strengthened for SuDS and woodland management, it remains limited for the other intervention types.

The review confirmed that evidence for high-flow management and flood resilience is the strongest and most mature across both SuDS and NFM interventions. Similarly, interventions such as ponds, leaky barriers on watercourses, bioretention systems and swales have relatively strong evidence, demonstrating their ability to attenuate peak flows and contribute to catchment-scale flood resilience.

In contrast, the evidence for biodiversity outcomes and carbon sequestration is patchier. There are remaining evidence gaps for SuDS and several NFM interventions, where many have limited or no evidence available of these benefits. However, this is caveated by the limited time and resource constraints associated with the evidence review. The information collected through the call for evidence is not exhaustive of all available evidence on the priority NbS and benefit categories. Therefore, a second round of review is recommended to test and validate the evidence gaps identified.

The redesign of the framework has improved the objectivity, consistency and replicability of the approach to reviewing and assessing evidence. The framework also now enables aggregation of findings across catchment and source types. Next steps should be to close the evidence gaps and focus on testing the applicability of the ‘Catchment Mapper’ typology used in the EA matrix (Lovett, 2024) to a wider range of source types so it can be adopted in the updated framework.

Additionally, the development a regulatory approach that incentivises and use of NbS for resolving chronic pressures and building catchment resilience is recommended. To support

this, next steps for the Tracked Programme should include further engagement with key decision-makers working on the A-WINEP and regional planning system. Specifically, a briefing note should be prepared on the proposed approach to catchment resilience in the regional planning system to support effective engagement with Defra.

Appendix A

Evidence matrix summarising the findings from new sources received through the call for evidence for priority NbS and benefit types:

MNbS Call for Evidence New Sources		SuDS				Natural Flow Management																				
	MNbS Category (Tier 1)	**Attenuation, infiltration, and treatment**				**Runoff management**			**Runoff storage**				**Woodland management**				**Leaky barriers**			**Offline storage**		**Floodplain reconnection**			
	MNbS Intervention (Tier 2)	Rain gardens	Swales (wet & dry)	Filter strips	Bioretention systems	Vegetative barriers	Buffer strips	Short rotation coppice	Ponds	Scrapes (temporary ponds)	Bunds and earthen dams	Swales	Cross slope woodland	Riparian woodland	Floodplain woodland	Catchment woodland	Leaky barriers on watercourses	Engineered logjams	Leaky barriers on runoff pathways	Offline storage next to watercourses	Offline storage adjacent to runoff	Lower, remove or set back existing embankments	Palaeochannel reconnection	In-channel features to push flow into	Floodplain wetland restoration
MNbS Benefit Categorisation	High flow management & flood resilience	H M21.1, E5.4a, E5.4c	H M21.1, E5.3e, E5.4, E6.1a		H E5.3g, E5.4, E5.4b	M O6	M E7.1		H M2.1, O6, E9.6				M O1	M E9.2, O1	M O1	H M2.1, E9.3, E9.4, O1	H M2.1, M7.2, E7.2, E9.1, E9.9, O1			M O1				L M22.1	H M2.1, E9.4, O1, M22.1
	Low flow management & drought resilience															H M2.1, E9.12, O6										
	Water quality (physical processes)	M E5.4a, E5.4c	H E5.3d, E5.3f, E5.4	M E5.4	H E5.3g, E5.4, E5.4b		M M6.1		M O6				M O1	M O1	M O1	M E9.13, O1	H E5.1b, E7.2, O1, E9.8			M O1					H E5.1a, O1
	Water quality (biological treatment)																								
	Emerging contaminant retention																								
	Biodiversity provision		M E5.4, E6.1a	M E5.4	M E5.4, E5.4b				M O6				M O1	M O1, E9.7	M O1	M O1	H E9.3, O1, O2								M O1, O2
	Carbon sequestration & storage		M E5.3a	M E5.3a	M E5.3c	M E8.5			H E5.3b, E8.5							M E8.5									M E8.5

Effects of NbS	
	Strongly supports (++)
	Weakly supports (+)
	Mixed support (+/-)
	Weakly refutes
	Strongly refutes (--)
	Negligible

Quantity and quality of	EA matrix	Updated matrix
H	2 or more studies with substantial evidence	>6
M	At least 1 study with evidence or multiple studies with some evidence	2-5
L	Evidence is limited, inconclusive or only modelled/hypothesised	1

Appendix B

Updated evidence matrix summarising the findings from the EA sources where these relate to priority NbS and benefit types:

Environment Agency sources		SuDS				Natural Flow Management																					
	MNbS Category (Tier 1)	Attenuation, infiltration, and treatment				Runoff management			Runoff storage				Woodland management				Leaky barriers			Offline storage		Floodplain reconnection			
	MNbS Intervention (Tier 2)	Rain gardens	Swales (wet & dry)	Filter strips	Bioretention systems	Vegetative barriers	Buffer strips	Short rotation coppice	Ponds	Scrapes (temporary ponds)	Bunds and earthen dams	Swales	Cross slope woodland	Riparian woodland	Floodplain woodland	Catchment woodland	Leaky barriers on watercourses	Engineered logjams	Leaky barriers on runoff	Offline storage next to watercourses	Offline storage adjacent to runoff pathways	Lower, remove or set back existing	Palaeochannel reconnection	In-channel features to push flow	Floodplain wetland restoration
MNbS Benefit Categorisation	High flow management & flood resilience	H EA22, EA50, EA66	H EA22, EA50		M EA22				H EA56, EA53b, EA70a		M EA36				M EA89	H EA56, EA72, EA73, EA82, EA121, EA118b, EA83		H EA38, EA13a		H EA2, EA57	H EA16, EA85	M EA56	H EA40, EA71		
	Low flow management & drought resilience					M EA131										H EA72, EA73, EA77, EA82, EA91, EA121, EA127		M EA38		M EA5			M EA40		
	Water quality (physical processes)	H EA22, EA50, EA66	M EA50			H EA122, EA133	H EA134a, EA62a		H EA28b, EA53b		H EA36, EA128a					H EA45, EA46, EA73							M EA58		
	Water quality (biological treatment)																M EA115a								M EA34
	Emerging contaminant retention																								
	Biodiversity provision						M EA62a							M EA47c			H EA4, EA33, EA100, EA106, EA110, EA113, EA125, EA11a	M EA93				M EA24		M EA54	
	Carbon sequestration & storage																								

Effects of NbS	
	Strongly supports (++)
	Weakly supports (+)
	Mixed support (+/-)
	Weakly refutes
	Strongly refutes (--)
	Negligible

Quantity and quality of	EA matrix	Updated matrix
H	2 or more studies with substantial evidence	>6
M	At least 1 study with evidence or multiple studies with some evidence	2-5
L	Evidence is limited, inconclusive or only modelled/hypothesised	1

Appendix C

Original matrix from the EA *Multiple benefits of nature-based solutions: an evidence synthesis* report (Environment Agency, 2025a):

Catchment Type	Beaver re-introduction	Afforestation	Constructed wetlands	Temporary water storage features	Riparian restoration	Buffer strips/zones	Hedgerows and vegetative barriers	Instream wood	Peatland restoration	Instream substrate addition	Channel restoration	Floodplain reconnection	Permeable pavement	Green roofs	Bioretention systems/rain gardens	Sustainable soil management	Assisted natural regeneration
Type 1: Western Upland Landscapes																	
Low flow management		L 127										M 40					
Flood management	L 84a	M 127										M 40					L 116a
Nutrient and sediment management												L 40					
Physico-chemical & biological water quality																	
Biodiversity & Habitat	M 55											L 40					
Type 2: Northern Upland Landscapes																	
Low flow management		H 74, 121		M 5				M 30	H 87, 88a, 90, 113								
Flood management		M 74, 121		M 5				M 30	H 87, 88a, 88b, 90, 112, 120								L 116b
Nutrient and sediment management	M 111				M 86			M 119	H 87, 112, 120								
Physico-chemical & biological water quality								M 119									
Biodiversity & Habitat	M 111							M 119, 120	M 87, 112								
Type 3: Western Livestock Agriculture																	
Low flow management									L 135								M 10a, 10b
Flood management	H 10a, 14			M 70a					M 135								M 10a, 10b
Nutrient and sediment management	M 14				M 32				L 135								
Physico-chemical & biological water quality					M 32												
Biodiversity & Habitat																	
Type 4: Grassland-based Agriculture																	
Low flow management		L 81					L 42									L 81	
Flood management	H 10b, 10c	H 81, 82, 89		M 52c, 70b		L 53b	M 42									M 81, 87a	
Nutrient and sediment management	M 3			L 52c		L 53b	M 42	M 115c								L 52a	
Physico-chemical & biological water quality								M 115a									
Biodiversity & Habitat	H 3, 49										M 98						
Type 5: Patchwork Middle England																	
Low flow management																	
Flood management																M 31b	
Nutrient and sediment management	M 55		M 14		M 34						L 92					M 31b	
Physico-chemical & biological water quality	L 15		M 14								L 105						
Biodiversity & Habitat					M 97a					M 97b, 97c, 101a, 101b	H 92, 105, 126	M 100					
Type 6: Urban-dominated Areas																	
Low flow management		L 44											L 46a, 69				
Flood management		M 15, 44		L 46d, 112	L 43								H 46a, 69	H 46b, 49	H 46a, 66		
Nutrient and sediment management		M 45	M 78a	H 46d, 65, 112	L 43						H 78b, 96		H 46a, 69	H 46b, 49, 67	H 46a, 52, 66		
Physico-chemical & biological water quality			M 63a, 63b, 78a	H 46d, 65							M 78b		H 46a, 69	H 46b, 49, 67	H 46a, 82		
Biodiversity & Habitat					L 43			M 124a			M 78b, 96						
Type 7: Mixed Agricultural Areas																	
Low flow management	M 132	L 110b															
Flood management	M 132	L 110b		H 16, 57, 85								L 71				M 31a, 31c, 110a	
Nutrient and sediment management	M 132		H 27, 28a, 35, 37a, 66, 123b	M 16, 23b, 123a		H 124a, 124b	M 133	M 119a								M 31a, 31c	
Physico-chemical & biological water quality	M 132			L 23b				M 115a									
Biodiversity & Habitat			L 27		H 11b, 23, 24	M 124d, 124e		H 4, 11a, 83, 121b			M 103	M 54					
Type 8: Arable on Lighter Soils																	
Low flow management		M 77, 91					L 123, 131					L 75				L 114	
Flood management	H 104, 114b	M 126, 131a					M 123, 131	L 131a				L 75				H 37a, 37b, 37c, 114	
Nutrient and sediment management			H 7a, 7b, 35			M 124c	M 122, 123, 131				M 94	L 75				H 37a, 37b, 37c	
Physico-chemical & biological water quality											M 94						
Biodiversity & Habitat			L 99			L 124c		H 99, 106, 119		H 106, 108	H 94, 102, 107, 117	L 75					
Type 9: Cereals on Heavier Soils																	
Low flow management																M 83	
Flood management		L 84		M 26												M 83	
Nutrient and sediment management			H 25, 26, 29a, 29b, 29c, 29d, 29e, 29f, 29g	M 26				M 115b									
Physico-chemical & biological water quality								M 115b									
Biodiversity & Habitat										M 109	M 52, 59	L 126					

Effects of NbS	
	Mostly positive effects reported
	Mixed effects/contradictory evidence reported
	Mostly negative effects reported
	No effects observed/detected
	No evidence available

Quantity and quality of evidence	
H	2 or more studies with substantial evidence
M	At least 1 study with evidence or multiple studies with some evidence
L	Evidence is limited, inconclusive or only modelled/hypothesised

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