WATER RESOURCES EAST

Webinar:
NbS opportunity mapping

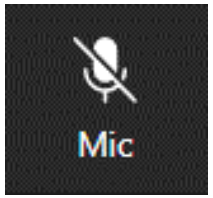
Chair: Hannah Gray

Thursday 14th May 2026

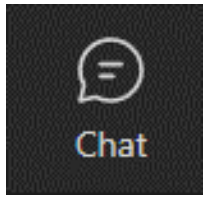
Agenda

Time	Details	Speaker
11:00	Welcome and introduction	Hannah Gray (WRE)
11:10	How the NbS opportunity maps were developed	Ben Howlett (JBA)
11:25	How to use and view the NbS opportunity maps	Katerina Laing (WRE)
11:35	Case study - using the NbS opportunity maps to engage landowners and find potential projects in the Tas, Tiffey and Tud catchments	Henry Walker (Norfolk FWAG)
11:45	Q&A	Hannah Gray (WRE)

Housekeeping



Microphones and cameras have been set to ‘off’ to improve bandwidth



Please use **Teams Chat** function for technical issues/general comments only

Use **Teams Q&A** function for all questions

The session is being **recorded**. Slides and the recording will be published on WRE’s website after the meeting

WRE
WATER RESOURCES EAST

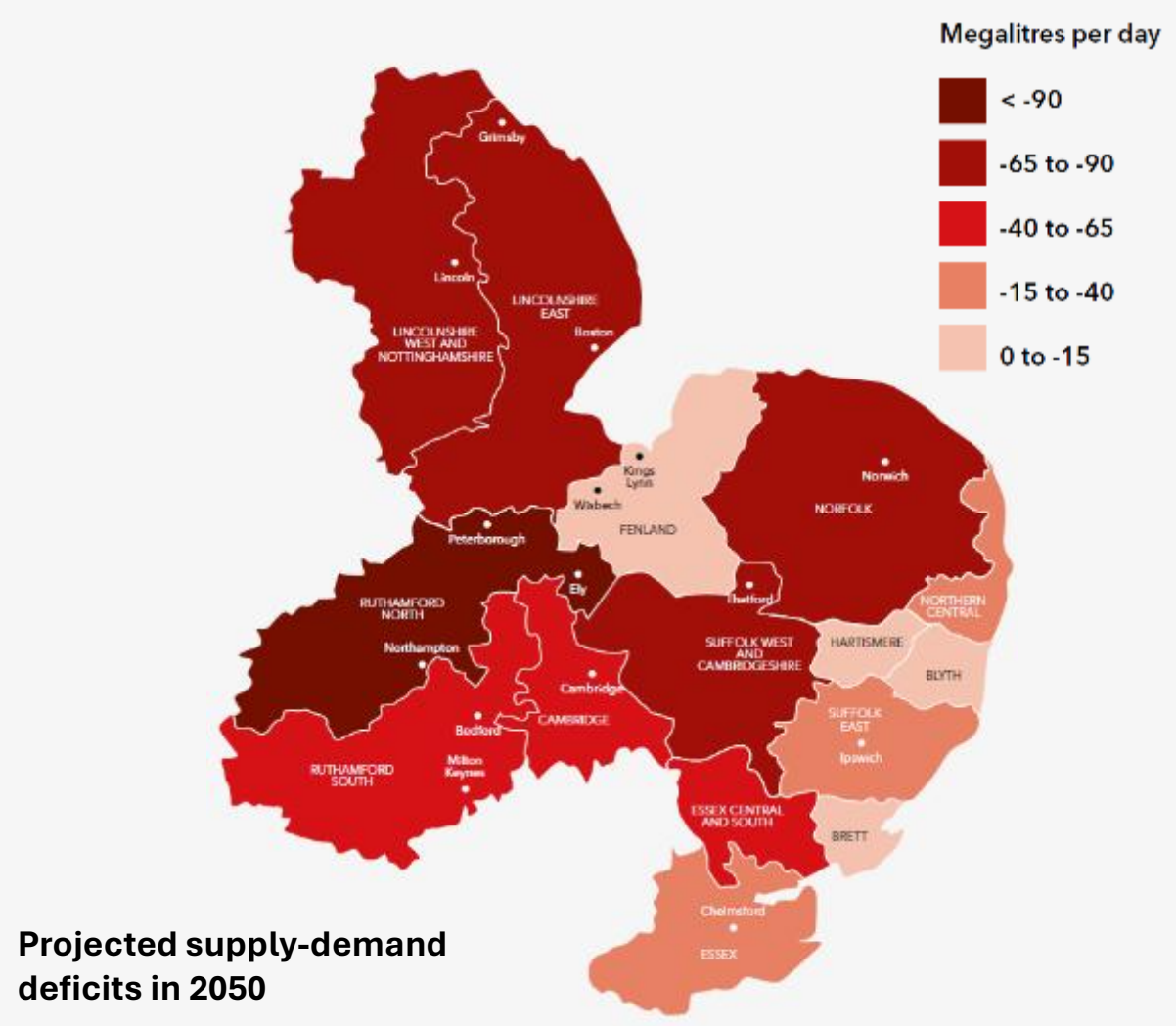
Introduction to WRE and NbS opportunity maps

Hannah Gray (WRE)

Introduction to WRE

- Independent, not-for-profit membership organisation
- One of five regional water resources planning groups
- Key sector interests form our board and fund our core costs

Economic prosperity and the health of the water environment at risk



Projected supply-demand deficits in 2050

- 800 million litres of water per day (Ml/d) shortfall projected for 2050
- Constraints already emerging for agriculture, housing and economic growth
- Regional Plan identifies the 'best value' approach to meeting the projected deficits in the public water supply in ways that maximise co-benefits for other sectors
- Aims to deliver sufficient water to meet:
  - Growth projections within local authority development plans
  - Increased drought resilience by 2040
  - Highest environmental ambition

How to meet the need sustainably

- New public water supply reservoirs
- Desalination plants
- Advanced Water Recycling
- Water transfer schemes
- Demand management
- Leakage reduction
- Winter storage reservoirs for agricultural use
- Local resource options
- **Nature-based solutions**

Regional Water Resources Plan - Water Resources East
December 2023

Working since 2021 to scale up NbS for Norfolk's water resilience

NORFOLK WATER STRATEGY PROGRAMME

Ensure that **water is not a barrier to economic growth**

Deliver **wider benefits** in terms of **flooding** and **water quality**

Provide **opportunities for water-related businesses**

Provide **academically rigorous evidence to policy makers**

Deliver **water related climate change mitigation** and **adaptation strategies**

Identify **opportunities** & **mechanisms** to **restore** and **enhance the environment**

Increase resilience of water resources management for all

WRE WATER RESOURCES EAST

love every drop anglianwater

The Nature Conservancy

Norfolk County Council

What are Nature-based Solutions?

NORFOLK WATER STRATEGY PROGRAMME

Nature-based Solutions (NbS) are actions that protect, sustainably manage and restore natural or modified ecosystems to address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits. (IUCN, 2016)

Why do we need NbS opportunity maps?

Attenuation and infiltration features

Riparian restoration

Soil management practices

Arable conversion to grassland

WRE
WATER RESOURCES EAST

Developing the NbS opportunity maps

Ben Howlett (JBA Consulting)

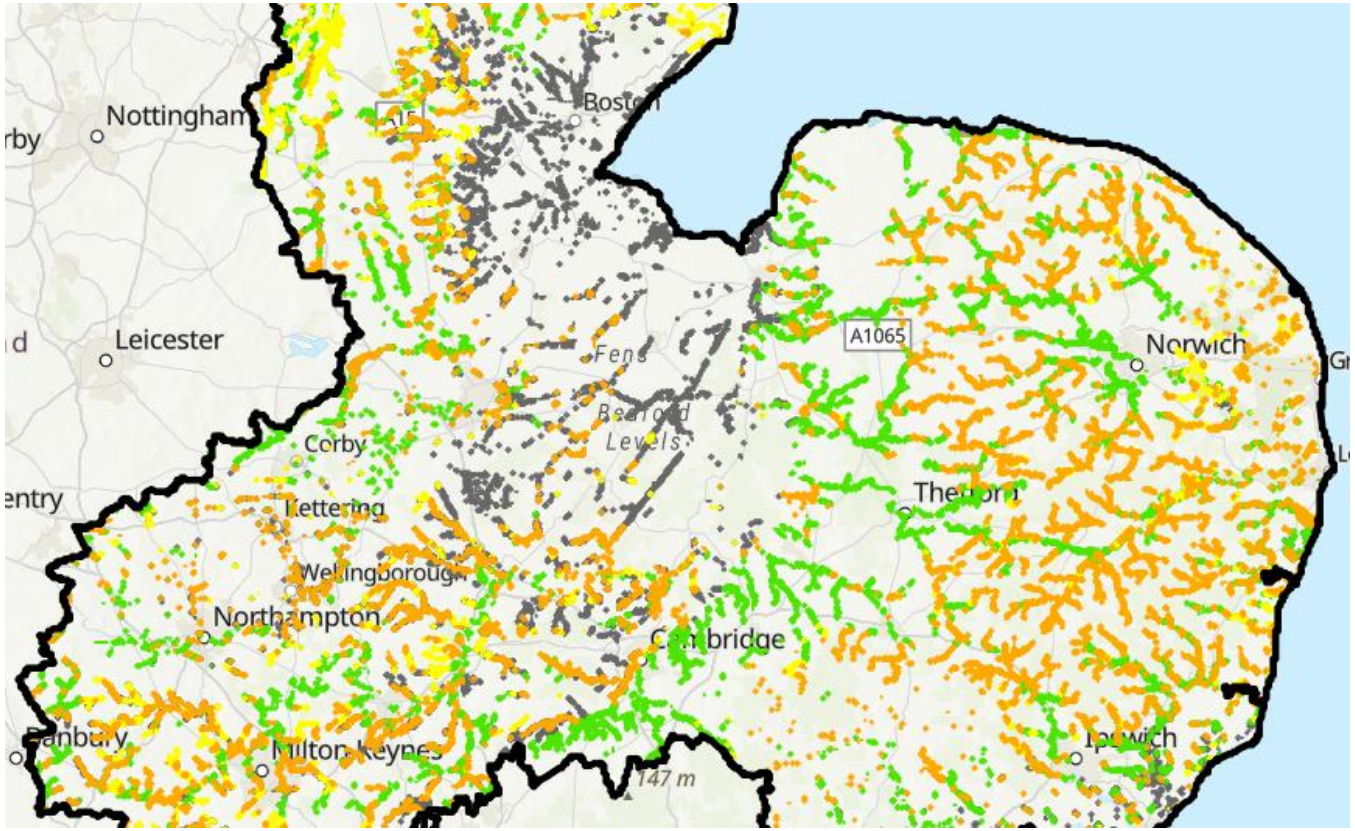
NbS opportunity mapping – technical background

- Technical work led by the groundwater team at JBA Consulting
- Original methodologies developed alongside the Environment Agency
- Partnerships with Groundwater Science and WSP to develop new groundwater modelling approaches

JBA Consulting (2026)

NbS opportunity mapping

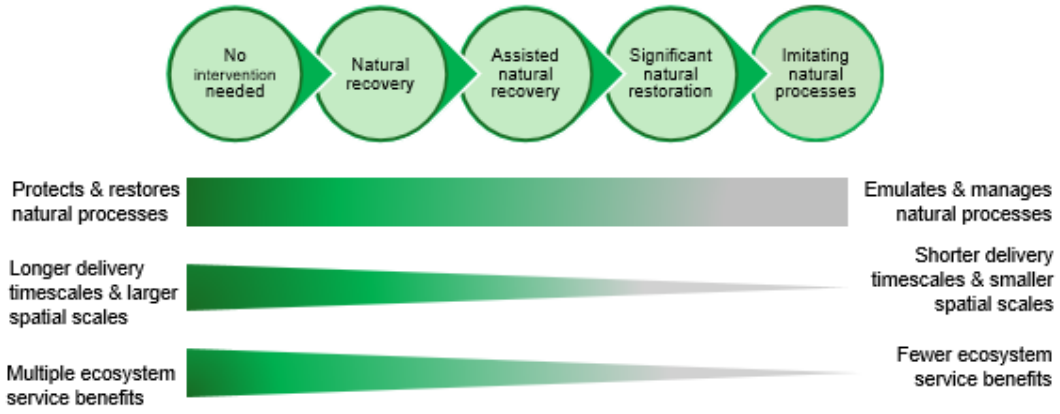
- JBA has produced NbS opportunity maps for the entirety of WRE's region
- Accessible via an interactive online map portal: https://experience.arcgis.com/experience/a9692c38e88049e296cc0028b057be87/page/Page?views=Map-Layers
- Seven NbS opportunity layers are available, with an assessment of their ability to increase recharge to groundwater

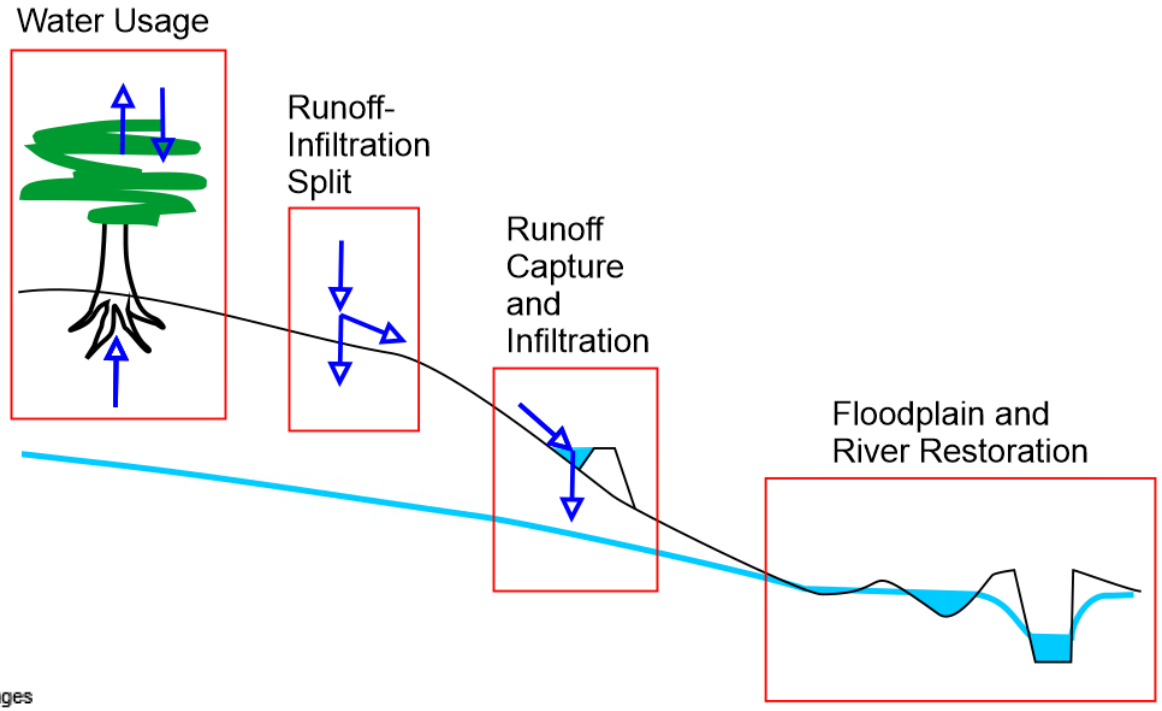


JBA Consulting (2026)

Principles behind NbS for water resources

- Core objectives include:
  - Augmenting stores of groundwater in aquifers
  - Enhancing low flows in rivers
  - Improving resilience to drought in the land and water environments

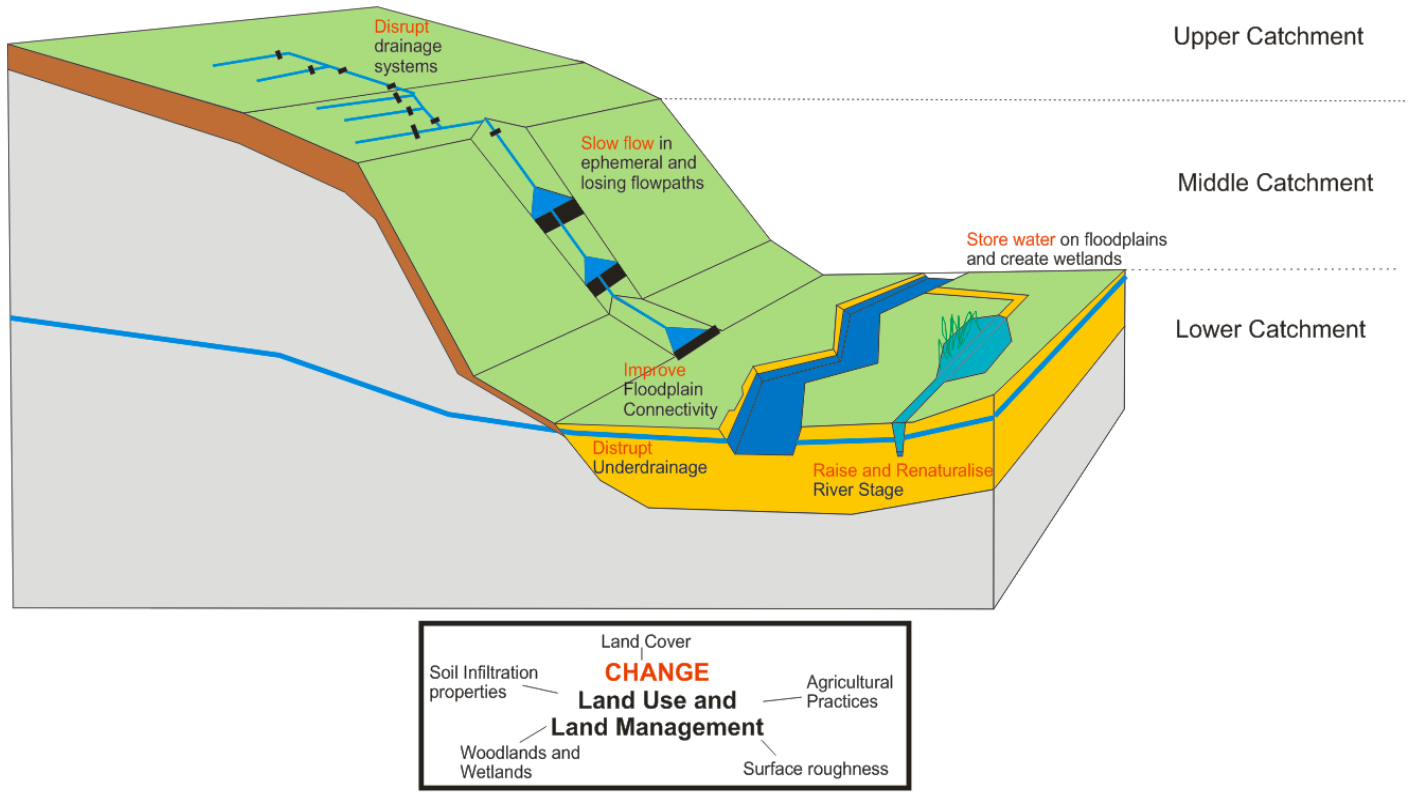




JBA Consulting (2026)

NbS for water resources toolkit of measures

- A range of different NbS interventions can be used to support water resources objectives
- Different styles of NbS are suited to different parts of the catchment
- Geology and hydrology control the efficacy and suitability of different types of NbS
- Important to consider implementation across the landscape as a whole



JBA Consulting (2026)

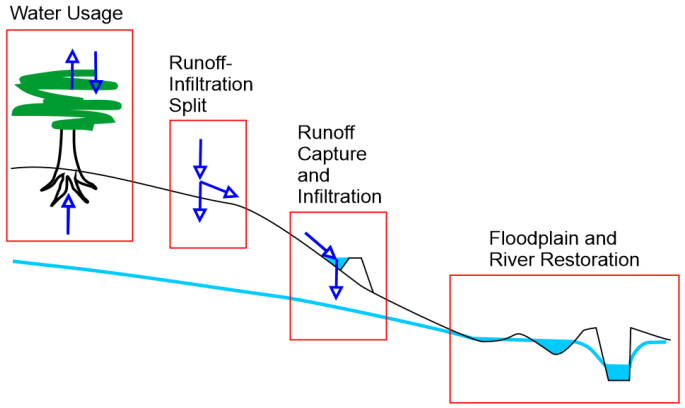
Wider NbS co-benefits

- NbS has a much wider range of benefits to society and the environment, as well as some risks
- Important to maximise the positive outcomes of NbS, not only in terms of water resources
- Management of potential risks is also key – some NbS measures could even be detrimental to water resources objectives

JBA Consulting (2026)

NbS opportunity mapping layers

- Slowly permeable soils measures
- Arable and grassland land cover management
- Runoff attenuation features (RAFs)
- Mid-upper catchment storage measures
- Mid-upper catchment riparian zone measures
- Lower catchment floodplain reconnection measures
- Lower catchment floodplain zone measures

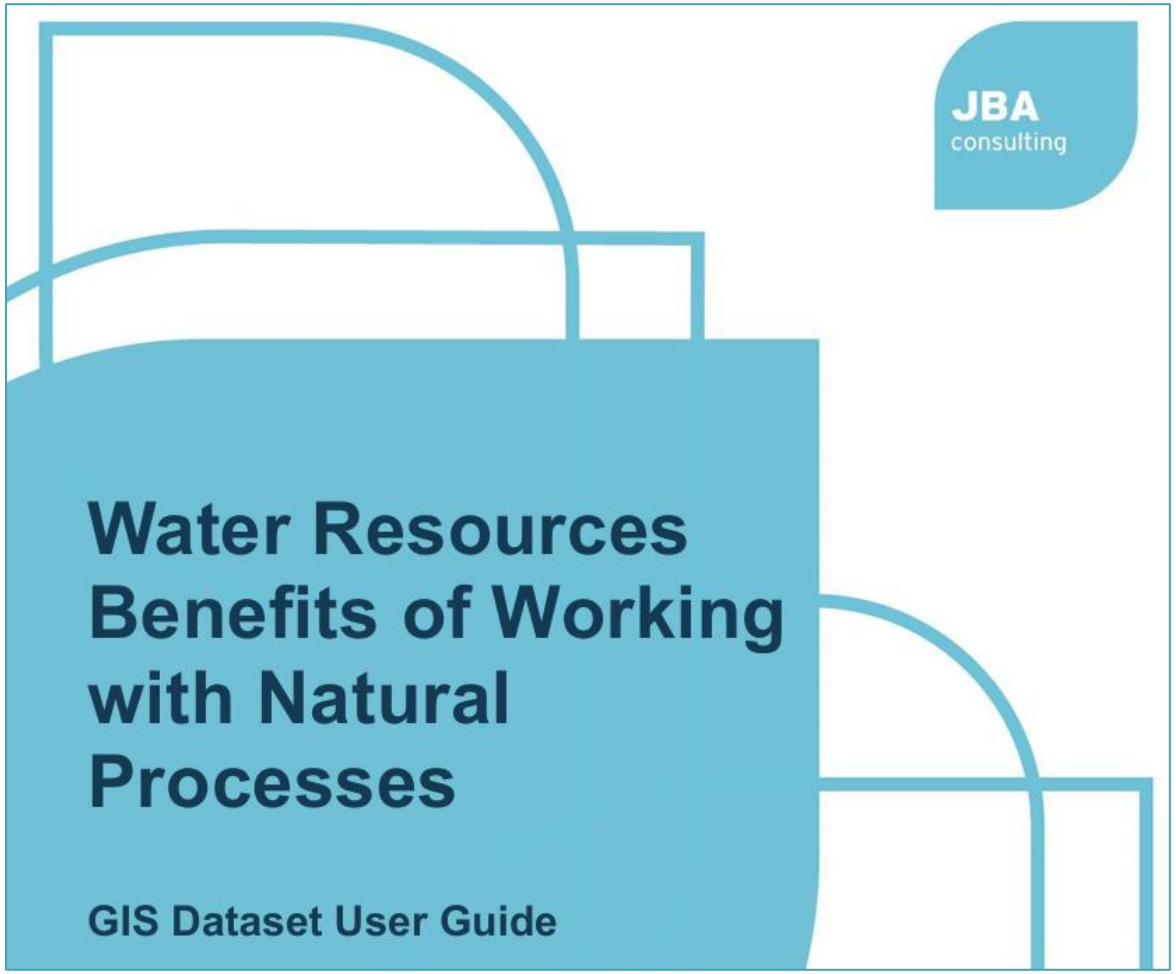


JBA Consulting (2026)

Guidance documentation

- User guide accompanying the GIS layers is available via WRE's website

- This explains the styles of NbS associated with each opportunity layer in further detail and how these maps can be interpreted



JBA Consulting (2026)

WWNP evidence directory

- GIS outputs from the Working with Natural Processes evidence directory used as the basis of the NbS opportunity mapping
- Removal of areas within the Environment Agency's Source Protection Zone 1
- Removal of areas near historic or active landfill sites
- Removal/inclusion of Flood Zones 2 and 3 where applicable

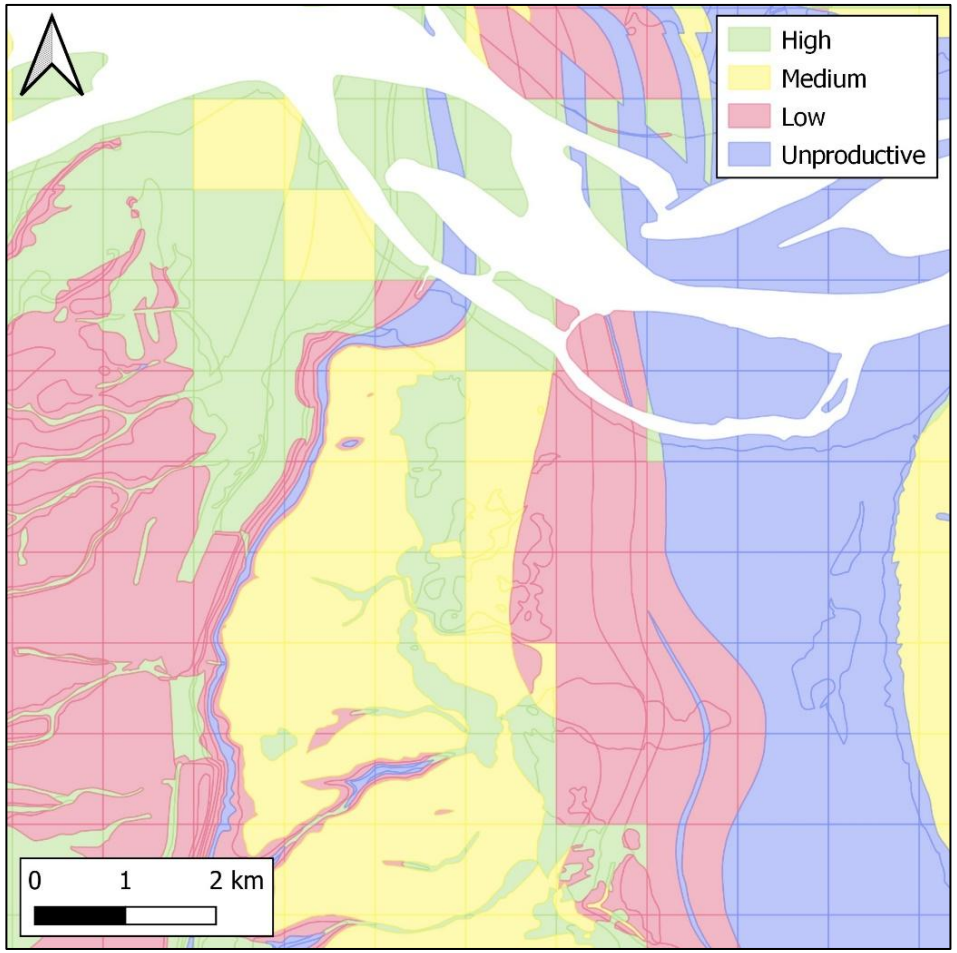
Working with Natural Processes – Evidence Directory

JBA Consulting (2026)

Recharge potential estimation

- Attribution of NbS opportunity locations with semi-quantitative estimates of potential to increase recharge to groundwater and thus offer benefits to water resources

- Allows targeting of measures to deliver maximal benefits and avoid areas which lack an aquifer that could be recharged by NbS



JBA Consulting (2026)

Input datasets

- Baseflow index (BFI) grid from the UK Centre for Ecology and Hydrology
- Aquifer designation map from the British Geological Survey
- Groundwater vulnerability map from the Environment Agency (contains data from the British Geological Survey)

UK Centre for Ecology & Hydrology

British Geological Survey

Environment Agency

JBA Consulting (2026)

Recharge potential scoring system

- Series of attributes scored using the input datasets, separately for bedrock and superficial aquifers
- Significance of different factors assessed by expert judgement
- A weighted score is calculated for every location, aggregating the individual attribute scores
- Scores are categorised as being indicative of one of 'high', 'medium', 'low' or 'unproductive' recharge potential

Attribute
BFI
Drift patchiness/cover
Drift thickness
Superficial infiltration potential/permeability
Bedrock flow
Aquifer designation

Recharge class	Superficial weighted score sum	Bedrock weighted score sum
High	<7	<6
Medium	7-10	6-12
Low	>10	>12
Unproductive or absent	Any instance of 100 (e.g. designated as unproductive or absent depending on superficial cover)	Any instance of 100 (e.g. designated as unproductive)

JBA Consulting (2026)

Production of NbS mapping

- Automation of map production using a series of Python scripts
- Use of the GeoPandas package in Python to carry out the necessary geospatial processing
- Quality checking and review of the outputs undertaken using GIS

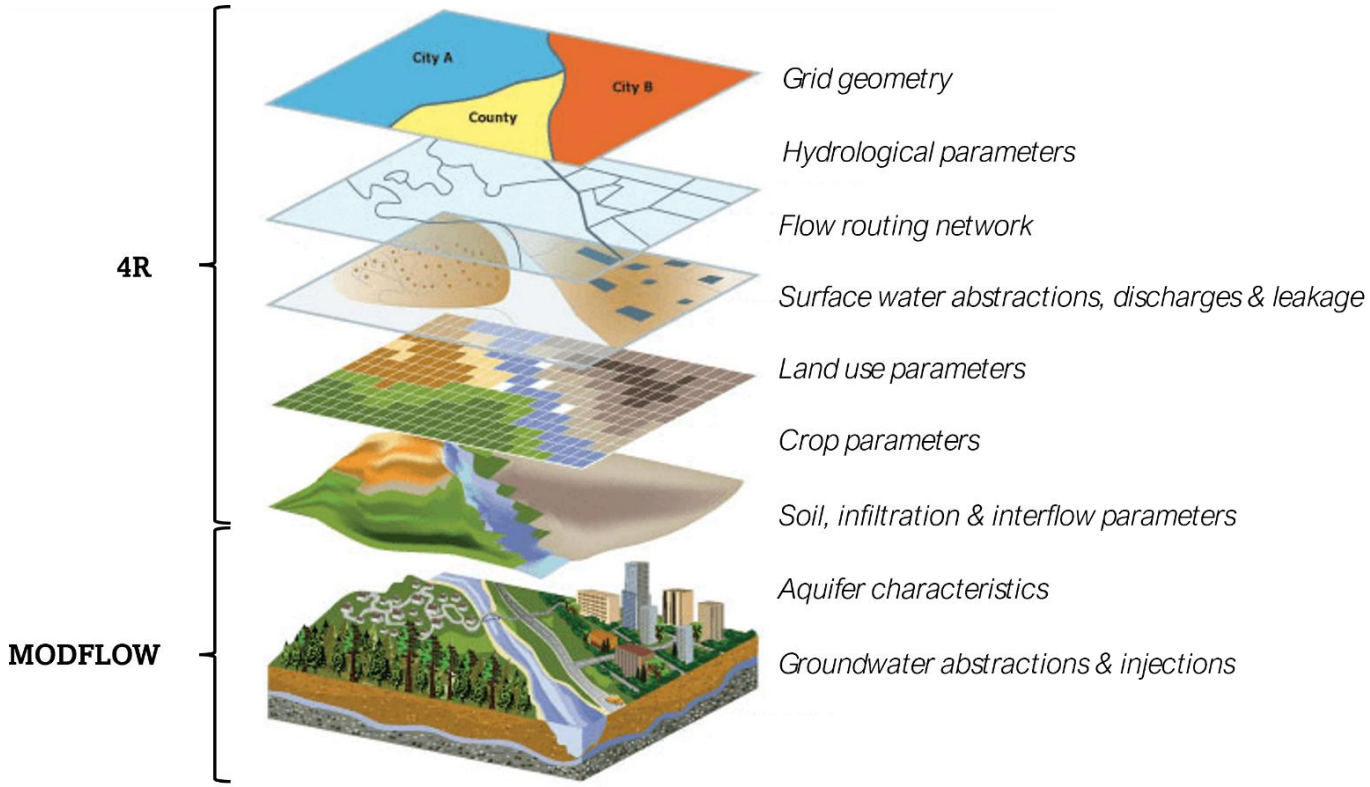
- The original methods used a series of ArcGIS toolbox tools to undertake the processing, but these were not suitable for producing outputs on the scale required

JBA Consulting (2026)

Regional groundwater modelling

- In parallel with the NbS opportunity mapping, JBA has undertaken numerical groundwater flow modelling across large parts of East Anglia to quantify the potential water resources benefits of NbS implementation

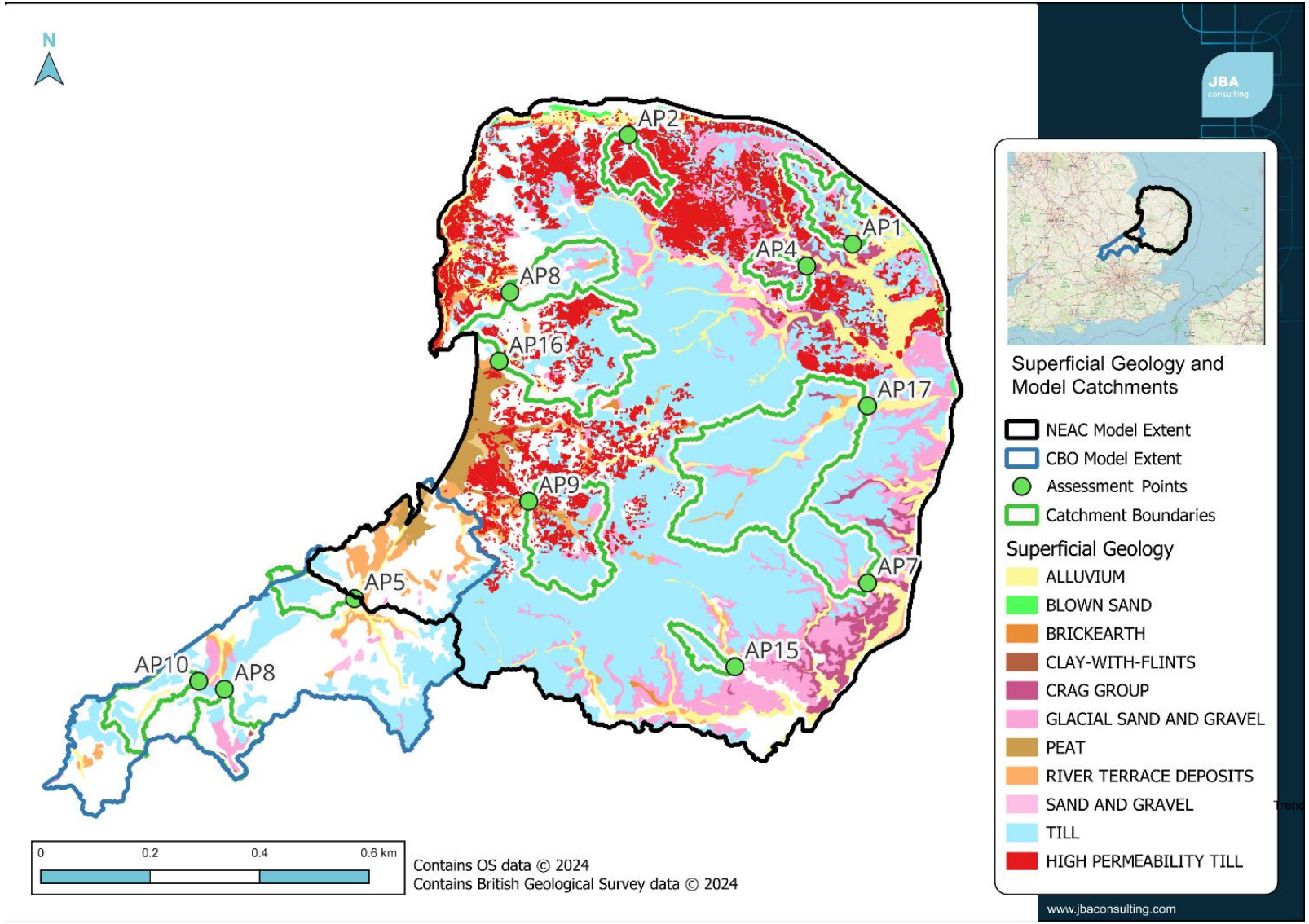
- Use of the Environment Agency's regional groundwater models built in MODFLOW96 VKD, with overlying recharge/routing models in 4R coupled to them



JBA Consulting (2026)

NEAC and CBO groundwater modelling

- Focus on the Northern East Anglia Chalk (NEAC) and Cam Bedford Ouse (CBO) regional groundwater models
- Chalk-dominated bedrock geologies
- Superficial deposits of variable permeability, offering partial confinement in places
- Assessment of effects on low flows in rivers, aquifer storage volumes and overall catchment water balances



JBA Consulting (2026)

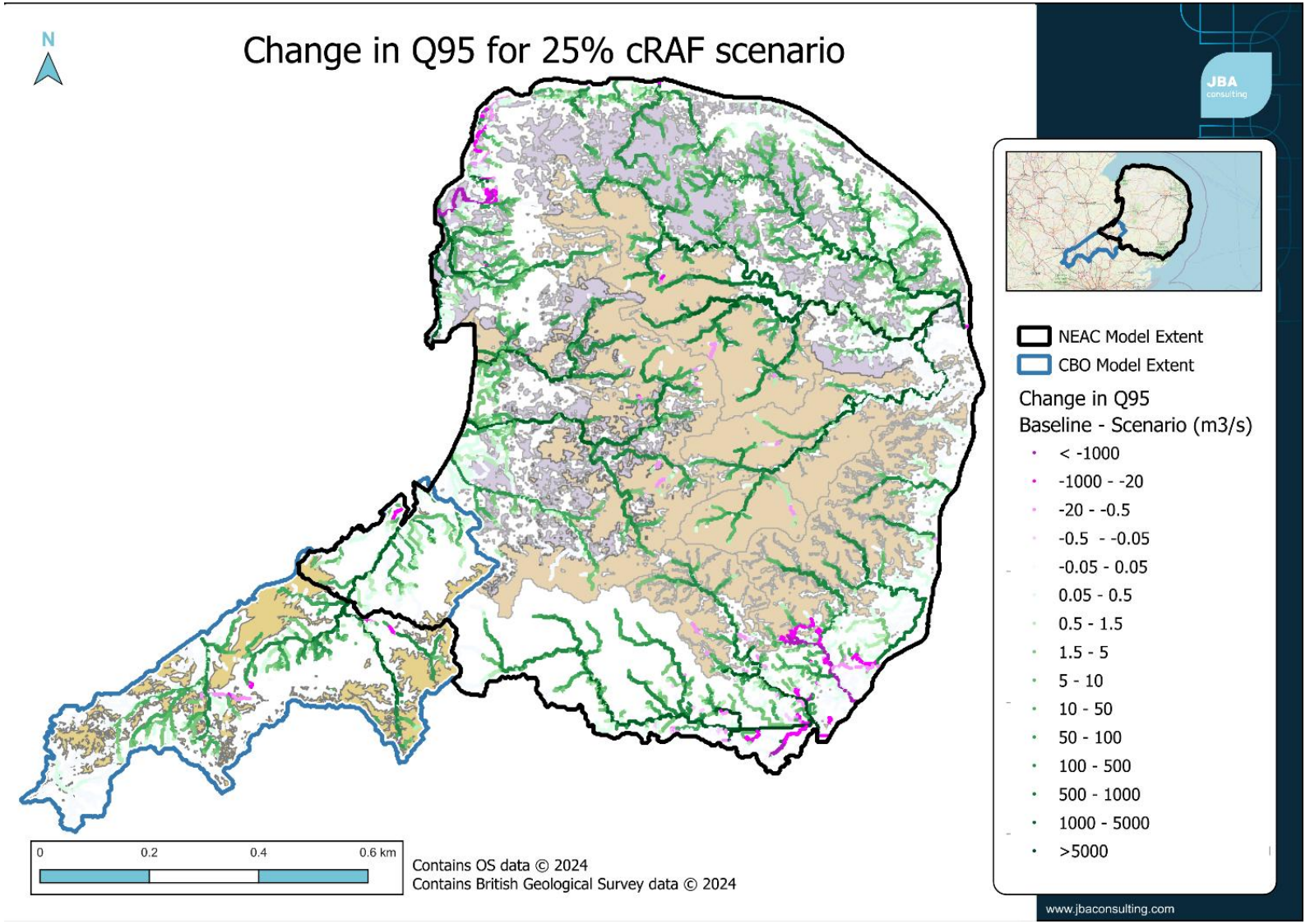
NbS model scenarios

- Implementation of RAFs:
  - sRAFs (surface water features) – infiltration basins in upland settings
  - cRAFs (channelised features) – situated in the upper-mid and mid catchments
  - Boundary RAFs – at the lithological boundary between low-permeability and high-permeability geologies
- Soil improvement measures
  - Varying intensities of management
- Land use changes
  - Conversion of arable land to pasture
  - Conversion of arable land to horticulture
  - Restoration of riparian corridors
- Deactivation of spray irrigation abstractions
  - Groundwater abstractions
  - Surface water abstractions

JBA Consulting (2026)

Results

- Model results indicate that NbS can have significant benefits to water resources if implemented at scale
- The magnitude of the benefits depends on local hydrogeological setting
- There is no discernible ‘law of diminishing returns’ on the scale of what could practically be implemented
- Different styles of NbS are more effective in certain catchments
- Model reports are available via WRE's website



JBA Consulting (2026)

NbS for water resources handbook

- JBA has authored a handbook for the Environment Agency on NbS for water resources (NbS4WR), with WRE on the steering group
- Trailed in the National Framework for Water Resources 2025 and due for forthcoming publication on GOV.UK
- Targeted at practitioners and stakeholders involved in water resources planning
- Includes chapters on NbS mapping and modelling techniques, in part informed by the work completed with WRE

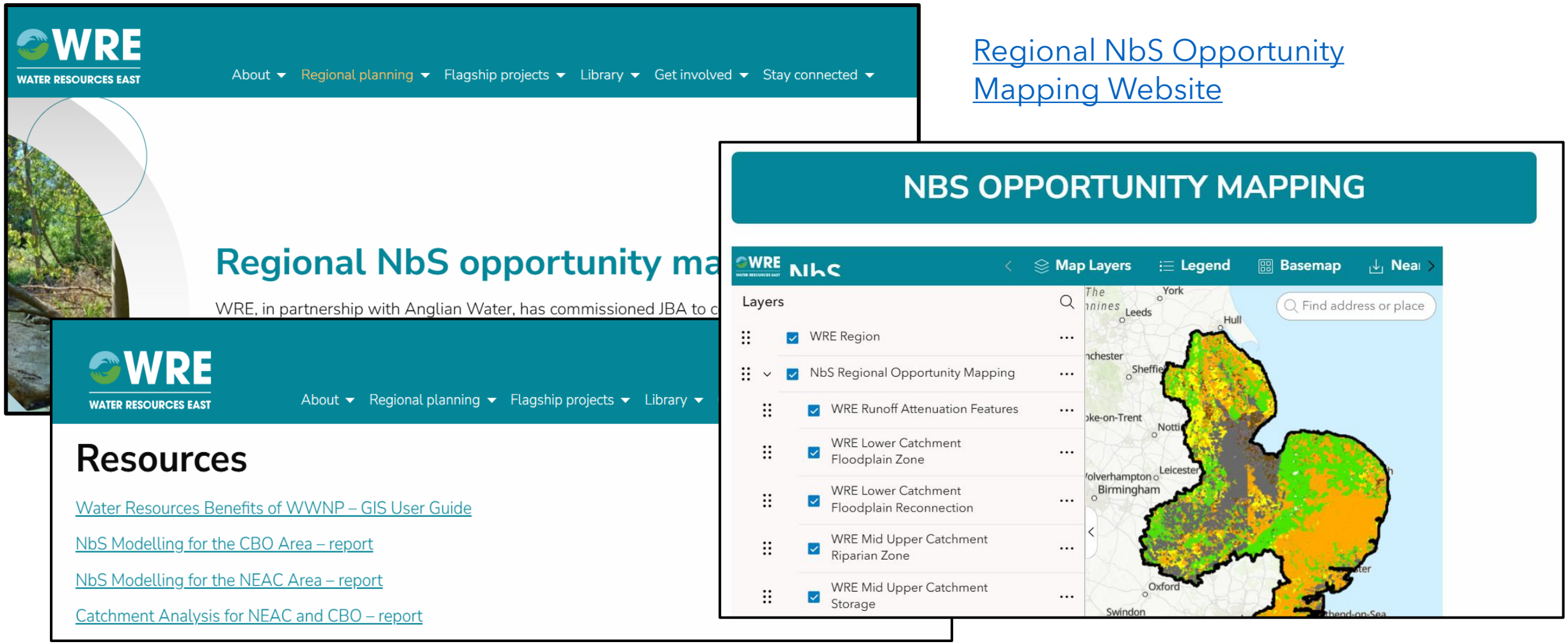
JBA Consulting (2026)

WRE
WATER RESOURCES EAST

How to use and view the NbS opportunity maps

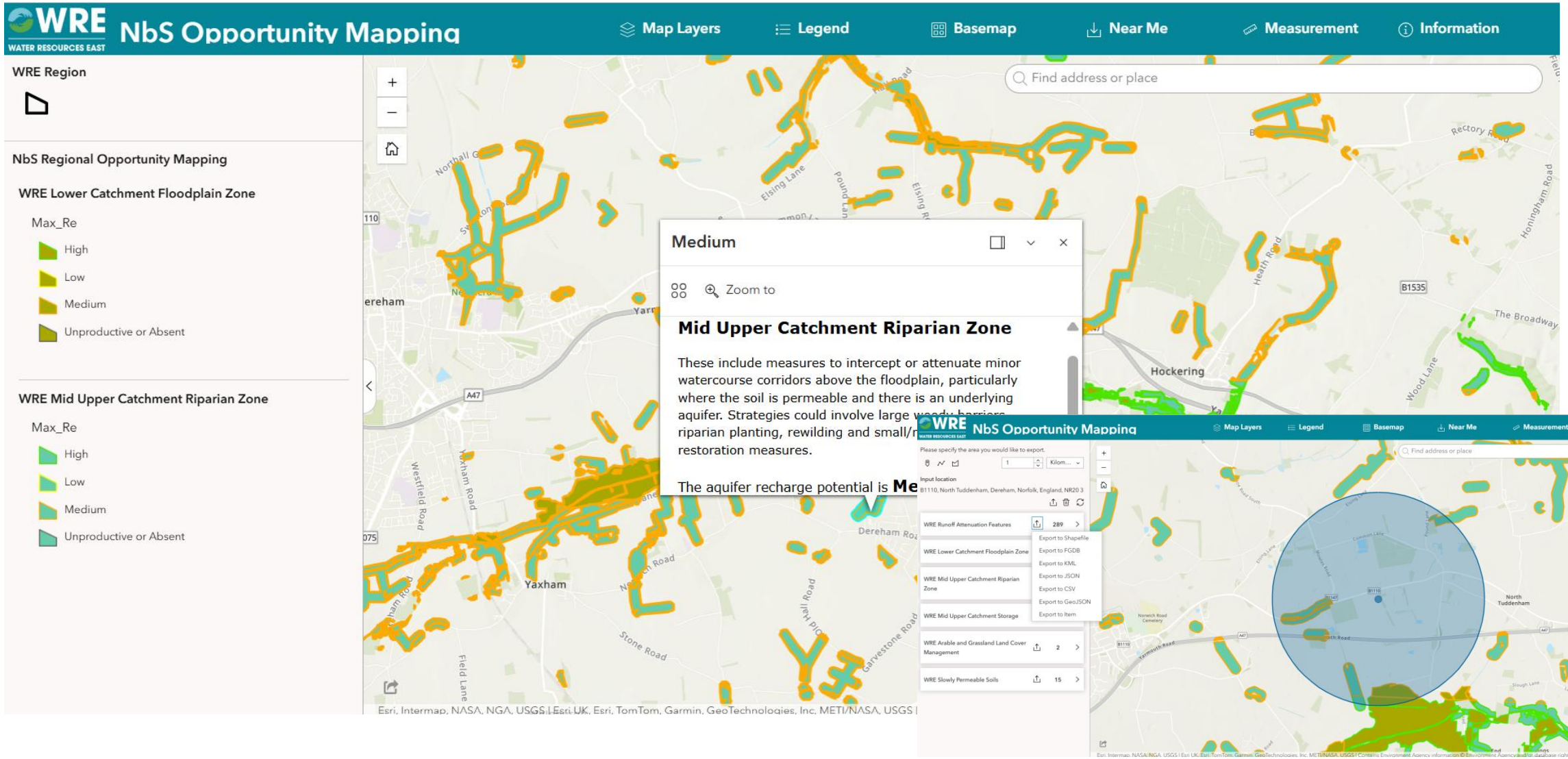
Katerina Laing (WRE)

NbS Opportunity Mapping

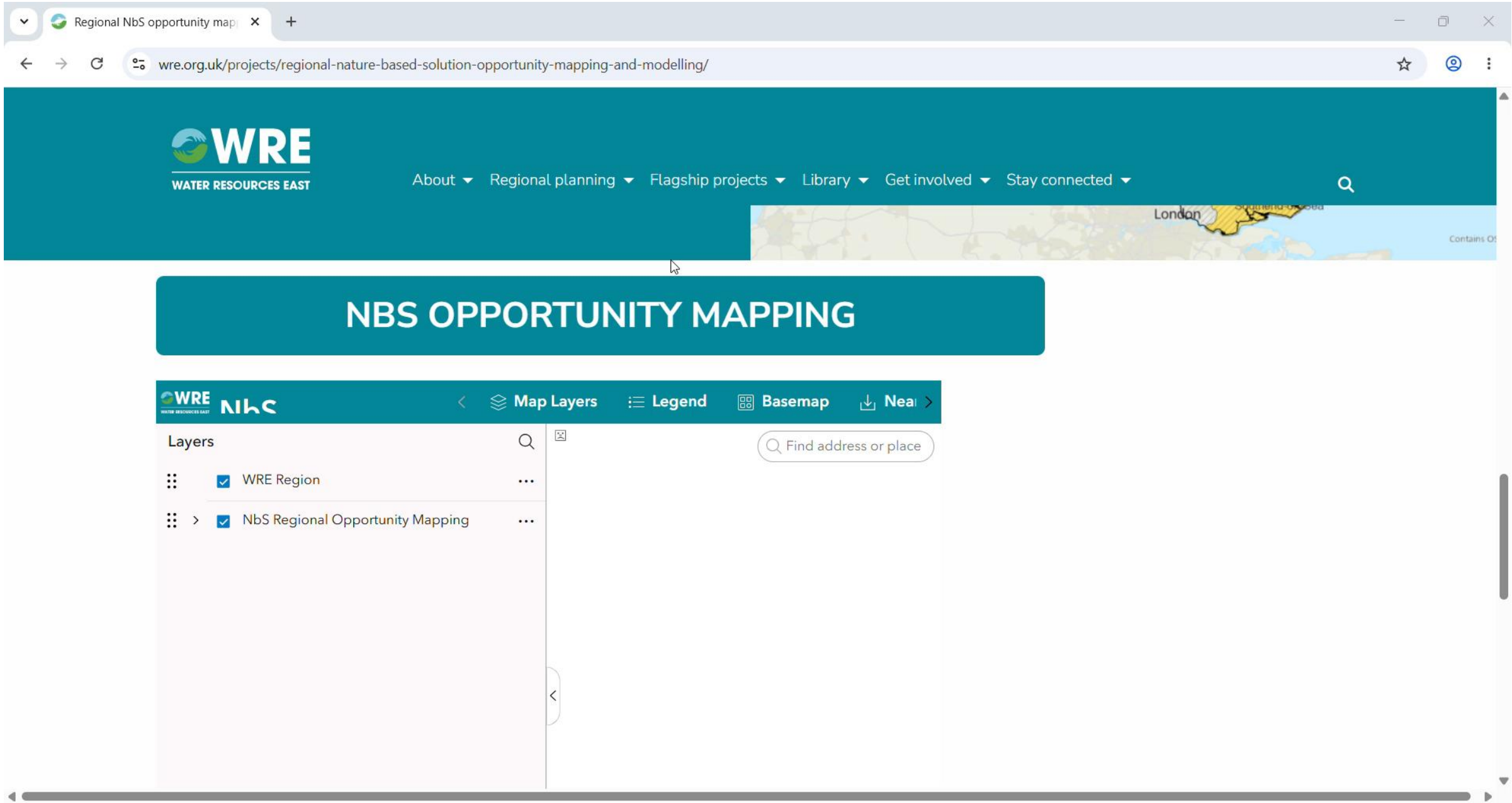


[Regional NbS Opportunity Mapping Website]

NbS Web Browser

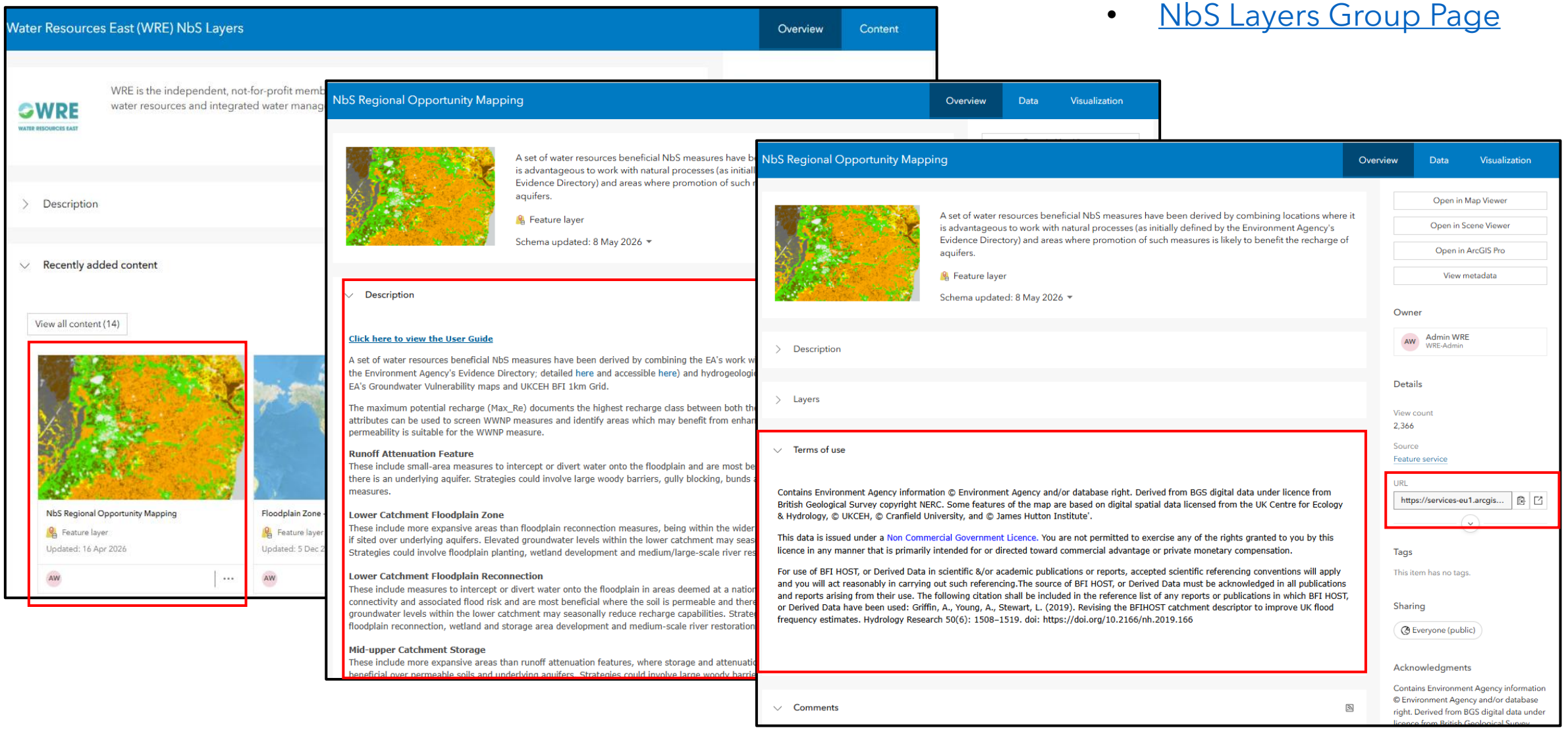


NbS Web Browser Demo Video

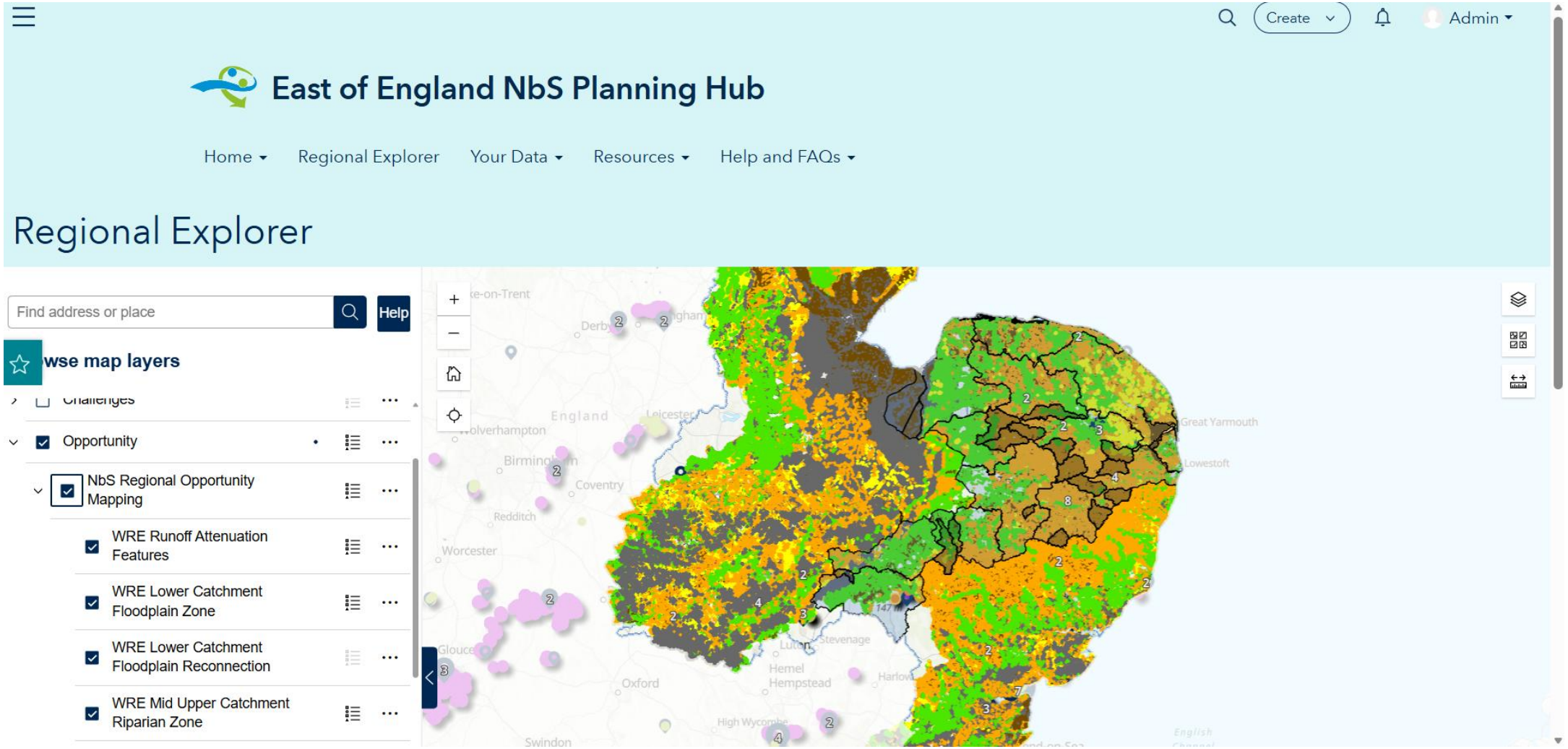


ArcGIS NbS Group Page

- [NbS Layers Group Page]



Rivers Trust East of England NbS Planning Hub



WATER RESOURCES EAST

Applying the NbS opportunity maps – a case study

Henry Walker (Norfolk FWAG)

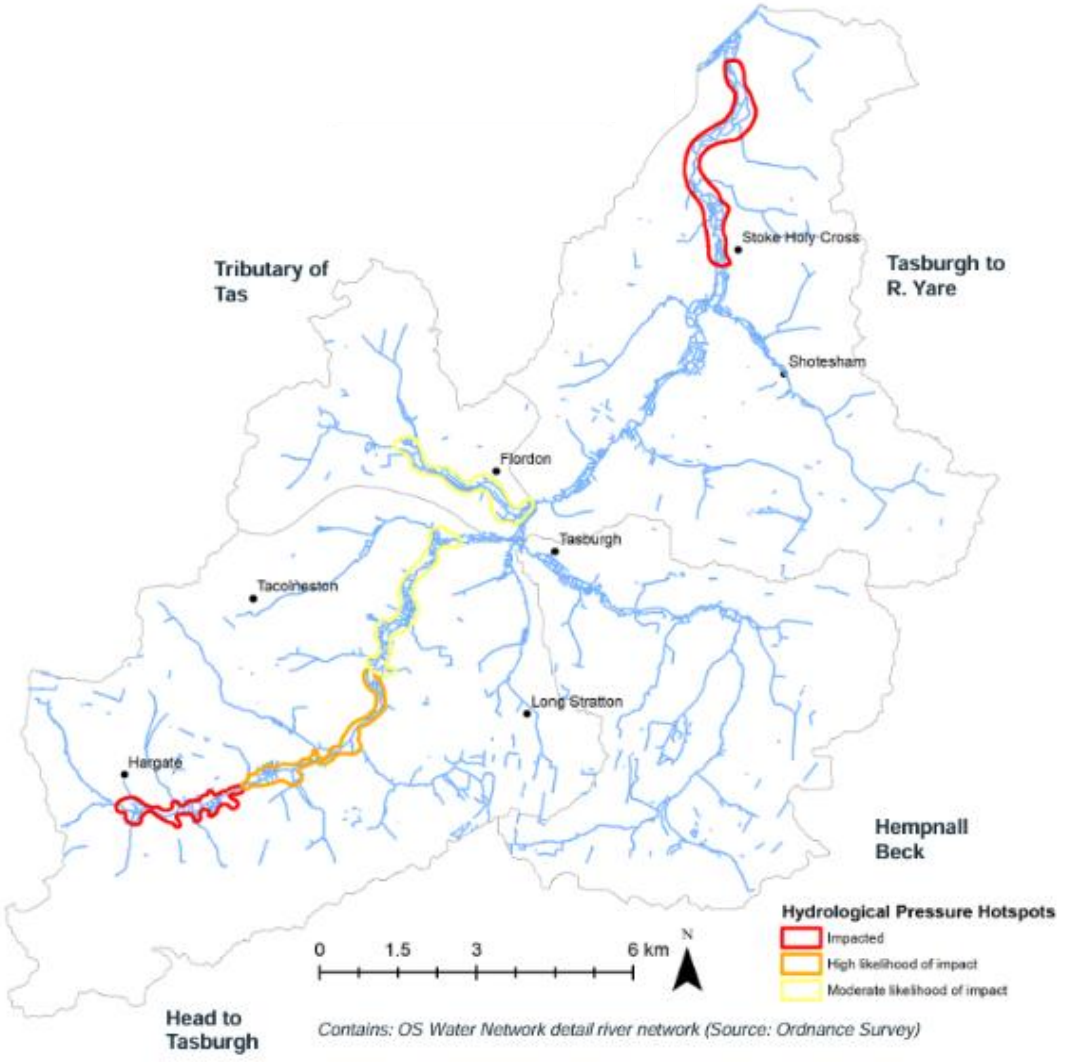
Chalky Tas project (2024-26)

NORFOLK WATER STRATEGY PROGRAMME

Funded by EA Chalk Streams Fund and Norfolk Water Fund. WRE managing, partnered with Norfolk FWAG and Swallowtail Consulting.

Objectives:

- Screen NbS opportunities and estimate benefits.
- Identify landowner interest in NbS implementation.
- Assess funding opportunities for investment readiness.
- Deliver some quick and easy NbS interventions.
- Support further design and feasibility for more complex NbS interventions, including financial appraisal.



Environment Agency

NORFOLK FWAG CONSERVATION ON FARMLAND

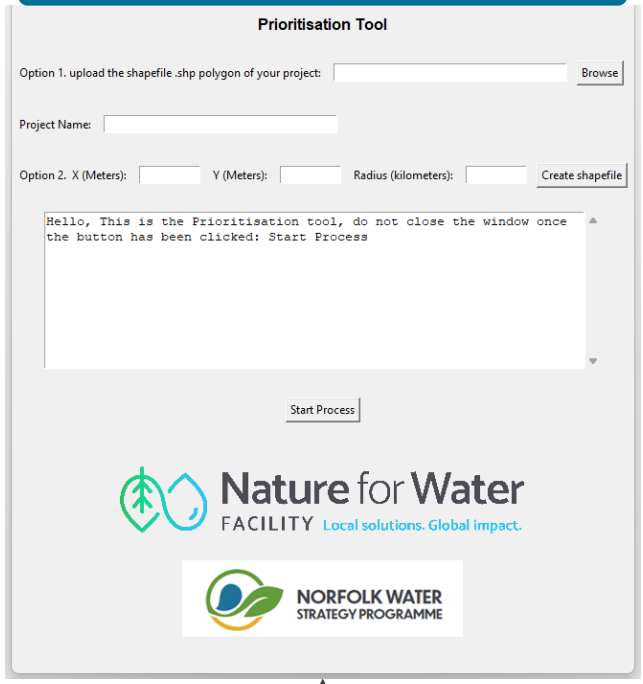
SWALLOWTAIL

NbS prioritisation tool

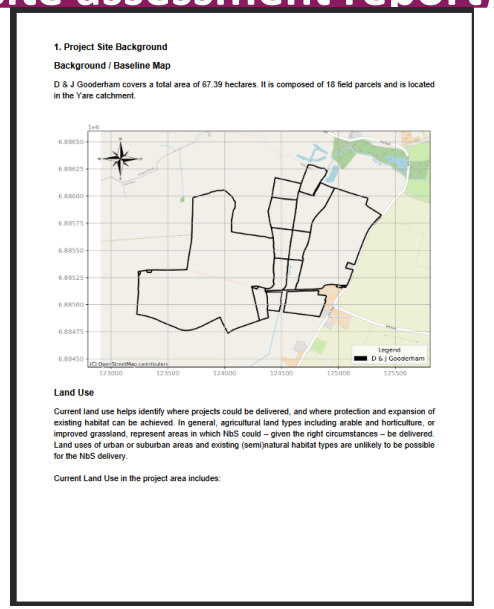
NORFOLK WATER STRATEGY PROGRAMME

Input: Shapefile

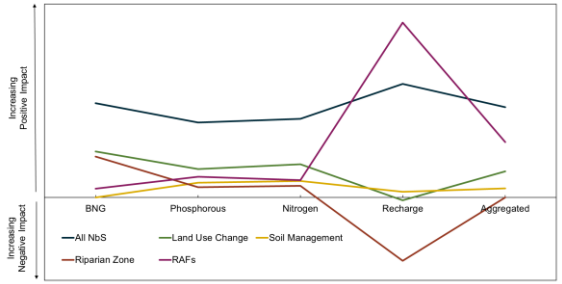
NbS Prioritisation Tool



Output: pdf report (site assessment report)



Opportunity Mapping



Norfolk Water Fund Business Case Modelling

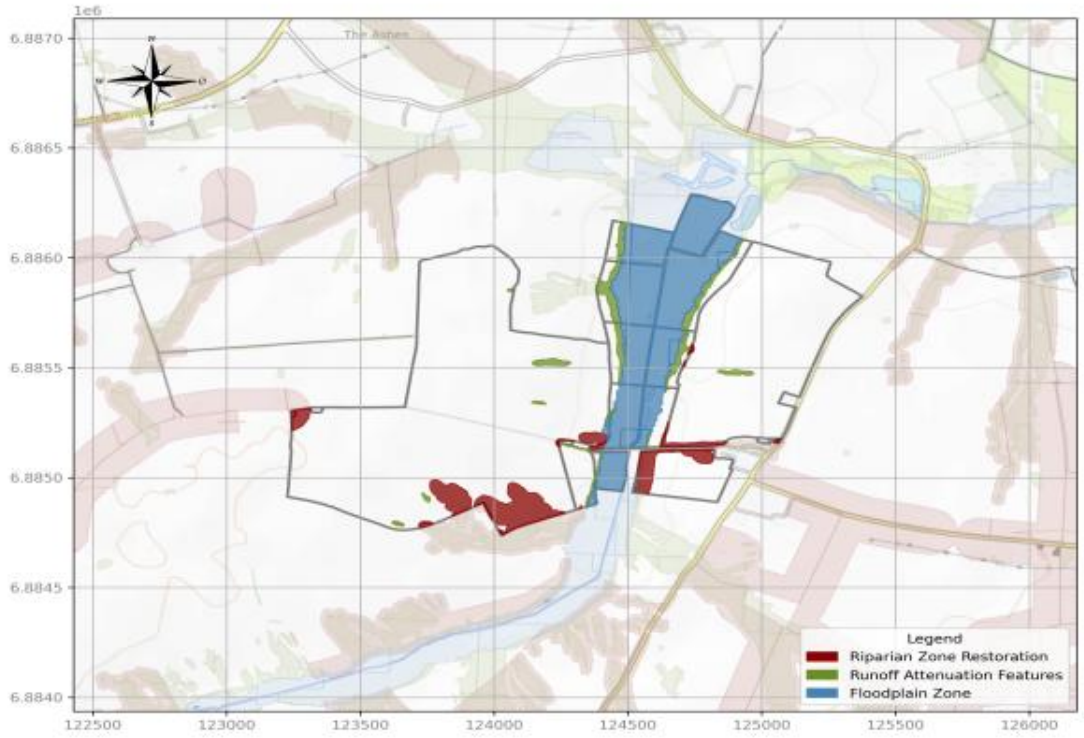
Site assessment report

NORFOLK WATER STRATEGY PROGRAMME

2. NbS opportunities

Feature-level Interventions

These interventions aim to restore or recreate natural processes in target areas. These often include measures targeting hydrologically important areas including floodplains, riparian areas and areas of runoff accumulation. They aim to buffer hydrological systems and store water, encouraging runoff reduction and infiltration.



Prioritisation categories

Potential Biodiversity Net Gain

Biodiversity ----------> **Low**

Potential Nutrient Neutrality

Nitrogen ----------> **High**

Phosphorous ----------> **High**

Potential Water Resources

Runoff ----------> **Very Low**

Infiltration ----------> **Very Low**

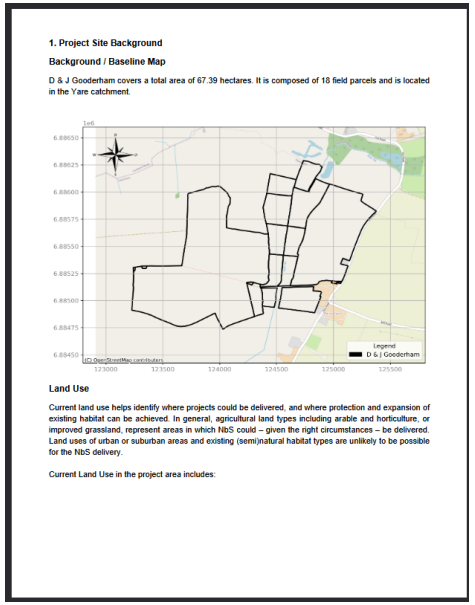
NbS	Area (Hectares)	Description	Local Context
Riparian Zone Restoration	3.05	These include measures to intercept or attenuate minor watercourse corridors above the floodplain, particularly where the soils are permeable and there is underlying aquifer.	Features are typically situated over arable hillslope streams. Riparian planting may slow flows to permit more gradual recharge into both superficial and bedrock aquifers together with trapping and filtering potential pollutants.
Runoff Attenuation Features	2.64	The interventions modify areas by providing storage and attenuation on hillslope flow pathways. The activities include restoration and recovery. They are most beneficial over permeable soils and underlying aquifers.	The density of features is highest on till covered areas in the south of the area of interest. On the chalk, they concentrate along topographical depressions draining into rivers. The most effective locations to target are likely to be those on the edge of the chalk, which are likely to be active more often capturing the run-off from till. Those that start on the chalk will likely have less run-off entering them on average.
Floodplain reconnection and restoration	10.95	The interventions modify areas within the wider floodplain by providing storage and attenuation on hillslope flow pathways. The activities include floodplain restoration or the creation of storage areas, including ponds and scrapes. Elevated groundwater levels within the lower catchment may seasonally reduce recharge capabilitie.	In the upper catchment this shows the area where the chalk stream valleys can be restored. In the lower catchment it highlights the fen areas where the drainage could be modified to store more water and recreate/improve the fenland habitats.

Metric	Catchment Scale Delivery Per Hectare	Project Delivery Per Hectare	Project Delivery as a Percentage of Catchment Scale Delivery (%)
Runoff Reduction (m3/yr)	586.78	67.72	11.54
Infiltration Enhancement (m3/yr)	1674.13	9.66	0.58
Nitrogen Export Reduction (kg/yr)	6.52	3.9	59.85
Phosphorus Reduction (kg/yr)	0.17	0.1	58.59
Biodiversity Credits (-)	0.69	0.17	25.16

NbS economic model

NORFOLK WATER STRATEGY PROGRAMME

Input: Site assessment report results



1. Project Site Background

Background / Baseline Map

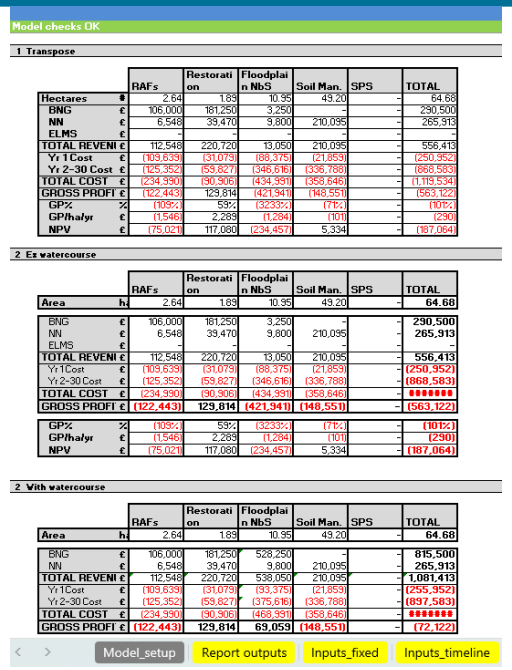
D & J Gooderham covers a total area of 67.39 hectares. It is composed of 18 field parcels and is located in the Yare catchment.

Land Use

Current land use helps identify where projects could be delivered, and where protection and expansion of existing habitat can be achieved. In general, agricultural land types including arable and horticulture, or improved grassland, represent areas in which NbS could – given the right circumstances – be delivered. Land uses of urban or suburban areas and existing (semi)natural habitat types are unlikely to be possible for the NbS delivery.

Current Land Use in the project area includes:

Economic model



Model checks OK

1 Transpose

		RAFs	Restoration	Floodplain NbS	Soil Man.	SPS	TOTAL
Hectares	#	2.64	1.89	10.95	49.20	-	64.68
BNG	£	106,000	181,250	3,250	-	-	290,500
NN	£	6,548	39,470	9,800	210,095	-	265,913
ELMS	£	-	-	-	-	-	-
TOTAL REVENI	£	112,548	220,720	13,050	210,095	-	556,413
Yr 1 Cost	£	(109,639)	(31,079)	(88,375)	(21,859)	-	(250,952)
Yr 2-30 Cost	£	(125,352)	(59,827)	(346,616)	(336,788)	-	(868,583)
TOTAL COST	£	(234,990)	(90,906)	(434,991)	(358,646)	-	(1,119,534)
GROSS PROFI	£	(122,443)	129,814	(421,941)	(148,551)	-	(563,122)
GP%	%	(109%)	59%	(3239%)	(71%)	-	(101%)
GP/ha/yr	£	(1,546)	2,289	(1,284)	(101)	-	(290)
NPV	£	(75,021)	117,080	(234,457)	5,334	-	(187,064)

2 Ex watercourse

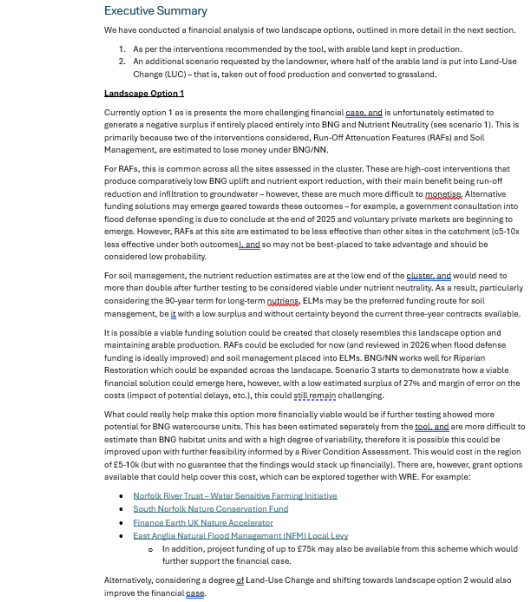
		RAFs	Restoration	Floodplain NbS	Soil Man.	SPS	TOTAL
Area	ha	2.64	1.89	10.95	49.20	-	64.68
BNG	£	106,000	181,250	3,250	-	-	290,500
NN	£	6,548	39,470	9,800	210,095	-	265,913
ELMS	£	-	-	-	-	-	-
TOTAL REVENI	£	112,548	220,720	13,050	210,095	-	556,413
Yr 1 Cost	£	(109,639)	(31,079)	(88,375)	(21,859)	-	(250,952)
Yr 2-30 Cost	£	(125,352)	(59,827)	(346,616)	(336,788)	-	(868,583)
TOTAL COST	£	(234,990)	(90,906)	(434,991)	(358,646)	-	########
GROSS PROFI	£	(122,443)	129,814	(421,941)	(148,551)	-	(563,122)
GP%	%	(109%)	59%	(3239%)	(71%)	-	(101%)
GP/ha/yr	£	(1,546)	2,289	(1,284)	(101)	-	(290)
NPV	£	(75,021)	117,080	(234,457)	5,334	-	(187,064)

2 With watercourse

		RAFs	Restoration	Floodplain NbS	Soil Man.	SPS	TOTAL
Area	ha	2.64	1.89	10.95	49.20	-	64.68
BNG	£	106,000	181,250	528,250	-	-	815,500
NN	£	6,548	39,470	9,800	210,095	-	265,913
TOTAL REVENI	£	112,548	220,720	538,050	210,095	-	1,081,413
Yr 1 Cost	£	(109,639)	(31,079)	(93,375)	(21,859)	-	(255,952)
Yr 2-30 Cost	£	(125,352)	(59,827)	(375,616)	(336,788)	-	(897,583)
TOTAL COST	£	(234,990)	(90,906)	(468,991)	(358,646)	-	########
GROSS PROFI	£	(122,443)	129,814	69,059	(148,551)	-	(72,122)

Model_setup | Report outputs | Inputs_fixed | Inputs_timeline

Output: financial report



Executive Summary

We have conducted a financial analysis of two landscape options, outlined in more detail in the next section.

1. As per the interventions recommended by the tool, with arable land kept in production.
2. An additional scenario requested by the landowner, where half of the arable land is put into Land-Use Change (LUC) – that is, taken out of food production and converted to grassland.

Landscape Option 1

Currently option 1 as is presents the more challenging financial case, and is unfortunately estimated to generate a negative surplus if entirely placed entirely into BNG and Nutrient Neutrality (see scenario 1). This is primarily because two of the interventions considered, Run-Off Attenuation Features (RAFs) and Soil Management, are estimated to lose money under BNG/NN.

For RAFs, this is common across all the sites assessed in the cluster. These are high-cost interventions that produce comparatively low BNG uplift and nutrient export reduction, with their main benefit being run-off reduction and infiltration to groundwater – however, these are much more difficult to monetise. Alternative funding solutions may emerge geared towards these outcomes – for example, a government consultation into flood defense spending is due to conclude at the end of 2025 and voluntary private markets are beginning to emerge. However, RAFs at this site are estimated to be less effective than other sites in the catchment (c5-10x less effective under both outcomes), and so may not be best-placed to take advantage and should be considered low probability.

For soil management, the nutrient reduction estimates are at the low end of the cluster, and would need to more than double after further testing to be considered viable under nutrient neutrality. As a result, particularly considering the 90-year term for long-term nutrients, ELMs may be the preferred funding route for soil management, be it with a low surplus and without certainty beyond the current three-year contracts available.

It is possible a viable funding solution could be created that closely resembles this landscape option and maintaining arable production. RAFs could be excluded for now (and reviewed in 2026 when flood defense funding is ideally improved) and soil management placed into ELMs. BNG/NN works well for Riparian Restoration which could be expanded across the landscape. Scenario 3 starts to demonstrate how a viable financial solution could emerge here, however, with a low estimated surplus of 27% and margin of error on the costs (impact of potential delays, etc.), this could still remain challenging.

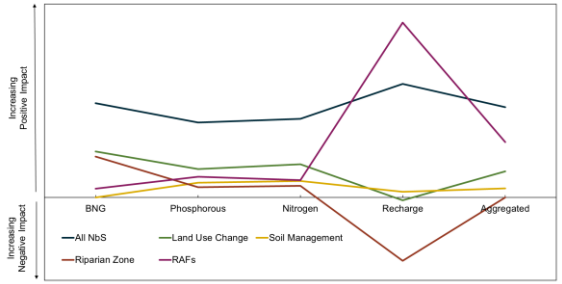
What could really help make this option more financially viable would be if further testing showed more potential for BNG watercourse units. This has been estimated separately from the tool, and are more difficult to estimate than BNG habitat units and with a high degree of variability, therefore it is possible this could be improved upon with further feasibility informed by a River Condition Assessment. This would cost in the region of £5-10k (but with no guarantee that the findings would stack up financially). There are, however, grant options available that could help cover this cost, which can be explored together with WRE. For example:

- Norfolk River Trust – Water Sensitive Farming Initiative
- South Norfolk Nature Conservation Fund
- Finance Earth UK Nature Accelerator
- East Anglia Natural Flood Management (NFM) Local Levy
  - In addition, project funding of up to £75k may also be available from this scheme which would further support the financial case.

Alternatively, considering a degree of Land-Use Change and shifting towards landscape option 2 would also improve the financial case.

Input: BNG pricing NN pricing ELMs rates

Current markets



Norfolk Water Fund Business Case Modelling

Work-flows

NORFOLK WATER STRATEGY PROGRAMME

All sites:

Landowner engagement
- Questionnaire
- Site shortlist
- Walkover and initial meeting

Initial NbS screening
- Run NbS prioritisation tool
- Produce Site Assessment Report

Initial farm report
- Synthesise results for landowner in simple visual format with top NbS options recommended

High potential and high interest sites:

Initial financial snapshot
- Run results from screening through economic model estimate NbS income opportunities

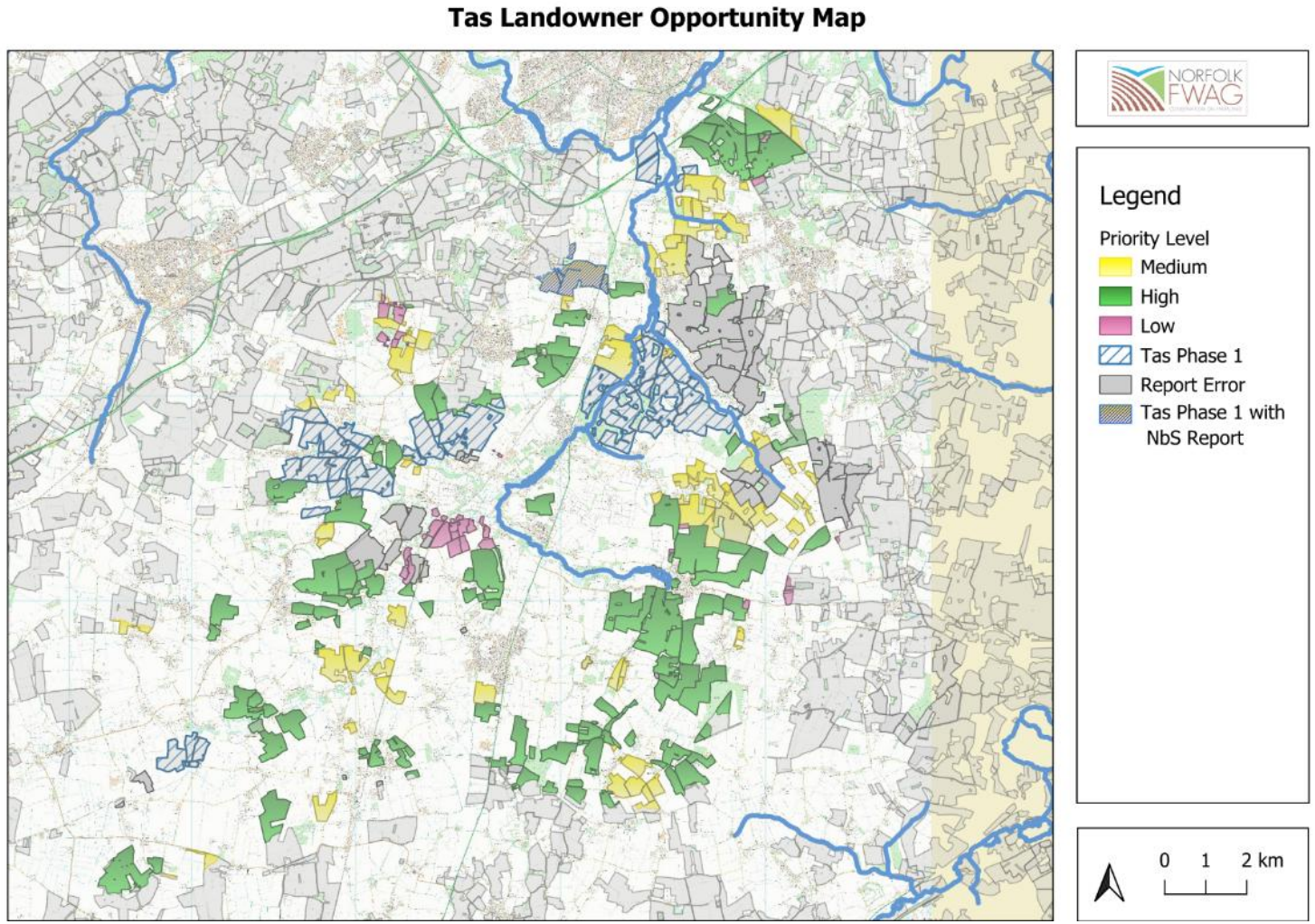
Landowner engagement
- Evaluate results of initial financial snapshot and align on preferred interventions

Final report
- Revenue and cost forecasts
- One or two modelled scenarios
- Valuation of co-benefits
- Market context

Design, Funding, Delivery

Initial NbS delivery in the Tas valley

Reviewing sub-catchment potential



Planning and funding NbS projects

Tools

- NbS Opportunity Maps
- CaBA East of England Hub
- Best Practice Guidance on Monitoring NbS

Funding

- Norfolk Water Fund (applications welcome year-round)
- Anglian Water's Catchment Regeneration Fund
  (next application window opens 1st June)

Coming soon

- NbS glossary (WRE)
- Data analysis report from RAF trials in the Wensum (WRE)
- Lessons learned report from RAF trials in the Wensum (WRE)
- NbS for water resources (NbS4WR) handbook (EA and JBA)

WRE
WATER RESOURCES EAST

Q&A

Thank you

Norfolk Water Strategy Programme - Water Resources East

Hannah Gray
NbS Programme Manager
hannahgray@wre.org.uk

Connect with us

www.wre.org.uk

Water Resources East

River Wensum © Emli Bendixen / The Nature Conservancy.