West Country Water Resources

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West Country Water Resources Group

Environmental Destination

Annex C: Rural Bristol Avon pilot catchment plan to increase future water supply and low flow environmental resilience

Wood Group UK Limited – April 2022

Draft - see disclaimer

Report for

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Contents

1. Overview

This document is one of five technical annexes that lay out plans for holistic measures that may be implemented in five West Country Water Resources (WCWR) pilot catchments to increase water supply and environmental low flow resilience. These set out steps towards an Environmental Destination for 2050 in each catchment, in response to the water resources-related 'Environmental Ambition' challenge set by the Environment Agency as part of its National Framework for Water Resources (March 2020).

1.1 This trial catchment plan

This pilot catchment plan sets out the measures best suited to achieve future water resources resilience and environmental improvement in the **Rural Bristol Avon Catchment**, in response to the challenge to meet environmental flow objectives, even as flows are expected to fall due to climate change.

Full details of the project context, scope, data sources and stakeholder engagement are given in the main report.

1.2 Contents of this annex

After this introduction,

- **Section 2** provides a summary of the catchment and the pressures on it.
- **Section 3** details the EA-suggested Environmental Ambition abstraction reductions that may be needed to improve river flows. It also provides an indication of how the flow regime is projected to change as the climate shifts into the future.
- **Section 4** describes the current projects underway in the catchment and summarises the strategic action plan of water company measures that could be implemented in a phased approach to increase water supply resilience. Projects currently focused on land management, habitat creation, restoration, re-wilding and diffuse water quality improvements are also included because these should improve ecological resilience through droughts, even though they will not make much difference to the flow regime.
- References are given in **Section 5.**

Figures are provided as a slide pack and at the back of this report in **Section 6.**

2. Catchment context

The large Rural Bristol Avon catchment is characterised by a remarkably mixed geology ranging from limestone to mudstone, sandstone and Chalk. This section describes the catchment context with respect to the rivers that drain it, the interaction of surface water with groundwater, the pressures from abstraction, and from diffuse and point sources of pollution.

2.1 The current state of the catchment

Geography, geology, rivers and environmental designations

The Bristol River Avon (also known as the 'Malmesbury Avon' in its headwaters) rises in the Cotswolds to the east of Chipping Sodbury, from here flowing east then southwards, turning to flow west and then north west, and discharging to the Severn Estuary via the Avon Navigation (**Figure C2.1**). The Rural Bristol Avon catchment only covers the river to Waddon and also encompasses tributaries upstream and downstream of Waddon, which include: Brinkworth Brook, Charlton Stream, River Chew, River Frome, River Mardon, Rodbourne Brook, Semington Brook and Wellow Brook. It covers parts of the Mendip Hills to the south, the Cotswold Hills to the north, the Marlborough Downs and Salisbury Plain to the east and the Severn Estuary to the west.

Most of the catchment is rural and agricultural with a mix of arable and pasture land uses, and urban areas are centred on Midsomer Norton, Frome, Westbury, Devizes, Chippenham, and Royal Wootton Bassett (**Figure C2.2**).

A strikingly wide variety of geology outcrops across the catchment (**Figure C2.1**). In the north, the Bristol Avon rises on the mudstones and oolitic limestones of the Cotswolds, passing onto the mudstones, siltstones and sandstones of the Kellaways Formation and Oxford Clay Formation. It is joined by tributaries such as the River Marden that drain the east part of the catchment, flowing from the North Wessex Downs from the margins of the Grey Chalk, Upper Greensand Formation and Lower Greensand. As the Avon turns to the west it is fed watercourses that arise from the Mendips limestones and Triassic mudstones in the south of the catchment, such as the Wellow Brook.

There are a number of designated sites in the catchment (**Figure C2.2**), the largest of which being the Chew Valley Lake Special Sites of Scientific Interest (SSSI), created by the reservoir.

Abstraction pressures

Abstraction within the Rural Bristol Avon catchment is from a mixture of both surface water and groundwater sources for water supply, agricultural and industrial uses, and also includes a number of groundwater to river low flow support schemes on the Malmesbury Avon headwaters and Chalfield Brook tributaries (**Figure C2.3**).

In **Figure C2.4a** it is evident that whilst there are a number of surface water abstractions for agricultural purposes, a large amount of these are for non-consumptive uses. The largest

proportion of consumptive surface water abstraction is for public water supply (over 90%). Total recent actual abstraction from the catchment is approximately 35 Ml/d.

A similar pattern is seen for groundwater abstractions (**Figure C2.4b**) with the full licensed groundwater abstraction for the catchment made up mainly of public water supply, with some additional abstraction for environmental and industrial purposes and transfer between sources – notably including the low flow river support schemes. Non-PWS abstractions are predominately non-consumptive so the majority of licensed abstraction (>95%) taken from the catchment is for public water supply. Total recent actual abstraction from the catchment is approximately 47 Ml/d.

Drinking water safeguard zones have been designated associated with Wessex Water's Dunkerton, Divers Bridge and Goodshill springs public water supply sources, all associated with nitrate pressures (**Figure C2.2**). There are also drinking water safeguard zones associated with Bristol Water's Egford source associated with nitrate pressures and for Chew Valley Springs associated with nitrate, ammoniacal nitrogen and cryptosporidium pressures. These have helped focus Catchment Sensitive Farming efforts to reduce diffuse pollution inputs of nutrients into the aquifer in order to protect public supply source water quality and ameliorate environmental eutrophication risks.

ARUP are also conducting a study to enhance the understanding of the current and future needs of non-PWS abstractions for agriculture, private water supplies, and mineral abstraction. As part of this assessment, ARUP have calculated the non-public water supply demands of the catchment, including generating figures for the number of animals in the catchment which have water demands. The preliminary results from the ARUP 2022 study are shown in **Figure C2.4a** and indicate non-public water supply demands from the catchment are approximately 29 Ml/d (mostly locally returned).

Although relatively small, these non-public water supply water users still need to be aware of the changes in resource availability expected due to climate change, as set out in **Section 3** - so that they can plan and adapt.

Water resource availability

Environment Agency published maps of river water body water resource availability at a range of historical climate flow conditions are shown in **Figure C2.5** (Environment Agency 2021[1]).

At high flows above Q30 (i.e. the flow exceeded for 30% of the time), water is assessed as being available across a large proportion of the catchment (that is, when flows are high, there is more water than is required to meet nationally consistent environmental river flow objectives, even if abstraction increased to Fully Licensed rates), there is no water available in the upper River Chew waterbodies, as well as in Chalfield, St Catherines and Pudding Brooks. There is restricted water available in the Bydemill Brook waterbody in high flows.

At moderate Q50 flows, Bydemill Brook now has no further water available, and the following waterbodies no have restricted water available in the Sherston Avon and the Luckington, Biss, Nunney and Maiden Bradley Brooks.

[1] https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/WaterResourceAvailabilityAndAbstractionReliabilityCycle2&Mode=spatial

At low flows (Q70) this picture changes, with flows falling below the Environmental Flow Indicator (EFI) in the upper River Avon and Gitten Brook, such that there is either restricted or no water is available at any time for licensing. At very low flows (Q95) there no water available for much of the upper River Avon waterbodies.

It is also important to note that around 50% of the Bristol Avon catchment remains "green" on **Figure C2.5** – i.e. as having more water available for licencing - and that there appears to be plenty of further water available downstream of the Rural Bristol Avon Rivers catchment in the Lower Bristol Avon.

Flood risk

The Rural Bristol Avon catchment has a history of flood risk, from surface water flooding and groundwater flooding. The greatest risks are associated with relatively impermeable geology, and with high intensity rapid run-off from compacted rural land, as well as urban hard surfaces and can lead to extensive flooding of the river valleys. There have been numerous engineering schemes implemented to reduce flood risk in the catchment historically[2] such as widening and deepening of rivers and removal of obstructions in Chippenham, Frome, Trowbridge, Melksham, Malmesbury, Calne, Radstock, Castle Combe and Great Somerford, as well as building flood bypass tunnels (e.g. at Midsomer Norton).

Waste water treatment works discharges and water quality pressures

Wessex Water operates the waste water treatment works which return mains water to the rivers across the catchment. There are over 90 treatment works for the many small villages and towns with the discharges consented and regulated by the Environment Agency. Considerable improvements in discharge water quality have been achieved over the past 30 years and investment is ongoing as clean-up standards continue to be tightened. As the sewer systems often combine household effluent with urban drainage runoff, occasional storm overflow of untreated water remains a focus for improvement.

Intensive agricultural land use in the catchment also results in diffuse pollution due to the application of nutrient fertilizers (nitrates and phosphates) and pesticides, sometimes associated with bare soil loss and sediment runoff into water courses. This is particularly an issue in the less permeable parts of the catchment, and there is a history of high sediment loads in the Bristol Avon catchment. The whole of the catchment has either been designated as a high or medium priority catchment under DEFRA's Catchment Sensitive Farming Programme, and a large proportion of the land is designated as a nitrate vulnerable zone (NVZ)[3]. In addition, phosphorous from wastewater treatment works, diffuse agricultural sources and urban run-off contributes to eutrophication of rivers with the risks of algal blooms and low dissolved oxygen increasing during dry summers when temperatures are high and flows are low.

2 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/294182/Bristol_Avon_Catchment_Flood_Management_Plan.pdf

3 South Wessex G151 Nitrates Directive, Bitham Bk NVZ

Future population pressures

In the Rural Bristol Avon catchment, significant future population growth is forecast across all council areas (Bristol, Bath& North East Somerset and North Somerset) which will put further strain on water resources.

Water Framework Directive (WFD) status

A map of the overall WFD (Cycle 2, 2019) status of water bodies across the catchment is shown on **Figure C2.6**. This combines both the chemical and ecological status reported by the Environment Agency for the water bodies. The recent recognition of new types of pervasive pollutants which affect many rivers across the country is tending to dominate overall WFD status. So, when focusing on water resources, abstractions and river flows it is more helpful to consider ecological status.

River flow and morphological condition (i.e. the naturalness of channel profiles, the existence of weirs and barriers etc.) are considered as supporting elements in the assessment of ecological status - which is primarily based on monitoring the health, diversity and abundance of plants, bugs and fish in rivers, lakes and estuaries. The WFD water body ecological status of Rural Bristol Avon water bodies (Cycle 2, 2019) is mapped on **Figure C2.7**.

None of the 75 waterbodies that make up the Bristol Avon achieve good overall status, with the large majority of the catchment achieving moderate overall status and 16 catchments classified at poor overall status. There are several key reasons for the failure to achieve good status which have nothing to do with abstraction pressures including phosphorus related to diffuse agricultural runoff and sewage discharges, zinc failures as a result of pollution from abandoned mines, contaminated urban runoff, sediment and barriers and physical modifications of the channel which affect fish and other aquatic life.

Environment Agency catchment data[4] are summarised in **Table 2.1** for selected water bodies of particular interest to this plan which is focused on future water resource and environmental low flow resilience. In these water bodies the Environment Agency's Environmental Ambition modelling has predicted the need for potential abstraction reduction to offset river flows falling regulatory thresholds by 2050. These calculations incorporate projections of future changes in river flows expected due to climate change, plus the potential impacts of fully licensed abstraction and Environment Agency aspirations around environmental targets (as discussed further in Section 3).

Table 2.1 2019 (Cycle 2) EA Data for selected water bodies of particular interest in the catchment

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydrological Regime	Chemical substances	RNAG
GB109053021852 Chew - Chew Valley Lake to conf Winford Brook	Moderate ecological status	Moderate (Macrophytes and Phytobenthos)	Moderate (Phosphate)	Does not support good	Fail (Mercury and its compounds and PBDE)	Point and diffuse sources (sewage discharge, poor nutrient management) Physical modification

[4] https://environment.data.gov.uk/catchment-planning/ManagementCatchment/3089 accessed 09/11/21

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydrological Regime	Chemical substances	RNAG
GB109053022050 Marden - source to conf Cowage Bk	Good ecological status	Good	Good	Supports good	Fail (Mercury and its compounds and PBDE)	Point source (landfill leaching)
GB109053021750 Biss Bk - source to conf unnamed trib	Poor ecological status	Poor (Fish)	Moderate (Phosphate)	Does not support good	Fail (Mercury and its compounds and PBDE)	Diffuse source (poor livestock and nutrient management) Natural mineralisation Physical modification (barriers)
GB109053022090 Maiden Bradley Bk - source to conf R Frome	Moderate ecological status	Moderate (Macrophytes and Phytobenthos)	Moderate (Phosphate)	Does not support good	Fail (Mercury and its compounds and PBDE)	Flow (surface water abstraction) Point and diffuse source (sewage discharge, poor nutrient and livestock management) Natural mineralisation
GB109053022140 Bulkington Drove w/c source to conf Semington Bk	Poor ecological status	Poor (Moderate Fish and Poor Macrophytes and Phytobenthos)	Moderate (Poor Phosphate)	Supports good	Fail (Mercury and its compounds and PBDE)	Flow (regulating reservoir flow regime) Physical modification (barriers) Other (fish stocking)
GB109053022290 Cam Bk - source to conf Wellow Bk	Moderate	Moderate	Moderate	Supports Good	Does not require assessment	
GB109053022000 Nunney Bk - source to conf Mells R	Moderate	High	Moderate	Supports Good	Does not require assessment	

RNAG Reasons for not achieving good, PFOS , PDBE Polybrominated diphenyl ethers

2.2 Existing water company water resource management planning (WRMP) options in the Rural Bristol Avon

Wessex Water's previously published strategy centres on demand management, focused on reductions in per capita consumption rates, as presented in the Water Resource Management Plan (Wessex Water, 2019). This includes the management of leakage (15% reduction in 5 years), enhancing metering and providing water efficiency services.

Bristol Water also has a particular focus on the management of demand and leakage (15% reduction in 5 years) as well as pledging to continue abstraction review as part of the AMP7 WINEP programme (Bristol Water, 2019).

Preferred options for both companies are detailed in **Table 2.2**.

Table 2.2 Preferred options in the 2019 WRMP relevant to the Rural Bristol Avon rivers catchment (from Wessex Water, 2019 and Bristol Water, 2019)

Option	Code	Type of option	Preferred (Y/N)	Earliest potential start date	WAFU Ml/d	Detail
Wessex Water						
Final Planning Scenario - 15% leakage reduction by 2025	ALY	Other leakage control	Y	2020-21	18.6	Infrastructure renewal, active leakage control, pressure management, improved data analysis, and DMA improvements
Met uplift optional	M1a	Metering optants	Y	2020-21	0.4	Enhanced metering
Home Check	WE1	Household water audit	Y	2020-21	3.7	Home advice and device fitting visits
Dashboard	WE2	Customer education / awareness	Y	2020-21	1.3	Customer engagement dashboard
Bristol Water						
Active Leakage Control	D21.1	Distribution	Y	2020-21	0.84-2.83	Enhanced leak detection and repair activities beyond our baseline leakage policy to reduce leakage to 36.5 Ml/d over the years 2020/21 - 2024/25 (2.83Ml/d).
Active Leakage Control	D21.2	Distribution	Y	2020-21	0.5-1.5	Enhanced leak detection and repair activities to reduce leakage from 36.5 to 35.0 (0.5 in 2029/30 and 1Ml/d in 2034/35).
Reduced leakage from raw water mains	P20	Production Management	Y	2020-21	5.5	Reduced leakage from raw water mains (enhanced leakage detection / raw mains repairs/replacement)

WAFU – Water available for use

A number of feasible supply-side options have also been explored by the water companies for this catchment, including the construction of desalination plants, new sources, bringing back mothballed sources into supply and effluent reuse. None of these have been taken forward as preferred options at this stage, as detailed in Error! Not a valid bookmark self-reference..

Table 2.3 Supply-side options reviewed (but not preferred) in the development of the Wessex Water (2019) and Bristol Water (2019) WRMPs, relevant to Rural Bristol Avon rivers catchment

Option	Code	Type of option	Preferred (Y/N)	Earliest potential start date	WAFU Ml/d	Detail
Wessex Water						
Desalination (30 Ml/d)	R1a	Desalination	N	2025-26	30	A large desalination development on the south coast with the water transferred across the Wessex Water supply system.
Bristol Avon abstraction at Saltford	R3	SW new	N	2024-25	30	
Avonmouth effluent reuse to industry	R4	Effluent reuse	N	2024-25	11	
Mothballed sources refurbished and brought back into supply - North	R5b	GW enhancement	N	2022-23	3.8	
Bristol Water						
Increase performance of P01-01R WTW	P01.1	Production management	N	Undecided	1.7	Increase performance of P01-01R WTW to increase deployable output to near licensed volume
Increase performance of P01-02R WTW	P01.2	Production management	N	Undecided	2.64	Increase performance of P01-02R WTW to increase deployable output to near licensed volume
Catchment Management of the Mendip Lakes	P06	Production management	N	Undecided	0.39	Catchment Management of the Mendip Lakes (P39R, P42R and P10R) to manage outage risk from algal blooms
P08R WTW (increased production)	P08	Production management	N	Undecided	2.0	
P10R WTW (increased production)	P10	Production management	N	Undecided	4.0	
New water sources within	R08.2	Resource	N	Undecided	1.4	New water sources within Bristol Water area: R08-02R

Option	Code	Type of option	Preferred (Y/N)	Earliest potential start date	WAFU Ml/d	Detail
Bristol Water area: R08-02R						
New water sources within Bristol Water area: R08-03R	R08.3	Resource	N	Undecided	1.1	New water sources within Bristol Water area: R08-03R
P10R Reservoir – standard design	R11.1	Resource	N	Undecided	16	P10R Reservoir – standard design
Purchase water from other water companies	R23.1	Resource	N	Undecided	10	Purchase water from other water companies
Bring R24R source back into supply	R24	Resource	N	Undecided	2.4	Bring R24R source back into supply

WAFU – Water available for use

Feasible demand-side options have also been explored by the water companies for this catchment, including options to reduce leakage and options to reduce demand for water. None of these have been taken forward as preferred options at this stage, as detailed in Error! Not a valid bookmark self-reference..

Table 2.4 Demand-side options reviewed (but not preferred) in the development of the Wessex Water (2019) and Bristol Water (2019) WRMPs

Option	Code	Type of option	Preferred (Y/N)	Earliest potential start date	WAFU Ml/d	Detail
Wessex Water						
Options to reduce distribution losses (leakage)	-	10 further options to manage and control leakage	N	2020-21	31.0	Active leakage management, mains replacement (not trunk mains), pressure management etc
Options to reduce the demand for water	-	3 metering options	N	2020-21	19.8	Reduction in demand through improved metering
Bristol Water						
Options to reduce	D23	Distribution	N	Undecided	0.5	Asset Renewal: specific targeted water mains asset renewal programme beyond

Option	Code	Type of option	Preferred (Y/N)	Earliest potential start date	WAFU Ml/d	Detail
distribution losses (leakage)						our baseline asset renewal programme included in our baseline leakage policy to maintain leakage at 43 Ml/d as assumed in the baseline demand forecast
Selective metering of domestic customers	C08	Customer Demand	N	Undecided	0.570	Selective metering of domestic customers based on (a) high consumption e.g. sprinkler use and/or (b) zones of high demand
Enhanced promotion of free meter option to unmeasured households	C12	Customer Demand	N	Undecided	0.572	Enhanced promotion of free meter option to unmeasured households beyond the promotion assumed in baseline demand forecast
Installation of rainwater harvesting	C20	Customer Demand	N	Undecided	0.029	Installation of rainwater harvesting in new build households and nonhouseh
Promotion of Water Efficiency to customers- Enhanced water efficiency communications	C26-01	Customer Demand	N	Undecided	0.080	Promotion of Water Efficiency to customers- Enhanced water efficiency communications campaign (different messages for different seasons). Over and above our baseline water efficiency programme assumed in the baseline demand forecast
Promotion of water efficiency to customers- Education programme	C26-02	Customer Demand	N	Undecided	0.080	Promotion of water efficiency to customers- Education programme on water efficiency on different key stages (primary, secondary, further and higher education). Over and above our baseline water efficiency programme assumed in the baseline demand forecast
Promotion of water efficiency to customers- Household water efficiency devices	C26-03	Customer Demand	N	Undecided	0.266	Promotion of water efficiency to customers- Household water efficiency devices installation programme plus selective water saving devices. Over and above our baseline water efficiency

Option	Code	Type of option	Preferred (Y/N)	Earliest potential start date	WAFU Ml/d	Detail
installation programme						programme assumed in the baseline demand forecast

WAFU – Water available for use

It is important to note that leakage from the public water supply system represents a return of water to the catchment. This is often associated with household connections rather than large leakage events from main supply pipes which are readily identified and quickly fixed. Leakage rates tend to be higher in winter when pressures are higher and temperatures lower than in summer. It follows that reductions in leakage, whilst reducing the rates of abstraction required for supply, may make less difference to river flows downstream of towns, particularly during summer months.

Similarly, reductions in per capita consumption will be more difficult to realise during warmer summers when demand usually increases, rather than during winter periods. And if demand reductions are achieved, they will be associated with lower rates of treated wastewater discharge which would reduce low flow resilience downstream of cities and towns.

3. Environmental Ambition challenge

This section summarises the predicted 2050 flow deficits and surpluses in the catchment and the potential future reductions in public water supply abstraction impacts highlighted by the Environment Agency's Environmental Ambition screening modelling, set out in the National Framework for Water Resources (March 2020).

The Environment Agency's modelling indicates the additional water that may be needed by 2050 to meet:

- environmental river flow targets based on existing (Business as Usual, BAU) or enhanced (ENH) thresholds; and
- predicted future predicted (FP) demands for public water supply and other water uses, and also worst-case, fully licensed (FL) demand assumptions
- in the context of natural Q95 low flow conditions which have been simply factored down from current estimates for 2050 based on a climate change projection.

The Environment Agency provided the WCWRG with WFD river water body scale National Framework estimates of 2050 environmental flow surpluses or deficits to highlight the water bodies of concern (as summarised in **Section 2** and presented in more detail below). An indication of the individual abstraction reductions which might be needed to meet the 2050 existing or enhanced environmental flows was also tabulated for the regional water resources groups and water companies to consider.

Whilst the main theme of the Environmental Ambition challenge is therefore framed in terms of 'potential abstraction reductions needed to meet river flow targets' and improve environmental low flow resilience, this implies that alternative sources of water will need to be found from elsewhere to maintain public supply resilience. It is noted that, alongside these catchments with abstraction pressures, there is still water available in several Rural Bristol Avon catchment water bodies, as well as downstream in the Lower Bristol Avon. There are also groundwater river support schemes in place across the Malmesbury Avon and Chalfield Brook which are already providing public supply and environmental low flow resilience through droughts.

At the same time, water companies must demonstrate that their demand suppression and supply systems are robust enough for a 1 in 500 year drought event. So smarter management options for the Rural Bristol Avon which allow existing drought-resilient abstractions to continue as well as to improve water quality treatment, must also be on the table.

Section 3.1 presents mapped and tabulated summaries of the water bodies with Environment Agency projected flow deficits. The climate change assumptions made in these projections are reviewed based on the latest suite of UKCP18 modelling data in **Section 3.2** which suggests that significant low and median flow reductions should be expected throughout the century. The potential licence reductions being scrutinised according to the Agency's analysis are listed in **Section 3.3**, and compared with published water company WRMP options in **Section 3.4**.

3.1 Predicted 2050 flow deficits and surpluses

Environmental Flow Indicator (EFI) targets are defined by the Environment Agency to indicate the river flow required to support Good Ecological Status under the EU Water Framework Directive (WFD). The EFI allows a percentage deviation from natural flows at a specific location, defined based on the Abstraction Sensitivity Band (ASB) of the site – a nationally consistent abstraction pressure screening approach intended to highlight areas where further ecological impact investigations should be carried out.

The predicted fully licensed 2050 flow surpluses and flow deficits for Rural Bristol Avon catchment water bodies under Q95 low flow conditions are mapped in **Figure C3.1,** under the EA's enhanced 2050 scenario, which is 'worst case' for planning purposes

In the enhanced scenario, increased environmental protection (i.e. a more stringent flow target) is assigned to protected areas, principal salmon and chalk rivers, and catchments with SSSI rivers and wetlands.

It can be seen from **Figure C3.1** that for the majority of the water bodies within the Rural Bristol Avon catchment, flow surpluses or flows close to the enhanced environmental flow target are predicted (mapped in green with Q95 flow surpluses labelled in Ml/d).

However, 2050 Q95 flow deficits are predicted by the Environment Agency modelling for 23 water bodies to some extent, the majority of which are small headwater streams, only some of which have abstraction impact reduction targets assigned. The flow deficits relate to both non-PWS and PWS abstraction:

- Chew Valley – impacted by Chew Reservoir abstraction. Reduction required in:
  - GB109053021852 - Chew - Chew Valley Lake to conf Winford Brook
- River Marden – impacted by Cherhill BHs. Reduction required in:
  - GB109053022050 - Marden - source to conf Cowage Bk
- Biss Brook – impacted by Westbury and Upton Scudamore BHs. Reduction required in;
  - GB109053021750 - Biss Bk - source to conf unnamed trib
- Maiden Bradley Brook – impacted by Dunkerton Springs. Reduction required in:
  - GB109053022090 - Maiden Bradley Bk - source to conf R Frome
- Bulkington Drove – impacted by "Boreholes 3". Reduction required in
  - GB109053022140 - Bulkington Drove w/c source to conf Semington Bk
- Nunney Bk – impacted by Egford Well. Reduction required in:
  - GB109053022000 - Nunney Bk - source to conf Mells R
- Cam Bk – impacted by Midford Springs Group, Bath. Reduction required in:
  - GB109053022290 - Cam Bk - source to conf Wellow Bk

There are also some waterbodies which are listed as having a deficit where a deficit has been assigned due to GWDTEs that are significantly downstream of the abstraction points (e.g. Upper

Avon) and these have been removed from the assessment. In addition, there are a number of waterbodies where targets have been removed as the abstractions are already under review as part of the WINEP process, or assessments have shown that no reduction is required – some because of the existence of groundwater to river support schemes. A summary of those waterbodies which have Environmental Ambition deficits but have been assigned no reduction are summarised in **Table 3.1** below.

Table 3.1 Predicted Fully Licensed 2050 Q95 Flow Surplus or Deficit (Water body outflow, Ml/d), and reason for exclusion from this report.

Waterbody ID	Waterbody Name	Flow Deficit at Q95	Reason for exclusion from summary
GB109053027650	Avon (Brist) conf Tetbury Avon to conf R Marden	-13.25	AP1 Brisol Avon - GWDTE DS of AP and offline
GB109053021851	Chew - source to Chew Valley Lake	-6.63	BAU & no target
GB109053021950	Chew - conf Winford Bk to conf R Avon (Brist)	-6.39	BAU & no target
GB109053027770	Charlton Str - source to conf Bristol Avon	-5.67	AP1 bristol avon & adapt
GB109053021900	Winford Bk - source to conf R Chew	-3.66	BAU & no target
GB109053027730	Gauze Bk - source to conf R Avon (Brist)	-3.51	AP1 bristol avon & adapt
GB109053022110	Rodden Bk - source to conf R Frome	-2.35	BAU & no target
GB109053027720	Rodbourne Bk - source to conf R Avon (Brist)	-1.76	AP1 bristol avon
GB109053027810	St Catherines Bk - source to conf R Avon (Brist)	-1.02	Adapt & no target
GB109053027760	Woodbridge Bk - source to conf Charlton Str	-0.29	BAU & no target
GB109053021890	Chalfield Brook - source to conf Avon	-0.16	Adapt & no target
GB109053021960	Bydemill Bk - source to conf RIver Avon (Brist)	-0.08	Adapt & no target
GB109053021930	South Bk - source to conf R Avon (Brist)	-0.07	Adapt & no target
GB109053027410	Pudding Bk - source to conf R Avon (Brist)	-0.07	Adapt & no target

Waterbody ID	Waterbody Name	Flow Deficit at Q95	Reason for exclusion from summary
GB109053021920	Clackers Bk - source to conf R Avon (Brist)	-0.02	Adapt & no target
GB109053027700	Sutton Benger Bk - source to conf R Avon (Brist)	-0.01	waterbody with target and deficit

Further detail regarding those water body flow deficits linked to PWS abstraction is given in **Table 3.2** below and a summary of their current ecological status catchment data has been presented in **Table 2.1**.

This provides the surpluses and deficits at different flow percentiles, and also compares with the same outputs for the less stringent 'Business as Usual' (BAU) scenario - where the regulatory approach remains the same, such that EFI ASB2 would apply for some water bodies (e.g. allowing impacts up to 15% of QN95 rather than the 10% allowed for ASB3).

Table 3.2 Predicted Fully Licensed 2050 Flow Surplus or Deficit (Water body outflow, Ml/d), for water bodies where PWS abstraction reductions are highlighted by the Environment Agency

	Q30		Q50		Q70		Q95	
Flow condition	**BAU (Ml/d)**	**ENH (Ml/d)**	**BAU (Ml/d)**	**ENH (Ml/d)**	**BAU (Ml/d)**	**ENH (Ml/d)**	**BAU (Ml/d)**	**ENH (Ml/d)**
GB109053021852 Chew - Chew Valley Lake to conf Winford Brook	-54.07	-56.05	-28.38	-30.46	-16.78	-18.29	-8.91	-9.74
GB109053022050 Marden - source to conf Cowage Bk	7.86	7.86	1.54	1.54	-2.34	-2.34	-4.38	-4.38
GB109053021750 Biss Bk - source to conf unnamed trib	-2.65	-3.28	-5.83	-6.42	-6.07	-6.53	-3.74	-4.02
GB109053022090 Maiden Bradley Bk - source to conf R Frome	0.06	-0.29	-2.60	-2.93	-3.02	-3.26	-1.55	-1.68
GB109053022140 Bulkington Drove w/c source to conf Semington Bk	2.46	1.79	0.88	0.48	0.17	-0.22	-0.24	-0.57
GB109053022000 Nunney Bk - source to conf Mells R	0.76	0	-2.33	-3.03	-2.08	-2.52	0.12	-0.1
GB109053022290 Cam Bk - source to conf Wellow Bk	17.20	15.81	7.02	5.71	2.80	1.89	0.35	-0.05

*BAU - Business as Usual; ENH – Enhanced Scenario

Waterbody Surplus or Deficit numbers are Ml/d based on EA natural flow, abstraction and environmental flow target assumptions for 2050

Figure C3.1 also maps the largest Fully Licensed 2050 Q95 environmental flow deficit for the Rural Bristol Avon Rivers (in red). It is important to note that the water body sub-catchments are coloured according to the deficits estimated at their outflow points. From this it is clear that whilst there are a number of waterbodies with deficits planned, there are also a number of waterbodies which have a flow surplus predicted (waterbodies in green) which could be utilised in the future. Perhaps most pertinently, the lower Avon river waterbodies have a surplus of >30 Ml/d, which could potentially be utilised to improve the water resource availability in the upper catchment by changing abstraction patterns through new abstraction sources. It is noted that the water quality associated with the lower Bristol Avon would require higher treatment requirements which have implications for financial and carbon costs.

3.2 How do the Environment Agency's estimates of flow reductions due to climate change compare with updated UKCP18 for the Rural Bristol Avon?

The Environment Agency's National Framework predictions of natural flows for 2050 were based on one of the eleven UKCP09 Future Flows projections known as 'afixK', as available at the time. This projected relatively more marked falls in flow over time compared with the remaining 10 'equally likely' suite of UKCP09 models. At the end of 2021, CEH and a consortium of associates working with the Meteorological Office have delivered the UKCP18 successor to the Future Flows data which includes 12 possible projections of river flows and groundwater levels from 1982 to 2080 using a variety of alternative modelling approaches. These Enhanced future Flows and Groundwater (eFlaG) data are available online[5] and have been used to compare against the Environment Agency's assumptions for one of the Bristol Avon tributaries (the Frome) to provide stakeholders with a clear picture of how flows might be expected to change to 2050 and beyond.

Figures C3.2 and **C3.3** plot rolling 18-year flow percentile statistics in Ml/d derived from modelled daily flow projections for the Bristol Frome at Frenchay. Plots are included to show how high (Q1 'floods'), median (Q50), low (Q95) and very low (Q99 'droughts') flows are predicted to change through the 21st century. There are lines for each of the 12 possible UKCP18 regional climate models (RCM) provided from eFlaG compared with the projection for the same location from UKCP09 Future Flows, as included in the Environment Agency's calculations.

On the right of each percentile time series, an area plots indicates how many of the 12 UKCP218 eFlaG models show increases or decreases in flow, how big that projected change is relative to the start of the century (2000), and how the differences evolve past 2050 and on to 2080.

These plots indicate that highest flood event flows (Q1 and above) are expected to be steady or perhaps increase with time according to most of the projection models. These increases are modest – perhaps over 10% by 2050, but this still represents a very large increase in highest flood flows. It indicates that flooding risks in the Bristol Avon are expected to get worse, but also emphasises the value of surface storage options designed to capture high flows to support drier period supplies.

[5] https://eidc.ac.uk/

Figure C3.2 flow predictions are based on the most reliable of the eFlaG gauge-calibrated river flow models (the Probability Density Model PDM) and indicate how flows calibrated against the historical gauged record for Frenchay (i.e. including the influence of upstream abstractions and discharges) may change due to climate shifts in rainfall and potential evaporation. Projected falls in median (Q50), low (Q95) and very low(Q99) flows are similar to or greater than the UKCP09 afixK dashed black line. i.e. the Future Flows scenario used by the Environment Agency which was considered worst case now appears reasonable or perhaps even optimistic compared with the updated UKCP18 projections. By 2050, most of the eFlaG models are predicting more than 10% reductions in median flows, with falls of 20 or even 30% predicted by several models under drier conditions.

The **Figure C3.3** plots are based on the natural flow projections of the national 'Grid to Grid' (G2G) model using the same RCM climate inputs, but no gauged record calibration. Although less well adapted to the gauged local flow responses and probably less reliable, these projections are included for comparative purposes because they ignore any abstraction or discharge influences on the gauged record. Highest flood flow projected changes are similar, but median and lower flow falls are much steeper.

Figures C3.2 and C3.3 confirm that low flows are expected to fall significantly to 2050 and beyond. Even though the Environment Agency will therefore need to allow EFI regulatory flow-based Hands-off-Flow thresholds to evolve downwards with time, the proportion allowed for abstraction will also be squeezed.

This forward look adds real urgency to the need to consider options which will boost storage and low flows support on the supply side, beyond the current demand-side and leakage focus of WRMP options. It also highlights the need for riverine and wetland habitat restoration and active management to enhance ecological refuge resilience to dry periods which are becoming and will continue to become more frequent and longer. Broader re-wilding, soil and environmentally sensitive farm land management initiatives are also vital to improve water quality but they will not change the projected decline in low flows. As the climate warms, the higher temperatures will result in more evapotranspiration and less water in our rivers regardless of any 'nature-based solutions' implemented upstream.

3.3 Licences highlighted by the Environment Agency for potential abstraction reductions (or other low flow support)

If the flow deficits identified in the Environment Agency's 2050 Environmental Ambition projections need to be fully addressed, licence reductions may be required for ten Wessex Water groundwater licences and one Bristol Water groundwater licence. Licence details for these abstractions which are 'at risk' are given in Error! Reference source not found..

The total groundwater licence impact reductions across the Rural Bristol Avon catchments for Wessex Water flagged by the Environment Agency could potentially be ~7.2 Ml/d – mostly in the Biss Brook.

There are currently no reductions highlighted for the surface water abstractions, however, they are currently under review.

Table 3.3 Details of PWS abstractions located in waterbodies with future abstraction reductions recommended by the EA

Abstraction Information	Licence Number	Water Company	Fully Licensed	Recent Actual	Surface Water/ Groundwater	WFD Waterbody	Investigations
Chew Reservoir	17/53/014/S/016	Bristol	4.391	2.445	SW	GB109053021900	AMP6. Discussed and agreed no investigation necessary
Cherhill #1	17/53/008/G/047	Wessex	0.7	0.38	GW	GB109053022050	
Cherhill #2	17/53/008/G/047	Wessex	0.7	0.38	GW	GB109053022050	
Cherhill #3	17/53/008/G/047	Wessex	0	0	GW	GB109053022050	
Upton Scudamore BH3	17/53/010/G/011	Wessex	1.2	0.96	GW	GB109053021750	AMP5 (2010-2015). Impact of abstraction unacceptable – daily licence of Upton Scudamore boreholes to be reduced by 5.4 Ml/d and hands-off flow for springs abstraction to increase from 1.0 to 1.5 Ml/d in 2018
Upton Scudamore BH4	17/53/010/G/011	Wessex	1.2	0.96	GW	GB109053021750	AMP5 (2010-2015). Impact of abstraction unacceptable – daily licence of Upton Scudamore boreholes to be reduced by 5.4 Ml/d and hands-off flow for springs abstraction to increase from 1.0 to 1.5 Ml/d in 2018
Upton Scudamore BH5	17/53/010/G/011	Wessex	1.2	0.96	GW	GB109053021750	AMP5 (2010-2015). Impact of abstraction unacceptable – daily licence of Upton Scudamore boreholes to be reduced by 5.4 Ml/d and hands-off flow for springs abstraction to increase from 1.0 to 1.5 Ml/d in 2018
Upton Scudamore BH6	17/53/010/G/011	Wessex	1.2	0.96	GW	GB109053021750	AMP5 (2010-2015). Impact of abstraction unacceptable – daily licence of Upton Scudamore boreholes to be reduced by 5.4 Ml/d and hands-off flow for springs abstraction to increase from 1.0 to 1.5 Ml/d in 2018

Abstraction Information	Licence Number	Water Company	Fully Licensed	Recent Actual	Surface Water/ Groundwater	WFD Waterbody	Investigations
Upton Scudamore Well/ Borehole	17/53/010/G/011	Wessex	1.2	0.96	GW	GB109053021750	AMP5 (2010-2015). Impact of abstraction unacceptable – daily licence of Upton Scudamore boreholes to be reduced by 5.4 Ml/d and hands-off flow for springs abstraction to increase from 1.0 to 1.5 Ml/d in 2018
Westbury BH2	17/53/010/G/009	Wessex	0.5	0.19	GW	GB109053021750	
Westbury BH3	17/53/010/G/009	Wessex	0.5	0.19	GW	GB109053021750	
Westbury BH4	17/53/010/G/009	Wessex	0.5	0.19	GW	GB109053021750	
Dunkerton Springs	17/53/011/S/011	Wessex	4.548	1.976	SW	GB109053022090	AMP6 (2015-2020). Investigation ongoing: monitoring of flows and ecology to understand impact – no licence change expected.
Boreholes 3	17/53/009/G/052	Wessex	1	0	GW	GB109053022140	
Egford Well No 1	17/53/012/G/015	Bristol	2.74	1.24	GW	GB109053022000	AMP6. Discussed and agreed no investigation necessary
Egford Well No 2	17/53/012/G/015	Bristol	2.74	1.24	GW	GB109053022000	AMP6. Discussed and agreed no investigation necessary
Midford Springs Group	17/53/013/S/090	Wessex	3.151	0.705	SW	GB109053022290	

3.4 Potential 2050 supply loss compared to WRMP options

Options explored in the water company WRMPs include demand reductions and leakage savings to reduce the future supply required (**see Section 2.2**). In this catchment, no options are currently being taken forward to boost supply.

Table 3.3 puts into context the scale and magnitude of the potential 2050 abstraction reductions against the current licensed and recent actual abstraction from the catchment, and WRMP options (Table 3.3: Potential 2050 catchment supply loss (% of abstraction). This shows a more significant reduction for the Wessex Water sources (18.6%) than for Bristol Water, although the absolute reductions for the Rural Bristol Avon Rivers catchment is relatively low.

It is clear that these Environmental Ambition challenges demand measures beyond the options published in existing WRMPs. Potential solutions will be associated with large financial and carbon costs and will take around 25 years to complete and potentially a shift change to the way abstraction is undertaken in the area, given there is significantly more available water in the lower Bristol Avon. The Environmental Destination plan needs to be phased so that incremental benefits can be realised along the way – as set out in **Section 4**.

Table 3.4 Rural Bristol Avon catchment: context of potential 2050 supply loss

Rural Bristol Avon	Wessex Water*	Bristol Water**	Unit
1.Annual PWS licensed abstraction (catchment total) *SWABS and GWABS combined*	78.3	74.2	Ml/d
2.Annual PWS RA abstraction (catchment total) *SWABS and GWABS combined*	34.8	43.3	Ml/d
3.Water company total water into supply (WAFU) *Base year 2017/2018*	408.9	301.7	Ml/d
4.WRMP baseline WAFU 2045	384.3	292.6	Ml/d
5.Catchment PWS RA as % of water company WAFU (Base Year 2017-18)	8.5%	14.4%	%
6.Total WRMP projected 2045 demand-side and leakage savings	23.8	9.8	Ml/d
7.2045 demand reductions and leakage savings as % of current total water into supply	5.8%	3.3%	%
WRMP preferred additional supply-side options (catchment total)	0.0	0.0	Ml/d
EA 2050 potential abstraction reductions (catchment total)	7.2	3.3***	Ml/d
Potential 2050 catchment supply loss, reduced by the effect of proportional 2045 demand reductions and leakage savings	9.2	4.7	Ml/d

Potential 2050 catchment supply loss (% of abstraction)	26.4%	3.3%	%
Potential 2050 catchment water impact (2045 WAFU impact, abstraction impact plus effect of demand and supply options)	6.4	0.7	Ml/d
Potential 2050 catchment supply loss (% of recent actual PWS Abs)	18.4%	1.6%	%

*Wessex Water catchment summarised in this table is the one Wessex Water WRZ
** Bristol Water catchment summarised in this table is the one Bristol Water WRZ
*** This reflects reductions in the Egford Well sources. Though there is a deficit in the Chew Valley reservoir catchment no licence reduction has been assigned to this source as it has been assumed that flow conditions can be met through changes to the compensation release, given the WRHMWB status of the waterbody. If this assumption is incorrect then further reduction may be required.

Data sources:
Wessex Water (2019). Final Water Resources Management Plan
Bristol Water (2019). Final Water Resources Management Plan.

4. Catchment plan to increase future water supply resilience

The Environmental Ambition challenge has highlighted the potential constraints to water resource availability in the 2050s. Adapting to the ongoing pressure of climate change and enhanced environmental ambition will require holistic approaches to deliver sustainable resilience for both public supplies and low flow habitats.

This section sets the context of the relevant projects already underway or soon to be implemented in the Rural Bristol Avon Rivers catchment, that include measures which will improve the resilience of the water resource for both public supplies and the environment. It also summarises wider catchment soil, land management, drainage restoration and nature-based initiatives which are important for the real biodiversity and water quality benefits they can deliver but are not expected to significantly change the decline in river low flows as temperatures warm.

A catchment plan is documented to set out and prioritise the water company measures best suited to achieve future flow and supply resilience as part of improving biodiversity outcomes in the catchment.

4.1 Current projects in the catchment

There are several projects currently being undertaken across the Rural Bristol Avon Rivers WFD catchment that may improve the water availability and the resilience of the Bristol Rivers. In addition, there are a number of catchment partnerships set up to promote the catchment-based approach (CaBA) examples, as well as strategic planning and demand management schemes.

A summary of current projects within the Rural Bristol Avon Rivers catchment is provided below.

Bristol Avon Catchment Partnership (BACP)

The Bristol Avon River WFD catchment is covered by the Bristol Avon Catchment Partnership (BACP). The catchment partnership meets quarterly to work with stakeholders across the catchment to deliver a more sustainable environment for a range of issues including for water resources. The BACP the following water-based issues have been identified as the highest priorities for the partnership:

- High sediment loading. Associated with rapid run-off from agricultural land.
- Flooding. Associated with compacted rural land and urban hard surfaces.
- Low river flows. Associated with abstraction for water supply and poor upstream water retention and aquifer recharge.

- Reduced natural habitat and wildlife. Associated with poor riparian habitat, highly modified channels, in-stream barriers to prevent fish migrating and increase of Invasive non-native species.
- Climate change. Associated with an overarching pressure as more extreme weather may result in more flooding and droughts within the catchment

It has hosted by Wessex Water since 2012.

Members also include Avon Wildlife Trust, Bath & North East Somerset Council, Bristol Avon Rivers Trust, Bristol City Council, Bristol Water, Environment Agency, Farming & Wildlife Advisory Group – South West, National Farmers Union, Natural England, North Somerset Council, South Gloucestershire Council, West of England Rural Network, Wessex Water, Wiltshire Council and Wiltshire Wildlife Trust.

Current projects include:

- Bydemill Brook Natural Flood Management (NFM) Pilot - This Pilot Project will deliver Natural Flood Management (NFM) interventions to help slow the surface water flow and improve water quality for Corsham, Wiltshire
- PEBBLE (Protect and Enhance the By Brook and its Local Environment) - This is a multiyear strategy to protect and enhance the By Brook by creating a sub-catchment action plan for the river.
- West Wiltshire Sustainable Water Project - The project is developing a business case that will enable a partnership approach to deliver multiple benefits to address some the water-based issues in this area of the catchment.
- Magnificent Marden - This project has focussed on river restoration work to help reduce the impacts of over widening and straightening of the river, bank erosion and previous impoundment.
- Starting with Semington - This project is focussed on addressing the high phosphate levels, sediment loads and a reduction in natural habitat which are causing significant issues on the watercourse.
- Wellow & Cam Initiative - Various projects have been delivered as part of this initiative, including river restoration work, feasibility studies and weir removals to improve the river habitat for fish and people.
- Mendip Lakes Partnership - Working with farmers across the Blagdon and Chew Reservoir catchments to improve water quality and enhance habitats.

Mendip Lakes Partnership

The Mendip Lakes Partnership project has been running since 2010 seeking to solve issues relating to water quality and WFD nutrients and improving water quality and reducing sediments. As such there are a number of nature-based solutions in the Mendips and Chew valley; mostly small-scale stuff looking at the river corridor, but which may impact water resource availability.

Chew Valley and the sustainable water usage project

There are various projects in Chew catchment as a result of a partnership between Bristol Avon Rivers trust, BANES council and WECA looking at nature-based solutions, natural flood management, restoring naturing natural processes and fisheries management. There is also a targeted Chew sustainable water usage programme involves community engagement, and increased use of water butts, SUDS and water efficiency measures to decrease water usage in the catchment

Bristol Avon Rivers Trust (BART)

The Bristol Avon River Trust (BART) are very active in the Chew catchment delivering a suite of investigations and nature-based solutions which include buffer strips, reducing livestock access to river banks, natural flood management and fisheries work. In addition, BART are working with Bristol Water on a number of projects to decrease sediment loads and hold water back in the catchment, as well as identifying and implementing areas of woodland creation. Although not directly impacting water availability, these solutions may impact water resources resilience.

West of England Joint Green Infrastructure Strategy 2020-2030

The West of England combined authority has developed a green infrastructure strategy, which is an ambitious environment programme focussed upon;

- Supporting resilient ecosystems and biodiversity.
- Mitigating and adapting the natural and built environment to climate change.
- Conserving and enhancing a legible network of physical green spaces.
- Reducing and managing flood risks and drought.

There are various elements to the strategy being delivered across the Rural Bristol Avon Rivers catchment, but there intention to create greater resilience to climate change through providing natural solutions to build resilience against the impacts of climate change (including use of well-designed GI to stabilise slopes and attenuate flood water, absorb carbon, and increased use of trees to reduce urban heating), as well as focussing on sustainable water management (by optimising and improve the use of GI to deliver an improved water environment by working with natural processes to help reduce flood risk, manage drought, improve water quality and improve connectivity to reduce the loss and quality of aquatic habitats and wildlife) which will have impacts on water resource availability in the Rural Bristol Avon Rivers catchments.

West of England Nature Partnership (WENP); Joining up the dots for nature

The West of England nature recovery network is a joined-up network of marine, water and terrestrial habitats where nature and people can thrive. The WENP strategy (2021-2030) includes activities such as tree planting, engagement with local farmers and the production of AONB nature recovery plans as well as engagement with regional policy, local authorities', NGOs and partnerships to ensure nature recovery.

Spring Restoration Schemes

There are currently a number of schemes looking at spring line restoration to improve springs and headwater catchments. The funding is coming through from the EA and local levies.

FWAG SW

There are a number of Farming and Wildlife Advisory Group (FWAG) projects across the Bristol Rivers catchment. One such example is being undertaken in the Maiden Bradley Brook catchment where there is a large project FWAG SW to reduce diffuse pollution from agriculture and looking at Natural Flood Management in headwaters.

A Better Biss Approach (ABBA)

The Wiltshire Wildlife trust has organised a project which will work in partnership with local authorities, charities, local businesses and community groups to restore and enhance the Biss catchment to improve habitats and to increase engagement of the river among landowners, communities and businesses, leading to a legacy of protection of the river.

CaBA opportunity mapping

CaBA's opportunity maps from the '**Working with Natural Processes - Evidence Base**' project[6] identify the types of measure that may be effective in flood and coastal risk management (FCRM) and wider ecosystem service benefits. These maps can be used to inform and prioritise future catchment measures.

Figure D4.1 shows the opportunity mapping across the Rural Bristol Avon Rivers catchment for:

- Floodplain reconnection.
- Tree planting in riparian areas (identified everywhere along the river network).
- Countryside stewardship options (for example, buffer strips, wildlife strips, regeneration of habitats, livestock fencing, coppicing of bankside trees, hedgerows).
- Priority habitat creation projects (at individual locations to create or restore habitats, e.g., Wellow Brook habitat restoration, Mardon River restoration project and Bydemill Brook natural flood management).

Wider scale implementation of these CaBA opportunities will help to deliver biodiversity and water quality benefits. Local channel, drainage and floodplain habitat restoration projects will also provide a vital role in improving the ecological resilience to droughts and dry periods. However, neither catchment-wide nor local habitat initiatives are expected to make much difference to river low flows, or to change the projected environmental flow deficits in the water bodies with abstraction pressures highlighted by the Environmental Ambition challenge.

[6] https://catchmentbasedapproach.org/learn/working-with-natural-processes-evidence-base/

Other projects

There are a number of other catchment projects which Wood do not directly impact Water Resources such as extensive monitoring programmes, the West Somerset Levels and Moors project and projects undertaken by FWAG.

These projects whilst not directly targeting water resource availability, may provide additional resilience during low flows.

4.2 Future planned projects

Mendip Quarry Reservoir

There are ongoing discussions about the potential for the utilisation of one of the Mendip quarry sites as a new reservoir source for Wessex Water. The project has assessed a number of historic quarry sites for feasibility to allow additional supply to the area, as well as additional transfer out of the catchment.

Cheddar 2

There has been ongoing work on the viability of the Cheddar 2 Reservoir. Originally reviewed a potential option for water transfer for Southern, this project is now under consideration for the next WRMP round to address resilience in Bristol Water area, potentially supplying up to 16 Ml/d (based on a 1 in 500-year event).

Bristol Avon Catchment Partnership (BACP)

The Bristol Avon River WFD catchment is covered by the Bristol Avon Catchment Partnership (BACP). As well as a range of currently active projects, the following projects have been proposed in the Rural Bristol Avon catchment:

- SHRIMP 2 - This is a proposed project to deliver more extensive river restoration improvements identities during the SHRIMP and the Upper Avon Sediment Pathways Projects.
- Upper Avon Restoration Project - This is a proposed large-scale river restoration opportunity: weir removal, river restoration, improved fish passage, reduced flood risk through increased floodplain connectivity.
- Brinkworth Brook Partnership Project - This partnership project could build on the work that Wessex Water is currently delivering; piloting a scheme with farmers to reduce levels of phosphorus from agricultural inputs in the Brinkworth sub-catchment.

4.3 WCWR Rural Bristol Avon Rivers catchment action plan

As is evident, some work is already underway or under consideration by catchment stakeholders in the Rural Bristol Avon Rivers catchment. There are a number of nature-based solution proposed across the headwater catchment which may deliver small-scale improvements to low flow availability as well as providing water quality and biodiversity resilience, but they are unlikely to significantly improve low flow resilience in the face of climate change. There are also some larger

strategic options provided in the form of the Mendip Quarry Reservoir site and Cheddar 2 which would increase the available supply in the area. Consultation with WCWR during this project has contributed to the development of a **strategic action plan of water company measures that could be implemented in a phased approach**. A phased implementation should deliver incremental benefits along the way and would require step-wise changes in abstraction regulation.

Both Wessex and Bristol Water are currently looking to deliver abstraction reductions through demand management but have considered a range of options that will impact the Rural Bristol Avon Rivers catchment but are currently not on their preferred list. Some of these options, may need to be reconsidered in the medium and long term. In addition, Wood has included a number of potential options that should be considered in response to the environmental ambition challenge in the Rural Bristol Avon Rivers catchment as seen in **Table 4.1**.

Schematic maps in **Figures C4.2** to **C4.4** show how the large-scale water company measures may be implemented over the short, medium, and long term.

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Table 4.1 Phased catchment action plan: Rural Bristol Avon

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
AMP7 and AMP8 investments	Customer side management options Leakage reduction	Enhanced metering, reduce distribution losses, leakage innovations, enhanced customer education and engagement and continued investment.	Rural Bristol Avon Rivers	Demand reduction			
Catchment Management	Catchment Schemes	Continuation of catchment management schemes and nature based solutions to improve water environment, and particularly, water retention in upper catchments. Low flow resilience not explicitly a goal in the Bristol Avon Catchment Plan. Add in goal for the BACP to work towards in a collaborative way.	Rural Bristol Avon Rivers	Water Quality			
Enhancing existing infrastructure	Refurbish old sources	Mothballed sources refurbished and brought back into supply - North	Rural Bristol Avon Rivers	Increase in supply			
Enhancing existing infrastructure	Increase performance of WTW	Consider increases to the performance of P01-01R and P01-02R, P08R and P10R WTW to increase deployable output to near licensed volume	Rural Bristol Avon Rivers	Increase in supply			
Local sources of water	Utilisation of more water from the Lower Bristol Avon	Assessment of viability and potential of a new abstraction at Saltford. Assessment of any other locations?	Rural Bristol Avon Rivers	Increase in supply			

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
Strategic Review	As above		Rural Bristol Avon Rivers	Supply resilience			
Local sources of water	New resources in Bristol Water area	Assessment of viability and potential of new sources in Bristol Water Area	Rural Bristol Avon Rivers	Increase in supply			
Regional solutions	New reservoir – Bristol Water	Cheddar 2, or alternate source	Rural Bristol Avon Rivers	Increase in supply			
Regional	New reservoir - Wessex	Mendip Quarry Reservoir, or alternate source	Rural Bristol Avon Rivers	Increase in supply			
Regional solutions	Desalination	A large desalination development on the south coast with the water transferred across the Wessex Water supply system.	South Coast (transfer) considered in WRMP				

5. References

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6. Figures

Environmental Destination

Figures accompanying Annex C: Rural Bristol Avon Pilot Catchment Plan to increase future water supply and environmental resilience

Figure C2.1 Rural Bristol Avon catchment: rivers and geology

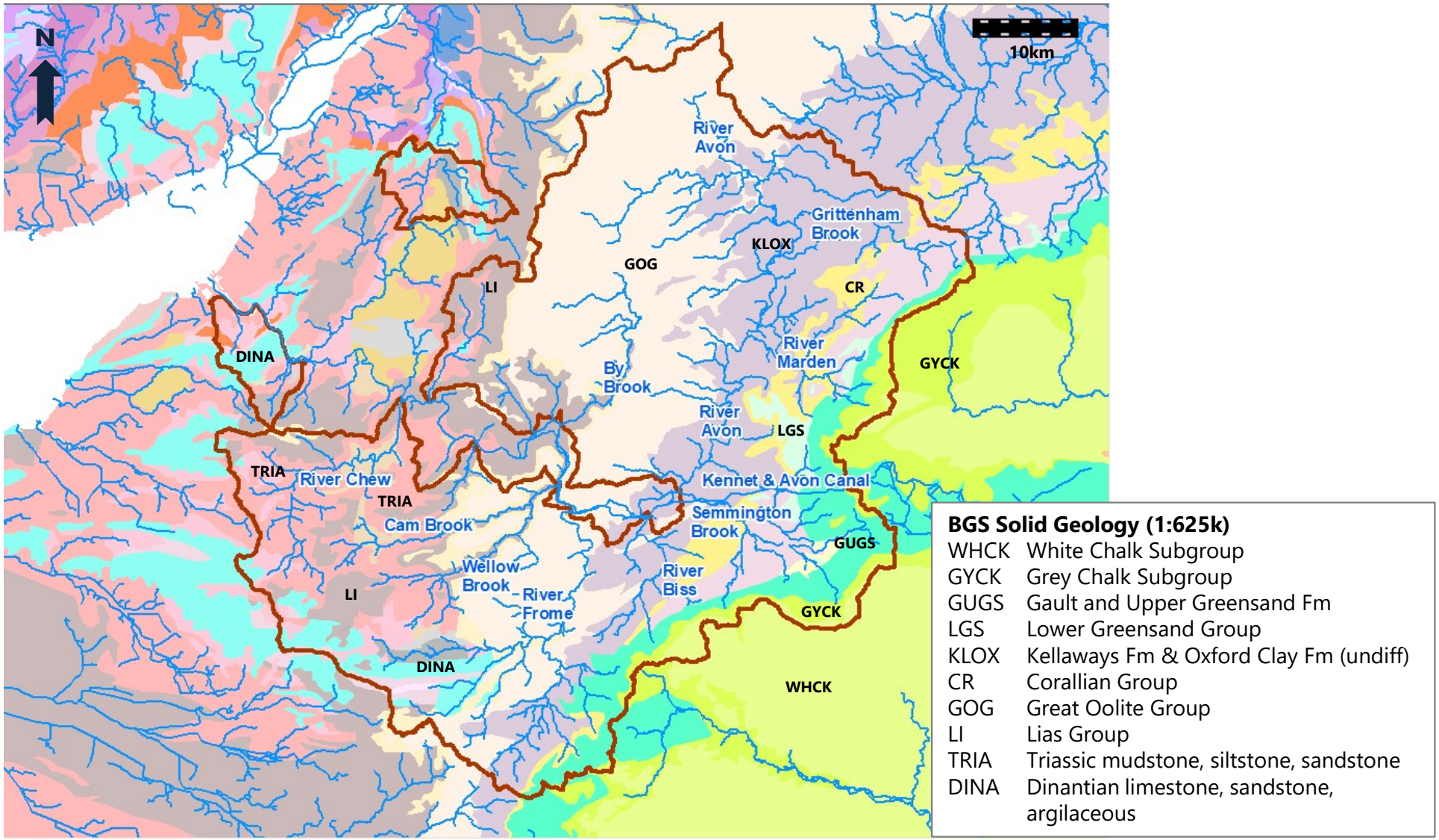


Figure C2.2 Rural Bristol Avon catchment: Designated sites and Drinking Water Safeguard Zones

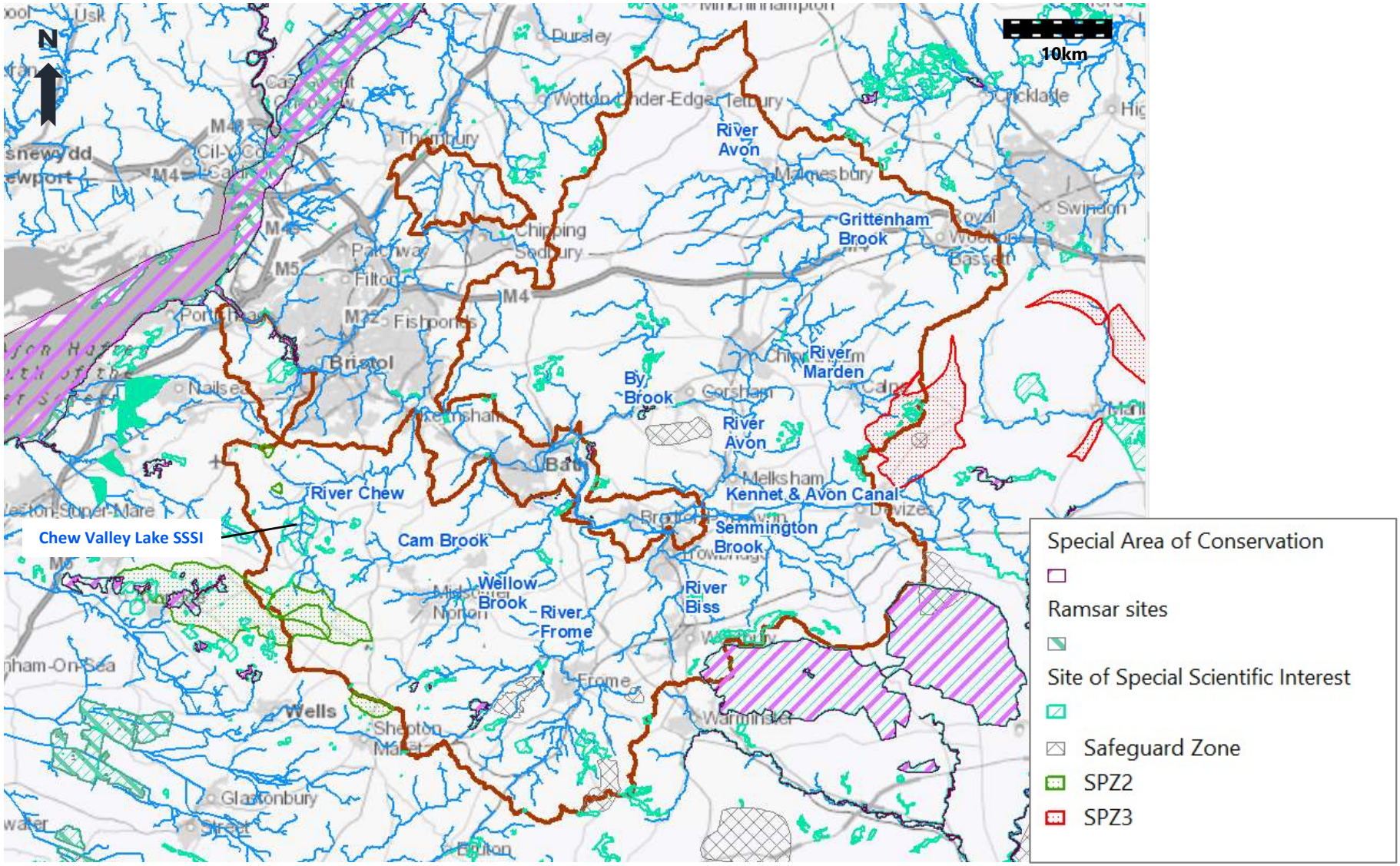
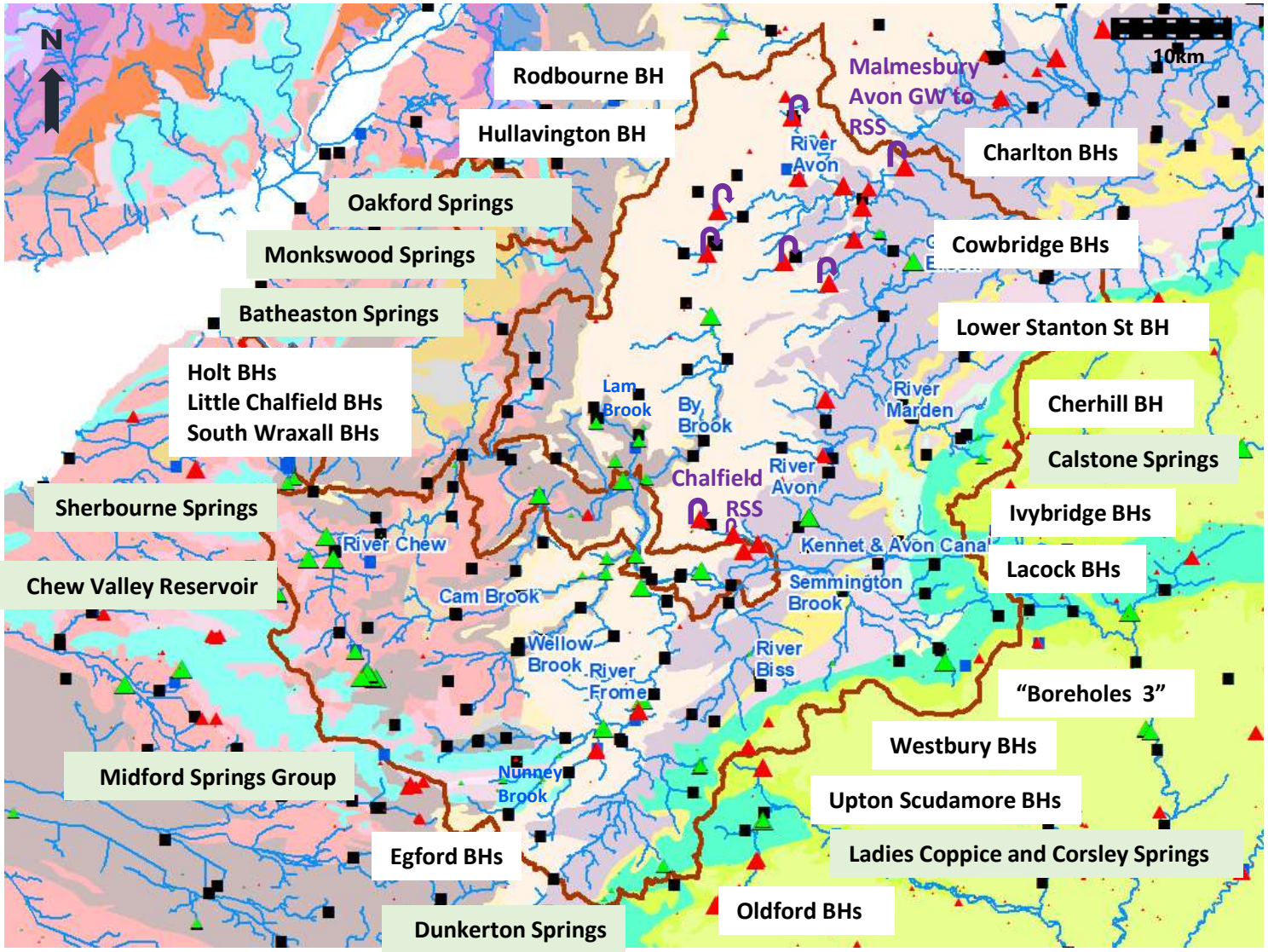
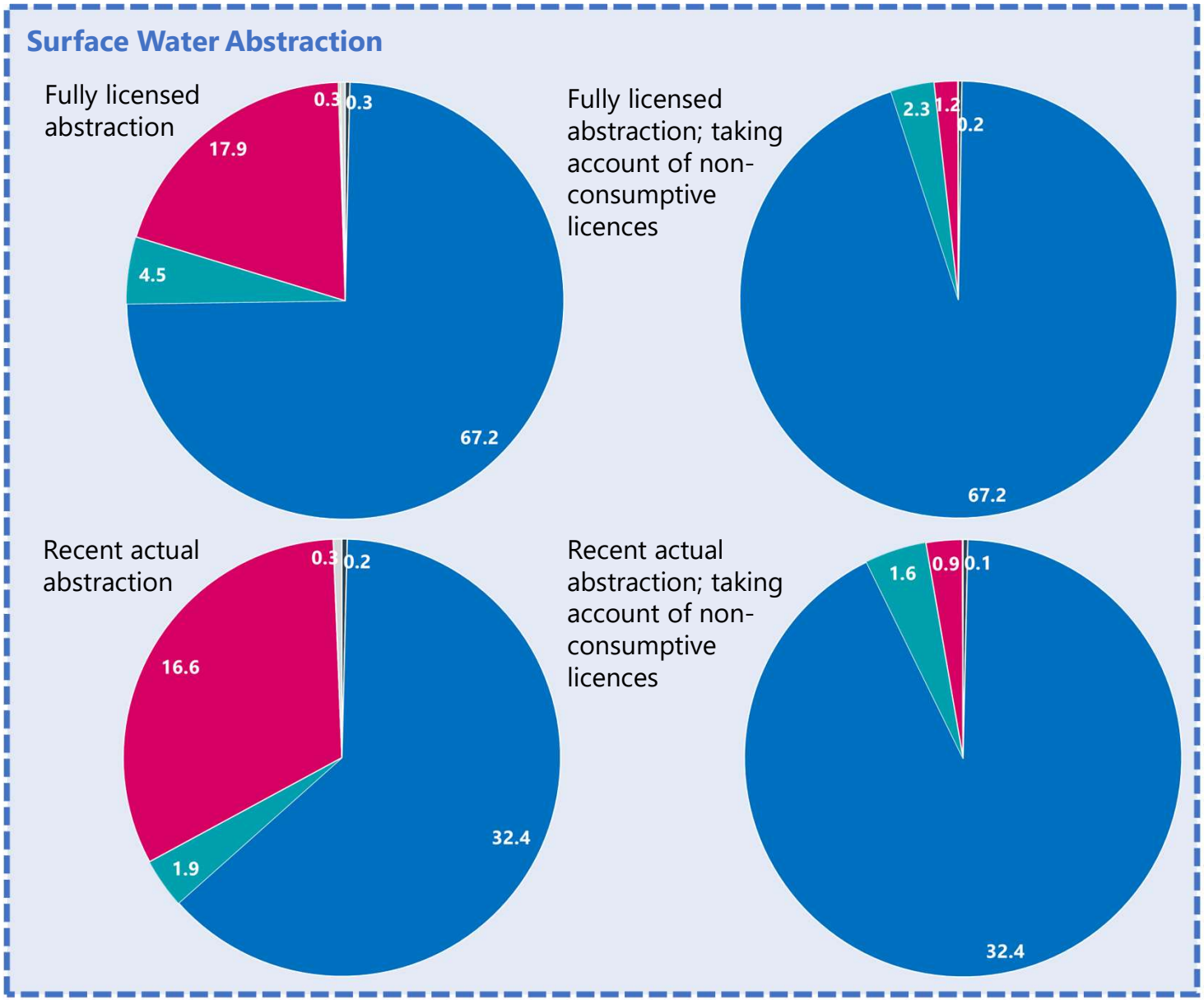


Figure C2.3 Rural Bristol Avon: PWS Groundwater abstractions, Surface water abstractions, WwTW Surface water discharges & river support schemes



Abstraction data downloaded June 2021 from Catchment Based Approach Data Hub website

Figure C2.4a Rural Bristol Avon catchment: Surface Water Abstraction by Sector (total, Ml/d)



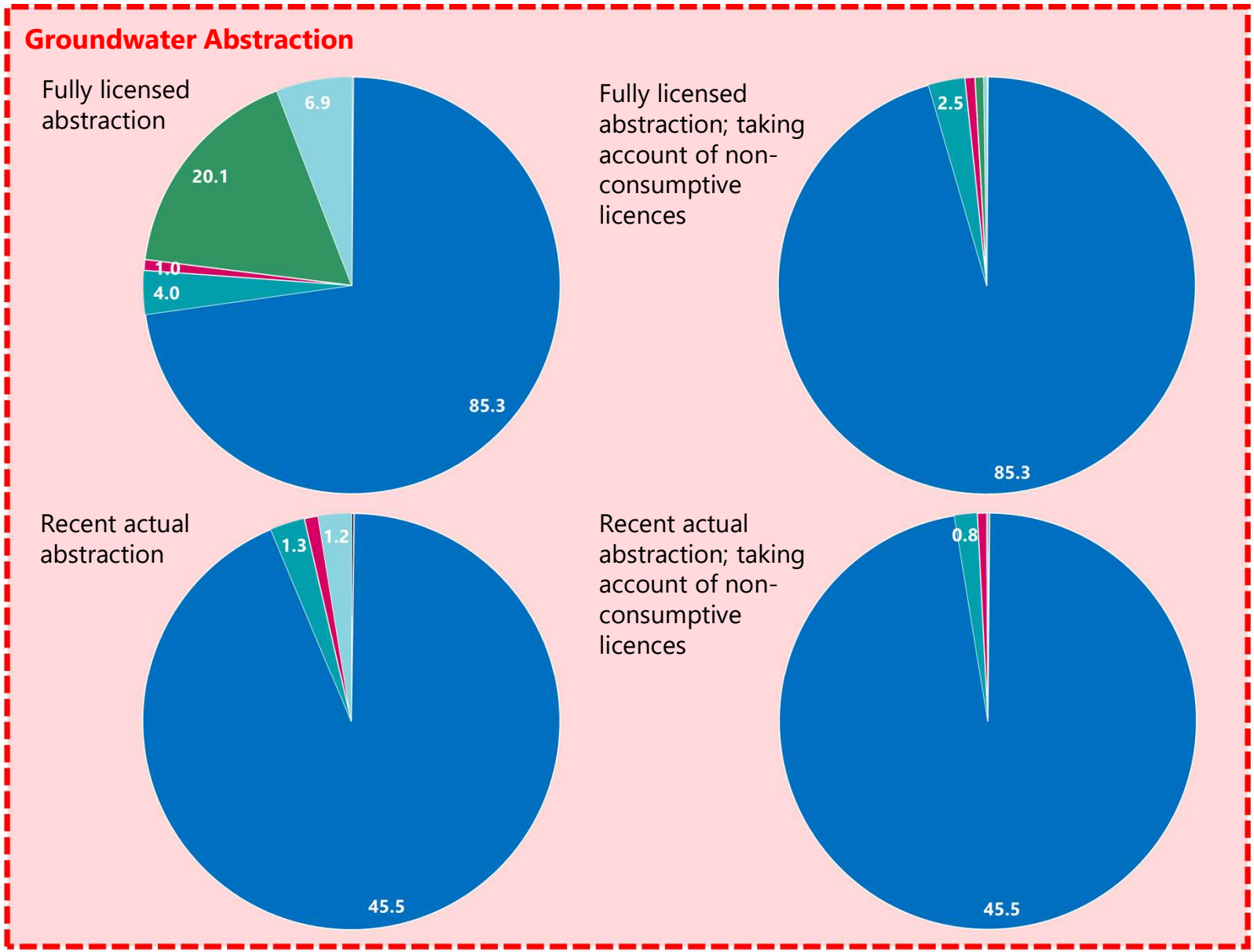
Non PWS supplies
(ARUP 2022 assessment output)

	Number	Ml/d Usage
Private Water Supplies	251	7.7
Number of unregistered residential address points	5,462	2.0
Dairy	62,054	6.6
Beef	36,549	1.5
Total Cattle	129,943	9.4
Total Sheep	81,269	0.6
Total Pigs	43,629	0.4
Total Poultry	2,185,576	0.7

Surface Water Abs Key

- Other water supply
- PWS
- Industrial and other
- Agriculture
- Energy Production
- Environmental
- Amenity
- Transfer Between Sources

Figure C2.4b Rural Bristol Avon catchment: Groundwater Abstraction by Sector (total, Ml/d)



River support schemes (Environmental & Transfer Between Sources)

Chalfield Brook
Wraxhall
Little Chalfield

Malmesbury Avon
Luckington
Stanbridge
Tetbury
Hullavington
Lower Stanton St Quinton
Charlton

Figure C2.5 Environment Agency water resource availability at Q30, 50, 70, 95 (Cycle 2, last updated 16 April 2021)

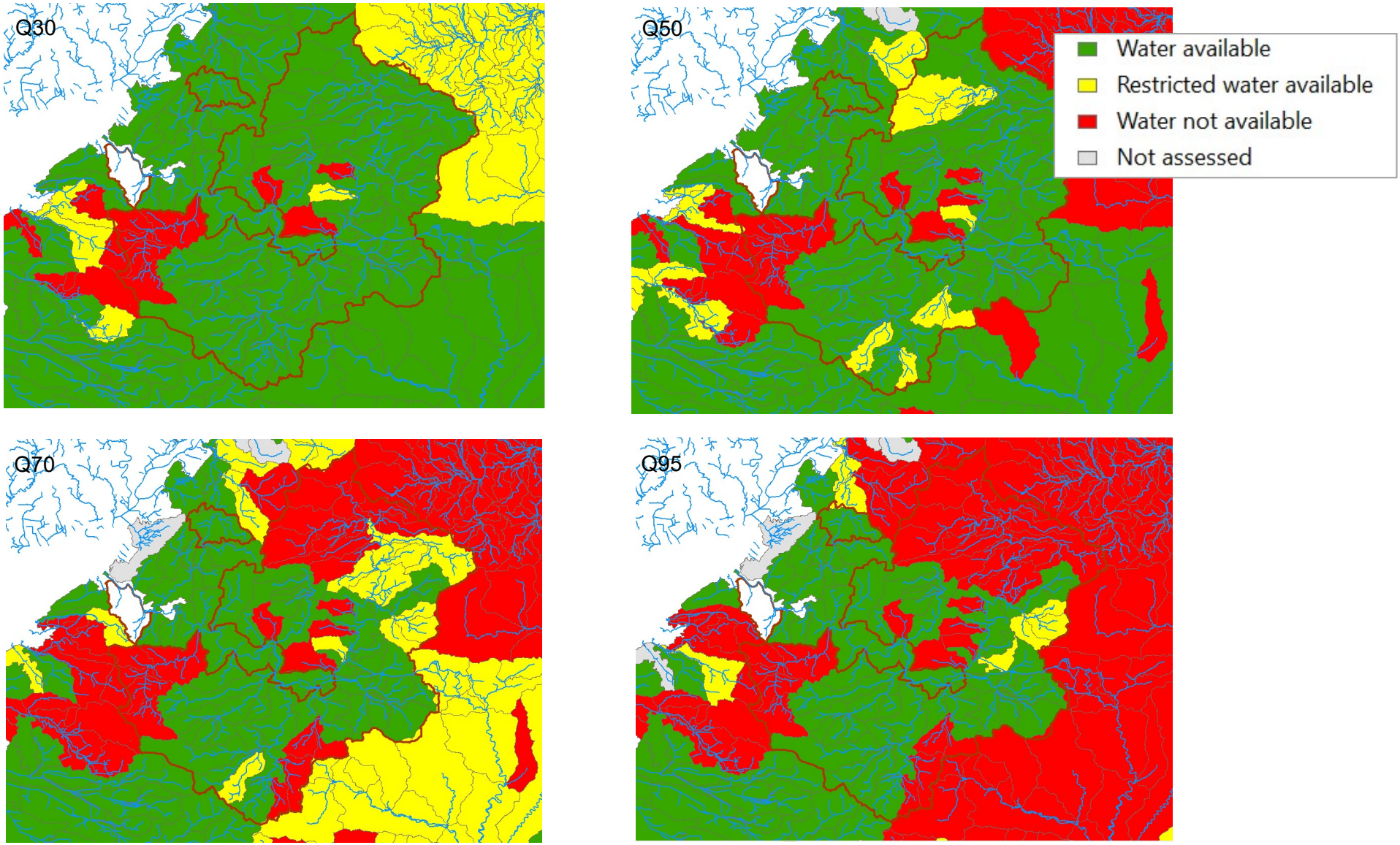


Figure C2.6 WFD water body overall status (Cycle 2, 2019)

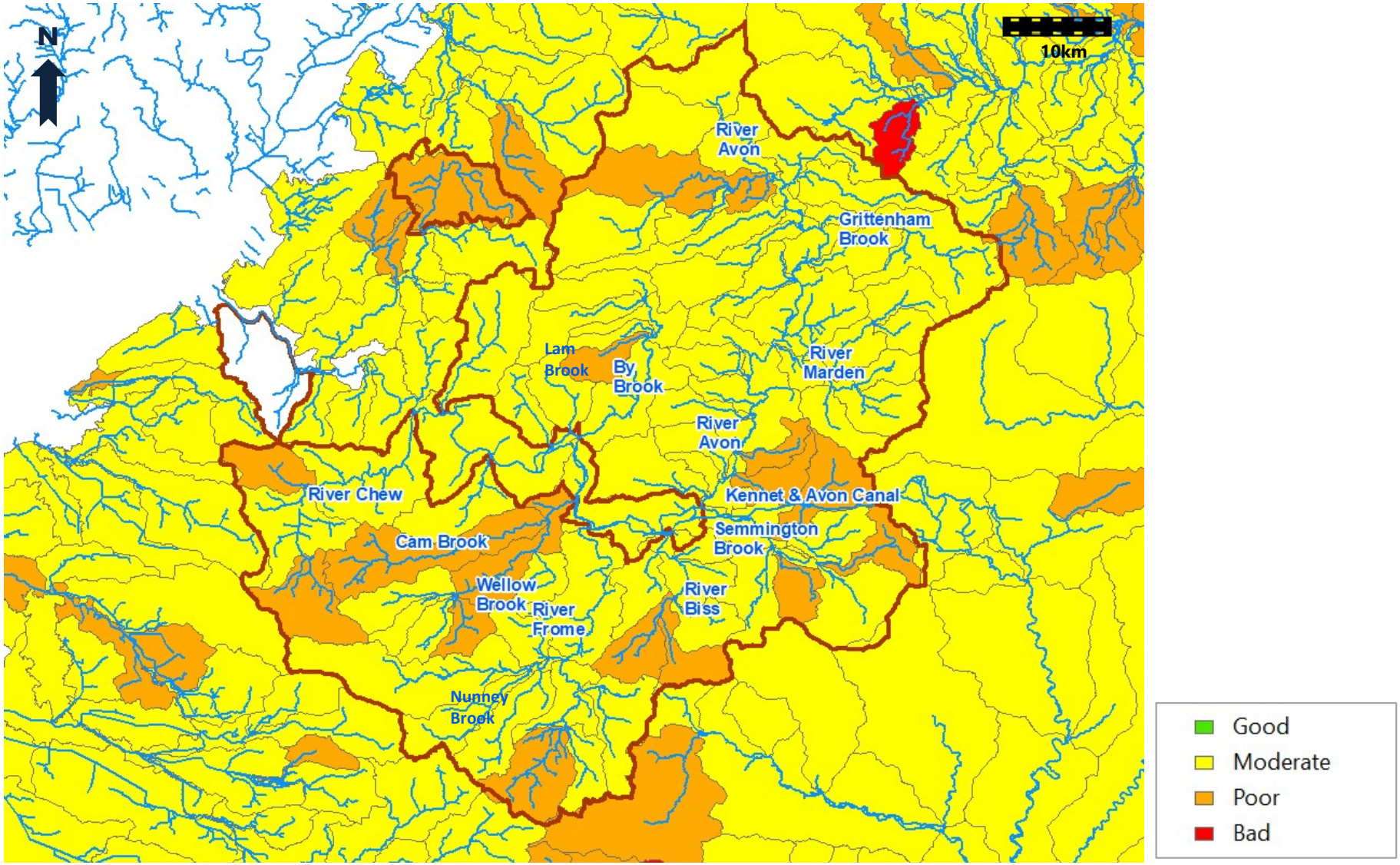


Figure C2.7 WFD water body ecological status (Cycle 2, 2019)

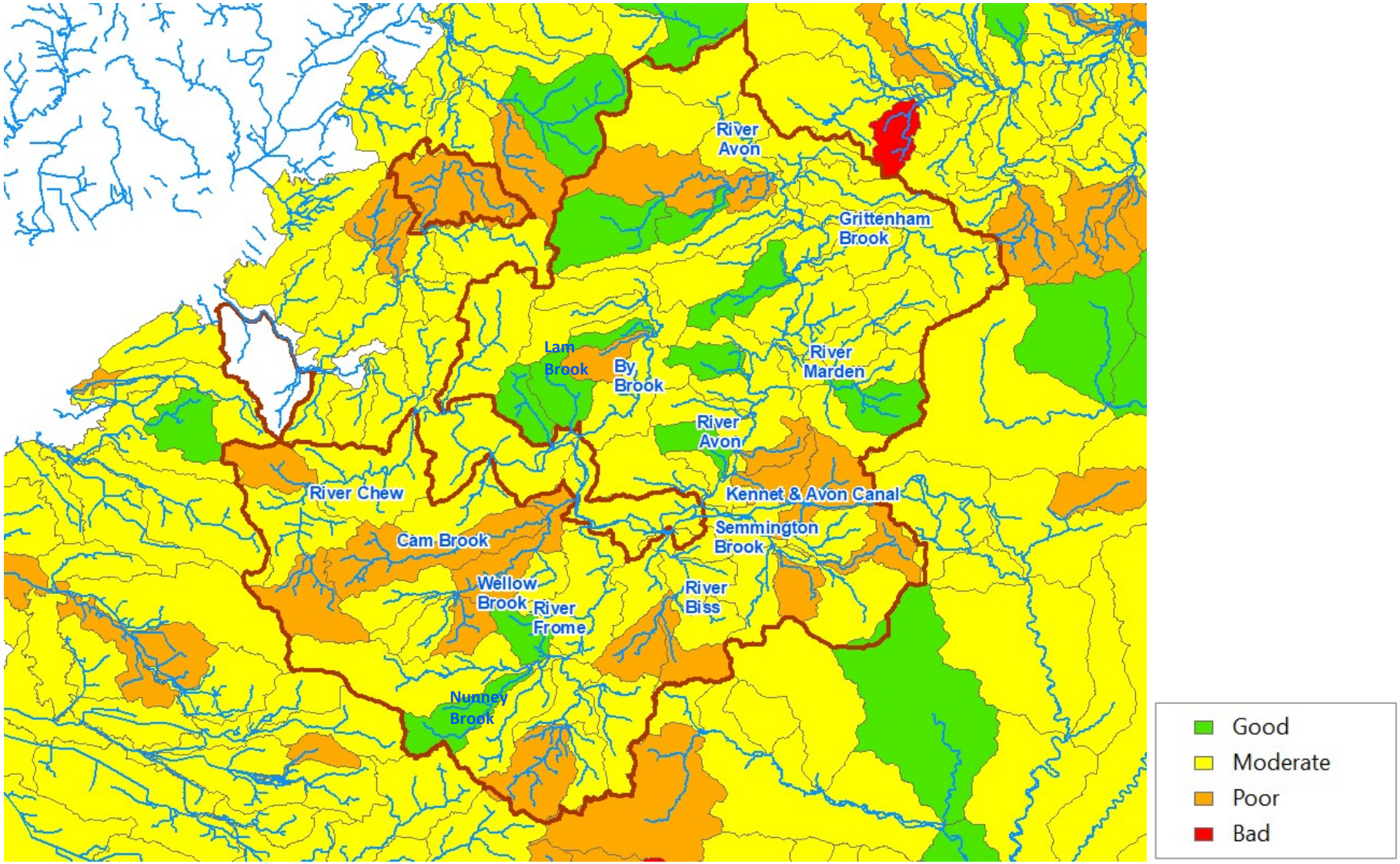
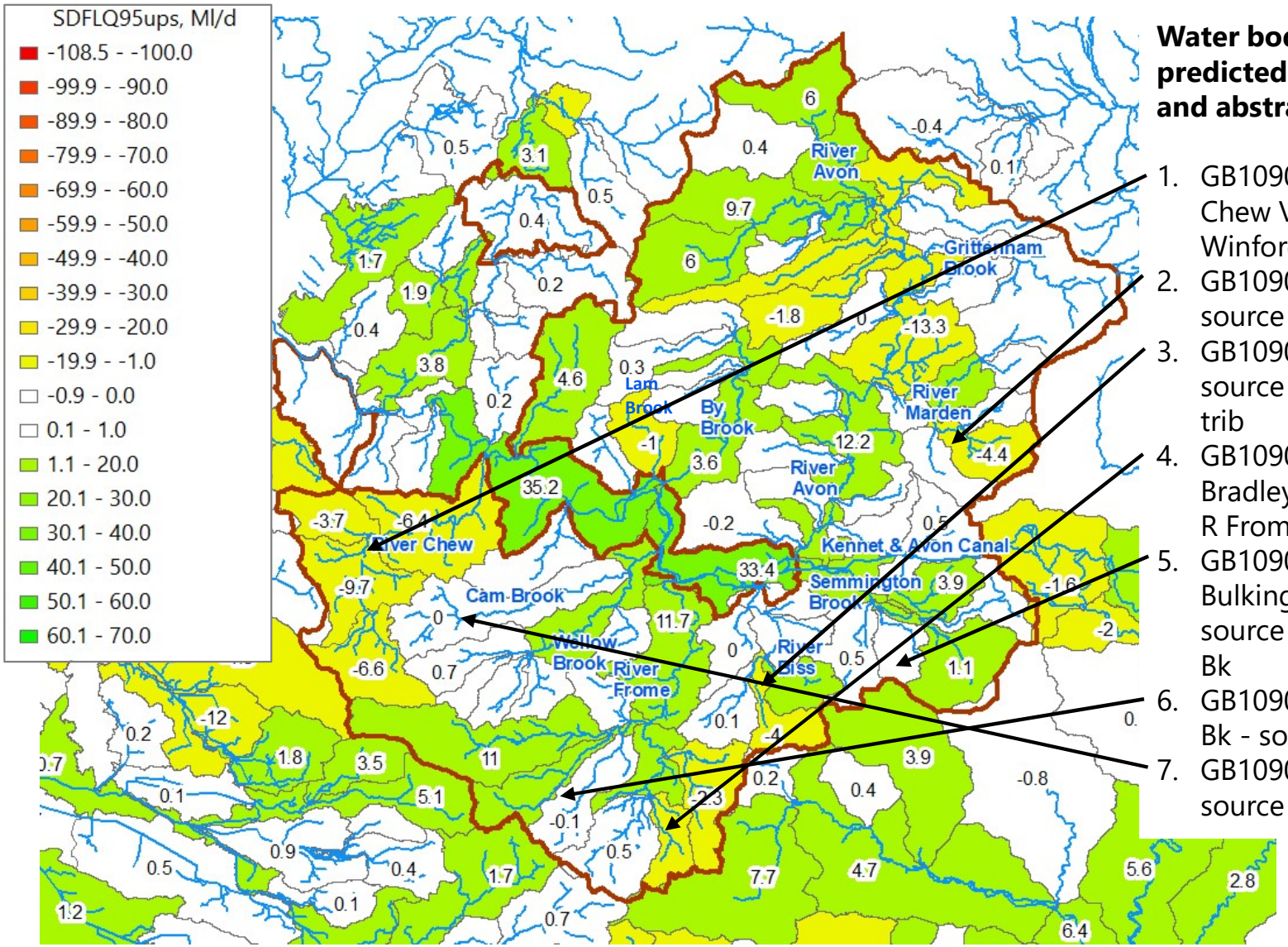


Figure C3.1 EA predicted fully licensed 2050 flow surpluses and flow deficits (Ml/d) for water bodies under Q95 low flow conditions (enhanced scenario)

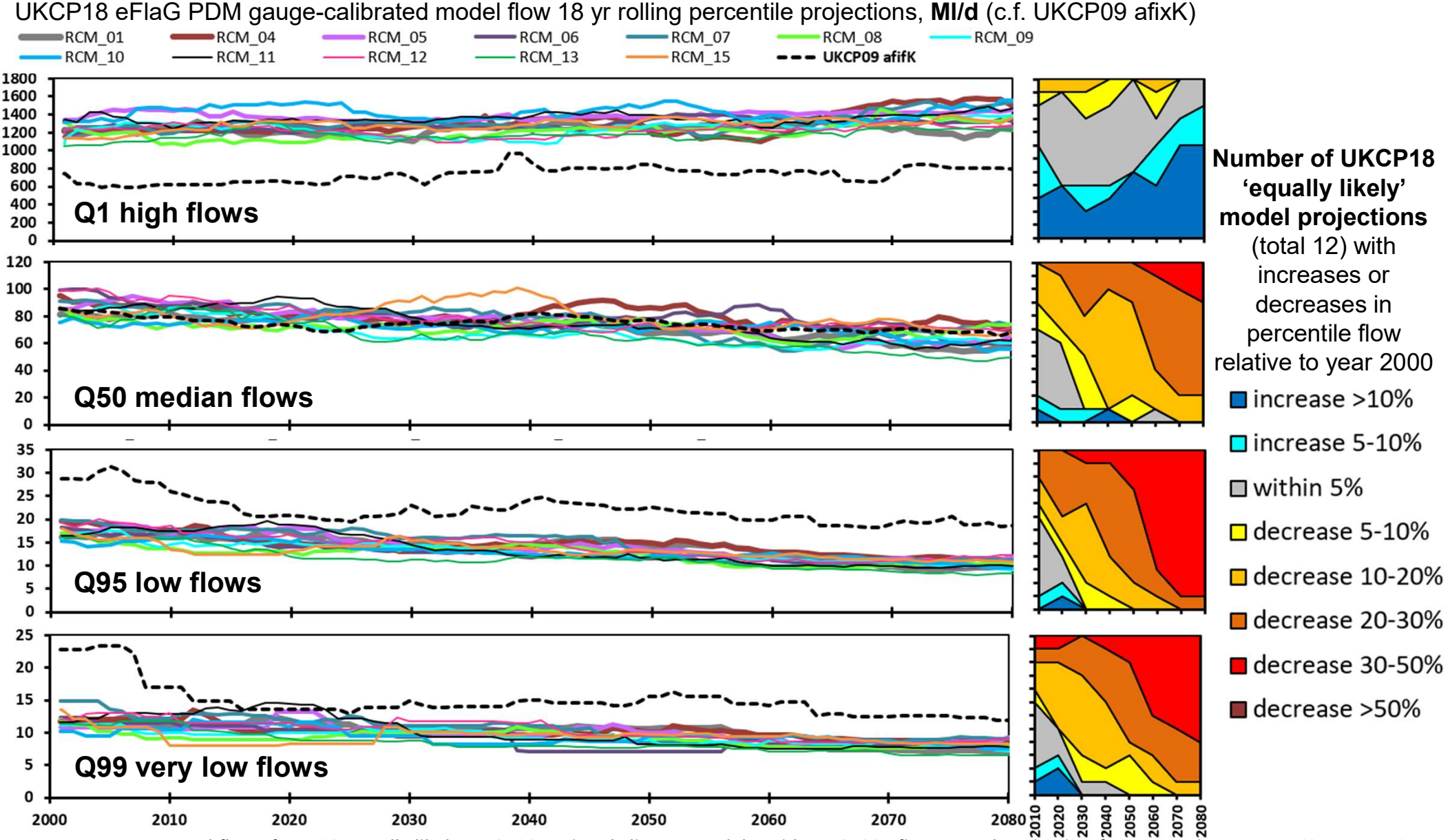


Water bodies with EA-predicted 2050 flow deficits and abstraction reductions

1. GB109053021852 Chew - Chew Valley Lake to conf Winford Brook
2. GB109053022050 Marden - source to conf Cowage Bk
3. GB109053021750 Biss Bk - source to conf unnamed trib
4. GB109053022090 Maiden Bradley Bk - source to conf R Frome
5. GB109053022140 Bulkington Drove w/c source to conf Semington Bk
6. GB109053022000 Nunney Bk - source to conf Mells R
7. GB109053022290 Cam Bk - source to conf Wellow Bk

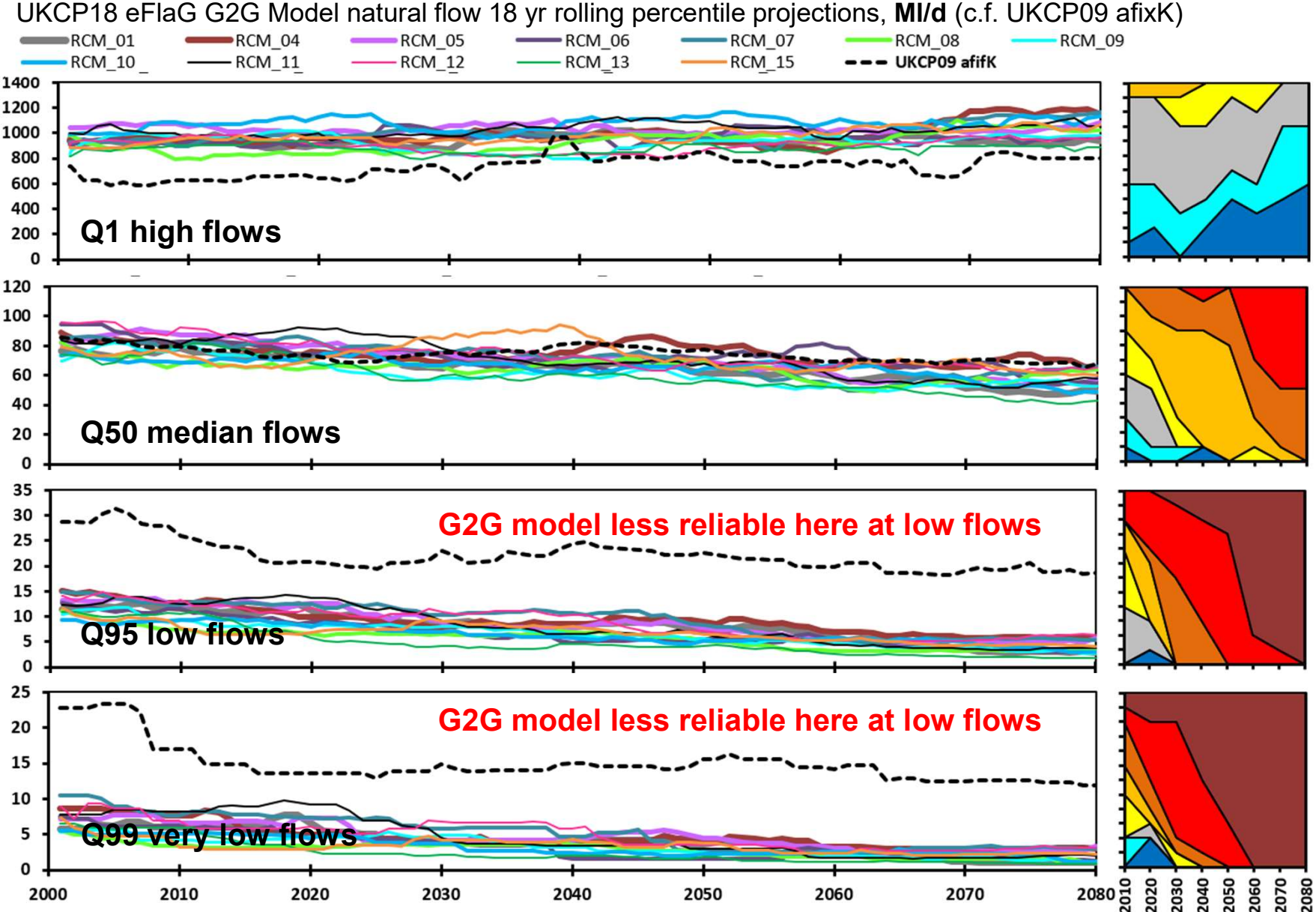
Data from EA's National Framework modelling in 2020

Figure C3.2 Flow changes expected due to climate (Bristol Frome at Frenchay): Projections from UKCP18 climate & PDM gauge-calibrated river flow models



Data source: natural flows from 12 equally likely UKCP18 regional climate models (with UKCP09 afixK natural projection for comparison): https://eidc.ac.uk/

Figure C3.3 Flow changes expected due to climate (Bristol Frome at Frenchay): Projections from UKCP18 climate & G2G national natural river flow models

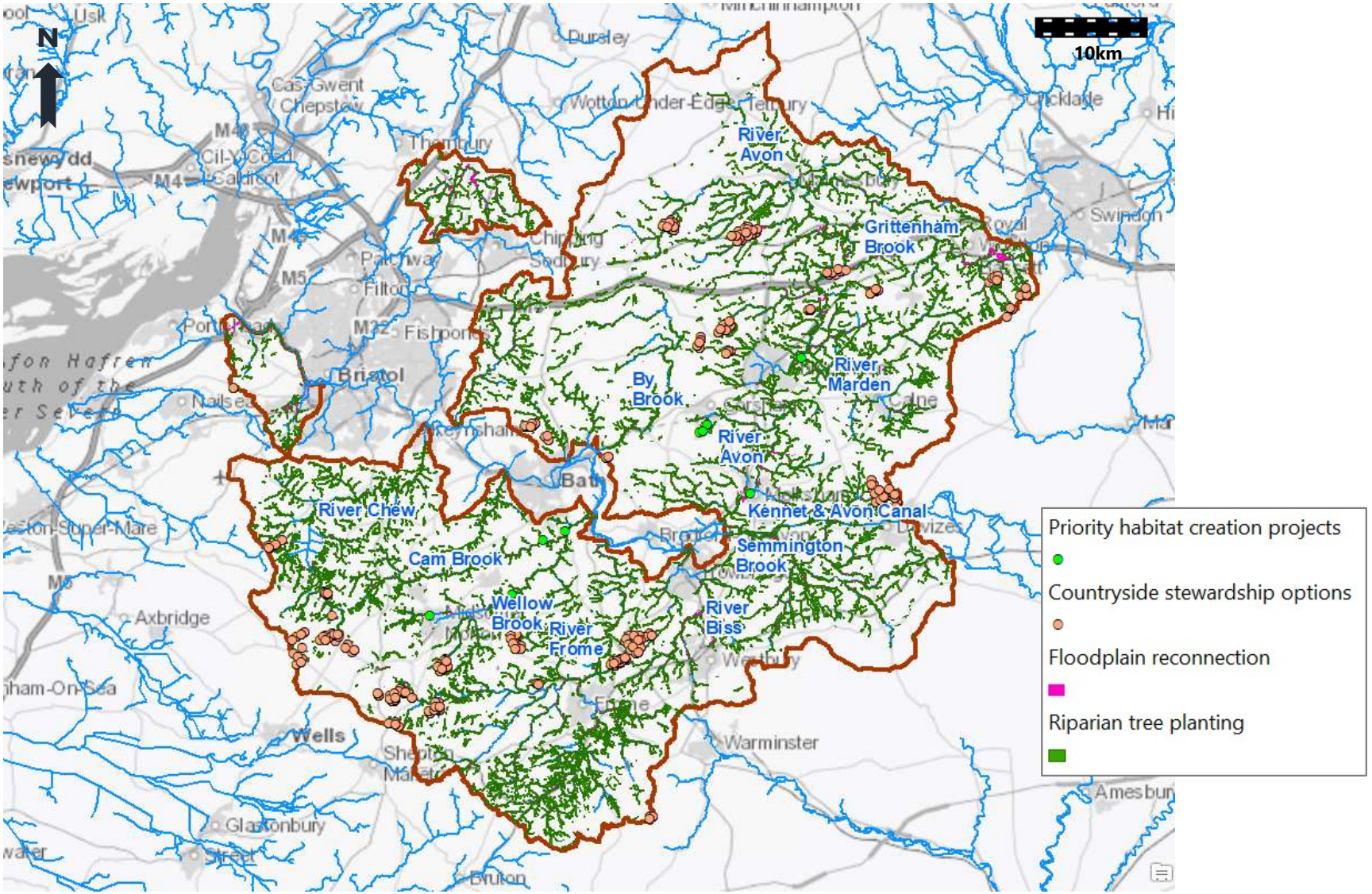


Number of UKCP18 'equally likely' model projections (total 12) with increases or decreases in percentile flow relative to year 2000

- increase >10%
- increase 5-10%
- within 5%
- decrease 5-10%
- decrease 10-20%
- decrease 20-30%
- decrease 30-50%
- decrease >50%

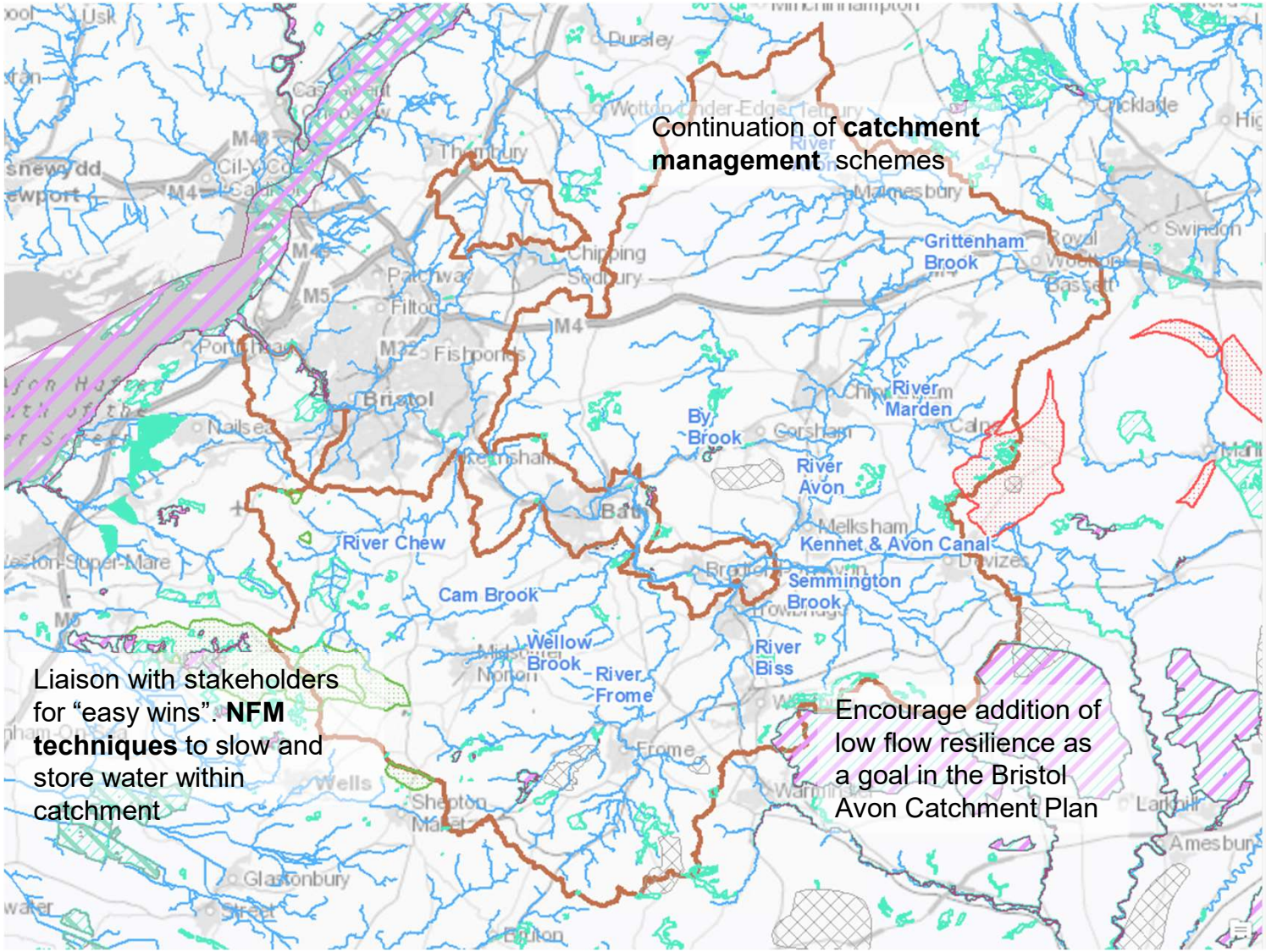
Data source: natural flows from 12 equally likely UKCP18 regional climate models (with UKCP09 afixK natural projection for comparison): https://eidc.ac.uk/

Figure C4.1 Rural Bristol Avon catchment CaBA opportunity mapping



Data downloaded June 2021 from Catchment Based Approach Data Hub website

Figure C4.2 Short term 2030 catchment measures: Rural Bristol Avon



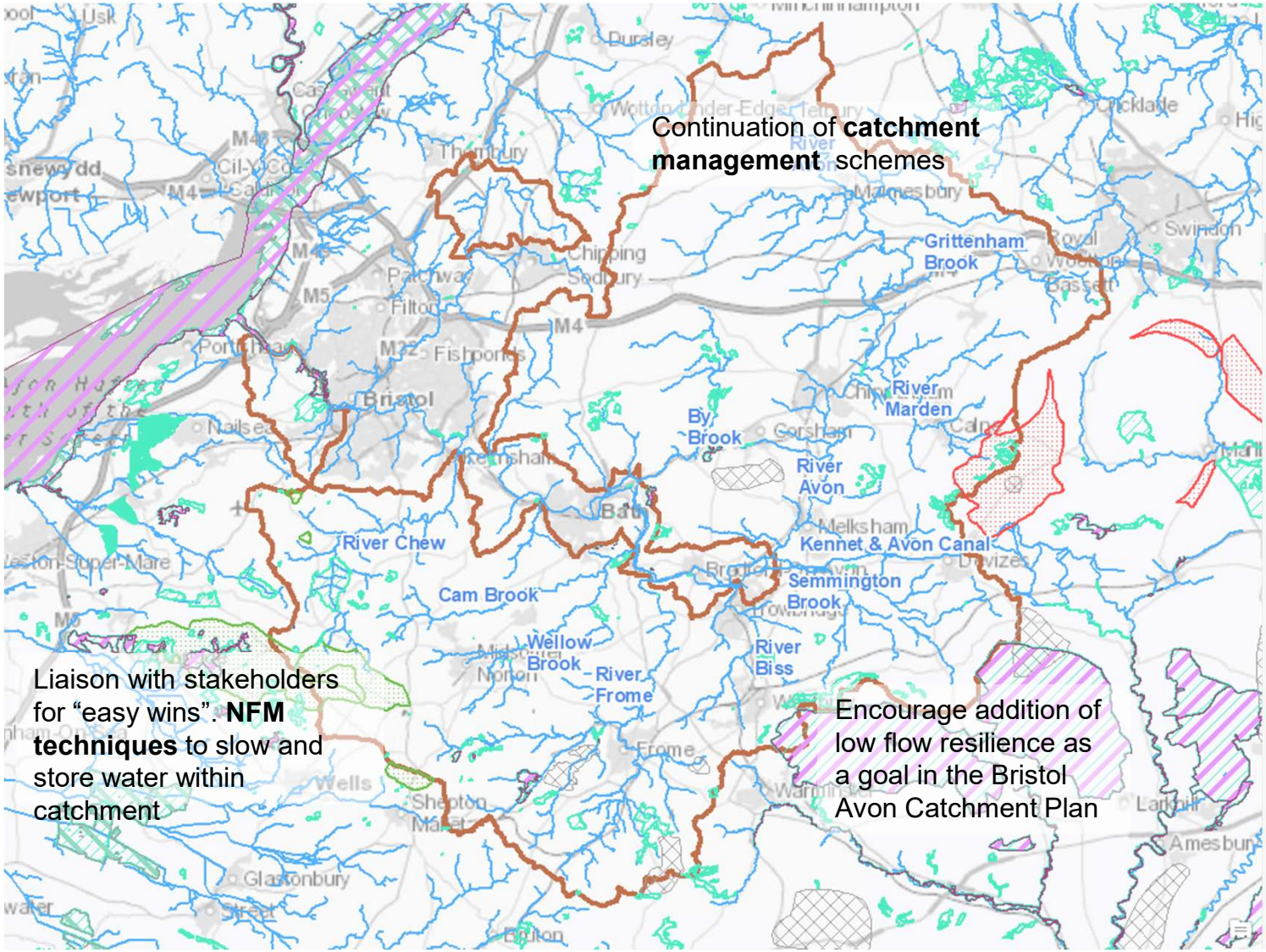
Investigations:

1. Continued review of Environmental Ambition Targets
2. Review potential to refurbish old sources
3. Assessment of viability and potential of new sources in Bristol Water Area
4. Review potential to upgrade WTW to increase deployable output

Other Activities

1. AMP7/8 Customer Side Management Options
2. Demand Reduction
3. Leakage Reduction

Figure C4.3 Medium term 2040 catchment measures: Rural Bristol Avon



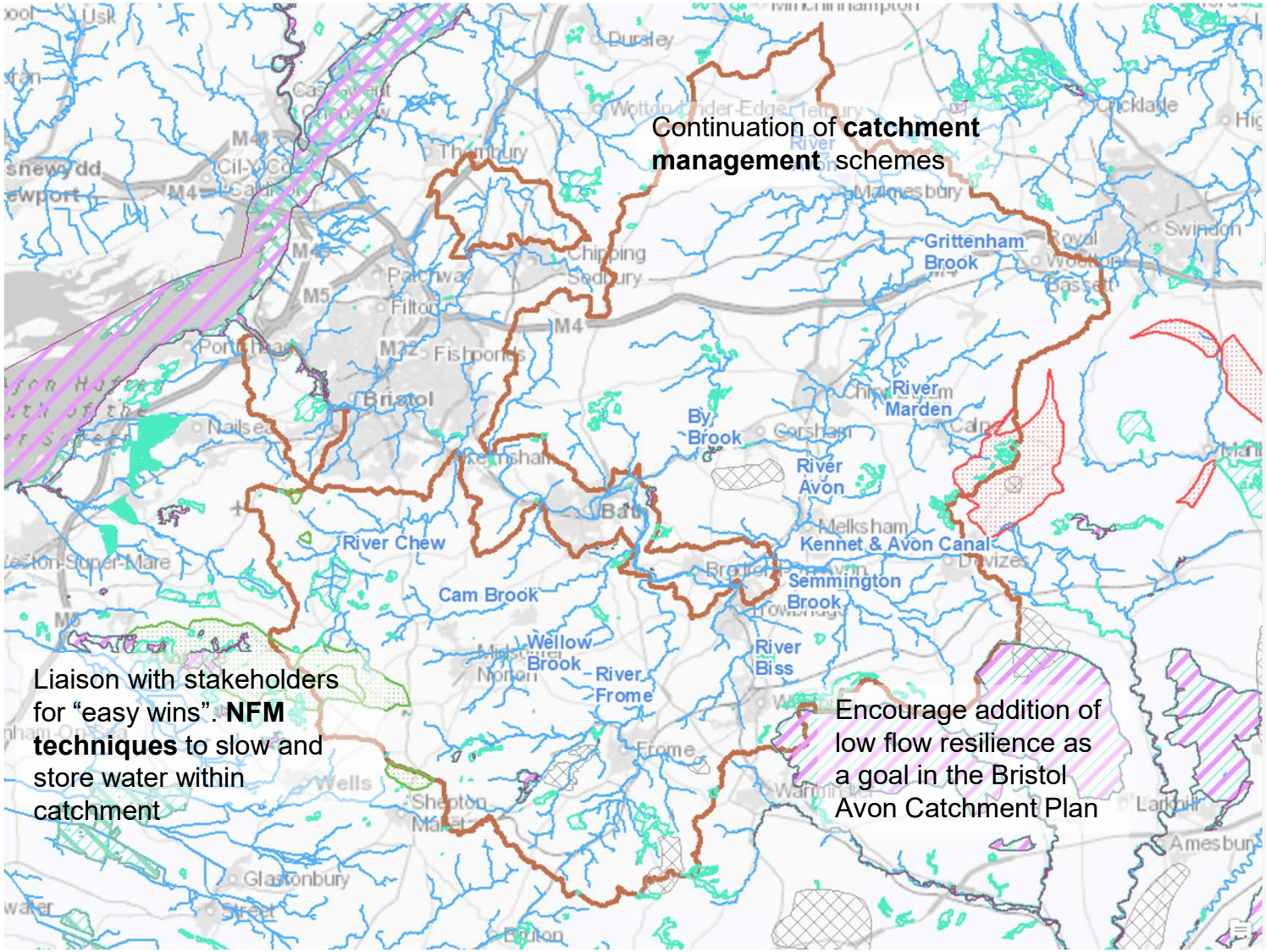
Investigations:

1. Continued review of Environmental Ambition Targets
2. Refurbish old sources
3. Drill or connect new water sources
4. Upgrade WTW to increase deployable output
5. Assessment of water resource availability and feasibility in the lower Bristol Avon to allow reduction in abstraction from rural Bristol Avon Rivers. Include strategic review of sources.

Other Activities

1. Addition of Cheddar 2 to increase Bristol Water supply resilience?
2. Mendip quarry reservoir to increase Wessex Water supply resilience?

Figure C4.4 Long term 2050 catchment measures: Rural Bristol Avon



Investigations:

1. Continued review of Environmental Ambition Targets
2. Implement any changes from strategic review of abstraction sources and abstraction patterns between lower Bristol Avon and rural Bristol Avon Rivers.

Other Activities

1. Cheddar 2
2. Mendip quarry reservoir
3. Desalinated water import from south coast