West Country Water Resources

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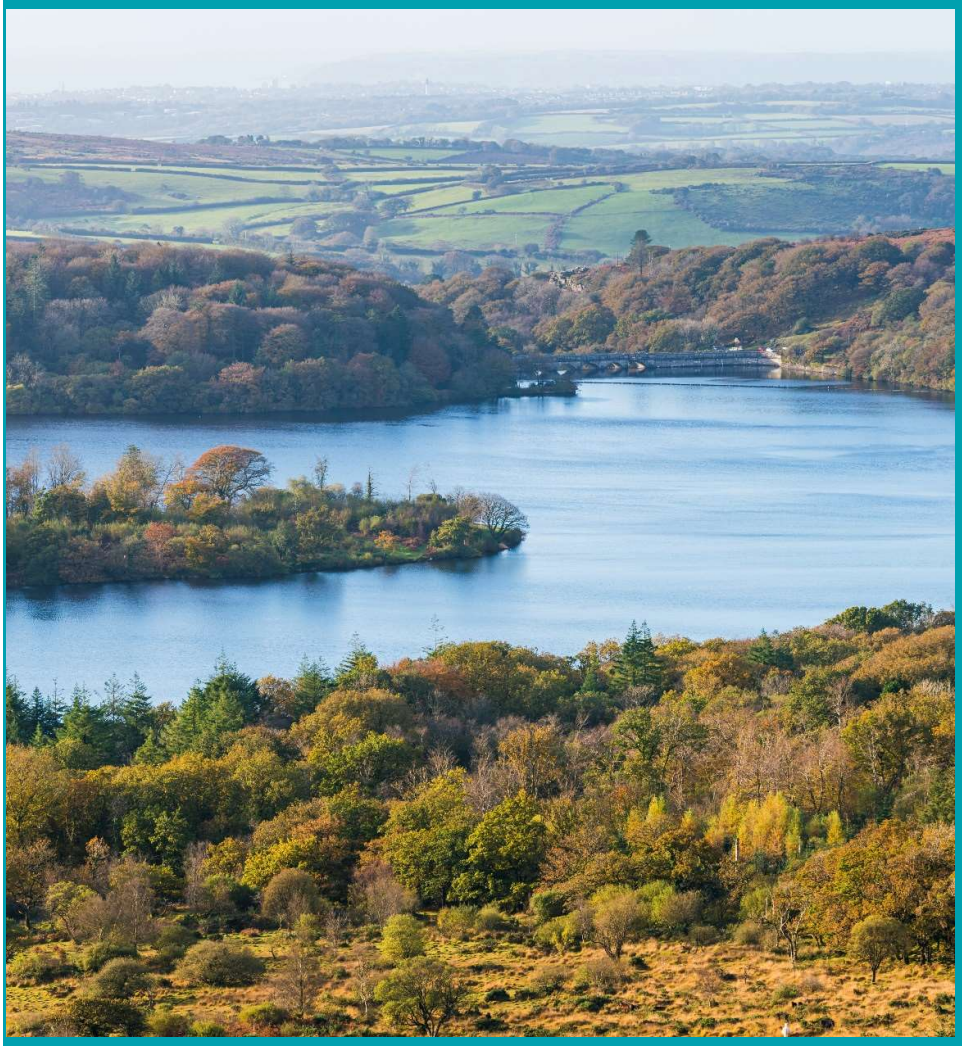
West Country Water Resources Group

Environmental Destination

Annex D: Tamar pilot catchment plan to increase future water supply and low flow environmental resilience



Wood Group UK Limited – November 2021

Draft - see disclaimer

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Doc Ref. 807434-WOOD-WRG-TA-RP-OW-0001_S0_P01.1docx

https://woodplc.sharepoint.com/teams/environmentalambition-wood/shared documents/wood/trial catchments/deliver/reporting/draft/annex d tamar/807434-wood-wrg-ta-rp-ow-0001_s0_p01.1.docx

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Document revisions

No.	Details	Date
i1.0	Draft for review	January 2022

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1. Overview

This document is one of five technical annexes that lay out plans for holistic measures that may be implemented in five 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 pilot catchment plan

This pilot catchment plan sets out the measures best suited to achieve future water resources resilience and improvement in the **Tamar 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 at the back of this Annex in **Section 0 (filename '807434-WOOD-WRG-TA-RP-OW-0001_S0_P01.1.ppt')**.

2. Catchment summary

The Tamar catchment is a rural catchment underlain by predominantly impermeable bedrock with low groundwater reserves. There is additional pressure on the Tamar catchment during the summer months due an influx of tourists to the region. 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 diffuse and point sources of pollution.

2.1 Why the Tamar pilot?

The WCWR scoring and consultation process for pilot catchment selection is presented in the main report.

The **Tamar catchment** has a relatively flashy, runoff-dominated response to rainfall – there is little groundwater storage buffer to reduce flood peaks or improve the natural resilience of summer baseflows. So medium to low flows are projected to fall significantly through to 2050 and beyond because of climate change, with some increase in the severity and frequency of higher flood flow events also likely. The summer seasonal peak in water demand associated with tourism is a significant pressure. The Environmental Ambition challenge calculations are still under review but suggest that large scale reductions in public water supply abstraction impacts on medium and lowish flows would be needed to stay within acceptable limits. Options for enhancing the pumped storage associated with Roadford Reservoir and connecting it better with Wimbleball Reservoir to the east are under consideration, as are alternative winter refill patterns for Burrator Reservoir. To the west, significant reductions in abstraction from the River Camel SAC are also being considered.

It will be important to join-up these water resources-focused plans alongside ongoing interventions to improve water quality and ecological resilience to low flows through land use, soil and drainage management.

2.2 The current state of the catchment

Geography, geology, rivers and environmental designations

The River Tamar catchment rises on Woolley Moor and flows southwards from just 4 miles off the Atlantic Ocean coast southwards towards Plymouth Sound (**Figure D2.1**). Its tributaries include the Deer, Claw, Ottery, Carey, Kensey, Inny, Lyd, Thrushel, Wolf, Tavy, Lynher, Meavy, Plym and Yealm. The Tamar catchment encompasses the city of Plymouth, and the towns of Tavistock, Launceston and Holsworthy, however, much of the catchment is rural, and undeveloped (**Figure D2.2**). Estimates provided by the Environment Agency back in 2012 suggest just 4% of the catchment was urbanised when the area had population of just over 341,000 (EA, 2012b).

The Tamar catchment is underlain primarily by Mudstones, Siltstone and Sandstone bedrock of the Holsworthy and Teign Valley Group in the upper catchment giving way to the mudstones, siltstones and sandstones of the Upper Devonian (**Figure D2.1**). To the east and west of the Tamar catchment there are outcrops of Granite on Dartmoor and Bodmin Moor. The largely impermeable bedrock is mostly at outcrop but along the river corridors the bedrock is overlain by alluvial silts and clays and terrace deposits (**Figure D2.1**).

The underlying geology means the catchment is very "flashy" with a quick response to rainfall events (EA, 2012a). Naturally low flows can occur during the summer months as a result of the low baseflow component from a lack of significant groundwater reserve. The long-term average annual rainfall across Devon and Cornwall is around 1100 mm/a and rainfall across the area varies with higher totals over Bodmin Moor, Dartmoor and Exmoor (EA, 2017). In 2012, the Environment Agency summarised annual rainfall ranges from more than 2,000 mm/a on the edge of Dartmoor to less than 1,000 mm/a on the coastal lowlands (EA, 2012a).

Designated sites in the catchment include Special Areas of Conservation (SAC), Special Sites of Scientific Interest (SSSI) and Ramsar sites (**Figure D2.2**) as well as a number of SPAs, and LNRs. Of note is the Dartmoor SAC to the east of the catchment. Dartmoor is the southernmost blanket bog in Europe and is also designated for northern Atlantic wet heaths with Erica Tetralix and European dry heaths (JNCC[1]). The Tamar catchment encompasses the South Devon, Tamar Valley and Cornwall AONBs (Areas of Outstanding Natural Beauty).

Abstraction pressures

Abstraction within the Tamar catchment is predominantly from surface water sources for water supply, agricultural and industrial use as energy production (**Figure D2.3**). There are a number of other South West Water abstractions within the Tamar catchment, the majority of which are associated with Water Resources Heavily Modified Water Bodies (HMWBs) (Roadford Lake, Burrator Reservoir, Upper and Lower Tamar Lakes), and the downstream river intake at Gunnislake. There are also two river abstractions on the River Yealm and Withey Brook.

As seen in **Figure D2.4** there are also some very large power generation abstractions, but these are largely non-consumptive (except at Abbey Weir, as discussed in Section 4). **Figure D2.4** shows that in terms of recent actual abstraction (apportioned for non-consumptive licences) almost half of abstraction is for public water supply, with approximately 1/6th each abstracted for industrial use, agricultural use and power generation. Recent actual surface water abstraction is in the region of 250 Ml/d.

There are several considerably smaller groundwater abstractions for agricultural and industrial uses, the largest groundwater abstractor in the catchment is Dairy Crest. As seen in Figure D2.4 recent actual groundwater abstraction is less than 1 Ml/d.

The Tamar catchment is also a prime spot for tourism, which brings water related challenges as demand increases significantly during the dryer summer months.

There are no drinking water safeguard zones in the Tamar catchment (**Figure D2.2**).

[1] https://sac.jncc.gov.uk/habitat/H4010

Water resource availability

Environment Agency published maps of water body water resource availability at a range of flows are shown in **Figure D2.5** (Cycle 2, Environment Agency 2021[2]). Green indicates where there is more water than required to meet the needs of the environment, yellow indicates where licensed flows fall below the Environmental Flow Indicators (EFI) or there is no more water available for licensing at these flows, and red indicates where there is no more water available under any flow conditions. The last abstraction licensing strategy for the Tamar catchment was published back in 2012.

The Environment Agency have assessed that in high and moderate flows (Q30 and Q50), there is restricted water available or no water available in the Upper Tamar Lakes, River Wolf (Roadford Reservoir), River Tavy and River Meavy (Burrator Reservoir) catchments (**Figure D2.5**). Under low flows (Q70), the whole Tamar catchment, the River Tavy and the River Meavy are assessed as either restricted or no water available. The results under Q95 change, and most the catchment has water available for licensing, except in the Tavy, Meavy, Plym and Yealm catchments.

Flood risk

The Tamar catchment has a history of fluvial, pluvial and tidal flooding. In the upper reaches, the main cause of flooding is the impervious bedrock and steeper catchments causing rapid run-off and a flashy response is characteristic. In some of the towns across the Tamar catchment, flooding is caused by inadequate drainage systems, and in the lower catchment, a mix of high tides and heavy rainfall can cause tidal flooding, as well as inundation caused by spring tides. The Environment Agency note to the west of the Tamar, river flooding is often caused through a combination of structure blockages and excessive surface water flows which results in rapid and often very localised flooding (Environment Agency, 2012).

Water quality pressures

The heavy agricultural land use in the catchment has led to water quality issues including phosphates, sediments, nitrates and pesticides. Much of the Tamar is designated as a priority catchment under DEFRA's Catchment Sensitive Farming Programme.

South West Water operates the sewage treatment works from small towns and villages in the catchment which return mains water to the river but these discharge rates are relatively small. Waste water from the city of Plymouth is treated and discharged to Plymouth Sound. These discharges are 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.

There are also large consented discharges from mineral workings (e.g. for china clay) into the River Plym and Tory Brook which flow into Plymouth Sound from the south west slopes of Dartmoor.

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

Future population pressures

In the Tamar catchment, future population growth is not forecast to be significant.

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 A2.6**. 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 Tamar water bodies (Cycle 2, 2019) is mapped on **Figure A2.7.**

There are several key reasons for the failure to achieve good status mapped in both **Figures A2.6 and A2.7** which have nothing to do with abstraction pressures:

- In the catchments in the upper Tamar (Lamberal Water, Tamar (Small Brook to Lamberal Water), Tamar (Small Brook to River Deer), Derril Water and Carey) there are issues with macrophytes and fish due to diffuse and point pollution caused by agricultural land management (poor livestock, soil and nutrient management and riparian/ in-river activities), flow issues caused by land drainage and natural conditions (drought).
- In addition, in some of these water bodies there are also problems with Phosphate (Derril Water and Tamar (Small Brook to River Deer) and Carey) caused by agricultural management and sewage discharges.
- In the River Claw catchment, issues are highlighted associated with fish only as a result of agricultural management causing diffuse and point source pollution as well as the natural conditions. In the River Tavy.

Environment Agency catchment data[3] are summarised in Error! Reference source not found. for selected water bodies of particular interest to this plan which is focused on future water resource resilience. In these water bodies the Environment Agency's Environmental Ambition modelling has predicted river flows could fall below regulatory thresholds by 2050, so the impacts of public water supply abstraction may need to be reduced. These calculations incorporate projections of future changes in river flows expected due to climate change, plus the potential impacts of fully licensed abstraction, as discussed further in **Section 3**). The focus water body locations are labelled on **Figures D2.6** and **D2.7.** The abstraction points include the River Tavy at Lopwell Dam, the River Tamar at Gunnislake, the Withey Brook at Bastreet, the Burrator Reservoir and Dendles Wood on the River Yealm. It should be noted that whilst there is no Q95 environmental flow deficit predicted on the Tamar, there is a significant deficit modelled under Q70 flow conditions.

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

Table 2.1 2019 (Cycle 2) EA Catchment Data for selected water bodies of particular interest in the catchment[4]

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydrological Regime	Chemical substances	RNAG
Lower River Tamar GB108047007860	Moderate ecological status	Moderate (macrophytes and phytobenthos combined moderate)	Good	Supports good	Fail (Mercury, PFOS & PBDE) Specific pollutants – copper moderate	Point and diffuse sources: Poor soil management, poor livestock management, riparian/ in-river activities, sewage discharge, poor nutrient management (macrophytes and phytobenthos combined) Point and diffuse source: abandoned mine (copper)
Withey Brook GB108047007680	Moderate ecological status	Moderate (fish moderate)	Moderate (pH moderate)	Does not support good	Fail (Mercury & PBDE)	Flow issues: Surface water abstraction (hydrological regime) Natural: barriers ecological discontinuity (fish)
Lower Tavy GB108047007840	Moderate ecological status	Good	Moderate (Phosphate poor)	Does not support good	Fail (Mercury & PBDE)	Flow issues: surface water abstraction (hydrological regime) Point source pollution: sewage discharge (phosphate)
Burrator GB30846279	Moderate ecological status	Good	Moderate (Phosphate moderate	N/A	Fail (Mercury & PBDE)	Physical modification: reservoir impoundment (phosphate) Diffuse pollution: poor livestock management (phosphate) and Flow: surface water abstraction (hydrological regime)

Water body	Ecological status	Biological quality	Physico-chemical quality	Hydrological Regime	Chemical substances	RNAG
Meavy catchment* **GB108047003660**	Moderate ecological status	Moderate (fish and invertebrates moderate)	Moderate (pH moderate)	N/A	Fail (Mercury & PBDE)	Natural: mineralisation and barriers to ecological discontinuity Flow: regulating reservoir flow regime
Upper River Yealm **GB108047004050**	Moderate ecological status	Moderate (Fish moderate)	High	Supports good	Fail (Mercury, PDBE	Flow: surface water abstraction Natural: mineralisation and barriers to ecological discontinuity Physical modification: barriers to ecological discontinuity (urban and transport)

RNAG Reasons for not achieving good, PDBE Polybrominated diphenyl ethers, Perfluorooctane sulphonate (PFOS)
* Meavy flows into the Burrator reservoir

2.3 Existing water company water resource management planning (WRMP) options in the Tamar

South West Water's previously published strategy centres on demand management, as presented in the Water Resource Management Plan (South West Water, 2019). This includes a reduction in distribution losses/ management of leakage (15% reduction in 5 years), enhancing metering and providing water efficiency services. Preferred options are detailed in **Table 2.2**.

A number of feasible supply-side options have also been explored by the water companies for this catchment, including new distribution and production management and new resource schemes. These have been taken forward as preferred options at this stage, as detailed in **Table** 2.3 but they may be required in the future.

Other feasible demand-side options have also been explored but have not been taken forward as preferred options at this stage, as detailed in **Table 2.4**.

Table 2.2 Preferred options in the 2019 WRMP, relevant to the Tamar catchment (from South West Water)

Option	Code	Type of option	Earliest potential start date	WAFU Ml/d	Detail

Innovation Colliford WRZ	LC1-LC10	Reduce distribution losses	2020-21	11.2*	Schemes supporting ALC - reduction in leakage by 15%
Innovation Roadford WRZ	LR1-LR10	Reduce distribution losses	2020-21	11.2*	Schemes supporting ALC - reduction in leakage by 15%

WAFU – water available for use
*Calculation for the whole of Colliford and Roadford WRZs which only covers part of the Tamar WFD.

Table 2.3 Supply-side options reviewed (but not preferred) in the development of the 2019 WRMP, relevant to the Tamar catchment (from South West Water, 2019)

Option	Code	Type of option	Earliest potential start date	WAFU Ml/d	Detail
Northcombe WTW capacity increase to 60 Ml/d	R2	Distribution/ production management	2024	10.0	This option would involve a pumped storage scheme for Roadford Reservoir based on an intake on the River Tamar at Gatherley. A pipeline would connect the new intake to the existing Lyd/Thrushel pipework and transfer water to Roadford Reservoir and/or directly to Northcombe WTW. Although the main abstraction would be from the River Tamar, there would also probably be a small abstraction from the River Thrushel / Lyd mainly for water quality reasons. This scheme makes more effective use of reservoir storage. This is a scheme that could take account of the potentially slightly higher winter flows that could result from climate change.
Roadford / Northcombe pumped storage from Gatherley (River Tamar)	R4	Resource Scheme	2025	14.0	This scheme will enable more Roadford water to be treated at Northcombe WTW. This scheme should be considered in conjunction with the Rivers Taw and Torridge study and Roadford pumped storage resource management option.

WAFU – water available for use

Table 2.4 Demand-side options reviewed (but not preferred) in the development of the 2019 WRMP across water company supply zones South West Water, 2019)

Option	Code	Type of option	Earliest potential start date	WAFU Ml/d	Detail
Customer Side options	Cu20, CU21, CU26, CU54, CU60, CU62 and CU66	Reduce water demand	2020-21	20.8*	Retrofit and advice service. Metering and leaky loos, social housing refit, holiday home rental water efficiency, reduced infrastructure charge, community incentives, social norms feedback on bills and non-household retailer water efficiency.

*Calculation for the SWW supply area which only covers part of the Tamar WFD.

There is a potential demand reduction across the WRZ's that cover the Tamar catchment of 22.4 Ml/d utilising the preferred options considered in the WRMP. The not preferred supply side options total 24 Ml/d, with the not referred demand side options potentially saving 20.8 Ml/d which could benefit the Tamar catchment. Mains leakage reductions in the Plymouth area would be expected to reduce demand on public supply abstractions from the Tamar and Tavy but may be partly offset by population growth unless significant reductions in per capita consumption can be realised.

3. Environmental Ambition challenge

This section summarises the predicted 2050 flow environmental 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, as 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;
- future predicted (FP) demands for public water supply and other water uses, and also worst-case, fully licensed (FL) demand assumptions; and
- 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. 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.

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. All of the river water bodies in the

Tamar have a default, highest sensitivity i.e. ASB3, so there should be no rationale for further tightening in the Environment Agency's 'Enhanced' environmental ambition scenario. However, the enhanced scenario apparently does incorporate Natural England (CSMG) standards for rivers flowing into Plymouth Sound which includes lower reaches of the Tavy and Tamar, and also for Dartmoor Streams.

The predicted fully licensed 2050 flow surpluses and flow deficits for the Tamar catchment waterbodies under Q95 low flow conditions are mapped in **Figure D3.1**, under the EA's **enhanced** 2050 scenario, which is 'worst case' for planning purposes. It can be seen from **Figure D3.1** that for most of the water bodies within the Tamar 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 for five water bodies, relating to both non-PWS and PWS abstraction:

- Withey Brook
- River Tavy
- Meavy catchment (including Burrator)
- River Yealm

The River Tamar is not included in this list as it does not have a Q95 deficit, but it should be noted that there is a significant deficit at Q70.

Further detail regarding those water body flow deficits linked to PWS abstraction is given in **Table** 3.1 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 '**Business as Usual'** (BAU) scenario which is less stringent at higher flows in the Lower Tamar and Lower Tavy river water bodies.

Table 3.1 Predicted Fully Licensed 2050 Environmental Flow Surplus or Deficit (Water body outflow, Ml/d), for water bodies where potential PWS abstraction reductions are highlighted by the Environment Agency

Flow Condition	**Q30**		**Q50**		**Q70**		**Q95**	
(Ml/d)	BAU	ENH	BAU	ENH	BAU	ENH	BAU	ENH
Lower River Tamar GB108047007860	239.07	-15.31	-5.43	-5.43	-48.93	-48.93	26.09	26.09
Withey Brook GB108047007680	6.87	6.87	-1.06	-1.06	-5.06	-5.06	-4.10	-4.10
Lower Tavy GB108047007840	-21.59	-121.19	-119.98	-119.98	-76.43	-76.43	0.5	0.5
Upper River Yealm	17.03	6.01	6.58	6.58	1.42	1.42	-0.49	-0.5

GB108047004050								
Burrator** **GB30846279**	-60.36	-72.39	-40.57	-40.57	-27.65	-27.65	-14.24	-14.24
Meavy **GB108047003660**	-41.53	-64.71	-32.74	-32.74	-24.59	-24.59	-13.23	-13.23

*BAU - Business as Usual; ENH – Enhanced Scenario
** Burrator Reservoir is Heavily Modified for Water Resources purposes, so closure of these environmental deficits is not required.

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

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 'equally likely' 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 will soon be available online[4] but an early release has been used to compare against the Environment Agency's assumptions for the Tamar and provide stakeholders with a clear picture of how flows are expected to change to 2050 and beyond.

Figures D3.2 and **D3.3** plot rolling 18-year flow percentile statistics in Ml/d derived from modelled daily flow projections for Gunnislake on the Tamar. 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 'equally likely' 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 Tamar are expected to get worse, but also emphasises the value of surface storage options designed to capture high flows to support drier period supplies.

Figure D3.2 flow predictions are based on the most reliable of the eFlaG gauge-calibrated models (the Probability Density Model PDM) and indicate how flows calibrated against the historical

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

gauged record (i.e. including the influence of upstream abstractions, discharges and reservoir storage operation) 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 which was considered worst case now appears reasonable or perhaps optimistic. By 2050, most of the eFlaG models are predicting more than 10% reductions in median flows, with falls of 30 or even 50% predicted by several models under drier conditions.

The **Figure D3.3** plots are based on the natural flow projections of the national 'Grid to Grid' 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.

In order to more confidently understand future flow shifts in all the water bodies across the Tamar catchment it is recommended that the UKCP18 climate projections are reviewed a considering the potential influence of reservoir storage, flow regulation and downstream abstraction management. However, **Figures D3.2 and D3.3** confirm that low flows are expected to fall significantly to 2050. 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 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 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, having accounted for the water resources purpose of the 'heavily modified' reservoir-related operations, licence reductions may be required for four surface water licences owned by South West Water. Licence details for these abstractions which are 'at risk' are given in

Table 3.2**.**

At this first draft report stage, no review of the implications of the Environmental Ambition challenge has been possible for the surface water abstractions associated with the current or potential future operation of the Roadford or Burrator reservoirs. Whilst annual and daily licence limits may not change, the imposition of tighter compensation release or hands-off-flow constraints may still affect drought period deployable output for public supply.

Additionally, for the Meavy catchment (which includes the Burrator reservoir) the EA has identified flow deficits, and this is partly due to a change in catchment sensitivity from ASB 3 to CSMG ASB 4, which has resulted in additional constriction of the available resource at the Q30. The CSMG designation appears to be connected to the downstream Plymouth Sound and Estuaries SAC. South West Water have noted that there is a deficit at all flow percentiles and that this is higher at higher percentiles due to the impact of the reservoir on flows. All abstractions are upstream of the reservoir or from the reservoir itself and South West Water note that it is possible that something could be done with the reservoir release patterns to support downstream ecology. Therefore, it has been recommended that the **compensation flow is changed to meet the deficit and the abstractions are not modified.** The ASB3 flow target has been recommended as the most appropriate for the Preferred Scenario, given the waterbodies status as a AWB/HMWB and the distance to the downstream SAC. South West Water acknowledge that if the reservoir cannot support the change in compensation flows then a reduction in the abstractions will need to be included, it is noted that this reservoir empties quickly and so this reduction may need to be considered to address the deficit. Changes to the reservoir release pattern could be considered as a part of climate change mitigation and that this could impact the abstraction volumes. The Burrator licence has been included in **Table 3.2** for completeness although at present there is no reduction calculated for this abstraction.

Table 3.2 Details of PWS abstractions for which potential abstraction reductions have been flagged by the EA

Abstraction Information	River Tavy at Lopwell Dam	River Tamar - Gunnislake	Withey Brook at Bastreet	River Yealm Dendle Wood, Cornwood	Burrator Reservoir
Licence Number	15/47/041/S/039	15/47/013/S/020	15/47/141/S/026	15/47/001/S/025	15/47/002/S/031
Water company	South West Water	South West Water	South West Water	South West Water	South West Water
Fully Licensed	91	148	7.745	0.165	70.286
Recent Actual	1.596	0.039	6.663	1.809	71.191
Surface water/ Groundwater	Surface Water	Surface water	Surface water	Surface Water	Surface Water
WFD Waterbody	GB108047007840	GB108047007860	GB108047007680	GB108047004050	GB30846279
Investigations	AMP 4-5 Increased prescribed flow for 1 July - 30 September inclusive. DO reduction 3.2Ml/d. Currently in Operating Agreement but not changed on abstraction license yet.			AMP5-6 2016. RSA Habitats Directive sustainability reductions of 4.8Ml/d. Estimated total impact of sustainability reductions on several licences in Roadford WRZ (Erme, Yealm, Swincombe, R Dart at Littlehempston, Fernworthy	
Environmental Ambition Conclusion	The abstraction impact pattern looks to have been modified as a complex impact in the WRGIS – the	The waterbody has not previously been flagged through WINEP and the 2019 WFD results show the	This waterbody is not enhanced and so ASB3 is applied in all scenarios. There are flow deficits at all	The waterbody has not previously been flagged through WINEP and the 2019 WFD results show the	The waterbody has not previously been flagged through WINEP, however the predicted 2050 results

Abstraction Information	River Tavy at Lopwell Dam	River Tamar - Gunnislake	Withey Brook at Bastreet	River Yealm Dendle Wood, Cornwood	Burrator Reservoir
	abstraction is turned off in the SWABS file provided by the EA, but there is a significant impact shown in the flow results. Looking at the pattern of deficits it appears that there is a low flow HOF which reduces take, and this is offset by more abstraction at higher flows (hence the Q50 deficit is greater than the FL abstraction). There are no other significant consumptive abstractions in this catchment. The scale of the deficit in the Enhanced Scenario (with the decreased take at Q30 due to the application at ASB) means that the recommendation is for the abstraction to be turned off in the Enhanced scenario. Some abstraction at higher flows does look to be possible in the BAU scenario, and a 75% reduction with a Q50 is suggested. This may need further consideration as it is apparent that the	hydrology as supporting good, however the predicted 2050 results from the EA show a deficit at low flows. This waterbody is failing against EFI targets in the baseline and enhanced. The application of the CSMG target has also removed the surplus at high flows. The recommendation is that this licence is reduced by 30% to remove the deficit, this could be reduced to a 10% reduction in the Preferred Scenario as the 30% reduction would provide a surplus at all flows other than the Q70.	flow percentiles below the Q50. Deficits at the Q95 at c.50% licenced quantity, Q70 is 60% licence quantity and 10% at the Q50. Turning off the licence would be too stringent a measure, therefore a 50% reduction or a Q70HOF is suggested. Deficit numbers in column O reflect no abstraction at the Q95 and a 60% reduction at the Q70.	hydrology as supporting good, however the predicted 2050 results from the EA show a deficit at low flows. The waterbody has an enhanced CSMG target (ASB 4), which provides further constraint on water availability at the Q30. Though the suitability of this waterbody for a CSMG 4 target (assumed to be associated with the downstream Plymouth sound & estuaries SAC) is uncertain. There is a small deficit at the Q95 and so a Q95 HOF has been recommended for this licence. The CSMG 4 target does not effect this conclusion as it does not impact low flows.	from the EA show a deficit. This is partly due to a change in catchment sensitivity from ASB 3 to CSMG ASB 4, which will result in additional constriction of the available resource at the Q30. The CSMG designation appears to be connected to the downstream Plymouth Sound and Estuaries SAC. There is a deficit at all flow percentiles, this is higher at higher percentiles due to the impact of the reservoir on flows. All abstractions are upstream of the reservoir or from the reservoir itself. It is possible that something could be done with the reservoir release patterns to support downstream ecology. Therefore, it has been recommended that the compensation flow is changed to meet the deficit and the abstractions are not modified. The ASB3 flow target has been recommended as the most

Abstraction Information	River Tavy at Lopwell Dam	River Tamar - Gunnislake	Withey Brook at Bastreet	River Yealm Dendle Wood, Cornwood	Burrator Reservoir
	management of this abstraction is complicated.				appropriate for the Preferred Scenario, given the waterbodies status as an AWB/HMWB and the distance to the downstream SAC. If the reservoir cannot support the change in compensation flows then a reduction in the abstractions will need to be included, it is noted that this reservoir empties quickly and so this reduction may need to be considered to address the deficit. Changes to the reservoir release pattern could be considered as a part of climate change mitigation – this could impact the abstraction volumes.
BAU Scenario	75% reduction and Q95 HOF	No change - surplus at low and high flows indicate that total take should be possible	50% licence reduction OR Q70 HOF	Q95 HOF	No change – assume change in reservoir compensation flow to address the deficit
BAU Licence Reduction	44.93125	0	2.40095	0.316575	0
ENH Scenario	Turn licence off	30% reduction in licence - no surplus at high flows	50% licence reduction OR Q70 HOF	Q95 HOF	No change – assume change in reservoir

Abstraction Information	River Tavy at Lopwell Dam	River Tamar - Gunnislake	Withey Brook at Bastreet	River Yealm Dendle Wood, Cornwood	Burrator Reservoir
					compensation flow to address the deficit
ENH Licence Reduction	91	44.4	2.40095	0.316575	0
Reasonable Scenario	Turn licence off	30% reduction in licence? Given that low flows are compliant, and this reduction would provide a surplus at flows other than around the Q70 this could be 10%.	50% licence reduction OR Q70 HOF	Q95 HOF	No change – assume change in reservoir compensation flow to address the deficit
Reasonable Licence Reduction	91	14.8	2.40095	0.316575	0

The EA's suggested Fully Licensed abstraction reductions based on the enhanced ambition scenario are as follows:

- **River Tavy at Lopwell Dam: Turn licence off. 91 Ml/d.** This will increase flows across all flow percentiles. Flow is compliant at Q95, and will increase flows under Q95 so there is a flow surplus. There will continue to be a flow deficit at Q50 (see **Table 3.1**).
- **River Tamar at Gunnislake: 30% reduction in licence. 44.4 Ml/d.** Given that low flows are compliant, this reduction would increase flows under all scenarios but there would still be a deficit at Q70.
- **Withey Brook at Bastreet: 50% licence reduction or Q70 HOF. 2.4 Ml/d.** This will improve flows, but there may still be a deficit at Q70 and Q95 flows (see **Table 3.1**).
- **River Yealm: Q95 Hands Off Flow. 0.3 Ml/d.** This will improve Q95 flows.
- **Meavy catchment (Burrator reservoir). No reduction.** Compensation flow is changed to meet the deficit and the abstractions are not modified.

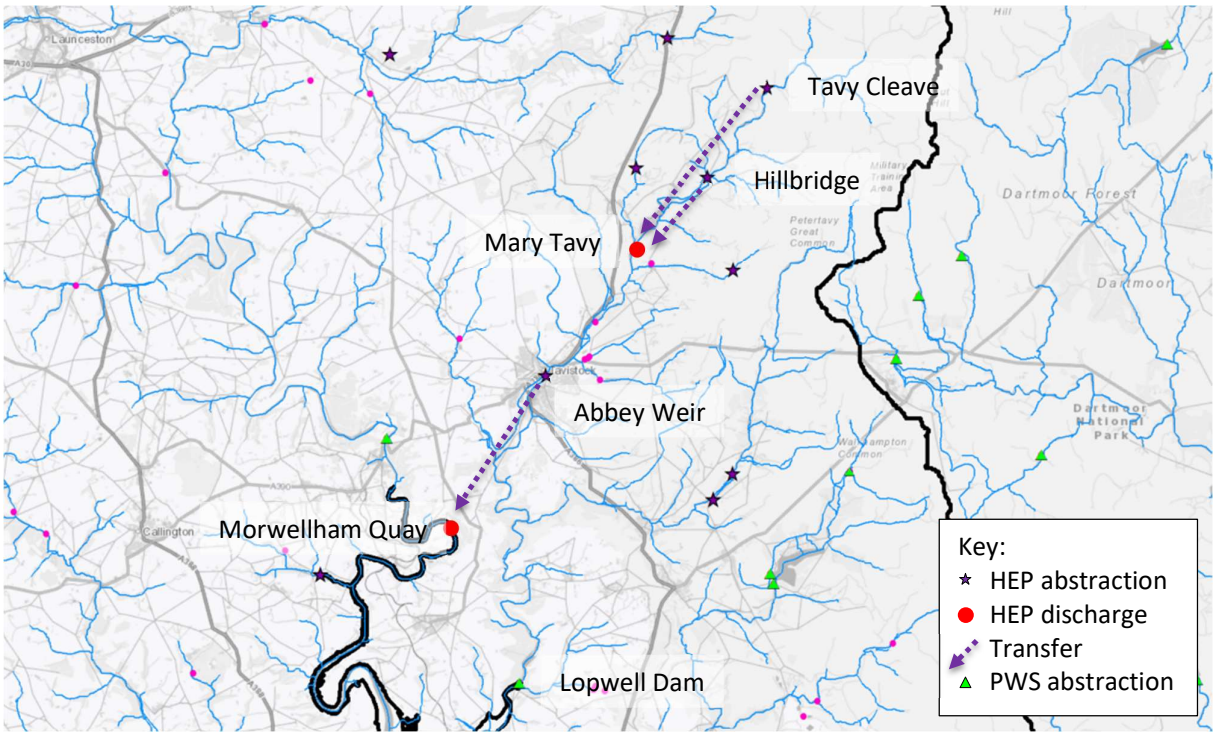
The total licence reductions across the catchment flagged by the Environment Agency therefore potentially amount to **138.1 Ml/d.**

A large proportion of the total reduction required across the Tamar catchment results from the River Tavy abstractions. The following licences have large abstractions from the River Tavy (pers. Comm Jackie Turner):

- Tavy Cleave: *non-consumptive* HEP licence which abstracts at Tavy Cleave (west Dartmoor), transfer to Mary Tavy power station for HEP generation, discharge to River Tavy at Mary Tavy.
- Hillbridge: *non-consumptive* HEP licence which abstracts at Hillbridge (west Dartmoor), transfer to Mary Tavy power station for HEP generation, discharge to the River Tavy at Mary Tavy.
- Abbey Weir (Tavistock): *consumptive* HEP licence which abstracts from River Tavy at Abbey Weir (Tavistock) and is then transferred along Morwellham Canal to Morwellham power station for HEP generation. Discharged to River Tamar at Morwellham Quay (downstream of tidal limit).
- Lopwell: consumptive public water supply abstraction

The locations and transfers can be seen below in **Graphic 3.1**. The Tavy HEP abstraction licences do not have prescribed flows, however there is a documented operating agreement with the EA whereby SWW agreed to prescribed flow and canal/leat sweetening flow conditions for the Tavy Cleave, Hillbridge and Abbey Weir HEP abstractions. When upstream flow at the abstraction point drops below the prescribed flow, SWW can only abstract a defined sweetening flow, to maintain a small flow in the leat/canal for ecology and structural integrity of the leat/canal. These operating agreement conditions therefore provide low flow protection. I'm not sure (until we have discussed this with the EA and/or received the SWABS info) as to whether or not they have included these operating agreement conditions in their WRGIS analysis or not.

Graphic 3.1: HEP licences on River Tavy



3.4 Potential 2050 supply loss compared to published WRMP options

Options explored in the water company WRMPs include demand reductions and leakage savings to reduce the future supply required (see **Section 2.3**). 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. If the EA's 2050 abstraction reductions were implemented, then the abstraction reductions would be higher than recent actual abstraction in the catchment (Table 3.3: Potential 2050 catchment supply loss (% of abstraction).

It is clear that these are huge Environmental Ambition challenges which demand measures well 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. 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 3.3 Tamar catchment: context of potential 2050 supply loss

Tamar	South West Water*	Unit
Annual PWS licensed abstraction (catchment total) *SWABS and GWABS combined*	344.4	Ml/d
Annual PWS RA abstraction (catchment total) *SWABS and GWABS combined*	123.9	Ml/d

Tamar	South West Water*	Unit
Water company total water into supply (WAFU) *Base year 2017/2018*	415.1	Ml/d
WRMP baseline WAFU 2045	399.1	Ml/d
Catchment PWS RA as % of water company WAFU (Base Year 2017-18)	29.8%	%
Total WRMP projected 2045 demand-side and leakage savings	22.4	Ml/d
2045 demand reductions and leakage savings as % of current total water into supply	5.4%	%
WRMP preferred additional supply-side options (catchment total)	0.0	Ml/d
EA 2050 potential abstraction reductions (catchment total)	-138.1	Ml/d
Potential 2050 catchment supply loss, reduced by the effect of proportional 2045 demand reductions and leakage savings	-131.4	Ml/d
Potential 2050 catchment supply loss (% of abstraction)	-106.1%	%
Potential 2050 catchment water impact (2045 WAFU impact, abstraction impact plus effect of demand and supply options)	-131.7	Ml/d
Potential 2050 catchment supply loss (% of recent actual PWS Abs)	-106.3%	%

*Southern Water catchment summarised in this table as the Roadford and Colliford WRZs combined

Data sources:
Wessex Water (2019). Final Water Resources Management Plan
South West Water Bournemouth Water (2019). Final Water Resources Management Plan.

4. Environmental Destination catchment plan to increase future water supply and low flow environmental 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 Tamar 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 Tamar catchment that may improve the water availability and the resilience of the Tamar catchment. In addition, there are a number of Tamar catchment partnerships set up to promote the catchment-based approach (CaBA) examples of which include the **Upstream Thinking**, a South West Water initiative looking at catchment improvements, the **Mires on the Moors** project which is focussed on scientific enhancement and the **Tamar Catchment Partnership** led by the Westcountry Rivers Trust.

A summary of current projects within the Tamar catchment is provided below.

Upstream Thinking

The Upstream Thinking (UST) project is a South West Water initiative which is large scale catchment management programme undertaken in strategic partnership between South West Water, Westcountry Rivers Trust, Devon Wildlife Trust, Cornwall Wildlife Trust, SW Lakes Trust, Natural England, FWAG, Exmoor National Park Authority, South West Peatland Partnership and the University of Exeter. There have been two phases conducted to date the phase 1 UST (UST1) and phase 2 (UST2) and phase 3 (UST) is currently underway.

The UST 1 project worked with farmers to undertake various interventions to improve water quality. These interventions included works to establish new hedges and in-field and riparian buffer strips,

minimise the volume of "dirty" water produced, farm track management, construct troughs with concrete bases, ensure manure heaps were stored on impermeable bases and collect effluent, and soil aeration.

The UST2 project works across the Fowey, Tamar, Exe, Dart and Otter catchments. The project continued the work from the UST1 project with the primary aim of improving the water quality across the South West Water area through consideration of land and water quality at a catchment scale, engaging with farmers to explain the issues and working with those farmers to plan appropriate water quality management strategies and explore funding opportunities. The Westcountry Rivers Trust note that the first round of UST aimed to improve water quality through nutrient and sediment reduction. The second round had a particular focus on reducing pesticide pollution. It has successful project for vastly improving the water quality in the Upper Tamar Lakes catchment (UST1), and the wider Tamar catchment (UST2).

The next phase of the project, Upstream Thinking 3, is currently underway with ongoing schemes in the Stour, Otter, Exe, Fowey, Tamar and Dart catchments. Works in the Tamar are undertaken by a working partnership with the Devon Wildlife Trust and West Country Rivers Trust. The scheme remains multi-faceted, and the partnership continues supporting farmers to release money from grants to support projects which improve water quality and habitat enhancements, undertake soil and is currently working with farmers to build new ponds, cover farmyard manure stores, reinstate or add fencing to stop cattle destroying the river banks, install troughs and rainwater harvesting.

Whilst the UST thinking programme is primarily aimed at improving water quality, it is hoped that there will be some small-scale secondary benefits for water supply resilience, for example:

- by slowing water to the watercourse during high flows (e.g., buffer strips, hedgerow planting, soil aeration), there is a slower release of water to the river reducing the amount of time the river experiences low flows. However, this is not expected to make much difference to flow during dry summers and droughts;
- providing additional sources of water (e.g., rainwater harvesting) reduces the need for pumping from the river and or groundwater supplies during times of low flow.
- ensuring that the rivers are functioning well by improving water quality and in-stream geomorphology (e.g., stopping cattle access to river banks) so that during low flow events the aquatic habitat and rivers themselves may be more resilient.

The scheme is highly successful, and South West Water have commented that they anticipate the scheme will continue into the future.

Mires on the Moors Projects

This project has been funded by South West Water and is a partnership between the Environment Agency, Natural England, Historic England, Dartmoor National Park and Exmoor National Park. The project is focussed on scientific enhancement and peatland restoration. Whilst there are some areas of very little change post-restoration, the most notable changes are in the deeper peats where restoration increased the permanent deep-water storage in the soil by 7.3 cm and increased average water table by 2.45 cm. In shallow peat, the water table responses to restoration were characterised as complex with the results showing that in the driest area, where drainage had the greatest effect pre-restoration, water tables rose by up to 4cm. The reporting (Brazier et al., 2020)

notes that restoration can significantly alter rainfall run-off regimes in restored catchments reducing gully flow by up 66%.

In terms of water resource resilience, the University of Exeter (Brazier et al., 2020) highlight that peatland restoration has the potential to drive changes in water storage and base flow regimes, reducing flood risk and improving water security, although the scale of these changes is currently unknown. In addition, the restoration will drive water quality changes, carbon stocks and fluxes, reducing in DOC loading, water colour and carbon cycling as well as alter habitat structure and function, enhancing priority habitats and delivering biodiversity and carbon sequestration benefits.

South West Peatland Partnership

The South West Peatland Partnership was a three-year partnership programme which started in 2018 to restore damaged peatland on Bodmin Moor, Dartmoor and Exmoor. The programme impacted the Tamar catchment through works to improve the Dartmoor national park. South West Water (SWW, 2021) note that the partnership in the Dartmoor area included the Dartmoor National Park Authority, Duchy of Cornwall, Forest of Dartmoor Commoners Association South West Water Dartmoor, Dartmoor Preservation Association, Dartmoor Society, Devon Wildlife Trust, Environment Agency, Historic England, Ministry of Defence, Natural England, National Trust, RSPB, University of Exeter, University of Plymouth and Westcountry Rivers Trust.

The project sought to block ditches in order to enable re-wetting of extensive areas of damaged peatlands. The various ditch blocking techniques using sustainable materials (wood, peat, grass and heather) are being used on historic peat cuttings, drainage networks and eroding gullies to enable the re-wetting. The benefits of this programme for water supply resilience are the increase in water storage in the upper reaches and the reduction of run-off and poor water quality.

Catchment Based Approach and the Tamar Catchment Plan

The Tamar Catchment Partnership was formed in 2011, under the "Catchment Based Approach" (CaBA) programme which is a multi-stakeholder model which promotes engagement, discussion and decision-making amongst community representatives, landowners and managers to ensure a catchment approach to ecosystem services and water management. The partnership is led by the Westcountry Rivers Trust.

The Tamar catchment partnership is a highly successful partnership, it is designed to facilitate communication between everyone working within the catchment landscape which will protect and improve the health of the river. The partnership has its own website http://my-tamar.org/action-plan/ where more details can be obtained. The partnership is composed of a 'Steering Group', 'Technical Members' and the 'Wider Partnership'. The Tamar catchment partnership website highlights the plans going forwards to resolve low flow issues which includes:

- Increase wetland management, restoration and creation; and
- Increase management advice on high-risk soils. Give best practice (win-win) advice through bespoke plans and promote soil management measures to reduce compaction and improve infiltration; and
- Promote development of sustainable drainage solutions on farms/ land including on-farm rainwater harvesting and water storage solutions for irrigation.

CaBA opportunity mapping

CaBA's opportunity maps from the '**Working with Natural Processes - Evidence Base'** project[5] identify the types of measure that may be effective in flood and coastal risk management (FCRM) and wider ecosystem service benefits (Environment Agency, 2018). These maps can be used to inform and prioritise future catchment measures.

Figure D4.1 shows the opportunity mapping across the Tamar catchment for:

- Floodplain reconnection (for example, in the headwaters of the River Carey and the River Ottery where there is connection to the underlying superficial deposits).
- 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., Culm Grassland projects in the headwaters of the upper Tamar or Tamar valley Invasives project).

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.

Natural Environment Investment Readiness Fund

DEFRA have announced a £10 million Natural Environment Investment Readiness Fund (DEFRA, 2021b) which is being used to develop the projects to the point they can provide a return on investment by capturing the value of carbon, water quality, biodiversity and other benefits provided by natural assets such as woodlands, peatlands, catchments and landscapes. Funding has been awarded to environmental groups, businesses and local authorities to develop projects that protect and enhance nature while also demonstrating innovative approaches to generating revenues from the wide range of benefits that nature provides.

The Tamar AONB has received £99,163 to developing a local ecosystem service market through testing trading mechanisms which will market benefits from environmental enhancement of five sites in the Tamar Valley. The project will identify and monetise a range of benefits in the form of carbon, biodiversity credits, natural flood risk management, and water quantity improvement (DEFRA, 2021b).

Tree-planting for Channel Payments for Ecosystem Services (CPES) and Riparian Planting Programme

Channel Payments for Ecosystem Services project lead a pilot study through the "Channel area" (Southern England and Northern France). The primary aim of the project was to improve water

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

quality in catchments by implementing sustainable Payments for Ecosystem Service. One of the six CES catchments was the Roadford Lake catchment and as part of this scheme the WRT have received over 7,000 trees to plant. The WRT had a further 9,000 trees that have been planted though the Riparian Planting Programme on the Tamar/Lyd. Tree planting is often used to improve water quality but can also benefit water resources availability through reducing run-off and slowing peak flows in the river which can mitigate against flood. Tree planting also reduces pollutants and sediment reaching the river and can be used for enhancing a rivers in-channel ecosystem to enhance resilience during low flows by improving biodiversity and habitat (e.g., for fish) through the provision of shade moderating river water temperatures and reducing the growth of weeds and algae.

4.2 Future planned projects

There are also plans to change the compensation scheme at Burrator Reservoir which aims to improve flows in the Meavy catchment. See **Section 4.3** for more details.

The majority of the current projects such as the South West Water led Upstream Thinking programme will continue into the future which aims to provide resilience and improve habitats in the upper catchments. In addition, the West Country Rivers Trust continue to work in the catchment working however, more work is required to improve the Tamar catchment and consider the extent to which future Environmental Ambition targets can be met.

4.3 WCWR Tamar catchment action plan

As is evident, some work is already underway or planned by catchment stakeholders in the wider Tamar catchment. These interventions 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.

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.** This plan has been sketched out to add supply-side options to the existing preferred demand management and leakage reduction measures in order to support the environmental ambition challenge. However, these water resources measures would also work in synergy and holistically with the wider catchment projects, all building resilience for the Tamar itself. A phased implementation should deliver incremental benefits along the way and would require step-wise changes in abstraction regulation.

South West Water are currently looking to deliver abstraction reductions through demand management but have considered a range of options over their Colliford WRZ and Roadford WRZ that will impact the Tamar but are currently not on their preferred list. Due to the scale of the Environmental Ambition challenge in the Tamar these options may need to be reconsidered in the medium and long term. The options presented by SWW are combined and summarised in **Table 4.1**.

In addition, Wood has included a number of potential options that should be considered in response to the environmental ambition challenge in the Tamar catchment as seen in **Table 4.2**.

Schematic maps in **Figures D4.2** to **D4.4** show how the large-scale water company measures may be implemented over the short, medium, and long term.

Table 4.1 Water company phased water resources resilience action plan to 2050 for the Tamar

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
Changes to existing operations	Burrator changes	Alterations to Burrator compensation release to improve flows along Meavy and adaptive management trials.	Meavy catchment	Improved flow regime			
Catchment Management	Catchment Schemes WINEP studies (Burrator and Roadford)	Continuation of Upstream Thinking initiative Continuation of Catchment Management Programme	Tamar WFD	Water Quality			
AMP7 investments	Customer side management options Leakage reduction	Metering, incentive, water efficiency campaigns, leakage innovations and continued investment.	Tamar WFD	Demand reduction			
Resource Scheme	Roadford / Northcombe pumped storage from Gatherley (River Tamar)	This option would involve a pumped storage scheme for Roadford Reservoir based on an intake on the River Tamar at Gatherley. A pipeline would connect the new intake to the existing Lyd/Thrushel pipework and transfer water to Roadford Reservoir and/or directly to Northcombe WTW. Although the main abstraction would be from the River Tamar, there would also probably be a small abstraction from the River Thrushel / Lyd mainly for water quality reasons. This scheme makes more effective use of reservoir storage.	Tamar catchment	Increased storage at Roadford			

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
		This is a scheme that could take account of the potentially slightly higher winter flows that could result from climate change.					
Enhancing existing supplies	Northcombe WTW capacity increase to 60 Ml/d	This scheme will enable more Roadford water to be treated at Northcombe WTW. This scheme should be considered in conjunction with the Rivers Taw and Torridge study and Roadford pumped storage resource management option.	Tamar catchment	Increased output from Northcombe could allow for reduced abstraction from elsewhere in catchment.			

Table 4.2 Additional solutions that could be considered as part of a phased catchment action plan: Tamar catchment

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
Catchment Management	Catchment Schemes	Continuation of catchment management schemes including, but not limited, to woodland management and planting, oversight of riparian and in-river practices, farm management e.g., livestock and nutrient management), continuation of advice on soil management. Develop closer ties with the Devon Local Nature Partnership to release mutual benefits under Devon LNPs nature recovery network and the resilient rivers and coasts initiative.	Tamar WFD	Water Quality			
Natural Flood Management	Slow and store water during higher flows to improve flow regime at low flows	Due to the lack of groundwater storage capabilities, to improve water availability NFM techniques should be utilised within the catchment. Natural attenuation features and further storage options in the wider catchment such as SUDS, natural attenuation features, leaky dams and increased use of rainwater harvesting across catchment. Liaison with stakeholder to identify "easy wins". Expect small gains.	Tamar WFD	Low flow improvements			
Strategic review of HEP licences	HEP licence review	Strategic review of the HEP licences and their operation. Could there be improvements to the current management pattern? Consider	Tamar and Tavy catchments	Low flow improvements			

Category	Option category	Measure	Location	Issues being targeted	Short term 2030	Medium term 2040	Long term 2050
		changes to the HEP discharge locations, especially at Morwellham Quay (Tidal). Would it be feasible and/ or advantageous to move this to a non-tidal discharge?					
Nature Partnership?		Consider a nature partnership to increase resilience in catchment. EA/NE					
Extension of existing resources	Enhance existing storage in catchment	Consider raising Roadford Reservoir, Upper Tamar Lakes and/ or Gunnislake by 1m to improve storage here. Not feasible to raise Burrator. Also unlikely at Lopwell Dam.	Tamar WFD	Increased storage			
Regional solutions	New water resource	Consider locations for new reservoirs	Tamar WFD	Increased storage			
	Water Trading	Import from other water companies and other WRZ. Current economically unviable, but this may change in future if significant deficit remains.		Water availability			
	Desalination	Removal of salt from seawater for use in catchment. Likely to be very expensive.		Water availability			

5. References

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Figures

Environmental Destination

Figures accompanying Annex D: Tamar Pilot Catchment Plan to increase future water supply and environmental low flow resilience

Figure D2.1 Tamar catchment: rivers and geology

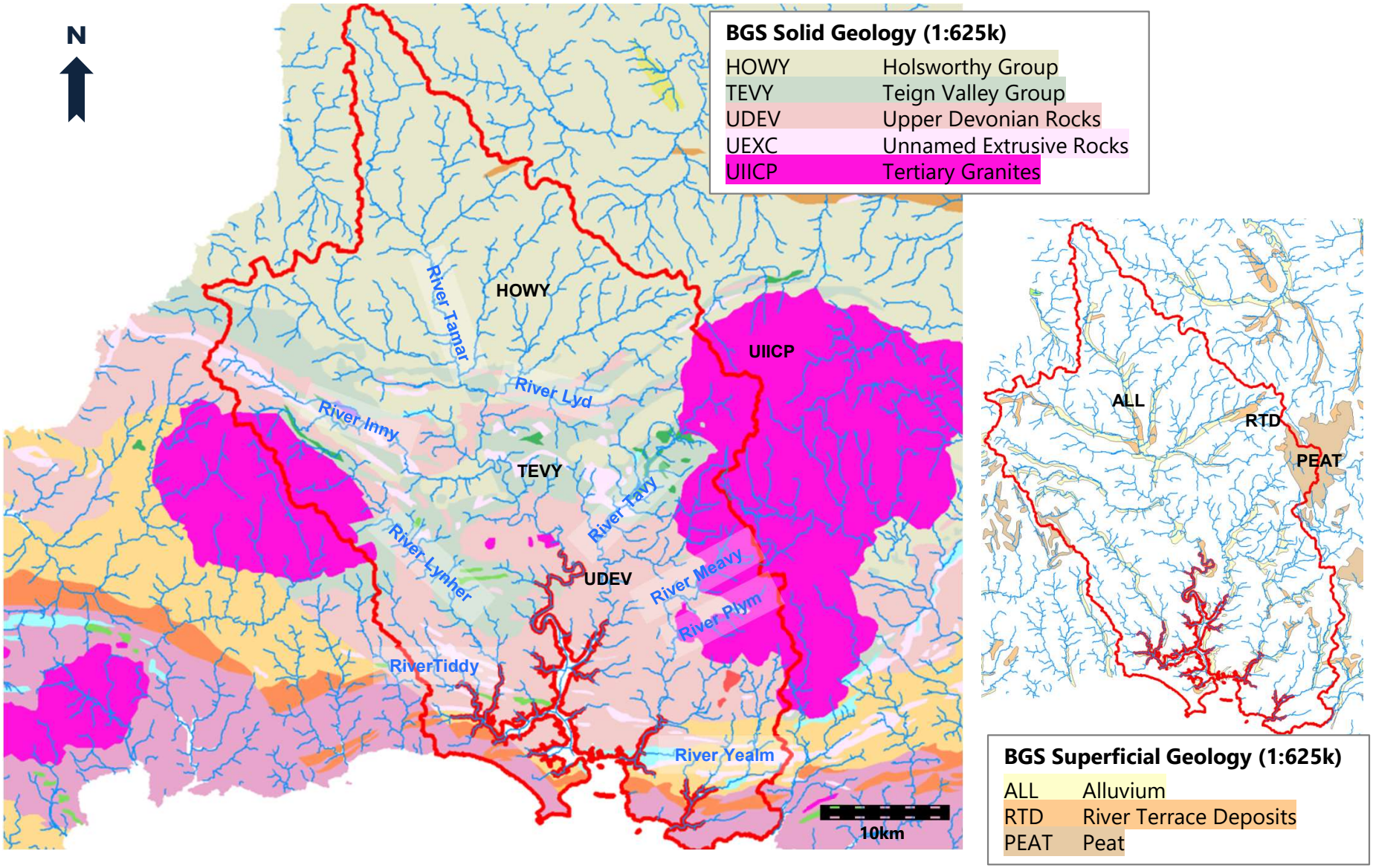


Figure D2.2 Tamar catchment: Designated sites and Drinking Water Safeguard Zones

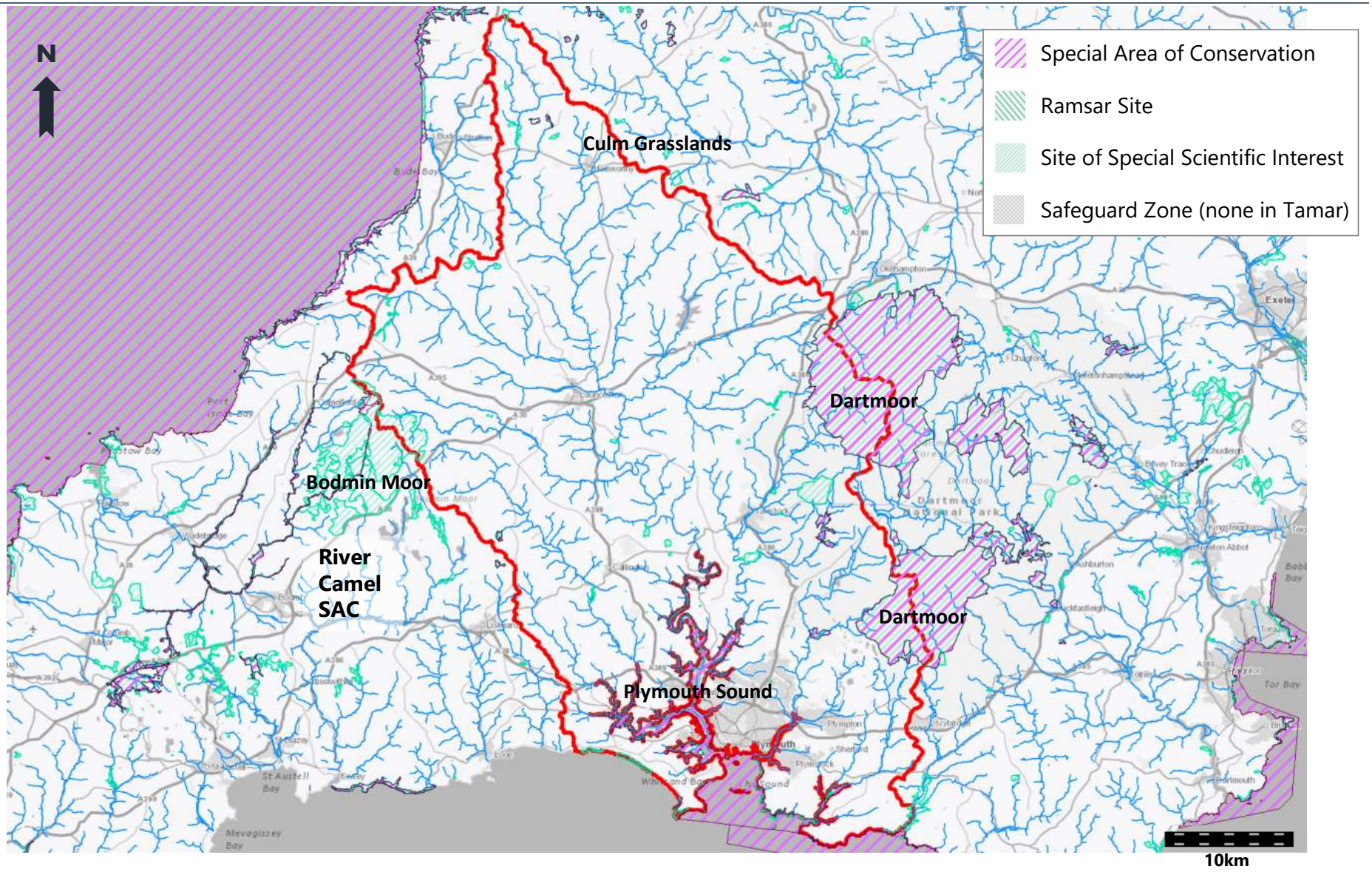
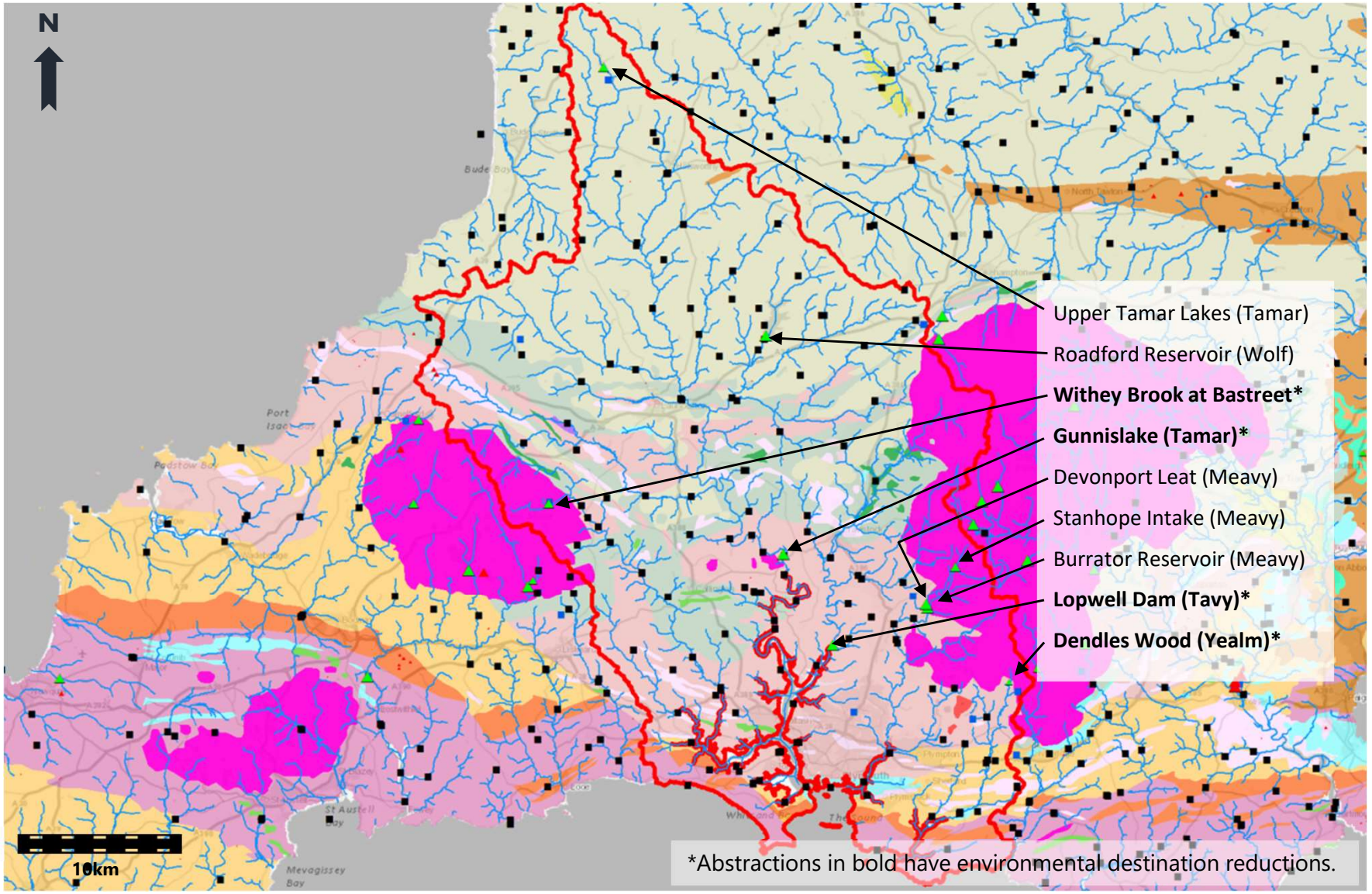


Figure D2.3 Tamar catchment: PWS Surface water abstractions, WwTW Surface water discharges



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

Figure D2.4 Tamar catchment: Water Abstraction by Sector (total, Ml/d)

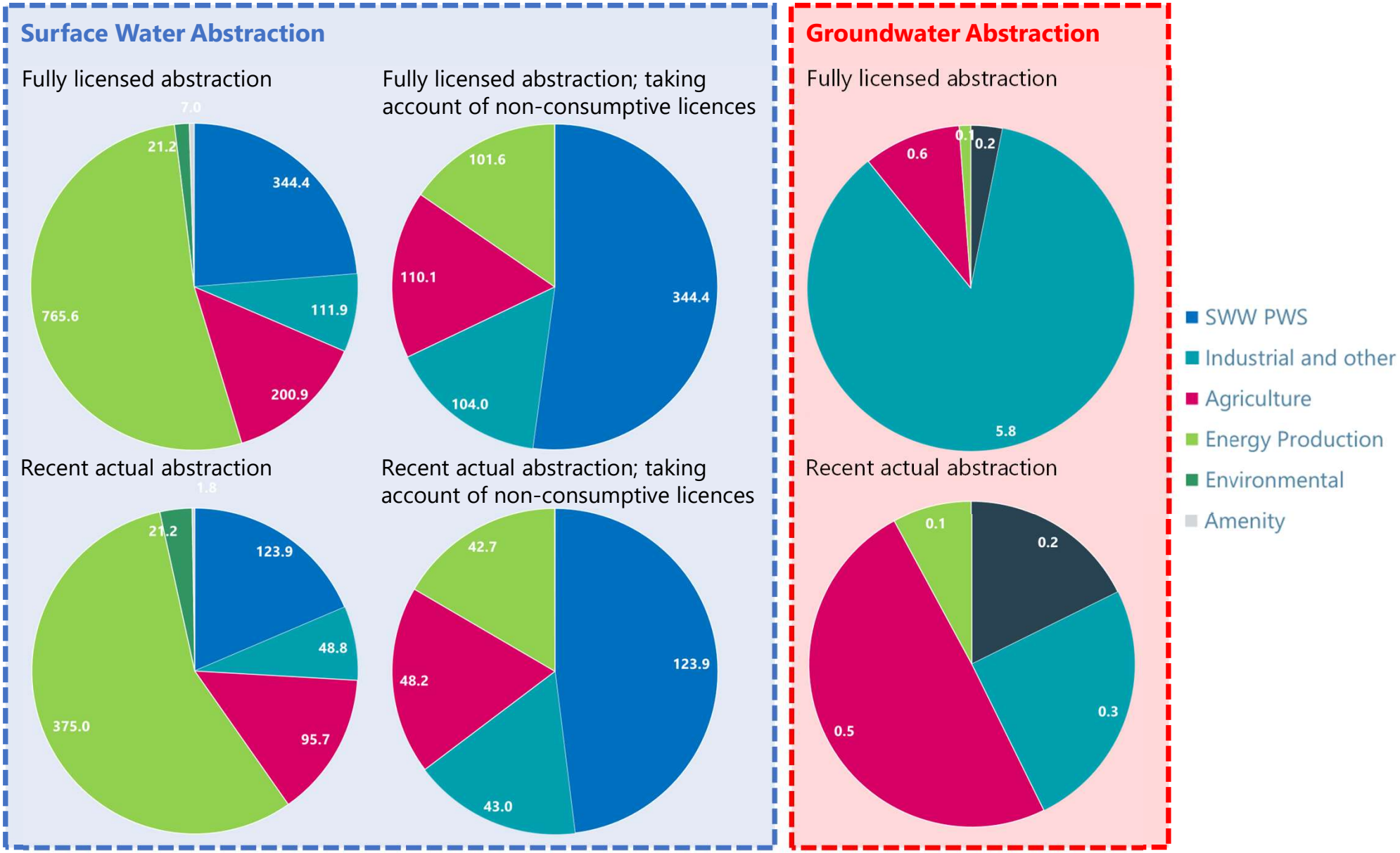
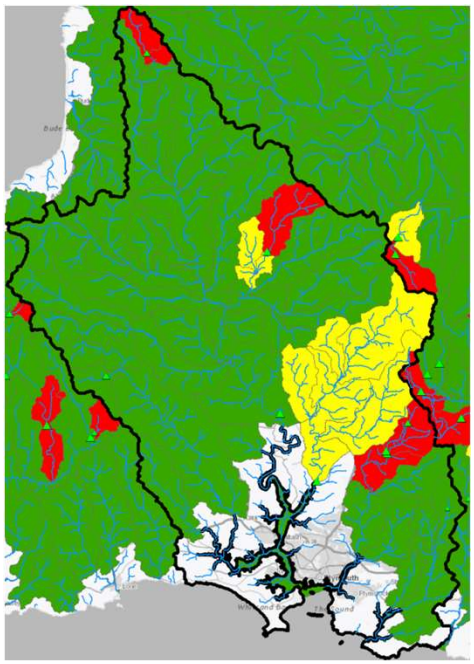
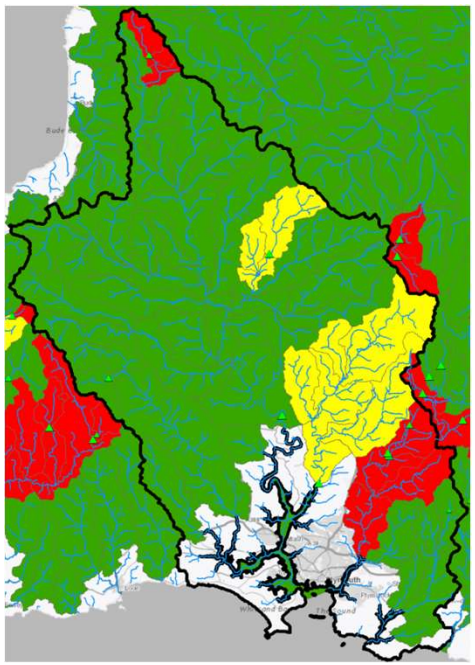


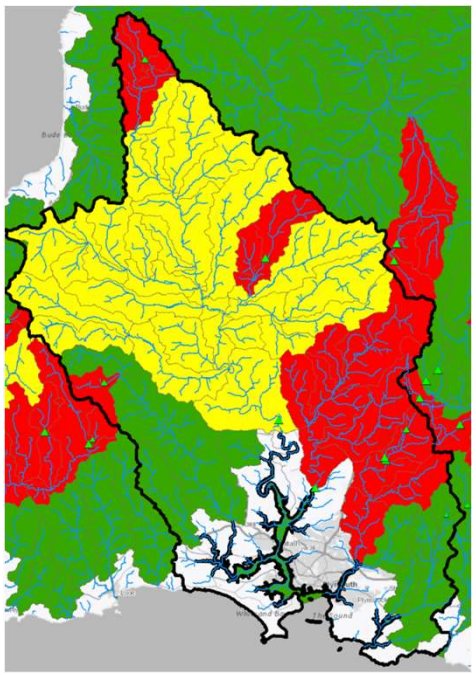
Figure D2.5 Environment Agency water resource availability at Q30, Q50, Q70, Q95 (Cycle 2, last updated 16 April 2021)



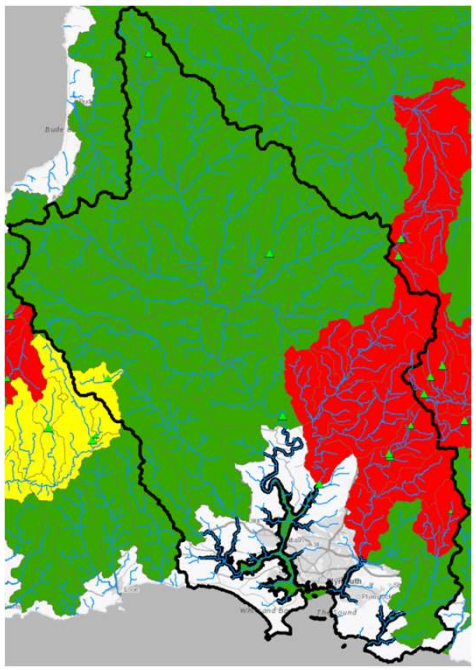
Availability at Q30 (high flows)



Availability at Q50 (moderate flows)



Availability at Q70 (low flows)



Availability at Q95 (very low flows)

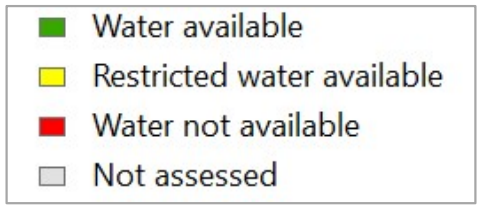


Figure D2.6 WFD water body overall status (Cycle 2, 2019)

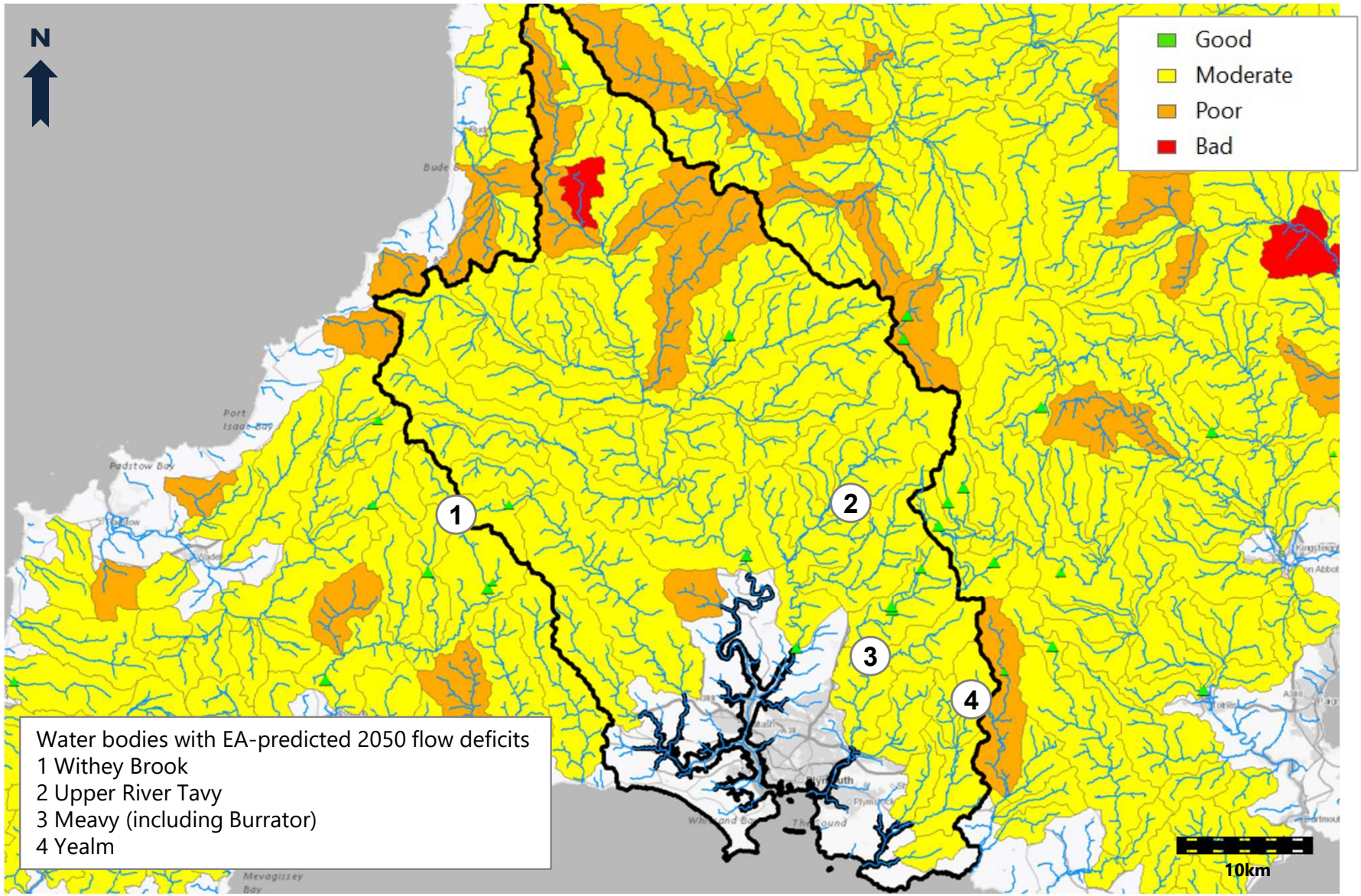


Figure D2.7 WFD water body ecological status (Cycle 2, 2019)

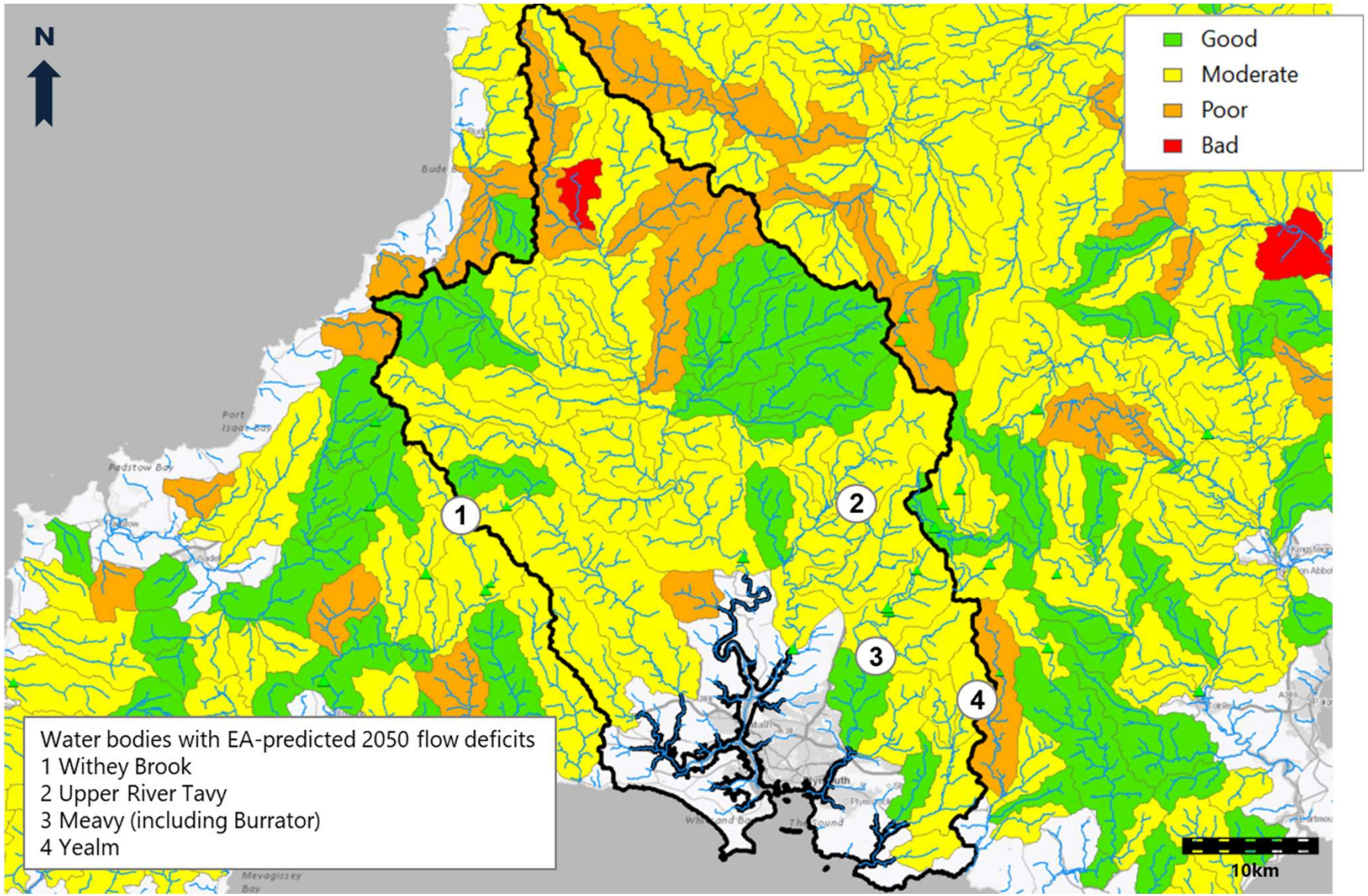
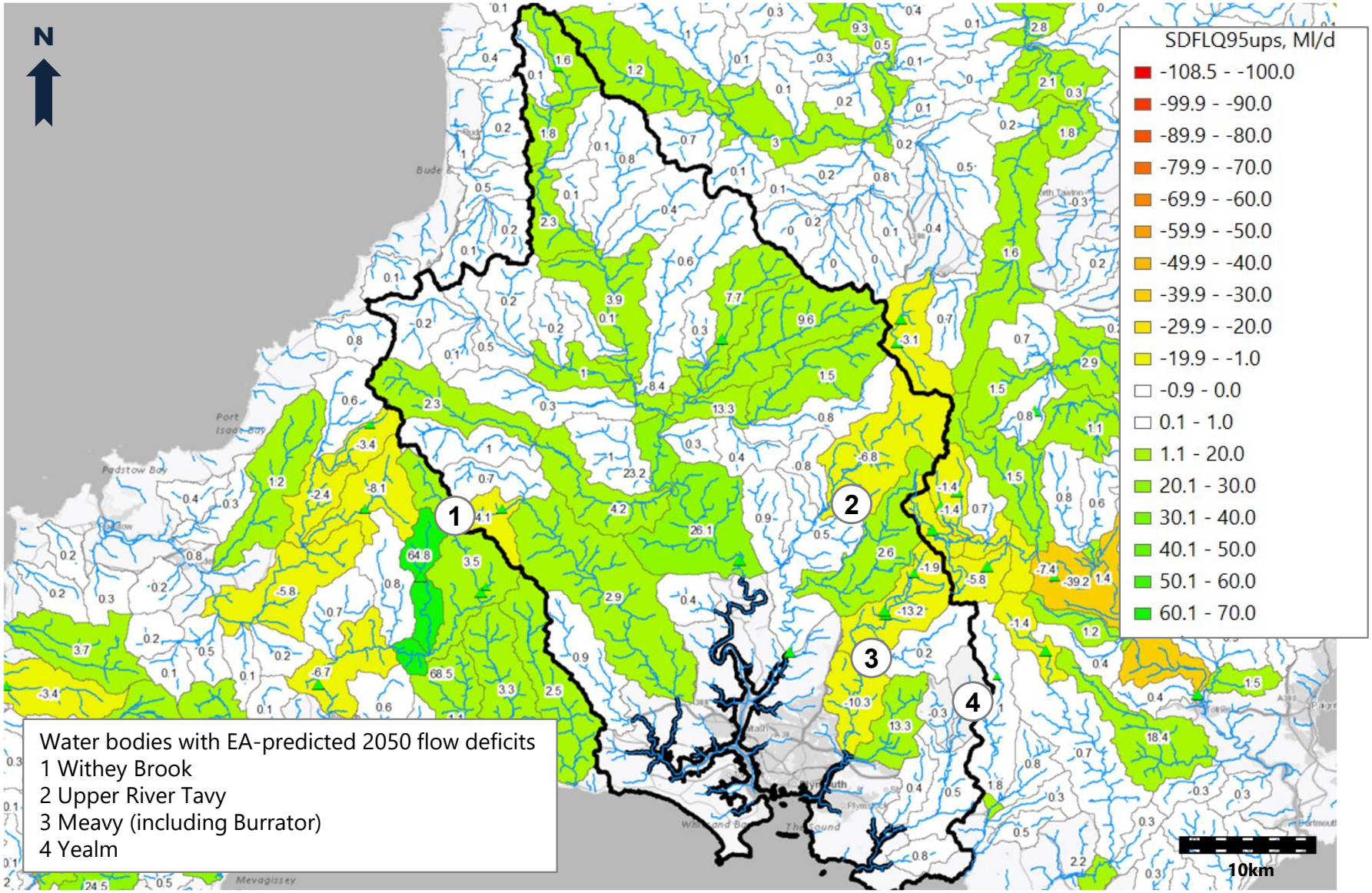
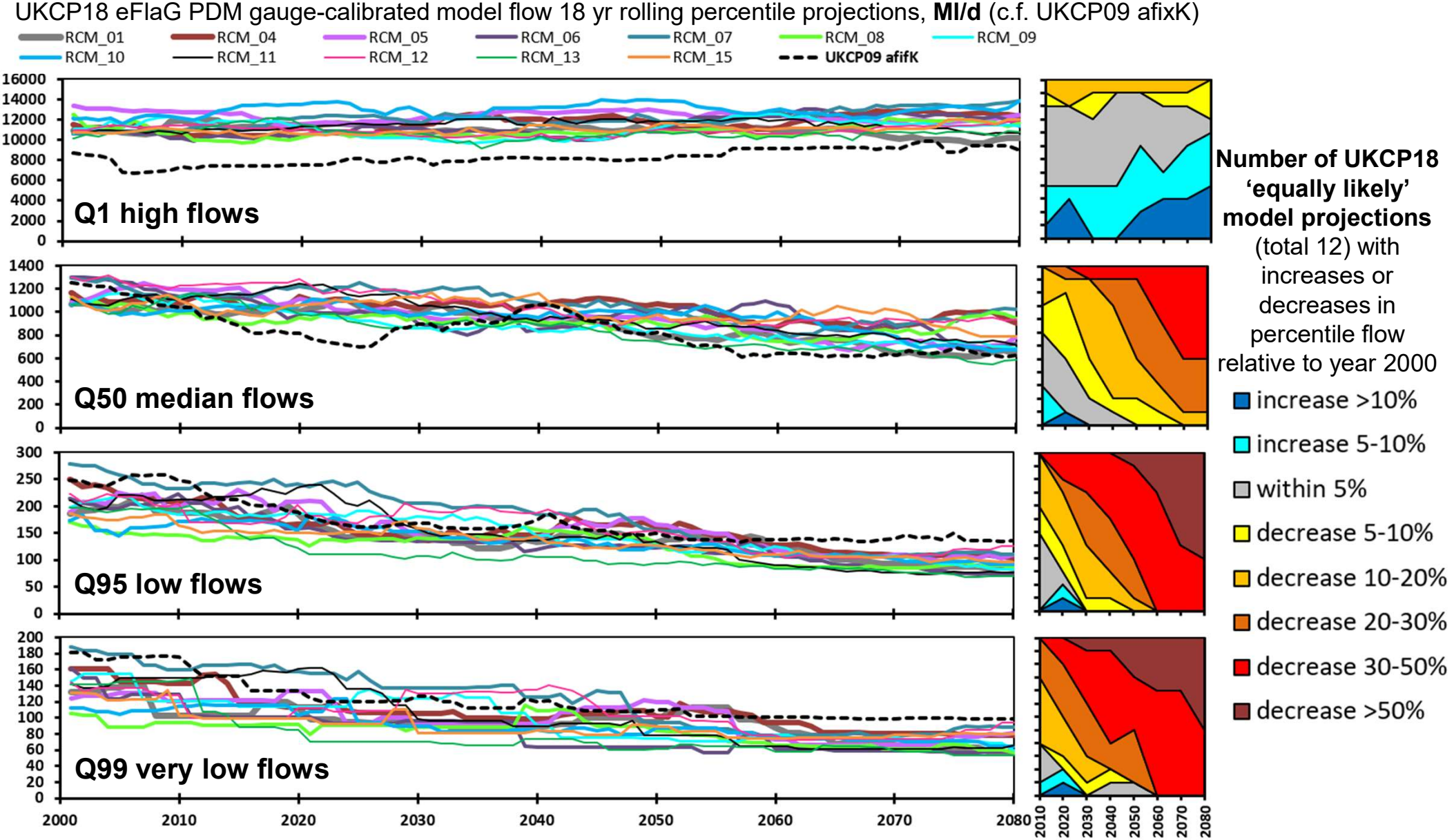


Figure D3.1 EA predicted fully licensed 2050 flow surpluses and flow deficits (Ml/d) for water bodies under Q95 low flow conditions (enhanced scenario)



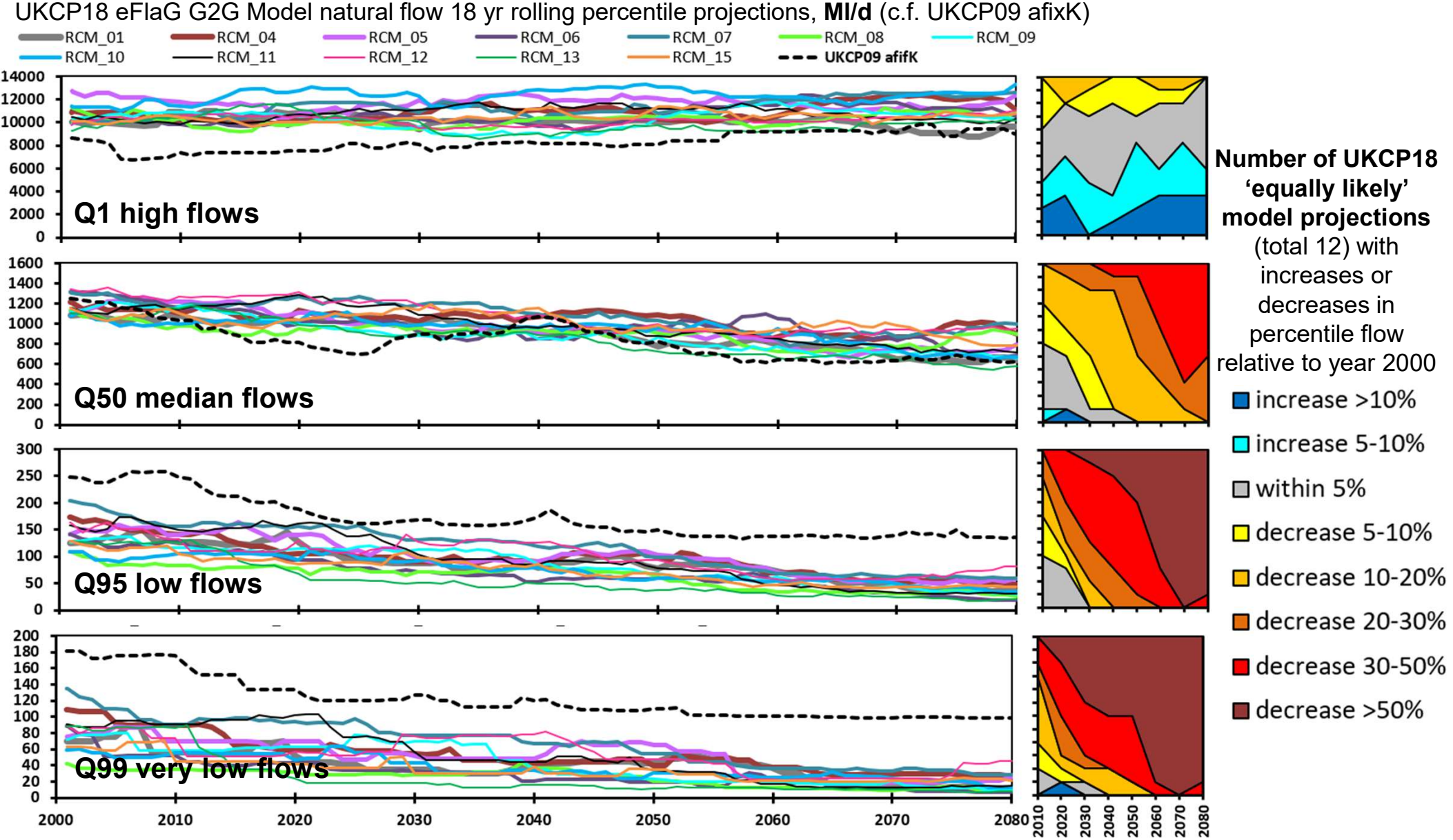
Data from EA's National Framework modelling in 2020

Figure A3.2 Flow changes expected due to climate (Tamar at Gunnislake): Projections from UKCP18 climate & PDM gauge-calibrated river flow models



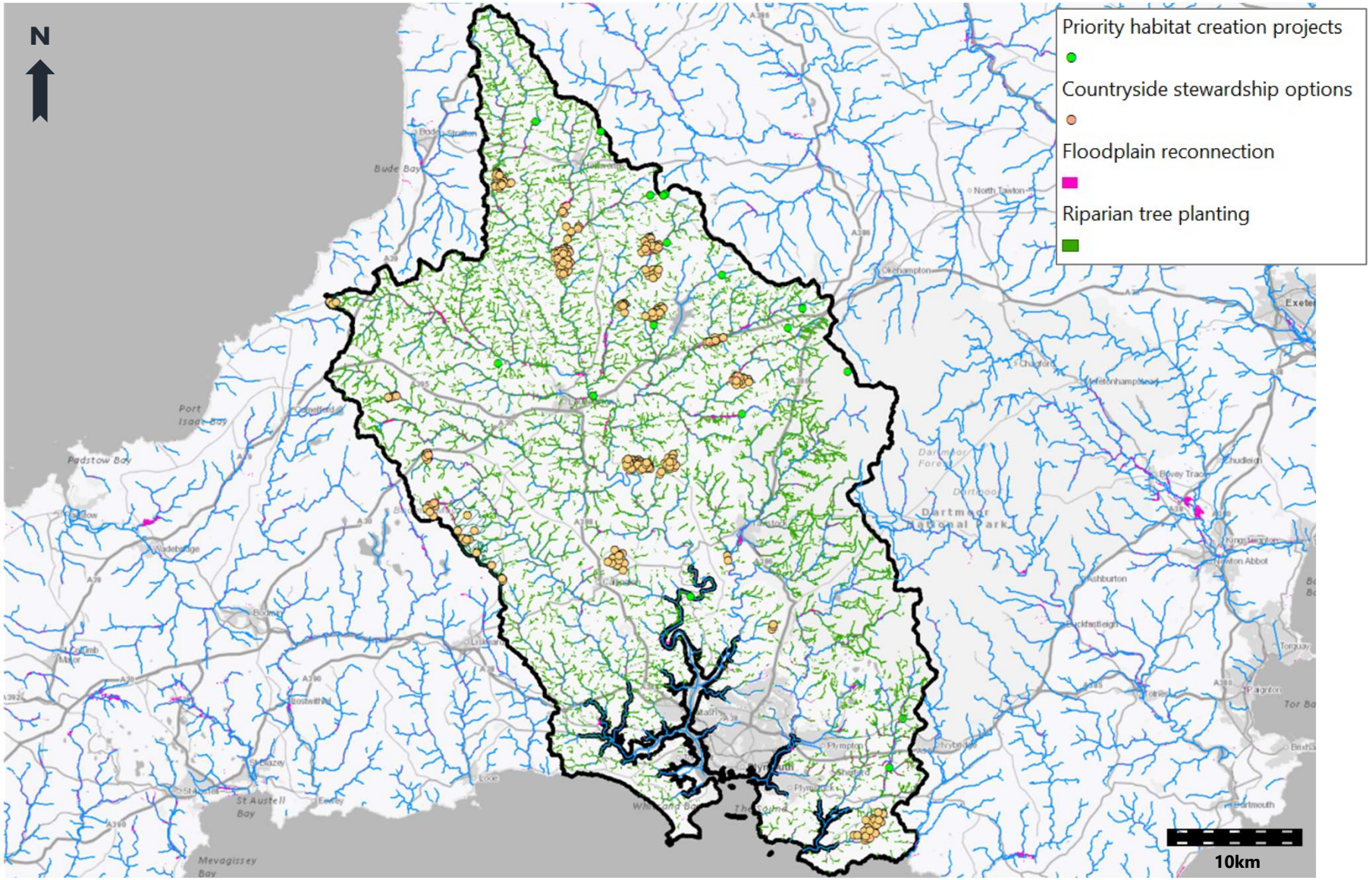
Data source: natural flows from 12 equally likely UKCP18 regional climate models (with UKCP09 afixK natural projection for comparison): https://eidc.ac.uk/

Figure A3.3 Flow changes expected due to climate (Tamar at Gunnislake): Projections from UKCP18 climate & G2G national natural 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 D4.1 Tamar catchment: CaBA opportunity mapping



Data downloaded June 2021 from Catchment Based Approach Data Hub website

Figure D4.2 Short term 2030 catchment measures: Tamar

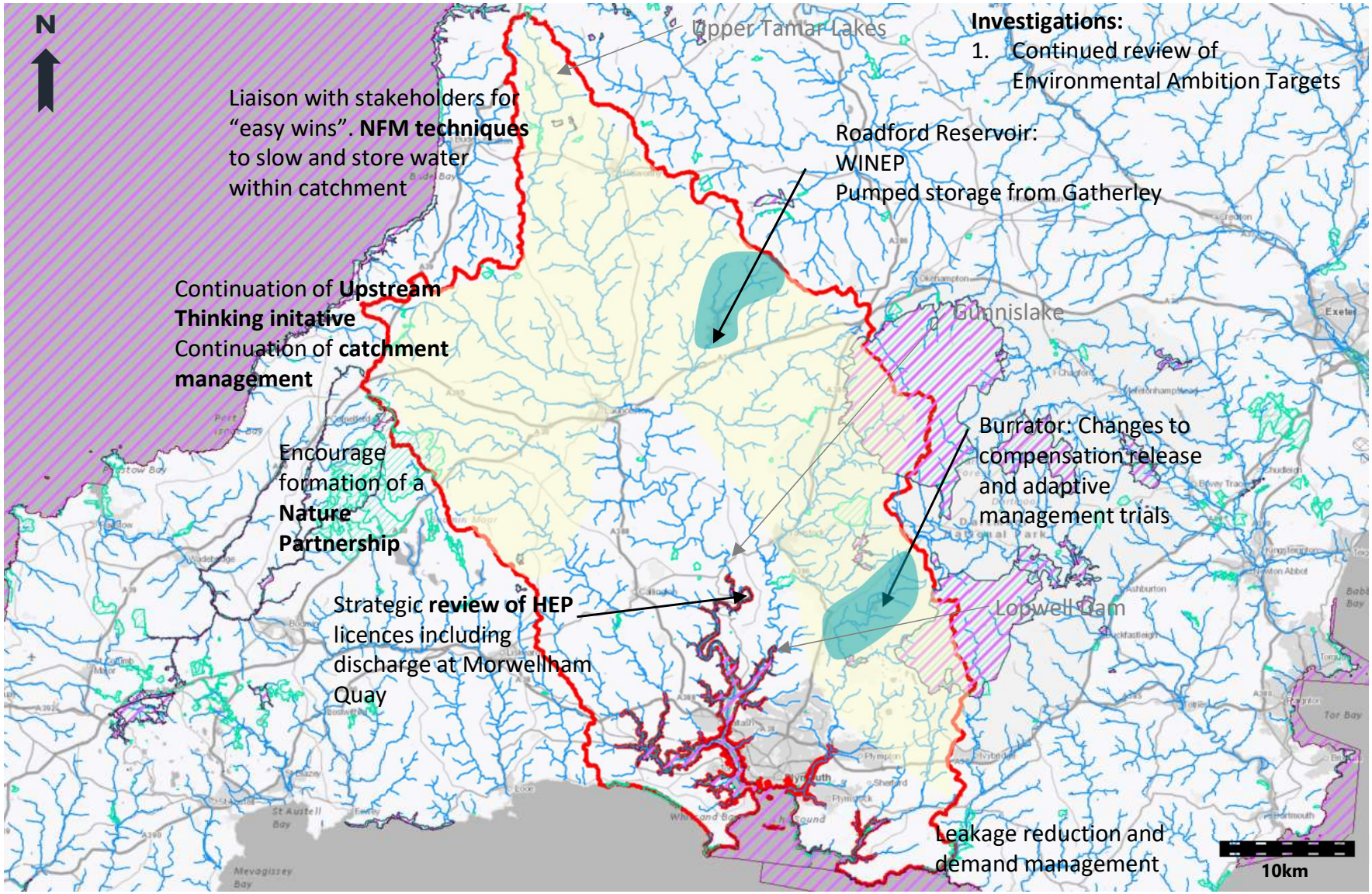


Figure D4.3 Medium term 2040 catchment measures: Tamar

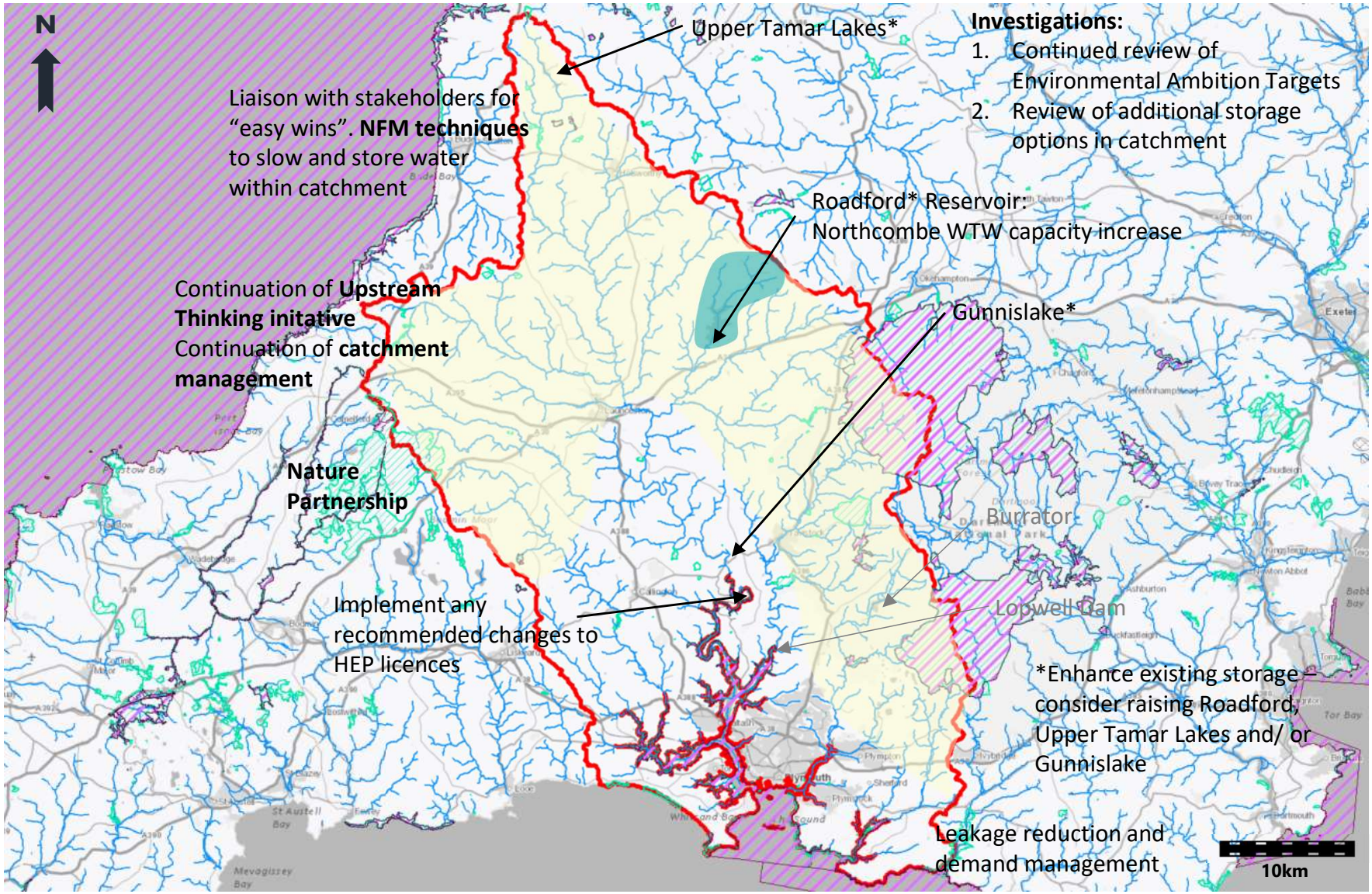


Figure D4.4 Long term 2050 catchment measures: Tamar