Title: The Environment Act – Water Targets (Agriculture; Abandoned Metal Mines; Wastewater; Water Demand) **IA No:** N/A **RPC Reference No:** N/A **Lead department or agency:** Department for Enviornment, Food, and Rural Affairs (Defra) **Other departments or agencies:** Environment Agency	**Impact Assessment (IA)** **Date:** 19/12/2022 **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Secondary legislation **Contact for enquiries:** catriona.penny@defra.gov.uk

Summary: Intervention and Options

RPC Opinion: Not Applicable

Cost of Preferred (or more likely) Option (in 2019 prices)			
Total Net Present Social Value	**Business Net Present Value**	**Net cost to business per year**	**Business Impact Target Status**
£19,181m	-£347m		Non qualifying provision

What is the problem under consideration? Why is government action or intervention necessary?

Water keeps us alive, drives our economy and sustains wildlife. Good water quality is essential to meet the health, business and leisure needs of society, while underpinning ecosystems on which the whole environment relies. Pollution and excessive use of water are externalities that damage these systems and are not always recognised or taken fully into account by businesses, public bodies and individuals responsible for the damage. Population growth and climate change are making the damage worse. Further action is needed to deliver the vision set out in the 25 Year Environment Plan.

What are the policy objectives of the action or intervention and the intended effects?

The objective is to improve the condition of the water environment by setting targets to reduce the damaging effects of (a) pollution and (b) taking water for public supply. Targets have been set to reduce: (i) nitrogen, phosphorus and sediment pollution from agriculture, (ii) metal pollution from abandoned metal mines, (iii) phosphorus pollution from wastewater treatment works and (iv) the use of water for public supply. The targets are quantified with specific metrics and to be achieved by 2038. The targets will drive future policy and thereby actions for the water industry, farmers, government and the general public.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base)

Under the Environment Act 2021, the government is required to create new, legally binding long-term targets in four priority areas including water. The targets for water and set out here have been developed working with scientific experts and a range of stakeholders representing the major affected groups and views gathered during the Environment Act targets consultation. The policy options analysed in this impact assessment represent an indicative policy pathway towards the targets rather than a prescribed set of policy instruments. They include a range of actions that are specific to the targets including direct public expenditure, requirements on the regulated water companies, regulation and enforcement, publicly-funded incentives, advice, information and voluntary action by industry and the public.

Is this measure likely to impact on international trade and investment?		No		
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)		**Traded:** N/A	**Non-traded:** TBC	

Will the policy be reviewed? Yes **If applicable, set review date:** Environment Improvement Plan cycle.

I have read the Impact Assessment and I am satisfied that, given the available evidence, it represents a reasonable view of the likely costs, benefits and impact of the leading options.

Signed by the responsible Minister: Minister Trudy Harrison Date: 15/12/2022

Summary: Analysis & Evidence

Policy Option 1

Description: Set targets for reductions in pressures on the water environment by 2038

FULL ECONOMIC ASSESSMENT

Price Base Year 2021	PV Base Year 2021	Time Period Years 79	Net Benefit (Present Value (PV)) (£m)		
			Low:	**High:**	**Best Estimate:** 19,181

COSTS (£m)	Total Transition (Constant Price) Years		Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low		To 2038		
High				
Best Estimate	4,932			**10,264**

Description and scale of key monetised costs by 'main affected groups'

Costs will depend on the final policy pathways chosen but we have modelled potential illustrative policy pathways. Potential costs in agriculture (assumed to be met by government through incentives) through transferring some land from agricultural to non-agricultural uses, and adopting practices that in net terms increase business costs and/or reduce business revenues (PV£5,672m). Costs to the water industry (passed on to customers in their regulated bills following Ofwat scrutiny) for added treatment to remove phosphorus (PV£3,671m) and to promote and support water efficiency (PV£646m). Cost to government for mine water treatment schemes (PV£276m).

Other key non-monetised costs by 'main affected groups'

Minor costs to non-household water customers to reduce their water consumption, offset by the saving in their water bill. In addition to the above costs in the agriculture sector, modelled pathways suggest that increased levels of compliance with existing regulations would also be needed to deliver the targets but the costs to farmers of those regulations (now estimated PV£8,771m to 2100) were considered in the relevant impact assessments at the time.

BENEFITS (£m)	Total Transition (Constant Price) Years		Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low				
High				
Best Estimate			373	**29,445**

Description and scale of key monetised benefits by 'main affected groups'

The key benefits are the increased recreational, amenity and non-use value (to the general public) of an improved water environment, enhancing our natural capital, improving air quality and reducing CO_2 emissions (PV£25,902m). Some pollution reductions also lead to savings in drinking water treatment costs (PV£203m). As well as protecting the environment, reductions in water demand will reduce the need for investment in new supply infrastructure, saving future costs to water companies (PV£3,340m).

Other key non-monetised benefits by 'main affected groups'

The targets will encourage innovation by polluting sectors and deliver a step change towards overall water quality ambitions. The monetised benefits underestimate or omit impacts on protected areas and valuable species, terrestrial habitats and marine areas. Local economy impacts contributing to Levelling Up are described but not included in the monetised impacts. Further benefits in agriculture including reduced wastage of chemical inputs and accumulated soil biology and carbon.

Key assumptions/sensitivities/risks	Discount rate	3.5

Both monetised and non-monetised costs are the estimated costs of an indicative policy pathway to achieve the targets. Some cost estimates are based on a national level analysis that does not account fully for local variation, with no allowance for adaptation by affected industries to reduce costs, and so could be an overestimate. Assumptions about what effect the adoption of targets would have on policy and its impacts are crucial to the appraisal but involve considerable speculation.

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**Score for Business Impact Target (qualifying provisions only) £m:**
Costs:	**Benefits:**	**Net:**	Not applicable

Contents

Executive Summary

This Impact Assessment (IA) outlines policy options for achieving the legally binding Environment Act targets for water.

The targets will be a mechanism for delivering government ambitions for clean and plentiful water outlined in the 25 Year Environment Plan. The targets are sector-specific in order to set clear ambitions for the relevant industries and actors impacting the water environment, focus action on the key issues that are preventing progress towards achievement of clean and plentiful water, and not duplicate existing objectives.

There are four targets assessed in this document including two nutrient targets to address the two principal sources of nutrient pollution.

- Agriculture target: reduce total nitrogen, total phosphorus and sediment pollution from agriculture to the water environment by at least 40% by 31 December 2038.
- Abandoned metal mines target: reduce the length of rivers and estuaries polluted by target substances from abandoned mines by 50% by 31 December 2038.
- Wastewater target: reduce phosphorus loadings from treated wastewater by 80% by 31 December 2038.
- Water demand: reduce the use of public water supply in England per head of population by 20% by 31 March 2038.

This IA does not specify precisely how the targets will be achieved, although it does suggest groups of policy options which could together deliver each target. As such, this IA is built upon reasonable illustrative assumptions on how targets could be delivered and the monetised cost-benefit analysis includes only new interventions.

The end dates for the water targets have changed since the Environment Act targets consultation. All targets have moved to a 2038 end date to meet the legal requirement that the targets cover a 15 year time period. The appraisal period, to 2100, remains the same therefore this change has not required an updated cost-benefit analysis for these three targets. The Environment Act creates a new statutory cycle of monitoring, planning and reporting. Long-term targets will be supported by interim targets, which will set a five-year trajectory towards meeting the long-term targets. The Act requires Government to set interim targets in the Environmental Improvement Plan. This will ensure that there is always a shorter-term goal Government is working towards, as well as the long-term target and will allow for an ongoing assessment of whether the government is on track to meet its long-term target ambitions.

The IA considers the costs and benefits of the proposed policy pathways to businesses, the public, environmental goods and government spending.

The *Overarching Impact Assessment for proposed Environment Act (2021) targets* provides a high-level, descriptive, and largely qualitative analysis of all the targets under the Environment Act.

1. Problem under consideration and rationale for intervention

Water keeps us alive, drives our economy and sustains wildlife. Good water quality is essential to meet the health, business and leisure needs of society, while underpinning ecosystems on which the whole environment relies. Clean water is a public good and to some degree an open access resource. Pollution and excessive use of water cause external costs to other users and non-user beneficiaries which are not always recognised or taken fully into account by businesses, public bodies and individuals responsible for the damage.

Since the mid-1990s, there has been great progress on improving England's waters but in recent years overall ecological results have plateaued. Population growth, land use and climate change are affecting the water environment at an alarming rate. Climate change will continue to impact river basin districts through changes to weather patterns, sea level rise, and increased frequency of natural hazards, extreme rainfall, heat waves and drought. All areas of the United Kingdom are projected to experience warming dependent on global levels of greenhouse gases. Warm, dry weather results in low water flows, and therefore less dilution of pollutants entering water bodies. This increases the negative impact of pollutants, and causes issues such as disease spread, pressure on abstraction and irrigation, and reduced crop yields. Additionally, increased precipitation can increase the run-off of pollutants into water bodies and overwhelm the sewage network[1].

Water pollution damages the quality and uses of waters. It harms the ecology of lakes, rivers, estuaries and coastal waters. It impairs the ecosystem services provided by these waters and detracts from their natural capital value. It reduces the quality of ground waters as sources of drinking water and river base flow. It impinges on uses such as angling, water contact sports and bathing, waterside recreation, abstraction and wildlife conservation. Protecting habitats and continuing to provide these benefits to people will require action to restore and protect the water environment.

We need to ensure that there is sufficient quality and flow of water in the water environment to meet the needs of people, the environment, industry and economic growth. Increased demand and reduced water availability from less predictable precipitation as a result of climate change will affect the environment and reduce security of water supply. An additional 4,000 million litres of water a day is expected to be required by 2050 due to increased population growth, climate change, and the need to leave more water in the environment. Of the additional 4,000 million litres of water a day expected to be required by 2050, half of this capacity is expected to be met by demand reduction.

[1] Climate Change Committee (June 2021), *Independent Assessment of UK Climate Risk (CCRA3)*. Available at: https://www.theccc.org.uk/publication/independent-assessment-of-uk-climate-risk/.

1.1. Existing water targets

The 25 Year Environment Plan sets out goals including achieving clean and plentiful water by improving at least three quarters of England's waters to be close to their natural state as soon as is practicable. Further, the 25 Year Environment Plan aims cover waters that are specially protected.

Clean and plentiful water is not only good for communities but also for the economy. Restoring and protecting water quality will enhance the stock of natural capital. This is an essential basis for economic growth and productivity over the long-term.

The 25 Year Environment Plan national goal is an aggregation of objectives set for each individual water body. River Basin Management Plans, developed under the Water Environment Regulations[2], set out objectives for 75% of water bodies to achieve good status by 2027. Good status means a state with only slight impact of human activity and requires a water body meets both good ecological status and good chemical status. Good ecological status takes into consideration water chemistry, biology, ecology, the physical state of water bodies, quantity of water and flow. It provides an assessment of the overall health of water bodies, and the ability of freshwater to provide a full range of ecosystem services. These objectives were set following detailed economic assessment[3].

The Environment Agency classifies the status of each water body, including nearly 5,000 rivers, lakes, estuaries, coasts and groundwaters. Classification is based on over one hundred different elements, including biology (fish, macrophytes and invertebrates), water chemistry, and hydromorphology. The most recent classifications, published in 2020, showed that surface water ecological status had remained at the same level nationally, compared to the previous assessment in 2016. 16% of water bodies met the criteria for good ecological status and no surface water bodies met the criteria for achieving good chemical status, compared to 97% pass in 2016[4]. This change in chemical status is due to

[2] The Water Framework Directive was transposed into domestic legislation under The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, referred to in this document as the Water Environment Regulations. Available at: https://www.legislation.gov.uk/uksi/2017/407/contents/made.

[3] The River Basin Management Plan 2015 Impact Assessment outlines the proposed options for improving the water environment and reaching the objectives of the WER. Available at: Impact assessment update to the RBMPs for England s water environment 2015 .pdf (publishing.service.gov.uk). The proposed option uses the exemptions allowed in the WFD to set less stringent environmental objectives on the grounds of technical feasibility and disproportionate expense. This analysis resulted in an overall ambition for the water environment in England to achieve overall good status or higher in 75% of water bodies.

[4] Under WER, the status of all surface water bodies is classified as being 'High', 'Good', 'Moderate', 'Poor', or 'Bad'. There is a requirement to achieve good status for all waters by 2021 (Cycle 2) or by 2027 (Cycle 3). Where status is less than Good, a Reason For Not Achieving Good status (RNAG) is assigned. The RNAG data allows us to determine the relative importance of different pressures and sectors in terms of their overall contribution to water bodies not meeting their good status objectives. Each identified RNAG has an associated level of certainty (suspected, probable or confirmed) based on a weight of evidence approach. The data summarises the main sectors responsible for pressures where the sector and pressure has a probable or confirmed level of certainty. Currently, 72% of all Cycle 2 water body catchments in England fail WER Good Status objectives due to one or more pressures from different sectors (2246 out of a total of 4950) (March 2019 data).

new substances, new standards, and improved techniques and methods. There is little underlying change in chemical status for other chemicals.

1.2. The Environment Act water targets

The Environment Act water targets will seek to complement and build on the range of existing legally binding targets in the Water Environment Regulations by ensuring progress in specific, challenging areas. The four areas identified for targets are:

Nutrient targets: to address the two principal sources of nutrient pollution:

- Reduce total nitrogen, total phosphorus and sediment pollution from agriculture to the water environment by at least 40% by 31 December 2038.
- Reduce phosphorus loadings from treated wastewater by 80% by 31 December 2038.

And two targets on other major pressures:

- Reduce the length of rivers and estuaries polluted by target substances from abandoned metal mines by 50% by 31 December 2038.
- Reduce the use of public water supply in England per head of population by 20% by 31 March 2038.

These areas have been chosen because of the acute pressure they place on the water environment. The data from river basin management planning show that pollution from rural areas, of which the vast majority originates from agriculture, is contributing to 40% of water bodies in England failing to meet good ecological status, and pollution from wastewater is impacting 36%[5]. 15% of water bodies in England are affected by changes to the natural flow and levels of water[6]. These effects can be particularly acute in specific areas of the country, where they can have serious effects on rare habitats such as chalk streams. Pollution from metal mines causes localised but serious pollution harming fish and other aquatic wildlife and is a government liability.

What sectors/ markets/ stakeholders will be affected, and how, if the government does intervene?

The agriculture and water industries, as the greatest sources of water pollution, will be most impacted by the measures required to achieve the water targets. Both will experience benefits as well as costs. However, all parts of society have a role to play in the change

[5] Environment Agency & Natural England (2021), *State of the water environment indicator B3: supporting evidence*. Available at: https://www.gov.uk/government/publications/state-of-the-water-environment-indicator-b3-supporting-evidence/state-of-the-water-environment-indicator-b3-supporting-evidence#key-issues-and-sectors-affecting-water-bodies-in-england.
[6] *Ibid.*

needed to achieve the ambitions of the 25 Year Environment Plan. Initial impacts on farming and the water industry feed through to other businesses and consumers in various ways. The targets will require additional public sector resourcing for monitoring, enforcement, engagement, advice and evaluation.

Why must it be government?

In order to achieve long term change in restoring the water environment, action must be taken by successive governments as well as the current administration. The targets allow for robust, objective scrutiny and accountability of government's progress. Industry and society will benefit from clear articulation of long-term targets as it will allow businesses to plan investments and innovation.

Without intervention from government, businesses would have no individual incentives to meet their own target and make the longer-term investments to deliver the outcomes required to improve water quality.

1.3. Agriculture

What is the issue being addressed?

Nearly 70% of land in England is used for agriculture. Agriculture and rural land management is responsible for approximately 40% of reasons for water bodies not achieving good status[7]. It is estimated that 50% of nitrate pollution, 25% of phosphorus in the water environment and 75% of sediment pollution comes from agriculture[8].

National estimates of phosphorus entering rivers vary between studies and contributions will vary across catchments. 55% of river water bodies and 73% of lake water bodies exceed phosphorus standards for "close to natural" and similar proportions exceed the phosphorus targets for favourable condition of water-dependent Habitats Sites. These waters are affected by or at risk from eutrophication, meaning that elevated nutrient levels cause excessive algal and plant growth, damaging the ecology, water quality and limiting possible uses of the waters[9].

Some waters are formally designated as affected by freshwater eutrophication (5164 km of rivers, 96 lakes and reservoirs in England)[10]. The Environment Agency has reviewed the

[7] Environment Agency (2021), *2021 River Basin Management Plans: Agriculture and rural land management*. Available at: https://consult.environment-agency.gov.uk/++preview++/environment-and-business/challenges-and-choices/user_uploads/agricultural-and-rural-land-management-challenge-rbmp-2021.pdf.
[8] Defra (2018), *A Green Future: Our 25 Year Environment Plan*. Available at: A Green Future: Our 25 Year Plan to Improve the Environment.
[9] Environment Agency (2019), *Phosphorus and Freshwater Eutrophication Pressure Narrative*. Available at phosphorus-pressure-rbmp-2021.pdf (environment-agency.gov.uk).
[10] *Ibid.*

extent of eutrophication impacts in river and lakes more generally, showing that eutrophication is a substantial issue for freshwaters in England[11].

Nitrogen exists in many different forms, including both inorganic (e.g., ammonia, nitrate) and organic (e.g., amino and nucleic acids)[12]. It undergoes many different transformations in the environment, changing from one form to another as organisms use it for growth and, in some cases, energy[13]. Some nitrogen forms pose a risk to human health and/or to the environment. Nitrate may pose a risk to human health in water bodies used for drinking water abstraction. In groundwater, 69% of water bodies are at risk of failing and 37% are classed at poor chemical status (or have rising trends) due to nitrate[14]. Nearly 30% of groundwater used for public water supply must be blended or treated to remove nitrate and meet drinking water standards, which is costly[15]. In eutrophic standing freshwaters, nitrogen can be a factor limiting or co-limiting biological production and reducing both nitrogen and phosphorus loads is often needed to restore ecological quality.

Excess fine sediment can have a negative impact on aquatic ecology and the quality of water abstracted for drinking water supply. It can also transport other pollutants, inhibit navigation and block water industry infrastructure. Fine sediment pressure in England is responsible for around 5% of reasons for not achieving good status[16].

There is no ecological in-river sediment standard and so there are no official compliance statistics. Sediment can impact directly upon river biology (invertebrates and fish) or indirectly through links to other pressures (e.g., pesticides, chemicals and nutrients). In addition, around 80 drinking water protected areas are at risk from colour problems, mainly caused by loss of dissolved organic carbon from peat uplands, which may be exacerbated by erosion[17].

The loss of valuable soil from land is of concern for the agricultural sector. Each year, farmers in England and Wales lose an estimated 2.9 million tonnes of soil to erosion[18]. Soil erosion is a natural phenomenon, but the rate of soil erosion varies. It is influenced by several factors including the intensity, duration and timing of rainfall events (erosivity); the physical, biological and chemical properties of soils (erodibility); the length, gradient and

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[11] *Ibid.*
[12] Wymore, A.S. et al (2021), 'Gradients of Anthropogenic Nutrient Enrichment Alter N Composition and DOM Stoichiometry in Freshwater Ecosystems', *Global Biogeochemical Cycles*, 35(8) e2021GB006953. Available at: https://doi.org/10.1029/2021GB006953.
[13] Durand, P. et al. (2011) 'Nitrogen processes in aquatic ecosystems', in Sutton M. et al. (ed(s).) *The European Nitrogen Assessment: Sources, Effects and Policy perspectives*. Cambridge University Press, pg 126-146.
[14] Environment Agency (2019), *2021 River Basin Management Plan: Nitrate.* Available at: 20190221_NitratesNarrative_Draft (environment-agency.gov.uk).
[15] *Ibid.*
[16] Environment Agency (2019), *Fine Sediment Pressure Narrative*. Available at: fine-sediment-pressure-rbmp-2021.pdf (environment-agency.gov.uk).
[17] *Ibid.*
[18] Environment Agency (2019), *The state of the environment: soil.* Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805926/State_of_the_environment_soil_report.pdf.

form of slope; the type of vegetation/crop on the land and its stage of development; and the type and timing of singular or combined land management practices.

What will the agriculture target address?

The target addresses the three key pressures (nitrogen, phosphorus and sediment) on the water environment caused by agriculture. They were chosen for the target based on existing knowledge, evidence and models on the impact of these pollutants on the water environment.

Given the length of time between action and ecological response, the target focuses assessments of the pollutant as it is emitted (pollutant loadings) to ensure that reductions are occurring as soon as is feasible. This metric will more effectively show immediate improvements in farming practices compared to waiting for changes to flow through into ecological status. The target will make clear to farmers and the wider public what needs to change and by when.

The target as constructed specifies the pollutants that are most important to be addressed and will allow regular monitoring of progress. By explaining the changes needed and measuring them in a way that will be very responsive to farmer actions relative to ecological change, successes can be monitored, and action can respond to the pace of progress.

Who will be impacted by the agriculture target?

This IA assumes a purely illustrative policy pathway to achieve the target, but no decisions have been made and it does not set out any specific policy intentions. Under the illustrative pathway for the target to be achieved, the sector will need to comply with all relevant regulations, government will need to incentivise significant improvements in the sustainability of agricultural practice, support the adoption of new technologies, improved crop varieties and cropping practices, and ensure that the creation of biodiverse habitats and tree planting provides the greatest possible environmental benefit per hectare. This will provide the greatest value for money and help to limit the amount of land use change required to achieve all legally binding environmental targets.

The groups most affected will be farmers and landowners. Domestic food production continues to be a high priority, and will be taken into consideration when developing policy measures to achieve the targets. The illustrative potential pathway includes options including those that achieve substantial improvements in the level and effectiveness of farmers' compliance with existing regulation on farm practices that cause pollution of freshwater. These will involve costs to farm businesses, already factored into the impact assessments for existing regulations . There will be business savings from improved management of nutrients (phosphorus and nitrogen), potentially reducing input costs. Additional cost to government is assumed for advice, support and enforcement (see below).

In addition to improved compliance, the illustrative pathway includes large scale adoption of a wide range of further farm management practices, implementation of advancements in innovation and technology and payments for habitat creation, particularly focussed on high risk land (e.g. sloped land alongside water bodies). The mechanisms to achieve these changes are not specified and would not be committed by adoption of the targets; no decisions on related policies have been made. It is also assumed here that these measures would be voluntary on the part of farmers and landowners. This may involve market changes, including responding to market-driven standards of good environmental practice, and new markets in bioenergy and carbon offsetting, independent of the targets. Or it may be achieved with government-funded incentives and advice. The assessment of costs and benefits (section F below) shows all costs as falling on government, assuming no supportive market changes over the period of the targets and entirely voluntary participation by farmers and landowners.

Why is government best placed to resolve the issue?

Losses of phosphorus, nitrogen and soil from agricultural land to water do of course involve costs to farm businesses which farmers take into account in their management decisions. But there are also “external costs” to other water users and those who value aquatic ecosystems (both groups including other farmers) which are not necessarily obvious to, or taken into account by, the land manager. This represents a market failure, meaning that the conditions for an efficient transactional mechanism to improve the overall outcome do not exist. This is a long-standing problem that justifies government intervention.

The duty to deliver the target is on government to incentivise the creation of the right policy framework to enable the sector to make the shift, through future farming reforms and related measures. This target will set a clear direction for the sector, to make changes at a catchment level and work with government to make the changes needed.

1.4. Abandoned metal mines

What is the issue being addressed?

Metal ores have been mined in England for over 3,000 years and played a major role in shaping our rich industrial history. There are thousands of metal mines scattered across the landscape, particularly in rural areas of the North East, North West, Yorkshire and South West. Most were abandoned over 100 years ago but still cause substantial environmental harm. Any pollution caused by new metal mines is out of scope for this target since they are regulated under current permitting requirements.

What will the target address?

About 1,500km of English rivers are polluted because discharges from abandoned mines cause concentrations of cadmium, lead, nickel, zinc, copper and/or arsenic in water to be above the statutory Environmental Quality Standard[19]. The Environmental Quality Standard concentrations are based on ecotoxicology data and are set at a level that should prevent environmental damage. When the concentration of a pollutant in a water sample is higher than the Environmental Quality Standard, adverse impacts are expected. Monitoring shows that the elevated metal concentrations in some rivers polluted by abandoned metal mines cause harm to fish and river insects (invertebrates) and adversely affect the overall aquatic ecosystem.

Up to half the metals discharged to rivers come from these abandoned mines, as much as is discharged from all currently operating sites regulated by permits, such as sewage works and industry[20]. Research has established that cleaning up metal pollution at the source from abandoned mines is far more cost-effective than further decreasing metal emissions downstream from sewage treatment works[21]. This is because there are fewer mine water discharges, they have higher metal concentrations and smaller flows, and the treatment technologies are less expensive to operate.

Climate change is worsening the environmental damage caused by abandoned metal mines. Lower rainfall and hotter summers lead to increased harm to river wildlife. Groundwater containing high metal concentrations (mine water) provides baseflow to rivers. When there is less dilution by rainfall, metal concentrations are higher and hence the pollution is more severe. Conversely, more intense rainfall erodes metal rich bankside soils and re-suspends contaminated in-river sediments causing greater transport of metals down rivers to the sea, and in some cases accumulates in estuary shipping berths threatening economic activity[22].

Why is government best placed to resolve the issue?

Pollution from mines abandoned before 2000 can only be resolved by government intervention, as the former mine operators are not liable for the long-term environmental impacts of their activities. Government has access to appropriate expertise and an existing mechanism to intervene. Since 2011, Defra has been working with the Environment Agency and Coal Authority (a non-departmental public body of the Department for

[19] *The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015*. Available at: https://www.legislation.gov.uk/uksi/2015/1623/pdfs/uksiod_20151623_en_auto.pdf.
[20] Mayes, W et at. (2010) 'Inventory of aquatic contaminant flux arising from historical metal mining in England and Wales', *Science Direct*, 408(17). Available at: Inventory of aquatic contaminant flux arising from historical metal mining in England and Wales - ScienceDirect.
[21] UKWIR (2015), *Water Framework Directive (WFD); cost-effectiveness of measures in other sectors*. Available at: Water Framework Directive (WFD); Cost-Effectiveness of Measures in Other Sectors (ukwir.org).
[22] Environment Agency (2019), *2021 River Basin Management Plan*. Available at: https://prdldnrbm-data-sharing.s3.eu-west-2.amazonaws.com/Challenge+narratives/Pollution+from+Abandoned+Mines+challenge+RBMP+2021.pdf.

Business, Energy and Industrial Strategy (BEIS)) to manage this pollution through the Water and Abandoned Metal Mines programme[23].

This target addresses a historical legacy of pollution which stems from a previous gap in legislation when metal mining operations took place with little regard for the negative externalities of harm to water users and the natural environment. Creating a legally binding target on government will be a powerful method of ensuring continued focus on metal mines in future spending rounds and demonstrate commitment to cleaning up a source of pollution that is a government liability. Achieving the target does not require any changes to regulations or widescale impacts on the public or other stakeholders.

1.5. Wastewater

What is the issue being addressed?

Wastewater from the water industry is one of the biggest pressures on the water environment, impacting 36% of water bodies that did not achieve good status in the 2019 classifications[24]. Both treated and untreated sewage discharges contribute to eutrophication which causes ecological harm.

The largest source of water pollution from water companies is the continuous discharge of treated sewage. The wastewater target will address phosphorus pollution from continuous discharges. Intermittent discharges (overflows) have been addressed separately through the Government's Storm Overflows Discharge Reduction Plan which set ground-breaking and ambitious targets for water companies to eliminate ecological harm and protect public health from storm overflows for the first time ever..

Phosphorus is the main nutrient responsible for eutrophication in freshwaters[25]. Eutrophication takes place when nutrient levels are too high and adversely affects the quality of the water, damaging the local ecology. Phosphorus is the most common reason a water body fails to meet good status. 55% of assessed river water bodies and 73% of lake water bodies failed the phosphorus standards which aim to prevent eutrophication[26]. Similar proportions exceed the phosphorus targets for favourable condition of water-dependent protected sites. Effluent from sewage treatment works is the main source of

[23] Coal Authority (2016), *Metal mine water treatment: The Water and Abandoned Metal Mines programme aims to tackle water pollution caused by historical metal mining.* Available at: Metal mine water treatment - GOV.UK (www.gov.uk).
[24] Environment Agency & Natural England (2021), *State of the water environment indicator B3: supporting evidence*. Available at: https://www.gov.uk/government/publications/state-of-the-water-environment-indicator-b3-supporting-evidence/state-of-the-water-environment-indicator-b3-supporting-evidence#key-issues-and-sectors-affecting-water-bodies-in-england.
[25] Environment Agency (2019), *Phosphorus and Freshwater Eutrophication Pressure Narrative*. Available at phosphorus-pressure-rbmp-2021.pdf (environment-agency.gov.uk).
[26] Environment Agency (2019), *Phosphorus and Freshwater Eutrophication Pressure Narrative*. Available at phosphorus-pressure-rbmp-2021.pdf (environment-agency.gov.uk).

phosphorus in many water bodies accounting for 60-80% of phosphorus entering rivers nationally[27].

Who will be impacted by the target?

The sector that will be directly impacted by the wastewater target is the water industry. Water companies will need to implement plans to reduce phosphorus loads. The funding mechanisms will be negotiated between water companies and Ofwat through the Price Review process and will be reflected in customers' sewerage bills.

Investment in the past two decades means there is now 67% less phosphorus in wastewater discharging into rivers[28]. Climate change and population growth mean that further action is needed to build on this progress and prevent water bodies from deteriorating. Wetter winters will increase runoff and erosion of phosphorus into water bodies; low summer river flows will reduce dilution and high temperatures have the potential to increase algal/plant growth. A growing population means more wastewater to treat and increased discharges into water bodies[29].

The wastewater target will address this pressure. Water companies will be able to make use of innovative methods such as nature-based solutions or biological phosphorus removal rather than solely focusing on chemical treatment.

Why is government best placed to resolve the issue?

The water industry is heavily regulated, with environmental (and other) priorities for investment by water companies set by Defra through the Strategic Policy Statement (SPS). Following introduction of a government target on the water industry, water companies will submit their business plans to Ofwat and, so long as they demonstrate good value for money and efficiency, these will be funded through the Price Review process. This is one of the main mechanisms used to address the negative externalities arising from wastewater discharges, ensuring that companies invest appropriately on behalf of their customers where there is otherwise no market incentive.

1.6. Water demand

What is the issue being addressed?

[27] *Ibid.*
[28] Environment Agency (2019), *Regulating for people, the environment and growth, 2019.* Available at: https://www.gov.uk/government/publications/regulating-for-people-the-environment-and-growth/regulating-for-people-the-environment-and-growth-2019 .
[29] Environment Agency (2021), *River Basin Management Plans 2021 – Challenges and Choices consultation summary report.* Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954201/Challenges_and_Choices_consultation_summary_reponse_210125.pdf.

A secure supply of water is needed to support a growing economy and population and reduce the strain on the water environment. Increased demand and reduced water availability will affect the environment and reduce security of supply. It is therefore essential that the demand for water is managed and monitored so that these challenges can be addressed.

Draft regional Water Resources Management Plans show we face a gap between supply and demand for water of 4,000 million litres per day by 2050. The plans suggest half of this can be met through reducing demand for water and half from new supply options. This gap is driven by the need to protect the environment, population growth, climate change and improving resilience to droughts[30]. The water demand target will ensure a more sustainable level of water demand and ensure more is left in the water environment to support habitats.

Without action to improve the supply-demand balance, households and businesses risk more frequent interruptions to water supply, including water use restrictions, bans and standpipes in the street. The environment would also be put under greater pressure from water abstraction and the impacts of climate change. The NIC predicts that the cost of relying on emergency options such as road and ship tankers of water would be around £40bn over the next thirty years[31]. A study presented in 2012 estimated that the impact of a severe drought on London's economy would be in excess of £250m per day[32]. Public water supply needs and increased resilience to droughts can be met by a combination of reducing consumption, reducing leakage, increasing supply and moving water from areas of surplus to areas of need.

Who will be impacted by the target?

The sector directly affected is the water industry. The target will give certainty on the limit for future demand that water companies need to factor into their Water Resources Management Plans. The government already challenges water companies to be more resilient through the Water Resources Management Plan process and Drought Plans. The target will add a statutory reduction figure and planning certainty to the existing process.

As the target covers public water supply to the non-household sector (this does not include direct abstraction for agriculture or other purposes), it will have implications for the competitive water retail market and non-household (e.g. business) customers. The non-household sector has developed an action plan to improve water efficiency involving wholesalers and retailers working together with water undertakers to include non-household demand management more explicitly in Water Resources Management Plan

[30]Environment Agency (2022), *Review of England's emerging regional water resources plans*. Available at:https://www.gov.uk/government/publications/review-of-englands-emerging-regional-water-resources-plans/review-of-englands-emerging-regional-water-resources-plans
[31] *Ibid.*
[32] Thames Water (2017), *London severe drought scoping study.* Available at: London severe drought scoping study.

guidance and process[33]. The Retailer and Wholesaler Group which represents the industry is supportive of a water demand target. Activities to reduce non-household demand may be delivered by wholesale water companies, with impacts on all water bill-payers or by retail water companies as part of their competitive service to businesses.

Why is government best placed to resolve the issue?

Government and its regulatory bodies, including Ofwat, have a role in setting ambition for water companies and determining the funds they can raise to deliver it. A statutory target will ensure that appropriate actions are taken to meet the water demand target by clearly demonstrating the government's expectations on water demand reduction and embedding reaching this objective in the Price Review process,

Without government intervention, water companies will have little incentive to reduce leakage or demand as works to reduce leakage are costly and business have a shorter business planning horizon than the target, so would make different decisions on what to invest in.

The water demand target formalises and draws together existing water efficiency commitments made by government, regulators and industry. The target adds value to these commitments by setting the level of ambition for the new policies to reduce household consumption; introducing a statutory target that includes non-household and linking demand reduction with leakage reduction.

[33] Water Resources Management Plans (WRMPs) are reviewed every 5 years. The non-household action plan (2021) aims to include non-household demand management in the next cycle of WRMPs, due to be finalised in 2024.

2. Rationale and evidence to justify the level of analysis used in the IA (proportionality approach)

Although the setting of targets is designed to deliver substantial improvements to the water and wider environment, these will be delivered through a suite of policies and interventions, some existing and some new. This IA does not specify precisely how the targets will be achieved, although it does suggest reasonable groups of policy options which could together deliver each target. As such, this IA is built upon reasonable illustrative assumptions on how targets could be delivered and the monetised cost-benefit analysis includes only the new interventions.

Although the evidence base which underpins each target differs in quality and quantity, the analysis builds upon many years of monitoring and assessments of the water environment. Details of the gaps in the evidence are given in the relevant sections below, but some key limitations include:

1. The water targets are focussed on reduction of key pressures on the water environment and this requires source apportionment for some cross-cutting pollutants (e.g., nutrient pollution which could be derived from either diffuse or point source agricultural or wastewater sources). This source apportionment remains challenging in many catchments and must be done by extrapolation.

2. The modelling which underpins our level of ambition for the target on agriculture is based on FARMSCOPER which estimates annual average losses of nitrate, sediment and phosphorus. As the target aims to reduce all forms of nitrogen pollution from agriculture (not just focussing on nitrate) Defra sought advice from water experts on whether similar levels of reduction are possible for all nitrogen containing compounds. Experts highlighted that many of the measures or land management practices which reduce nitrate, phosphorus and sediment will have positive impacts on total nitrogen pollution by minimising losses, mobilisation and transport of these pollutants. Defra have committed to commission an update for the model to include total nitrogen.

3. Description of options considered

Under the Environment Act, the government is required to create new, legally binding long-term targets in four priority areas including water. These new targets to address specific pressures will be an important mechanism to drive environmental improvement and meet the ambitious objectives for the water environment in the 25 Year Environment Plan.

The water targets address four sources of pressure on the water environment; abandoned metal mines, wastewater, agriculture and water demand. For each of these targets varying levels of ambition have been considered, accounting for cost, feasibility and environmental outcomes. A breakdown of these options and the rationale for each target is provided below.

The targets have been developed in an evidence-led process, drawing on independent advice from the Water Expert Advisory Group and engaging a range of stakeholders including the agriculture industry, water companies, environmental NGOs, and the business community.

Each of the water targets represents an option that is ambitious, viable and realistic within the timespan.

3.1. Agriculture

"Do nothing"

A variety of voluntary, incentivised and regulatory policy mechanisms currently exist to reduce agricultural pollution. However, nitrogen, phosphorus and sediment pollution from agriculture remain a major problem for the quality of water and surrounding environment. The "Do Nothing" option assumes that current regulation remains in place with increases over currently estimated levels of compliance.

England's agricultural policy is in a period of transition[34] from the previous mechanisms of the Basic Payment Scheme and Countryside Stewardship. The "Do Nothing" option in this IA assumes that the level of uptake of incentivised farm management practices that benefit the water environment would be identical to recent estimates. No further assumptions are made about the scale, design or uptake of new schemes. This means that any contribution that may be made above current practice towards the targets by Sustainable Farming Incentive, enhanced Countryside Stewardship (CS+) and Landscape Recovery are treated as additional.

Many farmers voluntarily follow good management practices that have an impact on nitrogen, phosphorus and sediment pollution, and a range of services and initiatives exist to support them. Examples are: Catchment Sensitive Farming, Championing the Farmed

[34] Rural Payments Agency (2020), *Rural payments and grants.* Available at: Rural payments and grants - GOV.UK.

Environment, water company catchment-based schemes, LEAF, Red Tractor and the Courtauld Commitment.

Preferred option: Reduce total nitrogen, total phosphorus and sediment pollution load from agriculture to the water environment by 40% by 31 December 2038.

Setting this target will focus policy interventions on the pollutants of most concern. Actions, regulations and other incentives will be focused on delivering the specified targets. The target will be measured through a combination of modelling using the best available modelling tools, including FARMSCOPER[35,36,] and the Environment Agency spatial land use change model, which will be informed by strategic monitoring. Overall levels of water pollution can be measured through water quality monitoring but modelling is needed to identify and track the contribution of agriculture, among the many other sources.

A reduction of 40% for each pollutant is considered technically achievable and impactful on the water environment. This is based initially on modelling in Defra research project WT1594[37] which assessed the effect on the water environment of future potential policy scenarios with varying levels of uptake of regulatory and incentivised measures alongside targeting land for biodiverse habitats or woodland cover. The results showed that current uptake of regulatory and voluntary measures achieve reductions of 7.9% for nitrate, 8% for phosphorus and 7.2% for sediment. The most ambitious modelled scenario improved these to 32.2%, 37.2% and 35.7%, respectively. This means, for example, incentivising farmers to maximise the potential for riparian habitat and rewarding the more precise and efficient use of nutrients (especially manures) in the farmed landscape.

Incentivising the conversion of some agricultural land to biodiverse habitat or woodland to meet habitat creation and/or net zero objectives provides greater water pollutant reductions than implementing land management measures. Modelling shows that targeting habitat creation and tree planting towards the land with the highest risk of loss of nutrients and soil, such as sloping fields prone to soil erosion and leaching to water bodies and habitats, increases the pollution reductions with a smaller amount of land. Recent Environment Agency work suggests that by using such an approach, 8% of agricultural land converted to biodiverse habitat, woodland or other uses could reduce nutrient and soil losses by 15% for nitrate, 15% for phosphorus and 16% for sediment. Technological innovation will significantly contribute to the delivery of the target by reducing the

[35] Gooday, R. (et al.) (2014) *Developing the FARMSCOPER Decision Support Tool*, Report No Defra SCF0104. Available at: http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18702.

[36] FARMSCOPER integrates multiple pollutant, emission and erosion processes, at a range of spatial scales in order to estimate pollutant loadings. Where modelling approaches are used, field verification of model predictions is important. FARMSCOPER-based estimates of agricultural pollutant loadings have previously been evaluated using PARCOM (1991–2010) (Collins et al., 2016; Zhang et al., 2017a) and Harmonised Monitoring Scheme water quality monitoring data (1980–2010) (Zhang et al., 2017b), but additional field verification would be important if applied to a new target.

[37] Defra (2019), *Water pollution from agriculture: A national scale assessment of current and future actions to reduce diffuse pollution of water by agriculture*, Project WT1594. Available at: Defra, UK - Science Search.

proportion of nutrients lost from agricultural systems, maximising yields with reduced inputs and increasing crop production using smaller areas of land. For example, new crop varieties, vertical farming which provides a greater proportion of food in controlled conditions and advances in the treatment of manures will reduce nutrient pollution.

As stated above, these are modelled illustrative policy pathways. The government may choose to adopt some of these measures or none of them to reach its target.

3.2. Abandoned metal mines

"Do nothing"

1,500km of English rivers are polluted by the metals specified in the target. To be included in the target baseline, metal concentrations in rivers must have been recorded above the Environmental Quality Standard when assessed as an annual average, and the source of those metals must have been confirmed as abandoned metal mines by the Environment Agency.

There is good confidence in the baseline length of polluted rivers. Analysis completed by an independent consultancy in early 2021 recommended the Environment Agency should carry out a further review of the polluted rivers, including gathering additional water quality data to decrease uncertainty. This work is in progress and will be used to set the formal baseline against which the target will be assessed.

As mine operators cannot be held liable for water pollution from mines abandoned before 2000, and most mines were abandoned before the 20th Century, environmental damage will continue unless government acts. Thousands of tonnes of arsenic, cadmium, zinc and lead will be washed into rivers over the next 100 years.

If this target had not been adopted, capital and revenue funding would still be required to operate the three existing treatment plants (plus one currently in construction), maintain diffuse measures and evaluate performance. These financial obligations are accounted for in Defra's financial provisions, as Defra holds departmental liability on behalf of government. A legally binding target on government will provide a strong basis on which to ensure adequate funding and action to tackle pollution from abandoned mines. Taking action now will prevent continued pollution of the water environment from metal mines which impacts ecosystems and biodiversity, contributing to that target area.

Option 1 (preferred): Reduce the length of rivers and estuaries polluted by target substances (Cd, Ni, Pb, Cu, Zn, As) from abandoned metal mines by 50% by 31 December 2038.

Following review by the Environment Agency and discussion at the Water Expert Advisory Group, this is considered to be the best metric for the abandoned metal mines target.

This metric will also contribute to statutory River Basin Management Plan objectives and 25 Year Environment Plan environmental indicators:

- B1: Riverine inputs of selected metals and nutrients into tidal waters.
- H4: Exposure and Adverse effects of chemicals on wildlife in the environment.

The Environment Agency estimates that to achieve the abandoned metal mines target, up to forty new mine water treatment schemes need to be built to capture metals before they can pollute rivers, and a similar number of diffuse interventions. These schemes will need to be operated in perpetuity.

Alternative levels of ambition were considered:

- 40% reduction in polluted river length: whilst this is more achievable as less funding from government is required, this level of ambition was considered too low to be consistent with the 25 Year Environment Plan objectives and evidence showed that a higher level of ambition can be delivered within the timeframe.
- 60% reduction in polluted river length: this would require much more funding from government. The Environment Agency and Coal Authority have low confidence that they would be able to accelerate the Water and Abandoned Metal Mines programme[38] to achieve this target by 2038.

Option 2: By 31 December 2038, reduce the mass flux (tonnes per year) of metals (Cd, Ni, Pb, Cu, Zn, As) discharged to rivers and estuaries from abandoned mines.

Mass flux is the amount of metal discharged to rivers from mine water discharges, or the amount of metal transported in rivers in a specified time period. Following review by the Environment Agency and discussion at the Water Expert Advisory Group this option was rejected due to low confidence in the baseline mass flux discharged to rivers by abandoned metal mines and the impact of rainfall. Mass flux is highest during periods of heavy rain which washes pollutants into rivers, however the rainfall also dilutes metal concentrations, reducing environmental harm. Considerable additional monitoring budget and resources would be required for the Environment Agency to establish an accurate baseline against which progress could be measured. The existing Environment Agency monitoring data used for the 25 Year Environment Plan B1 indicator reports mass flux of various contaminants to estuaries. However, there is considerable natural seasonal variability dependent largely on river flows, and particularly whether the Environment Agency collect samples at low, medium or high flows. It was considered a less useful and reliable metric than the length of polluted river.

[38] Coal Authority (2016), *Metal mine water treatment.* Available at: https://www.gov.uk/government/collections/metal-mine-water-treatment#:~:text=The%20Water%20and%20Abandoned%20Metal,caused%20by%20historical%20metal%20mining.&text=Metal%20mines%20played%20a%20major,an%20adverse%20impact%20on%20tourism.

Factors common to both options

For both options, the ambition level relates to the proportion of affected rivers that can be restored which is almost entirely determined by the level of funding. The degree of restoration that can be achieved within a given budget will also be determined by what is feasible within the context of each remediation project, constrained by the nature of the site and the pollutants involved.

There is a strategic case for addressing the largest source of metal pollution found in rivers in England and government intervention through the Water and Abandoned Metal Mines programme is the only way to tackle this. Identifying sustainable low-cost treatment options through Water and Abandoned Metal Mines programme monitoring and research will also help to develop a world leading programme to showcase UK scientific expertise, involving a strong partnership between government, private sector, universities and communities.

The Water and Abandoned Metal Mines programme is designed to address metal pollution with proven interventions that have immediate and quantifiable benefits in water quality. Improvements in water quality downstream from the treated discharges can be easily and rapidly measured enabling comparison with baseline conditions. Biological surveys can also be carried out to determine the biological recovery that results from the improvements in water quality.

3.3. Wastewater

“Do nothing”

Without the wastewater target, Defra and the regulators would use the available levers to influence water companies to ensure they protect and restore the water environment. However, a legally binding target will increase ambition and create a clear goal to spur action across future funding cycles. Water companies are already committed to reducing phosphorus levels by around 50% by 2027. The Environment Act wastewater target is a longer term and more ambitious target, which will reduce phosphorus emissions by a further 30 percentage points by 2038, leading to an overall reduction of 80%. This ensures progress is made beyond the next Asset Management Plan cycle towards the ambition of clean and plentiful water.

Phosphorus is a substantial pressure on the water environment and is one of the major contributors to eutrophication. To avoid eutrophication, the amount of phosphorus entering the water environment and the levels of phosphorus already in water bodies must be reduced.

Phosphorus emissions from sewage treatment works have been reduced over time through the use of environmental permits. In the period to 2027, more stringent limits on phosphorus emissions will be applied to about a thousand sewage treatment works. This will lead to a 50% reduction in emissions. These changes are incorporated in the “Do

Nothing” (more) option in the cost benefit analysis.

Which options have been considered?

To achieve an 80% reduction in phosphorus by 2038, it will be necessary to set phosphorus limits for more works and apply the most stringent phosphorus limit on wastewater treatment currently feasible at some of these works. This means tackling pollution from more sites and undertaking projects that were previously assessed as not cost-beneficial.

Beyond 2027, the plan would be to ensure that approximately 400 (compared to 160 committed by 2027) wastewater treatment works serving a population greater than 2,000 will have phosphorus reduction to the current Technically Achievable Limit of 0.25 mg/l. This is the tightest limit that the Environment Agency currently permit at. Allowance is made for future growth and development adding an additional 200 tonnes per year back into the environment. This results in an overall predicted phosphorus load of around 1,500 tonnes per year by 2038, which is a decrease of 80% against the 2020 baseline.

3.4. Water demand

"Do nothing"

A water demand target under the Environment Act would draw together a number of existing commitments, creating a statutory driver for delivering the level of ambition needed to meet the target, and create a new target on the non-household sector. It would facilitate the monitoring of overall water demand in England.

Analysis completed for the Environment Agency's "National Framework for Water Resources" assumes that actions in the latest round of Water Resources Management Plans are implemented up to 2025[39]. Between 2020 and 2025, water companies have planned to:

- Reduce leakage on average by 19%.
- Reduce domestic water consumption on average from 138 l/h/d to 132 l/h/d[40].
- Develop 145 Ml/d of new sources (such as reservoirs, water re-use schemes and desalination plants).

[39] Defra & Environment Agency (2017), *Water resources planning: managing supply and demand.* Available at: https://www.gov.uk/government/publications/water-resources-planning-managing-supply-and-demand.
[40] Restrictions due to the coronavirus pandemic were in place to varying levels throughout 2020/21. This meant far more people at home, and the reported PCC figures reflect this change together with periods of hot, dry weather. Overall consumption increased by approximately 2%. Non household use decreased. Average household water use per head per day (PCC) has increased since last year by around 8.5% (from 140.0 l/h/d to 151.8 l/h/d). It will be a challenge to bring PCC down given the pandemic has likely led to widespread working from home or hybrid working and this may continue in future.

- Increase resilience to drought.

Environment Agency analysis assumed that no further measures are taken beyond 2025 and estimates that England could need up to 3,435 Ml/d by 2050 to meet public (homes and businesses) water supply needs. Projections beyond 2050 carry increasing uncertainty, however analysis suggests something in the region of 5,500 to 6,000 Ml/d additional water may be needed between 2025 and 2100[41].

What options have been considered?

Two metrics for the water demand target were considered: Distribution Input (DI) and Distribution Input over population (DI/pop).

DI is the total amount of treated water supplied to customers through water companies' distribution network. This includes public water supply to households and non-households, as well as water lost through leakage, but does not include non-potable water supplies.

DI/pop identifies trends in water efficiency and allows for future changes in population. The population of England is to be determined using data for population given by water companies in the annual reviews of Water Resources Management Plans..

Non statutory sub-indicators of success will include:

- Household consumption (measured as a total or as per capita consumption)
- Non-household consumption
- Reduction in leakage

Low, medium and high levels of ambition were considered for the water demand target. The 25 Year Environment Plan declared an intention to set a non-statutory target for personal water consumption (per capita consumption (PCC). Average consumption is currently over 140 litres per person per day (l/p/d) and the water industry has agreed to a planning assumption of 110 l/p/d to be achieved by 2050 as set out in the National Framework report[42]. To achieve this, government has announced new policies to reduce water demand, which are:

- Asking water companies to develop a consistent approach to address leakage on customers' own pipes.

[41] Environment Agency (2020) *Meeting our future water needs: a national framework for water resources.* Available at: Meeting our future water needs: a national framework for water resources (publishing.service.gov.uk).
[42] Environment Agency (2020) *Meeting our future water needs: a national framework for water resources*. Available at: https://www.gov.uk/government/publications/meeting-our-future-water-needs-a-national-framework-for-water-resources.

- Making regulations to introduce a mandatory water efficiency label to inform consumers and encourage the purchase of more water efficient products for both domestic and business use.

- Writing to local authorities to encourage them to adopt the optional minimum building standard of 110 l/p/d in all new builds where there is a clear local need, such as in water stressed areas.

- In 2022 developing a roadmap towards greater water efficiency in new developments and retrofits, including the exploration of revised building regulations and how the development of new technologies can contribute to meeting these standards.

In most cases these policies do not currently have stated ambitions and/or timescales attached to the policy outcomes. A "Do Nothing" option therefore assumes that these policies are delivered later within the target timeframe, and/or with low ambition regarding the outcomes[43].

Option 2 (preferred) by 31 March 2038: DI/pop of 193.7, which is approximately a PCC of 122 l/p/d, 36.9% reduction in leakage from 2017/18 levels and 9% reduction in non-household from 2019/20 levels.

The preferred level of ambition requires a:

- DI/pop of 193.7 which is a 20% reduction.

- DI of 12,300 Ml/d[44].

This option aligns with water companies achieving a 50% reduction in leakage against the 2017-18 baseline. It also involves all the policies from the low ambition scenario, with the addition of greater non-household reductions being achieved by working with the sector to identify regulatory barriers to efficiency.

The setting of a statutory target encourages a certain level of ambition from the policies which are to be delivered and holds government to account for delivering the policies in a way which focuses on environmental outcomes being achieved by 2038. This option also sets a sub-measure of reducing non-household water consumption. There is currently no formally agreed target for this sector. The target does not involve new commitments in other areas but does strongly reinforce them.

This target is viable, and aligns with existing recently announced government policies on water efficiency, including the government's response to the 2019 consultation on personal

[43] HM Treasury (2020) *National Infrastructure Strategy*. Available at: National Infrastructure Strategy - GOV.UK (www.gov.uk).
[44] Based on a trajectory for achieving the following figures calculated for 2050: PCC 110 l/h/d, 50% leakage reduction, 15% reduction in NHH.

water consumption[45]. It aligns with wider government ambition on Net Zero and climate change resilience due to reduced energy consumption, as a lower water consumption results in less energy being used to abstract, treat, pump and heat water. By enabling housing growth and improving efficiency of business it also supports Levelling Up.

[45] DEFRA (2021) *Written Ministerial Statement – Reducing demand for water*. Available at: Written statements - Written questions, answers and statements - UK Parliament

Other options considered: By 31 March 2038: a DI/pop of 186.3, approximately a PCC of 116 (l/h/d), 37.5% leakage reduction from 2017/18 levels and 12% in non-household demand from 2019/20 levels

This option gives a DI/pop of 186.3 l/head/day which is a 22.79% reduction (against a 2050 projection of PCC of 100 (l/h/d), 60% leakage reduction and non-household reduced by 20%).

This level of ambition is not compatible with current policy, in particular because it would require compulsory metering to be introduced. To protect unmetered family homes from unexpected large increases in bills, government policy is to not make changes to the existing rules regarding when people can be charged for their water use through meters. This level of ambition would also require a higher leakage target than has been previously agreed by Ofwat and water companies. The Water UK Leakage Routemap to 2050 outlines how water companies will triple leakage reduction by 2030 and halve leakage by 2050. The report presents a range of scenarios that demonstrate it is difficult but possible to achieve this ambition. Going further will require even greater replacement of pipes, which would increase costs for customers, cause disruption and other practical problems[46].

[46] https://www.water.org.uk/news-item/milestone-leakage-routemap-to-revolutionise-the-reduction-of-leakage-from-pipes/

4. Policy objective

The water targets will address the biggest pressures on the water environment, and together deliver the step change needed to make improvements. Each target focuses on a specific pressure and sector/actor.

Clean and plentiful water is good for communities and for the economy. Restoring and protecting water quality will enhance natural capital. This is an essential basis for economic growth and productivity over the long-term.

4.1. Agriculture

Intended outcomes and result of intervention

The primary outcome of this target is to improve the health of water bodies by reducing the volume of total nitrogen, total phosphorus and sediment pollution from agriculture to the water environment, which is known to be a major cause of environmental damage.

SMART objectives

The agriculture target specifically addresses the main types of nutrient and sediment pollution that most impact the water environment from the agriculture sector.

The target is measurable, against a defined baseline. Progress will be measured by modelling the impact of changes in agricultural land use and uptake of mitigation measures. Water quality monitoring will be used to validate the modelled assessments.

Indicators of success

The indicators of success include a reduction in total nitrogen, total phosphorus and suspended sediment loads within the water environment measured at strategic monitoring points; the prevention of major agriculture pollution incidents; an increase in sustainable farming practices; a decrease in soil nutrient balance and improved biodiversity in the water environment[47].

[47] Defra (2021), *Soil Nutrient Balances Regional Estimates for England, 2019 (Provisional).* Available at: England Regional nutrient balances (publishing.service.gov.uk). Soil nutrient balances provide a method for estimating the annual nutrient loadings of nitrogen and phosphorus to agricultural soils. They give an indication of the potential risk associated with losses of nutrients to the environment; losses which can impact on air and water quality and on climate change. The nutrient balances are used as a high-level indicator of farming's pressure on the environment and of how that pressure is changing over time.

4.2. Abandoned metal mines

Intended outcomes and result of intervention

The primary outcome would be a reduction in the length of rivers that are polluted by abandoned metal mines, addressing the existing environmental harm to fish and river insects.

The abandoned metal mines target will address pollution in about 750km of rivers, and support progress towards the statutory River Basin Management Plan objectives to achieve good status by 2027.

Additional environmental, economic and social benefits include supporting climate change mitigation through creating wetlands, planting trees, enhancing biodiversity and supporting natural flood management, contributing to other targets within the environment programme.

Most of the investment is on or near to sites with protected ecological, geological or historical designations. The target will help to enhance priority biodiversity habitats whilst protecting mining heritage and archaeology, including in the Cornwall and West Devon Mining Landscape World Heritage Site[48] and the North Pennines AONB Global Geopark.

The target will also help to protect and increase jobs that rely on clean water and increase tourism and recreational access to cleaner rivers in catchments where discharges from abandoned metal mines cause pollution, harm and loss of amenity value. This will help to level up economic opportunity across parts of the North East, North West, Yorkshire, and the South West. It would also help protect jobs in the North East that are threatened because of the costs to dispose of metals that are accumulating in deep-water shipping berths.

SMART objectives

The target has a clearly defined baseline against which progress can be measured, and a defined date by which it should be achieved.

Success will be evaluated by monitoring water quality to establish if the interventions (mine water treatment schemes and diffuse control measures) are decreasing metal concentrations in rivers and by monitoring the performance of treatment schemes to quantify the total mass of metals captured each year. .

Indicators of success

[48] UNESCO, *Cornwall and West Devon Mining Landscape.* Available at: Cornwall and West Devon Mining Landscape - UNESCO World Heritage Centre

The indicators of success include improvements in river water quality downstream of interventions; increases in the mass of metals captured in mine water treatment schemes as each new scheme becomes operational and increased numbers of mine water treatment schemes.

4.3. Wastewater

Intended outcomes and result of intervention

This target for the water industry aims to improve environmental water quality by creating a specific target for reducing phosphorus pollution. Creating a legally binding long-term target will ensure reducing phosphorus will be a key consideration in future regulatory decisions and policies.

The phosphorus target will drive the water industry to reduce phosphorus loadings by 80%. This will deliver improvements to the water environment. This is an essential step in the restoration of England's water ecosystems, and for preventing further deterioration.

The phosphorus target specifically focuses on the principal reason that water bodies fail to achieve good status, with a clear reduction objective. The target also makes clear that water companies must directly address one of the main sources of phosphorus in the water environment. This will drive action by the industry to achieve the changes needed to improve the water environment.

Indicators of success

A decrease in 80% of phosphorus emissions to the water environment from water company wastewater treatment works against a 2020 baseline.

4.4. Water demand

Intended outcomes

The water demand target is intended to help build a secure and more drought resilient water supply. We would expect the demand target to reduce the amount of water put into public water supply by over 1400 Ml/d by 2037/38. An overall reduction in water taken from the environment for public water supply, will mean more water remaining within the natural environment, instead of abstracted.

Government will track progress towards the agreed target annually, and will be accountable for working together with regulators, water companies, and industry if the target is not on track to be achieved.

SMART objectives

The target stipulates a specific 20% reduction in water taken from the public water supply, per head of population.

The components that will make up the target are measurable. Household and leakage data is readily available and is considered to be sufficiently accurate. Non-household data is less accurate, but work is being done to improve this and it is possible to see trends from the current data.

The target is achievable. The reduction in leakage is consistent with existing commitments made by water companies and Ofwat. A reduction in household consumption is supported by policy interventions that have recently been announced by government. Whilst there is no agreed target for non-household consumption, the Retailer and Wholesaler Group (representing the non-household sector) are developing recommendations to support a reduction in demand. Government policy and future company efficiency and metering plans should mean that they are achievable.

The target has a 2038 deadline and is based on 2050 commitments.

Indicators of success

A reduction in the overall distribution input over population for England will be the primary indicator of success. Distribution Input is already measured by water companies and reported to the Environment Agency. The population of England is to be determined using data for population given by water companies in the annual reviews of Water Resources Management Plans.

Sub-indicators of success will include household consumption (measured as total consumption, or as per capita consumption per day), non-household consumption, and a reduction in leakage.

Whilst the overall environmental outcome is that more water remains in the environment, this is not easily measurable. However, the primary indicator and sub indicators are all measurable and the information is readily available.

5. Summary and preferred option with description of implementation plan

How will the preferred option be given effect?

The Environment Act requires the Secretary of State to set at least one legally binding target in each of four priority areas, one of which is water. Targets will be set using secondary legislation, which is subject to the affirmative procedure..

Achieving the water targets will require a broad range of current, planned, and future policies. These will be subject to the standard approval processes, including their own options appraisal and impact assessments as appropriate. Actual policy and delivery will be developed and amended over time in response to changing circumstances, and factors such as pressures on the water environment, new technologies, financing, and a changing policy landscape in areas that impact upon water.

5.1. Agriculture

Delivery mechanisms

The current Defra policy approach for tackling water pollution from agriculture relies on a mix of regulatory, advice, incentive, grant and Research and Development-based actions. Alongside this, a number of industry initiatives, often working in partnership with government schemes, support farmers and others to reduce water pollution.

Regulation relating to water quality in England includes primary and secondary legislation, providing a statutory baseline of good practice. This is primarily through the Water Resources Act 1991, which creates an offence to knowingly pollute water, and gives the Environment Agency the power to prosecute those knowingly polluting water bodies.

Existing regulations are a combination of baseline regulations that apply to all farms (e.g., The Reduction and Prevention of Agricultural Diffuse Pollution (England) Regulations 2018, known as the Farming Rules for Water (FRfW)), spatially targeted regulation (e.g., Nitrates Action Programme), and sector targeted (e.g., The Water Resources (Control of Pollution) (Silage, Slurry and Agricultural Fuel Oil) (England) Regulations 2010).

The target relates closely to future agricultural policy intentions, including the environmental land management schemes and reforms to regulation to better enable and support compliance.

Delivery of the agriculture target will involve a mix of voluntary effort, regulatory enforcement, and public funding support. The detail of these mechanisms is not specified here. For the purposes of the cost benefit analysis, it is assumed to be fully funded by government, where action is required to go beyond compliance with existing regulation (at a cost to farmers but not additional to the previously assessed impacts of those

regulations), market developments and other voluntary change. If this changes, such as through the introduction of new regulations that require additional investment by farmers, the impact of that reform will be separately assessed and consulted on.

Demonstrating progress against the target

Progress will be evaluated using a modelled approach that would be validated with water quality monitoring data (from the CSF Enhanced Water Quality Monitoring Programme). The target will be set at a national scale but can also be disaggregated to smaller spatial scales (e.g., Operational Catchments) to provide an assessment. A national inventory based on survey data to derive livestock numbers, fertiliser use, and other management practice data will be developed, and emission factors reviewed in the light of new data.

5.2. Abandoned metal mines

Adopting the legally binding abandoned metal mines long-term target will transform the pace and certainty of achieving the policy objective to clean up the polluting legacy of abandoned metal mines.

Who will be responsible for ongoing operation and enforcement of the new arrangements?

Achieving the target is wholly dependent on government funding to the Water and Abandoned Metal Mines programme. Construction and operation of the assets will be the responsibility of the Coal Authority.

Delivery mechanism

The Water and Abandoned Metal Mines programme will be the primary mechanism to achieve the target[49]. It was set up in 2011 as a partnership between Defra, the Environment Agency, and the Coal Authority, and has an established Programme Board. A robust governance system defines the roles and responsibilities, funding principles, and prioritisation criteria for including projects in the programme. These will be updated to reflect any minor changes in priorities as a result of the new target. The existing modest programme of interventions will be accelerated by implementing the target, delivering a step-change in environmental and economic benefits.

Delivery of the target will involve the construction of mine water treatment schemes and diffuse measures to directly limit the discharge of metals that pollute rivers.

The Water and Abandoned Metal Mines programme has a track record of securing non-Defra funding to deliver sustainable remedial interventions with wider societal benefits. For example:

[49] Coal Authority (2016), *Metal mine water treatment.* Available at: https://www.gov.uk/government/collections/metal-mine-water-treatment.

- North East Local Enterprise Partnership's Local Growth Fund to protect jobs, primarily in the renewable and off-shore energy sector.
- National Lottery Heritage Fund to enhance high nature value upland farming whilst preserving industrial archaeology, encouraging public engagement and access, and cleaning up polluted rivers.
- Welsh Government's SmartExpertise fund to operate experimental trials that will minimise the whole life costs of mine water treatment schemes.

The programme includes innovative R&D to improve the cost-effectiveness of treatment systems and decrease the environmental and carbon footprint of future schemes.

Demonstrating progress against the target

Progress will be objectively measured through the Environment Agency's water quality monitoring network.

5.3. Wastewater

Who will be responsible for ongoing operation and enforcement of the new arrangements?

Creating a legally binding target on government to ensure that water companies take action on reducing phosphorus within the environment will ensure continued focus on addressing the largest pressures on the water environment through the Price Review process. The target will be supported by requirements the Environment Agency sets in the discharge permits for sewage works.,

Delivery mechanism

Water companies will be responsible for implementing changes to meet the reduction in phosphorous loads specified in the target. The target will be reflected in statutory environmental 'driver' guidance provided by the Environment Agency to inform water company business plans. Once agreed, funding for these business plans will be negotiated between water companies and Ofwat through the Price Review process. Progress against the target will be monitored by water companies under operator self-monitoring and reported to the Environment Agency. Target requirements will be reflected in treatment works permits and the Environment Agency will be able to take enforcement action against any water companies failing to meet agreed standards under the Environmental Permitting Regime.

5.4. Water demand

A water demand target will give a single, England-wide metric to assess the efficiency of water use. If achieved, the target will reduce the overall amount of water abstracted from the environment by water companies.

Who will be responsible for ongoing operation and enforcement of the new arrangements?

Water companies will be responsible for delivery of a reduction in consumption (household and non-household) and leakage.

Defra will be responsible for delivering regulations to introduce a mandatory water efficiency label for certain water using products, and a roadmap to greater water efficiency in newbuilds and retrofits. Defra will work with the water industry on delivery.

The target will be measured using Distribution Input over Population (DI/pop) as a percentage reduction on the 2019/2020 levels.

The target will be measured against the sub-indicators of household consumption (either per capita or total household consumption for England; non-household consumption, and leakage (percentage reduction on 2017-2018 levels).

All of these sub indictors are reported annually by water companies in their Water Resources Management Plans. There are issues concerning the accuracy of non-household consumption data, however the sector is working to improve this as part of the Industry Action Plan[50].

An overall target of DI/pop will provide water companies with flexibility between variables (leakage, personal consumption and non-household) to reduce water use in the most cost-effective way for them, whilst also allowing for fluctuations in the population size.

[50] Ofwat & Environment Agency (2021), *Open letter: Delivering greater water efficiency in the business sector.* Available at: https://www.ofwat.gov.uk/wp-content/uploads/2021/02/Joint-open-letter-from-Ofwat-and-the-Environment-Agency.pdf .

6. Monetised and non-monetised costs and benefits of each option (including administrative burden)

This section sets out the approach to estimating the costs and benefits of indicative pathways to achievement of the targets and reports the results. These are early and sometimes partial estimates of the impacts, involving a high degree of uncertainty, explained further below for each of the target areas. The pathways are indicative only and do not imply exact future policy intentions. If further regulation is eventually proposed as part of implementation, then the costs and benefits of such regulation would be assessed in its own IA(s).

6.1. Agriculture

The approach to estimating costs and benefits for the agriculture target is based on the ADAS FARMSCOPER model, and in particular on work done for Defra project WT1594[51]. FARMSCOPER is a peer-reviewed model developed for Defra and is in regular use in Defra and Environment Agency appraisal work. It has also been described and used in peer-reviewed published research and in turn incorporates established peer-reviewed models of physical processes[52]. FARMSCOPER models the emissions from agriculture to water and air of the following substances: nitrate, phosphorus, sediment, ammonia, methane, nitrous oxide, pesticides, and faecal organisms; and models energy use. Starting from a baseline of normal farm operations, it then applies a set of mitigation methods (changes in farm management practice expected to reduce emissions) as specified by the user and estimates the impacts as reductions in each of the modelled pollutants. The pollutant reductions are multiplied by a monetary unit value for each pollutant to convert them to benefits values affecting society at large, which are reported against the modelled net financial effect on farm businesses of adopting the mitigation methods (mostly costs but net of some financial benefits). Monetary values have been updated in line with Defra's index of agricultural input and output prices.

The analysis in project WT1594 modelled an illustrative set of pollution mitigation measures applied across England. Examples of measures are "Establish cover crops in the autumn" and "Site solid manure heaps away from watercourses". WT1594 modelled a scenario representing current agricultural land use, cropping, stocking and management practices, and a scenario including very high uptake (85%) of those mitigation measures

[51] ADAS & Defra (2019), *A national scale assessment of current and future actions to reduce diffuse pollution of water by agriculture.* Available at: http://randd.defra.gov.uk/Document.aspx?Document=14778_WT1594_ADAS_Final_Report.pdf.

[52] For example: Gooday RD, et al, (2013), 'Modelling the cost-effectiveness of mitigation methods for multiple pollutants at farmscale', *Sci Total Environ*. Available at: http://dx.doi.org/10.1016/j.scitotenv.2013.04.078. Zhang et al, (2017) 'The potential benefits of on-farm mitigation scenarios for reducing multiple pollutant loadings in prioritised agri-environment areas across England', *Environmental Science and Policy*. Available at: http://dx.doi.org/10.1016/j.envsci.2017.04.004.

that are already required by regulation (even where current uptake is known to be lower). This is taken as the counterfactual for the present analysis, hence the on-farm impacts of raising compliance with existing regulation are not an additional effect of adopting the target. Additional government costs of advice, support and enforcement are included as an additional cost. This increased compliance costs £428m a year or £9,037m in present value terms for the entire appraisal period to 2100.

This analysis draws on several of the scenarios modelled in WT1594 to represent an illustrative potential policy pathway to deliver the agriculture target. This includes an increased uptake of a further set of mitigation measures to 50% of all farms. The pathway also takes into account potential changes in some agricultural land use in line with biodiversity and Net Zero ambitions, including some potential adoption of agroforestry (indicatively on 4% of land) and changes in systems and technologies to enhance nutrient management efficiency[53]. This is a single modelled scenario illustrating a scale of ambition, so it is not the only or most likely possible pathway.

The indicative scenario used here includes an element of targeting incentives where they are most likely to deliver reductions in pollution from agriculture to water. The more targeted the approach is, the greater the impact the measures will have for a smaller amount of land affected. The land use change incentives component relates closely to policy actions to deliver Net Zero, tree-planting, and biodiversity, so there are complex interactions between these outcomes and their costs and benefits which are difficult to disentangle at this indicative stage of appraisal.

Costs

In the illustrative pathway, the costs of new measures to deliver the targets are envisaged to be covered by public funding to incentivise farmer action. These costs arise from the net impact of adopting an illustrative set of pollution mitigation measures (farm management practices that help to reduce pollution of water and air) and incentivising habitat creation. Considering first the additional mitigation measures, this amounts to a net cost at farm level that rises gradually over time as measures are adopted more widely to reach £180m a year by 2038. These costs are calculated as an output of the FARMSCOPER model, updated using the agricultural price index for inputs and outputs. Further detail is provided in the model documentation and the WT1594 report and appendices, but it is not possible to show any simple calculation or breakdown.

On the second element of the illustrative pathway, scenarios in the WT1594 project modelled the reductions in agricultural emissions of pollutants that would result from a general reduction in arable land use but did not model any aspect of the future use of that land. Analysis in the consultation stage impact assessment assumed that, over a 15-year time-period to gradually implement a long-term shift of land use, farm businesses would choose to reduce fixed costs in proportion to the change and to undertake structural

[53] Details of the changes modelled are available within the report WT1594. Defra (2019), Water pollution from agriculture: A national scale assessment of current and future actions *to reduce diffuse pollution of water by agriculture*, Project WT1594. Available at: Defra, UK - Science Search.

adjustments. On that basis, the agricultural business income foregone was estimated as the average agricultural cost centre gross margin for the appropriate farm type, less all fixed costs except land and property costs. This approach assumed that all factors of production except farmer labour and land/property would be released in proportion to the land use change to alternative non-agricultural uses at their market value. However, the present analysis assumes more conservatively that it may be difficult for fixed cost savings to be realised in this timescale, meaning that any fall in agricultural revenues would be partly offset by reduced variable costs but not by reduced fixed costs, and incentives to farmers may require to reflect this. Using Farm Business Survey data for the most recent available years 2019/20 and 2020/21, this approach gives £658 per hectare of utilised agricultural area changing use. The previous approach gives an equivalent figure of £80 per hectare, showing the importance of fixed cost adjustments in realising the longer term advantages of the policy pathway. A significant proportion of the actions required to achieve the agricultural targets are likely to be achieved through other incentives and measures independent of the water targets, therefore are not included in the cost totals show below (section 6.5)., Where there would be an additional cost directly consequent on adopting the water targets, and hence attributable to targets in this appraisal, is where changes in land use are targeted to locations which have the greatest impact on emissions of agricultural pollutants to water, These costs have been estimated first by taking account of the mix of farm types typical of such locations, including farm types generating higher value per hectare farmed, and second by adjusting the costs upwards by 20% to reflect the conservative assumption that potentially higher than average performance of farms in these areas compared to the national average for their farm type. This results in higher average gross margins foregone of close to £900 per hectare (again assuming that fixed cost savings are not immediately available). These are purely illustrative figures and scenarios used to inform the model. Current and future decision makers would consider the best policy pathway, including whether targeting action was appropriate.

The illustrative policy pathway includes a component of agroforestry (silvo-pastoral and/or silvo-arable). In these systems, agricultural activity continues and the gross margin foregone approach is not appropriate. The costing method here was to assume standard rates of grant incentive for establishment and maintenance, adjusted where relevant as above to correspond to adoption in the areas with highest risk of pollution to water.

The farm business cost of measures that go beyond regulatory compliance could indicatively be met by a grant contribution from central government funds as agricultural policy is reformed over the period. In addition to the cost of the mitigation measures themselves, an allowance is made for the cost of farmer time for familiarisation, engagement with inspectors and advisers, and application for and management of grant funding. This is assumed to be a continuing annual cost equivalent to 5% of the total cost of the mitigation measures. For the purposes of illustrating an indicative policy pathway, government funding is assumed here to cover 100% of the on-farm costs of measures and the farm administrative cost, which would align with high voluntary uptake by farm businesses. This is a hypothetical illustration only.

The total cost to government includes the grant contribution to on-farm costs (as above), plus an element for grant administration, inspection and enforcement, and a substantial service of advice and support to farmers. These activities would be needed to deliver both increased compliance with existing regulation and the required uptake of more ambitious good practice and changes in land use. The additional costs are assumed to amount to 5% of the total cost of the mitigation measures (whether grant funded or not).

The total costs of the illustrative policy pathway that is additional to existing regulation and other policies amount to £2.4bn for the period to 2038 undiscounted (£1.7bn in present value terms), or over £18.5bn if sustained for the entire appraisal period to 2100 (PV £5.7bn). This approach assumes that the annual costs continue unchanged in perpetuity.

Benefits

Benefits to farmers (e.g. in reduced input costs) are taken into account in the estimation of net costs of mitigation measures above. The monetised benefits calculation relates to the environmental benefits which arise from the reduction of modelled pollutant emissions to air and water. The unit benefit values relating to reduced emissions to water are shown in the Defra appraisal guidance on Enabling a Natural Capital Approach (ENCA)[54]. The unit values reflect benefits for drinking water quality (reduced treatment cost for public water supply), improved river water quality (amenity), improved fishing, avoided freshwater eutrophication, bathing water quality, and impacts on natural habitat in freshwaters and wetlands. The values published in ENCA have been updated to 2021 prices using the GDP deflator.

Emissions of ammonia to air are valued using standard Defra unit values[55]. Emissions of greenhouse gases are valued using HMG carbon dioxide equivalent unit values[56]. Both published sets of values rise substantially over the long appraisal period. The benefit of reducing ammonia emissions is the major component of benefits even in the early years of the period and becomes dominant in the later years as the water unit benefit values are assumed constant in real terms.

A time lag of two years is assumed between the costs of mitigation measures and the delivery of benefits, based on research findings that suggest a lag of two to three years from the initial impetus to action, to incurring costs then to detecting water quality improvements[57]. This is a major simplification because some changes in emissions and

[54] Defra (2020), *Enabling a Natural Capital Approach (ENCA).* Available at: https://www.gov.uk/guidance/enabling-a-natural-capital-approach-enca.
[55] Defra (2021), *Air quality appraisal: damage cost guidance*. Available at: https://www.gov.uk/government/publications/assess-the-impact-of-air-quality/air-quality-appraisal-damage-cost-guidance#annex-a-updated-2020-damage-costs.
[56] Defra (2021), *Valuations of greenhouse gas emissions: for policy appraisal and evaluation.* Available at: https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-for-policy-appraisal-and-evaluation.
[57] Davey et al, (2020) 'Water quality benefits from an advice-led approach to reducing water pollution from agriculture in England', *Agriculture, Ecosystems and Environment,* 296(July 2020). Available at: https://doi.org/10.1016/j.agee.2020.106925.

their environmental impacts would be immediate, whilst others would take many years to begin and still longer to reach their full extent.

On this basis, the gross total benefits to 2040 (two-year lag) of the measures costed to 2038 amount to £6.68bn undiscounted (PV terms £4.23bn). The net present value (PV benefits minus PV costs) of the indicative additional measures towards the target is £2.55bn and the benefit cost ratio 2.5:1.

Assuming that the policies and mitigations were sustained for the whole appraisal period to 2100, the total benefits would be £100bn (PV£23.3bn), NPV £17.6bn and BCR 4.11:1. The improved BCR in the longer appraisal period arises because of the increase over time in the unit values of ammonia emissions to air.

The benefit values, NPVs and BCRs must be qualified by noting again that many of the on-farm actions in the illustrative pathway are assumed to be required to deliver policies other than for water and their full costs are not included here. Whilst it is also the case that many of their benefits are not included or not quantifiable, benefits for air quality in particular are substantial and are included. If only monetizable benefits to water are included, the net present value becomes negative and the BCR falls to 0.5:1, a figure that is in turn misleadingly low. These issues reflect the difficulty of disentangling the impacts of a multifunctional policy pathway that inevitably involves multiple drivers and impacts on many aspects of the environment.

6.2. Abandoned metal mines

The approach taken to appraise the costs and benefits of the abandoned metal mines target is based on data provided by the Coal Authority. The Coal Authority has built and operated 75 schemes since 1994 so has considerable data and experience in the operation and construction of treatment schemes. The appraisal covers mine water treatment and diffuse schemes in six management catchments chosen to illustrate the scale of work required to deliver the target (noting that interventions may also be implemented in other catchments providing they meet the target objectives and represent value for money). These catchments are: Tyne, Derwent, Tees, West Cornwall, Kent/Leven, and Swale/Ure/Nidd/Upper Ouse. Management catchments are the appropriate scale for appraisal because pollution is carried downstream through the catchment, so the costs of abatement in the upper reaches deliver benefits throughout the associated water bodies. These catchments have been chosen for appraisal because there is high confidence that effective schemes could be constructed and operating by the 2038 target date, and would achieve the target. Measures in these catchments would improve an estimated 769km of water bodies, which is a 52% reduction in the length of rivers and estuaries polluted by metals from abandoned metal mines.

Costs

Costs associated with building mine water treatment schemes or diffuse measures include development, construction, and operating costs. Costs have been estimated from a range

provided by the Coal Authority with low and high values for three phases of each scheme: development over three years, construction over two years, and operation in the long term. The midpoint of the range is used for best estimates of cost in the summary. Unit costs are set out in the table below.

Table 1: Costs associated with building mine water treatment schemes

Phase of Works	Development costs (Year 1-3 total)	Construction Costs (Year 4-5 total)	Annual Operating Costs (Year 6)	Annual Operating Costs (Year 7 onwards until 2100)
Low	£250,000	£4,500,000	£65,000	£95,000
High	£700,000	£6,300,000	£125,000	£155,000

Whilst experience to date cannot exactly replicate an appraisal period to 2100, the Coal Authority advises that a provision in increased long-term operating costs is a better reflection of future cost profiles than periodic capital reinvestment. This means that schemes in this appraisal incur high initial capital costs but deliver substantial net benefits each subsequent year and hence a long appraisal period is a truer reflection of their worth than the shorter period of a 2038 target.

Diffuse measures are much smaller in scale, typically require minimal development work and can be constructed within a year.

Table 2: Costs associated with diffuse measures

Diffuse Measures	Construction Costs (Year 4)	Annual Operating Costs (Year 4 onwards until 2100)
Low	£20,000	£1000
High	£300,000	£3000

The cost estimates draw on experience including two schemes built by the Water and Abandoned Metal Mines programme since 2011. A comparison of their predicted and actual costs is shown below.

Table 3: Saltburn Mine Water Treatment Scheme

	Projected	Actual
Build	£3.5m - £4.8m	£3.1m

Whole life cost: 25 Years Discounted	£7.2m - £11.6m	£5.4m (2021 update)

Table 4: Force Crag Mine Water Treatment

	Projected	Actual
Build	£0.5m	£0.7m
Whole life cost: 25 Years Discounted	£1.5m	£2.2m (2021 update)

Costs for 2021/22 and 2022/23 include calculated contingency risks for the individual projects. From 2023/24 onwards there is slightly increased uncertainty as some projects are at earlier stages of development, but this has been explicitly taken into account in estimating the capital cost. For a feasibility stage project, cost estimates include a 50% sensitivity allowance for optimism bias and risks.

Benefits

Treating pollutants from abandoned metal mines creates benefits by improving the status of each affected water body for fish, invertebrates, plants, and safety for recreational contact. These benefits are valued using the National Water Environment Benefits Survey (NWEBS) approach shown in the Defra appraisal guidance on Enabling a Natural Capital Approach (ENCA). The approach requires an assessment of the extent of river in which the improvements will occur and applies a unit value in £/year/km of river improved. In addition to using NWEBS values, intervention in some catchments may generate additional benefits which are estimated in locally-specific appraisals carried out by independent environmental economists on behalf of the Water and Abandoned Metal Mines programme. More generally, there may be unquantified beneficial impacts on freshwater biodiversity and water-related biodiversity, terrestrial habitats, and marine impacts from reduced outflow of metals to estuaries.

Table 5: Summary of the monetised expected costs and benefits to achieve the targets

Management catchment	PV of costs to 2100 (midpoint of range)	PV of benefits to 2100	NPV to 2100	Benefit-cost ratio
Tyne	£105m	£43m	-£61m	0.42
Derwent	£15m	£14m	-£1m	0.90
Tees	£13m	£11m	-£1m	0.89
West Cornwall	£106m	£45m	-£61m	0.42
Kent/Leven	£0.13m	£3m	+£3m	26.15
Swale/etc	£38m	£68m	+£30m	1.79
Total	£276m	£184m	-£92m	0.67

Local economy impacts

The estimated benefits in the quantified appraisal are conservative in that they omit any assessment of benefit from impacts on the local economies of these catchments that may arise from pollution abatement. The reason for this omission is that the local economy impacts do not necessarily represent a benefit in terms of a cost benefit analysis. There

may be local benefits in terms of productive activity maintained or generated but it is difficult to demonstrate that such activity is a net increase in national terms, as opposed to a displacement of activity to the catchment from other economically competing localities.

The local economy impacts of metal mine pollution have been investigated in some detail in the case of the Port of Tyne. At a local level, profit for the port area (alongside water quality benefits) can be counted as an additional economic benefit over and above the 'do-nothing' scenario as a result of implementing headwater intervention schemes. This is because the target would protect existing economic activity in the Tyne estuary valued at £660m (PV over 25 years), which is expected to cease if action is not taken to stop the continued input of target metals which accumulates in deep-water shipping berths. Sediments heavily contaminated with heavy metals cannot be disposed of in conventional ways (e.g., dumping at sea). The disposal cost then becomes so expensive that dredging is not financially worthwhile. Therefore, it is expected that capacity would be lost progressively if heavy metal deposition continues unabated.

A comparison of UK ports undertaken as part of the River Tyne benefits assessment suggests that it is unlikely that all of the activity from the Tyne port area could easily move to other UK ports if capacity in the Tyne is lost. This is due to the increase in capacity that would be needed, alongside issues around supply chains and practicalities such as efficient transport links. This means that impediments to port operations in the Tyne could result in internationally mobile companies relocating their operations outside the UK, rather than to another UK port. Any net economic benefit, subsequently, associated with these operations would therefore be lost rather than displaced.

6.3. Wastewater

The mechanism to deliver the wastewater phosphorus target would be the existing system of discharge permits where the Environment Agency acts to adjust the conditions imposed on water and sewerage companies discharging treated effluent into the water environment.

Water companies are committed in the current Asset Management Plan period (AMP7) to reducing phosphorus levels by around 50% by 2027. To reduce phosphorus levels by 80% by 2038 (against a 2020 baseline), additional upgrades will need to be made to treatment works.

Costs

The cost of achieving the phosphorus target are those additional costs that will be incurred from 2027 onwards. This is because these are the additional costs over and above AMP7 that are necessary to achieve the phosphorus target, and currently have no financial commitments in place. Costs include capital and operating costs of new investment in treatment processes, including carbon costs. Costs will fall directly to the water industry then passed on to customers in their regulated bills following Ofwat scrutiny.

The standard method to estimate the costs of reducing phosphorus emissions from wastewater treatment works is a standard spreadsheet tool used routinely by the Environment Agency. The tool is based on a set of cost curves estimated from water company data and representing unit costs for installing and operating treatment processes to remove units of pollutant from wastewater for different scales of treatment works. For the phosphorus target, the costings cover the installation of nutrient reduction for biological and chemical phosphorus removal. The tool estimates the capital costs and operating costs of removing total phosphorus under these two alternative processes. Costs vary with the throughput of the works (in population equivalent) and the initial and target level of phosphorus removal. The costs estimates are for treatment only and do not include disposal costs.

The following tables illustrate the capital and annual operating costs of phosphorus removal under chemical and biological processes for an illustrative load of 0.179 and a removal rate of 0.6. The chemical process of phosphorus removal is considerably cheaper than biological removal and is assumed in this appraisal. The majority of current sewage treatment works use chemical processes to remove phosphorus, with a limited number of works trialling biological removal.

Table 6: Capital and annual operating costs of phosphorus removal under chemical processes

	Capital Costs (£)			Annual Operating Costs (£)		
Population served per STW	Lower Bound	Mid-Range	Upper Bound	Lower Bound	Mid-Range	Upper Bound
20769	£145,769	£208,241	£270,714	£7,746	£11,066	£14,386

Table 7: Capital and annual operating costs of phosphorus removal under biological processes

	Capital Costs (£)			Annual Operating Costs (£)		
Population served per STW	Lower Bound	Mid-Range	Upper Bound	Lower Bound	Mid-Range	Upper Bound
20769	£509,656	£728,080	£946,504	£18,240	£26,058	£33,875

As the environmental regulator, the Environment Agency hold data on each sewage treatment works including the population equivalent they serve. The following table shows the number of works (and population served) where phosphorus removal has been

required over the three time periods that form the counterfactual for the present analysis.

Table 8: The number of works, and population served, where phosphorus removal has been required

Year	1995-2015	2015-2020	2020-2027
Population Served	24,000,000	4,000,000	10,000,000
No. of STWs	650	400	650
Pop Served (thousands) per STW	36,923	10,000	15,385

The following table summarises information on the number of works where additional treatment would be required, the pollution loads removed, and the costs involved.

Table 9: The number of works where additional treatment would be required, the pollution loads removed, and the costs involved

Size band	Number of works affected	Load removed t/year	Capital cost	Annual operating cost
250	464	15	£39m	£1m
2000	924	209	£586m	£21m
10000	572	512	£613m	£25m
50000	320	640	£383m	£19m
100000	64	270	£145m	£8m
1000000	88	1603	£282m	£20m
Total	2,432	3249	£2,048m[58]	£95m

Benefits

[58] This figure does not include the final costs for upgrades to wastewater treatment works required under the Government's proposed amendment to the Levelling Up and Regeneration Bill.

The benefits of phosphorus removal are estimated using the same unit values as the agriculture target earlier, £39.07/kg of phosphorus removed. This assumes for simplicity that the benefit to ecosystems of removing phosphorus from agricultural sources is the same as removing phosphorus from wastewater. The target requires the removal of 3249 tonnes of phosphorus a year from wastewater treatment works discharges, achieved gradually over the period to 2038, delivering a benefit valued at £2,620m in present value terms over the appraisal period to 2100.

Other benefits may arise, but these have not been quantified or monetised. In some cases, water companies may be able to deploy nature-based solutions that increase water storage, capture carbon from the atmosphere, and provide habitats. These can provide co-benefits and contribute to the biodiversity, air quality, soils, and trees targets. For phosphorus removal, certain technologies can enable the recycling of phosphorus to reduce the reliance on depleting mined supplies. More generally, there may be unquantified beneficial impacts on freshwater biodiversity and water-related biodiversity, terrestrial habitats, and marine impacts from reduced outflow of phosphorus from estuaries to sea.

Summary costs and benefits

The estimated cost for the entire appraisal period to 2100 in PV terms is £3.67bn, which requires one further phase of capital investment to replace initial works written off after a projected 40-year life. Set against the monetised benefits of £2.62bn, this gives a monetised net present value for the target of minus £1.05bn, and a benefit cost ratio of 0.7:1.

6.4. Water demand

The counterfactual assumed for appraising the water demand target is that existing non-statutory policies and water industry commitments as set out earlier will deliver reductions in leakage and in household water consumption, which contribute much of the target reduction in distribution input over population, assuming that they are delivered. The additional or incremental effect of the target will be on non-household demand, which makes up 20% of total consumption. Some of the non-household reduction will be achieved through committed measures already described, particularly product water efficiency labelling, which is relevant to the great majority of non-household water customers.

Additional activity is assumed to involve supplier-led audits of water consumption leading to adoption of water-efficient practices and gradual replacement of water-using equipment with more efficient versions in line with normal investment and replacement schedules

Costs

As part of the regulatory planning cycle, the water companies compile Water Resources Management Plans, projecting for the coming 25 years the water resources available to

them, the volumes of leakage and demand, and the measures they propose to take to achieve an appropriate balance. These assessments include costings of activities considered to promote water efficiency among their customers, together with projected demand reductions that would result. The type of activity required to deliver reduced non-household consumption might include programmes of water consumption audits, delivered at water company expense (subsequently transferred to all water bill payers after scrutiny from Ofwat), with engagement and follow-up costs for each non-household customer. A small number of actions in the current Plans relate directly to non-household consumption but there are considerably more that are specific to households or may cover both sectors. For this analysis the average unit costs of all relevant customer side actions have been used, with the exception of programmes of household meter installation, giving a more reliable average cost estimate but one which may overstate costs where economies of scale exist in working with much larger non-household customers. The average cost of these actions to the water companies is around £300 per million litres of water saved.

It is assumed that the costs to non-household customers themselves are offset completely by savings in their water bills or other business benefits, as efficiency measures are adopted voluntarily. Typically, reductions can be achieved through low-cost efficiency gains, upgrading to more water-efficient equipment as part of routine investment and refurbishment, in line with their corporate responsibility policies and/or justified by savings in their water bills. On this basis, delivering the additional element of the water demand target of 9% reduction in non-household water consumption (close to 100 million litres a year) is estimated to cost £169m in PV terms by 2037 and £646m if actions are required to continue over the whole appraisal period to 2100.

Benefits

The monetised benefits arise from the avoided costs of new water resource infrastructure (reservoirs, desalination plants, inter-regional transfers systems of pipelines and pumping, water reuse systems, etc) that would otherwise be required to allow consumption levels to be maintained against a background of projected shortage due to population growth, development, and climate change. The National Infrastructure Commission[59] has shown that demand management and new infrastructure is a substantially lower cost option than reliance on emergency options to deal with drought.

Costs of the avoided schemes are estimated on the basis of similar types of infrastructure evaluated as above in the water companies' Water Resources Management Plans. The average cost of these schemes is around £1,450 per million litres of water supplied. In addition to the cost of the resource provision, water supplied must be treated and distributed, involving further marginal costs of around £250 per million litres. (Some customers would also avoid the costs of heating a proportion of their supply if they can achieve efficiency in heated water use. This element of benefit has not been quantified

[59] National Infrastructure Commission (2018), *Preparing for a drier future: England's water infrastructure needs.* Available at: https://nic.org.uk/studies-reports/national-infrastructure-assessment/national-infrastructure-assessment-1/preparing-for-a-drier-future/.

here because of a lack of information on the non-household uses where efficiencies could be achieved.) The total benefit of avoiding the need to undertake new supply schemes amounts to £875m in PV terms to 2037, and £3,340m to 2100.

The 100 million litres saved a year would remain in the environment. The volume and flow of water are important for ecological quality, and for amenity and human uses. It is not currently possible to quantify or value these benefits. However, some water bodies currently fall below good status for water flow (rivers) or quantity (groundwaters). It is assumed that the avoided schemes would have been designed under regulatory supervision to avoid ecological damage wherever possible. Hence it has not been possible to quantify or monetise environmental benefits of the demand target in this assessment.

6.5. Summary of costs and benefits

The following table sets out the monetised costs and benefits of the targets over the whole period to 2100.

Table 10: Present Value of Benefits by target and affected sector for appraisal period to 2100.

	Recreation, amenity, non-use value of water	Air quality	Carbon emissions	Reduced water resource and treatment costs	Total benefits
	General public	**General public**	**General public**	**Water companies**	**All sectors**
Agriculture	£3,570m	£18,796m	£731m	£203m	£23,301m
Abandoned metal mines	£184m				£184m
Wastewater	£2,620m				£2,620m
Water demand				£3,340m	£3,340m
All water targets	£6,374m	£18,796m	£731m	£3,543m	£29,445m

Table 11: Present Value of Costs by target and affected sector for appraisal period to 2100

	Government	Farmers	Water companies	Total costs, all sectors
Agriculture	£5,497m	£0m		£5,497m
Abandoned metal mines	£276m			£276m
Wastewater			£3,671m	£3,671m
Water demand			£646m	£646m
All water targets	£5,773m	£0m	£4,317m	£10,090m

Over the whole appraisal period, indicative actions to deliver the water targets are estimated to deliver a monetised net present value of +£16.68bn to 2100, with a benefit cost ratio of 2.31.

Table 12: Summary Cost-Benefit Analysis by target for appraisal period to 2100

	Total benefits	Total costs	Net Present Value	Benefit Cost Ratio
Agriculture	£23,301m	£5,497m	+£17,804m	4.24
Abandoned metal mines	£184m	£276m	-£92m	0.67
Wastewater	£2,620m	£3,671m	-£1,051m	0.71
Water demand	£3,340m	£646m	+£2,694m	5.17
All water targets	£29,445m	£10,090m	+£19,355m	2.92

The following table sets out the costs to achieve the targets by 2038 and the consequent benefits, assuming no further actions or costs occur after 2038. These figures understate the benefits in cases where there is a lag in ecological response, and where capital investments in long-lived assets (also to some extent shifts in technology and practices) will continue to deliver benefits for many years beyond the investment, and with only low continuing running costs. This particularly affects the abandoned metal mines target,

where the period to 2038 includes all the required capital works, but excludes the long period of operation to 2100 where modest operational costs would deliver substantial continuing benefits. In contrast, the agriculture target is assumed to involve a largely constant stream of costs from modified farming practices and foregone land use. In this case the weaker benefit cost ratio in the shortened appraisal period arises from the fact that unit values for air quality and carbon benefits rise exponentially over time, while real unit costs are assumed constant.

Table 13: Present Value of Benefits by target and affected sector for measures applied to 2038 only

	Recreation, amenity, non-use value of water	Air quality	Carbon emissions	Reduced water resource and treatment costs	Total benefits
	General public	**General public**	**General public**	**Water companies**	**All sectors**
Agriculture	£939m	£3,096m	£137m	£53m	£4,225m
Abandoned metal mines	£26m				£26m
Wastewater	£2,087m				£2,087m
Water demand				£875m	£875m
All water targets	£3,052m	£3,096m	£137m	£928m	£7,213m

Table 14: Present Value of Costs by target and affected sector for measures applied to 2038 only

	Government	Farmers	Water companies	Total costs, all sectors
Agriculture	£2,173m	£0m		£2,173m
Abandoned metal mines	£177m			£177m
Wastewater			£2,907m	£2,907m
Water demand			£169m	£169m
All water targets	£2,350m	£0m	£3,076m	£5,426m

Table 15: Summary Cost-Benefit Analysis by target for measures applied to 2038 only

	Total benefits	Total costs	Net Present Value	Benefit Cost Ratio
Agriculture	£4,225m	£2,173m	+£2,052m	1.94
Abandoned metal mines	£26m	£177m	-£151m	0.15
Wastewater	£2,087m	£2,907m	-£820m	0.72
Water demand	£875m	£169m	+£706m	5.17
All water targets	£7,213m	£5,426m	+£1,787m	1.33

The above tables all omit important benefits that it has not been possible to quantify and value. Among these are substantial impacts on freshwater biodiversity and water-related biodiversity, terrestrial habitats, other benefits from changes in land use and agricultural practices e.g., landscape, soil carbon, and marine impacts (from reduced outflow of nutrients from estuaries to sea). For agriculture, the tables do not include any estimate of

the benefits and costs of any new uses of land, which would be at the discretion of the landowner. These other uses are not specified or required by adopting the water target, but may include habitat creation, woodland, or other land uses. They could therefore be public or commercial benefits.

7. Direct costs and benefits to business calculations

The water targets and the purely indicative measures described in this assessment do not immediately impose any direct costs or benefits to business. Future regulatory measures to help implement the targets may impose costs and would require their own full regulatory impact assessments where appropriate.

8. Risks and assumptions

8.1. Agriculture

Policies and time lags are indicative. It is assumed that the gradual introduction of policies and the adoption of measures by farmers will result in a linear increase in uptake, and hence costs, from an initial baseline in 2022 to reach the modelled scenario in full by 2038. The actions required to meet the target are ambitious compared to previous experience, and at this stage it is not possible to specify the measures to achieve them. A two-year lag is assumed between the costs and benefits, reflecting evidence of the gap before mitigation measures produce a consistent improvement in monitored water quality. This is a simplification because some environmental impacts are almost immediate, whilst other lags could be far longer, particularly for impacts on groundwater.

The counterfactual assumes a degree of change in agricultural land use (cropping and stocking), management systems, and technologies that deliver improvements in on-farm efficiency of nutrient use and reduced soil loss. Details of these changes are not specified. Prices of all agricultural inputs and outputs are assumed constant in real terms throughout. This is a simplifying analytical assumption, recognising that in the real world there will be trends and fluctuations.

8.2. Abandoned metal mines

Benefits begin two years after the construction date (i.e., when operation begins) and last until 2100.

Benefits and costs have been assessed at a management catchment scale rather than with respect to individual water bodies or estimated number of interventions. It is assumed all schemes and diffuse measures within a catchment are technically and practically feasible.

Diffuse measures take one year to build. Operating costs for diffuse measures begin in the year of construction. They are incurred annually until 2100. Treatment schemes take three years to develop and two years to construct. Operating costs for mine water treatment

schemes begin when construction has finished. Operating costs are then incurred annually until 2100. Operating costs increase by £30k per scheme from year 7 as it is assumed that increased operating costs are a better reflection of cost than periodic capital investment. The majority of the capital costs for new schemes is in earthworks and pipeline which have a long lifetime, and replacement is generally less than initial earthworks. It is assumed that current technology to remove pollutants will be used until 2100.

Delivery of the target is entirely dependent on government funding.

There is uncertainty around future technological improvements and to what extent investment in research and development will decrease costs. Time may also allow for improved evaluation of benefits.

8.3. Wastewater

The costs of the wastewater target were estimated using a standard model and the Environment Agency's experience with modelling costs of similar schemes over a long period. The Environment Agency's initial modelled costs are replaced in subsequent appraisals by water company estimates of the cost of each individual works enhancement that are subject to Ofwat scrutiny. This ensures that Environment Agency initial costings are now broadly in line with typical outturns.

Alternative technologies, including phosphorus recovery for reuse as fertiliser, are currently not economically viable at scale, but may become so in future with innovation and depending on world prices of phosphate rock, delivering better environmental outcomes.

8.4. Water demand

There are risks relating to the unpredictable impact of climate change on water consumption requirements and water availability, which could impact on the achievability of the target. However, this risk is also a driver for demand reduction.

There is a minor risk that climate change could lead to some abstractors (industrial water users who self-supply from their own reservoirs, wells, or river abstractions) shifting to the public water supply during periods of drought. There is limited data on water consumption practices in the non-household sector, leaving a degree of uncertainty over exactly what issues might arise.

9. Impact on small and micro businesses

The impacts set out in earlier sections are the estimated impacts of an indicative policy pathway to deliver the Environment Act water targets. A formal small and micro-business assessment has not been carried out here, but would be done in the IA of any regulatory measures actually proposed in future to support achievement of the targets.

Direct impacts on business would arise for the water companies, which are all large businesses. Their direct costs would be passed through the regulatory price review process onto customers through the sewerage component of their water bills, following careful scrutiny by Ofwat. The customers affected by this secondary, indirect impact would include households and businesses of all sizes.

Achieving the agriculture target will be dependent on actions taken by farm businesses, the majority of which are classified as small and micro businesses. The indicative pathway includes future measures, advice and incentives delivered by government that will encourage farmers to adopt practices and enrol in voluntary measures that will protect and restore the water environment. For any new regulation required to deliver the target, new impact assessments will be undertaken. The cost of existing regulations has been accounted for in the previous impact assessments for those regulations.

10. Wider impacts

Summary of overall impacts for water targets

Water is embedded throughout society, it is essential for human health, agriculture, ecosystems, and industry, and is impacted by many human activities. As a result, actions to improve the water environment touch on many other sectors and environmental outcomes, as water provides an essential ecosystem on which biodiversity, fish, and plant life depends.

10.1. Nature and biodiversity

Healthy water bodies are an essential ecosystem for thriving biodiversity. The water targets will improve these habitats and play a vital role in progressing towards our ambitions for biodiversity.

The abandoned metal mines target is linked to specific locations. Where these sites overlap with areas of interest for biodiversity, by delivering our targets we will contribute to achieving biodiversity targets. The decrease in over-abstraction and pollution in the water environment will contribute to achieving wider biodiversity targets

To achieve the targets for wastewater, agriculture, and abandoned metal mines, the responsible actors will be encouraged by government to pursue new methods including nature-based solutions. These often have multiple environmental outcomes however they are location specific and require assessment on an individual basis.

As an example, tree planting to reduce run-off and sediment erosion from agricultural land can also help to slow the flow of water and prevent flooding, increasing water retention in soils. The trees also help to remove harmful emissions from the atmosphere and benefit actions to mitigate climate change as well as providing cooling effects. Therefore, these targets will necessitate a joined-up approach between linked policy areas.

The interventions to deliver the abandoned metal mines target also include the use of nature-based solutions by creating new wetlands and planting trees. These will increase carbon sequestration in soils and vegetation, enhancing biodiversity particularly of priority vegetation habitats, as well as other natural flood management interventions that contribute to climate change mitigation.

Achieving the water targets will involve time-lags and different timescales in ecological recovery due to the processes of the freshwater systems involved. Understanding the time lags in ecological recovery are an integral part of assessing the full extent of co-benefits for biodiversity and nature.

10.2. Climate change and sustainability

The wastewater target may incentivise phosphorus recovery by water companies. Mined supplies of phosphorus are depleting, industries are becoming increasingly dependent on imports from a falling number of countries with remaining stocks. Recovery and recycling of phosphorus extracted from wastewater treatment would mean greater resilience to finite phosphorus supplies[60].

The use of nature-based solutions to achieve the water targets may also provide positive co-benefits for climate change adaptation and mitigation, depending on the solution used.

Water companies in England have committed to reaching Net Zero. Energy consumption accounts for the majority of the water industry's carbon footprint. Pursuing the measures to achieve the water demand target will reduce the amount of energy required to pump water across the country and heat water, delivering progress towards reducing carbon emissions. The phosphorus target for the water industry, however, may have a negative impact on their Net Zero ambitions if this results in increased chemical treatment at wastewater treatment plants. Water companies will have to account for these obligations in their Net Zero planning.

Decreased demand on the water supply could also potentially mean better resilience in incidences of extreme drought.

10.3. Marine

Rivers act as conduits for plastics as well as nutrients, sediments, and a wide range of other persistent and emerging contaminants to coastal waters and the ocean. Action to achieve the water targets and reduce the presence of pollutants in inland waters will reduce pollutant loads flowing into marine waters.

The abandoned metal mines target will impact upon the marine environment. In addition to ongoing programme works that will decrease metal inputs to the Tyne and other affected estuaries, benefits arise to marine wildlife when contaminated sediments are prevented from reaching estuaries. For example, to the UK Marine Strategy which sets values for metal contaminants in biota, and international treaty obligations under the OSPAR Convention[61]. Total riverine inputs of metals to the Greater North Sea have not decreased since 2012 after considerable decrease in the previous 20 years[62]; further decreases may not happen without action on abandoned metal mines although additional evidence needs to be gathered.

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[60] Environment Agency (2019), *Phosphorus and Freshwater Eutrophication Pressure Narrative*. Available at phosphorus-pressure-rbmp-2021.pdf (environment-agency.gov.uk).
[61] OSPAR Commission | Protecting and conserving the North-East Atlantic and its resources
[62] United Kingdom Marine Monitoring & Assessment Strategy, *Inputs of mercury, cadmium and lead via water and air.* Available at: Metal inputs (cefas.co.uk).

10.4. Economic/industry

The abandoned metal mines target will provide economic co-benefits for the North of England and cross-Government priorities, as well as supporting Levelling Up ambitions and the Industrial Strategy and aligning with policy on infrastructure development.

Interventions to prevent sediments silting up shipping berths in the Port of Tyne will directly contribute to its future as one of the UK's major deep-sea ports, contributing to national infrastructure. The abandoned metal mines target will contribute to levelling up strategies, by protecting 3,700 direct and 110,000 indirect existing jobs in the Tyne estuary, particularly in renewable and offshore energy (2019 figures), and potential substantial expansion. The target will support skilled employment opportunities for areas in the North and the South West e.g., in tourism at UNESCO World Heritage sites in Devon and Cornwall or environmental management.

A reduction in water use would need to consider the positive and potential negative impacts on businesses and economic growth. Introduction of a water efficiency label (linked with energy) would affect businesses. The water efficiency label will have impacts on manufacturers who make, and retailers who sell water using products. This is being addressed in a separate IA. More generally, the water demand target will contribute to improving and maintaining the balance between water supply and demand against the challenges of climate change and enabling long-term economic growth. This is an important part of the infrastructure underpinning economy and industry.

10.5. People/behaviour

The illustrative analysis in this IA is based on a simple counterfactual essentially involving no change in current behaviour by business people (including farmers and landowners) and the general public. It is reasonable to say that, over an appraisal period to 2100, this is not a realistic representation of what might occur. However, there is no clear evidenced basis to assume any other counterfactual changes (those changes that would occur in the absence of the water targets). It is likely that there will be changes in the water efficiency of non-household water consumers, and changes outlined above by agricultural landholders, over the period of these targets (to 20340) and even more so over the appraisal period (to 2100). The important and wide-ranging impact of human behaviour on the water environment is increasingly recognised.

11. Summary of the potential trade implications of measure

The water and sewerage industries in Britain are non-traded sectors and impacts on them are not expected to have any international trade implications.

Measures relating to agriculture may require incentives to farm businesses including public funding, which may need to be cleared through trade procedures but are not specific to water targets.

12. Monitoring and Evaluation

The Environment Act creates a new statutory cycle of monitoring, planning and reporting. Long-term targets will be supported by interim targets, which will set a five-year trajectory towards meeting the long-term targets. The Act requires Government to set interim targets in the Environmental Improvement Plan. This will ensure that there is always a shorter-term goal Government is working towards, as well as the long-term target and will allow for an ongoing assessment of whether the government is on track to meet its long-term target ambitions.

12.1. Agriculture

The target will be measured through a combination of modelling and monitoring.

Although it is relatively straightforward to directly measure levels of pollution through water quality monitoring and a long-term agriculture-focussed *Enhanced Water Quality Monitoring Programme* has been in place since 2007, through the Catchment Sensitive Farming (CSF) programme, the rural water environment is subject to multiple pressures including both point and diffuse sources (e.g. sewage treatment works, agriculture and industry). Monitoring alone would not, therefore, form a robust basis for setting sector-specific targets.

Modelling

Land use modelling is a well-established area that has been used extensively to support policy analysis, with FARMSCOPER[63] being the leading policy tool for diffuse pollution management in England. FARMSCOPER integrates multiple pollutant, emission, and erosion processes, at a range of spatial scales in order to estimate agricultural pollutant loadings (to the water environment).

[63] Gooday, R. et al. (2014) 'Modelling the cost-effectiveness of mitigation methods for multiple pollutants at farm scale', *Science of the Total Environment*, 468-469(Jan 2014), p.1198-1209. Available at: Modelling the cost-effectiveness of mitigation methods for multiple pollutants at farm scale - ScienceDirect. .

The following developments are required to apply land use modelling to the agriculture target:

- An England-wide farmer survey to provide detailed information on uptake of specific policy interventions as well as other changes to farming practices - although we have robust information for some policy interventions (notably Agri-Environment Schemes and CSF) as well as more generally through the Defra Farm Practices Surveys, for other interventions (e.g. Catchment Based Approach, water company schemes, and agri-industry schemes) this information is lacking - the survey needs to be independent, large scale (to provide statistically robust information on variations in farm sizes/ types, geology/climate etc) and repeated on a regular basis to identify trends.

- Development of an approach for modelling pollutant load reductions from targeted (whole field) land use change.

- Extension of the FARMSCOPER modelling framework to estimate total nitrogen loadings – the model currently estimates nitrate loadings.

Water Quality monitoring

Where modelling approaches are used, field verification of model predictions is important. CSF water quality monitoring has been in place since 2007 providing a relatively long-term data series and robust baseline. It is fully integrated within the Environment Agency's overall monitoring programmes (including the NCEA River Surveillance Network which has been in place since January 2021).

Site selection (sites with catchment areas >10km^2 to fit with catchment models and screened for not having significant sewage influence) and sampling frequency (weekly) make the monitoring uniquely suitable, among established water quality monitoring programmes, for assessment of agriculture's water quality impact.

The existing network of ca 120 sites is across (and representative of) the Countryside Stewardship High Priority Areas for Water (35% of England where agriculture has the greatest impact on water quality policy priorities) and will expand to ca 240 sites across Countryside Stewardship High and Medium Priority Areas (covering approx. 80% of England) in 2022.

The statistical method for comparing monitored pollutant concentrations with modelled pollutant loadings is established and published in the scientific literature[64].

[64] Davey, A., Bailey, L., Bewes, V., Mubaiwaa, A., Hall, J., Burgess, C., Dunbar, M., Smith, P., Rambohul, J. (2020) 'Water quality benefits from an advice-led approach to reducing water pollution from agriculture in England'. *Agriculture, Ecosystems and Environment,* 296. Available at: https://www.sciencedirect.com/science/article/pii/S0167880920301109

The outlined approach, combining modelling and monitoring assessments, will provide a robust evaluation of the success of the relevant policy interventions. Model results will reflect a combination of changes driven 'directly' by the range of policy interventions as well as 'wider' external factors (overall market forces, etc) and the farmer survey and modelling assessment will need to be carefully designed to inform understanding of the impacts of these different drivers of change, as well as the combined impact.

12.2. Abandoned metal mines

Progress towards the target will be evaluated through the existing Water and Abandoned Metal Mines programme which already requires the Environment Agency to monitor and assess performance against criteria set by the Programme Board.

The Environment Agency has established the target baseline against which progress can be objectively monitored through continued water quality monitoring. In early 2021, an independent analysis recommended that the Environment Agency should carry out a further review of the baseline evidence, including gathering additional water quality data. This work is in progress and will be used to set the formal baseline against which the target will be assessed..

Through the Spending Review 2021 funding has been allocated to the Environment Agency to increase their existing monitoring and evaluation provision to gather additional data that will robustly and transparently demonstrate whether the policy has been successful (i.e. there is progress towards the target to reduce the length of rivers polluted by abandoned metal mines).

12.3. Wastewater

The target can be objectively measured using the existing monitoring and evaluation framework of the Environment Agency using both data collected from monitoring and modelling.

For phosphorus, this includes monitoring conducted for assessment of good ecological status and the pressures and threats narrative that allows the relative source apportionment of phosphorus to particular industries (such as discharges from wastewater treatment works) to be ascertained. Water companies monitor the effluent load and self-report this to the Environment Agency, who review this information and assess compliance. The factors driving catchment failures are also modelled accordingly for River Basin Management Planning purposes.

The Environment Agency monitors water bodies as part of the Water Environment Regulations. Through their monitoring they are aware of phosphorus concentrations in waterbodies and how this has changed over past decades.

12.4. Water demand

Data on the primary indicator and sub indicators are collected annually by the Environment Agency reporting data. This data is provided as part of water companies' annual reviews of their Water Resources Management Plans (WRMPs), which they are under a statutory duty to carry out under the Water Industry Act 1991. Data is also collected by Ofwat through the price review process.

Government challenged water companies to produce a route map outlining their approach to delivering against the target, and government is working with regulators to ensure delivery through WRMPs and the 2024 price review.

In the long term, government is required to prepare a water conservation report for Parliament every three years. Progress on water efficiency would be covered by this report.