Environment Act 1995 c. 25
s. 4 Principal aim and objectives of the Agency.

Law In Force

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1 April 2013 - Present

Subjects
Environment

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Environment Agency; Ministerial guidance; Objects and purposes; Sustainable development

4.— Principal aim and objectives of the Agency.

(1) It shall be the principal aim of the Agency (subject to and in accordance with the provisions of this Act or any other enactment and taking into account any likely costs) in discharging its functions so to protect or enhance the environment, taken as a whole, as to make the contribution towards attaining the objective of achieving sustainable development mentioned in subsection (3) below.

(2) The [Secretary of State] [1] shall from time to time give guidance to the Agency with respect to objectives which [the Secretary of State considers] [2] it appropriate for the Agency to pursue in the discharge of its functions.

(3) The guidance given under subsection (2) above must include guidance with respect to the contribution which, having regard to the Agency's responsibilities and resources, the [Secretary of State considers] [3] it appropriate for the Agency to make, by the discharge of its functions, towards attaining the objective of achieving sustainable development.

(4) In discharging its functions, the Agency shall have regard to guidance given under this section.

(5) [The power to give guidance to the Agency under this section shall only be exercisable after consultation with–

(a) the Agency,

(b) Natural England, and

(c) such other persons as the [Secretary of State considers] [3] it appropriate to consult in relation to the guidance in question.

] [4]

(6) A draft of any guidance proposed to be given under this section shall be laid before each House of Parliament and the guidance shall not be given until after the period of 40 days beginning with the day on which the draft was so laid or, if the draft is laid on different days, the later of the two days.

(7) If, within the period mentioned in subsection (6) above, either House resolves that the guidance, the draft of which was laid before it, should not given, the [Secretary of State] [5] shall not give that guidance.

(8) In reckoning any period of 40 days for the purposes of subsection (6) or (7) above, no account shall be taken of any time during which Parliament is dissolved or prorogued or during which both Houses are adjourned for more than four days.

(9) The [Secretary of State] [6] shall arrange for any guidance given under this section to be published in such manner as [the Secretary of State considers] [7] appropriate.

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Notes

1 Word substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.362(2)(a) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

2 Words substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.362(2)(b) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

3 Words substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.362(3) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

4 Words substituted by Natural Environment and Rural Communities Act 2006 c. 16 Sch.11(1) para.140 (October 1, 2006)

5 Word substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.362(4) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

6 Word substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.362(5)(a) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

7 Words substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.362(5)(b) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

Part I THE ENVIRONMENT AGENCY AND THE SCOTTISH ENVIRONMENT PROTECTION AGENCY > Chapter I THE ENVIRONMENT AGENCY > Transfer of functions, property etc. to the Agency > s. 4 Principal aim and objectives of the Agency.

Department for Environment Food and Rural Affairs

The Environment Agency's Objectives and Contributions to Sustainable Development: Statutory Guidance

by the Secretary of State for Environment, Food and Rural Affairs

The Environment Agency's Objectives and Contributions to Sustainable Development: Statutory Guidance

by the Secretary of State for Environment, Food and Rural Affairs

December 2002

Department for Environment, Food and Rural Affairs

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CONTENTS

1. INTRODUCTION AND CONTEXT

This statutory guidance:

- sets out the principles which the Environment Agency should follow in deciding its priorities;
- states the objectives the Government has set for the Agency to pursue over the next few years; and
- identifies its roles in contributing to the achievement of sustainable development.

This guidance relates to England; the National Assembly for Wales will be issuing separate guidance in relation to Wales.

1.1 The Environment Agency was set up under the Environment Act 1995. The Government's main purpose in establishing the Agency was to enable the functions vested in it to be carried out in a way which brought greater overall benefit for the environment as a whole.

1.2 Section 4 of the 1995 Act defines the principal aim for the Agency: in discharging its functions the Agency is required so to protect or enhance the environment, taken as a whole, as to make the contribution that the Secretary of State for the Environment, Food and Rural Affairs (the Secretary of State) considers appropriate towards achieving sustainable development. (This principal aim is subject to the other provisions of the 1995 Act, and to any other enactment under which the Agency operates. Similarly, this guidance is subject to the requirements of legislation under which the Agency operates. It provides guidance to the Agency on such matters as the formulation of approaches that the Agency should take to its work, decisions about priorities for the Agency and the allocation of resources. It is not directly applicable to individual regulatory decisions of the Agency). This guidance has been issued after consultation with the Agency and other interested organisations and individuals.

1.3 The Agency is required to take into account any likely costs in achieving its principal aim, and to take account of the likely costs and benefits in exercising its powers. This includes both costs to people and organisations, and costs to the environment.

1.4 The Secretary of State is required by section 4 of the 1995 Act, after consultation with the Environment Agency and other interested parties, to give guidance to the Agency from time to time with respect to:

- the objectives which he considers it appropriate for the Agency to pursue in the discharge of its functions; including
- the contribution he considers it appropriate for the Agency to make towards the objective of achieving sustainable development.

The Agency must have regard to such guidance.

1.5 This guidance replaces that issued jointly by the then Department of the Environment and the Welsh Office in 1996. It has been developed following the first Financial Management and Policy Review (FMPR) of the Agency carried out by the Department for Environment, Food and Rural Affairs (Defra) during 2001 in consultation with the National Assembly for Wales.

1.6 The FMPR noted that, while the Government's environmental agenda had progressed considerably since the setting up of the Agency in 1996, there was no single statement bringing together the Government's strategic objectives for the Agency nor the environmental priorities it was expected to concentrate on. Neither was there up-to-date guidance from Government to the Agency in respect of the contribution the Agency was expected to make to sustainable development. The FMPR recommended that new guidance should be given to the Agency. This should clarify the principles that the Government expects the Agency to apply in carrying out its statutory functions; and, within those functions, determine the focus of its role and priorities for the next 5 years or so by specifying the strategic policy objectives which the Government expects the Agency to achieve over that period. There should also be revised guidance as to the contribution that the Agency should make to sustainable development, reflecting the UK Sustainable Development Strategy published in 1999.

1.7 This statutory guidance therefore identifies the Government's objectives for the Agency, which are designed to contribute to the achievement of the Government's priority outcomes, and gives new guidance on the contribution the Agency should make to sustainable development. The guidance reflects the environmental outcomes which Government policy is designed to achieve, and identifies the Agency's particular role in their achievement, having regard to the areas where it has a unique role to play and the greatest expertise, or where its role, as a result of its experience, skills, work or resources, mean that it is particularly well placed to make a contribution to developing environmental policy or delivering environmental outcomes. The aim is to provide the Agency and its sponsors with a new framework for accountability, which in turn will give the Agency a clear context for taking forward its work.

1.8 The Agency is expected to focus primarily on the achievement of the objectives set out in this statutory guidance and should prioritise its work and resources accordingly. The objectives are not intended to provide a comprehensive picture of what the Agency may wish to do over the next 5 years or so (or what Government may ask it to do). Neither are they intended unreasonably to limit the activity of the Agency, or the resources to be made available to it. But the Agency, like all public bodies, operates in a resource-constrained environment, and, where hard choices need to be made, the priorities set out in this guidance will be an important factor in influencing the Government's strategic decisions, including in relation to the Agency's resources.

2. PRIORITISATION AND ACCOUNTABILITY

Principles for prioritisation

2.1 The Agency should prioritise its activities, and its resource allocations, according to the following principles:

- **Relevance to objectives:** Giving priority to work which is clearly related to the specific delivery of the objectives set out in this statutory guidance which reflect the Agency's contribution to the environmental outcomes which the Government wishes to achieve.
- **Legislative remit:** Giving priority to work which directly supports or enhances the delivery of its statutory duties and the exercise of its powers, and particularly to those areas where it has unique duties or functions or the principal statutory role.
- **Relative expertise:** Giving priority to those areas or activities where, by virtue of its functions and resources, it has developed or will need to develop a unique or leading level of expertise, or a high level of specialist skills or leverage.

Accountability

2.2 The Agency should develop, in accordance with the principles outlined in this guidance, and agree with the Secretary of State:

- a corporate strategy which describes how the Agency will work to deliver the objectives outlined in this guidance; and
- a corporate plan which translates these objectives into specific targets.

2.3 The Agency's management statement further sets out its accountability, and the administrative arrangements that have been put in place between Government and the Agency to support this. The Financial Memorandum sets out the framework of financial controls.

3. SUSTAINABLE DEVELOPMENT

Statutory and policy basis

3.1 Section 4(3) of the Environment Act 1995 requires the Secretary of State to give guidance on the contribution which he considers it appropriate for the Agency to make, in discharging its functions, towards attaining the objective of achieving sustainable development. This guidance must have regard to the Agency's responsibilities and resources.

3.2 The UK Sustainable Development Strategy[1] sets out the Government's policy for bringing the environment, social progress and the economy alongside each other at the heart of policy-making. Sustainable development is about achieving a better quality of life for everyone, now and for generations to come. If sustainable development is to be achieved, four key objectives must be met at the same time. These objectives are:

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[1] *A Better Quality of Life: A strategy for sustainable development in the UK.* May 1999 (CM 4345, TSO).

- social progress which recognises the needs of everyone;
- effective protection of the environment;
- prudent use of natural resources; and
- maintenance of high and stable levels of economic growth and employment.

3.3 To achieve these objectives simultaneously, sustainable development concerns need to be integrated into policy development from the outset. The Strategy contains ten guiding principles which should shape the development of policy:

- putting people at the centre;
- taking a long-term perspective;
- taking account of costs and benefits;
- creating an open and supportive economic system;
- combating poverty and social exclusion;
- respecting environmental limits;
- the precautionary principle;
- using scientific knowledge;
- transparency, information, participation and access to justice; and
- making the polluter pay.

Agency roles

3.4 The Agency has two roles in contributing to the achievement of sustainable development. These are:

- to protect or enhance the environment in a way which takes account (subject to and in accordance with the 1995 Act and any other enactment) of economic and social considerations; and
- to be an independent advisor on environmental matters affecting policy-making, both within Government and more widely.

3.5 These roles are an integral part of the Agency's normal business. It follows that, in the allocation of its resources, sustainable development should not be seen as a separate and additional undertaking.

3.6 The Agency's main contribution to achieving sustainable development will be to deliver the objectives in part 4 of this guidance in a way which takes account (subject to and in accordance with the 1995 Act and any other enactment) of economic and social considerations.

3.7 In its second role, as an independent advisor, the Agency will be one of the Government's main sources of expert advice on environmental matters, which are a key component of sustainable development. It is an important source of influence as policy and strategy develop, given the skills and expertise it has at its command. The Agency is also well placed to influence the actions of others in relation to environmental matters. It should strive to maintain itself as a recognised centre of knowledge and expertise within its areas of responsibility.

3.8 It is for Government to take the eventual policy decisions which will integrate social, economic and environmental needs. The Agency's advice and influence should reflect the environmental perspective, where its expertise is greatest. In framing its advice and views the Agency should however bring to bear its knowledge of the interactions between environmental practice and social and economic factors.

3.9 The Agency's second sustainable development role can be reinforced by awareness-raising and education (for example in professions directly affected by its work, in further education and through the National Curriculum) where this offers good value for money and adds value to the work of lead bodies in this area. While the Agency should have regard to sustainable development as a whole, its work should focus on its particular expertise in environmental matters, rather than particular social or economic aspects of sustainable development.

Economic and social considerations

3.10 The Agency's work can have major social and economic as well as environmental consequences. The Agency should develop approaches which deliver environmental requirements and goals without imposing excessive costs (in relation to benefits gained) on regulated organisations.

3.11 The requirement to take account of economic and social considerations (set out in paragraphs 3.4 and 3.6 of this guidance) must be seen in the context of the specific activity the Agency is engaged in, and the degree of discretion it has under its statutory powers and duties.

3.12 The Agency's ability to take account of economic and social considerations will in practice be affected by the extent of its knowledge of how these interact with environmental practice. It thus needs to develop and maintain or have access to adequate experience and understanding of the interactions between environmental practice and social and economic factors. The partnerships it forges with other organisations (including those described in paragraph 4.1 i) will be particularly germane to this and thus help the Agency meet its objectives. The Agency should not duplicate the existing role of other expert bodies. For example, it will need to consult as appropriate with bodies with responsibilities for protection of public health, including the Department of Health, the National Health Service, the Health Development Agency, the Health and Safety Executive and local authority Environmental Health Departments. The Agency should where possible enter into agreements with other expert bodies to enable it to have continuing and rapid access to the necessary advice, while developing 'in-house' capability to act as an intelligent client.

3.13 In considering how best to integrate environmental, economic and social considerations the Agency should bear in mind all relevant Government policy and guidance.

4. GOVERNMENT OBJECTIVES FOR THE AGENCY

4.1 In discharging its functions and in developing its corporate strategy the Agency's objectives shall be to:

(a) Protect or enhance the environment, taken as a whole, in a way which takes account (so far as is consistent with the Agency's legal obligations) of economic and social considerations, so as to make the contribution towards achieving sustainable development which the Secretary of State considers appropriate, as set out in this guidance.

(b) Adopt an integrated approach to environmental protection and enhancement, which considers impacts of substances and activities on all environmental media, on natural resources, and where appropriate on human health.

(c) Discharge the Agency's functions in an economical, efficient and effective manner and to organise its activities in ways which reflect good management practice and provide value for money.

(d) Meet high standards of professionalism (based on sound science, information and analysis of the environment and of processes which affect it), transparency, consistency and environmental performance.

(e) Conduct its affairs in an open and transparent manner in full compliance with the requirements of all relevant statutory provisions and codes of practice relating to the freedom of, and public access to, environmental and other information and to make such information broadly available subject to legislative constraints.

(f) Ensure that regulated individuals and organisations comply with relevant legislation.

(g) Develop in conjunction with Government a risk-based, proportionate, consistent, efficient and cost-effective approach to the regulatory process; follow better regulation principles; and evaluate and where necessary improve the operation of regulation.

(h) Provide timely and high quality advice to Government, grounded in the Agency's technical expertise and operational knowledge, including where appropriate in relation to the development and implementation of Government policy and strategy, the implementation of international, European and domestic legislation and in European Union negotiations.

(i) Reflecting on and building upon the principles of public accountability, develop a close and responsive partnership with the public, local authorities and other representatives of local communities, regional chambers and other regional bodies, other public bodies and regulated organisations, and adopt effective procedures to manage these relationships.

(j) Collect data of appropriate quality and prepare and disseminate information in a timely fashion for monitoring and reporting on all areas of Agency responsibility.

(k) Monitor and produce periodic reports on the state of the environment, in collaboration with others as appropriate.

(l) Undertake research necessary to support the Agency's functions and the delivery of its objectives, in a manner which is consistent with and complementary to the Government's research programme and takes account of research undertaken by others.

4.2 The Agency, having regard to the guidance in paragraph 4.1 above, should pursue the following objectives in discharging its main operational functions and in developing its corporate strategy:

(a) *Flood defence*

To reduce the risks to people and to the developed and natural environment from flooding, and in particular:

- to provide adequate, economically, technically and environmentally sound and sustainable flood and coastal defences;
- to provide adequate and cost-effective flood warning systems which contribute to a seamless and integrated service of flood forecasting, warning and response; and
- to discourage inappropriate development in areas at risk from flooding.

(b) *Water quality and water resources*

To protect, enhance and restore the environmental quality of inland and coastal surface water and groundwater, and in particular:

- to address both point source and diffuse pollution;
- to implement the EC Water Framework Directive; and
- to ensure that all relevant quality standards are met.

To plan to secure the proper use of water resources by using strategic planning and effective resource management which takes into account environmental, social and economic considerations, and in particular:

- to ensure that the abstraction of water is sustainable, and provides the right amount of water for people, agriculture, commerce and industry and an improved water-related environment; and
- to develop and maintain a framework of integrated water resources planning for the Agency and water users.

(c) *Waste management*

To contribute to the successful implementation of the national waste strategy, and in particular:

- to ensure that waste is recovered or disposed of in ways which protect the environment and human health, by regulating waste management operations (including collection, transport, treatment, storage and disposal) and enforcing waste management controls in a nationally consistent manner;
- to provide comprehensive monitoring data (in conjunction with local authorities, as necessary) to enable the amount of waste arising and the final disposal method to be tracked and recorded for each significant waste stream; and
- to assist regional bodies and local government in developing waste plans and strategies that reflect the waste hierarchy and the national waste strategy.

(d) *Industry[2] regulation*

To control pollution from industry by means of the Pollution Prevention and Control (England and Wales) Regulations 2000 (the PPC Regulations) and any subsequent amendments or additions, and in particular:

- to encourage and determine applications for new and existing installations within the timescales laid down in the PPC Regulations; and
- to set permit conditions in a consistent and proportionate fashion based on Best Available Techniques and taking into account all relevant matters including:
  - sectoral and site-specific compliance costs; and
  - the resulting local, national and transboundary environmental benefits.

Insofar as the PPC system has not progressively replaced the integrated pollution control (IPC) system, to secure through the IPC provisions of the Environmental Protection Act 1990 the prevention or minimisation of pollution by industry.

In conjunction with the IPC/IPPC systems:

- to control industry discharges to watercourses through the powers provided by the Water Resources Act 1991; and
- to work with local authorities towards delivering the objectives of the National Air Quality Strategy and to support the development of regional air quality strategies.

[2] A wide interpretation of 'Industry' is meant here, embracing all industry covered by IPPC, including aspects of agriculture and land, water and waste management.

(e) *Fisheries*

To maintain, improve and develop salmon and freshwater fisheries, and in particular:

- to ensure the conservation and maintain the diversity of freshwater fish, salmon, sea trout and eels and to conserve their aquatic environment;
- to enhance the contribution salmon and freshwater fisheries make to the economy, particularly in remote rural areas and in areas with low levels of income; and
- to enhance the social value of fishing as a widely available and healthy form of recreation.

(f) *Radioactive substances*

To regulate aerial and liquid radioactive discharges, and solid radioactive waste disposal, in accordance with statutory duties, statutory guidance and Government policy.

(g) *Land contamination and soil*

To help identify and deal with unacceptable risks to human health and the environment from contaminated land, and in particular to develop technical material to support the new contaminated land regime; and to support Government policy for the sustainable use of soil.

(h) *Navigation*

To maximise the social, economic, environmental and heritage benefits of the waterways for which the Agency is the navigation authority and to work with other navigation authorities and others to create an enhanced and integrated inland waterway system and in particular:

- to maintain its assets in a condition which ensures the safe use of its waterways; and
- to promote urban and rural regeneration.

(i) *Conservation*

To help conserve and enhance the diversity of native wildlife and habitats, the landscape and historic environment and in particular:

- to contribute to the implementation of the UK Biodiversity Action Plan and the England Biodiversity Strategy, and in particular the delivery of those actions for which the Agency has lead responsibility;
- to further the conservation of Sites of Special Scientific Interest;
- in managing its own land, to enhance its biodiversity, cultural and recreational potential; and

- to ensure that all Agency consents[3] likely to have a significant effect of the integrity of a Special Protection Area, Special Area of Conservation or Ramsar site are reviewed and either confirmed, modified or revoked as appropriate, and that any new consents are dealt with in accordance with the requirements of the Conservation (Natural Habitats etc) Regulations 1994.

(j) *Recreation*

To promote the recreational use of inland and coastal waters and associated land in accordance with the Code of Practice on Conservation, Access and Recreation, and in particular;

- to promote greater recreational use of its waterways by all sectors of society and provide improved facilities for users; and
- to regularly review the Agency's regional recreation strategies.

5. INTERPRETATION OF OBJECTIVES

5.1 This provides guidance on the interpretation of the regulatory objectives (4.1(f) and (g)), and on how the Agency's objectives relate to climate change, land use planning and regeneration.

Better regulation

5.2 The Agency should have regard to the five principles of good regulation as set out in Cabinet Office guidance[4]: transparency, accountability, proportionality, consistency and targeting. Any enforcement action should be proportionate to the risk, and alternatives to formal enforcement action should be considered. Where the Agency has discretion as to the manner in which it implements regulatory regimes or requirements, it should have due regard to the impact on competition in markets. It should provide adequate and timely guidance to regulated companies on any new duties contained in new legislation.

5.3 The Government will work in partnership with the Agency to improve the effectiveness of the regulatory system that the Agency operates. The implications of forthcoming regulatory responsibilities on the existing system should be considered, including the cumulative effects of new regulations. In some cases, replacing traditional regulatory approaches with other approaches may be cheaper for business, the Agency and the taxpayer, and more effective in reducing environmental impacts and furthering the Agency's objectives. The Agency should consider with Government (in particular through the corporate strategy and corporate planning processes) the optimum mix of approaches, having regard to the environmental impacts and risks involved, the requirements of the relevant European and domestic legislation, and the economic and social costs and benefits of different approaches.

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[3]'Consents' is used in its widest meaning, including licences, authorisations, permits, and activities undertaken by the Agency itself.
[4]*Better Regulation Task Force: Principles of Good Regulation.* Cabinet Office (October 2000).

5.4 The Agency should take account of robust environmental management systems, in particular the Eco-Management and Audit Scheme (EMAS) and ISO 14001. Subject to and in accordance with the 1995 Act and any other enactment it should support and promote good practice that benefits the environment by improving resource use and minimising waste and pollution and which also enhances competitiveness and helps business save money. The Agency should work closely with partner organisations, such as the Government's Envirowise best practice programme, and collaborate with them to avoid duplication or confusion of roles.

5.5 Wherever possible, the Agency should discharge its functions in ways which maximise the scope for regulated organisations to plan for cost-effective investment in improved technologies and management techniques. It should also follow the principles of "think small first", a framework for Government support for all the UK's small businesses, so that burdens of regulation can be reduced.

The Agency's work in relation to climate change, land use planning and regeneration

5.6 The Agency contributes to the reduction of greenhouse gas emissions through its industry and waste regulation objectives, provides information on the effects of climate change under its data collection and monitoring objective, and plans for the likely impacts of climate change especially through its flood defence and water resources objectives. It also participates in regional and local initiatives to reduce greenhouse gas emissions and adapt to the impacts of climate change.

5.7 In support of its objectives the Agency is involved with land use planning, including advising on regional planning guidance, development plans and planning applications. Its primary role, subject to any changes in the light of the Planning Green Paper, is to advise on those aspects of draft plans, planning applications, environmental statements and hazardous substances consent applications which relate to its operational functions and particular expertise, using information it already has. The Agency also has a role in providing advice at an early stage in the planning process; both to help shape development briefs and draft plans before they go out to consultation; and to advise prospective applicants on the potential implications of their proposals before an application is made to the local planning authority. If the Agency considers there are gaps in a planning authority's draft plan or appraisal of an application from the wider sustainability point of view, it should draw the authority's attention to this. Where the Agency provides advice it should do so in a timely, consistent, justifiable and understandable way.

5.8 The Agency is required to promote urban and rural regeneration under its objective for navigation, where this activity is especially relevant. In exercising its other functions it may also have opportunities to promote regeneration, especially in collaboration with other public bodies, in a manner which is consistent with its legal powers and proportionate.

Deregulation Act 2015 c. 20
s. 108 Exercise of regulatory functions: economic growth

Law In Force

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108 Exercise of regulatory functions: economic growth

(1) A person exercising a regulatory function to which this section applies must, in the exercise of the function, have regard to the desirability of promoting economic growth.

(2) In performing the duty under subsection (1), the person must, in particular, consider the importance for the promotion of economic growth of exercising the regulatory function in a way which ensures that—

(a) regulatory action is taken only when it is needed, and

(b) any action taken is proportionate.

Exercise of regulatory functions > s. 108 Exercise of regulatory functions: economic growth

Department for
Business & Trade

Growth Duty: Statutory Guidance - Refresh

Growth Duty: Statutory Guidance

Statutory Guidance under Section 110(1) of

The Deregulation Act 2015

21 May 2024

Contents

Introduction

Regulators play a vital role in shaping the UK economy by the way in which they regulate. Regulators set strategies and make decisions that significantly affect the types, the scale and the locations of economic activity in important sectors. Regulators can improve the attractiveness of their sector to investors, bringing new products to market by encouraging innovation and ensuring competition to deliver the best service to consumers. It is a regulator's responsibility to design rules that set a level playing field between businesses and to ensure adequate protections for consumers and the environment. The regulations and licence conditions established by regulators set out the frameworks for businesses to be able to buy and sell in any given sector.

The decisions regulators make can also set the parameters for economic activity across all the sectors of the economy. In our interconnected modern economy, efficiencies from regulating one sector better can translate into lower input costs through supply chains to businesses in other sectors and higher economic growth overall.

It is clear that regulators can affect growth through their policy decisions on matters such as who to grant licences to, or what technologies can be used in a given context. But regulators can also affect growth through the approach they take to regulation and the wider environment that they establish, including in their relationships with regulated businesses. A good regulatory environment emerging from the attentive and responsive stewardship of an effective regulator can create the conditions for business confidence and investment, sensible risk-taking and innovation.

We start from a strong foundation. Our regulators are already recognised worldwide as commanding respect for their technical expertise and diligent enforcement of reliable trustworthy regimes. But there is an opportunity for regulators to foster economic growth, become more speedy and agile in decision making and forward thinking to anticipate and facilitate change in response to new technologies or business models. Making the right key decisions and setting the right strategy is vital. Taking a proportionate approach is essential.

This guidance sets out how the regulators in scope of the Growth Duty can better support sustainable economic growth through the decisions they take and through the way that they regulate.

Overview of the Growth Duty

Section 108 of the Deregulation Act 2015 ("the Act") establishes that a person exercising a specified regulatory function must have regard to the desirability of promoting economic growth (the "Growth Duty"). In performing this duty, regulators must consider the importance of the promotion of economic growth and ensure any regulatory action they take is necessary and proportionate. The Growth Duty applies to regulatory functions specified by a Minister in an order made under section 109(1) of the Act.

The Growth Duty is one of a number of statutory measures that support improvements in the implementation and delivery of regulation. These measures include the Regulators' Code and the statutory principles of good regulation.

The Growth Duty does not legitimise non-compliance with other duties or objectives, and its purpose is not to achieve or pursue economic growth at the expense of necessary protections. Non-compliant activity or behaviour that undermines protections to the detriment of consumers, employees and the environment and needs to be appropriately dealt with by regulators. It also harms the interests of legitimate businesses that are working to comply with regulatory requirements, disrupting competition and acting as a disincentive to invest in compliance.

Economic Growth

Specified regulators should give appropriate consideration to the potential impact of their activities and their decisions on economic growth, for the wider UK economy, alongside or as part of their consideration of their other statutory duties. Having regard to the desirability of economic growth does not mean having 'less' regulation. When regulators act to protect consumers, employees and the environment using well designed proportionate regulation, this ensures sustainable economic growth.

In the context of this guidance and the Growth Duty, sustainable growth encompasses the desirability of economic growth within the economy of the United Kingdom in the medium to long term. Regulators in scope of the Growth Duty should therefore interpret economic growth broadly and not just within the sectors they directly regulate.

Scope

The Growth Duty applies to a person exercising a regulatory function specified by Order[1] by a Minister of the Crown (such persons are collectively referred to as "regulators" for the purposes of this guidance). The regulatory functions[2] that are specified for the purposes of the duty are, broadly, those of named regulators and certain regulatory functions exercisable by a Minister of the Crown.

The regulatory functions of local authorities are not specified for the purposes of the Growth Duty.

Regulators which exercise devolved (or in relation to Northern Ireland, transferred) functions are not covered by the Growth Duty. Where a regulator operates across more than one of the four nations of the UK, the Growth Duty only applies to their regulatory functions to the extent that the functions relate to reserved matters.

Regulatory functions are broadly defined[3] for the purposes of the Growth Duty as functions under or by virtue of an Act or subordinate legislation:

- of imposing requirements, restrictions, or conditions in relation to an activity;
- of setting standards or giving guidance in relation to an activity[4]; or
- relating to the securing of compliance with, or the enforcement of, requirements, restrictions, conditions, standards, or guidance which relate to an activity.

In the context of criminal proceedings by a regulator, the Growth Duty applies to all functions up to and including the decision to refer the case to a prosecutor to review whether criminal proceedings should be instigated. The functions of instituting or conducting criminal proceedings are excluded from the Growth Duty[5]. Similarly, the function of conducting civil proceedings is excluded from the Duty[6].

[1] See The Economic Growth (Regulatory Functions) Order 2017 (S.I. 2017/267) as amended by the Economic Growth (Regulatory Functions) (Amendment) Order 2024 (S.I. 2024 No. 587) - https://www.legislation.gov.uk/uksi/2024/587/contents/made. In relation to Ofcom, Ofgem and Ofwat, the Growth Duty does not extend to the concurrent CMA powers held by Ofcom, Ofgem and Ofwat. Ofcom's regulatory functions under Part 3 of the Enterprise Act 2002 are also not in scope of the Growth Duty.

[2] For the purposes of the Growth Duty, schemes administered by a regulator on behalf of the government will usually be viewed as administrative rather than regulatory functions. For example, the schemes operated by Ofgem on behalf of government [as of 6th April 2024] are considered to fall outside the definition of "regulatory functions" at section 111 of the Act.

[3] Section 111(1) – (3) of the 2015 Act.

[4] Section 111(3) of the Act provides that an 'activity' includes providing goods and services and employing or offering employment to a person.

[5] Section 111(2)(b)(i) of the Act.

[6] Section 111(2)(b)(ii) of the Act

About the Guidance

This guidance is issued under section 110(1) of the Deregulation Act 2015 and should be read in conjunction with that Act. All those exercising specified regulatory functions to which the Growth Duty applies must have regard to this guidance. In accordance with section 110(5) of the Act, the Secretary of State has consulted the persons whose functions are specified in this Order and such other persons as the Secretary of State considered appropriate.

The guidance assists regulators in discharging their responsibilities under the Growth Duty. It also provides clarity for stakeholders as to what they should expect of regulators.

The requirement that regulators must have regard to the guidance means that regulators must consider the provisions of the guidance and give them due weight in determining how they will exercise their regulatory functions. They are not bound to follow a provision of the guidance in a particular case if they properly conclude that the provision is either not relevant or is outweighed by other considerations (for example if a regulatory initiative is already in the process of being implemented). However, the reasons for such a conclusion should be recorded.

This guidance outlines drivers of sustainable economic growth, supported by case-study examples, to provide clarity to regulators on the Growth Duty, the type of activities that could be considered in promoting economic growth, and ensure that regulators can clearly assess the impacts of their work on growth.

This guidance concerns the performance of the Growth Duty in section 108 of the Act and sets out ways in which regulators can exercise their regulatory functions in accordance with the Growth Duty by:

- Identifying drivers of sustainable economic growth to provide clarity and assist regulators to define their own sector-specific approach to defining and delivering growth.

- Outlining behaviours that contribute to good regulatory decision making and smarter regulation.

Terminology

The term regulator is used in this guidance to cover any person exercising a specified regulatory function, meaning both an organisation acting within scope of the Growth Duty and an officer or officers acting on behalf of that organisation in exercising a specified regulatory function.

The term sustainable economic growth is used in the guidance. The expectations behind this are set out in the *Economic Growth* section at page 4 of the Introduction.

Balancing Duties and Decision Making

The Growth Duty establishes economic growth as a factor that all specified regulators should have regard to in making strategic level decisions, alongside or as part of the delivery of their other regulations, duties, and protections as set out in the relevant legislation.

Overall, a well-protected and healthy population and environment leads to higher productivity and growth, and therefore in many cases there is no tension between a regulator's protection duties and the Growth Duty. Furthermore, a primary role for many regulators is to protect consumers against unfair practices and to promote safety. Protections generate consumer confidence to try new products, businesses and services further contributing to growth. Consumers are therefore essential for promoting economic growth through stimulating competition. Regulatory protections can also provide for a safe and functioning marketplace that is attractive to businesses and investors.

An effective regulator will set a strategy that strikes the right balance between competing pressures or duties, informed by an understanding of what approach might best support sustainable growth. There may be instances where a regulator has considered growth and reached a view that other duties or objectives may take precedence. This guidance therefore assists regulators in how to consider the importance of economic factors and fulfil the Growth Duty. Regulators are independent and are experienced and best placed to balance their own decision-making on duties. Decisions on growth will involve a consideration of a regulator's other duties, for example relating to environmental or consumer protection (such as online safety), and there may be a need to balance multiple objectives.

The purpose of the Growth Duty is to ensure that specified regulators give appropriate consideration to the potential impact of their activities and their decisions on economic growth, for the wider UK economy, alongside or as part of their consideration of their other statutory duties.

Non-compliant activity or behaviour undermines protections to the detriment of consumers, employees and the environment and needs to be appropriately dealt with by regulators. It also harms the interests of legitimate businesses that are working to comply with regulatory requirements, disrupting competition and acting as a disincentive to invest in compliance.

The Growth Duty can empower better decisions. Under the Growth Duty regulators can exercise their regulatory functions whilst having regard to the desirability to promote economic growth. There may be occasions where a regulator is empowered through the Growth Duty to consider other areas that may not be reflected, or may only be partly reflected, in their other duties. For example, guidance below indicates that promoting innovation or supporting trade are actions that promote economic growth. A regulator can therefore use this when taking a key strategic-level decision to choose a more innovative or trade-friendly option which would otherwise have been discounted.

Structure of this Guidance

Part 1: Drivers of Economic Growth – decisions on what is regulated

As set out in the Introduction, regulators can affect growth through their **decisions and strategies on what is regulated**. This can take many forms, but the regulator's rulebook, or licence conditions, or case-by-case approval decisions are the most common ways that regulators regulate. The policy decisions reflected in these have a major impact on the nature of economic activity, in the first instance within the regulator's sector, but also for the whole UK economy given the interconnectedness of businesses and individuals.

When taking major strategic decisions on what is regulated, a regulator should have due regard to the desirability of promoting economic growth. Regulators are experts in the contexts of their own sectors and thus are best placed to consider how this is best done. But to help regulators do this, this Guidance identifies **7 Drivers of Economic Growth.** The listed Drivers of Growth are not intended to be exhaustive, and regulators may identify other valid factors for consideration in meeting the duty.

The Drivers of Growth are the first section of this Guidance.

Part 2: Behaviours of Smarter Regulation – the approach to regulating

Regulators can also affect growth through their **approach to how they regulate**. Higher economic growth can be achieved in sectors where the behaviour of the regulator itself is pro-growth. Regulators can approach regulation in a pro-growth way in many forms, but this could include adopting best practice on how to support innovation, or minimising compliance burdens. Regulators who use a pro-growth approach to regulation facilitate a good regulatory environment that creates the conditions for business confidence and investment, sensible risk-taking and innovation.

When carrying out their regulatory functions, a regulator should have due regard to the desirability of promoting economic growth. Regulatory functions are shaped and informed by the way a regulator engages with issues such as innovation, efficiency, an international context, and the staff skills and capacity that the regulator has. As part of this, this Guidance identifies **7 Behaviours of Smarter Regulation.** The listed Behaviours of Smarter Regulation are not intended to be exhaustive, and regulators may identify other valid factors for consideration in meeting the duty.

The Behaviours of Smarter Regulation are the second section of this Guidance.

Drivers of Economic Growth

'Sustainable economic growth' ensures that current-day economic growth can be achieved without undermining the ability of future growth[7]. There are multiple key drivers of sustainable economic growth. The following section of this guidance outlines relevant Drivers to provide regulators with a basis upon which they can clearly consider the impact of their work on growth across sectors they operate in.

The Drivers can have a collective and mutually reinforcing impacts on delivering growth. In many cases a regulator's decision or strategy that aims to improve one Driver may also improve another Driver directly or indirectly.

Regulators operate across a diverse range sectors and businesses. Not all Drivers of Economic Growth will be applicable to every regulator, and not all Drivers will be relevant for any individual decision or policy choice. Regulators should consider Drivers that are most applicable to their activities.

Regulators should have regard to medium and long-term growth by ensuring that key policy decisions and strategic choices are informed by consideration of key Drivers of Economic Growth, which may include but is not limited to the following:

1. Innovation
2. Infrastructure and investment
3. Competition
4. Skills
5. Efficiency and Productivity
6. Trade
7. Environmental Sustainability

These Drivers are not placed in any order of priority or preference. In addition, regulators may also consider other aspects of economic growth, or other objectives that relate to economic growth, such as the desirability to foster regional growth or support SME development.

[7] The UN has defined sustainability as "meeting the needs of the present without compromising on the ability of future generations to meet their own needs." (United Nations, Brundtland Commission 1987)

Driver 1: Innovation

Innovation is a key driver of sustainable economic growth, through the development of new ideas, products and processes and their adoption and diffusion across the economy. Building and maintaining a strong modern economy relies on innovation, it is also central to overcoming the world's largest challenges for example future pandemics and meting climate goals. Investment in science, technology and innovation is more important than ever, science and technology will be a major driver of the of prosperity in the country. This is why the 'regulation and standards' strand of the UK Science and Technology Framework[8] sets a vision is that regulation is pro-innovation, stimulates demand for science and technology, and attracts investment while representing the UK values and safeguarding citizens.

Innovation can drive economic sustainable growth by increasing access to resources such as renewable energy sources. It improves competitiveness through the creation of new products and services. Higher productivity is achieved through innovation as more goods and services are produced. Innovation promotes the adaptability and the ability to respond to challenges quickly.

Regulation can alter market conditions, set standards and constraints, and establish incentives. Ultimately regulators have a pivotal role, often being at the forefront of striking the right balance between risk and openness to change.

Indicators that a regulator sets regulatory policy that supports innovation may include:

- Application- focusing on regulating the application of a technology rather than the technology itself.
- Regulating a new area of technology or business model or area of market activity.
- Updating existing rules to remove any unnecessary impediments to innovation.
- Investing in research and development.
- Adjusting to the growing presence and applicability of AI. [9]

[8] https://www.gov.uk/government/publications/uk-science-and-technology-framework.

[9] This may include considering how AI is affecting activities that are covered by a regulator. A regulator should be following rules or guidance relating to AI, At time of publication, this would include, consideration of five AI Principles outlined in the AI White Paper. https://www.gov.uk/government/publications/ai-regulation-a-pro-innovation-approach

Driver 2: Infrastructure and Investment

High quality and efficient infrastructure play a vital role in supporting a competitive and growing economy by providing services upon which businesses and citizens depend.

Investment in modern, climate compatible and clean infrastructure is a key factor for sustainable economic growth, especially in sectors that have suffered from chronic underinvestment. Simply investing in infrastructure is insufficient. To have the greatest impact on stimulating economic growth, in both the short- and long-term, infrastructure should be sustainable, resilient and inclusive.

Investing in infrastructure can provide a short-term demand stimulus to the economy, and in the long term, it also forms an important part of a successful economic growth strategy.

Well-designed infrastructure facilitates economies of scale, reduces costs of trade, and is central to the efficient production and consumption of goods and services. In turn, this reduces the cost of delivered goods, facilitates the physical mobility of people and products, remove productivity constraints, and increase competitiveness.

Indicators that a regulator sets regulatory policy that supports infrastructure and investment may include:

- Removing regulatory barriers to investments and the building of infrastructure.
- Reducing regulatory complexity, e.g. in price reviews for economic regulators to encourage greater investment.
- Making regulatory decisions in a timely manner, to minimise uncertainty and costs associated with what are often long infrastructure investments lead times.
- Developing long-term infrastructure plans and assessments or taking policy decisions that contribute to UK or sector-specific infrastructure strategies.
- Ensuring that infrastructure services are delivered efficiently, where competition alone is unable to achieve this outcome.

Driver 3: Competition

Competition can deliver better outcomes for consumers, by incentivising industries to provide better services at the lowest costs to attract customers from their rivals. Competition encourages technological advancement and innovation; companies compete with one another to deliver the best services and products. There is a strong case for regulation containing a clear competition dimension. Competition often leads to innovation, can act as a catalyst for productivity growth and is the main source of increases in standards of living.

Competitiveness motivates businesses to boost their productivity, allocate resources to innovation, research, and development, and enhance the quality of their products. Competition between firms therefore leads to increased productivity and is essential to growth.

Policies that lead to markets operating more competitively, such as enforcement of competition law and removal of regulations that hinder competition, can result in faster economic growth.

The nature of competition differs between sectors, which changes the nature of how competition is introduced in the market for certain industries.

Where there is scope for competition in the market, regulation should not unduly cause a barrier to market entry. Improper and convoluted regulation, or overzealous application of regulation can provide a barrier to competition, and growth.

Competition and regulation have similar market goals to prevent the illegitimate acquisition and exercise of market power, and to facilitate the effective allocation of resources. Where unrestricted competition is unlikely to achieve this, regulation is generally accepted as a means to achieving this outcome.

Indicators that a regulator sets regulatory policy that supports competition may include:

- Use Smart Data Regulation and similar approaches to open markets to new entrants. Smart data and approaches like quality star ratings can make it easier for a customer to compare the price and quality of suppliers, and make it easier to switch to an alternative supplier.
- Implementation – identification of measures that impede the ability of businesses to compete and grow based on efficiency and innovation.

- Consistency – application of rules and policies are adopted and/or maintained with the minimum distortion to competition.
- Reducing barriers to entry – to enable new products and services to enter the market by the regulator removing unnecessary restrictions that are preventing competition.
- Changing rules or other regulatory levers to help to level a playing field where justified competition should be occurring.

Case Study Example: Ofwat stocktake

In July 2022 Ofwat published a high level stocktake identifying opportunities and barriers to unlocking more competition in strategic investment in England. Ofwat currently uses two competitive delivery models for these projects. A licensed model called the Specified Infrastructure Project Regulations (SIPR), and a contracting model, Direct Procurement for Customers (DPC).

The stocktake showed that greater use of DPC could save customers between 6-40%, equating to saving of between £200m and £2bn on a hypothetical infrastructure investment of £5bn. The SIPR model, (used for the Thames Tideway Tunnel), is estimated to reduce consumer bills by c.£50 a year, relative to if the incumbent had delivered the project. Facilitating greater use of both competitive delivery models could therefore lead to substantive savings.

18 large scale infrastructure projects are planned in the water sector in the next decade. Through enabling a greater proportion of these projects to be delivered through the DPC and SIPR commercial frameworks, there is potential to significantly reduce the infrastructure delivery costs.

Driver 4: Skills

High quality education and skills training play a vital role in sustaining productivity growth and international competitiveness. Enhancing the skills of the workforce is crucial for the country's economic growth and improved productivity in the workplace.

Development of skills leads to structural transformation and growth by enhancing employability, labour productivity and helping competitiveness. Skills increase productivity by expanding an individual's economic capabilities. Economic prosperity of a country depends on how many people are in work and their productivity in the workforce[10]. A skilled workforce leads to the ability to compete in markets. Access to a skilled workforce plays a key role in where businesses decide to invest. Supplying businesses with the skills they need for the future economy will be an integral part to drive longer term growth.

Regulators should consider where their regulatory policy could improve skills. Regulators should consider whether they are best placed to address skills in their sectors, and whether it is appropriate for regulators to increase regulations (e.g. training standards) to boost skills if this could come at a cost to other parts of the economy.

Indicators that a regulator sets regulatory policy that supports enhancing skills may include:

• Building awareness of the wider skills context and policy environment.

• Upskilling professionals and future workers, e.g. through engagements, formal education and training and work experience placements.

Case Study Example: Civil Aviation Authority – Upskilling workers and future professionals

Civil Aviation Authority (CAA), Skills and STEM: The CAA have held virtual and face to face events to support young people across a range of the CAA's capability areas. A record number of engagements took place in 2022 including The Big Bang digital, involving 25,225 young people. A Primary Engineer competition involved 33,076 pupils from 330 schools submitting 22,480 entries. The CAA also hosted Careers events for University of West London, Stansted Airport College, STE

[10] Chartered Institute of Personnel and Development.

Mette's mentoring programme. The following events were also supported; Farnborough, The Royal International Air Tattoo, Women's World Gliding Championships, Armchair Air Show, Royal Airforce Cadets and the Jon Egging Trust.

Case Study Example: Civil Aviation Authority – Upskilling workers and future professionals

Civil Aviation Authority (CAA), Education and training: In partnership with Cranfield University, CAA has developed and delivered an MSc in Aviation Risk and Safety Management. The MSc is also offered as a Level 7 Apprenticeship programme. This is the first MSc offered by Cranfield University which is provided as a full virtual offering.

Working in partnership with ICAO and on behalf of the Department for Transport, CAA has developed a number of training courses and delivered over 104 bespoke and 120 open access course titles. The total number of delegates for 2022-2023 for all open, bespoke, e-learning and training project courses was 3825, with 175 internal delegates.

Driver 5: Efficiency and Productivity

Productivity measures output per unit of input, such as labour, capital, or other resources. The UK's ability to improve its standard of living heavily depends on its ability to raise its output per worker (i.e., producing more goods and services for a given number of hours of work). When productivity fails to grow significantly, it limits potential gains in wages, corporate profits, and living standards.

Productivity gains reflect the ability to produce more output by better combining inputs, owing to new ideas, technological breakthroughs and augmented business models. These transform the production of goods and services, fostering economic growth and rising living standards and well-being.

Productivity is, in part, the product of the other Drivers of Economic Growth. However, in a regulator context, efficiency and productivity is a particularly central concern, recognising the importance of proportionality.

A proportionate regulatory approach is one which requires a regulated business to meet the minimum requirements necessary to deliver assurance to meet the regulator's responsibilities for ensuring safety, environmental compliance, etc. A disproportionate approach, conversely, goes far beyond what is necessary and can stifle productivity as it ties up business and regulator's time and resources that could be more productively deployed elsewhere.

Indicators that a regulator sets regulatory policy that supports efficiency and productivity may include:

- Speed of decision making – where a product or service is already authorised by a counterpart regulator in another country faster decision making should be considered.
- Taking proportionate authorisations: Consideration of the associated compliance costs for businesses in licensing and permitting. Regulators should ensure that requirements are proportionate and used only when necessary, that associated costs are minimal and positive impacts are maximised. This may include streamlining application and renewal processes and providing clear guidance on them; collaboration with others who operate related authorisations to ensure a consistent approach.
- Compliance support through simple, clear and timely guidance and advice can provide businesses with clarity and certainty, minimising the cost to them of complying with regulatory requirements. This may include publishing clear,

robust compliance guidance in areas where the regulator has evidence that this is needed; making available tailored compliance advice for those businesses whose needs are not met by the regulator's existing standards and guidance; working with other regulators to ensure that guidance and advice is consistent and streamlined.

- Minimising costs of interventions: Regulators may intervene to conduct checks on businesses with a view to securing compliance, such as by inspection. The way interventions are conducted will influence the degree to which costs are incurred by the businesses. A regulator may, if appropriate, minimise costs by recognising where a business has established its own compliance system or participates in a wider compliance scheme and has regard to this in conducting its interventions; providing timely feedback on interventions; collaborating with others to improve efficiency and streamlining of interventions and minimise duplication.

Case Study Example: Health and Safety Executive: simplifying guidance for businesses

All reputable employers want to do their best to meet their health and safety obligations and protect their workers and members of the public. However, the volume of health and safety regulation has in the past led to confusion and uncertainty about responsibilities under the law, with a disproportionate effect on small businesses, which rarely have in-house health and safety advisers.

To make it easier for employers, the Health and Safety Executive redesigned part of its website to develop accessible, simple Health and Safety guidance. This approach is targeted at small and medium-sized employers in low-risk businesses and explains their basic health and safety duties in plain English.

The web pages cover a range of topics from appointing a competent health and safety advisor and writing a health and safety policy to completing risk assessments and obtaining Employees Liability Compulsory Insurance. It tells businesses what is needed and how they can approach compliance, signposting more detailed industry specific advice.

Driver 6: Trade

Increasing trade supports higher economic growth. Increasing exports expands production in our most competitive industries and products, which raises UK incomes. Shifting production to the most competitive areas of the economy helps raise the productivity of the average worker and through that the income they earn. With the ability to serve a global market, investment is encouraged in expanding export sectors and the rising scale of output helps lower average production costs. Higher imports increase consumer choice and help keep prices low, raising the purchasing power for consumers. Imports also provide high quality inputs for businesses helping companies become or remain highly competitive in both domestic and foreign markets.

Regulators can affect trade through their regulatory policy. Even where a regulator is ostensibly domestic, adopting a compatible approach to regulation as international counterparts could help encourage beneficial investment and competition from foreign-owned companies in the UK.

Where relevant, regulators should also consider the desirability of a coherent UK internal market for economic growth and seek regulatory policy that minimises any internal UK barriers.

Indicators that a regulator sets regulatory policy that supports trade may include:

- Designing or re-designing rules to match or be compatible to the rules of a counterpart regulator in a potential trade partner country.
- Designing or re-designing rules to adopt commonly used international approaches or international standards that will be easily recognised and readily understood by international businesses seeking to invest in the UK.
- Concluding Mutual Recognition Agreements with counterpart foreign regulators.

Driver 7: Environmental Sustainability

Natural capital and the ecosystems in which we live are fundamental to economic growth, and therefore need to be safeguarded for economic growth to be sustained. Environmental assets can help in managing risks to economic and social activity, and so valuing the condition of natural assets and resilience is a key factor in sustaining economic growth for the longer term. A resilient and prosperous society depends on the availability of natural resources and a healthy environment.

Government is committed to Net Zero and Environmental targets from the Climate Change Act 2008 and The Environment Act 2021. A credible policy path for a Net Zero transition is vital to reduce uncertainty and enable economic agents to react smoothly and appropriately[11]. Demand for environmental sustainability also has a key role in driving economic growth for green technologies.

Indicators of that a regulator sets a regulatory policy to support sustainable economic growth while continuing to consider environmental sustainability may include:

- Assessing the impact of environmental policies and plans on economic growth and how environmental commitments can be reached most efficiently to help identify improvements in processes, resource efficiencies and best practice.
- Setting sector-relevant incentives and advising on efficiency targets to reduce business costs.
- Reporting on the sustainability performance of industry for example investment in sustainable technologies and investing in research and development of resource-efficient products and processes.
- Enhancing capabilities and skills on sustainability within the regulatory environment to support sustainable economic growth and investment.
- Adopting policies that prioritise long term sustainable economic growth over short term activity that causes unacceptable environmental harm and may inhibit future economic growth.

[11] https://www.bankofengland.co.uk/quarterly-bulletin/2022/2022-q4/climate-change-possible-macroeconomic-implications

Behaviours of Smarter Regulation

Effective and consistent regulation is key for providing stable, transparent, and predictable regulatory environment for businesses and investors.

The best examples of effective decisions (e.g. licences approvals etc) come from those regulators that also take a positive approach to the way in which they regulate. A regulator is much more likely to set the right strategy, or make the right approval decision, if that regulator has a thorough understanding of its regulatory environment and a proactive attitude.

In terms of promoting economic growth, to support regulators understand and engage in their regulatory environment, this Guidance identifies 7 Behaviours of Smarter Regulation that relate to growth. A regulator that adopts the Behaviours will likely make better decisions, and importantly, will help to create a positive regulatory environment that creates the conditions for business confidence and investment, sensible risk-taking and innovation.

Regulators should be able to adopt the Behaviours set out below, although some Behaviours will be more relevant to certain regulators than to others. The Behaviours are broad to enable regulators demonstrate good practice against them. The Behaviours can have a collective and mutually reinforcing impacts on delivering growth. In many cases a regulator's approach that aims to improve one Behaviour may also improve another Behaviour directly or indirectly.

Regulators should have regard to medium and long-term growth by ensuring that they exhibit the Behaviours of Smarter Regulation, which may include but is not limited to the following:

1. Pro-Innovation
2. Skilled and Capable
3. Business Aware
4. Proportionate, Efficient and Responsive
5. Collaborative
6. Internationally Aware
7. Consistent, Transparent and Accountable

These Behaviours are not placed in any order of priority or preference.

Behaviour 1: Pro-Innovation

The importance of innovation, and the pivotal role of regulators in relation to innovation is outlined earlier in this Guidance.

Regulators can approach regulation in a pro-innovation manner by adopting anticipatory and agile governance for emerging technology or new disruptive business processes.

Indicators that a regulator is acting in a pro-innovation manner may include:

- Application – focusing on regulating the application of a technology rather than the technology itself.
- Engaging – at an early stage ('upstream') with innovators to understand the enablers of commercial success and the role of regulation.
- Collaboration – adopting collaborative approaches to overcome fragmentation of regulatory remits and provide guidance on issues that straddle different regulatory boundaries.
- Participating in cross-regulator and cross-government regulation innovation forums with a view to agreeing clear, straightforward guidance that meets the needs of businesses.
- Publishing clear, robust compliance guidance in emerging areas the regulator has evidenced that this is needed.
- Experimental approaches – demonstratable use of experimental approaches (e.g., through sandboxing, including multi-regulator sandboxes) to help position the UK as a 'first mover' in shaping the regulation or standards for early-stage technologies.
- Enacting policy changes as a result of findings from sandbox/innovation services.
- Other experimental approaches can include running an advice/guidance centre or innovation hub, horizon scans, published guidance on regulation to provide clarity where this is needed, roadmaps for the regulator's stages for emerging technologies, offering fast track approval pathways, or innovation

pathways, having an innovation executive committee as part of senior governance.

Case Study Example: Ofgem's Regulatory Sandbox helps innovators trial or bring to market new products, services, business models and methodologies without some of the usual rules applying.

London Power Networks plc/ Eastern Power Networks plc (LPN and EPN respectively) is trialling a new price discovery methodology for facilitating investment in on-street electric vehicle (EV) charge point infrastructure, where reinforcement costs may be a barrier to deployment. Funded through its Network Innovation Allowance, the trial will happen in Cambridge, Norwich and Redbridge and should enable higher EV take-up for those without access to off-street parking. The trial is currently underway, with the evaluation report due in May 2024. (Ofgem website)

Behaviour 2: Skilled and Capable

Regulators need to have an appropriate level of understanding of the business environment, of the role that regulation and the activities of regulators play in that environment, of their own business technical requirements, and of individual businesses that they regulate. This understanding will inform their approach when they exercise their regulatory functions, allowing them to discharge their responsibilities properly and effectively in respect of the Growth Duty.

Indicators may include:

- Incorporating an understanding of business into staff competency and development, recruitment, induction programmes, training, performance management, and the regular sharing of relevant information and good practices.
- Regulators placing greater importance on regulatory business environment knowledge, with officers being aware of the current economic, and overall economic social and technological factors in which businesses are operating, as well as awareness of the business life cycle and the key indicators to growth through training session.
- Encouraging officers to have an understanding of how a regulator's approach to delivering regulation, and the individual actions a regulator takes, impact on businesses generally, and on business growth, including both economic impacts and indirect impacts.
- Regular training sessions and reflections on how regulation impacts on growth in both positive and negative ways and can create a more dynamic business environment.
- Incorporating an understanding of business into recruitment considerations, induction programmes and early training
- Sharing business support mechanisms that are available, including online resources, sandboxes, innovation hubs and government initiatives to support businesses.
- Supporting improvements in business understanding through the provision of staff development and training.

Behaviour 3: Business Aware

Regulation is one of the many factors that shape the business environment. Regulators need to have understanding of the business environment, of the role that regulation and the activities of regulators play in that environment, of their own business community, and of individual businesses that they regulate.

It is important that regulators have awareness of current economic environment including social and technological factors likely to drive change and how regulation impacts growth. Regulators should also ensure a good understanding of how individual businesses achieve compliance and the reasons for these. This will enable them to regulate in a cost-effective way and understand what businesses needs from the regulator for example clarity and guidance.

Businesses are best placed to understand the sectors in which they operate. Businesses are constantly adjusting, innovating, and working to achieve their goals. This ensures that businesses have the most detailed and up to date understanding of the challenges to their sector. It is therefore essential for regulators to engage with businesses and stakeholders, to understand the challenges they are facing and to understand the opportunities which existing data does not demonstrate.

Indicators may include:

- Knowledge of how a regulator's approach to delivering regulation, and the individual actions that a regulator takes, impact on businesses generally, and on business growth; including both direct economic impacts and indirect impacts;
- Ongoing engagement with the business community to understand any economic impacts and perceived impacts of the regulator's current approach to delivering regulation; proposed changes to the regulator's approach;
- Providing mechanisms for businesses to easily provide feedback on their interactions with the regulator.[12]

[12] The Regulators' Code (provision 2) sets out specific provisions in relation to feedback and complaints.

Behaviour 4: Proportionate, Efficient and Responsive

The Better Regulation Framework (BRF) published in September 2023[13] provides the right system to ensure the future regulation of our changing economy is streamlined, recognises dynamic factors not just immediate compliance costs, and puts smart, forward-looking regulation at the heart of government decisions. Where an independent regulator makes its own Regulatory Provisions[14] it is recommended that the regulator follows the BRF where possible, whilst avoiding duplication when there is a separate process in place that considers better regulation issues. This section outlines how regulators could ensure a proportionate, efficient and responsive approach, in line with the BRF.

Regulators should consider the regular review and streamlining of their rules to ensure they are fit for purpose, responsive to emerging issues and an evolving regulatory environment. Regulators should seek to provide services in a way that meets identified business needs and maximises cost effective delivery. This involves assessing what the perceived regulatory barriers are at each stage of the product lifecycle and putting in place measures to minimise such burdens. When a regulator runs a quick process with minimal inputs and compliance burdens for a business, that frees up businesses to use the time and money they would otherwise spend with the regulator instead to put to more productive uses, leading to lower operating costs, driving profits and investments. With less time and money on regulatory compliance, businesses can redirect resources toward more productive activities such as innovation, expansion and job creation. Lower compliance costs can potentially lead to more competitive pricing and improved product or service quality, benefiting consumers and driving increased demand. Regulators should adopt an agile and flexible approach to reach pro economic outcomes. Regulators should consider the findings of the Cabinet Office public bodies review programme in their pursuit of efficiency, and the specific functions of the review of the cross-cutting functions and operation of spend controls.[15,16]

Section 108(2)(b) of the Act provides that in exercising a regulatory function[17], regulators must, in particular, consider the importance of ensuring any regulatory action is necessary and proportionate.

[13] https://www.gov.uk/government/publications/better-regulation-framework.
[14] The Better Regulation Framework applies to Regulatory Provisions as defined in Chapter 2.
[15] Guidance on the undertaking of Reviews of Public Bodies.
[16] Review of the cross-cutting functions and the operation of spend controls - GOV.UK (www.gov.uk)
[17] Regulatory functions subject to the Growth Duty are specified in the Economic Growth (Regulatory Functions) Order 2017 (S.I. 2017/267) as amended by the Economic Growth (Regulatory Functions) (Amendment) Order 2024 (S.I. XXX).

Regulatory action should be taken only when needed. Regulators have a range of interventions at their disposal when responding to non-compliance, from incentives and support compliance to those intended to tackle the most serious or persistent non-compliance. In some circumstances the matter may be referred to an organisation, such as another regulator, that is better suited to dealing with it. Enforcement action is sometimes necessary to protect human health or the environment, but certain enforcement actions, and other activities of the regulator, can be particularly damaging to the growth. These include, for example, enforcement actions that limit or prevent a business from operating; financial sanctions; and publicity, in relation to a compliance failure, that harms public confidence. Regulators should ensure enforcement policy sets out clearly the hierarchy of their enforcement actions and the factors that guide their use, so that their interventions are deployed in a proportionate manner on a day-to-day basis.

Indicators may include:

- Consideration of reviews to streamline, relax, revoke or remove rules.
- Consideration of steps to minimise the requirements, restrictions and conditions, and the frequency of changes to them, recognising that such changes incur costs for businesses.
- Offering streamlined decision making and approval processes with clearly defined published timelines.
- Ensuring understanding of the steps taken by the business to achieve regulatory compliance and any clear reasons for the failure.
- Willingness and ability of the business to address the non-compliance.
- Likely impact of the proposed intervention on the business, and the wider business community both in terms of remedying and deterring the non-compliance and in terms of economic costs and benefits to businesses.

Where a business fails to comply with regulatory requirements regulators may be able, to ensure that the costs associated with remedying the non-compliance are reduced to the minimum necessary.

Indicators of ensuring proportionate costs may include:

- The regulator discussing with the business the non-compliance and potential reasons for it, in order to be able to provide the best guidance and advice on sustainable solutions.

- The regulator considering the business' own approach to delivering compliance, including establishing whether this is based on advice or guidance that the business has received.
- The regulator explaining clearly to the business what compliance would look like in the business' context and acknowledges where there might be different ways of delivering compliance, recognising that these might incur different costs for the business.
- The regulator clearly explaining the potential consequences of non-compliance and reasonable timescales for remedy.
- The regulator communicating any decision to take enforcement action to the business clearly and promptly and provides a timely explanation of the business' right to appeal.

Regulators should ensure that enforcement action is always proportionate and considers the needs of businesses. In particular, businesses that are in the 'start-up' period, for example, require a specific style of intervention to enable them to meet the particular challenges that they experience in achieving compliance in all areas, whilst becoming established in their business. A regulator's response to identified non-compliance by start-up businesses should recognise these challenges.

This Guidance also sets out expectations in this important topic.

Time targets and fast-track service:

- Regulators are encouraged to consider the merits of setting targets (where permitted by law) on the length of time in which they expect to make a decision on business applications, for approval. These time targets are at the discretion of regulators and could be publicly communicated. Regulators could monitor and record their percentage delivery against these targets, and publicly report on these.

- In addition, regulators are encouraged to consider whether there would be merit in offering fast-track services for businesses that provide appropriate evidence of relevant approvals from regulators in other jurisdictions, where permitted by law. These fast-tracks would be delivered in such a way that does not lower performance against the time targets above.

- It is at the discretion of the regulator as to what constitutes the threshold for appropriate international evidence (as well as considering relevant legal requirements). As part of the process of considering whether they can offer fast-track services, regulators may want to take into account how they would finance these services including whether they have the necessary powers to charge.

- Where regulators have a range of time targets across different types of approvals, they should consider how best to measure overall performance. One option may be to also report a single summary measure, such as weighted average of performance against the individual targets.

The Productivity Lock:

- Regulators, like businesses, benefit from productivity growth in the UK at large; whether it be through innovation, adoption of new technological advancements, the use of RegTech, more efficient processes or increasingly skilled workers. The Productivity Lock sets an expectation (which regulators are encouraged to report against) that they should deliver year-on-year improvement in their productivity, for example through faster approval times or equivalent measures where the regulator can show that approval times would not be the best metric. Government's view is that regulators' productivity should increase in line with wider cross-economy productivity growth. In the same way that businesses deliver efficiency and productivity ever year, regulators should do also. The more productive and efficient regulators are by setting standards to do things at pace, the better it is for quicker regulatory decision making and, ultimately, for growth in their sectors and the whole economy.

- Regulators remain responsible for making good regulatory decisions informed by thorough and robust processes. Targets should be met by improving productivity and not by cutting corners.

- Approval times (or equivalent measures) are excluded from the expectation of year-on-year improvements in performance where Parliament (via statute or elsewhere) has set out timelines or similar that would prevent the approach.

Behaviour 5: Collaborative

Collaboration can help streamline the regulatory process, reducing the time and resources required for regulators to operate and for businesses to comply. By working together, different regulators can share information and avoid duplicating efforts, ensuring the process of regulation provides for an efficient use of resources.

Indicators might include:

- Knowledge of other national regulators that regulate the business community, particularly where these regulators may have complementary areas of responsibility.
- Knowledge of other public sector bodies that have a relevant monitoring role in respect of the business community.
- Working with other regulators to ensure that guidance and advice is consistent and streamlined.
- Involvement in Cross- Government forums.

Behaviour 6: Internationally Aware

International cooperation is a key to enhancing the quality and impact of domestic regulation. Collaboration with international governments, regulators and international organisations can help to identify opportunities to increase cross-border regulatory alignment when in the UK's interest. This can support the reduction of unnecessary non-tariff barriers for businesses, resulting in greater trade and investment, the sharing of ideas and fostering of technological innovation, helping to establish the right regulatory environment for UK businesses, alongside creating jobs and supporting economic growth.

The International Regulatory Cooperation (IRC) toolkit is aimed at both UK government officials and industry regulators who work on the design, monitoring, enforcement, and review of regulation.[18] It acts as a reference guide by providing a series of prompts to ensure a more systematic consideration of the international environment when working on regulation.

Indicators could include:

- Understanding of international best practice, this could include identifying successes in other jurisdictions for regulatory reform and innovation or looking at performance metrics.
- Aligning with and influencing regulatory standards and practices with international norms and standards wherever conducive to sustainable economic growth.
- Benchmarking regulatory processes, procedures and outcomes to other leading international regulators.
- Engage with international stakeholders, including industry experts, consumer advocates and international organisations to gather diverse perspectives and insight to drive growth and regulatory performance.
- Embrace technological advancements used by global regulators to enhance regulatory efficiency, such as data analytics, AI, and regulatory technology.
- Invest in training and development of regulatory officers to ensure they have the right skills and knowledge to excel in a global regulatory landscape.
- Regularly assess and prioritise emerging global risks and trends to proactively address potential challenges and opportunities.

[18] https://www.gov.uk/government/publications/international-regulatory-cooperation-toolkit

Behaviour 7: Consistent, Transparent and Accountable

Section 21 of the Legislative and Regulatory Reform Act 2006 states regulatory activities should be delivered out in a way which is transparent, accountable, proportionate, and consistent. The principles apply to regulatory functions specified in the Legislative and Regulatory Reform (Regulatory Functions) Order 2007 (as amended).

An appropriate level of consistency and predictability helps to sustain stability and confidence for investors and stakeholders. Consistency is especially important in regulatory decision making for complex judgements. Regulators should ensure they are transparent about how they have had regard to the desirability of promoting economic growth across their activities. This will ensure that those they regulate, government, and others with an interest in the regulation are able to hold the regulator accountable.

Indicators that a regulator is acting in a consistent, transparent and accountable manner may include:

- The regulator explains their approach to promoting economic growth, including in relation to promoting and supporting business innovation, and sets out what businesses and others can expect from them in relation to the Growth Duty.
- The regulator engages with their business community, consulting publicly where appropriate, on proposed changes to their policy or practices which may have a significant economic impact on businesses they regulate, and publishes the results of any consultations.
- The regulator publishes any assessments that they undertake the impacts that they have on their business community. For example, assessments of where and how their current approaches impact on their business community and the likely impacts of proposed changes to their approach
- Clear and consistent overall approach to regulating and intervention that is understood by stakeholders.
- A stable environment for investment and stakeholders that is reflected in plans and regulation.
- Rationale for changes are clearly and timely communicated when rapid changes have occurred.
- Consistent evaluation to ensure regulators are meeting their aims.

- Regulators are invited to incorporate information published to meet the provisions of this guidance into existing publications, such as their annual reports, service standards, and consultation responses. (See section on reporting on the Growth Duty).
- Good record keeping of their decisions and the reasons for them. In doing so, they should record where the duty to have regard to the desirability of economic growth and the provisions of this guidance were relevant to their decisions and where, having regard to all the circumstances, those matters were not relevant or were outweighed by other considerations.

Reporting on the Growth Duty

The Government has published this guidance under section 110(1) of the Act, and this statutory guidance sets a template for how regulators can help support economic growth.

Separately, the Government also wants to encourage regulators to report on actions that they have taken under the Growth Duty with sufficient due regard to the drivers of growth and behaviours that contribute to good decision making and in line with this guidance. However, this is on a voluntary basis. The reporting framework that regulators are encouraged to use does not form part of this statutory guidance, although it **will** build on the substance within this guidance. **The reporting framework will be published separately.**

Reporting pro-growth activities provides regulators with an opportunity to showcase and evidence pro-growth activity, providing accountability and transparency on activities to stakeholders.

The Civil Aviation Authority (CAA) have been voluntarily reporting on the Growth Duty since 2020 and provides a helpful case study on the approach to reporting.

Case Study Example: The Civil Aviation Authority (CAA)

"The CAA enacts the Growth Duty in the context of its wider 'Better Regulation' approach ensuring that its regulatory decisions demonstrate transparently how the CAA has had regard to economic growth. Safety and security remain the CAA's primary duties and the Growth Duty is considered alongside other duties not instead or at the expense of other protections. The Growth Duty also informs the design and delivery of our corporate Strategy as well as our Regulatory Principles"

The Growth Duty is seen as a route to demonstrate the CAA's impact on the economy. The regulator started reporting against the Growth Duty from 2020, and reporting was accompanied by a regulatory approach programme.

The CAA has taken a varied approach to reporting: In 2021 and 2022, reporting was published as part of their Annual Report and included in report annexes. In 2023, the CAA published a stand-alone report, to increase accessibility and transparency.

Reporting is largely qualitative, and structured around the CAA's self-defined Impact Categories:

- Reduction in cost or effort: A reduction in cost or effort for organisations/individuals

- Reduction of a barrier to entry: A reduction of a barrier to entry for organisations/individuals

- Increase in agility/flexibility of regulation: An increase in agility/flexibility of regulation

- Supporting innovation or investment: Supporting innovation or

- Other benefit: Other (impact is described under the ‘benefit’ heading)

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December 2024

Overview of Thames Water's PR24 final determination

Ofwat

Overview of Thames Water's PR24 final determination

Introduction

We regulate the water and wastewater sector to achieve the right outcomes for customers and the environment. One of the ways we do this is by carrying out a price review. Through a price review, we enable the companies in the sector to make the investment needed to meet their obligations and achieve great outcomes for customers and the environment now and in the future. This price review, which covers 2025-30, will see the largest investment in the sector of any five-year period since privatisation. Much of this investment is necessary to meet environmental and quality requirements.

To help identify what improvements and investments it needs to undertake, in October 2023 Thames Water published its business plan for 2025-30. It then updated its plan in April 2024 to ensure that the plan included expenditure for all statutory investment. Customers and stakeholders were able to challenge and shape this plan, including through the 'Your water, your say' open sessions held in the summer and autumn of 2023. We then published our draft decision in July 2024 and invited companies, customers and stakeholders to give us their views. We considered all of this feedback when working towards our final decisions.

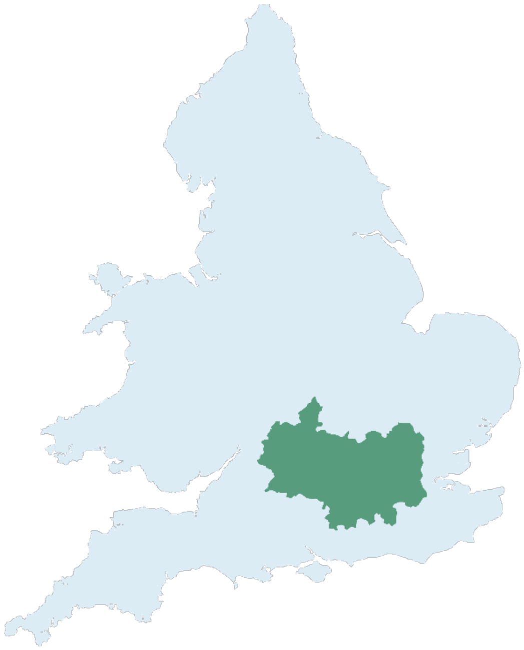
Since receiving company responses to our draft decisions, we have scrutinised all of the proposed costs so that customers do not pay more than is necessary for the service they receive and are not charged twice for work which should have already been delivered. One of the ways we do this is to compare the company's proposals to the cost of work previously done, and the costs that other companies forecast for similar work. This can show whether a company can deliver the same for less, without customers suffering a lower quality service. We have also aligned the interests of the company's investors with customers, by ensuring the returns that investors earn reflect the performance delivered for customers and the environment.

Our final decision provides the means for Thames Water to deliver the investment that is required. We have incentivised it to go beyond its targets to achieve even better outcomes for customers and the environment. We will hold the company to account to deliver these improvements for customers and the environment. Working with other regulators, like the Environment Agency and the Drinking Water Inspectorate, we will monitor its progress in meeting its obligations, and we will not hesitate to act if it falls short.

We set out our decisions for all water companies in England and Wales in our sector summary.

Unless stated otherwise, where this document talks about the company's performance targets for the 2025-30 period we quote the change between the baseline for 2024-25 and the comparable performance target we are setting for 2029-30.

Summary



The improvements we expect Thames Water to deliver for customers and the environment

At present, Thames Water's performance is average compared to most other companies in the sector, meeting targets for six of the twelve key performance indicators.[1] In addition, it has only achieved two out of four stars in its environmental performance assessment for 2023-24.[2] In our 2023-24 Monitoring financial resilience report, we categorised Thames Water as 'action required'. The company and the group have a challenging financial position that must be addressed through performance turnaround and strengthening of the balance sheet.[3] We have generally set more stretching performance targets than the company proposed for it to achieve in the period 2025-30.

Under our final decision, we require Thames Water to deliver a significantly improved level of service for customers and the environment, and we make significant interventions to Thames Water's proposals as the information it provided did not meet our standards.

Improving the environment	Protecting our water supply
Over 2025-30, we expect Thames Water to deliver a 29% reduction in spills from storm overflows and reduce pollution incidents by 30%. We also expect it to invest £1.2 billion to prevent harmful nutrients polluting rivers.	Over 2025-30, Thames Water should deliver a 22% reduction in leakage by investing £161 million. We also expect it to deliver a 3% reduction in both household and business use. The company has a number of major projects designed to increase the amount of water available to customers, in response to climate change and population growth.
Improving service to customers	**Maintaining asset health and resilience**
Over 2025-30, Thames Water should deliver a 68% reduction in water supply interruptions from its 2020-24 performance level. We also expect it to reduce internal sewer flooding by 24%. We allow the company to invest £273 million to improve the quality of water before it is treated, and to remove lead pipes.	Over 2025-30, we expect Thames Water to deliver a 5% reduction in the need to repair bursts on its mains. In addition, we have allowed £1.25 billion for Thames Water to improve the health of its assets. We have put in place strong customer protection around this investment and Thames Water will need to pass

[1] Ofwat, 'Water company performance report 2023-24,' October 2024.
[2] Environment Agency, 'Water and sewerage companies in England: environmental performance report 2023', July 2024.
[3] Ofwat, 'Monitoring Financial Resilience report 2023-24', November 2024.

	through a series of stages set by us for the investment to be approved.

Overall, to deliver its performance commitments and legal obligations, our final decision provides Thames Water with a total expenditure allowance **of £20.5 billion over the 2025-30 period.** This is **£8.4 billion** more than the company was provided with in the current price control period (2020-25). We consider that Thames Water can deliver its performance commitments and obligations for less cost than it requested, and our allowances are **£4 billion (16%)** lower than the company's response to our draft decision.

Key changes from our draft decision

Significant changes from the draft decision for Thames Water are:

- Our allowance for day-to-day expenditure is **increased by £996 million to £12.3 billion**. This increase is largely due to:
    - updates to our allowances for energy costs and business rates, which will be adjusted at the end of the price control period to reflect actual changes in prices;
    - additional allowances to facilitate growth through the network reinforcement sector-wide cost adjustment; and
    - our decision to accept the company's proposal to include Beckton Sludge Powered Generator replacement in the large scheme gated process.
- We **increase our allowance to £474 million[4] for Thames Water to continue to develop strategic resource options**. These include a project designed to increase the amount of water available in a drought by creating an interconnector between the rivers Severn and Thames. Another project is the South-east strategic reservoir option (SESRO) which is planned to supply customers of Thames Water, as well as other companies based in the south-east of England.
- We **have increased the amount allowed for Thames Water to reduce phosphorus levels** in rivers, a key issue in the drive to improve river health. In our draft decision we allowed £968 million, we are allowing £1.2 billion in our final decision.
- We have decided that our **categorisation of Thames Water's 2025-30 plan in our quality and ambition assessment (QAA) remains 'inadequate'**. Our final decision provides the company with an opportunity to earn its QAA penalty back as part of arrangements for 2030-2035 if it demonstrates sufficient improvement during the 2025-30 price control period.

We set out these improvements and investments in later sections below.

[4] Thames Water have asked for an uncertainty mechanism to fund a further £364 million of land a delivery costs across their portfolio.

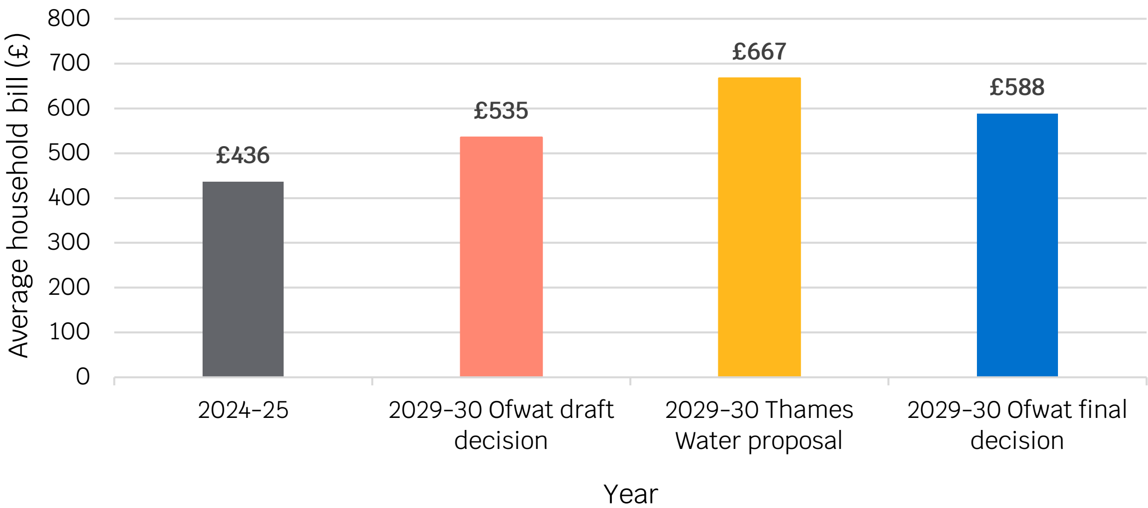
What our final decision means for customers' bills

The costs of the investment that Thames Water makes are recovered from customer bills over the long-term (extending beyond the 2025-30 period). Our aim is to ensure the recovery of investment over a time period that broadly aligns with the benefits that customers receive from that investment. Because we spread the recovery of these costs over the long-term, companies must first finance their planned expenditure by attracting investment from both debt and equity providers.

In return, our final decision **allows Thames Water to collect £16.4 billion through bills** from both households and businesses over the 2025-30 period. This will recover a share of the cost of historical expenditure, as well as a portion of the £20.5 billion expenditure planned for 2025-30.

Overall, this will **increase average household bills by £152** from 2024-2025 to 2029-30 for Thames Water customers, before inflation.[5] This includes an average rise of £108 between 2024-25 and 2025-26. Because of our challenge on Thames Water's costs and the speed that revenue is recovered from customers, average bills will be lower than those proposed by Thames Water in response to our draft decision (see Figure 1.1).

Figure 1.1 Average household bills for Thames Water, 2024-25 and 2029-30, before inflation[6]



We will continue to hold Thames Water to account against its targets for improved service for customers and the environment and expect it to report on its performance every year. If the company does not deliver the expected outputs and outcomes, this will be reflected in lower bills for customers. Where it delivers a better level of performance, it will

[5] Our decision is for the revenue companies can collect through bills, not the average bills per customer – the latter is a forecast.
[6] As set out in the delivery mechanism section the average bill information and amount Thames Water can collect through bills in this section excludes the schemes within the delivery mechanism.

be allowed to collect more from customers, to reflect the additional benefits to customers it has created.

£20.5 billion

Total expenditure allowance for 2025-30

Our final decision for Thames Water

Our final decisions recognise the need for all companies to improve performance. We are committing Thames Water to deliver **significant improvements on current performance for a range of measures** that matter to customers and the environment. In some areas, we have challenged the company to deliver more stretching improvements than it proposed. This document sets out over the next sections some of the key improvements we expect.

We set Thames Water a total expenditure allowance **of £20.5 billion** in the 2025-30 period. This is £4.0 billion lower than Thames Water asked for in its response to our draft decision. However, it is significantly more than Thames Water's allowance for 2020-25, which was £12 billion. The increased allowance reflects a step change in size of the water industry national environment programme, expenditure on water supply/ demand balance, water quality, increased resilience, improved asset health, investment to facilitate population growth and new housing, and improved services to customers.

The total expenditure allowances includes £12.3 billion for Thames Water to run the business from day-to-day, operating and maintaining the company's assets (also known as base expenditure allowances). It also includes £8.2 billion to allow Thames Water to deliver the enhancement schemes it proposed in its plan. These include:

- £784 million to **reduce the number of spills from storm overflows**;
- £485 million to **improve the resilience of the water network** so that fewer customers are supplied by a single source of water, and water can be moved around the system more efficiently in times of low rainfall; and
- £161 million to **reduce leakage**. Thames Water will use operational measures, such as pressure management and active leakage control, as well as increasing mains renewals to drive down leakage.

This expenditure is not just about the next five years. We have required companies to position their near-term plans in the context of a 25-year delivery strategy. This gives us confidence that the company is thinking strategically about its future challenges, and that its PR24 business plan is an important step towards achieving essential outcomes in the longer-term.

In our last Monitoring financial resilience report we made it clear that Thames Water has significant issues to address in strengthening its financial resilience. We have been clear that safeguards are in place to ensure that services to customers are protected regardless of issues faced by shareholders of Thames Water. The focus of the price review is putting customers and the environment at the heart of the sector – that does not change for Thames Water. It is important that the sector attracts new investment to fund the improvements that customers rightly expect. We expect equity investors in Thames Water to provide significant investment to support the programme of work for 2025-30, consistent with our expectations for other companies. Our final decision will enable Thames Water to attract the borrowing and equity it needs to deliver a step up in performance, but we will make sure that investors can only earn high returns from great performance in delivering for customers and the environment (see A fair return for investors).

In our draft decision we set out that Thames Water should fall within the scope of our turnaround oversight regime given the significant operational and financial resilience challenges the company faces. Since then, we have appointed an independent Monitor to monitor and review Thames Water's compliance with undertakings accepted by Ofwat in relation to the loss of the company's credit ratings.[7] These undertakings address steps required by the company to restore its credit ratings, and among other things, the Monitor will oversee Thames Water's progress in the turnaround as part of delivery of its business plan.

As well as the closer monitoring of Thames Water's progress against its plan, we are adding additional protections for customers at this price review, which we introduced in our draft decision.

Delivery mechanism

One of the ways we are protecting customers from non-delivery of improvements is by implementing a delivery mechanism. This is because Thames Water has had significant issues in the delivery of its 2020-25 programme, and it has not been able to provide us with assurance that it can deliver everything required in the period 2025-30.

In our final decision, we are increasing the amount we include in the delivery mechanism from £944 million in our draft decision to £1.22 billion. This is for improvements to storm overflows, phosphorus removal from wastewater that enters rivers and Industrial Emissions Directive expenditure.

The company is required to share its plans for delivery in the period 2025-30 with us before we allow it to make the associated adjustment to customer bills. This way we can have greater oversight of the company's ability to deliver to ensure that customers get the right outcomes for the money. The company continues to be responsible for ensuring that it complies with all its legal obligations and the mechanism does not impact our ability to take enforcement action where necessary.

Unless stated otherwise, where this document discusses expenditure allowances, these include schemes within the delivery mechanism. When referring to how much money Thames Water can collect from customer bills in this document, we exclude the value of the schemes included in the delivery mechanism.

[7] Ofwat, 'Undertakings-for-the-purpose-of-Section-19-of-the-Water-Industry-Act-1991-1.pdf' August 2024.

Asset improvement

In our draft decision we introduced an arrangement that will increase our monitoring and challenge to Thames Water's management of its asset improvement programme. This recognises the need to improve confidence that expenditure on the asset improvement programme is incurred efficiently and targeted at delivering asset improvements that will benefit customers in the long term. It includes requirements for Thames Water to provide us with additional scrutiny provided by an independent third-party assurance provider.

We are increasing the asset improvement allowance from £1 billion in our draft decision to £1.25 billion in our final decision. This allows for additional progress to be made on the wastewater service. The company has already started on the first stages of the planning for this work. For avoidance of doubt, any improvements required to address current non-compliance against existing permits must be addressed by the company, and we will not allow customers to pay for this.

Contingent allowances

We are making expenditure allowances for large and complex schemes contingent on more detailed cost information being provided by the company in the 2025-30 period. Costs are currently uncertain. So, providing allowances now may lead to customers overpaying.

Nonetheless, we have provided development cost allowances to allow the companies to conduct pre-construction work, for example, detailed scheme design. We will also be engaging constructively with the company after our final decision to help ensure timely delivery of these large complex schemes.

In addition to the above schemes, Thames Water also proposed some major water projects within its plan. For major projects over £200 million in whole life total expenditure, our approach requires companies to put large infrastructure projects out to competitive tender where the proposed infrastructure is discrete and separable from the company's network. We consider that development of major infrastructure by competitively appointed third parties is expected to achieve significant benefits for customers. These benefits include both innovation and potentially lower whole life costs of the project while maintaining quality.

Those major projects which are suitable for competitive delivery will be delivered by a competitively appointed third party under either Ofwat's Direct Procurement for Customers (DPC) model or under Specified Infrastructure Projects regulations (SIPR). We set allowances in the price review for the efficient costs related to the company's pre-construction development of these projects, which comprise the project development costs and the cost of developing the project for competitive delivery. We explain our major projects process and full list of projects in more detail in 'Major projects development and delivery', including our reasons where we have not accepted a project or the company's proposed development costs.

Following our scrutiny of its proposed costs, we are allowing Thames Water £474million[8] to progress development of these projects. These include:

- **South East Strategic Resource Option (SESRO):** Thames Water will need to increase the amount of water it supplies to its area to make sure that supply keeps up with population growth and climate change. SESRO is planned to supply customers of Thames Water, Southern Water and Affinity Water in periods of low flow on the River Thames. The companies have proposed to deliver the project under the SIPR model. The total allowance for 2025-30 for developing this project is £316 million. The estimated whole life cost of delivering the project is £7.5 billion.
- **London water recycling**: This project includes Teddington direct river abstraction which will allow water to be abstracted from the River Thames upstream of Teddington Weir and transferred along a section of new connecting pipeline to an existing underground tunnel that flows into reservoirs. The total allowance for 2025-30 is £31 million, with a further construction allowance of £108 million to deliver the project in house. The estimated whole life cost of the scheme is £989 million. It also includes Beckton water recycling which will transfer and discharge recycled water into the River Lee diversion above the inlet for King George V Reservoir to supplement the raw water supply to the Lee Valley reservoirs, through two tunnels. The 2025-30 costs are £37 million and the estimated whole life cost is £3.5 billion.
- **Lower Thames West London Reservoir**: Thames Water is investigating whether this project can be delivered under the DPC model. It incorporates the Surbiton to Queen Mary Transfer, which is now the company's preferred option (in our draft decision this was the Teddington to Queen Mary Transfer). This project will allow water to flow from a new abstraction point on the lower River Thames to the Queen Mary Reservoir. The total allowance for 2025-30 for developing this project is £64 million. The estimated whole life cost of delivering the project is £1.7 billion; and
- **Severn to Thames Transfer**: This DPC project is designed to increase the amount of water available during times of drought. This will happen by way of an interconnector planned between the rivers Severn and Thames. This is a joint project with Severn Trent Water and United Utilities. The total allowance for 2025-30 for developing this project is £26 million. The estimated whole life cost of delivering the project is £4.3 billion.

We also accept Thames Water's **bespoke performance commitment** proposal to incentivise the company to deliver streetworks interventions collaboratively through a 'Dig-Once' approach to investment in London. The measure brings significant additional benefits to customers by reducing the overall number of days of disruption compared to the works being delivered in isolation.

Our final decision will enable Thames Water to attract the borrowing and equity it needs to deliver a step up in performance, but we will make sure that **investors can only earn high**

[8] Thames Water have asked for an uncertainty mechanism to fund a further £363.97 million of land a delivery costs across their portfolio.

returns from great performance in delivering for customers and the environment (see A fair return for investors).

Improving the environment

We expect Thames Water to deliver significantly better outcomes for our natural environment in the coming years and to meet its legal obligations: we want lower pollution, healthier rivers and waterways, and the company to do its bit to combat the effects of climate change. Compared to the last price review, we are setting a much broader range of commitments to protect and improve the environment. These line up with a number of long-term targets set by governments, such as achieving UK Government's interim and final net zero emission targets by 2050.

Reducing storm overflow spills	Reducing phosphorus	Reducing pollution incidents	Reducing green-house gas emissions
29%[9]	**15%**	**30%**	**5%**

Even when heavily diluted, untreated wastewater may damage the environment and increases risk to human health. It is therefore important that Thames Water protects and improves the environment. As such, we expect Thames Water to **reduce the use of storm overflows** by at least 29% by 2029-30, down to an average of 14.2 spills per overflow. The average number of spills per overflow in 2023 was 30 for Thames Water.[10] The reduction in spills will help to improve river quality, protect public health, and increase people's enjoyment of the environment.

We know that excessive levels of nutrients are pollutants, which can lead to the smothering of river beds and are the most common reason why rivers do not achieve the Environment Agency's grading of 'good ecological status' in England. Our final decision also includes a non-financial target for Thames Water to **reduce the amount of phosphorus** entering rivers from water company activities by 15%.

For the first time, we are setting companies a **sector-wide target to conserve and enhance biodiversity**. This measure will monitor the number and range of species and living organisms in water company regions. The more habitable an ecosystem, the more life it can support. We are challenging Thames Water's proposals by **setting a more stretching target** to improve water bodies by **reducing pollution incidents by 30%.** As Thames Water

[9] This is calculated based on average spills per overflow per year and we compare to 2025-26 rather than 2024-25 for storm overflows because this represents calendar year 2025 reporting which aligns with our PR24 methodology target of 20 average spills per overflow per year and aligns with the UK government targets in the Storm Overflow Discharge Reduction Plan (SODRP).

[10] Average spills per overflow numbers presented are adjusted where necessary to represent our view of spills assuming 100% monitoring of overflows.

has underperformed in this area it needs to improve by 42% compared to its 2023-24 performance.[11]

We also expect the company to play its part in meeting net zero by 2050, although we recognise that the scale of construction demanded by the 2025-30 investment programme it will carry out will increase emissions without mitigating action from the company. We are setting a target Thames Water to **reduce its operational greenhouse gas emissions** by 5% overall.

Reducing use of storm overflows	Preventing nutrient pollution
£784 million	**£1.2 billion**

To help meet these targets, Thames Water will undertake a significant investment programme to improve the environment over the 2025-30 period, worth **£2.5 billion**. It includes:

- **£784 million to reduce the use of storm overflows.** Improvement actions include increasing treatment capacity at sewage works, providing storage for high flows, reducing flows entering the system and provision of treatment for storm overflows which are separate from the main treatment route.
- **£1.2 billion to prevent nutrient pollution.** Thames Water will act to remove harmful pollutants entering rivers by removing them from treated wastewater.

Through the price review, we have challenged the efficiency of Thames Water's proposed spending. This means we expect Thames Water to deliver all the schemes it proposed within its water industry national environment programme to the same scale and standard, but for £491 million less than it put forward, reducing the impact on customers' bills.

[11] Ofwat, 'Water company performance report 2023-24,' October 2024.

Protecting our water supply

With the pressures of climate change, it's more important than ever to protect our water supplies. Customers rightly question why hosepipe bans are needed when leakage is high. We need water companies to help reduce water use where possible, and to secure new supplies where necessary.

Reducing leakage	Reducing household water use	Reducing business water use	Metering
22%	**3%**	**3%**	**£281 million**

Under our final decisions, Thames Water has several commitments to reduce demand for water. We expect the company to **reduce leakage** by 22%, **household water use** by 3%, and **business water use** by 3% in the 2025-30 period.

Leakage is an important issue for customers. Thames Water proposed to reduce leakage by 22% by 2029-30 and we accept this as an appropriately challenging target in our final decision. Thames Water has not achieved our targets in the last two years for leakage, and as a result it has returned money to customers through lower bills. We are allowing Thames Water £161 million expenditure to reduce leakage by 2029-30, but if it does not meet its annual targets it will continue to incur financial penalties.

Thames Water will invest £281 million in metering to help customers save water and contribute towards protecting the region from drought.

We are allowing Thames Water to develop schemes that improve resilience of the water supply, these are listed in the 'Our final decision for Thames Water' section of this document.

Improving service to customers

We expect water companies to deliver excellent service to their customers. Even the best in the water industry have room for improvement when we look across to some other sectors of the economy.

We therefore want to mark a step change in the standard of customer service that water companies offer, both through this price review and through the new enforceable customer-focused condition that we introduced into all companies' licences in February 2024.[12]

Reducing water supply interruptions	Cutting contacts about water quality	Reducing internal sewer flooding
Same target as current period	**24%**	**24%**

We recognise that Thames Water's current performance overall across customer service metrics is not as good as it should be, and we push it to improve over the next price control period.

We propose sector-wide **improvements in the duration of interruptions to customers' water supply**. The current duration of interruptions to supply is 15 minutes and 23 seconds per property (average performance during 2020-24). We are setting a target of 5 minutes in our final decision which is an improvement of 68%.

We expect Thames Water to ensure its customers enjoy high-quality water and for it to learn lessons from its recent performance. We set targets, measured by the Drinking Water Inspectorate (DWI), that incentivise full compliance with statutory obligations on drinking water quality and to limit and resolve any failures effectively. This means serious failures will result in penalties. As compliance is a minimum expectation, companies will not be rewarded for achieving it.

We also set targets on the number of customer contacts the company receives on taste, odour and appearance of the water it provides. We want it to manage and operate its network to minimise issues of taste, odour and appearance to **reduce the number of contacts it receives from customers about water quality by 24%**.

We know that sewer flooding is one of the worst failures customers can experience – so we expect continued and significant reductions. This includes a sector-wide target for **internal**

[12] Ofwat, 'Customer-focused licence condition - Ofwat', February 2024.

sewer flooding, which is a 24% reduction for the company from its target in 2024-25. We also expect Thames Water to reduce its levels of external sewer flooding by 19%.

Over 2025-30, we will also increase financial incentives for Thames Water to deliver a step change in customer service, through our **measures of customer experience**. These rank water companies based on how they perform in customer satisfaction surveys – including how they compare to companies elsewhere in the economy.

Improving quality of drinking water	Shareholder contributions to customers struggling to pay
£273 million	**£8.4 million**

We expect Thames Water to deliver most of these improvements using its day-to-day expenditure allowance. The company **proposed an additional £273 million to improve the quality of drinking water**. This includes putting in place measures to prevent a deterioration in the quality of raw water (water before it starts the treatment process) and replacing lead pipes within the company's network. We allow this expenditure in our final decision to protect and improve the quality of water for consumers.

Water companies have arrangements in place to support customers that might be struggling to pay their bills. This is called a social tariff, and it helps to reduce the bill for these customers. Thames Water plans to increase social tariff provision from 5% of households in 2020-25 to 9% in 2025-30. Thames Water has committed to a shareholder contribution of £8.4 million; most of this money is for matching payments which are made by customers repaying debts. Companies should ensure that schemes that support customers struggling to pay are well funded. We will hold Thames Water to account for these contributions through our monitoring and reporting, and through the customer-focused licence condition.[13]

[13] Ofwat, 'Customer-focused licence condition - Ofwat', February 2024.

Maintaining asset health and resilience

It is crucial that a water company maintains and improves the health of its assets; namely, its pipes, sewers, treatment works and other infrastructure. This includes responsibly managing them day to day, as well as managing the impact of events such as adverse weather and cyberattacks. There is also an expectation that companies plan for future growth in demand which may be due to factors such as an increase in population, or the development of new or expanding businesses.

Reducing the need to repair water main bursts	Reducing number of sewer collapses	Increasing resilience of assets
5%	**11%**	**£1.0 billion**

Under our final decision, Thames Water is expected to **reduce the need to repair bursts on its water mains** by 5% from the 2024-25 baseline performance level. This target incentivises the company to be proactive, responsibly maintaining and improving its water network, therefore reducing the need for reactive repairs.

Thames Water has a commitment to reduce the **number of sewer collapses by 11%** from the 2024-25 baseline performance level. Sewer collapses may happen as a result of blockages, deterioration of pipes or soil movement.[14]

We task Thames Water with **investing £1.1 billion to increase the resilience of its assets.** This investment will protect against the impact of power failures and support protecting its sites from extreme flooding. This includes an allowance to improve security and cyber security resilience.[15]

[14] Percentage reductions in asset health performance commitments are based on reduction from our assumed 2024-25 baseline to the PR24 2029-30 PCL level. As targets are based on average performance levels companies may have outperformed these levels in previous years.
[15] 'The Security and Emergency Measures Direction 2022', February 2022.

A fair return for investors

4.03%
Allowed return on capital

Our final decisions seek to align the interests of companies and investors with those of customers by setting a balanced package of risk and return. Our final decisions provide sufficient revenue for Thames Water, if efficient, to finance its functions.

Investment in long-life assets benefits customers and the environment over the long-term. Therefore, each generation of customers that benefit from the investment should make a fair contribution through their bills to the efficient costs. To spread the costs over the long-term, these investments must be financed by debt and equity investors. The sector needs to remain attractive to investors if companies are to raise finance at efficient cost, and investors expect to earn a return that reflects the risks of their investment.

We have provided guidance that a dividend yield of 4% is reasonable for a company that is performing in line with our decisions and where the company has adequate levels of financial resilience. Shareholders should only expect to earn a higher return where a company delivers great performance, and shareholder returns will be lower where a company's performance falls short.

We set an **allowed return on capital** as part of our revenue allowances that we consider fairly remunerates investors for the risks they face and to support companies to raise the funding needed to deliver the investment programme. Setting the allowed return at the right level is important. If it is too high, customers will pay more than is fair and if it is too low, investors may not be willing to provide additional funding to finance the investment needed to provide a high-quality service and to protect the environment. Our final decision sets the allowed return on capital for the whole business at **4.03%.** This is higher than the allowed return that was set in our draft decisions, primarily reflecting an update for more recent market data.

Our final decision also determines **the time period over which we allow Thames Water to recover allowed costs from its customers**. Our aim is that the costs of investment are shared fairly between current and future customers in a way that broadly aligns with the period over which customers benefit from that investment. If the costs are recouped too quickly, current customers would end up paying more than their fair share. If it is too slow, companies may struggle to finance their activities now, and the share of costs paid by future generations may be higher than it should be.

We have applied Thames Water's proposal about the speed at which it recovers costs over time, which we consider is a fair recovery of costs from customers now and in the future.

Our final decisions will support efficient companies to raise the finance necessary to deliver the investment requirements and meet their obligations in 2025-30 and beyond. However, each water company has some discretion to make decisions about its financing and capital structure arrangements. It is Thames Water's responsibility to maintain adequate levels of financial resilience if it is to continue to raise the capital, on reasonable terms, that is necessary to support the investment programme.

Thames Water's business plan stated a target credit rating of Baa1 for the actual capital structure which is in line with the notional target set in our determination. The business plan proposed a total equity injection of £3.3 billion by 2030, a dividend yield of 0% and gearing of 70.4% in 2030.

The final decision provides Thames Water with certainty about the package that will apply for the 2025-30 period which will support it to address known issues about its financial resilience under its actual structure. The company remains a priority for our ongoing monitoring and engagement on its financial resilience.

The company has proposed changes to the dividend policy in its business plan in response to challenges we made in our draft decision. It remains the company's responsibility to reflect these changes in its policy and to ensure dividend payments made in the 2025-30 period meet the requirements of its licence.

Thames Water's proposed policy for executive pay does not meet all of our minimum expectations because it does not explain how the remuneration committee will consider overall performance delivered for customers and the environment, in addition to performance against specific metrics. We expect the company to address this issue ahead of the policy being implemented from 2025 onwards.

Water companies are accountable for their actions, and **we review all executive director bonus payments each year**. If Thames Water's decisions on performance related executive pay do not meet our expectations on a wide range of criteria, including substantial alignment to environmental performance and delivery for customers, we will step in to ensure that customers do not pick up the bill.[16]

[16] Ofwat, 'Protecting-customer-interest-on-performance-related-executive-pay-–-recovery-mechanism-guidance.pdf (ofwat.gov.uk), June 2023.

Our assessment of the quality and ambition of Thames Water's business plan

Outstanding	Standard	Standard (intervention)	Conditions met at FD	Inadequate
Categorisation of the business plan				

Given the challenges facing the sector, companies will need to strive to transform their performance. That is why we incentivised each company to give us a good quality and ambitious plan that demonstrated how it will meet these challenges, the levels of performance it will deliver and the associated costs. We assessed these plans against our minimum expectations at our draft decisions and against other companies' plan to identify those that show levels of ambition that help to push the whole sector forward. We also identified where a company's plan hadn't been prepared to the level of quality we require.

On assessing the quality and ambition of the 2025-30 business plan that Thames Water submitted to us in October 2023, **overall, we categorised the plan as inadequate.** We set a number of conditions for Thames Water to meet before we made our final decision. Whilst Thames Water has made progress since our draft decision, we have material outstanding concerns in multiple areas. To reflect this, and in recognition of the significance of our concerns, we have decided that Thames Water's plan should remain in the inadequate category. As a result, we will apply the full penalty that we set out in our draft decision. This includes a financial adjustment equivalent to -30 basis points (£141 million) and a 60:40 cost sharing rate on base expenditure. This means that Thames Water will bear 60% of the cost of any overspend and customers will benefit from any underspend by 60%.

However, we are applying this penalty on a provisional basis and are providing the company with an opportunity to earn this penalty back at the next price control period if it demonstrates sufficient improvement during 2025-30.

More information can be found in the 'Quality and ambition assessment summary' document.

Responses and views on the draft decision

All companies were invited to provide responses and raise points where their views differed to those within our draft decisions by 28 August 2024. More detail about the issues raised in the response made by the company and our consideration of those issues can be found elsewhere in this document, the technical appendices and other documents published alongside our final decisions. Table 2.1 highlights the key points made by Thames Water in its response together with any further submissions after that date and a summary of our reply to each of those points.

Table 2.1: Company response

Key points in Thames Water's response	Summary of our reply to the points raised
Thames Water argues that its historic funding has been insufficient to cover costs, resulting in a £2.5bn wholesale total overspend in the previous three price control periods. It states that our expectation of what base buys is disproportionate to the allowance.	We do not agree that Thames Water has been underfunded in previous price controls. Between 2015-20 we provided the company with more than it requested on total expenditure allowances. In the 2020-25 price control period we provided the company with more on base expenditure. For total expenditure at this price review, we are allowing £8.8 billion more than at 2015-20, and this includes £1.25 billion to improve assets.
Thames Water stated a concern that total expenditure does not include contingent allowances. This is where we allow expenditure, but only let the company include it in bills when we have reviewed in more detail the specific plan for the projects being funded. For Thames Water this means that there was £800 million not in bills in our draft decision which impacts the company balance sheet, as they will face a revenue shortfall when the spend is incurred.	We have increased our base allowances by £1 billion which will help the company with cashflow. The company will be able to recover additional revenue from customers during the control period if the relevant conditions are met.
Thames Water considered in its response to our draft decision that we should take account of actual performance this period to set glide-paths to improvement to 2030. It states our proposed potential penalties are excessive, and it proposed measures to cap potential rewards and penalties.	We have adjusted baselines to align more closely with recent company performance and moved away from using targets from this price control period as default. This will benefit Thames Water as it has performed particularly poorly on some performance commitments, for example internal sewer flooding. With the additional funding of £1.25 billion for Thames Water through the asset

	improvement programme, this is an opportunity for the company to catch-up in areas where it is behind other companies, most notably in the wastewater service.
The company accepted the need for enhanced oversight as we set out in the draft decision but stated that there should be a 'tuning down' of losses and rewards that new investors face. This includes introducing an efficiency glide path to efficient costs by 2030 and increasing the use of gated processes where we have rejected schemes we consider are not fully justified. It also put forward other measures to limit the company's exposure to penalties such as limiting the threshold for the aggregate sharing mechanism for both costs and outcomes to 100 basis points.	We do not agree that a dialling down of the incentive package is necessary as it would ultimately alter the risk and return balance in favour of investors, meaning that customers bear greater risk, and impact the extent to which customers bear the costs of company failures.
Thames Water stated an allowed return of 4.6% is necessary for it to be considered financeable and investible, we set an allowed return of 3.72% in our draft decision.	We are not convinced that the evidence provided by the company supports a view that an allowed return of 4.6% best balances the interests of customers and investors over the long-term. Our final decision allowed return of 4.03% includes an allowed return on equity that is at the upper end of our assessed range and is supported by evidence from our economic and academic consultants.
Thames Water stated its concern that it could not agree with our view of the allowed return in our draft decision, and therefore would not be able to change the quality and ambition assessment of 'inadequate'.	Our QAA assessment was not limited to the view of the allowed return. On balance, our view is that the areas where we have outstanding material concerns, including the evidence provided for the company's cost proposals and its financial resilience, are significant enough to warrant that we keep its plan in the inadequate category.
Thames Water included in its response to our draft decision a request to include an option to reopen the price review process in case of a company suffering severe financial distress.	We consider that the company did not put forward a convincing case that its proposed reopener was in the best interests of customers or the long-term stability and predictability of the regulatory regime.

We also invited other stakeholders to provide responses to our draft decisions either as a direct response to the draft decision or following on from the Ofwat 'Your water, your say' sessions held on 23 and 24 July 2024. We received a range of responses from individuals and organisations. Where these responses are directly relevant to Thames Water, they are summarised in table 2.2, which also includes our reply to those responses.

Table 2.2: Stakeholder responses

Stakeholder responses	Summary of our reply to points raised
Upper Coln Restoration Group states that there has been an exponential increase in spills from Andoversford sewage treatment works, and expresses concern on the impact on the River Coln. It wants infrastructure upgrades at the sewage treatment works. Bibury trout farm expressed concern about the lack of proposals to remedy breaches at Andoversford STW, and the impact on its trout business.	On the river Coln, there is a storm overflow scheme at Andoversford sewage treatment works. We are allowing more money than we would normally allow for this project in recognition that it is on the list of schemes where the company is proposing green, sustainable solutions. We are also allowing funding for population growth at Andoversford Sewage treatment works in our final decision, which we did not accept in our draft decision. This should allow the company to address any performance issues at the works.
Chedworth Parish Council expressed concern about sewage spillages in the River Coln, and the need for urgent work to be carried our on Andoversford sewage treatment works.	
Withington Parish Council wrote to us about sewage spills in the River Coln and the impact on local wildlife. It urges action on Andoversford sewage treatment works, including infrastructure upgrade and an investigation on surface water ingress.	
An individual wrote in reporting possible illegal sewage discharge from Andoversford sewage works. They have concerns over river water quality and the impacts it is having on the environment and wants a call to action for the water company to clean up.	
An individual wanted to draw our attention to the condition of the River Coln, highlighting possible spillages from Andoversford and Fairford. They want the company to commit to investment at Andoversford.	
An individual has concerns over water pollution into the River Coln, and notably spillages from the Andoversford Sewage treatments work. They want to ensure that the company makes mandatory investment into this site as part of the 2025/30 business plan.	

Cotswolds Rivers Trust state that there are numerous Thames Water planned works from AMP7 that have been delayed or pushed back and asks how we will ensure that the funding for these delayed projects will not be reallocated or diverted from other critical areas. The Trust is concerned about the completion of key works in the upper Thames area that remain outstanding under the current price control period, which include essential upgrades at Witney, Bourton-on-the-Water, and Fairford.	Thames Water requested more expenditure for some schemes allowed at the previous price review. We only accept additional allowances where the company has provided evidence that schemes need to change to account for population growth, or a change in the scope of the project. We have allowed some additional expenditure for these reasons in our final decision. We consider that Thames Water is sufficiently funded to deliver these schemes in full, and should not delay implementation further.
Deputy Mayor Environment and Energy is supportive of the increase in investment but is mindful that bills should be kept fair and affordable, including for future customers. They add that targets should be stretching but affordable.	Bills will increase in the 2025-30 period to deliver the improvements customers want, however the delivery mechanism and gated allowances give greater control allowing heightened scrutiny on delivery and protection for customers. Our final decision allowance for Thames Water is 70% greater than at PR19. In return, we are setting stretching PCLs in areas of importance to stakeholders, including leakage, supply interruptions, storm overflows and pollution incidents. On executive pay, we currently have a consultation open on how we introduce the new rules on remuneration and governance provided for in the Water (Special Measures) Bill. Currently Thames Water is subject to measures that prohibit it from paying dividends without our consent. We also announced on 21 November that Thames Water would be prevented from paying £770,000 in bonuses to its CEO and CFO with customer money under our new rules on executive bonuses.
Chair of the Environment Committee, London Assembly, highlights the need for ambitious plans to reduce leakage, protect London's customers from excessive price increases and prevent pollution incidents in London.	
MP for Reading West and Mid Berkshire expressed concerns about the level of pollution and its impact on the environment, leakage levels, water supply interruptions and Thames Water's asset health and resilience.	
London Assembly, Liberal Democrat group strongly supports limits on price rises in the draft determination, the cost of improvements should not be carried by customers. It adds that Ofwat should be replaced by a body with more powers and funding. It raises concerns about the level of executive pay in the context of poor performance.	
SOLAR outlines concerns about Thames Water, in particular the Teddington Direct River Extraction, which it says is poor value for money and damaging to the environment.	The Environment Agency is a statutory consultee and will ensure that development complies with environmental requirements. Projects such as the Teddington Direct River Extraction scheme are

An individual focuses on supply enhancement funding for Teddington Direct River Abstraction (TDRA) scheme. One key issue raised was on the funding process for this scheme and transparency in decision making with RAPID, WRMP and Ofwat while listing questions and arguments for this scheme.	necessary to secure the supply of water against the pressures of climate change and population growth.
OXWED LLP concerned over delays to Oxford sewage treatment works and the impact on development of brownfield land.	Given the increase in scale of the Oxford sewage treatment works scheme for 2025-30 compared to work already planned in 2020-25, we make an allowance for elements of the scheme that have not been covered in 2020-25 expenditure allowance or where there is overlap with other allowed expenditure in the 2025-30 period.
Oxford University & Colleges Group (Oxford Growth Group) wants the FD to allow for prompt delivery of Oxford sewage treatment works, as delays risk delays in development in and around Oxford.	
An individual writes to us to report on concerns she has regarding a local sewage treatment works in Oxfordshire and the unpleasant odour for the last 2 years.	
Water resources South East expresses concerns about the significant cost reductions in the Thames Water draft decision and wants more money available for strategic resource options and demand reduction.	Our final decision is overall £3.6 billion greater than our draft decision. Thames Water has four strategic resource options included in the final decision as direct procurement for customers (DPC) projects see earlier in this document. We expect Thames Water to reduce both household and business demand in 2025-30, and we allow £281 million for the company to spend on smart metering to help reduce consumption.
The Test & Itchen Association Ltd – concerns that financial penalties are being taken from the companies and the environment suffers, and that nature-based solutions are not being funded. Also should be more investment in chemicals removal.	We allow companies to charge their customers for the work they need to deliver. If they do not deliver improvements or specific schemes then the companies must return money back to customers in the form of lower bills. In our final decision we have allowed a total of £20.5 billion for Thames Water, that is £8.4 billion more than for 2020-25. On chemicals removal, we allow £1.2 billion in our final decision.
Thames Water customer challenge group states that the CCG could help to inform the appointed Monitor of the needs of customers, particularly those that are vulnerable. They welcome the increased emphasis on customers and the environment, and states the need for a fair balance between risk and reward.	On risk and reward, we have made a number of changes from draft to final decision, these are set out in, 'A fair return for investors' earlier in this document.

<table>
<tr><td>An individual states they want Ofwat to focus on customer support, highlighting their concerns on investigations, investment in infrastructure, deep dive on how Ofwat operate and the nationalisation of water companies and the benefits of not having privatisation.</td><td rowspan="3">On executive pay, we currently have a consultation open on how we introduce the new rules on remuneration and governance provided for in the Water (Special Measures) Bill. Currently Thames Water is subject to measures that prohibit it from paying dividends without our consent. We also announced on 21 November that Thames Water would be prevented from paying £770,000 in bonuses to its CEO and CFO with customer money under our new rules on executive bonuses.</td></tr>
<tr><td>An individual has concerns regarding prices rises in line with investment plans and the companies' shareholders.</td></tr>
<tr><td>An individual raises issues with infrastructure improvements, shareholders, salaries/dividends and transparency around private contractors and value for money.</td></tr>
<tr><td>An individual lists issues regarding implementation of innovations in sewage treatment, including: Implementation after trials, worries of missed opportunities because of perceived company culture, management of technological innovations, framework agreements and mandatory reporting.</td><td>We promote innovation in the water sector with our Innovation Fund, which is a competition with £200 million available for projects that grow the sector's capacity to innovate.</td></tr>
</table>

Ofwat (The Water Services Regulation Authority) is a non-ministerial government department. We regulate the water sector in England and Wales.

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OGL

December 2024

PR24 final determinations

Expenditure allowances – enhancement cost modelling appendix

Ofwat

PR24 final determinations: Expenditure allowances – Enhancement cost modelling appendix

Summary

This document presents further detail on the econometric cost models we have used to help set efficient enhancement expenditure allowances for our PR24 final determinations. It focuses on granular scheme-level enhancement econometric cost models we have developed to assess a subset of enhancement areas.

Enhancement expenditure is generally where there is a permanent increase or step change in the current level of service to a new 'base' level and / or the provision to new customers of the current service level. Enhancement funding can be for environmental improvements required to meet new statutory obligations, improving service quality and resilience, and providing new solutions for water provision in drought conditions.

The 2024 price review (PR24) has seen a significant increase in the scope of enhancement expenditure activities compared to PR19. This includes an increase in investment to improve the environment from the Water Industry National Environmental Programme (WINEP) for England and the National Environmental Programme (NEP) for Wales, particularly in relation to water companies' wastewater activities.

The increase in scope of the enhancement programme at PR24 prompted us to reconsider our enhancement cost assessment approach. Where possible, we have developed scheme level benchmarking models to assess enhancement expenditure. Benchmarking is important as it helps to address the information asymmetry between us and water companies. Scheme level models use data on cost and cost drivers for individual sewage treatment works, water treatment works and other water company assets. They help to alleviate disadvantages of company level models, including sample size and transparency of allowances for each enhancement scheme. They also better reflect the mix of schemes being taken forward by companies.

We aimed to develop scheme level models for enhancement areas where:

- we have granular scheme level data that capture the key cost drivers;
- activities are comparable across companies; and
- there is a sufficiently large sample of schemes to support robust modelling.

This led us to develop scheme level models using a consistent model development and selection framework for the following enhancement areas:

- storm overflows;
- phosphorus removal;
- growth at sewage treatment works (STWs);
- bioresources industrial emissions directive (IED);
- sanitary parameters; and

- supply interconnectors.

This document also discusses two water enhancement areas where we used company level econometric models to help set efficient expenditure allowances at PR24 draft determinations: metering and lead communication pipe replacement.

Stakeholders generally supported scheme level models as an improvement compared to company level models. However, they proposed some changes to the models and requested to take greater account of scheme specific circumstances. In response to stakeholder views, we tested different parameters in our models and make changes where appropriate. We also introduce the concept of engineering outliers where we provide an uplift to reflect unique scheme specific characteristics.

Storm overflows

Companies requested storm overflows enhancement expenditure of £12 billion, which is primarily driven by WINEP requirements and Defra's Storm Overflows Discharge Reduction Plan (SODRP) in England, and NEP requirements in Wales. Storm overflows is by far the largest enhancement expenditure area in PR24.

We set allowances for three separate categories of expenditure:

- **modelled schemes** – we use the outputs of econometric models to set allowances for three types of schemes (storage at the network, storage at STWs and flow to full treatment (FFT) schemes);
- **deep dive schemes** – we undertake deep dives for schemes less suited to scheme level modelling including Cook's distance outliers and engineering outliers; and
- **unmodelled schemes** – we undertake a more aggregate efficiency assessment of expenditure not suited to modelling such as green only schemes, screen only schemes and wetlands.

For modelled schemes, we assessed the efficient costs of storage using a mix of grey and grey-green hybrid schemes. We do this separately for network and STW schemes because the cost of storage at STWs tends to be lower. We also identify and model FFT schemes separately. These schemes have different characteristics compared to storage schemes as they represent additional capacity. Cost drivers reflect engineering judgement of the key drivers of cost.

Volume of equivalent storage is the only explanatory variable included in our scheme level storm overflow models. It captures the volume of spill which needs to be stored and managed to mitigate storm overflow discharges to meet the target spill frequencies.

Capacity increase (litres / second) is the only explanatory variable included in our scheme level flow to full treatment models. It captures the additional hydraulic capacity added at the network or STWs to avoid sewage spills to the environment either through additional treatment capacity or the ability to drain down larger storm tanks in between storm events.

Since draft determinations, we collected historical scheme level data on cost and cost drivers in relation to the delivery of storage schemes in the 2015-2020 and 2020-25 periods and FFT schemes in the 2020-25 period. This provides additional outturn cost evidence to complement the use of forecast data in our modelling approach. That helps to address the risk of over-reliance on forecast data which could be subject to forecasting uncertainty and information asymmetry.

For network storage and FFT schemes we use scheme level models using forecast and historical data to set efficient storm overflows enhancement allowances. We assign equal weights to two historical and two forecast models (a log and a levels specification for each dataset). We do not apply an additional efficiency challenge since we view more efficient historical delivery imposes an efficiency challenge.

For storage at STW schemes we use forecast models only with a log functional form. We found that historical data provides a very stringent efficiency challenge to companies potentially driven by a systematically larger size of schemes at STWs in PR24. We set a median efficiency challenge using forecast data only. We identify hybrid storage storm overflow schemes with high cost gaps and a significant proportion of the storage delivered through green solutions as engineering outliers. We also treat some schemes with evidence of engineering construction challenges as engineering outliers.

Phosphorus removal

Companies requested £5.8 billion to enhance phosphorus removal, based on requirements set out in WINEP / NEP. This is almost double the amount we allowed at PR19 for companies to enhance phosphorus removal.

We assess the efficient costs of conventional phosphorus removal schemes using scheme level cross-sectional econometric models.[1] Since draft determinations we introduce a different approach for some phosphorus removal schemes. We model transfer schemes separately. We remove schemes with enhanced permits >= 2mg/l from the sample as "optimisation schemes" as unrepresentative of a typical PR24 scheme that tightens P permit to below 0.5mg/l. Finally, we identify schemes tight phosphorus permits <0.25mg/l and schemes with a biological treatment component as engineering outliers. We provide an additional adjustment for these engineering outlier schemes to reflect their higher efficient costs.

[1] Please see Annex A1 for an overview on how we assessed other phosphorus removal enhancement schemes, including nature-based solutions, catchment nutrient balancing and catchment permitting.

We triangulate across four scheme level phosphorus removal models. Two models are estimated using forecast data, and two models are estimated using historical data. The models capture the following key cost drivers:

- **Population equivalent (PE) served** captures the size of the STWs receiving phosphorus removal upgrades.
- **Enhanced phosphorus permit** captures treatment complexity and provides the best indication of the nature of upgrades that companies need to undertake.
- **Historical phosphorus permit** captures the extent of pre-existing phosphorus removal processes at each STW prior to implementation of enhanced phosphorus permits. Sites with a pre-existing permit should generally incur a lower upgrade cost.
- **Enhanced phosphorus permit squared** to capture a continuous non-linear relationship between the enhanced phosphorus permit and the upgrade cost. This recognises the higher costs associated with more stringent phosphorus permits. This driver is included in two out of four models.
- **Technically achievable limit (TAL)** dummy variable indicates schemes where the phosphorus permit is <= 0.25mg/l. It aims to capture a discrete step change in costs at the level of the TAL permit (<= 0.25mg/l). This driver is included in two out of four models.

We consider both the historical and forecast models provide important information on the efficient cost of delivering PR24 phosphorus removal upgrades. So we apply equal weight to each model. We apply a catch-up efficiency challenge based on the average efficient company. We do not apply a more stringent catch-up efficiency challenge as we consider the use of historical models leads to a sufficiently stretching but achievable cost challenge.

Growth at sewage treatment works

Companies requested around £2.4 billion for upgrading sewage treatment works to accommodate population growth in the catchment area (ie growth at sewage treatment works).

At PR19, we assessed growth at STWs expenditure as part of base costs. In July 2022, we commissioned Arup to assess if is appropriate and feasible to assess growth at STWs expenditure separately from base costs. Arup concluded it was appropriate and feasible to separately assess growth at STWs, and recommended the use of a company level econometric model with cumulative spend over a long time period to smooth the discrete and lumpy nature of investment.[2] The recommended model included the change in PE served by STWs and treatment intensity. Some companies were critical of Arup's approach because capacity headroom was not captured.

We collected data on each proposed PR24 growth scheme to address this concern. This included data on expected change in PE, process capacity added and the impact of the

[2] Arup, 'Assessment of growth-related costs at PR24', May 2022.

scheme on permit levels at each STWs - dry weather flow (DWF), flow-to-full (FFT) treatment, biological oxygen demand, phosphorus, and ammonia permits.

Using this forecast data, we triangulate equally between log and levels cross-sectional scheme level econometric models to help set efficient growth at STWs enhancement expenditure allowances, which include the following cost drivers:

- **Process capacity added to meet current and expected quality permits** describes the increase in treatment capacity for the relevant scheme to accommodate the increased PE flow and load received at the STW. It measures the output that will be delivered.
- **Expected change in DWF permit**, which is likely to increase as a result of population growth. DWF permit changes impacts growth at STWs costs in two ways:
    - **Increase in hydraulic capacity at the STW** to meet the new FFT permit. DWF permit increases are associated with proportional increases in the permitted FFT level to maintain a suitable FFT / DWF ratio.
    - **Potential increase in secondary biological treatment capacity or tertiary treatment capacity** due to pro-rata tightening of sanitary parameters and / or nutrient permit limits so that the water quality of the receiving watercourse does not deteriorate.

- **Ammonia permit <3mg/l dummy variable** to capture if the new ammonia permit level required due to the change in the DWF permit is expected to be below 3mg/l.

We applied a catch-up efficiency challenge based on the average efficient company.

Our PR24 approach to introduce forward-looking scheme level enhancement modelling for growth at STW enhancement expenditure promotes companies to undertake a more proactive assessment of future growth needs.

Our approach also protects customers from paying twice, by removing expenditure that overlaps with the expectations of base expenditure, such as compliance with existing permits and claws back funding where companies have under-spent growth at STW allowances in the 2015-20 and 2020-25 periods.

Bioresources industrial emissions directive (IED)

Wastewater companies are required to obtain installation permits and expected to bring their applicable biological sludge treatment sites up to the standard required by IED and the Best Available Techniques (BAT) reference document for Waste Treatment (the BREF).[3] Companies requested £1.5 billion enhancement investment to achieve compliance with IED.

[3] Best Available Techniques (BAT) Reference Document for Waste Treatment Industrial Emissions Directive 2010/75/EU

We collected scheme level data on cost and cost drivers for all company sludge treatment centres subject to IED. We use a hybrid approach to set efficient enhancement expenditure allowances for IED compliance:

- scheme level econometric modelling for secondary containment and tank covering costs; and
- we apply the company level modelled efficiency of secondary containment and tank covering to other IED costs.

Our cost assessment uses the following key cost drivers:

- **Bund wall surface area, the product of wall length and height** to explain differences in the scale of secondary containment costs between companies. Larger wall surface area, that prevents spillage issues from digesters and sludge holding tanks, results in higher secondary containment costs.
- **Volume of bund** to explain differences in the scale of secondary containment costs between companies. Higher design volume of the enclosed area needing containment results in higher secondary containment costs. The volume captures the aggregate bunding activity required in terms of impermeable surface area and bund wall surface area.
- **Surface area of tank covers** to explain differences in tank covering costs between companies. Higher area coverage for open sludge tanks to reduce fugitive emissions results in higher tank covering costs.

We applied an upper quartile catch-up efficiency benchmark to set secondary containment and a median benchmark to set tank covering efficient expenditure allowances. We apply the company level modelled efficiency of secondary containment and tank covering to other IED costs.

Sanitary parameters

Companies requested £1.8 billion to remove sanitary determinands, compared to an allowance of £336 million at PR19.[4]

The removal of sanitary determinands is required under the WINEP / NEP to reduce or maintain the levels entering surface waters. Sanitary determinands permits included in the WINEP / NEP are either for ammonia or biochemical oxygen demand (BOD).

We use a scheme level model and a company level model with equal triangulation weights to set efficient sanitary parameters enhancement allowances at PR24. The models use PE served as the key cost driver to capture the size of each scheme (scheme level model) and

[4] This excludes any investment proposed under the nature-based solutions or catchment permitting cost lines for sanitary determinands.

the overall programme size (company level model). Our approach recognises the benefit of triangulating across a wide range of models. We apply a median efficiency challenge.

Since draft determinations we introduce a different approach for some sanitary parameters schemes. We model transfer schemes separately. We remove schemes with a solution type of "no additional treatment capacity" from the sample as "optimisation schemes". Finally, we identify schemes with tight ammonia permits <=1mg/l and BOD <=7mg/l as engineering outliers. Therefore, we provide an additional adjustment for these schemes.

Supply interconnectors

Companies requested over £1 billion to build supply interconnectors, which is double the allowed expenditure for interconnectors at PR19.

We use two scheme level cross-sectional econometric models to help set efficient supply interconnector expenditure allowances at PR24 draft determinations. We estimated one model using historical data, and the other using forecast data. Both models are estimated using a log-log functional form as the estimated intercept in the linear model produced an estimate of fixed costs that was not plausible. The models included the following cost drivers:

- Length (km) – we expect costs to increase with the length of the interconnector.
- Benefit (Ml/d) captures the additional water available for use the interconnector will deliver to address the supply and demand balance.

We place equal weight on each model. We applied a catch-up efficiency challenge based on the average efficient company.

We apply a post modelling adjustment to uplift allowances to account for length of crossings. We do this for those companies which length of crossings as percentage of pipeline length is above the average across the data. We also apply a post modelling adjustment for Anglian Water's Grafham interconnector to account for the type of pipe material used and the mid-transfer treatment element of the scheme.

Metering

Companies requested £1.7 billion in PR24 business plans to install 2.7 million smart meters and deliver 7.6 million meter technological upgrades.

Water resource management plans (WRMPs) define the scale of metering activities in companies business plans. Metering allows companies to reduce water consumption and support the supply-demand balance by helping to deliver reductions in per capita consumption and leakage.

Before assessing efficient expenditure, we exclude expenditure associated with like-for-like replacements to prevent customers paying twice as these activities are funded through base expenditure allowances.

We triangulate between a company level econometric panel data model and industry median unit cost to set efficient metering enhancement expenditure allowances.[5] We apply equal weight to the industry median unit cost and the econometric model. We use separate models for new meter installations and meter upgrades because unit costs differ between these two activities. We use the number of new meter installations and population density to explain differences in the scale of efficient new meter installation costs between companies; and the number of meter upgrades to explain differences in the scale of efficient meter upgrade costs between companies.

We use a log-log functional form to assess the relationship between cost drivers and costs. We apply a catch-up efficiency challenge based on the average efficient company.

Lead communication pipe replacement

Companies requested £270 million to replace or reline lead communication pipes.

We set efficient enhancement expenditure allowances for the replacement or relining of lead communication pipes by triangulating between a panel data econometric model and the industry median unit cost. We use the quantity of lead communication pipes replaced or relined to explain differences in efficient expenditure between companies. Both in the econometric model, and to calculate unit costs.

We apply equal weight to the industry median unit cost and the econometric model.

We apply a median catch-up efficiency benchmark on top of the average efficiency challenge implied by the triangulation between the cost model results and the median unit cost.

Further details on enhancement cost assessment

In Annex A1, we set out brief descriptions on how we have assessed all other wastewater and water enhancement areas.

[5] The exception is Thames Water bulk metering programme, which we assessed with a deep dive assessment.

Contents

1. Our approach to enhancement cost modelling

We set enhancement cost allowances so that companies have efficient allowances to complete the work they need to over the next price control period and that they retain incentives to manage long-term costs and outcomes effectively.

Our approach to assessing costs has evolved since PR19 due to more granular information. But, at its core it remains the same: when assessing costs we select the right tool for the job, whether that be cross sector benchmarking, benchmarking to historical information or in-house engineering assessment (or 'deep dives').

The most significant development since PR19 is the development of a suite of benchmarking models exploiting individual scheme level datasets. These datasets were released and consulted on as part of draft determinations. In the rest of this section, we explain why we have developed these models, before going on to set out the areas we have modelled and the data we have used.

1.1 Why are we using scheme level data at PR24?

The PR24 price review has seen a significant increase in the scope of quality enhancement expenditure activities compared to PR19. This includes additional investments to improve the environment as included in the Water Industry National Environmental Programme (WINEP) for England and the National Environmental Programme (NEP) for Wales, particularly in relation to water companies' wastewater activities.

In PR19, we generally benchmarked enhancement costs at the company level using business plan forecasts. The PR19 enhancement benchmarking models generally included one observation per company, with forecast costs summed over the 2020-21 to 2024-25 period to reflect that yearly enhancement costs do not always align well with the outputs delivered. This approach can assess relative efficiency at the company level, but it has some drawbacks:

- it cannot assess cost efficiency at the scheme level, which makes it challenging to identify allowances for individual enhancement schemes;
- it does not reflect scheme specific differences in company submissions;
- it only uses a small sample, which can affect model precision and lead to outputs being sensitive to changes in the underlying sample; and
- it generally relies on business plan cost forecasts, which may not be a good reflection of actual cost efficiency.

The increase in scope of the enhancement programme at PR24 prompted us to reconsider the most appropriate cost assessment approach. Where possible, we have developed scheme level benchmarking models to assess enhancement expenditure. In the PR19 redeterminations, the Competition and Markets Authority (CMA) highlighted that scheme level enhancement models can be an alternative to company level enhancement models.[6] Scheme level models use data on cost and cost drivers for individual sewage treatment works, water treatment works and other water company assets. They help to alleviate some of the disadvantages of company level models, including sample size and transparency of allowances for each enhancement scheme. The latter helps us to set Price Control Deliverables (PCDs) to track delivery and claw back allowances for any undelivered schemes if required.

1.2 What enhancement areas does scheme level modelling cover and why?

We focused scheme level modelling on enhancement areas that are most suitable for granular econometric modelling. These are enhancement areas where:

- we have granular scheme level data that can capture the core drivers of cost supported by strong underlying economic and engineering rationale;
- the activities are comparable across companies; and
- there is a sufficiently large sample of schemes to support robust modelling.

This led us to consider scheme level models for the following enhancement areas[7]:

- storm overflows;
- phosphorus removal;
- growth at Sewage Treatment Works (STWs);
- bioresources industrial emissions directive (IED);
- supply interconnectors; and
- sanitary parameters.

We developed the scheme level econometric benchmarking models using a consistent model development and selection framework, which we summarise in section 2. Sections 3-8 set out the detailed modelling approach we follow for each area.

The main focus of this document is to set out our scheme level approach to econometric modelling in final determinations after considering stakeholder views. However, we also discuss two material water enhancement areas where we use company level econometric modelling to assess efficient costs:

[6] Competition and Markets Authority, 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: final report', March 2021, p. 413.
[7] We also use some scheme level modelling in the raw water deterioration enhancement area which are outside of the scope of this appendix. Please see 'PR24 draft determinations: Expenditure allowances' for more detail.

- metering (section 9); and
- lead (section 10).

Both areas are large population models as they benefit from a large number of discrete schemes, which allows us to develop more robust company level econometric models using annual data.

There are other scheme level and company level models in the PR24 final determinations but these are simpler. The focus of this appendix is on the more complex econometric models with the highest requested cost.

In Annex A1, we set out brief descriptions on how we have assessed all other enhancement areas for completeness.

1.3 What data sources did we use?

We used several different sources of scheme level cost and cost driver data to develop our scheme level enhancement models in draft determinations:

- **historical scheme level data from Annual Performance Reports (APRs)** – we used historical data in reported annual performance report (APR) tables 7F (phosphorus removal) and 6F (supply interconnectors);
- **forecast scheme level data from PR24 business plan data tables (BPTs)** – we used forecast data submitted in response to Information Notice IN23/05 for storm overflows, business plan Table CWW19 for phosphorus and business plan Table CW8 for supply interconnectors;
- **data requests issued under the PR24 queries process** – we collected scheme level data on growth at STWs, PR24 sanitary parameters schemes and PR19 outturn storm overflows schemes using the PR24 queries process; and
- **bespoke data requests** – we issued a data request on IED cost and cost drivers in August 2023. We reissued an updated IED data request in autumn 2023. Companies updated their submissions in December 2023.

We transposed the data requests issued under the PR24 queries process and the bespoke IED data request into standalone business plan tables under the additional business plan tables (ADD). Therefore, we received updated data for all scheme level areas in company representations to our draft determinations. We used these datasets to develop our final determinations scheme level enhancement models.

We have queried companies extensively to improve data quality and the robustness of our econometric models. One of the key challenges we faced was around the evolving PR24 WINEP / NEP programmes for the sector, especially for wastewater. That resulted in further updates compared to the scope included in draft determinations to reflect the most recent WINEP / NEP programme agreed with the Environment Agency / Natural Resources Wales. All figures in this document are in 2022-23 prices and on a pre frontier shift and real price effects basis.

2. Our approach to model development and selection

2.1 Approach to model development

We followed a systematic approach to develop the PR24 scheme level econometric models.

Firstly, we collected the necessary data to help us undertake our assessment, as discussed in section 1.3 above.

Secondly, we prepared the datasets for modelling. We created datasets that include yearly cost and cost driver data reported in company submissions. For example, phosphorus PR24 forecasts include data from 2024-25 to "After 2029-30" (labelled as 2030-31 in the dataset), a total of seven observations for each scheme. The "After 2029-30" year is included in most of the datasets we use for our scheme level modelling (excluding IED). The last year captures capex (capital expenditure) incurred in the next price control period and a full year equivalent for opex (operating expenditure).

We aggregated costs and cost drivers over the entire PR24 price control period to align costs and outputs for each scheme. Using this data, we estimated cross-sectional PR24 scheme level econometric models with one observation per scheme. Unlike company level econometric models, companies are not equally represented in the scheme level models as some companies will have more enhancement schemes than others.

The cost drivers included in our selected scheme level enhancement models are underpinned by a clear engineering and economic rationale. As a minimum, they capture volume / size of the scheme. Data permitting, we also consider additional cost drivers such as treatment complexity and economies of scale. Sections 3-8 set out the cost drivers we used for each scheme level enhancement area.

The rest of this section covers the model estimation approach and functional form, treatment of outlier schemes, model selection process and our overall approach to setting the efficiency benchmark.

2.2 Model estimation method

What we said in our draft determinations

We used ordinary least squares (OLS) to estimate our cross-sectional scheme level enhancement econometric models and random effects models for the large population econometric models of metering (section 9) and lead (section 10).

Stakeholders' representations

Companies broadly supported the use of OLS to estimate scheme level enhancement models as a transparent and well understood approach used across all enhancement areas.

Anglian Water argued we should consider random effects for the scheme level models, with updated data, in its representation and that we should update our approach if this leads to material improvements to model performance.

United Utilities supported using random effects to account for the company-specific factors associated with each company. It argued that several of the scheme level models failed the Breusch-Pagan LM statistical test which shows that random effects would be more appropriate than pooled OLS. As a minimum, it said it expects us to use clustered robust standard errors to account for intra-company effects. Thames Water also supported accounting for company effects in the scheme level models.

Severn Trent Water agrees with OLS in principle. However, it proposes we use weighted least squares models as a superior estimator as it allows all companies to have the same influence over the model. The company also suggested that stochastic frontier models may also be considered but said it had mixed success with these models in the time it had available to respond.

Our assessment and reasons

Following our assessment at final determinations, we use OLS to estimate our scheme level enhancement econometric models. We use random effects models for the large population econometric models of metering (section 9) and lead (section 10) to recognise the panel dimension of these datasets.

We considered using random effects in the scheme level models by specifying each company group across which random effects are drawn.[8] Schemes belonging to the same company are not necessarily independent from one another. OLS does not recognise this and treats each observation as being independent.

However, consistent with draft determinations, we decided not to use random effects estimation as it did not appear to materially improve the precision of model estimation results. In addition, using random effects estimation introduces additional implementation issues related to applying our preferred PR19 log bias adjustment approach in areas where we use log models (see section 2.4). In particular, since random effects models do not adjust to set the industry allowance equal to industry request as OLS models do when using a levels specification, the PR19 log bias adjustment cannot be applied directly.

We did not implement weighted least squares models. Weighted least squares assigns an equal weight to each company by changing the weight of each scheme in the modelling. Our

[8] In practice this means setting the company as the cross-sectional identifier, and the scheme as the 'time' dimension, in statistical software.

focus in setting scheme level allowances is to model efficient allowances for an average scheme. Every scheme has its own unique characteristics that we want to take into account when estimating efficient allowances. We do not consider it is appropriate to give schemes different weights depending on the size of the programme of the underlying company.

We use regular standard errors when estimating the PR24 scheme level econometric models. We also considered alternative standard errors as a sensitivity to check if our model selection would have been different, for example clustered standard errors and heteroskedasticity-robust standard errors.

2.3 Outlier treatment and deep dive process

What we said in our draft determinations

Outlier schemes that appear to be much more efficient or inefficient compared to the average scheme could adversely influence the modelled outcome of our scheme level enhancement models.

To address this concern, we identified potential outliers using the Cook's distance statistic, which is commonly used in econometrics literature.[9] We dropped all observations with a Cook's distance metric that is higher than a threshold of four divided by the number of observations of the relevant model (4 / N) from the econometric models.

For 'efficient' outliers (those with requested costs less than the model suggests) we provided an allowance equal to the company request. For outliers indicated as 'inefficient' (requested cost greater than modelled) we provided a challenge based on our engineering 'deep dive' assessment. This led to providing a percentage of the cost gap from 0% (retain modelled) to 100% (award full request). This approach ensured that our scheme level enhancement model estimation results were not affected by the inclusion of a limited number of influential observations. We did not exclude outliers in the supply interconnectors model due to the sample size (see section 8).

Stakeholders' representations

There was general support for the outlier framework, both in terms of the Cook’s distance approach with a threshold of 4 / N and the application of different adjustments to modelled costs based on a deep dive assessment where companies demonstrate the factors driving higher efficient costs.

[9] Cook RD. Detection of Influential Observation in Linear Regression. Technometrics. 1977;19:15–18.

Anglian Water said that the approach is pragmatic but there are alternative outlier approaches like the F-distribution method which directly connects the threshold to a significance level, providing a formal test of whether an observation is influential.

Southern Water said the final decision on whether schemes are outliers should be taken in the round considering also unique factors affecting the schemes that are not accounted for in the econometric models. Severn Trent Water said Cook's distance provides a suitable framework, but it should be applied to log models.

United Utilities also noted that there are alternative methods which might produce different results. Therefore, we should take a holistic approach to examine carefully how outlier exclusion affects the overall cost assessment framework. The company argued that excluding outliers might justify a more simplistic model as it excludes observations that do not fit it which might contain valuable information.

United Utilities disagreed with the decision to give efficient outliers requested costs. It argued that would encourage companies to submit costs that do not reflect the most efficient solutions, undermining model accuracy. That might affect the ability to set efficient benchmarks in future price reviews. It proposed that we allow modelled cost for efficient outliers. Wessex Water and South West Water also said efficient outliers should be awarded modelled costs.

Wessex Water argued Cook’s distance is not a tool to address explanatory power in the models. It said that Cook’s distance does not guarantee that a given observation which requires closer scrutiny will be identified.

Yorkshire Water did not agree with excluding outliers above the 4 / N ‘rule-of-thumb’ threshold, on an automatic basis. It argued that we need to confirm whether the identified outliers need to be removed (eg using supplementary engineering assessments). Only after establishing schemes are truly outliers, then a deep dive approach to assessing them should be considered. In addition, the company stated that there are alternative methods to deal with outliers. For example, robust regression which ‘down-weights’, rather than rejects influential observations. Alternatively, robust regression could be used in addition to identifying and removing unambiguous outliers.

Thames Water said it does not support the outlier removal process as it can lead to the removal of genuine observations that are not well captured by the functional form and / or the limited set of cost drivers presented in the models. The company argued outliers should be removed if they are the result of a reporting error or a particularly unique scheme, but not if it is the result of a mis-specified model.

Our assessment and reasons

2.3.1 Need for separate outlier treatment

The scheme level modelling approach increases the number of observations compared to company level models. This allows us to better control for differences in efficient enhancement costs between companies giving us greater confidence that our allowances capture company specific factors.

However, scheme level assessment also relies on modelling observations where the cost and cost drivers have a wider variance and range across all schemes than the variance and range present at the company level. For example, our phosphorus scheme level enhancement models consider efficient cost to implement upgrades for reducing phosphorus at sewage treatment works (STWs) which range in size from less than 250 population equivalent (PE) served to STWs serving more than 1 million people. That distribution is wider compared to PR24 company level enhancement models where companies are generally more comparable in terms of cost and cost drivers on a normalised basis.

In this context, there is a risk that outlier schemes that appear to be much more efficient or inefficient compared to the average scheme could negatively influence the modelled outcome. In addition, the model might not provide the most appropriate estimate of efficient costs for these schemes. This could be due to inefficiency / efficiency, or because of some other factor that is not explained in the models. This could lead us to reach incorrect conclusions on the:

- robustness of scheme level enhancement models;
- most appropriate cost drivers;
- most appropriate functional form; and
- relative cost efficiency assessment.

Therefore, we continue to consider we need to adjust for outliers in our scheme level enhancement models.

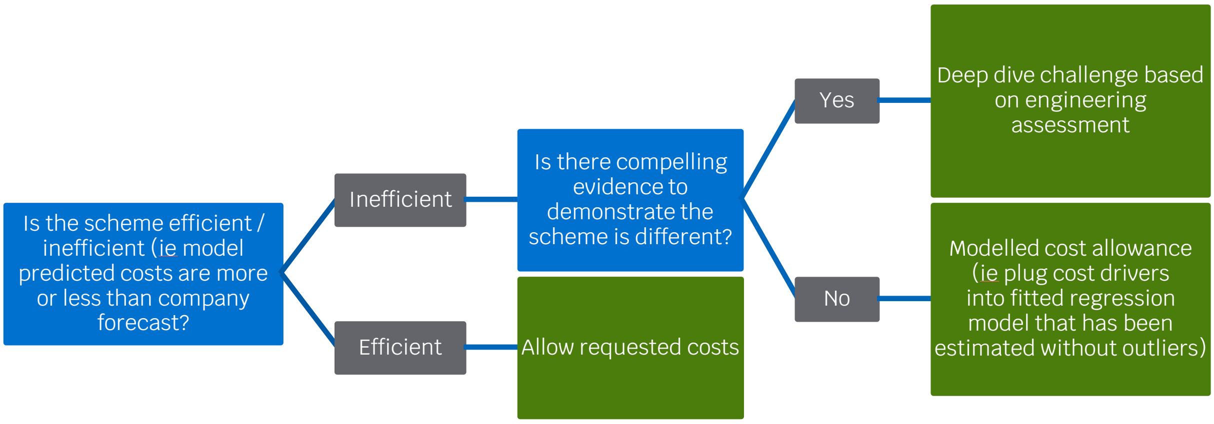
To address this concern, we identified potential outliers using the Cook's distance statistic, which is commonly used in econometrics literature.[10] Cook's distance measures the influence of each observation on model estimation results. The higher the Cook's distance of an observation, the higher its influence.

We used a standard threshold of four divided by the number of observations of the relevant model (4 / N). We dropped all observations with a Cook's distance metric that is higher than this threshold from the econometric models. This approach reduces the risk that our scheme level enhancement model estimation results are unduly affected by the inclusion of a limited number of influential observations. For simplicity, we performed only one iteration of removing outliers for each scheme level enhancement modelling area.

[10] Cook RD. Detection of Influential Observation in Linear Regression. Technometrics. 1977;19:15–18.

We used the following framework to set efficient allowances for outlier schemes.

Figure 1: Framework to assess Cook's distance outliers



We continue to consider that excluding Cook's distance outliers improves the robustness of our scheme level modelling approach. Our objective is to model efficient allowances for the average efficient scheme. We consider there is a risk that we may not be able to identify the most appropriate modelling approach if we do not exclude observations with undue influence on the overall benchmark.

We recognise that Cook's distance is not the only approach to identify outliers to our scheme level models. However, of the available approaches it has the advantage of being transparent and tractable in a regulatory setting. We continue to consider that it is appropriate to separately consider the costs of schemes which do not seem to be consistent with the model as identified by Cook's distance, and to exclude them from our models so that we can be more confident that the benchmarking models assess comparable schemes. Our overall approach leads to a balanced approach in which we use:

- a model estimated cost for schemes which are sufficiently similar;
- a deep dive assessment for outliers indicated as inefficient (forecast cost above modelled cost) which considers the company evidence of high cost factors; and
- an allowance set at company forecast costs for schemes indicated as efficient.

We consider that our approach to provide requested costs to efficient Cook's distance outliers continues to be appropriate for final determinations. Our approach recognises that the models are not able to explain the efficient cost of these schemes, to the point that they become Cook's distance outliers. Therefore, the company forecast costs provides the best available estimate of outturn costs for these schemes. We do not consider that this would encourage companies to submit costs that do not reflect the most efficient solutions in the future as the identification of outliers will be dependent on future scheme level models. In addition, efficient outliers form a small share of the overall number of schemes.

We disagree that our Cook's distance outlier removal leads to a risk of leading to more simplistic models. On the contrary, excluding these observations is a mechanism that allows for the unique characteristics of the remaining hundreds of observations to have the desired effect of capturing the average relationship between cost and cost drivers. We note that this approach screens out a relatively small share of observations overall by number of schemes (eg 4% for forecast phosphorus models).

The framework for assessing scheme level outliers is aligned to our approach to undertaking deep dives in other enhancement areas.

As the schemes are outliers to the model, we apply our need for enhancement model adjustment criteria to determine whether there is compelling evidence to adjust the modelled allowance.[11] The criteria are outlined below.

- **Costs outside model scope** – is there compelling evidence that the additional costs identified are not included in our enhancement model approach?
- **Insufficient allowances** – is there compelling evidence that the allowances would, in the round, be insufficient to account for evidenced special factors without an enhancement model adjustment?
- **Driver evidence** – is there compelling econometric or engineering evidence that the factor(s) identified would be a material driver of costs?

Table 1 sets out the levels of efficiency challenge applicable under different outcomes.[12]

Table 1: Outlier enhancement schemes – efficiency challenge adjustments

Score	Adjustment	Quality of evidence to inform modelled cost efficiency score
Pass	Company receives requested costs in full	Compelling evidence
Minor concerns	Modelled benchmark + 75% of cost gap	Reasonable evidence
Some concerns	Modelled benchmark + 50% of cost gap	Limited evidence
Significant concerns	Modelled benchmark	No evidence

We have published our deep dive assessment of all outliers within the relevant PR24 scheme level enhancement models.

[11] PR24_final_methodology_Appendix_9_Setting_Expenditure_Allowances.pdf (ofwat.gov.uk), December 2022, p156
[12] We do not apply this framework to supply interconnectors (see section 8).

2.3.2 Engineering outliers

In addition to excluding Cook's distance outliers for separate treatment, for final determinations we considered whether there are any additional schemes that should be considered as outliers. To determine that, we examined the unique characteristics of schemes that could lead to an increase in efficient costs compared to the average scheme. We refer to these observations as engineering outliers.

Unlike our approach with Cook's distance outliers, we retain these observations within the modelling samples. This allows us to retain an implicit allowance for the unique characteristics identified within our efficient modelled allowances. We provide an additional allowance for inefficient engineering outliers using the framework set out in section 2.3.1.

There is a high bar to us treating schemes as engineering outliers. We have focused on the most material factors that companies identified in their draft determinations representations as additional cost factors. This is essential to maintain the integrity of our scheme level modelled benchmarks as they already control for a combination of unique characteristics across a large number of modelled schemes. Sections 3-8 provide further details on our approach to the engineering outliers assessment if relevant.

2.4 Functional form and addressing log-bias

What we said in our draft determinations

The functional form of our scheme level enhancement econometric models is informed by engineering and economic rationale. We generally used levels models without a logarithmic transformation as we found significant log bias in log-log scheme level models driven by the wide distribution of data.

For storm overflows and supply interconnectors, we used log-log models to help set efficient enhancement allowances as the functional form was supported by engineering and economic rationale. We also used log-log models for the large population models of metering and lead. We corrected the log-bias by implementing an upwards adjustment to model predicted costs which was equal to the percentage difference between industry requested costs and industry model predicted costs same as our approach in PR19 (PR19 log-bias adjustment).

Stakeholders' representations

There was limited feedback on the functional form of our scheme level models.

Severn Trent Water was the only company that strongly supported log-log models. The company argued that log models can capture economies of scale better. In addition, it said that log models, in conjunction with Cook's distance, are superior in identifying outliers across the whole range of the dataset. It showed that the Cook's distance approach only drops very large schemes in the levels specifications, failing to screen out very efficient schemes of smaller size. In contrast, the transformation of data in log models helps to screen out these schemes more effectively.

All companies supported our approach to applying the PR19 log bias adjustment where relevant because it is a simple and pragmatic approach. However, Severn Trent Water, Thames Water and United Utilities said that there are alternative approaches to adjust for log bias.

Our assessment and reasons

The functional form of our scheme level enhancement econometric models is informed by engineering and economic rationale. We aim for our models to capture the key cost drivers that influence efficient costs while being sensibly simple and transparent.

We generally did not make a log transformation of the dependent and explanatory variables prior to estimating our scheme level enhancement models. We found that taking logs and transforming model predicted costs back into levels by taking the exponential introduces substantial log bias in many of the scheme level models. Log bias is a downward bias in model predicted costs for the sector, which would lead to allowances being set too low. The wide distribution of data in the scheme level enhancement models appears to be the main contributing factor.

The need for log bias adjustments and the additional complexity means that log models should only be chosen where they are materially better than levels models.

Log models have several disadvantages related to the substantial log bias present. We consider these outweigh the benefits in some scheme level enhancement areas. We continue to consider that log bias is a significant implementation issue to the scheme level modelling approach that needs to be considered before deciding on a log specification.

First, there are different approaches to adjusting for log bias. Therefore, the application of alternative approaches could lead to different modelled allowances and potential implicit industry efficiency challenges directly tied to the choice of a log bias adjustment method. We consider this is undesirable as it reduces the transparency of our benchmark. Indeed that is one of the reasons we use the simple PR19 log bias adjustment where relevant.

Second, the log bias adjustment factors we use are the same for all observations within the relevant models. We found that in general, modelled costs for larger schemes tend to be significantly lower under a log specification compared to levels. That might suggest that log models systematically overestimate the economies of scale that could be achieved by larger schemes due to the application of a uniform log bias adjustment. Although the assumption of constant marginal impact of the volume driver in levels models can be argued to be at the other extreme of not fully correcting for economies of scale, we found that it results in a much better fit to larger schemes across the different models.

We agree that the set of Cook's distance outliers is different in log models as these identify a larger range of observations and not just the largest schemes which are most influential in the levels specifications. It is also possible that the log models could have a higher R-squared than the levels models. Both of these findings are likely to be partly driven by the log transformation of the cost and cost drivers. However, we do not consider that these factors alone are sufficient to conclude that the log functional form is more appropriate than levels.

We have considered whether to use log models in each of the scheme level models. For most areas they do not provide a material improvement in results that outweighs the implementation issues related to log bias. For storm overflows and supply interconnectors, we used log-log models to help set efficient enhancement allowances as the functional form was supported by engineering and economic rationale. We also used log-log models for the large population models of metering and lead. Finally, we have added a log model for growth at STWs in final determinations due to similar performance to the levels model and a better ability to screen out low-cost outliers.

We continue to correct for log bias in final determinations by implementing an upwards adjustment to model predicted costs equal to the percentage difference between industry requested costs and industry model predicted costs. We applied the same approach for some enhancement areas at PR19 (PR19 log bias adjustment) as it is relatively simple and leads to sensible outcomes. Log bias is a well-documented issue in econometrics literature and there is no single best practice approach to address it.

Finally, our approach to addressing log bias is not appropriate for econometric models that are estimated using historical data. When we use historical data to estimate a model and use this to forecast efficient costs using PR24 schemes cost drivers, efficient costs could turn out to be lower than industry requested costs if companies have submitted inefficient business plan forecasts. In this context, it is difficult to implement the PR19 log bias adjustment as we cannot distinguish between log bias and efficiency of business plan forecast costs. Uplifting model predicted costs to business plan requested costs could lead to customers paying for inefficiency. Estimating scheme level models in levels helps to avoid this issue.

For storm overflows where we use historical data, we estimate the PR19 log bias adjustment factor by fitting the historical models to the historical cost drivers and estimating the factor as the percentage difference between industry outturn costs and industry modelled costs. We then use this factor as our best available estimate of log bias in the historical models. That is consistent with our approach in the supply interconnectors model. Section 3 (storm overflows) and section 8 (supply interconnectors) provide further detail of the approach we followed.

2.5 Model selection process

Our model selection process involves the following steps.

- We identify cost drivers with a clear engineering and economic rationale based on the data available.
- We test various model specifications using the data available and select models with a clear engineering and economic rationale that produce robust results. To assess model robustness, we assess:
    - if the estimated coefficients have the correct sign, are of reasonable magnitude, and are statistically significant;
    - the efficiency score range – a wide efficiency score range may indicate that key cost drivers are omitted from the model, or reflect differences in cost efficiency; and
    - the sensitivity of allowances to changes in the model specification.
- We aim for sensibly simple models, avoiding complexity when it does not materially improve our ability to set efficient expenditure allowances.

Sections 3-8 set out in detail the process we follow when selecting our final determinations models for each enhancement area after considering representations to our draft determinations.

2.6 Efficiency benchmark

What we said in our draft determinations

We set the efficiency benchmark at the company level by aggregating model predicted costs across schemes for each company and comparing this to each company's total requested costs. For each enhancement area, this results in an efficiency score for each company that we used to set the efficiency benchmark. We generally set the benchmark based on the efficiency of the median company.

Stakeholders' representations

Companies generally agreed with our approach to setting the efficiency challenge at company level. Anglian Water argued that the scheme level efficiency challenge is not achievable for any company.

Several companies argued that the level of the efficiency challenge should be informed by the quality of models. Severn Trent Water said that the models proposed are not of sufficient quality to set an upper quartile challenge unlike for base cost models. United Utilities also added that the decision on whether to apply an upper quartile challenge in some areas does not appear to be fully justified.

Our assessment and reasons

We benchmarked costs at the scheme level for the enhancement areas covered in this report.[13] But we set the efficiency benchmark at the company level by aggregating model predicted costs across schemes for each company and comparing this to each company's total requested costs. For each enhancement area, this results in an efficiency score for each company that we used to set the efficiency benchmark.

Setting the efficiency benchmark at the company level recognises that companies have to deliver schemes of different scale and complexity. Using a company level benchmark balances out modelled cost differences across individual schemes. That helps to set an achievable cost efficiency challenge as each company has an equal weight in the cost efficiency assessment.

We generally set the benchmark based on the efficiency of the median company. That is consistent with the efficiency benchmark we apply in company level enhancement models. We deviated from this approach only in limited circumstances:

- we did not apply the median benchmark when the median efficiency score was more than one as this would have resulted in us uplifting model predicted costs (such as growth at STWs); and
- we apply a more stringent upper-quartile efficiency challenge when we consider a median efficiency challenge is insufficiently stretching (such as industrial emissions directive secondary containment costs).

Our approach to setting the efficiency benchmark at the median company for most areas continues to be appropriate for final determinations. Our approach to setting a median benchmark recognises:

- the novelty of the scheme level enhancement modelling approach compared to company level modelling in PR19;
- the quality of the models; and
- more broadly the challenge for delivery and efficiency associated with the large size of the overall enhancement programme for the industry.

We have also made several improvements across the models since draft determinations that help us set more targeted overall efficiency challenges. That includes:

- separate models for different types of schemes;

[13] Except sanitary parameters, lead and metering.

- engineering outlier assessments; and
- application of the modelled efficiency challenge to schemes not suited to modelling (unmodelled schemes).

Sections 3–8 set out further detail on the efficiency benchmark applied in each scheme level enhancement area in PR24 final determinations.

3. Storm overflows

Summary

We have three separate modelled storm overflows areas in PR24: storage at the network, storage at STWs and flow to full treatment (FFT) schemes.

For network storage and FFT schemes we use **scheme level models using forecast and historical data** to set efficient storm overflows enhancement allowances. We assign **equal weights to two historical and two forecast models**. We implement this by giving each of the four models a triangulation weight of 25%. We do not apply an additional efficiency challenge since we view more efficient historical delivery imposes an efficiency challenge.

For storage at STW schemes we use forecast models only. We found that historical data provides a very stringent efficiency challenge potentially driven by a systematically larger size of schemes at STWs in PR24. We set **a median efficiency challenge** on forecast data.

The key cost driver of storm overflows schemes is **equivalent storage (m3)**, comprised of grey, green and other storage. We refer to models as grey / grey-green hybrid to recognise they include different types of storage.

The key driver of FFT schemes is **capacity increase (litres / second)**. Our models create an overall industry cost challenge of 7%.

Since draft determinations we made the following changes:

- **assess flow to full treatment (FFT) schemes separately** – we have developed econometric models using capacity increase (litres / second) as the cost driver;
- **use historical data to set efficient allowances where appropriate** – we collected historical cost and cost driver data for storage in the network and STWs over the 2015-20 and 2020-25 periods and FFT schemes in the 2020-25 through industry data requests.
- **exclude schemes with a significant AMP9 component from modelling –** at draft determinations we used schemes from Southern Water in the sample but we drop these for final determinations.
- **identify hybrid schemes with a significant proportion of non-grey storage as engineering outliers**. After undertaking our assessment, we apply a cost gap adjustment to these schemes.
- **identify schemes significantly impacted by exogenous factors increasing costs such as contaminated land, soil hardness and planning constraints as engineering outliers**. After undertaking our assessment, we apply a cost gap adjustment to these schemes.

Storm overflows are designed to act as relief valves when the sewerage system is at risk of being overwhelmed, such as during unusually heavy rainfall when a lot of rainwater runs into combined sewer systems for a brief period. If the sewerage system gets overwhelmed it can have negative impacts for customers, causing flooding or even sewage backing up into people's homes and businesses. To prevent that, water and sewerage companies can seek environmental permits from the Environment Agency or Natural Resources Wales which allow them to discharge the combined rainwater and diluted sewage into rivers. To reduce the frequency of these discharges companies can use storage tanks to capture wastewater before it is discharged into rivers, and aim to reduce the amount of rainwater that enters the sewers through nature based solutions to decrease the amount and frequency of storm overflows operating.

Storm overflows enhancement expenditure in England is primarily driven by WINEP requirements introduced by the Environment Act 2021, and Defra's Storm Overflows Discharge Reduction Plan (SODRP) and meeting the requirements of the Urban Waste Water Treatment (England and Wales) Regulations 1994 not covered by current permits. In Wales the requirements relating to improving the classification standard of storm overflows and reduce harm are set out in Natural Resources Wales (GN066- Assessing Storm Overflows and GN021- Unpermitted Storm Overflow guidance). Any investment required for compliance will be set out in the NEP. Compliance with this guidance will deliver legislative requirements in Wales including the Environment (Wales) Act 2016 and Urban Waste Water Treatment (England and Wales) Regulations 1994.

The requirements for new storm overflows improvements under the Water Industry National Environment Programme (WINEP) and the Storm Overflows Discharge Reduction Plan (SODRP) have led to a programme of works for the industry in PR24 which is significantly larger than in previous price control periods. Companies requested £12 billion across different storm overflow schemes in response to our draft determinations. Storm overflows is by far the largest enhancement expenditure area in PR24. There is no additional funding for remediating to meet current permit levels. That must be funded through base expenditure as customers should not pay twice.

Storm overflow solutions can be broadly categorised into:

- **grey storage** – comprising storage tanks, predominantly either circular sunk shafts with a pumped return (offline), or linear tanks / oversized pipes which drain back into the network via gravity (online);
- **green solutions** – can comprise a range of sustainable drainage systems (SuDS) features such as swales, ponds, raingardens or permeable paving. Surface water often needs to be separated / diverted to the feature. Storm overflow wetland treatment solutions are also considered a green solution; and
- **other solutions** – these can include a range of options such as sewer upsizing, surface water separation, flow management and control, and infiltration removal.

To enable an assessment of cost and value across different activities, we collected additional scheme level data on storm overflow enhancement expenditure. This captures the equivalent storage volume delivered by each scheme, subdivided into the above categories of grey, green and other. Equivalent storage relates to the volume of storage that is required to achieve a target spill frequency. For most storm overflow improvements under the SODRP the target is ten spills. Using traditional storage methods, this is usually the volume of effluent spilt on the n^{th}+1 event, where n is the target spill frequency, and all annual storm overflow spills are ranked by spill volume. The equivalent storage achieved by non-storage solutions can be calculated by running a hydraulic model with the alternative solution included within the model and assessing the extent to which the storage requirement is reduced.

We have assessed the costs of storm overflows solutions using scheme level econometric cost models where feasible. The rest of this section sets out our approach to modelling in final determinations after considering stakeholder views in draft determination representations. In summary, we set allowances for three separate categories of expenditure:

- **modelled schemes** – we use the outputs of econometric models to set allowances for three types of schemes (storage at the network, storage at STWs and flow to full treatment (FFT) schemes);
- **deep dive schemes** – we undertake deep dives for schemes less suited to scheme level modelling including Cook's distance outliers and engineering outliers; and
- **unmodelled schemes** – we undertake a more aggregate efficiency assessment of expenditure not suited to modelling such as green only schemes, screen only schemes and wetlands.

3.1 Data used

What we said in our draft determinations

To assess the costs of grey and grey-green hybrid solutions we requested additional information on forecast scheme level cost and cost driver data for PR24 storm overflow programme over the 2025-30 period. We also collected historical storm overflows data over the last ten years (2013-14 – 2022-23) through the PR24 queries process, which contained historical scheme level data cost and cost driver data.

The datasets included key information which we used as part of the modelling process including **yearly opex and capex forecasts** and **total storage volume (m3)** forecasts of proposed equivalent storage to be delivered broken down by type of storage (grey storage, green storage and other storage).

Historical data was provided relatively late through the PR24 query process, so we did not use it to estimate storm overflow scheme level models. But we said we intend to revisit this for final determinations.

Stakeholders' representations

Generally companies agreed with the use of forecast data to estimate scheme level models.

Yorkshire Water said that the model may be affected by poor company forecast data. The company stated that there is a risk that companies will systematically be under- or over-estimating their costs due to using different approaches to estimating scheme level costs. This could affect the estimated relationship between storage volume and cost which could lead to flawed cost allowances.

United Utilities also said that high-level approaches to forecasting cost of storm overflows schemes could have a large effect on model robustness and the efficiency assessment.

Some companies commented on the use of historical data to estimate scheme level models. That was in response to a historical data request we issued following the publication of draft determinations.

United Utilities said that it welcomes the collection of historical data but noted that PR19 storm overflows schemes might reflect spending on lower cost solutions as early schemes had a higher benefit:cost ratio. Yorkshire Water also said that the inclusion of historical scheme level data may be inappropriate due to the risks of under-estimating the cost of PR24 schemes. The company stated that storm overflow schemes that have been delivered historically under the Storm Overflows Assessment Framework (SOAF) and Urban Pollution Management were subject to a cost-benefit test as part of these frameworks. In contrast, the SODRP does not have a cost-benefit test. Therefore, the use of historical data is inconsistent with the schemes in the forecast PR24 dataset, as past schemes will generally be the ones with a higher benefit:cost ratio.

Thames Water and United Utilities commented on the use of flow-to-full treatment (FFT) schemes to complement storage solutions. Thames Water argued that the scale of FFT solutions could be measured better with alternative drivers such as litres per second (l/s) rather than equivalent storage. United Utilities challenged the robustness of the dataset in relation to treatment of FFT schemes. The company said that the schemes may not be treated consistently between companies with different assumptions of how litres per second (l/s) capacity converts to avoided equivalent storage.

Our assessment and reasons

We issued a historical data request to collect scheme level data on cost and cost drivers in relation to historical delivery of storage schemes in the 2015-2020 and 2020-25 periods. This provides additional outturn cost evidence to complement the use of forecast data in our modelling approach. That helps to address the risk of over-reliance on forecast data which could be subject to forecasting uncertainty.

The other key data change we implement is to separately identify Flow to Full Treatment (FFT) schemes. We agree with stakeholders that FFT schemes have different characteristics compared to storage schemes as they represent additional capacity. Therefore, we use additional information collected alongside the draft determinations to carve out the cost and cost driver (litres per second) of FFT schemes to consider in a standalone FFT dataset.

In addition, to further expand our FFT sample, we additionally collected:

- historical scheme level data on PR19 FFT schemes under WINEP drivers U_IMP5 and W_U_IMP5; and
- forecast scheme level data on PR24 FFT schemes under WINEP drivers U_IMP5 and W_U_IMP5.

That allows us to consider the efficiency of FFT schemes separately, recognising their different characteristics compared to other storage schemes in the storm overflows dataset.

Following our assessment at final determinations, we use the following data sources to assess storm overflows and FFT enhancement costs using scheme level econometric models:

- **Additional data table 20 (ADD20) – Forecast storm overflows scheme level dataset**, which contains scheme level cost and cost drivers data for the PR24 storm overflows programme over the 2025-30 period.
- **Historical storm overflows scheme level dataset** which contains costs and cost drivers data for historical storm overflows and other storage schemes (network and stw) over the 2015-20 and 2020-25 price control periods.
- **Forecast FFT scheme level data** which contains FFT cost and cost drivers data for schemes in scope of storm overflows and the WINEP U_IMP5 / W_U_IMP5 programme over the 2025-30 period.
- **Historical FFT scheme level data** which contains FFT costs and cost driver data for schemes in scope of the WINEP U_IMP5 / W_U_IMP5 programme over the 2020-25 period.

We used the following key information from the datasets to develop our models:

- **yearly opex and capex forecasts**
- **total equivalent storage volume (m3)** - proposed equivalent storage to be delivered, which includes storage tanks, nature-based green storage, constructed wetlands and separation schemes. Storage volume was broken down by type of storage (grey storage, green storage and other storage); and
- **increase in litres per second (l/s)** – capacity increase measured in litres per second.

We queried companies on all datasets to address inconsistencies and improve the quality of the final datasets used for modelling.

For example, storm overflow related FFT scheme data was requested from companies that had included full or partial FFT schemes as part of their storm overflow programme. As a result of this assessment, we removed flow to full treatment costs and storage equivalent from the forecast storm overflow scheme level dataset. We also validated the final datasets by putting them back to companies.

We undertook a similar query process for the historical storm overflows and FFT datasets. For example, we requested companies to reconcile their historical dataset submission to outturn data in the APR and to explain differences in outturn storage / capacity increase compared to forecasts in the PR19 company level storm overflows and FFT enhancement models.

We allocated storm overflows schemes into two sub-categories:

- grey and grey-green hybrid (mix of grey, green and / or other) solutions in the network; and
- grey and grey-green hybrid (mix of grey, green and / or other) solutions at sewage treatment works (STWs).

In addition to the core modelled schemes, we assessed some schemes not suited to a scheme level modelling approach using alternative approaches, including green only schemes, screen only solutions, wetlands and no output schemes. These scheme types were assessed individually, either through shallow dives, deep dives or unit cost analysis, within the storm overflow feeder model and included within the storm overflow final allowance. Section 3.5.1 provides more detail.

Table 2 below presents summary statistics using storm overflow data on grey and grey-green hybrid storage solutions. It shows that the final determinations storm overflows enhancement programme is larger than at draft determinations. That reflects a combination of factors, including:

- additional scope added to the programme;
- revisions to existing equivalent storage values for some schemes; and
- changing costs for some schemes to reflect new information.

The storage delivered in the historical dataset is relatively lower than in the forecast dataset in terms of number of schemes and volume of total storage delivered. In addition, the unit cost is also lower, reflecting more efficient forecasts compared to the final determinations forecast dataset. We also note the systematic difference between STW schemes in the historical and FD forecast dataset. The average PR24 scheme is almost three times the size of the average PR19 scheme. That suggests historical cost efficiency might be less representative of PR24 efficient cost for schemes at STWs.

Table 2: summary statistics of grey and grey-green hybrid storage schemes in the storm overflows datasets

	DD forecast		FD forecast		Historical	
Variable	Network	STW	Network	STW	Network	STW
Number of schemes	1,470	409	1,899	616	261	277
Volume of total storage (m3)	2,065,638	1,267,190	2,548,787	1,683,162	374,235	267,717
Totex (£m)	£6,062m	£2,348m	£7,138m	£3,540m	£954m	£520m
Unit cost (£/m3)	£2,935	£1,853	£2,801	£2,103	£2,550	£1,941
Average storage size (m3)	1405	3098	1342	2732	1434	966

Table 3 shows a more comparable programme between PR19 and PR24 for FFT schemes. That is due to the large PR19 WINEP / NEP programmes of FFT upgrades as explained earlier in this section. Similarly to storm overflows storage schemes, the unit cost of schemes is lower in the historical dataset reflecting more efficient delivery compared to company forecasts in PR24.

Table 3: summary statistics of FFT schemes in the FFT datasets

	FFT	
Variable	Forecast	Historical
Number of schemes	102	159
Capacity increase (l/s)	5635	7926
Totex (£m)	£828m	£760m
Unit cost (£/l/s)	146,946	95,934
Average capacity increase size (l/s)	55	50

3.2 Models considered

3.2.1 Selected cost drivers

What we said in our draft determinations

At draft determinations we identified volume of equivalent storage as the primary cost driver of grey and grey-green hybrid storage costs in storm overflows models. This driver is the only explanatory variable included in our scheme level cost models along with a fixed element to represent the preparatory and civil works to enable the delivery of the scheme. It has a clear engineering rationale as it captures the volume of spill which needs to be stored and managed to mitigate storm overflow discharges to meet the target spill frequencies.

Stakeholders' representations

Most companies broadly accepted our approach to storm overflows but stated that the models are relatively simple with a single cost driver of equivalent storage.

Hybrid schemes

Severn Trent Water said that we should control for the share of green storage in our STW models as green schemes are likely to be more complex. It proposed to control for this either by splitting out the relevant hybrid schemes or including a variable capturing the percentage of green storage within total storage. This would effectively provide a higher allowance to companies with a higher proportion of green schemes.

Southern Water also said that its programme has a significant non-grey component that is modelled in the grey and grey-green hybrid models. It demonstrated that the biggest ten efficiency challenges across its programme are on sites with a significant non-tank component (ie green and or other storage provided).

United Utilities stated that not accounting for the difference between grey and non-grey solutions might lead to companies prioritising cheaper grey solutions.

Exogenous factors missing

Wessex Water said that alternative cost drivers that are difficult to capture at any scheme level modelling may drive efficient costs. This included ground conditions, length of connection for large tanks and the type of tank (over / underground and steel / concrete).

United Utilities stated that the models do not capture the set of exogenous factors affecting efficient storm overflow costs. The company proposed alternative models based on extensive work it undertook to map overflows to exogenous cost drivers data including urbanity and soil hardness and indicate that these factors are driving cost in its storm overflow plan. The company stated that if models are not updated in final determinations then its allowance should be uplifted to be consistent with its models proposed models controlling for these factors.

United Utilities explored other factors that affect models including the installation of screens. Yorkshire Water said accounting for assets like screens and ancillaries would avoid omitted variable bias as non-volume factors that may affect efficient cost.

Our assessment and reasons

Storm overflow models

For our storm overflow models, we use equivalent storage as our key cost driver across forecast and historical datasets. We split our storm overflows models into schemes at the network and at STWs due to differences in the type of solution required for each. This reflects company views that the cost of storage at STWs is often significantly lower as:

- storage structures are predominantly open and above ground;
- land access and availability is better at STWs; and
- there is a lower disruption to the public and less need for road works.

As a result of the above, we separately assess the cost of equivalent storage using scheme level econometric cost models for network and STW schemes.

Figures 2 and 3 show the distribution of storage schemes at the network and at the STW in the grey and grey-green hybrid storm overflows forecast dataset. We split the schemes into different categories to show the distribution of size of schemes across the sector. The split shows that small tanks up to 200 m^3 form a large part of the dataset with 670 out of 1906 in the network sample and 120 out of 622 in the STW sample. We also see that there is a relatively larger number of large tanks above 1000 m^3 at STWs compared to the network.

Figure 2: Distribution of tank size at the network (m3)

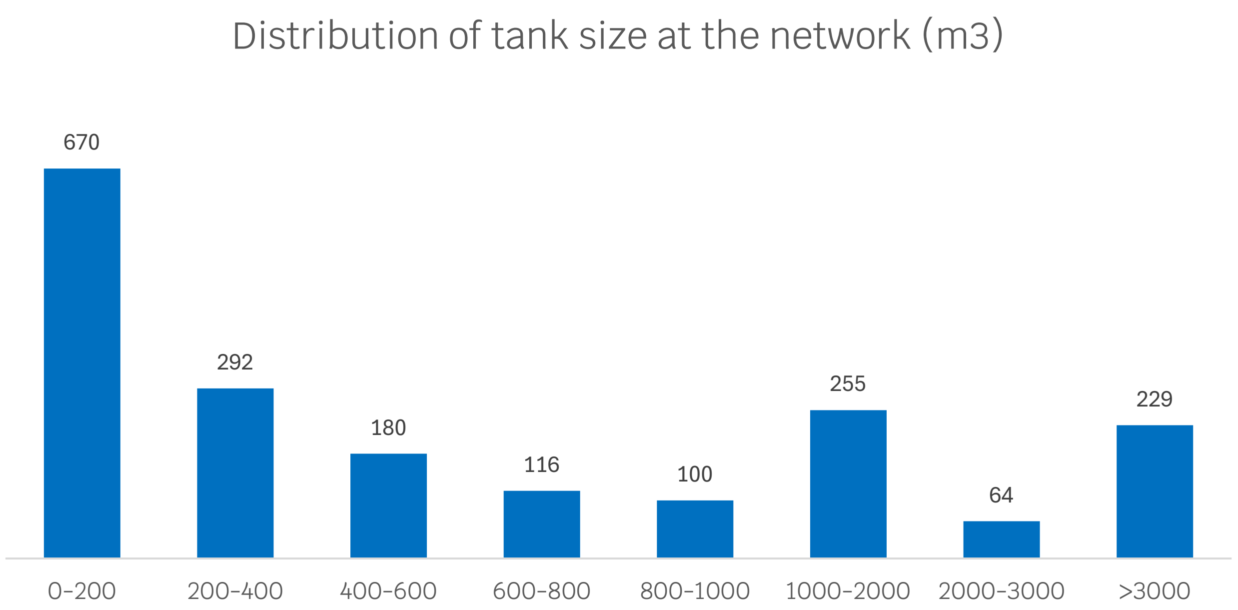
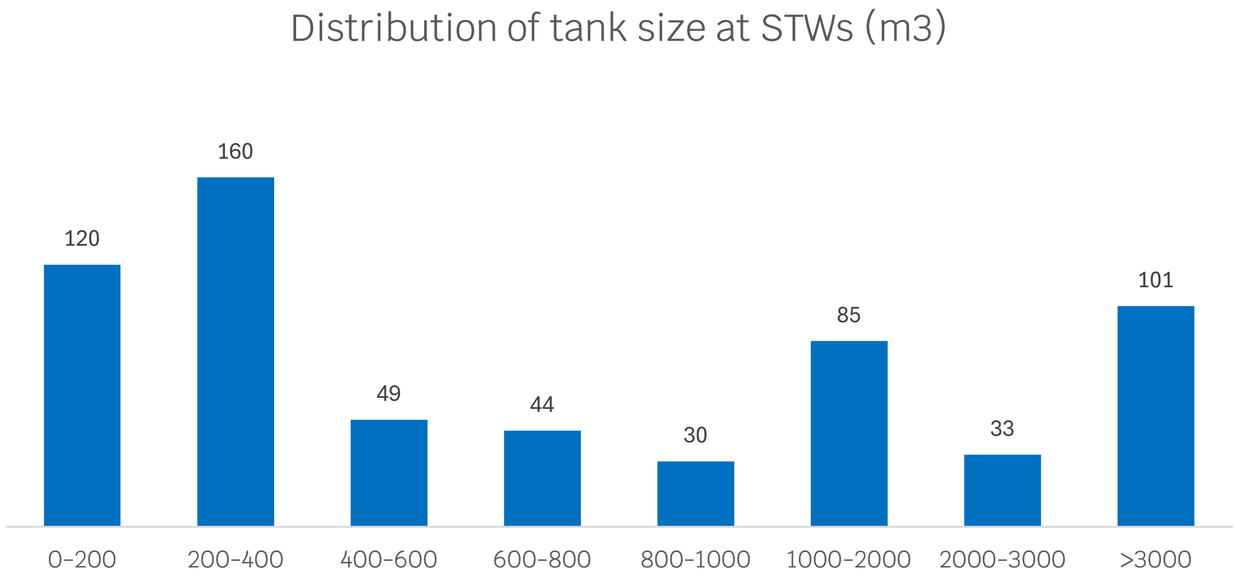


Figure 3: Distribution of tank size at STWs (m3)

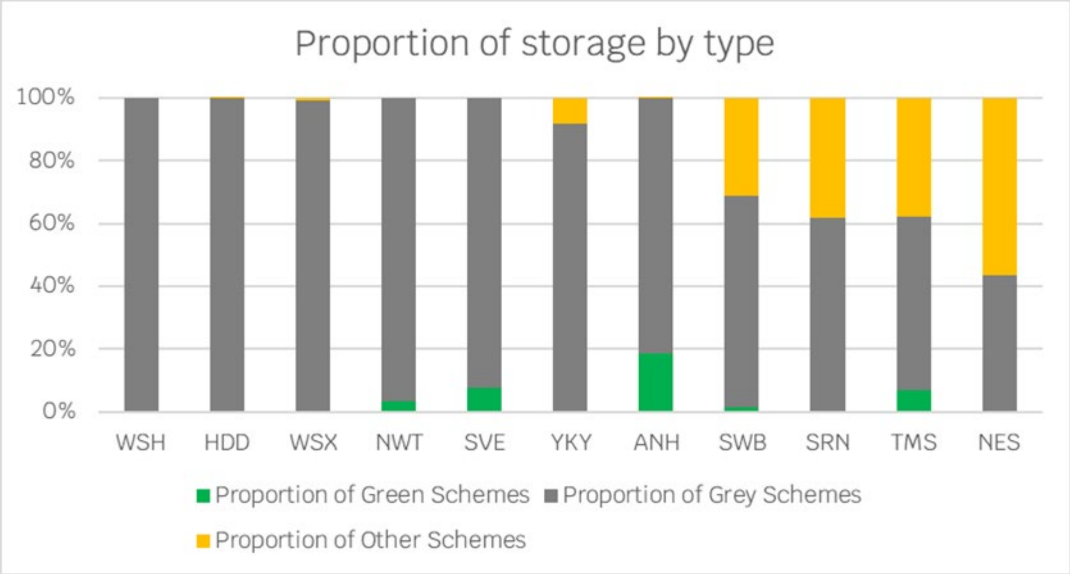


The volume of equivalent storage has a clear engineering rationale as it captures the volume of effluent spill which needs to be stored and managed to mitigate storm overflow discharges. All else being equal, we would expect companies delivering solutions with higher storage volumes will require higher efficient costs.

Engineering rationale suggests that average unit costs decrease due to economies of scale as scheme size (storage tank capacity) increases. To help capture this, we use a log-log model to help set efficient allowances (discussed below).

Our cost driver, equivalent storage, can be a combination of grey, green and other storage. Figure 4 shows the share of storage by type across the sector using modelled schemes. This figure shows that most of the storage delivered via grey and grey-green hybrid storage schemes that we include in our econometric models is grey.

Figure 4: Proportion of grey, green and other storage for modelled grey and grey-green hybrid storage schemes



In general, our storm overflow models contain data on a large number of schemes. Therefore, the sector receives an allowance reflecting the average impact of the unique scheme characteristics that stakeholders have pointed out in representations. In that context, our focus is on reviewing schemes for companies that are materially affected by cost drivers not reflected in the models.

In general, green infrastructure elements appear be higher cost than traditional grey storage, as shown by the green only scheme costs, but there are a range of activities categorised as green / other that have a large range in both costs and additional benefits. Within hybrid schemes there is scope to optimise green / other elements and so there are instances where inclusion of a proportion of green infrastructure reduces the overall cost. There is also significant variation in the types, cost, and delivery approaches of green / other proposed by companies. As a result, including the percentage of green / other does not improve our modelling.

We modelled the cost driver proportion of non-grey and the proportion of green storage to test whether the prevalence of green and other storage in schemes leads to higher efficient cost. However, we found that the models were not robust due to limited non-grey storage in the historical dataset. This makes it difficult to use modelled approaches that directly control for non-grey storage.

Therefore, as an alternative we have considered hybrid storage storm overflow schemes with high cost gaps and a significant proportion of the storage delivered through green solutions as engineering outliers. For these schemes, we assessed them further through company queries to understand whether there was sufficient justification for higher allowances. This included Northumbrian Water large catchment scale solutions in Berwick-on-Tweed and

Marske, Southern Water's Local Authority highway drainage programme, Yorkshire Water's SuDS programme and Thames Water's SuDS for treatment work programme. Section 3.5.1 provides more detail of our approach to outliers.

Our approach to include hybrid schemes within the modelled dataset helps to promote green and other schemes, as all schemes get an additional allowance associated with the potential additional complexity of these solutions. By incorporating hybrid schemes within grey we provide an overall allowance that will enable the sector to deliver some hybrid schemes within the cost allowance.

Similarly, we considered the range of exogenous factors that United Utilities stated could impact costs. We consider that the wide range of factors raised by the company, including urbanity, soil hardness, contaminated land, planning constraints, etc. cannot be implemented into a modelled approach. That is due to data constraints which limit the ability to calculate comparable site-level metrics across the large PR24 programme of storm overflows. In addition, some of these factors are within management control, as they relate to the choice of location for the scheme.

We queried companies to understand the degree to which these factors affect their storm overflows programme. We have treated schemes as engineering outliers where there is compelling evidence the factors are leading to higher efficient costs. See section 3.5.1 for more detail of our approach to outliers.

Finally, we consider that we do not need to assess costs of screens separately where the scheme is also delivering storage. There is a large proportion of storage schemes in the dataset which require screens to comply with WINEP obligations, with all companies affected by the requirement to install screens. As the majority of schemes include a screen in the submitted costs, the models provide an efficient allowance for screen installation. Where a scheme includes a screen but no storage, it has been assessed separately.

Flow to Full Treatment models

At draft determinations companies provided cost driver information for flow to full treatment schemes, the key driver being the capacity increase (l/s) to be provided through flow to full treatment improvements. However, the data was inconsistent and insufficient to enable cost benchmarking to be undertaken at the time. Therefore, we applied the company level combined storm overflows grey / grey-green hybrid storage efficiency challenge to the pass forward flow schemes as our best available estimate of company efficiency.

At final determinations, we have developed alternative models for FFT schemes. As explained in section 3.1, we collected additional information related to FFT schemes in the historical and forecast periods in response to draft determinations and subsequently through the PR24 queries process. This has enabled us to develop standalone FFT models. We use the increase in litres per second (l/s) as our key cost driver, across both forecast and historical datasets.

Engineering rationale suggests that the capacity increase is the key driver of FFT enhancement expenditure. The driver captures the additional hydraulic capacity added at the network or STWs to avoid sewage spills to the environment either through additional treatment capacity or the ability to drain down larger storm tanks in between storm events.

We consider that developing alternative models is a significant improvement to our approach as it fully recognises the different characteristics of FFT schemes. It also avoids potential inconsistencies associated with the conversion of FFT capacity increases to avoided equivalent storage.

Given the potential overlap between FFT increases to reduce storm overflow spills and FFT increases to achieve permit compliance, the allowances are conditional on the company evidencing to our satisfaction that all funding is for enhancing the functioning of the asset beyond the level set out in its environmental permit or beyond that which could be achieved through maintenance. Further details in relation to this are included within the 'PR24 final determinations: Price control deliverables appendix'.

3.2.2 Functional form

What we said in our draft determinations

At draft determination we triangulated between a levels model and a logarithmic model with equal weighting for the grey and grey-green hybrid storage costs at the network.

For grey and grey-green hybrid storage at sewage treatment works, we used a log functional form only to set efficient allowances.

Stakeholders' representations

We did not receive specific feedback on the functional form of our storm overflow models.

As explained in section 2.4, Severn Trent Water stated that in general log models can capture economies of scale better and are superior in identifying outliers across the whole range of the dataset.

Our assessment and reasons

For grey and grey-green hybrid storage costs in the network, we triangulated between a levels model and a log-log model with equal weighting. There is a strong engineering rationale for economies of scale. We expect all schemes to require some element of fixed costs associated with land and connection to the network which may not be fully captured by the log model. However, we equally do not expect costs to increase linearly with the increase in storage as assumed in the levels model. Therefore, we triangulated equally between the levels model and the log model. We also used a combination of log and levels models for the new FFT schemes models for the same reasons.

For grey and grey-green hybrid storage at sewage treatment works, we used a log functional form to set efficient allowances to capture economies of scale. Engineering rationale also suggests that the fixed costs associated with a storage tank at a sewage treatment works should be lower than for a storage tank situated at a point on the network. This is because factors such as land and connection to the network should be minimised as the storage is provided at the sewage treatment works site. We also tested a levels model but the estimated intercept produced an estimate of fixed costs that was not plausible from an engineering perspective.

As we use log models for storm overflows, we correct the log-bias in models using forecast data by implementing an upwards adjustment to model predicted costs equal to the percentage difference between industry requested costs and industry model predicted costs.

However, as explained in section 2.4, our approach to addressing log-bias is not appropriate for econometric models that are estimated using historical data. Therefore, for historical models, we estimate the PR19 log bias adjustment factor by fitting the historical models to the historical cost drivers and estimating the factor as the percentage difference between industry outturn costs and industry modelled costs. We then use this factor as our best available estimate of log bias in the historical models.

Our approach to the log bias adjustment is conservative. We found that in the models where we use historical data to set the efficiency benchmark (network and FFT), total industry allowances are lower in the levels historical models (models S03 and FFT3) which are not affected by log bias compared to the log models (models S04 and FFT4) affected by log bias. That suggests that our methodology to apply the log bias adjustment may uplift allowances more than necessary. However, we consider that our approach is tractable, proportionate and consistent with other areas of the price control. Any impact will also be moderated by the equal weighting between log and levels models in the network and flow to full treatment models.

3.2.3 Forecast vs historical data models

What we said in our draft determinations

At draft determination we used forecast cost and cost drivers to estimate the scheme level models to help set efficient grey and grey-green hybrid storm overflows cost allowances. We used historical data and external benchmarks to validate the outputs of the econometric cost models estimated using PR24 business plan forecasts. We did not use historical data to estimate models directly as it was provided relatively late through the queries process, but we said we will revisit this for final determinations.

Stakeholders' representations

As explained in section 3.1, United Utilities and Yorkshire Water welcomed the collection of historical data in their representations. However, they said historical data might not be representative of forecast costs as the PR24 programme is subject to less cost:benefit challenges, leading to inclusion of more complex schemes.

To understand better what explains differences in efficiency of schemes between the historical and forecast datasets we issued an industry query. We asked companies to explain reasons for overall cost increases for storm overflows from the historical to the forecast period after controlling for the cost drivers we used in draft determinations.

Companies across the sector highlighted several reasons why PR24 costs for storm overflows are materially higher compared to PR19. These reasons include increased regulatory requirements, more complex solutions and external market pressures.

In relation to stricter regulatory targets, companies suggested that the SODRP requirements to reduce spills to 10 or less leads to the inclusion of less cost-effective schemes since the cost benefit test that was applied as part of the previous Storm Overflow Assessment Framework (SOAF) no longer applies, and so non cost-beneficial schemes have to be progressed to achieve the statutory requirements.

United Utilities and Thames Water argued that supply chain inflation is an important factor leading to increasing costs. They said construction material costs inflation is above CPIH due to external economic factors which increases the cost of the programme.

United Utilities, Northumbrian Water and Yorkshire Water argued that there is lower flexibility in solution design in the PR24 programme. The companies suggested that at PR19 companies they had more flexibility to optimise solutions across multiple overflows within a catchment, often building a larger, more efficient tank at one site to avoid costly works at another. The definition of more priority sites in PR24 (eg around bathing waters) limits the choice of solutions to achieve the desired reduction in spills which drives up costs in PR24.

Severn Trent Water, United Utilities and Northumbrian Water stated that PR24 requires addressing broader environmental drivers. These schemes typically involve larger storage volumes and the need for additional infrastructure which was not required in PR19.

Finally, Yorkshire Water, Northumbrian Water and Severn Trent Water said that PR24 involves a transition from traditional “grey” schemes to more complex “hybrid” and “green” schemes, such as surface water separation. Companies state that these complex solutions coupled with projects with higher volume of storage requirement, particularly in sensitive coastal and inland bathing areas are driving the increase in industry costs.

Our assessment and reasons

In our final determination we use historical and forecast datasets to develop our grey and grey-green hybrid storm overflows and FFT scheme level enhancement models.

As explained in section 3.1, our additional work to collect data on a consistent basis across the industry helped us to develop robust datasets for historical storm overflows and FFT schemes.

Having historical storm overflows and FFT data on cost and cost drivers is beneficial as it:

- helps us understand the relationship between outturn cost and cost drivers;
- provides insights on the outturn cost of storm overflow and FFT in PR19, which is helpful in removing forecasting bias and information asymmetry; and
- helps us to identify inefficient forecast costs by comparing historical and forecast efficiency scores for each company.

Therefore, historical data is an important tool to validate company forecasts and help to develop a well-justified efficiency challenge on company forecast data.

We estimate separate models using historical and forecast data. To derive modelled allowances, we fit the PR24 storm overflow cost drivers to the estimated coefficients for both the historical and forecast models. Similarly for the FFT model, we fit the PR24 FFT cost drivers to the estimated coefficients for both the historical and forecast models.

PR24 forecast costs appear to be higher than historical costs at an aggregate level across the industry for all models. This could indicate inefficient business plan cost forecasts or forecast real terms increases in costs.

Companies have raised some valid points on why the PR24 programme may be more expensive than historically. For example, they state that it is expected that PR24 costs should increase due to the higher level of green and / or other storage that is in the storm overflow programme. As explained in section 3.2.1, there is limited non-grey storage in the historical storm overflows dataset which may have led to lower storage costs. This could lead to higher costs in the forecast dataset in comparison to the historical data, however we have adjusted for companies and schemes with high proportion of green storage through engineering outliers, as discussed in section 3.5.1. In addition companies indicate that the less prescriptive requirements in PR19 may have incentivised companies to target cheaper storm overflow schemes. Whereas in PR24 there is a focus on delivering high priority storm overflows to meet the 2035 Storm Overflows Discharge Reduction Plan targets.

While lower benefit:cost ratios could be driven by schemes having higher costs for reasons not explained in our models, it may also be because of having higher costs for reasons captured in our models, or because of relatively low benefits. We found that many storm overflows schemes have low benefit:cost ratios due to the low benefit as the impact on the environment is minimal or hard to evaluate, and schemes can be high cost due to the volume of storage required, as opposed to the relative cost per m^3. That does not necessarily mean that there is a systematic cost efficiency difference between storm overflows in the past and the PR24 programme.

Overall, we think that both forecast and historical data provide important information on the efficient cost of the PR24 storm overflows programme. We explain our final decisions in relation to using forecast and historical models in section 3.4.

3.3 Selected models

We set out our selected models in the following tables:

- storm overflow models at the network (table 4);
- storm overflow models at the STWs (table 5); and
- FFT models (table 6).

We have selected these models after reviewing different alternative specifications and taking into account stakeholders responses to draft determinations. The estimated coefficients of all drivers have the correct sign, are of a reasonable magnitude, and are statistically significant.

Models estimated using forecast data (SO1 and SO2; FFT1 and FFT2) tend to explain more variation in forecast costs (as indicated by adjusted R-squared) than the historical models (SO3 and SO4; FFT3 and FFT4) explain variation in historical costs. This does not mean the forecast models are more robust. Instead, this is likely to be because companies have developed their business plan proposals using similar benchmarking approaches, which reduces heterogeneity in company costs. Using models means companies develop the same cost for the same schemes. In contrast, in the historical data similar schemes could have different costs due to random cost shocks that are not present in the forecast data.

Table 4: Scheme level storm overflows enhancement totex models (network)

Explanatory variable	SO1	SO2	SO3	SO4
Total storage (00s m3)	0.130*** {0.000}		0.098*** {0.000}	
Total storage (00s m3) (log)		0.438*** {0.000}		0.407*** {0.000}
Constant	1.747*** {0.000}	0.250*** {0.004}	1.598*** {0.000}	0.027 {0.626}
Adjusted R-squared	0.714	0.759	0.46	0.456
Observations	1698	1698	236	236
Dataset	Forecast SO	Forecast SO	Historical SO	Historical SO

Table 5: Scheme level storm overflows enhancement totex models (STW)

Explanatory variable	SO2	SO4
Total storage (00s m3) (log)	0.539*** {0.000}	0.354*** {0.000}
Constant	-0.096** {0.021}	-0.490*** {0.000}
Adjusted R-squared	0.626	0.368
Observations	547	254
Dataset	Forecast SO	Historical SO

Table 6: Scheme level storm overflows enhancement totex models (FFT)

Explanatory variable	FFT1	FFT2	FFT3	FFT4
Capacity increase (l/s)	0.091*** {0.000}		0.053*** {0.000}	
Capacity increase (l/s) (log)		0.579*** {0.000}		0.618*** {0.000}
Constant	2.680*** {0.000}	-0.226* {0.070}	2.138*** {0.000}	-0.725*** {0.000}
Adjusted R-squared	0.758	0.685	0.923	0.489
Observations	90	90	143	143
Dataset	Forecast FFT	Forecast FFT	Historical FFT	Historical FFT

3.4 Efficiency benchmark

What we said in our draft determinations

At draft determinations we set an upper quartile efficiency challenge for storm overflows schemes in the network and a median efficiency challenge for storm overflows schemes at the STWs. For FFT schemes, we applied the company level combined storm overflows grey / grey-green hybrid storage efficiency challenge as our best available estimate of company efficiency. We cross-checked our storm overflow model outputs against available outturn data as well as external benchmarks to arrive at a stretching but achievable efficiency challenge. Our efficiency challenges were informed by engineering rationale that suggests cost of storm overflows at STWs tend to be lower than at the network.

Stakeholders' representations

Companies generally supported our overall approach to modelling storm overflows but were cautious that it is relatively simple due to the use of a single cost driver. The companies that did raise disagreements generally represented against the upper quartile challenge for network storm overflow model.

Northumbrian Water said it is not convinced by the analysis provided to inform the upper quartile challenge on network schemes. It stated that the same challenge should not be applied to all companies, as it is challenged more under an upper quartile efficiency challenge, due to having smaller schemes. The company also excluded outlier companies from its analysis and showed how the network efficiency challenge changes significantly. It stated that this shows the network challenge is not robust from a statistical perspective.

United Utilities argued that our approach to setting upper quartile efficiency challenge for network schemes is not transparent. The company stated that it is not clear what benchmarks we used and whether we controlled for exogenous characteristics of schemes when making our assessment.

Wessex Water and Yorkshire Water did not agree with the application of an upper quartile benchmark, with Yorkshire Water arguing that the choice of benchmark does not correspond to model quality.

Our assessment and reasons

We have developed new models using historical data of company delivery in final determinations. These models provide additional evidence of the efficiency of the delivery of storm overflow schemes in the 2015-20 and 2020-25 price control periods and delivery of FFT schemes in the 2020-25 period.

Historical data is an important tool to validate company forecasts and help impose a well-justified efficiency challenge, compared to relying on forecast models alone. Since historical data provides evidence of delivery of schemes in recent periods, it provides a robust and defensible benchmark which we can compare to the stringency of the benchmarks we set on forecast data.

Tables 7-9 set out modelled allowances for the three types of models we are considering, excluding Cook's distance outliers for each company under the forecast and historical models. Since we retain engineering outliers within our models, we do not exclude them from the tables below even though we have undertaken a deep dive assessment for these schemes. We also apply log-bias adjustment as explained in section 3.2.2.

Table 7: Network grey / grey-green hybrid modelled allowances excluding Cook's distance outliers (£ million, 2022-23 prices)

Company	Request	SO1	SO2	SO3	SO4
Anglian Water	168.29	213.48	205.70	176.30	183.70
Dŵr Cymru	814.81	956.42	866.82	757.40	749.59
Hafren Dyfrdwy	1.15	3.84	3.16	3.46	3.05
Northumbrian Water	437.52	449.79	456.65	386.69	419.53

Severn Trent	709.24	816.85	789.07	697.83	720.94
South West Water	393.42	477.67	454.58	414.17	421.19
Southern Water	326.10	312.26	329.44	257.76	294.17
Thames Water	192.10	167.88	197.38	138.01	175.46
United Utilities	1307.98	965.37	1036.24	820.70	944.01
Wessex Water	213.00	249.71	265.86	209.79	240.21
Yorkshire Water	866.00	816.34	824.70	706.18	760.90
Total	**5429.60**	**5429.60**	**5429.60**	**4568.29**	**4912.74**

Table 8: STW grey / grey-green hybrid modelled allowances excluding Cook's distance outliers (£ million, 2022-23 prices)

Company	Request	SO2	SO4
Anglian Water	187.96	282.88	113.45
Dŵr Cymru	66.82	82.46	37.39
Hafren Dyfrdwy	1.95	6.61	3.76
Northumbrian Water	78.85	71.38	35.24
Severn Trent	382.88	434.56	188.31
South West Water	106.14	121.04	54.18
Southern Water	147.45	152.23	68.20
Thames Water	415.33	258.50	116.90
United Utilities	421.73	345.99	137.04
Wessex Water	105.99	131.03	53.90
Yorkshire Water	253.32	281.75	154.83
Total	**2168.42**	**2168.42**	**963.20**

Table 9: Flow to full treatment modelled allowances excluding Cook's distance outliers (£ million, 2022-23 prices)

Company	Request	FFT1	FFT2	FFT3	FFT4
Anglian Water	44.73	44.93	44.45	30.28	35.33
Dŵr Cymru	60.18	113.77	105.23	83.09	79.58
Hafren Dyfrdwy	7.90	25.09	25.57	18.10	19.44
Northumbrian Water	0.00	0.00	0.00	0.00	0.00
Severn Trent	0.00	0.00	0.00	0.00	0.00
South West Water	111.06	75.80	81.25	47.77	66.32
Southern Water	0.00	0.00	0.00	0.00	0.00
Thames Water	120.97	101.26	119.64	68.36	94.03
United Utilities	110.12	88.11	90.14	64.66	67.68
Wessex Water	0.00	0.00	0.00	0.00	0.00

Yorkshire Water	92.33	98.32	81.02	59.23	68.92
Total	**547.29**	**547.29**	**547.29**	**371.49**	**431.30**

Overall, we see across all three models the sector allowances are lower when using the historical models. This suggests that on average historical schemes were delivered at a lower cost compared to companies' forecast in their draft determinations representations:

- storm overflows network schemes are 15% more expensive than historical costs;
- storm overflows STWs schemes are 125% more expensive than historical costs; and
- FFT schemes are 36% more expensive than historical costs.

That highlights the important role historical cost benchmarking plays in identifying what companies have achieved in the past as it can be used to challenge PR24 forecasts.

As explained in section 3.2.3, we recognise that the PR24 storm overflows programme has some different characteristics to the PR19 programme. That includes a higher focus on providing alternative green and / or other storage and that targeting priority sites reduces the scope for companies to prioritise low cost / high impact sites. However, we are confident that historical cost still provides good and equally valid information of the level of efficient cost in the PR24 period as forecast data, because the bulk of the schemes remain grey, and the bulk of costs are related to building standard concrete tanks, for which there is no evidence of a fundamental change in requirements going forward. We recognise that some of the ancillary work might be higher cost, but our engineering experts do not consider that this fully explains the difference in costs between the historical and forecast models.

Overall, we find that both the historical and forecast models provide important information on the efficient costs of storm overflows and FFT schemes. Therefore, for the network storm overflows and FFT models we assign equal weights to historical and forecast models. We implement this by giving each of the four models a triangulation weight of 25% and we do not apply any further catch-up efficiency challenge.

This approach may be conservative. In other settings like base costs, we use historical data only to set efficient allowances. On balance, we recognise that costs could be higher in the 2025-30 period compared to the past when comparing the costs of like-for-like schemes because of the reasons set out above. So, we consider placing equal weight on historical and forecast models across network and FFT models strikes the right balance between providing companies with a sufficient allowance, while making sure that customers do not pay for company inefficiency. The final determinations efficiency challenge for network schemes using a mix of historical and forecast models is less stringent than allowances when applying the upper quartile challenge on forecast data that we used in draft determinations.

For STW storm overflows models we continue to use the forecast log model only (SO2) with a median efficiency challenge as at draft determinations. This is due to the historical cost data providing a very stringent efficiency challenge which we do not consider is appropriate. That suggests that STW schemes might exhibit more systematic differences between the historical and forecast dataset. Given the low historical cost of providing traditional grey solutions at STW compared to the network, the forecast costs appears to be impacted more significantly by green / other elements, which companies state is because the green / other elements of a STW scheme often need to be implemented in the network (eg surface water separation has to occur at the source, and not at the receiving STW) and so do not benefit from the historic efficiency of STW grey storage. United Utilities states that historically STW schemes have been either below ground open tanks, or above ground tanks which are more efficient to construct than below ground covered tanks, whereas a greater proportion of the forecast costs relate to below ground covered tanks, with planning constraints and odour control given as justification.

Tables 10-12 below set out our modelled allowances for storm overflow network and STW schemes and FFT schemes. Allowances are before the application of frontier shift efficiency and real price effects. The allowances also exclude the assessment of Cook's distance outliers.

Table 10: Network grey / grey-green hybrid modelled allowances excluding Cook's distance outliers – triangulated (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	£m
Anglian Water	168.29	194.79	26.50	16%
Dŵr Cymru	814.81	832.56	17.75	2%
Hafren Dyfrdwy	1.15	3.38	2.23	195%
Northumbrian Water	437.52	428.17	-9.36	-2%
Severn Trent Water	709.24	756.17	46.93	7%
South West Water	393.42	441.90	48.48	12%
Southern Water	326.10	298.41	-27.70	-8%
Thames Water	192.10	169.68	-22.41	-12%
United Utilities	1307.98	941.58	-366.40	-28%
Wessex Water	213.00	241.39	28.39	13%
Yorkshire Water	866.00	777.03	-88.97	-10%
Total	**5429.60**	**5085.06**	**-344.54**	**-6%**

Table 11: STW grey / grey-green hybrid modelled allowances excluding Cook's distance outliers (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	£m
Anglian Water	187.96	249.24	61.28	33%
Dŵr Cymru	66.82	72.65	5.84	9%

Company	Request	Allowance	Allowance minus request	
			£m	£m
Hafren Dyfrdwy	1.95	5.82	3.87	199%
Northumbrian Water	78.85	62.89	-15.96	-20%
Severn Trent Water	382.88	382.88	0.00	0%
South West Water	106.14	106.65	0.51	0%
Southern Water	147.45	134.13	-13.32	-9%
Thames Water	415.33	227.76	-187.57	-45%
United Utilities	421.73	304.84	-116.89	-28%
Wessex Water	105.99	115.45	9.46	9%
Yorkshire Water	253.32	248.24	-5.08	-2%
Total	**2168.42**	**1910.55**	**-257.87**	**-12%**

Table 12: Flow to full treatment modelled allowances excluding Cook's distance outliers – triangulated (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	£m
Anglian Water	44.73	38.75	-5.98	-15%
Dŵr Cymru	60.18	95.42	35.24	37%
Hafren Dyfrdwy	7.90	22.05	14.15	64%
Northumbrian Water	0.00	0.00	0.00	
Severn Trent Water	0.00	0.00	0.00	
South West Water	111.06	67.78	-43.28	-64%
Southern Water	0.00	0.00	0.00	
Thames Water	120.97	95.82	-25.15	-26%
United Utilities	110.12	77.65	-32.48	-42%
Wessex Water	0.00	0.00	0.00	
Yorkshire Water	92.33	76.87	-15.46	-20%
Total	**547.29**	**474.34**	**-72.95**	**-15%**

3.5 Post modelling adjustments

At draft determinations we added the allowance for outliers and non-modelled schemes that we assessed outside of the econometric models to calculate a total storm overflow allowance. We then applied a reconciliation adjustment to the total allowances for each company so that we provide allowances for cost requests consistent with totals requested in business plan data tables CWW3, CWW12 and CWW17. A reconciliation was required as some companies had a variation between the IN23/05 scheme level dataset totex and the business plan data table totex.

We continue to use the same approach for final determinations as discussed below.

3.5.1 Outlier treatment and unmodelled schemes

Modelled outliers

At final determinations, we continue to identify outliers using the Cook's distance statistic as set out in section 2.3, and engineering outliers as outlined in section 2.3.2. These schemes are subject to deep dive assessments and where justified we provide additional allowances on top of the modelled allowances.

Engineering outlier identification

We identify potential engineering outliers through company representations and a review of the datasets to determine:

- is there compelling evidence that the additional costs identified are not included in our enhancement model approach?
- is there compelling evidence that the allowances would, in the round, be insufficient to account for evidenced special factors without an enhancement model adjustment?
- is there compelling econometric or engineering evidence that the factor(s) identified would be a material driver of costs?

For storm overflows, this involved a specific focus on solutions with high proportions of green / other storage. This allows us to promote best value by accounting for company proposals that achieve greater benefits than traditional solutions, but at a higher cost, for the delivery of which the model allowances would in the round be insufficient. That could disadvantage companies that have adopted the best value approach that we have promoted throughout the price review process.

This included identification of catchment solutions, where:

- storage is applied across the network for overall catchment level benefits including significant green infrastructure;
- where schemes were identified as having high percentages of green equivalent storage volume; or
- where companies proposed innovative approaches, such as Local Authority led delivery of SuDS.

The engineering outlier schemes were then assessed via deep dives. The schemes were reviewed alongside company submitted evidence and compared with other datasets, including assessing the green equivalent storage cost against the costs proposed under the green only storage model, and other similar programmes such as flooding and A-WINEP. This allowed us to identify where the green elements of the hybrid schemes were efficient and to provide sufficient funding to account for the evidenced special factors.

We have also considered company representations where they provide evidence for higher allowances due to engineering construction challenges. As the models include a wide range of schemes, and some companies have no, or very few outliers, we consider that an efficient company should be able to deliver a programme of schemes with a range of ground conditions and site constraints within the modelled allowance. Allowing a higher allowance for a small number of schemes with relatively challenging ground conditions and site constraints could lead to cherry picking, and so we are cautious when assessing these types of schemes.

United Utilities provided additional evidence for 90 schemes where there was a large cost gap. The majority of these schemes were traditional grey storage solutions. The company identified costs for 23 scheme specific 'additional' items, including contaminated land, dewatering, rock excavation, mine workings, power supply, ground profile, piling, land purchase, and AMP8 opex, suggesting that other companies had either not included these in their cost request, or that the impact on United Utilities was greater than on other companies.

To assess the accuracy of this assertion, we requested information from all companies on the extent to which the main factors identified were included within their historical costs and forecast cost models. The majority of companies indicated that they had based their forecast costs on high level top down cost modelling, predominantly driven by storage volume (m^3). This was informed by historical costs that included the majority of factors identified, although there was some variance in the extent to which companies had historically been impacted by some factors, such as rock excavation and mine working.

Based on historical data the identified factors accounted for between 1.4% and 4% of scheme totex, with United Utilities own data indicating that these factors accounted for around 2% of its historic cost, whereas United Utilities forecast costs for these items was around 10%. Companies stated that they included risk and optimism bias to cover additional uncertainty around the impact of these and other factors.

While there was some evidence provided in support of the risk of these items at different sites, the evidence was not compelling that the scale of the additional allowance was commensurate with the risk. In addition, we also identified that United Utilities storage tank costs alone were higher than the benchmark for full scheme costs, and so these factors alone did not explain the inefficiency.

Where United Utilities schemes were assessed as inefficient, we used the scheme level data submitted and additional query responses, including the information on exogenous factors, to deep dive and assess the extent to which the company had provided compelling evidence to justify higher allowances, and applied a cost gap efficiency challenge based on the evidence provided.

Large scheme gated allowance

Where the requested scheme value was greater than £100 million and we have concerns around scope, cost, deliverability, complexity or if schemes involve novel elements or complex technologies, we assessed the schemes under either:

- **Enhanced engagement and cost sharing** – this is a lighter touch approach rather than a formal gated process for schemes where there is cost uncertainty; or
- **Large schemes gated approach** – this is a full gated approach for schemes where we had significant concerns around scope, cost and complexity and if it is novel.

Further details of our approach to large schemes are provided within 'PR24 final determinations: Expenditure allowances'.

Other assessments

As explained in section 3.1 only schemes for which companies provided the relevant cost drivers (ie cost and equivalent storage) could be included in the grey / grey-green hybrid network and STW models. Within the scheme level datasets there were additional scheme expenditure included which were assessed separately.

Screen only

The majority of storm overflow storage schemes had costs for EnvAct IMP5 6mm 2D screen improvements included, so were assessed within the grey / grey-green hybrid models. Where companies provided screen costs separately, but the storm overflow also had a storage solution, the costs were combined and assessed as a single solution. For storm overflows that were included with a provision for a screen only, and no storage, the schemes were assessed as a screen only solution.

Five companies present screen-only schemes, at a total request of £30 million for 119 schemes. A median unit cost was used to calculate a screen only cost and applied to the total number of screen only schemes to calculate the allowance per company.

Wetlands

Wetland solutions to reduce storm overflow spill frequency were not included in the scheme level modelling. Seven companies provided costs for wetlands; the total cost request was £278.9 million.

At draft determination, wetlands were initially assessed using number of schemes, total wetland equivalent storage and total wetland area (ha). However, it was determined that the data was not robust enough to use this approach. Instead, allowances were capped at the second highest unit cost request with all other companies receiving their cost request. As the dataset was similarly non-robust at final determinations, we calculated the median unit cost per hectare. Costs above the median were assessed further through deep dives where material and shallow dives where non material. Companies that were efficient against the median were passed through without challenge.

This gave a shallow dive efficiency challenge to two companies, a deep dive challenge to one company, with the other four companies receiving their requested costs.

Companies must comply with their legal obligations including under Environmental Agency permits and regulation 4 of the Urban Waste Water Treatment (England and Wales) Regulations 1994. Defra, the Environment Agency and Ofwat have been engaging with companies about trials for alternative treatment solutions for groundwater ingress activated storm overflows[14]. If wetlands are determined not to be a suitable storm overflow spill reduction solution by reference to these legal requirements, the companies will have to provide alternative solutions to meet the required spill frequency for each storm overflow. The storm overflow uncertainty mechanism allows companies additional revenues if required to deliver solutions in period. If the trial has not commenced, we would expect companies to return the funding for wetlands solutions in this instance. If the scheme has been delivered in full, in accordance with the requirements of the trial, and the company has spent all of its wetlands allowance, then the company can request additional funding for an alternative solution under the uncertainty mechanism.

Green only

Storm overflow storage schemes that included both grey and green storage were assessed in the network grey / grey-green hybrid or the STW grey / grey-green hybrid econometric models. Where schemes had only green storage they were assessed separately in the green only storage model. This reflected the expectation that schemes with green-only storage will cost more, and could potentially be under funded if included in the grey-green hybrid model.

The green-only model uses the total equivalent storage against the total requested cost to calculate a unit cost for green storage. This unit cost was then used to benchmark companies against each other to establish an efficient cost per m^3 for green-only storage.

The total requested cost for the green-only sub-model at final determination was £198.9 million across six companies.

At draft determination, given the range of solutions proposed under this line, and the limited historical cost base, we allowed companies their requested costs capped at the second

[14] As outlined in a letter from Defra to sewerage companies dated 9 August 2024.

highest unit cost, to encourage companies to deliver green-only schemes at PR24 so that we can better inform alternatives to grey storage for future periods.

At final determination we used the green only unit costs from draft determinations as an initial benchmark to assess company programme efficiency. Five of the six companies provided programme costs more efficient than this value, so cost requests were passed through without challenge. United Utilities provided a unit cost higher than this value, so was given an efficiency challenge based on the green-only unit cost allowed at draft determinations. We continue to allow higher than median unit cost for green storage to encourage companies to deliver green-only schemes.

No model

Some companies included some WINEP schemes in their scheme level datasets which have no output, and in some cases no costs. These schemes therefore could not be included in the scheme level grey / grey-green hybrid modelling. Schemes were identified and queried, where companies provided explanation as to no outputs for the schemes the costs were passed through as they were not material.

The significant expenditure included in the No Model element of the storm overflow model was the UUW A-WINEP scheme which was assessed separately through deep dive and established as efficient.

Southern Water AMP9 delivery expenditure

Southern Water provided some scheme level data that passed beyond the 2025-30 enhancement period, with completion dates of 2035. This approach is referenced in the business plan and the specific schemes were included in their business plan tables.

We exclude all Southern Water schemes with a completion date after 2030 from the models. Instead, we apply efficiency challenge factors based on the efficiency of the company's storm overflow schemes delivered in the 2025-30 period. When calculating final allowances, we only include the proportion of expenditure for the 2030-35 schemes forecast in the 2025-30 period. The rest of the enhancement costs for the schemes that are being delivered by 2035 will need to be requested and assessed as part of PR29.

3.5.2 Reconciliation adjustment

Companies provided scheme level storm overflow data as part of additional data tables ADD20. In conjunction with this, companies also provided expenditure for storm overflows in their business plan data tables, under CWW3.15-CWW3/48, as well as CWW12 (transitional funding) and CWW17 (accelerated funding).

We identified differences between the totex values provided in ADD20 and CWW3, CWW12 and CWW17. We queried companies to allow the best match between the two datasets. From this we established a percentage difference between the two datasets for each company.

As we did at draft determination, we used the expenditure and outputs provided in the scheme level dataset ADD20 to calculate the modelled allowance. Post-modelling we then reconciled the modelled allowance back to the business plan data table CWW3, CWW12 and CWW17 totex using the company specific percentage as shown in table 13.

Table 13: Total requests differences between CWW3 and IN23/05 storm overflow data (£ million, 2022-23 prices)

Company	Business Plan CWW3.15-3.48 totex	Storm overflows and FFT totex (ADD20)	Difference (£m)	Reconciliation factor (%)
Anglian Water	624.13	625.46	1.33	1.00
Dŵr Cymru	1046.76	1049.18	2.42	1.00
Hafren Dyfrdwy	11.34	11.51	0.17	1.00
Northumbrian Water	1072.28	1056.58	-15.70	0.98
Severn Trent Water	1527.21	1527.31	0.10	1.00
South West Water	708.95	708.82	-0.13	1.00
Southern Water	1132.33	1129.57	-2.76	1.00
Thames Water	850.35	870.50	20.15	0.98
United Utilities	3188.15[15]	3195.58	7.43	1.01
Wessex Water	505.79	500.36	-5.42	1.01
Yorkshire Water	1550.73	1550.89	0.17	1.00
Total	**12218.00**	**12225.78**	**7.77**	

Tables 14-16 set out our final allowances for network grey / grey-green hybrid and STW grey / grey-green hybrid schemes and FFT schemes including outliers and after reconciliation adjustments. These allowances also apply an additional cost gap adjustment to reflect our assessment of the engineering outliers.

[15] United Utilities has included an additional £250 million top down challenge to its grey / grey-green hybrid storage schemes, reflecting that it may find efficiencies during the delivery of its storm overflows programme. This has been taken into account in the subsequent tables.

Table 14: Network grey / grey-green hybrid modelled allowances including outliers (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	206.36	232.87	26.50	13%
Dŵr Cymru	871.72	889.47	17.75	2%
Hafren Dyfrdwy	1.66	3.89	2.23	135%
Northumbrian Water	614.46	612.33	-2.12	0%
Severn Trent	804.17	851.10	46.93	6%
South West Water	452.48	494.12	41.63	9%
Southern Water	565.77	481.52	-84.25	-15%
Thames Water	192.10	169.85	-22.24	-12%
United Utilities	1784.00	1303.84	-480.16	-27%
Wessex Water	213.00	239.40	26.40	12%
Yorkshire Water	1131.99	1057.51	-74.48	-7%
Total	**6837.70**	**6335.89**	**-501.81**	**-7%**

Table 15: STW grey / grey-green hybrid modelled allowances including outliers (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	284.43	345.71	61.28	22%
Dŵr Cymru	66.82	72.65	5.84	9%
Hafren Dyfrdwy	1.95	5.82	3.87	199%
Northumbrian Water	442.13	426.17	-15.96	-4%
Severn Trent	629.69	629.69	0.00	0%
South West Water	111.30	116.25	4.95	4%
Southern Water	327.92	293.70	-34.22	-10%
Thames Water	423.17	380.08	-43.09	-10%
United Utilities	673.13	518.86	-154.27	-23%
Wessex Water	105.99	115.45	9.46	9%
Yorkshire Water	321.26	326.09	4.83	2%
Total	**3387.79**	**3230.48**	**-157.31**	**-5%**

Table 16: flow to full treatment modelled allowances including outliers (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request

Anglian Water	45.06	39.08	-5.98	-13%
Dŵr Cymru	94.07	120.94	26.87	29%
Hafren Dyfrdwy	7.90	22.05	14.15	179%
Northumbrian Water	0.00	0.00	0.00	
Severn Trent	0.00	0.00	0.00	
South West Water	111.06	67.78	-43.28	-39%
Southern Water	0.00	0.00	0.00	
Thames Water	167.84	142.69	-25.15	-15%
United Utilities	248.71	176.77	-71.94	-29%
Wessex Water	61.04	34.61	-26.43	-43%
Yorkshire Water	92.33	76.87	-15.46	-17%
Total	**828.01**	**680.80**	**-147.21**	**-18%**

Table 17 sets out the final allowances showing the aggregation of total scheme level modelled allowances and unmodelled allowances and applying the reconciliation adjustments.

Table 17: Econometric modelling and non-modelled allowances after reconciliation adjustment (£ million, 2022-23 prices)

Company	**Modelled allowances**	**Unmodelled allowances**	**Allowance before recon adj.**	**Reconciliation factor**	**Allowance after recon adj.**
Anglian Water	617.66	88.12	705.77	1.00	704.27
Dŵr Cymru	1083.06	16.58	1099.63	1.00	1097.08
Hafren Dyfrdwy	31.76	0.00	31.76	1.00	11.34
Northumbrian Water	1038.50	0.00	1038.50	0.98	1022.90
Severn Trent	1480.79	93.45	1574.25	1.00	1574.53
South West Water	678.16	28.81	706.97	1.00	708.70
Southern Water	775.22	236.40	1011.62	1.00	1011.55
Thames Water	692.63	65.24	757.87	0.98	740.32
United Utilities	1999.47	233.95	2233.43	1.01	2266.61
Wessex Water	389.46	120.34	509.79	1.01	515.32
Yorkshire Water	1460.48	5.08	1465.55	1.00	1465.39
Total	**10247.17**	**887.97**	**11135.14**		**11118.01**

Table 18 sets out the final storm overflows allowances combining modelled and unmodelled schemes compared to company requests.

Table 18: Final allowances for storm overflows (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	624.13	704.27	80.14	13%
Dŵr Cymru	1046.76	1097.08	50.32	5%
Hafren Dyfrdwy	11.34	11.34	0.00	0%
Northumbrian Water	1072.28	1022.90	-49.38	-5%
Severn Trent	1527.21	1574.53	47.32	3%
South West Water	708.95	708.70	-0.25	0%
Southern Water	1132.33	1011.55	-120.78	-11%
Thames Water	850.35	740.32	-110.03	-13%
United Utilities	2938.15	2266.61	-671.53	-23%
Wessex Water	505.79	515.32	9.53	2%
Yorkshire Water	1550.73	1465.39	-85.33	-6%
Total	**11968.00**	**11118.01**	**-850.00**	**-7%**

4. Phosphorus removal

Summary

We use **two forecast models and two historical scheme level models** to set efficient phosphorus removal enhancement allowances at PR24.

We assign **equal weights to historical and forecast models**. We implement this by giving each of the four models a triangulation weight of 25%. We do not apply an additional efficiency challenge since we view more efficient historical delivery imposes an appropriate efficiency challenge.

The key cost drivers of phosphorus removal enhancement activities are **population equivalent (PE) served; enhanced phosphorus permit; historical phosphorus permit; enhanced permit squared; and technically achievable limit (TAL) dummy (permit <= 0.25mg/l).**

Our models create an overall industry cost challenge of 15%.

Since draft determinations we made the following changes:

- **exclude costs for the year "After 2029-30"** (labelled as 2030-31) from the forecast dataset and operating costs for the year "After 2025-26" (labelled as 2030-31) from the historical dataset.
- **use a scheme level econometric modelling approach to determine efficient costs for transfer schemes**. At draft determinations, we treated these schemes as unmodelled and funded through the reconciliation adjustment factor that implicitly applied the company challenge to these schemes.
- **remove schemes with enhanced permits >= 2mg/l** as "optimisation schemes". This improves our models as the optimisation schemes are unrepresentative of a typical scheme in PR24. We treat these schemes as unmodelled.
- **apply the company level modelled efficiency of phosphorus removal schemes to unmodelled schemes**. This approach effectively assumes that company specific inefficiency is equivalent across modelled and unmodelled schemes. For efficient companies, we cap allowances at the request.
- **identify schemes with tight phosphorus permits <0.25mg/l as engineering outliers**. After undertaking our assessment, we apply a 75% cost gap adjustment to these schemes.
- **identify schemes with a biological treatment component as engineering outliers**. After undertaking our assessment, we apply a 75% cost gap adjustment to these schemes.

Excessive nutrients (phosphorus and nitrogen) in waterbodies leads to a process called eutrophication. Eutrophication can lead to algal blooms and excess vegetation growth which deplete oxygen levels and have detrimental environmental impacts on ecosystems with a harmful impact on aquatic life. There are multiple contributing factors to excessive nutrients in waterbodies in England and Wales. Sewage treatment works (STW) effluent discharges from the water sector account for a share of this.

The PR24 WINEP / NEP contains statutory requirements for water companies to undertake a programme of works that remove nutrients before discharging to waterbodies. These upgrades help to reduce the level of nutrients and improve the ecological status of relevant waterbodies. In particular, the WINEP / NEP phosphorus removal programme for the sector is extensive, covering a large number of STW upgrades across all companies.

Companies requested £5.8 billion to enhance phosphorus removal, based on requirements set out in WINEP / NEP. Phosphorus removal enhancement is the second largest area of enhancement after storm overflows, and is much larger than in PR19 when we allowed companies £3.3 billion to enhance phosphorus removal.

The large PR24 phosphorus removal enhancement programme created a need for us to reconsider the most appropriate approach to assessing efficient phosphorus removal enhancement costs.

At PR19, we used company level models with one observation per wastewater company, which aimed to capture the scale and complexity of each company's phosphorus removal programme. We reassessed the performance of the PR19 company level models for PR24. However, the models were not sufficiently robust to help set efficient phosphorus removal enhancement allowances. In particular, the estimated coefficients on the treatment complexity and economies of scale drivers had a counterintuitive negative sign, suggesting:

- a higher number of phosphorus removal schemes for a company leads to lower costs. That is contrary to engineering rationale that suggests that a higher number of schemes is associated with lower opportunities for economies of scale and higher costs; and
- a higher number of phosphorus removal schemes with a phosphorus permit below 0.5 mg/l leads to lower costs. That is also contrary to engineering rationale as schemes subject to tight permits below 0.5 mg/l are more likely to require additional and / or more complex treatment processes. Therefore, companies with a higher number of complex schemes (with a tight permit <= 0.5mg/l) should have higher costs.

We subsequently decided to explore more granular scheme level econometric models to help assess efficient phosphorus removal enhancement costs at PR24. We have access to a large dataset of historical and forecast phosphorus removal schemes, which allows us to capture the complexities of each company's programme more accurately. We can also benchmark efficient costs with historical and forecast data.

Scheme level benchmarking also allows us to set an allowance more clearly for each upgrade at a sewage treatment works (STW). This is important in the context of Price Control Deliverables (PCDs) that will return money to customers if the company does not deliver the upgrade included in its allowance.

The rest of this section considers stakeholder representations on our scheme level phosphorus removal modelling approach at draft determinations as well as our response to these views that lead to our final determinations view.

4.1 Data used

What we said in our draft determinations

We used two datasets to assess phosphorus removal enhancement costs:

- **APR Table 7F dataset,** which contains historical scheme level data on cost and cost drivers of the PR19 WINEP / NEP phosphorus removal programme.
- **BPT Table CWW19 dataset,** which contains forecast scheme level data on cost and cost drivers of the PR24 WINEP / NEP phosphorus removal programme.

The datasets included key information which we used as part of the modelling process including **yearly opex and capex, PE served** in addition to **historical and enhanced phosphorus permit levels**.

After producing efficient modelled allowances, we applied a reconciliation adjustment to correct for three implementation issues:

- exclude costs after 31 March 2030 from efficient allowances;
- fund schemes we removed from our model (such as transfers); and
- account for differences in business plan requested costs between scheme level data (CWW19) and aggregate phosphorus removal enhancement costs (CWW3, CWW12 and CWW17).

Stakeholders' representations

We received some comments on the way we use historical and forecast datasets to inform our assessment of phosphorus removal enhancement costs.

Severn Trent Water recommended the use of a log functional form. It also considered dropping observations where significant activity is not taking place (for example optimisation solutions). It said optimisation solutions are not comparable with full build solutions. It suggested, for the purposes of model estimation, removing schemes that cost less than £1 million where assets are not built and the intervention is very low cost, can further improve the modelled outcome.

Severn Trent Water, Southern Water and South West Water support modelling using cost and cost driver information up to and including the year 2029-30. They said schemes with significant spend after 2029-30 can be treated separately.

Wessex Water suggested that Anglian Water report its final effluent monitoring costs of phosphorus removal schemes as a separate line. The company said these costs are included against individual schemes in its own submission. Therefore, it argued that allocating monitoring costs across all of phosphorus schemes for Anglian Water will result in a more appropriate cross-company comparison.

Severn Trent Water said we should consider an alternative assessment for unmodelled schemes. At draft determinations, these schemes were dropped for modelling purposes and funded through the reconciliation adjustment factor that implicitly applied the company challenge to these schemes. It suggested a deep dive approach or using the supply interconnector model to determine efficient costs for transfer schemes.

The Environment Agency recommends separate assessments for chemical and biological phosphorus removal options. It suggests that this would avoid limits on innovation for biological treatment options where these can support sustainability, flexibility and resilience of chemical supply. United Utilities said biological phosphorus removal is the best value way to meet tight phosphorus permits. It also argued biological schemes have a lower whole life cost when compared to chemical solutions. It did not agree with treating chemical and biological solutions the same. It suggested providing an additional allowance for schemes with a biological component.

Our assessment and reasons

We used the following data sources to assess phosphorus removal enhancement costs:

- **APR Table 7F dataset,** which contains historical scheme level data on cost and cost drivers of the PR19 WINEP / NEP phosphorus removal programme for a seven-year period from the first year before the price control period to an "After 2024-25" (labelled as 2025-26 in the dataset). The dataset contains company forecasts for the years 2024-25 to 2025-26.
- **BPT Table CWW19 dataset,** which contains forecast scheme level data on cost and cost drivers of the PR24 WINEP / NEP phosphorus removal programme for a seven-year period from the first year before the price control period to an "After 2029-30" (labelled as 2030-31 in the dataset).

We used the following key information from the data sets to develop our models:

- **yearly opex and capex;**
- **PE served** – the population equivalent that the STW serves in each year;
- **historical phosphorus permit level** – the old phosphorus permit level at the STW prior to the phosphorus removal upgrade; and
- **enhanced phosphorus permit level** – the new phosphorus permit level at the STW required in the WINEP / NEP.

Our scheme level models focus on providing an allowance for conventional phosphorus removal schemes, which are included in the following enhancement lines in business plan Table CWW3:[16]

- treatment for phosphorus removal (chemical) (WINEP / NEP) – lines CWW3.64 – CWW3.66; and
- treatment for phosphorus removal (biological) (WINEP / NEP) – lines CWW3.67 – CWW3.69.

We assessed the costs of chemical and biological treatment together as the number of biological schemes was relatively small and dominated by a small number of companies. The cost drivers are also the same across both treatment types. However, we recognise that biological phosphorus removal can be more complex than chemical removal and has longer term environmental benefits due to lower use of chemicals. Therefore, to capture the unique characteristics of biological phosphorus removal schemes, we treated them as engineering outliers. Section 4.5.1 provides more detail of our approach to outliers.

We assessed other schemes, including nature-based solutions, catchment nutrient balancing and catchment permitting separately where companies have included expenditure in these costs' lines in CWW3.

We reviewed the data in Table 7F extensively following the 2023-24 Annual Performance Report (APR) publication. We raised queries with companies where needed to improve data quality. We shared an aggregated scheme level dataset from Table 7F with each company to validate their data.

We followed an equally extensive process on scheme level data on cost and cost drivers from BPT Table CWW19. We shared an aggregated scheme level dataset from BPT Table CWW19 with each company to validate their data.

At final determinations, we have changed our approach to funding transfer schemes. Transfer schemes involve transferring sewage from existing sites to a nearby site or to alternative watercourse to avoid the need for investing in treatment upgrade schemes.

[16] We also include the equivalent lines in tables CWW12 (transitional expenditure) and CWW17 (accelerated programme expenditure)

Our phosphorus removal and sanitary parameters datasets contain the two key cost drivers of transfers the **length of the transfer (km)** and the **transferred flow (m3 / day)**. Therefore, we pulled out all information on transfer schemes across all datasets into a standalone transfers dataset. Pooling all transfers schemes gave us a sufficient sample size which we used for scheme level econometric modelling of transfer schemes. We do not use the supply interconnectors model to determine efficient costs for transfer schemes. We consider it is more appropriate to use the cost and cost driver information relevant to the wastewater transfer schemes directly available in tables CWW19, ADD17 and APR Table 7F.

We agree that Anglian Water should allocate monitoring costs across all of its phosphorus schemes to ensure a more appropriate cross-company comparison. We queried Anglian Water and reflected changes to scheme level data to ensure these costs are included against individual schemes and not as a separate line.

We agree that we should model using cost and cost driver data up to and including the year 2029-30 for transparency. Therefore, for final determinations, we exclude costs for the year "After 2029-30" (labelled as 2030-31 in the dataset) when estimating our model coefficients. We note that only two schemes have significant spend (greater than £5 million) after 2029-30. We do not include these two schemes in our sample when estimating our model coefficients to mitigate the risk of downward bias since the cost over the 2025-26 to 2029-30 period is not representative of the full cost of delivery (that include costs after 2029-30).

We do not use a log functional form for reasons outlined in section 2. However, we agree that optimisation solutions are likely not to be comparable with full build solutions. We considered the impact of optimisation schemes and found some evidence of bias in our estimated coefficients as a result of including these schemes in our sample. Severn Trent Water suggest dropping all schemes with total expenditure less than £1 million. We do not agree with approaches that remove upgrades below any particular totex threshold as this is arbitrary and could result in the removal of non-optimisation upgrades at smaller sewage treatment works.

We tested the following options to identify optimisation solutions:

- dropping all schemes with **enhanced permits >= 2mg/l;** and
- dropping all schemes with **enhanced permits >= 1.5mg/l;** and
- dropping all schemes with a **permit change <= 0.3mg/l;** and
- dropping all schemes with a **permit change <= 0.5mg/.**

For final determinations we remove schemes with enhanced permits >= 2mg/l as "optimisation schemes" when estimating our model coefficients. We assess and fund these schemes separately. We found the models to not be robust to the other scenarios considered. Excluding optimisations to lax permits above 2mg/l is appropriate as these schemes are unrepresentative of a typical scheme that tightens P permit to below 0.5mg/l. We found that this improves model performance and helps to alleviate potential downward bias of our estimated coefficients on enhanced permit.

For final determinations we remove the opex for the year "After 2024-25" (labelled as 2025-26 in the dataset). This operating expenditure is not relevant to the delivery of the PR19 WINEP / NEP phosphorus removal schemes given it is ongoing expenditure that is incurred once the upgrade has been delivered.

Table 19 shows the summary statistics for the 7F and CWW19 datasets representing the total phosphorus removal programme for the industry. We made the following changes to the raw data provided by companies before modelling phosphorus removal allowances:

- Anglian Water and Thames Water have some PR19 schemes that are in the forecast CWW19 dataset as they will not be delivered in the 2020-25 period. PR19 allowances were made for these schemes within the PR19 WINEP uncertainty mechanism. As these schemes are still to be completed, we clawback funding via the PR19 WINEP reconciliation model, and provide allowances for these schemes in the PR19 WINEP carryover model.
- For Severn Trent Water, we included phosphorus removal schemes under Green Recovery in the historical 7F dataset as the company said schemes are going to be delivered in the 2020-25 period. We provide allowances for these schemes in the Green Recovery cost allowance adjustment reconciliation mechanism.

Therefore, the totals in Table 19 do not fully correspond with data in the rest of this section and 'PR24 draft determinations: Expenditure allowances'.

Table 19: Summary statistics for 7F and CWW19 datasets

Variable	DD Forecast	FD Forecast	DD Historical	FD Historical
Number of schemes	993	996	763	761
PE served	16,986,073	17,320,393	15,507,119	15,580,546
Totex	£7bn	£6.9bn	£3.2bn	£3.1bn
Average totex / PE	£409.44	£398.50	£202.83	£198.82
Weighted average enhanced permit (by PE)	0.53	0.52	0.58	0.57
Average PE served per scheme	17,090	17,390	20,324	20,474

The table shows that the PR24 phosphorus removal programme is larger than at PR19 in terms of number of schemes and PE served. The table also shows that the average unit cost per PE is 100% higher than at PR19. This could be driven by factors such as:

- **weighted average enhanced permit (by PE)** - capturing treatment complexity; and
- **average PE served per scheme** – capturing lower scope for economies of scale due to smaller sites receiving upgrades.

Table 19 confirms that PR24 represents a more complex phosphorus removal programme compared to PR19 with smaller sites receiving tighter permit upgrades on average. We aimed to capture these factors in our scheme level models to help explain differences in efficient phosphorus removal enhancement costs between companies.

Finally, we also note that there were some reductions to sector totex requests due to additional scope and changes in company requests in representations to the draft determinations.

4.2 Models considered

4.2.1 Selected cost drivers

What we said in our draft determinations

We used five key exogenous cost drivers of efficient phosphorus removal enhancement costs that we viewed to be important from an engineering and economic perspective:

- **Population equivalent (PE) served** – the key scale / volume driver.
- **Enhanced phosphorus permit** – the key exogenous treatment complexity variable.
- **Historical phosphorus permit** – to capture the extent of pre-existing phosphorus removal processes at each STW.
- **Enhanced permit squared** – to capture a continuous non-linear relationship between enhanced phosphorus permit and the costs of the upgrade.
- **Technically achievable limit (TAL) dummy (permit <= 0.25mg/l)** – to capture a discrete step change in costs at the level of the TAL permit.

We considered but did not use a series of alternative cost drivers such as design PE as the key scale / volume driver (instead of PE served), permit change variables and variables that aimed to capture the lower scope for economies of scale at small STWs.

Stakeholders' representations

Companies generally agreed with the cost drivers used to assess efficient phosphorus removal enhancement costs.

Severn Trent Water, Southern Water, South West Water, Thames Water and United Utilities proposed using design PE over PE served as the key scale / volume driver. Southern Water considered design PE to be more closely aligned with actual costs incurred than PE served since investment is planned to accommodate additional headroom. Severn Trent Water recognised our decision to not include design PE in our models at draft determinations due to concerns that it is endogenous (inside management control). It said using PE served treats all headroom as inefficiency and companies that allow for more risk will appear more efficient. South West Water argued design PE better accounts for 'peak' populations as a result of tourist pressures. Thames Water said design PE is a more appropriate scale driver as enhanced permits are calculated according to Dry Weather Flow (DWF) permits.

Wessex Water generally agreed with the cost drivers used at draft determinations. It considered a threshold of 0.7mg/l (instead of our TAL dummy) to be more appropriate. It also suggested that for sites without existing phosphorus limits, Suspended Solids (SS) permit limits could be considered a cost driver.

Thames Water argued that the historical phosphorus removal permit does not impact costs linearly. It stated that starting from a permit of 3mg/l has a different cost impact than starting from a permit of 1mg/l as permits above 1mg/l imply there are not many phosphorus removal assets on site. It also argued it has many more sites at very low permit (<=0.2mg/l). It proposes that these are deep dived or that the model is changed to recognise the higher costs of these sites.

South West Water said that the historical consent assumption of 5mg/l is appropriate only where no other data exists.

Severn Trent Water proposed a variety of alternative models. It suggested a quadratic PE served variable to capture a decreasing economies of scale effect (in combination with a log functional form) in addition to a variable that captures the ratio of design PE to PE served.

Our assessment and reasons

For final determinations, we retain the five key exogenous drivers of efficient phosphorus removal enhancement costs from an engineering and economic perspective. We consider each cost driver we have included in our scheme level models below in addition to our assessment of stakeholder representations.

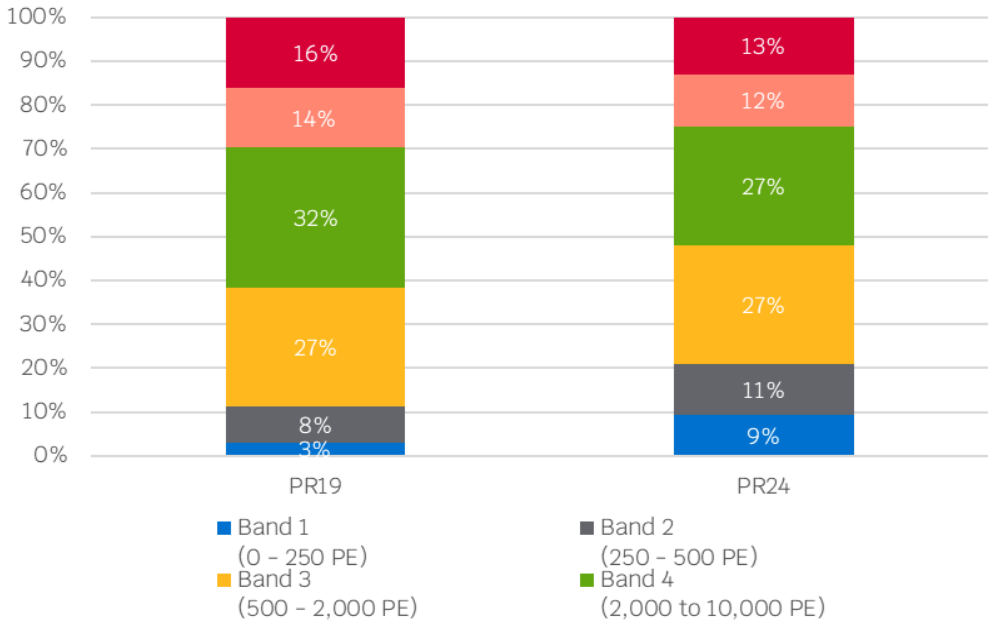
Population Equivalent (PE) served

We used PE served as a key scale / volume cost driver. PE served captures the size of the STWs receiving upgrades for phosphorus removal. All else being equal, STWs that serve a higher PE require higher efficient costs. We used average PE served over the modelling period given the focus on cross-sectional econometric models.

PE served also accounts for economies of scale. That is driven by the constant term in our models, which is fixed and therefore the same for STW of any size. Therefore, everything else being equal, smaller STWs get a higher allowance per PE due to the fixed constant being spread over a lower PE served.

Figure 5 shows the share of phosphorus removal schemes in companies' PR19 and PR24 WINEP / NEP allocated to each of the six size bands we use in our regulatory reporting that capture the size of STWs receiving upgrades. The figure shows that there is a higher share of phosphorus removal schemes in lower bands in PR24 compared to PR19. In PR19, 38% of phosphorus removal schemes were in STWs smaller than 2000 PE, this share is increasing to 49% in PR24. Engineering rationale suggests that this leads to an increase in efficient phosphorus removal enhancement costs in PR24 compared to PR19 due to lower scope for economies of scale.

Figure 5: Share of sewage treatment works by size band – PR19 and PR24



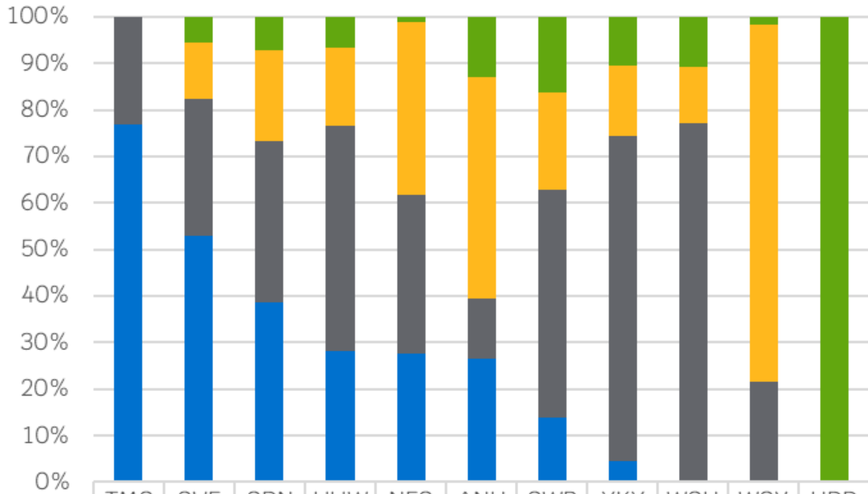
Enhanced phosphorus permit

We use the level of enhanced phosphorus permit as the key exogenous treatment complexity driver. The permit level provides the best indication of the nature of upgrades that companies need to undertake. Engineering rationale suggests it has a negative impact on costs – the higher (less tight) the permit, the lower the efficient costs required to achieve it.

Permits above 0.8mg/l typically require a single treatment process to meet the permit level, for example single point chemical dosing. Permits below this level that approach the technically achievable limit (TAL) of 0.25mg/l are more likely to require more advanced tertiary treatment processes and / or the use of a combination of processes. The enhanced phosphorus permit level driver enables us to capture this difference and provide higher efficient cost for STWs subject to more stringent phosphorus permits.

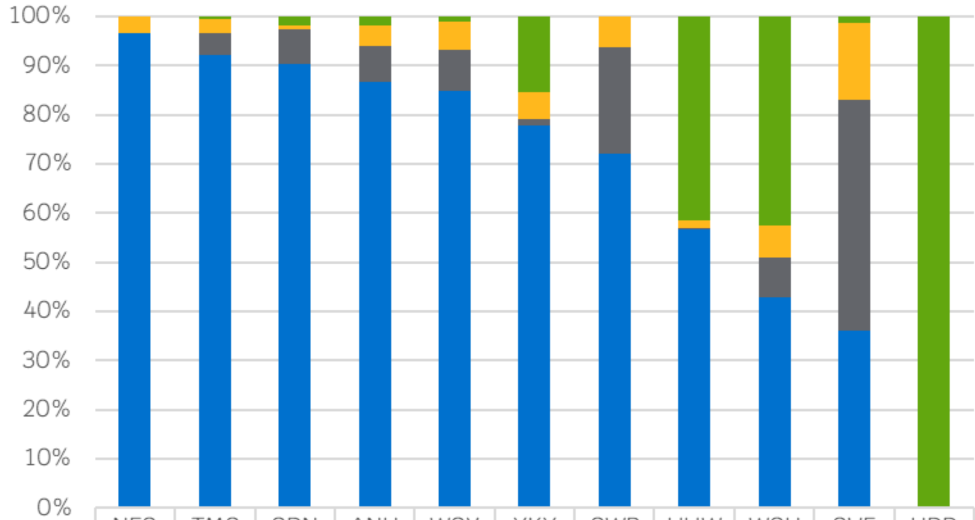
Figures 6 and 7 show the share of PE subject to different levels of enhanced phosphorus permits within companies' PR19 and PR24 WINEP / NEP. The figures suggest that the phosphorus permits at or below the TAL of 0.25mg/l are much more prevalent in PR24 compared to PR19. Therefore, we expect that companies need to invest in more complex phosphorus removal processes to be able to reach these more stringent permits. Including enhanced phosphorus permit in our models allows us to account for the higher efficient costs associated with more stringent permits.

Figure 6: Share of PE served by enhanced permit level – PR19



	TMS	SVE	SRN	UUW	NES	ANH	SWB	YKY	WSH	WSX	HDD
P > 1mg/l	0%	5%	7%	7%	1%	13%	16%	11%	11%	2%	100%
P > 0.5mg/l to <= 1mg/l	0%	12%	20%	17%	37%	48%	21%	15%	12%	77%	0%
P > 0.25mg/l to <= 0.5mg/l	23%	29%	35%	48%	34%	13%	49%	70%	77%	22%	0%
P <= 0.25mg/l	77%	53%	39%	28%	28%	26%	14%	4%	1%	0%	0%

Figure 7: Share of PE served by enhanced permit level – PR24



	NES	TMS	SRN	ANH	WSX	YKY	SWB	UUW	WSH	SVE	HDD
P > 1mg/l	0%	1%	2%	2%	1%	16%	0%	41%	42%	1%	100%
P > 0.5mg/l to <= 1mg/l	3%	3%	1%	4%	6%	5%	6%	2%	7%	16%	0%
P > 0.25mg/l to <= 0.5mg/l	0%	4%	7%	7%	8%	1%	22%	0%	8%	47%	0%
P <= 0.25mg/l	97%	92%	90%	87%	85%	78%	72%	57%	43%	36%	0%

Historical phosphorus permit

We use the level of historical phosphorus permit to capture the extent of pre-existing phosphorus removal processes at each STW prior to implementation of enhanced phosphorus permits. Engineering rationale suggests that sites with a pre-existing permit should generally incur a lower cost to upgrade to a new enhanced permit level. That is because companies may be able to optimise and / or improve the pre-existing phosphorus removal processes to achieve the new permit level. Therefore, the historical permit level has a positive impact on costs – the higher (less tight) the historical permit level, the lower prevalence of pre-existing phosphorus removal processes on site, the higher the efficient costs required to implement the new upgrade. The ability to optimise or improve existing phosphorus removal processes is dependent on the specific circumstances of each STW.

Relatively minor tightening of permits can often be achieved through 'no build' solutions, where the enhanced permit can be met through additional ongoing opex (such as increasing chemical dosing). We partially account for this impact at final determinations by dropping all schemes with enhanced permits >= 2mg/l. However, the historical permit continues to have an important role to capture a spectrum of different starting points for companies that affect efficient PR24 phosphorus removal enhancement costs at STWs.

We considered Thames Water's view that the historical phosphorus removal permit may not impact costs linearly. We explored modelling approaches to capture a potential non-linear relationship between historical permit levels and efficient cost. We considered:

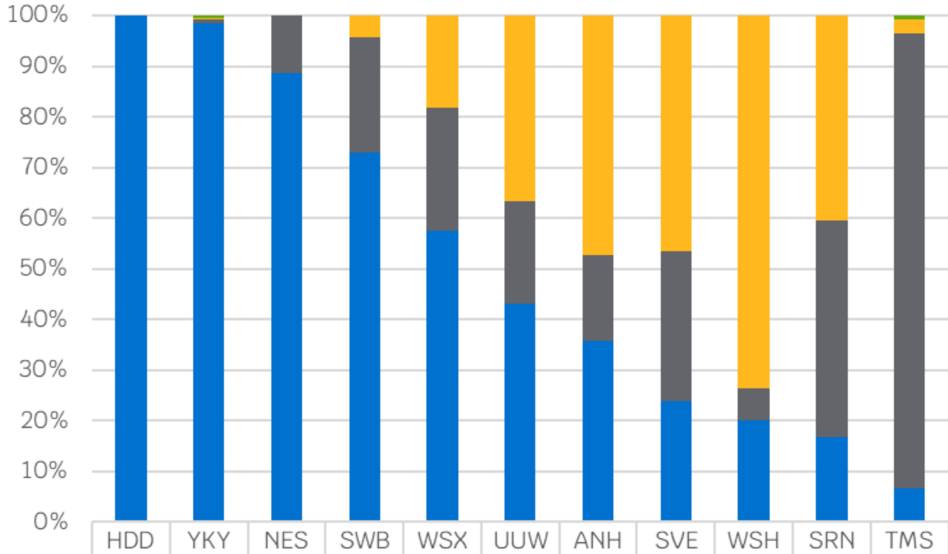
- Adding **a historical consent squared variable**. This modelling option aims to capture a continuous non-linear relationship between historical phosphorus permit and the costs of the upgrade that recognises the higher costs associated with starting from more lax permits.
- Adding **a dummy variable that indicates schemes where the historical phosphorus permit is >= 1mg/l**. This modelling option aims to capture a discrete step change in costs at the level of historical permits >=1mg/l. This is different than the continuous relationship modelled with historical consent squared.

However, the updated models with these drivers included were not sufficiently robust.

Where there is no historical permit, we use an assumed permit of 5mg/l. Engineering insight suggests this is the average baseline level of phosphorus in effluent that gets discharged from STWs in the absence of any treatment. The Environment Agency also applies the same assumption on effluent phosphorus levels where a site has no current permit and therefore there is limited actual measured phosphorus data for the site. For example, it is used in establishing 2020 baseline phosphorus load levels for the Environment Act 2021 phosphorus removal WINEP driver and for water quality modelling. We do not have access to any other more accurate data on baseline level of phosphorus.

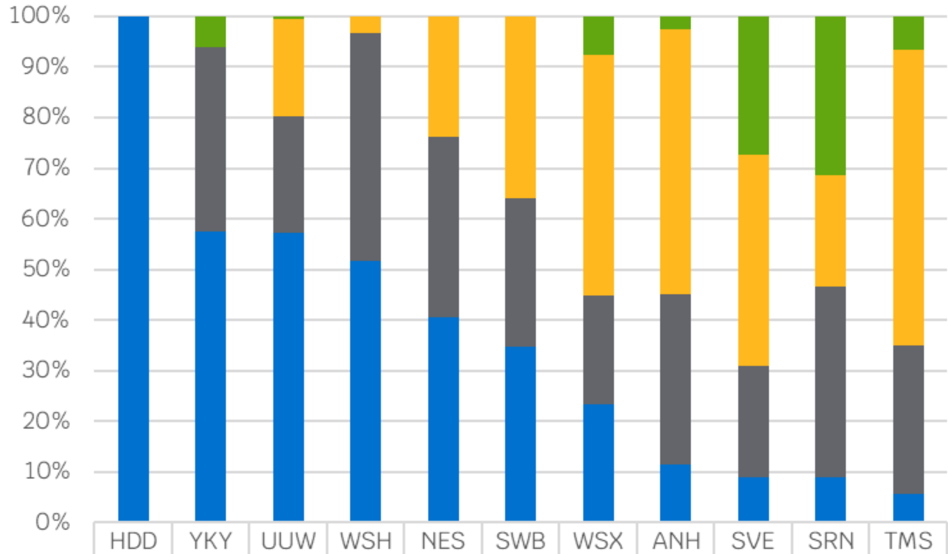
Figures 8 and 9 show the share of PE subject to different levels of historical phosphorus permits within companies' PR19 and PR24 WINEP / NEP. We see that there is a significant difference in historical phosphorus removal across the sector. That highlights the importance of including this driver in our scheme level models.

Figure 8: Share of PE served by historical permit level – PR19



	HDD	YKY	NES	SWB	WSX	UUW	ANH	SVE	WSH	SRN	TMS
P <= 0.5mg/l	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
P > 0.5mg/l to <= 1mg/l	0%	0%	0%	4%	18%	37%	47%	46%	74%	40%	3%
P > 1mg/l	0%	1%	11%	23%	24%	20%	17%	30%	6%	43%	90%
No P consent	100%	98%	89%	73%	58%	43%	36%	24%	20%	17%	7%

Figure 9: Share of PE served by historical permit level – PR24



	HDD	YKY	UUW	WSH	NES	SWB	WSX	ANH	SVE	SRN	TMS
P <= 0.5mg/l	0%	6%	1%	0%	0%	0%	8%	2%	27%	31%	7%
P > 0.5mg/l to <= 1mg/l	0%	0%	19%	3%	24%	36%	48%	53%	42%	22%	58%
P > 1mg/l	0%	36%	23%	45%	36%	29%	22%	34%	22%	38%	29%
No P consent	100%	57%	57%	52%	41%	35%	23%	11%	9%	9%	6%

Enhanced permit squared and a TAL dummy

Engineering insight suggests the enhanced phosphorus removal permit may not impact costs linearly. PR24 company business plans argued that achieving tight permits around the technically achievable limit (TAL) result in a step change in costs due to the need for additional and / or more complex treatment processes. We recognised this in PR19 by including the number of schemes subject to a permit <= 0.5mg/l in the company level phosphorus enhancement totex models as a treatment complexity driver. As shown in Figures 6 and 7, there is a growing share of phosphorus permit levels at or below TAL.

The prevalence of more stringent permits in PR24, and the potential increased costs associated with these, created the need for us to consider how to capture this.

We use two modelling approaches to capture the potential non-linear relationship between enhanced permit level and efficient cost at more stringent levels of enhanced phosphorus permit.

The first approach is to **add enhanced permit squared to the model**. To be consistent with the above engineering and economic rationale, the sign of the estimated coefficient on this term should be positive. That suggests that as the enhanced phosphorus permit becomes more stringent, the marginal cost increase gets higher (the slope of the relationship gets steeper). Therefore, this modelling option aims to capture a continuous non-linear relationship between enhanced phosphorus permit and the costs of the upgrade that recognises the higher costs associated with more stringent permits.

The second approach is to **add a dummy variable indicating schemes where the permit is <= 0.25mg/l (a TAL dummy)**. The sign of the estimated coefficient on this term should be positive so that STWs that need to achieve an enhanced phosphorus permit of 0.25mg/l or lower receive a higher allowance. It also captures a discrete step change in costs at the level of the TAL permit (<= 0.25mg/l), which is different to the continuous relationship modelled with enhanced permit squared.

We considered a dummy variable indicating schemes where the permit is <= 0.5mg/l (the PR19 threshold) but the TAL dummy variable had a clearer engineering rationale and produced more robust model estimation results. For similar reasons we do not consider the 0.7mg/l threshold for the tight consents dummy variable proposed by Wessex Water. We note that the majority of PR24 schemes will achieve this enhanced permit.

Finally, to further improve the robustness of our approach, we considered potential engineering outlier schemes in relation to enhanced permits. The models provide efficient allowances for an average scheme. However, we recognise that complex schemes with very tight phosphorus permits are likely to require higher efficient costs. Therefore, we have considered schemes with very tight phosphorus permits as engineering outliers. Section 4.5.1 provides more detail of our approach to outliers.

Design PE as a scale / volume variable

We considered design PE as a volume driver instead of PE served. Design PE can more directly reflect the design specification of phosphorus removal upgrades. Companies design the phosphorus removal upgrades with a future PE design horizon to ensure the solution remains robust to growth in PE served by the STW. That usually results in a higher design PE than PE served which reflects the average size of STWs in the 2025-30 period.

Despite its advantages, we disagree with the use of design PE from an engineering and economic perspective. Using design PE:

- introduces endogeneity into our model as it is within management control;
- leads to a lack of consistent treatment across companies in the model as companies do not have a consistent approach to the design horizon period used or the methods and data used for calculating design horizon PEs;
- increases the risk of significant design PE revisions as designs finalise. This is because there is more uncertainty in the values in design horizon PEs as they involve estimating on uncertain planning and long-term PE growth forecasts. This would risk affecting the legitimacy of the model estimation and lead to large changes under the phosphorus scheme level PCD.

We consider it appropriate that companies receive scheme level allowances consistent with the average size of the asset over the 2025-30 period. Additionally, our engagement with the Environment Agency suggests there is no sector standard for calculating design PE. This is likely to lead to a lack of consistent treatment across companies in the model as companies have different approaches to defining design PE with a range of different time horizons used. For these reasons, we continue not to use design PE in our models for final determinations.

Figures 10 and 11 show that there is a wide variation of the gap between design PE and PE served across companies for both the PR19 and PR24 phosphorus removal programmes. That highlights our concerns that using design PE might bias the assessment of relative efficiency of companies due to different engineering standards and / or approaches to forecasting design PE.

Figure 10: Total Design PE and PE served – PR19

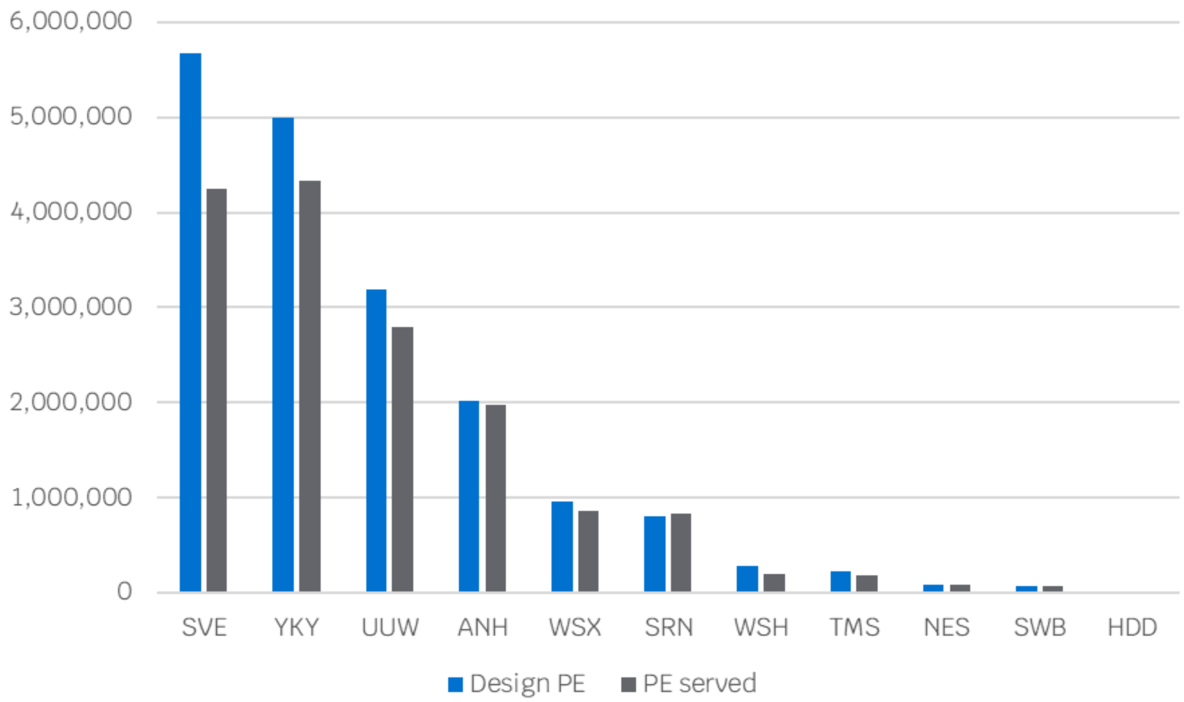
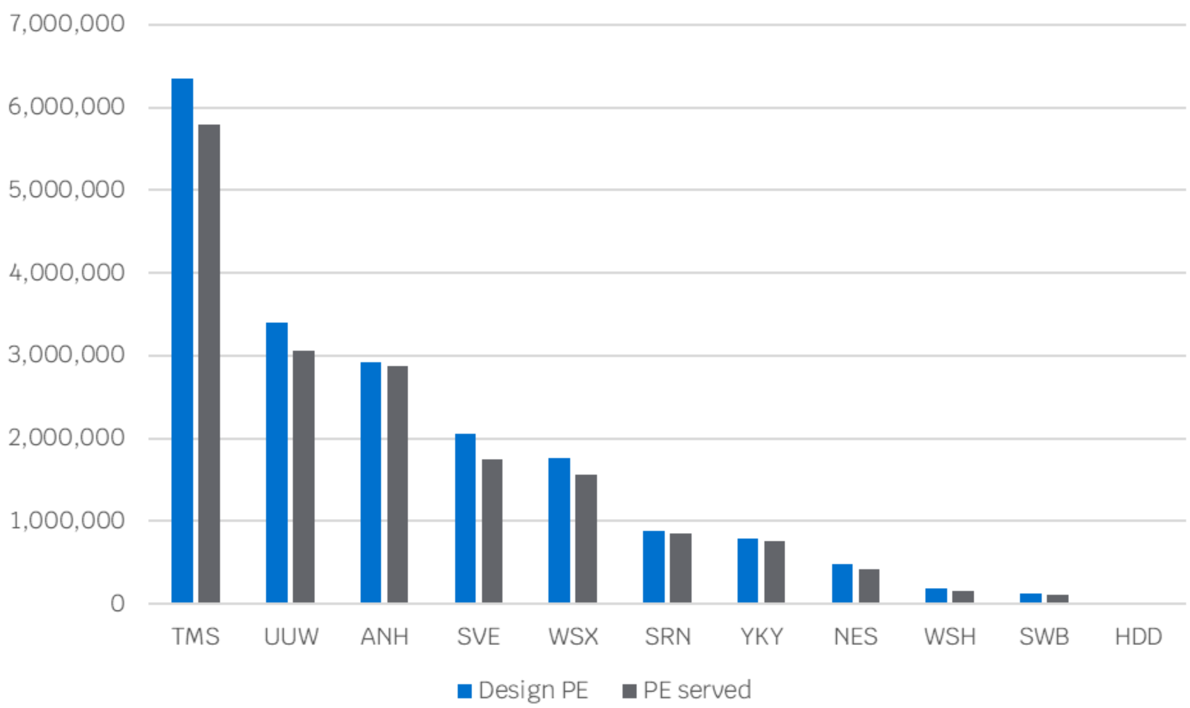


Figure 11: Total Design PE and PE served – PR24



Transfer schemes cost drivers

We also developed transfers models that use a pooled dataset of transfer schemes delivered under sanitary parameters and phosphorus removal in the historical and forecast periods. We include the two key cost drivers of transfers the length of the transfer (km) and the transferred flow (m3 / day) mentioned in the previous section. However, we do not exclude any outlier observations from the transfers model due to the limited sample size. We consider that this approach is much more appropriate than treating transfers as unmodelled schemes. It can better recognise the different characteristics of transfer solutions which might lead to a different company efficiency compared to the delivery of the conventional phosphorus removal enhancement programme.

4.2.2 Functional form

We did not make a logarithmic (log) transformation of the dependent or explanatory variables prior to estimating our scheme level phosphorus removal enhancement models for the reasons set out in section 2. For the avoidance of doubt, log-log models did not appear to perform significantly better than levels models in our model testing and economies of scale are already captured through the constant term.

4.2.3 Forecast vs historical data models

We used the historical (7F) and forecast (CWW19) datasets to develop our phosphorus removal scheme level enhancement models.

Most other PR24 enhancement models in the draft determinations use only PR24 forecast data. This is due to limitations of the respective historical data, if available. In contrast, the historical 7F dataset is based on scheme level data in the APR which provides additional assurance.

Having historical phosphorus removal cost and cost drivers data is a distinct advantage because it:

- helps us understand the actual relationship between cost and cost drivers;
- provides insights on the actual cost of phosphorus removal in PR19, which is a good indication of what it will be in PR24; and
- helps us to identify inefficient forecast costs by comparing historical and forecast efficiency scores for each company.

We estimate our selected models separately using historical and forecast data. To derive modelled allowances, we fit the PR24 phosphorus removal programme cost drivers to the estimated coefficients for both sets of models.

As mentioned in the previous section, PR24 forecast costs appear to be higher than historical costs at an aggregate level across the industry. This is not fully explained by the cost drivers included in the models (such as scale and treatment complexity). This could indicate inefficient business plan cost forecasts or forecast real terms increases in costs.

Section 4.4 on the efficiency benchmark sets out our final decisions on the use of historical and forecast models to set efficient phosphorus removal allowances after considering stakeholder views.

4.3 Selected models

We set out our selected models in Table 20 (conventional phosphorus removal schemes) and Table 21 (transfers). The estimated coefficients of all drivers have the correct sign, are of a reasonable magnitude, and are statistically significant.

Models estimated using forecast data (PR1 and PR2) explain more variation in forecast costs (as indicated by adjusted R-squared) than the historical models (PR3 and PR4) explain variation in historical costs. This does not mean the forecast models are more robust. Instead, this is likely to be because companies have developed their business plan proposals using similar benchmarking approaches, which reduces heterogeneity in company costs. Using models means companies develop the same cost for the same schemes. In contrast, in the historical data similar schemes could have different costs due to random cost shocks that are not present in the forecast data.

Table 20: Scheme level phosphorus removal enhancement totex models

Explanatory variable	PR1	PR2	PR3	PR4
Population equivalent served (thousands)	0.159*** {0.000}	0.159*** {0.000}	0.049*** {0.000}	0.047*** {0.000}
Historical consent (mg/l)	0.322*** {0.000}	0.301*** {0.000}	0.377*** {0.000}	0.372*** {0.000}
Enhanced consent (mg/l)	-7.876*** {0.000}	-2.247*** {0.000}	-8.178*** {0.000}	-2.448*** {0.000}
Enhanced consent squared (mg/l)	2.980*** {0.000}		3.445*** {0.000}	
TAL dummy (<=0.25mg/l)		0.932*** {0.004}		0.615** {0.044}
Constant	5.453*** {0.000}	3.415*** {0.000}	4.583*** {0.000}	2.670*** {0.000}
Adjusted R-squared	0.53	0.526	0.31	0.299
Observations	737	737	596	592

Dataset	CWW19	CWW19	7F	7F

Table 21: Scheme level transfers enhancement totex model

Explanatory variable	T1
Length of transfer (km)	0.445*** {0.000}
Transferred flow (m3/d)	1.074*** {0.000}
Constant	1.751*** {0.000}
Adjusted R-squared	0.897
Observations	63

4.4. Efficiency benchmark

What we said in our draft determinations

We found that the total sector allowances are much lower when using the historical models PR3 and PR4. That suggests that on average, the PR19 phosphorus removal programme was delivered more efficiently compared to companies' PR24 business plan forecasts. We considered some of the reasons for the significant difference in historical and forecast cost efficiency could be:

- companies may have different risk appetites;
- companies have submitted higher business plan cost forecasts;
- PR24 WINEP / NEP programme is much larger than at PR19;
- potential data reporting issues; and
- prevalence of tighter permits.

Overall, we viewed both the historical and forecast models provide important information on the efficient cost of delivering PR24 phosphorus removal upgrades. Therefore, we applied equal weights to historical and forecast models. We implemented this by giving each of the four models a triangulation weight of 25%. This provided a sufficient efficiency challenge to business plans at a sector level so we did not apply any further catch-up efficiency challenge.

Stakeholders' representations

Anglian Water supported the use of forecast and historical models. The company said our models strike an appropriate balance between historical evidence of actual costs and forecast costs which are higher with more complex schemes at smaller sites.

Around half the wastewater companies proposed different levels of triangulation weight on historical data and models.[17] Companies against applying equal weights to historical and forecast models supported weights ranging from zero to 33.3%. All companies that do not support the use of historical data highlighted the relatively poorer model performance of the historical models in terms of adjusted R-squared. Severn Trent Water, South West Water and United Utilities said the historical models do not appropriately account for the higher number of upgrades at small STWs with very tight phosphorus permits.

We sent a sector wide query to companies requesting evidence of why modelled costs using the forecast PR24 sector phosphorus removal enhancement programme are materially higher than modelled costs using the PR19 enhancement programme. Companies put forward several reasons for overall cost increases for phosphorus removal from the historical to the forecast period after controlling for the cost drivers we used in our draft determinations. These include:

- **The prevalence of stricter permit limits**. Severn Trent Water, Southern Water, Thames Water, United Utilities and Wessex Water stated they are facing more stringent permit limits in PR24 close to or at the technical achievable limit (TAL) of 0.25 mg/l. Companies said that the PR19 phosphorus removal programme is more focused on upgrades at STWs with higher population equivalents and less stringent permits. In contrast, companies view the PR24 phosphorus removal programme is focused on upgrades at smaller STWs with significantly tighter consents that are more complex and costly to implement.
- **The prevalence of smaller sites requiring upgrades**. Severn Trent Water, United Utilities and Yorkshire Water said that an increasing number of upgrades at smaller STWs imply less scope for economies of scale. Companies also argued there are additional requirements to improve the surrounding infrastructure at the smaller sites that result in higher costs.
- **Additional regulatory requirements**. Thames Water, Wessex Water and Yorkshire Water argued new regulatory requirements under Environment Act driver result in upgrades at STWs that would otherwise not pass cost-benefit analysis thresholds used at PR19. Similarly, Southern Water said nutrient neutrality requirements to be a reason for the submission of inefficient schemes.

Our assessment and reasons

[17] Severn Trent Water, Southern Water, South West Water, Thames Water, United Utilities, Wessex Water and Yorkshire Water do not agree

Table 22 below sets out modelled allowances excluding Cook's distance outliers for each company under the four models phosphorus removal models.

Table 22: Phosphorus removal modelled allowances excluding Cook's distance outliers (£ million, 2022-23 prices)

Company	Request	PR1	PR2	PR3	PR4
Anglian Water	602.00	989.80	995.23	706.28	693.26
Dŵr Cymru	94.54	122.08	115.91	97.55	81.28
Hafren Dyfrdwy	0.79	1.89	2.03	1.67	1.36
Northumbrian Water	6.30	10.20	10.43	7.06	7.21
Severn Trent Water	541.73	433.81	431.98	270.42	255.56
South West Water	113.13	114.68	116.79	85.91	86.54
Southern Water	325.67	405.29	401.03	277.86	265.91
Thames Water	818.90	584.13	577.30	384.78	368.97
United Utilities	411.51	354.46	357.21	221.41	215.61
Wessex Water	740.43	578.90	587.86	379.88	372.31
Yorkshire Water	294.89	340.64	339.66	253.23	246.76
Total	**3949.90**	**3935.89**	**3935.43**	**2686.05**	**2594.78**

The total sector allowances are much lower when using the historical models PR3 and PR4. That suggests that on average, the PR19 phosphorus removal programme was delivered more efficiently compared to companies' PR24 forecasts in draft determination representations.

This difference cannot be explained by the key cost drivers as these are included in the models. That highlights the important role historical cost benchmarking plays in identifying what companies have achieved in the past as it can be used to challenge PR24 business plan forecasts.

The points below explore the potential reasons behind the significant difference in historical and forecast cost efficiency.

- **Companies may have different risk appetites** of how much ambition to show in business plans based on their prior experience of phosphorus removal. For example, companies with more historical phosphorus removal, particularly for tighter permits, might have more experience of what solutions worked well in the past and a more reliable / efficient supply chain to deliver them in PR24. This could materialise in more ambitious and realistic phosphorus removal business plan requests.

- **Companies have submitted higher business plan cost forecasts**, which may be due to cost uncertainty, expected cost increases, or an attempt to obtain a higher allowance under the assumption we will use these costs to set efficient cost allowances. We compared company forecast efficiency for modelled PR24 schemes compared to the sector average (by fitting our forecast models to the forecast cost and cost driver data) against company outturn efficiency for modelled PR19 schemes compared to the sector average (by fitting our historical models to the historical cost and cost driver data). We expect a company's relative efficiency to be consistent across the forecast and historical periods. This is because a company's experience and knowledge on how to successfully deliver phosphorus removal schemes is unlikely to change from one period to the next. However, we found some evidence of inconsistencies in relative efficiency from the historical to the forecast period consistent with the submission of inflated forecasts.
- **PR24 WINEP / NEP programme is much larger than at PR19**. That might come with more deliverability challenges and lead to a stretched supply chain, resulting in higher efficient costs. Several companies questioned the deliverability of the statutory phosphorus removal obligations. However, the PR24 phosphorus removal programme is not much larger than the PR19 programme in terms of the population served receiving phosphorus upgrades.
- **Data reporting issues**. Companies were asked to exclude bioresources and business rates expenditure from phosphorus removal enhancement costs. Companies confirmed they excluded these costs from APR Table 7F via the queries process. Whilst we have queried data in CWW19, we are concerned that companies might have included some of this expenditure in PR24 business plan Table CWW19. That would inflate forecasts compared to historical costs due to increased scope of costs.
- **Prevalence of tighter permits**. There are more enhanced phosphorus permits at or below TAL in PR24 compared to PR19. The historical cost models might not be able to fully explain efficient costs associated with very tight permits as there are fewer observations in the data.

On the other hand, most companies have more experience with phosphorus removal upgrades compared to other enhancement areas due to the large PR19 enhancement programme. Therefore, companies should be able to forecast PR24 enhancement totex requirements more precisely than other enhancement areas, which should warrant lower risk allowances.

Most of the stakeholder responses we received already highlight and repeat considerations we fully explored in draft determinations. All of these led to our view that both forecast and historical models contain important information on efficient costs for the PR24 programme with an equal 50% weight on each. If these factors were not relevant, we would have set a higher weight on historical data than 50%.

We recognise company views that the PR24 phosphorus removal programme is characterised by a greater number of upgrades to tighter phosphorus permits at the smaller STWs. This could mean the historical cost models might not be able to fully explain efficient costs associated with very tight permits as there are fewer observations in the data. However, our levels functional form provides higher allowances for small schemes compared to a log model as the enhanced permit impact does not vary with the size of scheme. Therefore, smaller schemes get a higher allowance per PE served for tight permits compared to the average scheme.

We recognise company views that an increasing number of upgrades at smaller STWs imply less scope for economies of scale. However, we capture an economies of scale effect in our levels models. That is driven by the constant term in our models, which is fixed and the same for STW of any size. All else being equal, smaller STWs get a higher allowance per PE due to the fixed constant being spread over a lower PE served.

In addition, we have removed all schemes with **enhanced permits >= 2mg/l** from our modelling sample in final determinations. That helps to promote a more tailored modelling approach focusing on the representative set of schemes which usually have tight permit requirements of <= 0.5mg/l. This results in a significant increase in the size of the estimated coefficients on enhanced consent and higher constant terms. All else being equal, we expect smaller STWs with tight permits to get a higher allowances as a result of this change.

We adjust the modelled allowance of schemes we have assessed as engineering outliers to recognise unique characteristics of schemes. This includes schemes that upgrade to tight phosphorus permits <0.25mg/l and schemes that have a biological treatment component. We consider these adjustments in more detail below in section 4.5.1. We have also introduced transfer schemes modelling to recognise the differential characteristics of these schemes.

We consider that the totality of all of our changes materially improves our simpler modelling approach in draft determinations. After controlling for the above improvements, both the historical and forecast models continue to provide important information on the efficient cost of delivering PR24 phosphorus removal upgrades. Therefore, we assign equal weights to historical and forecast models. We implement this by giving each of the four models a triangulation weight of 25%. This approach results in a strong efficiency challenge to business plans at a sector level of 17%. Therefore, we do not apply any further catch-up efficiency challenge.

This approach may be conservative. In other settings like base costs, we use historical data only to set efficient allowances. On balance, we recognise that costs could be higher in the 2025-30 period compared to the past when comparing the costs of like-for-like schemes because of the reasons set out above. So, we consider placing equal weight on historical and forecast models strikes the right balance between providing companies with a sufficient allowance, while making sure that customers do not pay for company inefficiency.

Table 23 below sets out our triangulated modelled phosphorus removal enhancement allowances after placing equal weight on the historical and forecast models. Allowances are before the application of frontier shift efficiency and real price effects, before the addition of allowances for outliers we have assessed outside of the models, and before the application of the post modelling adjustment discussed below.

Table 23: Phosphorus removal modelled allowances excluding Cook's outliers – triangulated (£ million, 2022-23 prices)

Company	Request	Triangulated allowance	Allowance minus request	
			£m	% of request
Anglian Water	602.00	846.15	244.15	41%
Dŵr Cymru	94.54	104.21	9.66	10%
Hafren Dyfrdwy	0.79	1.74	0.94	119%
Northumbrian Water	6.30	8.72	2.42	38%
Severn Trent Water	541.73	347.94	-193.79	-36%
South West Water	113.13	100.98	-12.15	-11%
Southern Water	325.67	337.52	11.85	4%
Thames Water	818.90	478.80	-340.11	-42%
United Utilities	411.51	287.17	-124.33	-30%
Wessex Water	740.43	479.74	-260.69	-35%
Yorkshire Water	294.89	295.07	0.19	0%
Total	**3949.90**	**3288.04**	**-661.86**	**-17%**

Table 24 sets out modelled allowances for transfers schemes. Since the dataset we use pools historical and forecast data, we do not apply a further efficiency challenge. This is consistent with our approach in storm overflows and phosphorus removal where we do not apply an additional efficiency challenge since more efficient historical delivery already imposes an efficiency challenge.

Table 24: Phosphorus removal transfers allowances (£ million, 2022-23 prices)

Company	Request	Allowance
Anglian Water	0.00	0.00
Dŵr Cymru	1.52	3.05
Hafren Dyfrdwy	0.00	0.00
Northumbrian Water	5.34	3.18
Severn Trent Water	95.97	88.80

South West Water	5.77	5.96
Southern Water	14.52	14.74
Thames Water	0.00	0.00
United Utilities	0.00	0.00
Wessex Water	10.91	4.68
Yorkshire Water	0.00	0.00
Total	**134.03**	**120.41**

Table 25 combines the total allowances for modelled phosphorus removal and transfer schemes excluding Cook's distance outliers for conventional schemes. The overall industry cost challenge is 17%.

Table 25: Phosphorus removal modelled allowances excluding Cook's distance outliers for conventional schemes (£ million, 2022-23 prices)

Company	Request	Triangulated allowance	Allowance minus request	
			£m	% of request
Anglian Water	602.00	846.15	244.15	41%
Dŵr Cymru	96.07	107.26	11.19	12%
Hafren Dyfrdwy	0.79	1.74	0.94	119%
Northumbrian Water	11.64	11.90	0.26	2%
Severn Trent Water	637.70	436.74	-200.96	-32%
South West Water	118.90	106.95	-11.95	-10%
Southern Water	340.19	352.27	12.08	4%
Thames Water	818.90	478.80	-340.11	-42%
United Utilities	411.51	287.17	-124.33	-30%
Wessex Water	751.34	484.41	-266.93	-36%
Yorkshire Water	294.89	295.07	0.19	0%
Total	**4083.93**	**3408.45**	**-675.48**	**-17%**

4.5 Post modelling adjustments

4.5.1 Outlier treatment and unmodelled schemes

At final determinations, we continue to identify outliers using the Cook's distance statistic. These schemes are subject to deep dive assessments and we added allowances on top of the modelled allowances as set out in section 2.3.

To further improve the robustness of our approach, we considered potential engineering outlier schemes. The models provide efficient allowances for an average scheme. However, we recognise that complex schemes with very tight phosphorus permits and / or schemes with a biological treatment component are likely to require higher efficient costs. Therefore, as an alternative to the modelling approach we have considered schemes with very tight phosphorus permits and / or schemes with a biological treatment component as engineering outliers.

We identified schemes with phosphorus permits <0.25mg/l and / or schemes with a biological treatment component as appropriate for treatment as engineering outliers. We issued queries for all inefficient schemes that meet this criteria to better understand the additional costs incurred. After undertaking our assessment, our decision is to apply a 75% cost gap adjustment to all schemes in scope. We consider that this is a proportionate approach to control for treatment complexity and solution type in our final determinations models. As explained section 2.3.2, we do not exclude engineering outliers from the modelling sample.

We have implemented a bespoke approach to some sites. We provide gated allowances of 6% of request for some schemes subject to uncertainty. In addition, we have assessed large schemes under the enhanced engagement process using a bespoke challenge based on requested costs. This recognises the models are less appropriate to determine allowances for these outlier schemes.

As explained in section 4.1, we excluded some schemes from our modelling approach. That includes schemes dropped from the models and optimisation schemes that have enhanced permits >= 2mg/l. We refer to these as unmodelled schemes. At final determinations, we apply **the company level modelled efficiency of phosphorus removal schemes** to unmodelled schemes. This approach effectively assumes that company specific inefficiency is equivalent across modelled and unmodelled schemes. For efficient companies, we cap allowances at the request.

4.5.2 Reconciliation adjustment

After producing modelled efficient cost allowances, we added allowances for outliers that we assessed outside of the models (as discussed in section 2).

We also applied a reconciliation adjustment to adjust phosphorus removal modelled costs calculated using scheme level data in CWW19 to reflect the aggregate request in CWW3, CWW12 and CWW17. Because we exclude 2030-31 from scope and we remove and address unmodelled schemes separately in response to feedback in company representations, the reconciliation adjustment is of a lower scope compared to draft determinations.

We calculated the reconciliation adjustment factor as the ratio of company request in CWW3, CWW12 and CWW17 divided by the total we used to model costs based on the scheme level phosphorus removal dataset (CWW19). We then multiplied the modelled allowance by this reconciliation adjustment factor.

Table 26 sets out the total phosphorus removal enhancement allowances including Cook's and engineering outliers, transfer schemes, optimisation schemes, unmodelled schemes and applying the reconciliation adjustment factor. These allowances are before the application of frontier shift efficiency and real price effects. The overall cost challenge is 15%.

Table 26: Total phosphorus removal enhancement allowances (£ million, 2022-23 prices)

Company	Request	Triangulated allowance	Allowance minus request	
			£m	% of request
Anglian Water	908.46	952.34	43.88	5%
Dŵr Cymru	151.01	164.41	13.40	9%
Hafren Dyfrdwy	7.07	8.02	0.94	13%
Northumbrian Water	24.89	25.15	0.26	1%
Severn Trent Water	744.52	544.17	-200.36	-27%
South West Water	119.03	110.75	-8.28	-7%
Southern Water	354.94	377.22	22.28	6%
Thames Water	1516.54	1219.04	-297.50	-20%
United Utilities	672.99	510.96	-162.03	-24%
Wessex Water	916.43	630.30	-286.14	-31%
Yorkshire Water	356.54	356.73	0.19	0%
Total	**5772.44**	**4899.08**	**-873.36**	**-15%**

5. Growth at sewage treatment works

Summary

We use **two forecast scheme level models** to set efficient growth at sewage treatment works (STWs) enhancement allowances at PR24. We triangulate between a levels and log-log model specifications. We do not apply an additional efficiency challenge.

The key cost drivers of growth at STWs enhancement activities are **Process capacity added to meet current and expected quality permits; Expected change in Dry Weather Flow (DWF) permit; Ammonia permit <3mg/l dummy.**

Our PR24 approach to introduce forward-looking scheme level enhancement modelling for growth at STW enhancement expenditure promotes companies to undertake a more proactive assessment of future growth needs.

While growth is likely to remain uncertain, our forward-looking approach helps to recognise differences in capacity and / or DWF headroom across the sector and provides efficient growth allowances to deal with forecast population growth in relevant catchments at the time of the PR24 price review.

In parallel, our granular approach to the growth at STWs scheme level price control deliverable (PCD) protects customers where population growth does not materialise and / or materialises in a different catchment.

Our approach also protects customers from paying twice, by removing expenditure that overlaps with the expectations of base expenditure, such as compliance with existing permits and claws back funding where companies have under-spent growth at STW allowances in the 2015-20 and 2020-25 periods. This results in an overall industry cost challenge of 25%.

Since draft determinations we made the following changes:

- **remove the model using change in population equivalent served over the 2025-30 period** to reflect that growth at STWs schemes address longer term growth that may not be fully reflected in this driver.
- **introduce a log-log model and triangulate equally between a levels model and a log-log model.**
- **update our past under delivery adjustment to reflect outturn expenditure for 2023-24** to replace the forecast expenditure used in draft determinations.
- **update our assessment of overlap with base expenditure** – based on the latest information on compliance with permits.

Growth at sewage treatment works (STW) expenditure relates to costs for upgrading STWs to accommodate population growth in the catchment area so as to ensure that the STW meets the requirements of Regulation 4(4) Urban Waste Water Treatment (England and Wales) Regulations 1994 and its EA permit obligations. Although population growth is the underlying driver of need, companies will also select the best option based upon the existing headroom at the STWs, as well as other site-specific factors.

Companies should be tracking how soon they are likely to start exceeding their environmental permits following increases in population in the STW's catchment area given current infrastructure, conditions in these permits related to Dry Weather Flow (DWF), Flow to Full Treatment (FFT) and various effluent quality permits. Changes in flow or quality permit conditions due to population growth would not usually be included as a permit change within the WINEP / NEP. They are only included where growth results in a site exceeding an Urban Waste Water Treatment (England and Wales) Regulations 1994 (UWWTR) population equivalent threshold, which would be reflected by a WINEP / NEP action.

DWF is defined as the average daily flow to a STW during a period without rain.[18] There are two ways to calculate DWF as set out in table 27.

Table 27: Two methods for calculating DWF

	1. DWF Formula	2. Q80 exceedance
Method	$DWF = PG + I_{DWF} + E$	Non-parametric 80% exceeded measured daily flow (Q80) in a year.
Where	DWF = total dry weather flow (l/d) P = catchment population (number) G = per capita domestic flow (l/hd/d) I_{DWF} = dry weather infiltration (l/d) E = trade effluent flow (l/d)	The non-parametric 20-percentile value of a time series of measured total daily volume (TDV) data provides a good estimate of DWF. The 20-percentile figure is that value exceeded by 80% of the recorded daily values. It is also known as the Q80.

For existing sites, the Q80 exceedance method is generally used, whereas for new sites, or small existing sites without a flowmeter, the DWF formula method is generally used.

Companies are responsible for monitoring compliance with permitted DWF limits across their sites. In addition, they must also account for the impact of future population growth in the catchment and apply for a revised permit if flow increases due to growth are likely to lead to the current DWF permit being exceeded. A change in DWF limit will often lead to an associated change in the FFT (see below) and effluent quality permit conditions to ensure no deterioration in waterbody quality.

The Environment Agency and Natural Resources Wales are updating the method used for determining a DWF failure and have proposed to include DWF within a new Environmental Protection Assessment (EPA) wastewater treatment works flow metric from 2026. Sites will

[18] Calculating dry weather flow (DWF) at waste water treatment works - GOV.UK (www.gov.uk)

be compliant with their DWF permit conditions unless the permitted limit was exceeded in the compliance assessment year, and two or more exceedances have occurred in the preceding four years, summarised as '3-in-5 year' compliance. The method for measuring and calculating DWF is not new, but the Environment Agency and Natural Resources Wales are changing the way compliance with the DWF permit limit is determined. From 2026 (data year) sites will be compliant with their DWF permit conditions unless the permitted limit was exceeded in the compliance assessment year, and two or more exceedances have occurred in the preceding four years, summarised as '3-in-5 year' compliance. This will result in an objective and robust approach to assessing DWF compliance and will link to other related permit conditions such as FFT and final effluent quality permit conditions being updated regularly following changes in DWF limits.

FFT refers to the level of flow an STW must treat at any time before it is permitted to divert flows to storm tanks. The storm tank contents need to be returned to the head of the works for full treatment once storm flows have subsided, unless the storm flows are prolonged or sustained, then the permit may allow for some discharge of diluted flows to the watercourse. A site must treat all flows up to the FFT value specified in the site permit. Some sites must treat all flows received and do not have an FFT condition. A DWF limit increase might consequently require an increase in the FFT value to maintain an appropriate FFT / DWF ratio. There may also be pro-rata tightening of effluent quality permit limits, such as sanitary parameters (ammonia and BOD) and nutrients (phosphorus and total nitrogen) so that the water quality of the receiving watercourse does not deteriorate. This may require investment in treatment if the tighter permit limit cannot be achieved through existing assets. The Environment Agency and Natural Resources Wales have confirmed that DWF and associated FFT and quality permit changes are not included in the WINEP / NEP.

Companies should take a proactive approach to monitoring how any expected population growth will impact existing flow and quality permit conditions. Companies should request enhancement allowances to fund these updates under the Growth at STWs enhancement area. Companies have been funded to meet existing permit conditions. Any non-compliance with existing permit conditions should be addressed by companies, and we do not expect customers to pay for this.

At PR19, Growth at STWs was assessed as part of base costs. Historical growth at STWs expenditure was included in the base cost econometric models and allowances reflected forecast population growth in each company's area. We conducted deep dives of business plan evidence where appropriate. We also applied a post-modelling cost adjustment depending on whether the company operated in an area with relatively high or low forecast population growth relative to the historical average growth rate for the sector.

For PR24, we reassessed our approach to assessing growth at STWs expenditure. In July 2022, we commissioned Arup to analyse whether a separate assessment of growth-related costs is appropriate and feasible. Arup concluded that growth at STWs expenditure could be assessed separately from base costs as there is little overlap with operating and capital maintenance expenditure, and because it was able to develop robust econometric benchmarking models to assess growth at STWs costs. Arup recommended the use of a company level econometric model with cumulative spend over a long time period to mitigate for lumpiness in the cost data. Arup found 'change in PE served by STWs' and '% of load with tertiary treatment' to be key drivers. They also acknowledged the importance of capturing the effect of capacity headroom but were not able to test this due to lack of data.

Some companies said that STWs headroom is an important cost driver and therefore Arup's models do not fully explain company costs. In addition, in their early cost adjustment claim submissions, Severn Trent Water and Wessex Water pointed to the importance of STWs nearing exceedance of their permitted DWF limits as an important driver of Growth at STWs costs.

Some companies stated that the DWF permit compliance calculated using the new methodology would be tighter and so this will trigger a need for investment. We engaged on this with the Environment Agency who confirmed that this discussion with companies has been ongoing for more than ten years. Therefore, companies are aware that the Environment Agency will be updating their method of determining compliance from 2026. Companies should have been increasing their STW capacity and DWF permit levels over time to accommodate for future growth.

To address these concerns, we collected data at scheme level, which allowed us to assess the impact of updates to DWF, FFT and sanitary parameters permit levels on growth at STWs costs, in addition to changes in population. Scheme level data allows us to capture the complexities of each company's growth at STWs programme more accurately. Therefore, it improves on Arup's recommended company level models that only use aggregate cumulative totex and do not consider the specific circumstances of each scheme. This new scheme level growth at STWs data is reported in a new business plan data Table ADD19.

Scheme level benchmarking also allows us to set an allowance more clearly for each growth at STWs upgrade. This is important in the context of Price Control Deliverables (PCDs) that will return the funding to customers if the company does not deliver the upgrade included in its allowance.

5.1 Data used

What we said in our draft determinations

To better capture cost drivers related to capacity headroom in STWs, we collected detailed data for each growth at STWs scheme due to commence in the 2025-30 period. The datasets included the following key information we used to develop scheme level models including costs, size of STWs (PE served), flow and quality permit levels and proposed process capacity increases.

Stakeholders' representations

Stakeholders generally supported standalone growth at STWs enhancement models to replace the PR19 approach of including growth at STWs in scope of base costs. They did not make specific representations about the data used.

Our assessment and reasons

To better capture cost drivers related to capacity headroom in STWs, we collected detailed data for each growth at STWs scheme due to commence in the 2025-30 period as part of the PR24 queries process. We collected data for a seven-year period from the first year before the price control period to an "After 2029-30" (labelled as 2030-31 in the dataset). We expected this data to reconcile with the relevant total growth at STWs request in BPDTs (line CWW3.155).

The datasets included the following key Information we used to develop scheme level growth at STWs models:

- **yearly opex and capex;**
- **historical DWF permit level (m^3/day)** – the DWF permit level prior to the proposed growth scheme;
- **expected DWF permit level (m^3/day)** – the expected new DWF permit level to be achieved following the updates;
- **process capacity added to meet current quality permits (PE)** – the expected added process capacity in PE to meet historical quality permits;
- **process capacity added to meet expected quality permits (PE)** – the expected added process capacity in PE to meet expected quality permits;
- **historical ammonia permit level (mg/l)** – the ammonia permit level prior to the proposed growth scheme; and
- **expected ammonia permit level (mg/l)** – the expected new ammonia permit level to be achieved following the updates.

The tables include additional information about PE served, FFT, Biochemical oxygen demand (BOD), Phosphorus and total suspended solids permit limits, as well as whether the STW was compliant with the DWF permit limit (based on the 3-in-5 rule), and any overlaps with WINEP schemes.

We aim to capture the relevant factors in our scheme level econometric modelling approach to help model efficient PR24 growth at STWs enhancement costs robustly.

Before excluding any schemes for overlap with base costs, we first exclude 11 schemes for being otherwise ineligible for growth at STWs allowances. Five of these schemes (four for Wessex Water, one for Anglian Water) are excluded for having no AMP8 expenditure, one is excluded for being a feasibility study instead of a growth scheme, three are excluded as they have no forecast population growth, and two schemes related to a new South West Water STW are assessed for a separate allowance outside of the model.

Table 28: Summary statistics for growth at STWs dataset – as submitted

Variable	DD	FD
Number of submitted schemes	251	297
Totex	£1,595m	£2,384m
Total process capacity expected to be delivered at all growth at STWs schemes (PE)	1.55m	2.14m
Expected change in DWF permits (m^3/day)	125,081	192,071
Number of schemes with expected ammonia permit <3mg/l	28	42

Table 28 shows that there were some substantial changes to the set of schemes submitted for growth at STWs in response to draft determinations. Severn Trent Water added 51 schemes and the total sector schemes increased by 46 net new schemes for an additional £788 million expenditure request. Anglian Water and Wessex Water substituted schemes but overall, the number of schemes remained similar.

Our draft determinations approach to introduce forward-looking scheme level enhancement modelling for growth at STW enhancement expenditure is promoting a more proactive assessment of future growth needs in company areas. While we welcome the proactive approach to planning for growth, companies should be planning for growth at STWs in any event to meet their obligations under the UWWTRs and through the Drainage and Wastewater Management Plans (DWMP) process. We are concerned about the large volume of changes at a late stage of the price review process, particularly those from Severn Trent Water which is not in a high growth area. The requests are also a step change from previous price controls. Companies requested £659m and £1.17bn at PR14 and PR19 respectively (in 22-23 prices), meaning the PR24 request is roughly double the PR19 request. While growth is likely to remain uncertain, our forward-looking approach helps to recognise differences in capacity and / or DWF headroom across the sector and provides efficient growth allowances to deal with forecast population growth in relevant catchments at the time of the PR24 price review. We want companies to have robust long-term plans and our price review allowances should be part of the delivery of these plans.

In parallel, our granular approach to the growth at STWs scheme level Price Control Deliverables (PCDs) will protect customers if population growth does not materialise and / or materialises in a different catchment. Overall, we consider that the PR24 framework facilitates growth and allows expenditure to be targeted where it is needed most, while protecting customers if that growth does not materialise.

5.2 Overlap with base costs

What we said in our draft determinations

We developed a scenario framework to assess each scheme and its potential overlap with base costs to determine whether schemes should be delivered by companies with or without an additional growth at STWs enhancement allowance. Each scheme was allocated to a scenario which determined its inclusion or exclusion for a growth at STWs allowance. This methodology focused on excluding schemes for two reasons:

- Restoring FFT / DWF ratios: where funding had been allocated at PR19 and there is no increase in the DWF permit (previously labelled as scenario 3)
- Remediation of non-compliance with existing permits: funding for any new permit conditions has already been allowed for at previous price reviews and there is no forecast PE growth (previously labelled as scenario 4);

Stakeholders' representations

Several companies including Anglian Water, Severn Trent Water, South West Water and United Utilities explicitly supported the application of the scenario framework to prevent non-compliant works from receiving growth allowances to become compliant with permits. South West Water said this protects customers from paying twice for improvements and holds companies to account on previously agreed deliverables.

Southern Water and Thames Water disputed some specific scheme scenario allocations and resulting exclusion decisions.

Our assessment and reasons

We do not expect customers to pay for any non-compliance with existing permit conditions as this has already been allowed for at previous price reviews. Therefore, before assessing growth at STW enhancement, we developed the framework in table 29 using the scheme level data to identify:

- growth at STWs schemes that companies should deliver without a growth at STWs enhancement allowance (for example, to address non-compliance with existing DWF and / or FFT permit conditions); and
- growth at STWs schemes that we should set an efficient growth at STWs enhancement allowance for (for example, to increase capacity at an STW as a result of forecast population growth over the 2025-30 period).

Table 29: Framework for providing allowances for growth at STWs schemes

Number	Scenario	Outcome

Scenario 1	The STW has not exceeded its permitted DWF limit over PR19. However, site improvements are still needed to remain compliant with existing permit when having to cope with additional flow and load due to growth. Company forecasts population growth in the catchment area, however this does not exceed the DWF limit so there would be no change in flow or quality conditions. Funding for WINEP / NEP actions relating to no deterioration permit changes is considered under the relevant WINEP / NEP enhancement cost lines and not under Growth at STWs.	We set an efficient growth at STWs allowance for this scheme at PR24.
Scenario 2	The STW has not exceeded its permitted DWF limit over PR19. Company forecasts population growth in the catchment area, and this will likely result in the exceedance of the current DWF limit. This is likely to trigger a need for investment in hydraulic treatment capacity and biological and / or chemical treatment capacity.	We set an efficient growth at STWs allowance for this scheme at PR24.
Scenario 3	The STW has not exceeded its permitted DWF limit over PR19. The company does not forecast an update of its DWF limit, however it does expect an update in its permitted FFT level. At PR19, investments in hydraulic capacity were funded and included in WINEP / NEP under U_IMP5. At that stage, the Environment Agency / Natural Resources Wales made a judgement on which STWs had unsuitable FFT / DWF ratios and included actions in the PR19 WINEP / NEP. These actions were funded for improvements at PR19. We do not consider it is appropriate that additional restoration of ratios should be funded from the Growth at STWs enhancement line in PR24. Specific Environment Agency / Natural Resources Wales deferred U_IMP5 actions in the PR24 WINEP / NEP are funded through the 'Increase Flow to Full Treatment' enhancement area.	Additional costs for restoration of FFT / DWF ratios should be met by companies. Customers should not pay for this.
Scenario 4	The STW has exceeded its permitted DWF limit over PR19. There is no extra forecasted growth over PR24, however companies are requesting funding for accommodating a change in the DWF limit.	Costs for remediating any non-compliance should be met by companies. Customers should not pay for this.
Scenario 5	The STW has exceeded its permitted DWF limit over PR19. There is extra forecasted growth over PR24, and companies are requesting funding for accommodating a change in the DWF limit.	We set an efficient growth at STWs allowance at PR24 to accommodate expected population growth in the 2025-30 period. Costs for remediating any non-compliance against current DWF limits should be met by companies. Customers should not pay for this.

We reassessed the scenarios for the updated set of growth at STWs schemes submitted in response to our draft determinations. Most schemes fall in scenario 1 or 2, with no schemes in scenario 3. Three schemes fall in scenario 4 and for one of these schemes we give a separate allowance outside of the model.

Our assessment of DWF compliance data in 2023 led to a higher number of 65 schemes that we allocated to scenario 5 up from 11 schemes at draft determinations. The 2023 year was characterised by high levels of rainfall and therefore higher rates of non-compliance with DWF permits by the Q90 metric, applying the 3-in-5 years rule.

We queried companies whether scheme expenditure included costs for compliance with existing DWF permits given this expenditure is not in scope of growth at STWs costs under scenario 5 of the framework. Companies gave varying responses. Not all of them provided sufficient assurance that DWF compliance costs were excluded. As a result, we keep scenario 5 schemes in the model with submitted expenditure and we apply a post-modelling adjustment to exclude DWF non-compliance costs. We provide more detail on how we calculate this adjustment in section 5.6.4.

We welcome the companies' recognition of the importance of ensuring customers do not pay twice for improvements. Following our assessment of the application of the scenario framework, we include the disputed schemes raised by Southern Water and Thames Water in scope of the growth at STWs modelling dataset.

Although not included in the scenario framework, we sought further assurance through the PR24 queries process that companies have not included any expenditure to remediate FFT non-compliance (as opposed to compliance with DWF permits). Companies provided assurance they have not included any of this expenditure in scope of their growth at STWs requests. We will continue to seek assurance through the PCD process that none of the expenditure incurred is to address compliance with existing DWF and FFT permit conditions. While we accept non-compliant works might experience significant growth, our growth at STWs models focus on providing incremental allowances over and above addressing pre-existing non-compliance issues.

5.3 Models considered

5.3.1 Selected cost drivers

What we said in our draft determinations

At draft determinations we triangulated between two econometric models, each with a key scale driver, either:

- **Change in PE served over the 2025-30 period** – this is a direct and exogenous measurement of catchment growth, therefore reflecting the increase in the amount of flow and load the STW would have to treat.
- **Process capacity added to meet current and expected quality permits** – describes the increase in treatment capacity enhancements to accommodate the increase PE flow and load, therefore measuring the output from growth at STWs allowances. Highly correlated with change in PE served, therefore used in separate models.

We included the following additional drivers in both econometric models:

- **Expected change in Dry Weather Flow (DWF) permit** – this increases growth at STWs costs through the need for proportional increases in hydraulic capacity to maintain suitable FFT / DWF ratio and investment to apply tighter sanitary parameters and / or nutrient permit limits.
- **Ammonia <3mg/l dummy** – the key exogenous treatment complexity driver capturing the need for additional and / or more complex tertiary treatment processes driven by DWF permit changes.

We also considered other drivers which we decided not to include. The expected FFT permit change was highly correlated with expected DWF permit change. This lead to collinearity when adding to the models. We also tested other tight permit level dummy variables for phosphorus and BOD but did not find them to be statistically significant.

Stakeholders' representations

Southern Water said that disproportionate costs are incurred for sites which require increases in hydraulic capacity which is not captured at a site level by the variables in the model. It suggested that we need to consider a deep dive approach for these sites.

Severn Trent Water identified that the change in PE served reflects only growth to the end of the 2025-30 period, while the growth investment considers planning for growth in future periods. As a result, it suggested that process capacity installed is a more appropriate cost driver. It argued that although this is more endogenous, companies do not have incentive to build excessive capacity due to the EA permitting approach and higher operating costs of large assets. The company is also concerned about incentivising schemes that do not deliver efficiency for customers, by considering a short timeframe in our models.

Severn Trent Water also proposed several additional drivers. On scale drivers, to tackle the issues with the growth in PE served variable, it proposed adding a 'headroom ratio' variable, defined as the extra capacity installed divided by the change in PE, to retain a fully exogenous scale driver while allowing for some increased allowance for building in headroom. It also suggested that a squared scale driver (either growth in PE served or process capacity added) to account for economies of scale. It said that there are factors limiting economies of scale in large schemes, including complexity, more specialist equipment and greater levels of management.

On non-scale drivers, Severn Trent Water proposed including a variable that describes the change in FFT / DWF ratio between current and expected levels. It said these ratios can be lower than the typical value of 3 due to how permits were updated historically (eg update of DWF permit without a corresponding FFT permit change). Therefore, the company stated this variable can better account for instances where additional hydraulic capacity is required to restore these ratios.

United Utilities stated that the use of change in PE served leads to an inconsistency between cost and cost drivers. This is due to PE growth being up to 2030 but costs including post-2030 expenditure.

Wessex Water proposed an alternative ammonia permit dummy, suggesting its threshold for considering tertiary treatment is 5mg/l. Severn Trent Water proposed expanding the ammonia dummy to become a composite, capturing tight BOD and phosphorous permits in addition to ammonia. United Utilities also proposed an additional complexity measure, by including a dummy capturing sites with phosphorous permit falling below 0.5mg/l. It suggested adding a separate model and triangulating between models using both tight ammonia and phosphorous permits to capture the distinct cost pressures.

Our assessment and reasons

In final determinations, we continue to focus on exogenous cost drivers that are supported by clear economic and engineering rationale. We set out the final cost drivers / explanatory variables included in our selected models after considering stakeholder responses.

Process capacity added to meet current and expected quality permits

Process capacity added to meet current and expected quality permits describes the increase in treatment capacity enhancements for the relevant scheme to accommodate the increased PE flow and load received at the STW. It therefore measures the output that will be delivered with growth at STWs allowances. This cost driver captures the company's long-term investment decisions, which may capture growth projections beyond 2030. Process capacity added is highly correlated with change in PE served over the 2025-30 period. We retained this cost driver in the final determinations models.

We have decided to remove the model using the volume driver of change in PE served over the 2025-30 period. We included this driver in draft determinations as the most direct measurement of exogenous catchment growth which creates the need for growth at STWs investments. As such, it provides an alternative view to capacity added which is within company control.

However, we found significant differences between PE served and process capacity added models in our testing. That is partly driven by the difference in timescales where process capacity added better captures how companies address the need for growth at STWs investments. This need may go beyond what the forecast PE served growth will be by 2030.

In addition, when comparing the datasets between draft and final determinations, we found that some companies changed PE growth forecasts significantly. Therefore, we were concerned that these issues undermine the robustness of this variable, while process capacity added corresponds more directly with the output of growth schemes.

Expected change in Dry Weather Flow (DWF) permit

DWF is likely to increase over time as a result of population growth. There are two ways in which the change in DWF impacts growth at STWs costs.

DWF limit increases are associated with proportional increases in the permitted FFT level to maintain a suitable FFT / DWF ratio. This often requires the company to increase hydraulic capacity at the STW to be able to meet the new FFT level.

In addition, a DWF limit increase is often associated with a pro-rata tightening of sanitary parameters and / or nutrient permit limits so that the water quality of the receiving watercourse does not deteriorate. This will often require investment in additional treatment capacity (such as secondary biological treatment capacity or tertiary treatment capacity) unless the tighter limit can be achieved through existing assets. Engineering rationale suggests it has a positive impact on costs – the larger DWF permit level update, the more significant the effluent permit tightening required, and the higher the efficient costs required to achieve compliance.

We consider that our models reflect the need for additional hydraulic capacity due to growth. The DWF change driver in our models is associated with the need for hydraulic capacity investments to implement the new FFT permit. Therefore, our models already account for the average cost impact of any increases in FFT permits.

In addition, we do not penalise any restoration of historically low FFT / DWF ratios by looking at exogenous growth only. That is because we removed the model using change in PE served for final determinations. Therefore, we expect that sites where this ratio was lower due to historical permit setting are likely to have higher process capacity added leading to higher efficient costs. We engaged with the Environment Agency to confirm that restoration of FFT / DWF ratios through growth at STWs funding is appropriate provided the company does not use growth funding to remediate past non-compliance.

Ammonia permit <3mg/l dummy

Engineering insight suggests the enhanced permit might not impact costs linearly. Companies argued in PR24 business plans that achieving tight permits could result in a step change in costs due to need for additional and / or more complex tertiary treatment processes. We constructed a dummy variable to capture if the new ammonia permit level required due to the change in the DWF permit is expected to be below 3mg/l. We use this cost driver as the key exogenous treatment complexity driver due to growth. As ammonia permit changes are often related to permit changes of other biological parameters, this cost driver accounts for overall treatment complexity.

To be consistent with the above engineering and economic rationale, the sign of the estimated coefficient of this term should be positive. That would mean that STWs that need to achieve an enhanced ammonia permit of less than 3mg/l would attract a higher growth at STWs allowance.

We do not consider that we need to change our approach to accounting for treatment complexity. We tested the alternative dummy variable using phosphorus permit <= 0.5mg/l but we found the variable was not statistically significant. In addition, we do not agree with including different tight permits (ammonia, BOD and phosphorus) in a composite dummy variable. Since we have already tested that BOD and phosphorus are not individually statistically significant, we are concerned that a composite variable could mask the insignificant individual impact of other tight permits. We also consider that the 3mg/l threshold is appropriate as it is aligned with the treatment complexity driver in the wastewater base cost models and supported by engineering rationale.

5.3.2 Functional form

What we said in our draft determinations

We did not make logarithmic (log) transformations of the dependent or explanatory variables prior to estimating our scheme level growth at STWs enhancement models.

Stakeholders' representations

Severn Trent Water stated that there is a log relationship between cost and scale, which affects model performance, the reliability of the estimated efficiencies, and the outlier removal process. By plotting the linear and log transformed data, it argued that the logarithmic data is visually more 'modellable'. It also argued that without logarithmic transformations, the outlier removal process fails to remove any low-cost outliers. Finally, it recognised the issue of log bias and proposed an adjustment to account for this.

Our assessment and reasons

We continue to use a model without log transformation in final determinations that we refer to as a "levels" model in this section, as the levels model with process capacity added continues to perform well. In addition, we tested log-transformed models and found that consistent with stakeholder responses, log models detect a larger range of outliers as influential compared to levels models that detect high-cost outliers. The log-transformed model, when applied to a dataset with both sets of outliers removed, performs similarly to the levels model with all drivers statistically significant and a similar R-squared. Therefore, we triangulate between a levels and log model specification for final determinations similar to our approach to storm overflows.

We found substantial log bias in modelled allowances for the log model. Therefore, we corrected the log-bias by implementing an upwards adjustment to model predicted costs equal to the percentage difference between industry requested costs and industry model predicted costs.

In addition, to be able to estimate the log models, we added an arbitrary small positive value to the DWF change variable, as there are zero values that would otherwise be undefined. We tested the sensitivity of the modelled costs to the choice of this small positive value and found a negligible impact.

The two models have similar patterns in terms of company efficiency scores after calculating modelled costs, but some companies show different results from the two models, including Northumbrian Water and Wessex Water. We therefore consider that triangulating between both models minimises the bias in allowances from using any one functional form.

5.4 Selected models

We set out our selected growth at STWs enhancement models in table 30. The estimated coefficients of all drivers have the correct sign, are of reasonable magnitude, and are statistically significant.

Table 30: Scheme level Growth at STWs enhancement totex models[19]

Explanatory variable	GS1	GS2
Added Process Capacity in PE	0.000358*** {0.000}	
Added Process Capacity in PE (log)		0.376*** {0.000}
Expected change in DWF permit	0.00525*** {0.000}	
Expected Change in DWF permit (log)		0.00757*** {0.000}
Ammonia permit change dummy (<3 mg/l)	5.147*** {0.000}	0.737*** {0.000}
Constant	3.19*** {0.000}	-1.337*** {0.000}
Adjusted R-squared	0.436	0.412
Observations	255	255

[19] The parameters in Table 4 reflect a model with the total expenditure dependent variable initially being transformed by dividing by 1,000,000. This transformation is also done prior to any logarithmic transformations.

5.5 Efficiency benchmark

What we said in our draft determinations

We did not apply an additional catch-up efficiency challenge on top of the average efficiency challenge from the models. The median efficiency score was larger than one so a median challenge would have resulted in the sector receiving more than it requested. We said we will reconsider whether it is appropriate to apply a more stretching efficiency challenge at final determinations.

Stakeholders' representations

Stakeholders did not make particular representations on the efficiency challenge.

Our assessment and reasons

Similarly to draft determinations, the median is above the mean for the levels model, but marginally below one for the log model. Therefore, we consider there is no need to make a median adjustment. Further, the upper quartile adjustment of 0.89 is relatively stretching when combined with our post-modelling adjustments for past under delivery (see section 5.6). We consider that our post-modelling adjustments are better targeted at protecting customers. Not imposing an additional efficiency challenge provides companies with sufficient allowances to make improvements. Therefore, we continue to apply no additional efficiency challenge on top of the average efficiency challenge from the models.

Table 31 sets out modelled growth at STWs allowances excluding outliers[20] for each company under the two models. We place equal weight on both growth at STWs models to produce a triangulated view of modelled growth at STWs allowances. Allowances presented are before the application of frontier shift efficiency and real price effects.

Table 31: Growth at STWs modelled allowances excluding outliers[21] (£ million, 2022-23 prices)

Company	Request	GS1	GS2	Triangulated allowance	Allowance minus request	
					£m	% of request
Anglian Water	184.78	265.00	289.80	277.40	93	50%
Dŵr Cymru	70.08	131.09	114.98	123.04	53	76%

[20] We identified outliers by a combination of Cook's distance calculations and manual identification of schemes which are difficult to model, or which generate outlying results. For example, we could not model new STWs schemes. We have conducted an engineering assessment of these schemes. For more information, please refer to the outlier assessment in our growth at STWs enhancement model.

[21] Note that the request and resulting allowances include costs for AMP8 schemes which the company intends to incur (or has incurred) in AMPs other than AMP8.

Hafren Dyfrdwy[22]	-	-	-	-	-	-
Northumbrian Water	53.44	41.55	62.78	52.17	-1	-2%
Severn Trent Water	532.32	515.25	504.20	509.73	-23	-4%
South West Water	20.93	20.31	20.40	20.35	-1	-3%
Southern Water	266.95	293.63	305.47	299.55	33	12%
Thames Water	230.22	115.49	124.81	120.15	-110	-48%
United Utilities	109.30	111.42	112.08	111.75	2	2%
Wessex Water	266.01	234.76	190.63	212.69	-53	-20%
Yorkshire Water	39.04	38.55	42.22	40.39	1	3%
Total	**1773.07**	**1767.06**	**1767.36**	**1767.21**	**-6**	**0%**

5.6 Post-modelling adjustments

After producing efficiency modelled allowances, we add allowances for outliers that we assessed outside of the models. We also:

- adjust allowances to that we only provide an allowance for costs that will be incurred in the 2025-30 period;
- adjust allowances for past under-delivery of additional capacity at STWs; and
- adjust allowances for companies remediating past DWF non-compliance through growth at STWs schemes.

5.6.1 Outlier treatment

At draft determination we identified outliers using the Cook's distance statistic. These schemes were subject to deep dive assessments and allowances added on top of the modelled allowances. We continue with this approach at final determinations. Additionally, we manually identify some schemes that are difficult to model and apply deep dive assessments here as well. This is the case, for example, for new STWs.

As at draft determination, we include Hafren Dyfrdwy's two schemes in the modelling sample as these are not statistical outliers, but set an allowance for these schemes through the deep dive process. This is because Hafren Dyfrdwy's programme consists of very small schemes that the models do not capture well.

Southern Water has resubmitted a request for Whitfield STW, excluded at draft determinations as DPC-lite scheme, and increased the costs from £55m to £103m. We assess this schemes as a gated scheme and provide a 6% development allowance.

[22] We include Hafren Dyfrdwy's two schemes in the modelling sample as these are not statistical outliers, however we set an allowance for these schemes through the deep dive process.

Finally, one Dŵr Cymru scheme that is considered as an outlier is Laugharne STW. In addition to the £2.8m originally submitted by Welsh Water in the ADD19 table, an additional £8.4m from the reconciliation line is included in Laugharne's growth at STWs allowance.

We separately implement a cap on Dŵr Cymru's allowances at 20% above requests. The company is significantly more efficient than the rest of the sector and we are concerned that this could reflect the company schemes having different characteristics to other companies, given the level of outperformance. Therefore, we consider that a cap is appropriate.

5.6.2 Adjustment to account for multi-AMP schemes

Table 31 above includes costs for all schemes commencing in the PR24 period of 2025-30. Some schemes have costs that will be incurred after 31 March 2030. We benchmarked the total cost of the scheme (excluding post 2029-30 operating expenditure) to help match the costs to the cost drivers. But this means we must adjust the resulting allowances to only make an allowance for costs that will be incurred in the 2025-30 period.

To calculate the growth at STWs allowances for the 2025-30 period, we add allowances for the deep dive outlier schemes to the modelled allowances. We then applied a post-modelling adjustment to allowances based on the proportion of total growth at STWs forecast costs reported in the 2025-30 period in draft determinations representations. The adjusted allowances are reported in table 32 before the application of frontier shift efficiency and real price effects.

Table 321: Growth at sewage treatment works allowances including outliers, after adjusting allowances to remove costs incurred outside of the 2025-30 period (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	%
Anglian Water	265.25	350.96	85.71	32%
Dŵr Cymru	72.68	134.21	61.52	85%
Hafren Dyfrdwy	0.88	0.88	0.00	0%
Northumbrian Water	53.44	52.17	-1.27	-2%
Severn Trent Water	929.54	802.84	-126.69	-14%
South West Water	34.40	33.82	-0.58	-2%
Southern Water	348.00	254.90	-93.10	-27%
Thames Water	355.17	213.43	-141.74	-40%
United Utilities	109.30	111.68	2.38	2%
Wessex Water	176.21	143.55	-32.66	-19%
Yorkshire Water	39.14	40.39	1.24	3%
Total	**2384.01**	**2138.82**	**245.19**	**-10%**

5.6.3 Past under delivery adjustment

What we said in our draft determinations

We made an adjustment to reflect that some companies do not appear to have delivered, or are not forecast to deliver, the proposed capacity increases at sewage treatment works in the 2015-25 period. Therefore, there is a risk that customers pay twice for improvements.

Companies' allowances were adjusted down by the difference between requested and actual spend over the 2015-25 period. To account for several implementation challenges, we reduced the final calculated adjustment by 50%.

Stakeholders' representations

Several companies raised issues with the past delivery adjustment in principle. Yorkshire Water and United Utilities argued that companies did not have specific outputs (PCDs) to deliver, and with uncertain growth companies have flexibility to use allowances in the most efficient way in response to incentives. Anglian Water also noted that growth schemes require a further level of flexibility as growth is more uncertain. South West Water said that past under-delivery can be due to factors outside of company control such as the pace of property developments.

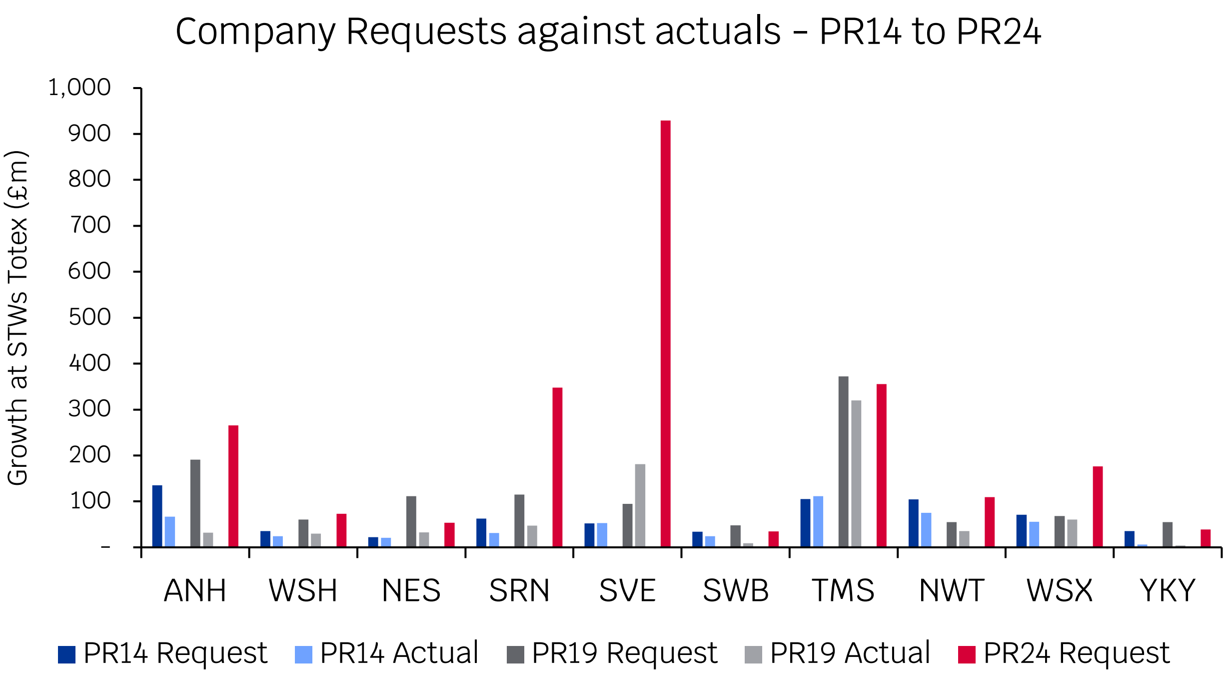
United Utilities also stated that Ofwat does not provide clear evidence that underspending has resulted in demonstrable STW capacity shortages and argued an adjustment should only be made in those circumstances.

Other companies agreed with the principle of the adjustment but disagreed that using company requests is appropriate. Anglian Water, Wessex Water, United Utilities and Yorkshire Water argued that implicit allowances for growth at STWs in the past were significantly different from company requests, for example due to frontier shift efficiencies or other efficiency challenges. Therefore the past delivery adjustment overstates the level of under-delivery. Wessex Water argued that compared to implicit allowances, it has overspent in the period considered.

Our assessment and reasons

Some companies do not appear to have delivered, or are not forecast to deliver, the forecast capacity increases at sewage treatment works in the 2015-25 period. Our analysis shows that all but one company have spent less than their growth at STWs business plan requested costs when looking across the 2015-25 period. [23] Figure 12 shows the requested and outturn expenditure in the 2015-25 period and PR24 company requests.

Figure 122: Growth at sewage treatment works requested and outturn expenditure in the 2015-25 period and PR24 company requests (£ million, 2022-23 prices)



Anglian Water and Yorkshire Water have spent less than half of what they requested in their business plans over this period. We queried both companies on how they spent their allowances, and we discovered a significant difference between the schemes companies said that they would deliver in business plans and schemes that were delivered. There is therefore a risk that customers pay twice for improvements. We have therefore adjusted our proposed PR24 growth allowance to account for previous under spending / delivery over the 2015-25 period.

To achieve this, we adjusted companies' PR24 growth at STWs enhancement allowance down by the difference between requested and actual spend over the 2015-25 period.

We are aware of the practical challenges with this approach:

[23] We consider this approach to be appropriate as wastewater totex allowances were similar to requests at PR14 and wastewater base allowances were close to business plan requests at PR19. See Table A1.2 of [PR19 final determinations: Securing cost efficiency technical appendix](), and Table A3.5 of PR14 Final price control determination notice: policy chapter A3 – wholesale water and wastewater costs and revenues ([PR14 FD Policy Chapter A3]())

- It is difficult to establish the implicit allowance for growth at sewage treatment works enhancement at PR19 as it was assessed in the scope of base costs. But we do know that the overall base cost challenge at PR19 was small (requested costs were 2% more than allowed for the industry). At PR14, allowances were about 1% lower than business plan requested costs.

- We do not know for sure how much companies will spend on growth at STWs in the current regulatory period as it is still ongoing. We have reflected outturn 2023-24 costs and use forecast spend for 2024-25 costs included in PR24 business plan tables.

- Companies have told us they face uncertain growth, which means previous business plan requests were optimistic in hindsight. The totex regime gives companies some flexibility to use allowances in the most efficient and effective way in light of new information.

- Due to the cost sharing mechanism, a proportion of any underspend will have been returned to customers.

To calculate the amount of the post-modelling adjustment, we therefore apply cost sharing rates to the difference between requested and outturn spend, and then reduce the adjustment by 50% again to account for the factors listed above.

The resulting past delivery adjustment is shown in Table 33 below and is immaterial for most companies.

Table 33: Growth at STWs allowances for PR24 final determinations after applying the past under delivery adjustment (£ million, 2022-23 prices)

Company	Request	Allowance before past-delivery adj.	Past delivery adjustment	Allowance after past-delivery adj.	Allowance minus request	
					£m	% of request
Anglian Water	265.25	350.96	-45.05	305.91	40.65	15%
Dŵr Cymru	72.68	134.21	-9.35	124.86	52.18	72%
Hafren Dyfrdwy	0.88	0.88	0.00	0.88	0.00	0%
Northumbrian Water	53.44	52.17	-13.97	38.20	-15.24	-29%
Severn Trent Water	929.54	802.84	0.00	802.84	-126.69	-14%
South West Water	34.40	33.82	-12.48	21.34	-13.06	-38%
Southern Water	348.00	254.90	-20.01	234.89	-113.11	-33%
Thames Water	355.17	213.43	-11.54	201.89	-153.28	-43%
United Utilities	109.30	111.68	-12.16	99.52	-9.77	-9%
Wessex Water	176.21	143.55	-5.31	138.24	-37.97	-22%
Yorkshire Water	39.14	40.39	-15.73	24.65	-14.49	-37%

Total	2384.01	2138.82	-145.60	1993.23	-390.79	-16%

We considered many of the arguments raised by companies during draft determinations. There are implementation difficulties to separately identify implicit allowances for growth at STWs as we included growth at STWs in scope of base costs in PR19. Given the small industry difference between requests and allowances for base in both PR14 and PR19, we consider this is a reasonable proxy for implicit allowances. Our approach to reduce the past under-delivery adjustments by 50% sufficiently accounts for uncertainty in our adjustments.

More broadly, this is an important mechanism to protect customers from paying twice for improvements. Growth at STWs investments are not included in statutory WINEP / NEP programmes, which results in a lower customer protection in case of non-delivery. In addition, growth is uncertain, potentially removing the need for growth investments as companies have pointed out in representations. Therefore, our past under delivery adjustment is a proportionate mechanism to recognise instances of significant non-delivery and returning funded allowances to customers.

5.6.4 DWF compliance adjustment

As mentioned in section 5.2, we queried companies whether scheme expenditure included costs to comply with DWF permits given this expenditure is not in scope of growth at STWs costs under scenario 5 of the framework. Companies gave varying responses but not all of them provided sufficient assurance that DWF compliance costs were excluded. As a result, we keep scenario 5 schemes in the model with submitted expenditure and we apply a post-modelling adjustment to exclude DWF non-compliance costs.

Using 2023 data to assess DWF compliance increased the number of schemes that might overlap with base compliance expenditure from 11 at draft determinations to 65. The 2023 year was characterised by high levels of rainfall and therefore higher rates of non-compliance with DWF permits by the Q90 metric, applying the 3-in-5 years rule.

As part of the PR24 query process, Severn Trent Water proposed an adjustment for base overlap that we have implemented. That involves calculating the ratio of:

- the DWF of the non-compliant years in the last five years minus the 2023 DWF permit; and
- the company proposed DWF change under the growth at STWs scheme.

This ratio effectively captures the share of proposed growth at STWs expenditure that addresses DWF compliance as of 2023. Therefore, we exclude this expenditure by multiplying this proportion by the modelled scheme level allowances for relevant schemes. We do this for all companies that did not provide assurance they excluded DWF compliance remediation costs from requested growth at STWs expenditure.

Despite Anglian Water arguing that it will account for DWF remediation costs through base expenditure, we identified seven schemes where the site was non-compliant with their DWF permit and either the:

- DWF permit does not change as a result of the growth scheme; or
- DWF permit does not change sufficiently to bring the scheme into compliance with the average of the failing years in the 2019-2023 period.

While we do not apply a DWF non-compliance adjustments for Anglian Water's other sites, we disallow allowances for these seven schemes. These schemes do not appear to deliver sufficient value for customers and risk customers paying for sites that remain non-compliant with their updated DWF permits.

Table 34 below sets out the allowances post-DWF non-compliance adjustment. The adjusted allowances are reported before the application of frontier shift efficiency and real price effects.

Table 34: Growth at STWs allowances for PR24 final determinations after applying the DWF non-compliance adjustment (£ million, 2022-23 prices)

Company	Request	Allowance before DWF compliance adj.	DWF compliance adj.	Allowance after DWF compliance adj.	Allowance minus request	
					£m	% of request
Anglian Water	265.25	305.91	-23.20	282.70	17.45	7%
Dŵr Cymru	72.68	124.86	0.00	124.86	52.18	72%
Hafren Dyfrdwy	0.88	0.88	0.00	0.88	0.00	0%
Northumbrian Water	53.44	38.20	0.00	38.20	-15.24	-29%
Severn Trent Water	929.54	802.84	-118.81	684.04	-245.50	-26%
South West Water	34.40	21.34	0.00	21.34	-13.06	-38%
Southern Water	348.00	234.89	-6.32	228.57	-119.43	-34%
Thames Water	355.17	201.89	-19.35	182.53	-172.63	-49%
United Utilities	109.30	99.52	0.00	99.52	-9.77	-9%
Wessex Water	176.21	138.24	-16.26	121.98	-54.23	-31%
Yorkshire Water	39.14	24.65	0.00	24.65	-14.49	-37%
Total	**2384.01**	**1993.23**	**-183.95**	**1809.28**	**-574.74**	**-24%**

5.6.5 Reconciliation adjustment

At draft determinations we had no reconciliation adjustment to account for differences between requested total expenditure in business plan table CWW3 and ADD19 scheme level growth at STWs expenditure.

We undertook a reconciliation exercise to ensure these expenditures reconcile. We apply a reconciliation adjustment factor where we have not been able to account for the difference. For final determinations, we find that there were more differences for Anglian Water, where the per year totals are marginally higher in ADD19 submission. For Severn Trent Water, it appears that 2023-24 transition expenditure has been excluded from ADD19.

Table 35 below sets out final growth at STWs enhancement allowances after applying this reconciliation adjustment. The adjusted allowances are reported before the application of frontier shift efficiency and real price effects. We also apply the capping for Dŵr Cymru as part of this step.

Table 35: Growth at STWs allowances for PR24 final determinations after applying the reconciliation adjustment (£ million, 2022-23 prices)

Company	Request	Allowance before reconciliation adj.	Reconciliation adj. factor	Allowance after reconciliation adj.	Allowance minus request	
					£m	% of request
Anglian Water	265.25	282.70	0.9910	280.17	14.92	6%
Dŵr Cymru	72.68	124.86	1.0000	87.00	14.32	20%
Hafren Dyfrdwy	0.88	0.88	0.9993	0.88	0.00	0%
Northumbrian Water	53.44	38.20	1.0000	38.19	-15.24	-29%
Severn Trent Water	929.54	684.04	1.0257	701.61	-227.93	-25%
South West Water	34.40	21.34	1.0000	21.34	-13.06	-38%
Southern Water	348.00	228.57	1.0000	228.57	-119.44	-34%
Thames Water	355.17	182.53	1.0000	182.54	-172.62	-49%
United Utilities	109.30	99.52	1.0006	99.58	-9.72	-9%
Wessex Water	176.21	121.98	0.9999	121.98	-54.24	-31%
Yorkshire Water	39.14	24.65	0.9999	24.65	-14.49	-37%
Total	**2384.01**	**1809.28**		**1786.51**	**-597.50**	**-25%**

6. Bioresources industrial emissions directive (IED)

Summary

We use **scheme level models** to set efficient IED enhancement allowances at PR24. We use three models to set secondary containment allowances and one model to set tank covering allowances. We apply **the company level modelled efficiency of secondary containment and tank covering** to other IED costs with a cap at requests for efficient companies.

We apply an upper-quartile catch-up efficiency challenge for secondary containment costs and a median catch-up efficiency challenge for tank covering costs. The IED data updates for efficient companies in draft determinations representations have resulted in a substantial lessening of the efficiency challenge for secondary containment and tank covering compared to draft determinations. Therefore, we retain the level of efficiency challenges at the level at draft determinations.

The key cost drivers of secondary containment IED activities are **bund wall surface area** and **volume of bund.** For tank covering IED activities we use **surface area of tank covers provided.**

Our models create an overall industry cost challenge of 16%.

Since draft determinations we made the following changes:

- **we triangulate between three secondary containment models** using **bund wall surface area** and **volume of bund** with one model for each cost driver and one model that includes both cost drivers. We weight the three secondary containment cost models equally to set efficient IED allowances for secondary containment.
- we apply **the company level modelled efficiency of secondary containment and tank covering**. This approach effectively assumes that company specific inefficiency is equivalent across secondary containment / tank covering and other IED costs. That improves our approach as we avoid bundling very disparate activities falling in the 'other IED' cost category into a modelled approach.
- we maintain the view that **companies that received cost sharing in the PR19 redeterminations should have made an early start on achieving compliance** in the current price control period. Therefore, when setting the final allowances, we remove 25% of Yorkshire Water's final modelled costs as the company had enhanced cost sharing in the current price control period. Northumbrian Water did not request any IED cost allowances in PR24.

The Industrial Emission Directive 2010/75 EU (IED) was the main EU instrument regulating pollutant emissions from industrial installations. The requirements of IED were implemented in the UK through the Environmental Permitting (England and Wales) Regulations 2016 (EPR).

IED sets out requirements to reduce harmful industrial emissions to achieve a high level of protection of human health and the environment. It regulates emissions to air, water, outputs management, and soil and groundwater contamination. Wastewater companies are required to obtain installation permits and expected to bring their applicable biological sludge treatment sites up to the standard required by IED and the Best Available Techniques (BAT) reference document for Waste Treatment (the BREF)[24].

Please see 'PR24 draft determinations: Expenditure allowances' for more background and context on our approach to IED.

To assess efficient cost of IED compliance over the 2020-21 to 2029-30 period, we issued a data request in August 2023 that asked for scheme level IED cost and cost drivers data with the cost data split into several categories:

- secondary containment;
- tank covering for abatement of fugitive emissions;
- cake pad / cake storage covering;
- control and monitoring;
- liquor sampling;
- permit application; and
- other.

We asked companies to re-submit the data in December 2023 to help account for the further clarification of IED compliance requirements (for example, in terms of scope). We also created an additional business plan Table ADD14 for companies to provide updated IED data in response to draft determinations.

We used this scheme level data to determine efficient costs of compliance with IED requirements as part of the PR24 price review. We have data on cost and cost drivers at all company bioresources treatment centres subject to IED. That creates a sample of schemes available across all companies over the 2020-30 period.

We used a **hybrid modelling approach** to set efficient allowances for IED compliance at final determinations:

- scheme level econometric modelling for secondary containment and tank covering costs; and

[24] Best Available Techniques (BAT) Reference Document for Waste Treatment Industrial Emissions Directive 2010/75/EU

- we apply the company level modelled efficiency of secondary containment and tank covering to other IED costs.

The rest of this section sets out our approach in detail.

6.1 Data used

What we said in our draft determinations

At draft determinations we used an IED dataset which contained scheme level data on cost and cost drivers related to IED compliance over 2020-21 to 2029-30 based on the December 2023 company submission. We used the key information to model efficient IED cost including costs, secondary containment bund wall length, tank covering surface area provided and total sludge produced.

We also made some refinements to the dataset to exclude base costs and cake pad covering costs. We also did not use data from Dŵr Cymru in our benchmarking models because of potential differences in the regulatory guidance for IED compliance in Wales.

Stakeholders' representations

Companies did not make specific representations about the data used. However, there were changes to the forecast IED enhancement expenditure requested from several companies. Main changes included the following:

- Anglian Water reported additional secondary containment costs due to more concrete in updated designs, additional drainage channels, storage and sealing roadways. The company also reported additional tank covering costs due to new Environmental Agency guidance communicated in IED Task and Finish group, including adding sites which were previously assumed not to require investment. Finally, there are additional liquor sampling costs.

- Yorkshire Water submitted higher secondary containment costs due to firm contractor engagement. The company also stated that unlike in draft determinations we should provide 25% of AMP7 costs and full AMP8 costs to ensure a consistent treatment with other companies.

- Northumbrian Water did not submit the ADD14 table in response to draft determinations. The company said that it is not requesting any further IED expenditure provided the policy of 25:25 cost sharing for IED expenditure that it got through the PR19 CMA redetermination is retained for PR24.

- Severn Trent Water added some scope to the IED costs, mainly to include three additional sludge treatment centres in scope.

- United Utilities reported lower IED costs due to improved data quality. The company also proposed further stretch efficiencies in their submitted IED costs.

- Wessex Water reported lower IED costs due to its decision to close one site but still included rationalisation costs (proportionally spread across the remaining sites) as IED expenditure.

Our assessment and reasons

At final determination we use the IED dataset which contains scheme level data on cost and cost drivers related to IED compliance over 2020-21 to 2029-30 based on the additional business plan table ADD14 company submission in response to draft determinations.

We use the following key information from this dataset to assess efficient IED costs:

- **yearly enhancement opex and enhancement capex to comply with IED** – data is for 2020-21 to 2029-30 split into several cost categories;
- **secondary containment bund wall surface area** – this is the product of containment bund wall length and wall average height installed to implement CIRIA 736 Guidance (or accepted approach by the Environmental Agency for the specific site) in relation to secondary containment requirement (for the named site);
- **secondary containment volume of bund –** this is the actual volume of bund proposed within the IED installation boundary for the named site, ie, this should be interpreted as the total volume of containment (m3) as per design, provided for the named site to retain the volume of any potential sludge spillages (including the design freeboard); and
- **covers - surface area provided (tanks)** [25] - surface area of the open tanks that are to be covered (for the named site).

The final dataset used in our analysis includes some updates which are discussed further later in this section. At final determinations, we are not using the:

- **wholesale wastewater dataset feeder model 1 (FM1).** This is because we revisited our approach to benchmarking 'other IED costs'.
- **secondary containment bund wall length** as a cost driver in secondary containment cost models. This is because we revisited our approach to set an efficient allowance in relation to secondary containment.

[25] We requested more granular information to help refine our cost assessment and clarify the potential impact on IED costs for tank covering. This included a cost evaluation of (1) provision of cover to existing tanks, (2) covering tanks that required tank replacement and (3) replacement of floating roofs.

We followed an extensive query, review and reconciliation process of the IED data. The final dataset used in our analysis included the following refinements:

- all base costs were excluded from the IED enhancement cost assessment as an allowance will be provided through our bioresources base cost models;
- we removed cake pad covering costs as our understanding is that this expenditure is not specifically required under IED unless otherwise specified by the permit conditions for any specific site;
- we do not use IED cost and cost drivers data from Dŵr Cymru in our benchmarking models because of potential differences in the regulatory guidance for IED compliance in Wales; and

In addition, we assumed the costs included in our PR24 draft determinations for Northumbrian Water following confirmation by the company that its cost and cost drivers remain the same. The company did not submit table ADD14 in its representation.

Please see the IED enhancement model and accompanying datasets we use to underpin our econometric analysis for more detail.

Table 36 shows summary statistics for the cost and cost drivers in the IED dataset that we used in our econometric modelling.

Table 36: Summary statistics for IED dataset of the cost drivers used

Variable	DD	FD
Number of sites	117	114
Enhancement totex for secondary containment	£559.67m	£653.97m
Enhancement totex for tank covering	£609.24m	£632.56m
Enhancement totex for all other categories	£374.02m	£324.74m
Secondary containment bund wall surface area	72,447 m^2	72,723 m^2
Secondary containment volume of bund	932 m^3	922 m^3
Surface area of tank covers provided	156,544 m^2	158,810 m^2

The table shows that secondary containment and tank covering form the majority of enhancement totex required to comply with IED. Therefore, our modelling approach focused on developing scheme level econometric models that use key cost drivers to model efficient secondary containment and tank covering costs.

6.2 Models considered

6.2.1 Selected cost drivers

What we said in our draft determinations

At draft determinations we assessed three categories of costs separately:

- secondary containment costs;
- tank covering costs; and
- other IED costs.

We used volume drivers with strong engineering rationale to model secondary containment costs with bund wall length and tank covering with surface area of tank covers provided.

'Other IED costs' are made up of control and monitoring; liquor sampling; permit application; and other. We benchmarked 'other IED costs' per tonne of dry solids sludge produced (the unit cost) between companies, with sludge produced used to explain differences in the scale of other IED costs between companies.

Stakeholders' representations

Severn Trent Water agreed with our models. Anglian Water argued that the performance of IED models is poor and we should consider additional modelling for final determinations where possible. Thames Water, Southern Water, Wessex Water, United Utilities and South West Water have significant concerns about the robustness of the models. In light of that, Thames Water and Southern Water proposed a deep dive approach to set IED allowances.

United Utilities proposed secondary containment models using product of wall length and wall height, as a measure of the surface area of the wall. For tank covering models, the company proposed collection of data on tank types to account for different kind of assets covered. It also proposed that the methane reduction costs (Carbon Net Zero enhancement proposals) identified as IED costs should be reallocated to the IED tank covering cost models.

Thames Water suggested using log tank covering models as model fit improves, applying the PR19 log bias adjustment as required. The company also stated that we could consider using the number of tanks as a cost driver in tank covering models and the height of the wall of the bund as a cost driver in secondary containment models.

Southern Water stated that for secondary containment, Ofwat’s model and their highest performing alternative models (ie surface area of the wall) do not meet Ofwat’s criteria for model robustness. The company developed an alternative model for monitoring and sampling costs. For other IED costs, Southern Water stated that sludge produced does not align with engineering rationale.

Wessex Water tested models including volume of bund and log specifications. The company stated sludge produced is not a relevant cost driver for most of the cost lines grouped in other IED costs. Therefore, it argued that we should develop more disaggregated models for other IED costs.

Our assessment and reasons

We want to use exogenous cost drivers supported by clear economic and engineering rationale in our cost models. The drivers we used are exogenous to the extent that IED upgrades are designed to correspond to the scale of existing assets. For example, the number and size of sludge digesters (driven by scale of the site) largely determine the secondary containment and tank covering IED upgrades required (see below).

In practice, companies will have some discretion in how to design the upgrades so there is a level of endogeneity. However, the Environment Agency issues IED permits and challenges companies on their proposals for achieving IED compliance. This reduces the risk of inefficient design as the Environment Agency permit requirements are exogenous to the company.

We assessed three categories of costs separately:

- secondary containment costs;
- tank covering costs; and
- other IED costs.

We also considered 'top-down' models using all IED costs, but these explained less variation in IED costs between companies. This is because the granular models include scale drivers with a clear engineering rationale for the specific costs being modelled.

The rest of this section explains our final determinations modelling approach for secondary containment, tank covering and other IED costs in turn.

Secondary containment costs

For secondary containment costs we agree with stakeholder responses that wall height is important as the bunding solution can comprise long, low-height walls or short, high-height walls to provide containment for an equivalent bund volume. Therefore, we use **bund wall surface area, the product of wall length and height** as a more holistic measure of the level of bunding activity required to explain differences in the scale of secondary containment costs between companies. Engineering rationale suggests that larger wall surface area, that prevents spillage issues from digesters and sludge holding tanks, results in higher secondary containment costs.

We also use **volume of bund** to explain differences in the scale of secondary containment costs between companies. We tested this driver in draft determinations but it was not statistically significant. Engineering rationale suggests that higher design volume of the enclosed area needing containment results in higher secondary containment costs. The volume captures the aggregate bunding activity required in terms of impermeable surface area and bund wall surface area.

Secondary containment cost models using wall surface area and volume of bund as cost drivers perform well with the updated dataset. Therefore, we consider secondary containment cost models using these cost drivers.

We considered using other secondary containment scale drivers including:

- sludge produced – as a weak proxy for the volume of tanks;
- volume of tanks (m3) – broadly defines the total secondary containment requirement as per CIRIA 736 standard;
- impermeable surface area upgraded (m2) – measures the surface area dimension of the works; and
- bund wall weighted average height (m) – measures the height of the bund wall.

But bund wall surface area and volume of bund explained the highest variation in secondary containment costs between companies out of all the potential scale variables. Therefore, at PR24 final determinations we use **three secondary containment cost models** with one model for each cost driver and one model that includes both cost drivers. We weight the three secondary containment cost models equally to set efficient IED allowances for secondary containment.

Tank covering costs

Companies carrying out biological sludge treatment are required to cover any sludge tanks on-site in the companies' sludge treatment centres that fall under IED regulations (where a cover is considered necessary and applicable). These actions are required to prevent emissions to the environment (in particular emissions to air). We used **surface area of tank covers provided** to explain differences in the scale of tank covering costs between companies. Engineering rationale suggests that higher area coverage for open sludge tanks to reduce fugitive emissions results in higher tank covering costs. Tank surface area is driven by the number and diameter of open tanks that need covering.

We considered using other tank covering scale drivers including:

- sludge produced - as a weak proxy for the number and diameter of tanks;

- number of tanks – to directly capture the number of tanks covered; and
- volume of tanks – as a proxy for the diameter of tanks.

But surface area explained the highest variation in efficient tank covering costs between companies.

We have reviewed company representations on additional cost drivers for tank covering. We acknowledge that there is a wide range of scope items and site-specific approaches within the tank covering proposals. Due to the complexity and wide range of options proposed by companies for tank covering provided both in companies representations and additional queries responses, the surface area of tank covers continues to provide the most appropriate cost driver for our assessment of efficient tank covering costs. We also clarify that carbon net zero enhancement costs related to methane reductions are assessed separately where the scope goes above and beyond IED requirements under the Net Zero Enhancement proposals [26] and therefore outside of the IED scope.

Other IED costs

For 'other IED costs', we recognise that our draft determinations approach to bundle very disparate activities falling in the 'other IED' cost category and applying a unit cost per sludge produced benchmark is a simple approach. We did not develop any disaggregated econometric models on other IED costs. This cost category accounts for only 20% of total IED submitted costs and the activities it includes are not suitable for modelling with the available cost driver data. We continue to consider it is appropriate to assess the activities within this category jointly.

Therefore, at final determinations, we apply **the company level modelled efficiency of secondary containment and tank covering** to other IED costs. This approach effectively assumes that company specific inefficiency is equivalent across secondary containment / tank covering and other IED costs. For Severn Trent Water and United Utilities, we cap the allowance at requested costs as modelled secondary containment and tank covering costs are higher than requested costs.

6.2.2 Functional form

We did not make a logarithmic (log) transformation of the dependent and explanatory variables prior to estimating our bioresources IED enhancement models for the reasons set out in section 2.

[26] PR24 Final Determinations-Expenditure Allowances, Section 3.9, Ofwat, December 2024

6.3 Selected models

We set out the selected scheme level econometric models for secondary containment and tank covering in table 37. As we set out in the previous section, we excluded Dŵr Cymru from our benchmarking analysis because of potential differences in regulatory guidance for IED compliance in Wales.

The estimated coefficients of the drivers in the models have the correct sign, are of a reasonable magnitude, and are statistically significant.

Table 37: Scheme level IED totex models

Explanatory variable	Secondary containment			Tank covering
Secondary containment bund wall surface area (m2)	0.006*** {0.000}		0.005*** {0.000}	
Secondary containment volume of bund (m3)		0.340*** {0.000}	0.240*** {0.000}	
Surface area of tank covers provided (m2)				0.002*** {0.006}
Constant	1.885*** {0.001}	3.182*** {0.000}	1.277** {0.000}	3.988*** {0.000}
Adjusted R-squared	0.323	0.288	0.447	0.097
Observations	92	92	92	78
Dependent variable	Secondary containment enhancement costs		Tank covering enhancement costs	

6.4 Efficiency benchmark

What we said in our draft determinations

At draft determinations we set an upper quartile efficiency challenge for secondary containment and other IED costs and a median efficiency challenge for tank covering.

This approach recognised multiple factors, including that we are setting the benchmark based on companies further progressed in IED implementation and that we provide favourable cost sharing to recognise higher cost uncertainty compared to other costs.

Stakeholders' representations

In response to draft determinations, companies did not support the use of upper-quartile catch-up efficiency challenge for secondary containment models due to poor model performance. United Utilities proposed no efficiency catch-up challenge for tank covering cost models due to poor model performance.

The company also proposed to apply a high-level efficiency to submitted 'other IED' costs. This efficiency factor could be derived by estimating the cost gap (between predicted and submitted costs) from secondary containment and tank covering models. This approach effectively assumes that company-specific inefficiency is equivalent across secondary containment / tank covering and 'other IED' costs.

United Utilities, Southern Water and Wessex Water challenged our arguments that the efficiency challenge is based on companies further progressed in IED implementation such as Yorkshire Water and Northumbrian Water. Companies argued that efficiency is driven by site-specific factors, permit requirements and site layout / topography. Southern Water said that since Yorkshire Water and Northumbrian Water received funding in the 2020-25 period, we may have not taken all of their costs into account.

Our assessment and reasons

After considering responses to our draft determinations, we have decided to set the efficient bioresources IED enhancement allowances at final determinations as follows:

- for secondary containment costs, we applied an upper-quartile catch-up efficiency challenge;
- for tank covering costs, we applied a median catch-up efficiency challenge; and
- for other IED costs, we applied the company level modelled efficiency of secondary containment and tank covering to other IED costs.

We have set bioresources IED allowances that will incentivise companies to deliver IED upgrades efficiently. The more stringent efficiency challenge compared to other enhancement areas recognises multiple factors:

- we are providing PR24 allowances for IED compliance obligations that were required to be delivered in the current 2020-25 price control period;
- there is still a level of uncertainty, which appears to have led to higher IED totex requests for some companies;
- a more stringent challenge is based on companies that are further progressed in IED implementation and are likely to have greater cost certainty; and
- we are providing favourable cost sharing of 25:25 to recognise the higher cost uncertainty compared to other costs (see 'PR24 final determinations: Expenditure allowances' for more details on our approach to cost sharing).

We use the median company efficiency challenge for tank covering as it provides a sufficient cost efficiency challenge.

As discussed in the previous section, we use an updated suite of three models to set secondary containment allowances, using secondary containment surface wall area and volume of bund as cost drivers. Our final determinations models perform better with these cost drivers using the updated dataset. In addition, we note that the data updates for efficient companies has resulted in a substantial lessening of the efficiency challenge compared to draft determinations. Therefore, we continue to consider that an upper-quartile catch-up efficiency challenge for secondary containment costs is appropriate.

Similar to secondary containment, data updates for efficient companies for tank covering has resulted in a substantial lessening of the efficiency challenge compared to draft determinations. Therefore, we continue to use a median company efficiency challenge for tank covering.

Finally, as explained in section 6.2, we have decided to revisit our approach to setting the efficiency challenge on other IED costs. Rather than using a unit cost model for this category of costs and setting the benchmark at the upper quartile unit cost, we apply the modelled efficiency of secondary containment and tank covering to other IED costs. This is an approach we use in other scheme level areas for schemes that cannot be modelled. For Severn Trent Water and United Utilities, we cap the allowance at requested costs as modelled secondary containment and tank covering costs are higher than requested.

Tables 38 and 39 set out efficient modelled allowances for secondary containment, tank covering and other IED costs after the application of our catch-up efficiency challenge, but before (i) the addition of allowances for outliers, (ii) the application of post modelling adjustments; and (iii) frontier shift efficiency and real price effects.

Table 38: IED allowances before outliers and adjustments (£ million, 2022-23 prices)

Company	Request	Secondary containment modelled allowance	Tank covering modelled allowance	Other IED costs allowance	Total IED modelled allowance
Anglian Water	115.71	61.84	31.27	11.80	104.92
Dŵr Cymru[27]	0.00	0.00	0.00	0.00	0.00
Hafren Dyfrdwy	0.00	0.00	0.00	0.00	0.00
Northumbrian Water	0.00	0.00	0.00	0.00	0.00
Severn Trent Water	186.78	91.60	104.82	63.54	259.96
South West Water	16.07	5.15	6.10	4.74	15.98
Southern Water	172.11	68.51	12.78	57.16	138.45

[27] As explained in the section, we do not use Dŵr Cymru data in our benchmarking models.

Thames Water	410.27	100.99	83.80	29.31	214.10
United Utilities	110.91	49.52	30.64	42.06	122.22
Wessex Water	98.71	21.62	17.38	18.84	57.84
Yorkshire Water	102.08	51.73	42.61	6.59	100.93
Total	**1212.63**	**450.96**	**329.40**	**234.05**	**1014.41**

Table 39: IED allowances before outliers and adjustments versus requested (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	115.71	104.92	-10.79	-9%
Dŵr Cymru	0.00	0.00	n/a	n/a
Hafren Dyfrdwy	0.00	0.00	n/a	n/a
Northumbrian Water	0.00	0.00	n/a	n/a
Severn Trent Water	186.78	259.96	73.18	39%
South West Water	16.07	15.98	-0.09	-1%
Southern Water	172.11	138.45	-33.66	-20%
Thames Water	410.27	214.10	-196.16	-48%
United Utilities	110.91	122.22	11.31	10%
Wessex Water	98.71	57.84	-40.86	-41%
Yorkshire Water	102.08	100.93	-1.15	-1%
Total	**1212.63**	**1014.41**	**-198.22**	**-16%**

There is a relatively narrower distribution of efficiency scores / cost gaps across companies. That reflects increases in requests by companies that were efficient and setting the benchmark in draft determinations. This has led to increases in efficient allowances despite the overall sector request not increasing significantly.

6.5 Post-modelling adjustments

What we said in our draft determinations

In draft determinations we made a number of post-modelling adjustments. We capped at request for efficient companies. In addition, companies funded in the 2020-25 period through the CMA redetermination did not receive an IED cost allowance at PR24 for investment that has been previously funded.

Stakeholders' representations

In response to draft determinations Yorkshire Water said that that we should provide 25% of 2020-25 costs and full 2025-30 costs to ensure a consistent treatment with other companies.

Our assessment and reasons

We do not agree with Yorkshire Water's proposal. We maintain the view that companies that received cost sharing in the PR19 redetermination should have made an early start on achieving compliance in the current price control period. We have therefore made an adjustment to remove 25% of the company's final modelled costs.

Table 40 sets out the total IED allowances in PR24 final determinations after a number of adjustments:

- adding in allowances for outlier schemes we assessed separately;
- reconciling for differences between the total bioresources IED costs requested in CWW3 and the scheme level data reported in the IED data request; and
- when setting the final allowances, we remove 25% of Yorkshire Water's final modelled costs as the company had enhanced cost sharing in the current price control period.

At final determinations, we do not cap IED allowances at the company request for efficient companies. As mentioned in section 6.4, updates to cost data in companies' representations (particularly companies' identified as efficient in our draft determination) have resulted in a substantial lessening of the efficiency challenge and an increase in allowances compared to our draft determinations. We have further validated our final determination site-level allowances against the costs per site submitted by the companies (Northumbrian Water and Yorkshire Water) who received specific settlement as part of the CMA and initiated discussions with the Environment Agency and started addressing IED requirements at an earlier stage compared to other companies (these companies are expected to have more certain IED costs submissions). The average forecast outturn enhancement IED expenditure per site for these two companies is £18m, whereas companies average forecast outturn IED cost per site for the whole sector is £14m. At final determinations our final allowance to address compliance with IED requirements is an average £11m per site.

Please refer to the IED enhancement model published alongside the final determinations that sets out all the adjustments in detail.

Table 40: Total IED totex allowances after adjustments (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	115.19	104.45	-10.74	-9%

Dŵr Cymru[28]	14.30	14.30	n/a	n/a
Hafren Dyfrdwy	0.00	0.00	n/a	n/a
Northumbrian Water	0.00	0.00	n/a	n/a
Severn Trent Water	204.50	274.33	69.83	34%
South West Water	47.14	38.99	-8.15	-17%
Southern Water	171.12	137.65	-33.47	-20%
Thames Water	534.29	299.67	-234.62	-44%
United Utilities	232.88	238.26	5.38	2%
Wessex Water	116.76	76.16	-40.61	-35%
Yorkshire Water	72.51	81.44	8.93	12%
Total	**1508.68**	**1265.24**	**-243.44**	**-16%**

[28] Dŵr Cymru did not explicitly request expenditure in 2025-30 but we have assessed the company's requirements and made allowances based on the totex provided by the company in the ADD14 table.

7. Sanitary parameters

Summary

We use a **scheme level model and a company level model** to set efficient sanitary parameters enhancement allowances at PR24.

We assign **equal weights to the scheme level and company level models**. We apply a median efficiency challenge.

The key driver of sanitary parameters enhancement activities is **population equivalent (PE) served.**

Our models create an overall industry cost challenge of 2%.

Since draft determinations we made the following changes:

- **use a scheme level model in addition to a company level model** to better account for economies of scale and triangulate across a wider range of models.
- **exclude costs for the year "After 2029-30"** (labelled as 2030-31) from the sanitary parameters dataset.
- **use a scheme level econometric modelling approach to determine efficient costs for transfer schemes**. At draft determinations, we treated these schemes as unmodelled and funded through the reconciliation adjustment factor that implicitly applied the company challenge to these schemes.
- **remove schemes with a solution type of "no additional treatment capacity"** as "optimisation schemes". This improves our models as the optimisations schemes are unrepresentative of a typical scheme in PR24. We treat these schemes as unmodelled.
- **apply the company level modelled efficiency of sanitary parameters schemes to unmodelled schemes**. This approach effectively assumes that company specific inefficiency is equivalent across modelled and unmodelled schemes. For efficient companies, we cap allowances at the request.
- **identify schemes with tight ammonia permits <= 1mg/l as engineering outliers**. After undertaking our assessment, we apply a 75% cost gap adjustment to these schemes.
- **identify schemes with tight BOD permits <= 7mg/l as engineering outliers**. After undertaking our assessment, we apply a 75% cost gap adjustment to these schemes.

The removal of sanitary determinands is required under the WINEP / NEP to reduce or maintain the levels entering surface waters. Sanitary determinands permits included in the WINEP / NEP are either for ammonia or biochemical oxygen demand (BOD). Although other parameters, such as suspended solids (SS) are categorised as a sanitary determinand, permits are not generally revised for this parameter unless the BOD or ammonia permits are tightened significantly.

For the PR24 WINEP / NEP, the main legislative driver for updated sanitary determinands permits is the Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 . Proposed expenditure for sanitary determinands under this cost line for PR24 is largely for the implementation of either improvement actions (WFD_IMP) or no deterioration actions (WFD_ND). PR24 WFD_IMP actions have 2030 completion dates and WFD_ND actions have 2026 completion dates.

In PR19, companies received a £336 million totex allowance to remove sanitary determinands. Companies requested £1.8 billion to fund additional improvements in PR24. This excludes any investment proposed under the nature-based solutions or catchment permitting cost lines for sanitary determinands.

In PR19, we estimated company level models with forecast data, with one observation per wastewater company. But we could not develop sufficiently robust econometric models and funded the company request in full in the PR19 final determination before a WINEP in-the-round efficiency challenge.

For PR24, we reassessed our approach to assessing efficient sanitary parameters enhancement expenditure[29]. In draft determinations, we considered both company level and scheme level approaches to model efficient sanitary parameters enhancement costs. We were not able to develop robust scheme level models at draft determination that control for the main cost drivers of volume (population equivalent of each scheme) and different sanitary parameters (BOD, ammonia and suspended solids). This may be partly due to the relatively smaller sample of schemes in the sanitary parameters dataset compared to other areas covered by scheme level models. In addition, each scheme is subject to tightening of a different combination of the three sanitary parameters which introduced additional complexity.

We therefore implemented a company level econometric modelling approach. This is similar to the approach we use for other areas of PR24 enhancement costs where scheme level data is not available. A key difference is that our sanitary parameters modelling approach used the granularity of scheme level data to:

- identify and exclude outliers from modelling; and

[29] Our decisions for draft determination are set out in this document [PR24-draft-determinations-Expenditure-allowances-Enhancement-cost-modelling-appendix.pdf](). The section relating to sanitary parameters is pp 80-85.

- improve the quality of the data used to develop company level models.

For final determinations we have reassessed our approach to modelling and considered the scheme level approach to modelling further. We have developed a robust scheme level model, using PE served as the cost driver. We consider there is a benefit of using a wider range of models to set efficiency sanitary parameters allowances in final determinations. Therefore, we have triangulated equally between the company and scheme level model to set allowances in final determinations.

The rest of this section sets out our sanitary parameters enhancement modelling approach in detail.

7.1 Data used

What we said in our draft determinations

We developed our company level model using scheme level cost and cost driver data collected through the PR24 query process. The datasets included key information which we used as part of the modelling process including **yearly opex and capex** and **PE served**.

After producing efficient modelled allowances, we applied a reconciliation adjustment to correct for three implementation issues:

- exclude costs after 31 March 2030 from efficient allowances;
- fund schemes we removed from our model (such as transfers); and
- account for differences in business plan requested costs between scheme level data (CWW19) and aggregate phosphorus removal enhancement costs (CWW3, CWW12 and CWW17).

Stakeholders' representations

South West Water stated that including the additional year of data "2030-31" is not necessary given companies are not requesting this expenditure.

Wessex Water and Southern Water highlighted there are schemes in the dataset with proposed costs but no tightening of any sanitary parameter. Wessex Water argued in its representation that there is clear engineering rationale for treating "no additional treatment capacity" solutions separately. It said that there is evidence these schemes will underestimate the efficient cost of a scheme requiring investment.

Southern Water highlighted that the schemes with costs proposed but no tightening of permits are significantly different to schemes requiring considerable additional treatment capacity or site reconfiguration.

United Utilities also said that unmodelled schemes should be dropped and considered separately via the deep dive process.

Our assessment and reasons

We developed our company level cost models using cost and cost driver data in table ADD17 (**BPT Table ADD17 dataset**). This dataset contains the same key information:

- **yearly opex and capex**; and
- **PE served** – the population equivalent that the STWs serves in each year.

The table also includes information about historical and enhanced permit levels for each sanitary parameter (BOD, ammonia and suspended solids), solution type, cost drivers for transfer schemes and other factors.

In addition, our econometric models focus on providing an allowance for conventional sanitary parameter schemes, which are included in the enhancement line 'Treatment for tightening of sanitary parameters (WINEP / NEP)' – lines CWW3.73 – CWW3.75.[30]

We assess other sanitary determinands schemes, including nature-based solutions and catchment permitting, separately. Please see Annex A1 for further details on our assessment.

At final determinations, we have changed our approach to funding transfer schemes. Transfer schemes involve transferring sewage from existing sites to a nearby site or to alternative watercourse to avoid the need for investing in quality upgrade schemes.

Our phosphorus removal and sanitary parameters datasets contain the two key cost drivers of transfers the **length of the transfer (km)** and the **transferred flow (m3 / day)**. Therefore, we pulled out all information on transfer schemes across all datasets into a standalone transfers dataset. Pooling all transfers schemes gave us a sufficient sample size which we used for scheme level econometric modelling of transfer schemes.

We agree with South West Water that the additional year of data after 2029-30 can be removed from the dataset. This also allows the reconciliation between CWW3 + CWW12 + CWW17 and the ADD17 dataset given the numbers are now compared on a like for like basis.

We have considered the inclusion of optimisation schemes within the dataset as suggested by Wessex Water. We agree that these schemes are not suited to a modelling approach due to limited correlation with the cost driver we use.

[30] We also include the equivalent lines in tables CWW12 (transitional expenditure) and CWW17 (accelerated programme expenditure)

Therefore, consistent with our approach in phosphorus removal, we applied the following updates to the ADD17 dataset:

- remove the additional year of data "2030-31" from the dataset; and
- remove "no additional treatment capacity" schemes from the dataset for a separate assessment as unmodelled as these are optimisation schemes with different characteristics.

We also drop some schemes from the models due to other reasons (eg no tightening of permits).

Table 41 shows the key characteristics of the PR24 sanitary parameters enhancement programme including changes between draft determinations and final determinations.

Table 41: Summary statistics for the sanitary parameters dataset

Variable	DD	FD
Number of schemes	287	334
PE served	5,951,322	6,005,804
Totex	£1.8bn	£2bn
Average totex / PE	£304.59	£337.24
Weighted average enhanced BOD permit (by PE)	11.03	12.93
Weighted average enhanced ammonia permit (by PE)	2.39	3.26
Weighted average enhanced suspended solids permit (by PE)	18.81	32.34
Average PE served per scheme	20,736	17,981

7.2 Models considered

What we said in our draft determinations

We considered both a company and a scheme level approach at draft determinations. We were not able to develop robust scheme level models that control for treatment complexity in terms of tightness of ammonia and BOD permits. Therefore, we decided to use a simple company level model.

Stakeholders' representations

Companies submitted their representations to our draft determination decisions detailing their views. We also issued an industry query to all companies offering the opportunity to submit any further views on the potential use of a scheme level approach in final determinations. Company views were mixed and are set out below.

Anglian Water, Northumbrian Water, Southern Water, Severn Trent Water and United Utilities supported the company level approach. These companies raised concerns relating to scheme level models such as the systematic difference in programmes between companies, with not all sites performing the same activities and the relatively smaller sample size. The companies highlighted the company level model is more robust than the scheme level approach with a higher R squared value. Northumbrian Water also highlighted that the scheme level model is heavily influenced by the four largest totex schemes, which is not the case in the company level model.

Southern Water suggested consideration of the PR19 approach, which would allow costs in full subject to a shallow dive assessment. Southern Water also further recommended a broader approach to selecting which outlier schemes to deep dive with the final decision considering unique factors not accounted for in the econometric model.

South West Water, Dŵr Cymru, Thames Water and Wessex Water supported a scheme level approach to modelling sanitary parameters. These companies stated that each company's programme is significantly varied and that using a scheme level model can better account for economies of scale which supports the use of a scheme level approach. They also argued these models perform relatively well, and that sample size is not an issue given the comparable sample size in other scheme level enhancement areas.

Thames Water suggested triangulation between the company and scheme level models to mitigate the advantages and disadvantages of each modelling approach.

Severn Trent Water suggested that design PE should be used as the scale cost driver. Wessex Water and Severn Trent Water stated consideration should be given to including controls for different sanitary parameters to more accurately capture the different costs of intervention.

Our assessment and reasons

We focus on using exogenous cost drivers supported by clear economic and engineering rationale in our modelling. We consider that our dataset contains the key drivers of efficient sanitary parameters enhancement costs. We use PE served as a key scale / volume cost driver.

Company level vs scheme level models

In light of stakeholder responses, we have reassessed the use of a scheme level approach to modelling. The scheme level approach accounts for economies of scale and can capture different costs per site which is a better modelling approach for companies with an unusual programme compared to the rest of the industry (eg a large share of small sites). In contrast, the company level model treats every additional PE served equally.

We agree that sample size is not an issue given the comparability with the growth at STWs sample size. We also do not consider that the R-squared between the scheme level model and company level model should be compared directly due to the significant difference between the two model types.

The four largest schemes are all categorised as Cook's distance outliers in our model and are removed from the modelling so do not have any impact on the scheme level or the company level model. We also do not consider the PR19 approach is appropriate given the data we have available which can be used to generate efficient modelled allowances. We also tested using design PE instead of PE served which did not lead to a material improvement. We do not use design PE in our models for the reasons set out in section 4.2.

Overall, we recognise the benefit of triangulating across a wide range of models. Therefore, our final determinations decision is to **triangulate equally between the company and scheme level models**.

Treatment complexity

To improve the scheme level model, we considered further options to control for treatment complexity related to tightness of ammonia and BOD permits, including:

- tight consent dummies to capture schemes with tight sanitary parameters permit levels;
- consent change variables; and
- indicator variables to capture whether one, two or three parameters are tightened.

However, we did not find any robust scheme level models controlling for treatment complexity consistent with our conclusions in draft determinations.

To further improve the robustness of our approach, we considered potential engineering outlier schemes. The models provide efficient allowances for an average scheme. However, we recognise that complex schemes with very tight ammonia and / or BOD permits are likely to require higher efficient costs. Therefore, as an alternative to the modelling approach we have considered schemes with very tight ammonia and / or BOD permits as engineering outliers. Section 7.5.1 provides more detail of our approach to outliers.

We also developed transfers models that use a pooled dataset of transfer schemes delivered under sanitary parameters and phosphorus removal in the historical and forecast periods. We include the two key cost drivers of transfers the length of the transfer (km) and the transferred flow (m3 / day) mentioned in the previous section. However, we do not exclude any outlier observations from the transfers model due to the limited sample size. We consider that this approach is much more appropriate than treating transfers as unmodelled schemes. It can better recognise the different characteristics of transfer solutions which might lead to a different company efficiency compared to the delivery of the conventional sanitary parameters enhancement programme.

Finally, we continue not to make a logarithmic (log) transformation of the dependent and explanatory variables prior to estimating our selected models for the reasons set out in section 2.

7.3 Selected models

We set out our selected sanitary parameter models in Table 42 (scheme level and company level for conventional schemes) and Table 43 (transfer schemes). The estimated coefficients of all drivers have the correct sign, are of a reasonable magnitude, and are statistically significant.

Table 42: sanitary parameters enhancement totex models

Explanatory variable	SD1	SD2
Population equivalent served (thousands)	0.249*** {0.000}	0.347*** {0.000}
Constant	2.075*** {0.000}	23.910*** {0.000}
Adjusted R-squared	0.688	0.910
Observations	196	10
Model type	Scheme level	Company level

Table 43: Scheme level transfers enhancement totex model

Explanatory variable	T1
Length of transfer pipeline (km)	0.445*** {0.000}
Transferred flow (m3/d)	1.074*** {0.000}
Constant	1.751*** {0.000}
Adjusted R-squared	0.897
Observations	63

7.4 Efficiency benchmark

Table 44 below sets out modelled allowances for the scheme level and company level models excluding Cook's distance outliers before applying catch-up efficiency challenge. The models show that the outcome of the scheme level and company level models is significantly different. That reflects the better ability of the scheme level to capture economies of scale, leading to potentially higher allowances for companies with predominantly smaller schemes.

Table 44: Sanitary parameters modelled allowances excluding Cook's distance outliers (£ million, 2022-23 prices)

Company	Request	SD1	SD2	Triangulated allowance
Anglian Water	24.93	37.20	35.26	36.23
Dŵr Cymru	87.37	164.02	61.64	112.83
Hafren Dyfrdwy	0.00	0.00	0.00	0.00
Northumbrian Water	9.36	18.42	40.90	29.66
Severn Trent Water	171.16	160.76	181.49	171.12
South West Water	31.99	36.30	25.34	30.82
Southern Water	99.99	96.05	108.63	102.34
Thames Water	68.39	43.26	55.29	49.27
United Utilities	215.23	175.29	207.53	191.41
Wessex Water	87.30	51.89	61.54	56.71
Yorkshire Water	33.11	38.97	43.53	41.25
Total	**828.85**	**822.16**	**821.16**	**821.66**

Table 45 sets out modelled allowances for transfers schemes. Since the dataset we use pools historical and forecast data, we do not apply a further efficiency challenge. This is consistent with our approach in storm overflows and phosphorus removal where we do not apply an additional efficiency challenge since more efficient historical delivery already imposes an efficiency challenge.

Table 45: Sanitary parameters transfers allowances (£ million, 2022-23 prices)

Company	Request	T1
Anglian Water	0.00	0.00
Dŵr Cymru	8.40	11.43
Hafren Dyfrdwy	0.00	0.00
Northumbrian Water	0.00	0.00
Severn Trent Water	0.00	0.00
South West Water	8.31	7.83
Southern Water	0.00	0.00
Thames Water	18.23	16.08
United Utilities	1.93	1.90
Wessex Water	0.00	0.00

Yorkshire Water	0.00	0.00
Total	**36.87**	**37.24**

Table 46 combines the total allowances for modelled sanitary parameters and transfer schemes excluding Cook's distance outliers for conventional schemes. The overall industry cost challenge is 1%.

Table 46: Sanitary parameters modelled allowances excluding Cook's distance outliers for conventional schemes (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	24.93	36.23	11.30	45%
Dŵr Cymru	95.77	124.26	28.49	30%
Hafren Dyfrdwy	0.00	0.00	0.00	0%
Northumbrian Water	9.36	29.66	20.30	217%
Severn Trent Water	171.16	171.12	-0.04	0%
South West Water	40.30	38.65	-1.66	-4%
Southern Water	99.99	102.34	2.35	2%
Thames Water	86.62	65.36	-21.26	-25%
United Utilities	217.16	193.32	-23.85	-11%
Wessex Water	87.30	56.71	-30.59	-35%
Yorkshire Water	33.11	41.25	8.14	25%
Total	**865.72**	**858.90**	**-6.82**	**-1%**

7.5 Post modelling adjustments

7.5.1 Outlier treatment and unmodelled schemes

At final determinations, we continue to identify outliers using the Cook's distance statistic. These schemes are subject to deep dive assessments and we added allowances on top of the modelled allowances as set out in section 2.3.

To further improve the robustness of our approach, we considered potential engineering outlier schemes. The models provide efficient allowances for an average scheme. However, we recognise that complex schemes with very tight ammonia and / or BOD permits are likely to require higher efficient costs. Therefore, as an alternative to the modelling approach we have considered schemes with very tight ammonia and / or BOD permits as engineering outliers.

We identified schemes with ammonia permits <= 1mg/l and BOD <= 7mg/l as appropriate for treatment as engineering outliers. We issued queries for all inefficient schemes with these permits to better understand the additional costs incurred. After undertaking our assessment our decision is to apply a 75% cost gap adjustment to all schemes in scope. We consider that this is a proportionate approach to control for treatment complexity in our final determinations models. As explained section 2.3.2, we do not exclude engineering outliers from the modelling sample.

We have implemented a bespoke approach to some sites. We provide gated allowances of 6% of request for some schemes subject to uncertainty. In addition, we have assessed large schemes under the enhanced engagement process using a bespoke challenge based on requested costs. This recognises the models are less appropriate to determine allowances for these outlier schemes.

As explained in section 7.1, we excluded some schemes from our modelling approach. That includes schemes dropped from the models and the "no additional treatment capacity" optimisation schemes. We refer to these as unmodelled schemes. At final determinations, we apply **the company level modelled efficiency of sanitary parameters schemes** to unmodelled schemes. This approach effectively assumes that company specific inefficiency is equivalent across modelled and unmodelled schemes. For efficient companies, we cap allowances at the request.

7.5.2 Reconciliation adjustment

After producing modelled efficient cost allowances, we added allowances for outliers that we assessed outside of the models (as discussed in section 2).

We also applied a reconciliation adjustment to adjust sanitary parameters modelled costs calculated using scheme level data in ADD17 to reflect the aggregate request in CWW3, CWW12 and CWW17. Because we exclude 2030-31 from scope and we remove and address unmodelled schemes separately in response to feedback in company representations, the reconciliation adjustment is of a lower scope compared to draft determinations.

We calculated the reconciliation adjustment factor as the ratio of company request in CWW3, CWW12 and CWW17 divided by the total we used to model costs based on the sanitary parameters dataset. We then multiplied the modelled allowance by this reconciliation adjustment factor.

Table 47 sets out the total sanitary parameters enhancement allowances including Cook's and engineering outliers, transfer schemes, optimisation schemes, unmodelled schemes and applying the reconciliation adjustment factor. These allowances are before the application of frontier shift efficiency and real price effects. The overall cost challenge is 2%.

Table 47: Total sanitary parameters totex allowances (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	26.16	36.59	10.43	40%
Dŵr Cymru	118.88	150.64	31.76	27%
Hafren Dyfrdwy	0.00	0.00	0.00	0%
Northumbrian Water	9.37	29.10	19.74	211%
Severn Trent Water	195.62	191.45	-4.17	-2%
South West Water	40.37	37.88	-2.49	-6%
Southern Water	105.11	130.01	24.91	24%
Thames Water	94.80	70.00	-24.80	-26%
United Utilities	1056.58	978.73	-77.85	-7%
Wessex Water	87.30	55.40	-31.90	-37%
Yorkshire Water	40.91	54.27	13.36	33%
Total	**1775.09**	**1734.08**	**-41.01**	**-2%**

8. Supply interconnectors

Supply interconnectors join two or more existing water resource zones (WRZs), facilitating a water transfer between them and provide a benefit to the supply-demand balance (Water Available for Use, WAFU benefit). The WRZs might be close to each other for a simple redirection of water, or they could be distant, with potentially more complex interconnection with infrastructure. Interconnector schemes may occur within a single water company's operating area or involve transfers between companies. Companies have requested over £1 billion of investment to build interconnectors in PR24 representations.

At PR24, we assessed supply interconnector expenditure separately from other supply schemes using a scheme level econometric cost modelling approach. This was facilitated by a scheme level dataset collected in business plan data tables that includes data on costs and key cost drivers (namely WAFU benefit and length). At draft determinations, we proposed a triangulated approach between an outturn and forecast log-log regression models to set allowances of £986.5 million.

Since draft determinations, we have made the following key changes to our cost modelling approach:

- a post-modelling adjustment to account for length of crossings;
- a post-modelling adjustment to account for pipe material and treatment element of scheme (only affecting Anglian Water); and
- a number of smaller-scale changes to our modelling approach including identifying and removing Cook’s distance outliers from the models, use of WFD schemes, and log bias updates.

8.1 Data used

What we said in our draft determinations

We used two key data sources to assess interconnector enhancement expenditure at draft determinations. The outturn data source was the Annual Performance Reporting (APR) Table 6F dataset. This contains historical, actual scheme level data on cost and cost drivers of the PR19 interconnector programme for a seven-year period from the first year before the PR19 period to "After 2024-25". The forecast data set was the PR24 business plan Table CW8 dataset. This contains forecast scheme level data on cost and cost drivers of the PR24 interconnector programme for a seven-year period from the first year before the PR24 period to "After 2029-30". The datasets include the following information key for use in the econometric model: yearly opex and capex (£m); water available for use (WAFU) benefit (Ml/d); interconnector length (km); interconnector diameter (mm); pumping capacity installed (kW); storage capacity installed (m3); and transfer capacity installed (Ml/d).

At draft determinations, we included additional WFD and resilience schemes as datapoints in the forecast model to widen the dataset data points for benchmarking supply interconnector schemes against.

Stakeholders' representations

There were limited responses on the data used. Affinity Water and Anglian Water discussed that other variables should be considered that contribute to the cost of building interconnectors, namely the number and length of crossings. Affinity Water and Anglian Water argue that some interconnectors are more costly due to crossings (roads, rivers, environmental, utility etc) and the model does not, but should, account for this. In particular, Affinity Water represented on the efficiency challenge to its 'Egham to Iver' scheme, which has crossings under the M4 and rivers.

Anglian Water supported our draft determinations decision to include the additional water framework directive and resilience schemes in the forecast model as datapoints.

Our assessment and reasons

In response to companies' representations on the importance of crossings data in determining the cost of building interconnectors, we requested data on crossings from companies through queries to help us provide an uplift where companies were being underfunded. All companies provided data on the number and length (in metres) of crossings in the proposed interconnectors (ie crossings for railways, roads, rivers, drainage, environmental areas and utilities) for all their schemes[31]. This data was also broken down into the different types of crossing.

We received cost data on crossings from Anglian Water, however no other companies provided us with this detail. Anglian Water reported £140.8m of spending across 11 schemes, which totalled 30km of crossing length, at an average cost of £12.8m per scheme and average length of 2.73km of crossings per scheme. We divided the total cost of £140.8m across the total crossing length of 30km, calculating a £4,689.66 per metre of crossing unit cost. Although this is only based on Anglian Water's cost data, this was substantially higher than the £1,173.85 per metre of overall interconnector length we observed in the model. Our analysis therefore shows that there was evidence that the length of crossings has an impact on scheme cost, and that not all crossing costs would be accounted for by the modelled allowances for schemes that had particularly complex routes. As a result, we have considered this data as a new cost driver (explained further in section 8.2.1) and ultimately applied uplifts as a post-modelling adjustment (the calculation for which is explained further in section 8.5).

[31] The only scheme we did not receive data for is Severn Trent's Carsington to Tittesworth scheme, which we are now funding through the interconnector model, but at the time the query was sent out, was still being assessed through DPC.

At draft determinations, we proposed to include water framework directive and resilience schemes in our interconnectors dataset in the forecast model. This had the benefit of expanding our dataset and providing additional insight into the efficiency of the interconnector costs presented by companies. We have revisited this proposal for final determinations. We consider that we must be consistent across all companies and schemes and only use data where WAFU is the main benefit and cost driver as this captures the customer needs case and drives scheme scope. We have therefore taken out the additional water framework directive and resilience schemes out of the model dataset. The scope across the additional schemes was also not consistent with other schemes we were benchmarking, particularly on the size of the interconnector. There were also concerns over the benefit that these schemes were providing being less associated with WAFU benefit to aid the company's supply-demand balance. We have, therefore, removed them from the dataset for final determinations. The interaction of this change and efficiency benchmarking is noted further in section 8.4.

Our final determination

For final determination, we maintain our use of forecast and outturn datasets in our econometric modelling approach. We have utilised updated outturn forecast datasets. For outturn modelling, we utilise the 2023/24 APR dataset which now includes one additional year of outturn data. For forecast modelling, we have utilised the PR24 business plan Table CW8 dataset which companies have updated and resubmitted for final determination as part of their draft determination representations. We have assessed and considered how some large increases in costs have been justified, which is explained further in the 'PR24 final determination – Expenditure allowances' document (section 4.6.2).

We have also made changes to the use of WFD and resilience schemes as data points in the model, which are now excluded.

For final determination, we also consider new data on interconnector crossings. We provide a post-modelling adjustment to uplift allowances for companies underfunded on crossing length, which is detailed in section 8.5.

8.2 Models considered

8.2.1 Selected cost drivers

What we said in our draft determinations

At draft determinations, we used a triangulated approach. We placed equal weight on a log-log regression model looking at outturn interconnector costs and a log-log regression model looking at forecast interconnector costs. The two models use length of interconnector and

WAFU benefit as the only explanatory variables in the model (in addition to a constant which captures fixed costs). We tested including additional explanatory variables to the model, namely diameter and pumping capacity. However, we did not find statistically significant or robust results. Utilising WAFU as the single key variable alongside length also aligned with engineering rationale that other variables would be captured, as the more WAFU benefit is delivered, the larger the diameter of the pipe is likely to be, and the more pumping capacity is likely to be required.

Stakeholders' representations

South West Water discuss that WAFU benefit is not a good comparator, and that its one scheme (WIM14 Whitecross distribution) should be used in a length-only model. Anglian Water has also stated in its representation that capacity, as opposed to WAFU benefit, should be considered as the comparator for scheme cost.

Affinity Water and Anglian Water discuss that some interconnectors are more costly due to crossings (roads, rivers, environmental, utility etc) and model does not, but should, account for this. Affinity Water represented on the efficiency challenge to its 'Egham to Iver' scheme, which has crossings under the M4 and rivers.

In its representation on the draft determination, Anglian Water also raised two aspects of interconnector scheme costs that it considers are not accounted for in the Supply Interconnectors model, namely pipe material and more specifically in respect of its Grafham to Bury interconnector (CAM4 and SWC8), mid transfer treatment.

Our assessment and reasons

We reject South West Water's suggestion to exclude WAFU as an explanatory variable, and Anglian Water's representation to consider capacity over WAFU as a variable. We determine that benefit and length remain the independent variables that give the best indication of efficiency. WAFU benefit is also an appropriate variable to assess efficient costs on, as it is this WAFU benefit to the company and zonal supply demand balances which provides customers with the resilience benefit that they have funded. Engineering assessment also determines that as WAFU benefit increases, diameter, capacity and pumping capacity (as other cost drivers to the scheme) also increase. Therefore, by including WAFU benefit in the model we also control for other important features of an interconnector. As a result, we do not allow a scheme-specific modelled adjustment for South West Water's Whitecross scheme and only adjust at the post-modelling stage through the crossings uplift.

In section 8.1 we explain how we have used additional company cost and length data on interconnector crossings to explore where crossing complexities in schemes are not accounted for in the model and may justify allowance uplifts. We tested the inclusion of crossing length and number of crossings as additional explanatory variables in the forecast model, both at the total level and split up by type of crossing (eg rail, road, river, environmental and utility). We found robust and statistically significant results to suggest that they should be added to the model as a cost driver. However, we only had crossings data for the forecast model, not the outturn model. Because the model is weighted 50/50 between the outturn and forecast data, this would mean that building crossing data into the model would only partially reflect the impact that crossing length has on delivering forecast interconnector schemes. As a result, we decided that it would be more appropriate to provide a post-modelling adjustment to account for any additional costs related to building interconnector pipe length over rail, road or river crossings. See section 8.5 for more information on how this is calculated and applied.

We also address the point raised from Anglian Water on its Grafham scheme by applying a post-modelling adjustment to take account of the treatment element and pipe material used. We discuss this in more detail in section 8.5.

Our final determination

We do not adjust our approach to utilising WAFU as a key variable alongside length in determining efficient costs for the interconnectors.

We apply post-modelling adjustments for all companies where there is underfunding as a result of crossing length, and Anglian Water's Grafham scheme for steel material.

8.2.2 Functional form

What we said in our draft determinations

At draft determinations, we proposed to use a log-log functional form for both the outturn and forecast models rather than a simple linear model specification. In principle we would expect economies of scale to be present due to project management costs and other overhead costs in the construction of interconnectors. Both log and linear models can capture these fixed costs. Both models seem to fit the underlying data, but we deemed the log model more appropriate as the estimated intercept in the linear model produced an estimate of fixed costs that was not plausible from an engineering perspective.

At draft determinations, we calculated pre-adjusted efficiency scores and therefore the log bias correction needed to uplift for the log bias using a transformed dataset which adjusted for 2025-2030 costs. We did this by adjusting the unadjusted allowances for 2025-2030 spend and comparing this to each scheme's 2025-2030 spend when total costs had been used in the regression model.

Stakeholders' representations

Affinity Water stated that working out the efficiency scores for the log bias uplift by adjusting unadjusted allowances for 2025-2030 spend and comparing this to 2025-2030 spend was incorrect when total costs had been used in the regression model.

Our assessment and reasons

We accept that the way we calculated the log bias uplift at draft determinations was incorrect. To be consistent with the approach taken in other areas of our assessment where we use log-log models, we now perform the log-bias adjustment based on the total (rather than 2025-2030 only) costs and then adjust for the 2025-2030 only portion of that allowance after the log bias adjustment has been applied. We accept that the purpose of the log-bias correction is to adjust cost predictions that have been transformed using a logarithmic function to reduce bias. This correction should therefore be based on the exact requested costs that was used to model the schemes.

Our final determination

We retained our draft determination proposal to use a log-log functional form for both outturn and forecast models.

We now perform the log bias uplift through comparing total requested costs to total allowed costs in the log-log model.

8.2.3 Forecast vs historical data models

What we said in our draft determinations

At draft determinations, we placed equal weight on the outturn and forecast models. This means that we applied a 50% weight on each model to calculate the scheme allowance prior to frontier efficiency.

Stakeholders' representations

Northumbrian Water discuss that the equal weighting on the forecast and outturn model means that Anglian Water has undue influence on the cost benchmark, with Anglian Water having a high unit cost in relation to benefit delivered (£m / Ml/d) in its outturn data. They state that equal weighting of forecast and outturn model therefore means penalising companies that have a high WAFU benefit unit cost but low length unit cost (£m / km) as the coefficient on benefit is larger. As a result, they suggest putting more weight on the forecast model compared to the outturn model, and to only use the outturn model as a useful cross-check that the forecast model is broadly right.

Our assessment and reasons

We have determined that it is right to challenge company forecast costs by placing equal weighting on outturn costs. The cost activities underpinning the interconnectors being built in PR19 are similar to those underpinning the proposed interconnectors in PR24. These costs are recent and therefore provide a good indication as to the costs of interconnectors in PR24. We acknowledge that there might be further pressures in PR24 that are not wholly captured by PR19 costs. Therefore, we place equal weight on outturn and forecast costs. By placing weight on the outturn model, we are also mitigating the influence that a single company's forecast data may have on the outcome of the assessment.

Our final determination

We retain our draft determinations to place equal weight on the forecast and outturn models.

8.3 Outliers

What we said in our draft determinations

At draft determinations, we used the Cook's distance outlier test to identify schemes which may have looked particularly inefficient or efficient to help engineers with the query process. We did not use the Cook's distance test to remove any schemes from the dataset, judging that the dataset was already limited in size, and not wanting to reduce it further.

Stakeholders' representations

No companies responded specifically on outliers.

Our assessment and reasons

Since draft determinations we have conducted further work on the identification of outliers. We have updated the Cook's distance test with the updated data provided by companies in their representations. To be consistent with other areas of our assessment where we do scheme-level analysis, we are now removing outliers from both the outturn and forecast models. We identify outliers through performing a Cook's distance outlier test and removing schemes with a Cook's distance value greater than 4 divided by the total number of schemes in the model.

Table 48: Forecast model outliers:

Scheme	Length (km)	Benefit (Ml/d)	Cost (£m)	Allowance (£m)
Bungay to Barsham pipeline (Northumbrian Water)	9.80	1.00	13.83	5.75

Table 49: Outturn model outliers:

Scheme	Length (km)	Benefit (Ml/d)	Cost (£m)
Stoke Ferry to Diddlington (Anglian Water)	8.40	0.40	5.09
Bewl to Cottage Hill (South East Water)	14.84	5.00	0.03

Our final determination

In the forecast model, Northumbrian Water's Bungay to Barsham pipeline scheme is the only outlier and therefore the only scheme removed from the forecast model dataset. We still, however, provide Northumbrian Water with an allowance for this scheme.

In the outturn model, South East Water's Bewl to Cottage Hill scheme and Anglian Water's Stoke Ferry to Diddlington scheme are the only two outliers identified. We remove both outliers from the dataset before performing the outturn model regression.

8.4 Efficiency benchmark

What we said in our draft determinations

At draft determinations, we included 10 additional WFD and resilience schemes as datapoints in the forecast model. However, we did not include these additional schemes in the efficiency score calculation itself. They were purely used as datapoints and did not factor into the calculation of the log bias uplift.

Stakeholders' representations

Affinity Water asks for forecast datapoints (ie, including WFD and resilience schemes) to be used in the calculation of company efficiency scores, rather than only the smaller sample of interconnector schemes used in the model.

Our assessment and reasons

We have now removed WFD and resilience schemes from the forecast model and therefore do not need to include them in the calculation of company efficiency scores.

Our final determination

We retain our draft determinations approach to calculating efficiency scores.

8.5 Post modelling adjustments

What we said in our draft determinations

We did not apply any post-modelling adjustments at draft determinations.

Stakeholders' representations

Affinity Water and Anglian Water discuss that some interconnectors are more costly due to crossings (roads, rivers, rail, environmental, utility etc) and that the model does not, but should, account for this. Affinity Water also disagreed with the efficiency challenge applied to its ‘Egham to Iver’ scheme, which has crossings under the M4 and rivers.

In its representation on the draft determination, Anglian Water also raised two aspects of interconnector scheme costs that it considers are not accounted for in the Supply Interconnectors model, namely pipe material and more specifically in respect of its Grafham to Bury interconnector (CAM4 and SWC8), mid transfer treatment.

Anglian Water states that for pipes greater than 700mm internal diameter, materials such as lined ductile iron (DI), and steel are more appropriate than plastic (HPPE) due to factors such as fitting constraints. The company also states that steel mains are less likely to have defects causing leakage after construction than other materials. The Grafham to Bury interconnector uses steel pipe material which the company considers helps to explain the difference in the cost of this scheme from the cost allowed at draft determination by the Supply interconnectors model.

Anglian Water states that the Supply Interconnectors model did not take account that its Grafham to Bury interconnector (CAM4 and SWC8) had a mid-transfer treatment which is required for water chemistry (chlorination) to enable blending into the receiving zone.

Our assessment and reasons

Length of crossings

We use the additional crossings data provided by companies to calculate a post modelling adjustment to schemes that have above an average crossing length which has been underfunded in the model.

All schemes provided data on length and number of crossings, but we only received cost data for Anglian Water's schemes. We opted for length of crossing over number of crossings to calculate the uplift due to this variable being less sensitive to the type of crossing (rail, road (and the difference between motorways and small lanes, for example), river and others).

The model gives an implicit allowance for a proportion of length that is crossings (an average of 8.18%), but some companies have crossing lengths which are above this average proportion, and those companies would be underfunded based on the current model approach. As a result, we determine the incremental allowance that would fund the gap created by the current modelling approach. Only four companies fall into this category: Southern Water, Affinity Water, Northumbrian Water and Dŵr Cymru. We apply an uplift for these four companies. We do not reduce allowances for other companies with less than average crossings as we have not consulted on this adjustment and do not have crossings data for the historical period (the implicit allowance is based on forecast data only).

To calculate the uplift, we calculated the additional length of crossings for each company over and above the 8.18% average crossing length in the forecast dataset. We then calculated the incremental cost allowance provided by the forecast and outturn models for an additional unit of pipe length for each company. We then calculated the difference between this incremental cost and the unit cost of crossing (coming from our analysis of Anglian Water's crossing data). We applied this difference to the incremental crossing length for each company. The allowance uplifts provided for each company are set out in the table below.

Table 50: Allowance uplift provided to companies to account for length of crossings (£, 2022-23 prices)

Company	Crossings uplift
Affinity Water	6,779,000
Northumbrian Water	20,813,100
Southern Water	4,362,200
Dŵr Cymru	1,583,400
Total	33,537,900

Grafham interconnector

To determine an uplift for Grafham's pipe material, we assess the cost of steel pipe material in comparison to other pipe materials used for supply interconnectors. The supply interconnector model indicated that pipe costs on average across all forecast interconnector schemes is £1.460m per km. Based on additional information provided by Anglian Water, we determine that steel pipe material cost at £2.476m per km. Therefore, we assess there is a potential uplift of £1.016m per km for steel pipes which is not currently accounted for in the model. Multiplying this by the 75.31km length of the Grafham to Bury interconnector would give a potential uplift for the scheme of £76.499m. We recognise that this approach has limitations in that using inferring pipe cost per km from all forecast interconnector schemes total costs does not consistently isolate pipe cost from other fixed costs and cost drivers such as crossings and ancillary assets. We considered an alternative approach which uses just Anglian Water's cost breakdowns of pipe cost by material and diameter which allows us to better isolate the cost of the pipe itself, and thus the cost differential between material. However, we do not consider this as robust an approach to provide an uplift to Anglian Water's Grafham to Bury interconnector as it utilises only Anglian Water's data, as opposed to industry wide data. On balance, we therefore use the uplift based on the pipe cost per km averaged across all industry interconnectors length of pipe, as this variable is also used within the model itself.

On assessing an uplift for Anglian Water's Grafham's mid-transfer treatment, we assess the £35.744m total request relating to chlorination separately and remove this cost from the Supply interconnectors unit cost model. We determined from the schemes cost profile that 70% (£25.021m) of the total £35.744m request would fall in the 2025-2030 period. We assess the £25.021m request separately as part of a deep dive assessment to determine an efficient allowance for the 2025-2030 period. The deep dive concluded that we accept the need for chlorination treatment to avoid taste and odour issues in the receiving zone. However, the company does not provide sufficient and convincing evidence that the investment is efficient. Whilst the company states in response to a query that its costs have been benchmarked and its methodology audited, the company has not provided evidence of this particularly in relation to the treatment element we are assessing separately. We therefore apply a 10% efficiency challenge to the £25.021m 2025-2030 request as a result of these concerns. The final allowance determined for the treatment element is therefore £22.519m, which is then added as a post-modelling adjustment to the Grafham to Bury interconnector scheme.

Our final determination

We apply an uplift to allowances to four companies to account for number of crossings. This results in a £6.78 million increase in Affinity Water's allowance, a £20.81 million increase in Northumbrian Water's allowance, a £4.36 million increase in Southern Water's allowance and a £1.58 million increase in Welsh Water's allowance.

We also apply an uplift to Anglian Water's Grafham scheme. This is to take account of the use of more costly steel pipe material and the mid-transfer chlorination treatment element, resulting in uplifts of £76.499m and £22.519m respectively.

Table 51: Total Supply interconnectors requested and allowed spend after all deep dives and post-modelling adjustments (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	626.85	616.92	-9.93	-1.58%
Dŵr Cymru	49.73	46.30	-3.43	-6.90%
Northumbrian Water	132.81	131.97	-0.83	-0.63%
Severn Trent Water	271.45	269.28	-2.17	-0.80%

South West Water	13.78	9.25	-4.53	-32.86%
Southern Water	211.89	181.74	-30.14	-14.23%
Affinity Water	61.19	56.27	-4.92	-8.04%
Total	**1367.69**	**1311.74**	**-55.96**	**-4.09%**

9. Metering

A smart metering network can improve leakage targeting and incentivise behavioural change, which provides long term benefits to leakage and per capita consumption (PCC).

We have set enhancement allowances for the technological uplift or new installation of advanced meter infrastructure (AMI) meters. We have excluded enhancement funding for activities associated with automatic meter reading (AMR) meters, which involves carrying out manual readings to collect the data, such as drive by readings. AMR meter readings have lower monthly read frequencies reducing the potential demand benefits. We have funded elements of the meter upgrade request through a base uplift for meter replacements.

Dŵr Cymru has proposed a large-scale programme using only AMR technology and stated the cost of setting up AMI metering in their region currently outweigh the benefits. We have allowed enhancement funding to Dŵr Cymru; but adjusted the allowance downwards to reflect the fact that AMI infrastructure expenditure is not required for an AMR programme.

The water resources management plan (WRMP) process defines the scale of metering activities companies propose to reduce demand. We are expected to fund metering programmes in the WRMP and have sought to fund at least the number of AMI meters identified in the WRMP through enhancement.

9.1 Data used

9.1.1 Historical data

What we said in our draft determinations

At draft determinations we used historical data to validate business plan forecast costs. Given that historical AMI cost data was only available for a short time period and for few companies. We proposed to not use this data to set cost allowances but to use it to validate company cost forecasts.

Stakeholders' representations

We did not receive representations on this area.

Our assessment and reasons

We analysed an extra year of annual performance reporting metering data for 2023-24 using data from APR Table 4L and 6D.

The sector median unit cost for new household AMI meters was £329 per meter, the sector mean unit cost was £440 per meter (in 2022-23 prices). This data covers 170,000 optant and selective household AMI meters reported in table 6D and is only available for nine companies. The data excludes non-household meters (which have an immaterial quantity).

The meter upgrades 2023-24 unit rate data is only available for seven companies, and had a wide variation between £13 per meter and £481 per meter, in 2022-23 prices. The sector median and sector mean unit costs for 2023-24 meter upgrades was £66 per meter and £48 per meter respectively. This data covers 568,000 meter upgrades and includes upgrades from basic or AMR to AMI for both household and non-household. We are concerned about the quality of this data given the significant issues we observed in business plans with regards to the allocation of meter upgrade costs between base and enhancement.

We continue to have concerns around the use of historical data to set cost allowances. In PR19 there are only few companies rolling out AMI meters. This provides few data points to develop robust benchmarking. We also have concerns on the quality of the data given the variation in unit costs and the allocation issues we found in the data provided in business plans. We will provide further guidance to improve reporting in future APRs.

Our final determination

We continue to not use historical data on meter installations to set cost allowances in final determinations but use it to validate company cost forecasts.

9.1.2 Forecast data

What we said in our draft determinations

At draft determinations we used a panel data comprising all companies and a seven-year period going from 2022-23 to 2029-30. This is using the forecast data provided by companies in business plans. We applied several adjustments, including removing expenditure related to AMR activities and reallocating expenditure across enhancement expenditure lines to improve comparability between companies.

Stakeholders' representations

Key cost changes

At final determinations companies have requested £1.102 billion to fund new meters, compared to £1.077 billion at draft determinations. Companies have requested £715 million to fund meter upgrades, compared to £780 million at draft determinations.

Key quantity changes

At final determinations companies have requested funding for 2.737 million new meters, compared to 2.644 million new meters at draft determinations. Companies have requested funding for 7.569 million meter upgrades, compared to 7.660 million meter upgrades at draft determinations.

Our assessment and reasons

Key cost changes

Most companies submitted changes in costs due to increased cost certainty. Overall costs have gone down due to some companies reallocating from costs for meter upgrades to base. Where cost increases are attributed to new drivers or are supported by sufficient and convincing evidence of market engagement we accept the cost increase.

We make one adjustment to Southern Water who have moved a large amount of DPC costs into the metering enhancement request. The company confirmed that this request includes draft determination allowance for the base uplift for meter replacements plus the draft determination allowance for metering enhancement. We allocate the base uplift for meter replacements back to base costs. We do not use the draft determination enhancement allowance as an input to the cost model, we retain the input from draft determinations of £63 million.

Key quantity changes

Where a change in meter quantities at least matches the WRMP, we accept the quantity change. Most companies proposed an unchanged quantity of meters since draft determinations. Yorkshire Water, Thames Water and Hafren Dyfrdwy have revised their meter quantities since draft determinations. We make one quantity adjustment for Yorkshire Water.

Yorkshire Water have proposed a net reduction of 97,000 meters which includes a decrease of 108,000 household meters and an increase of 11,000 more business meters. This level for household meters is below WRMP proposals, and the company has not provided sufficient and convincing evidence that the revision will achieve PCC benefits set out in the WRMP. We adjust the metering enhancement model, and the base sector wide meter renewals model. We align Yorkshire Water's quantity with the draft determination and WRMP submissions, of an additional 108,000 AMI household upgrades. For modelling purposes, we keep the cost and quantity information provided by the company in its representations. We then apply the modelled unit cost of enhancement to the additional quantity of meter upgrades to uplift allowances for the company.

9.1.3 Other data adjustments

At draft determinations we applied further adjustments to the data to:

- Apportion smart meter infrastructure costs to new installations and meter upgrades respectively.
- Address overlap with base expenditure. For several companies we concluded that elements of AMI upgrade programme did not qualify for enhancement allowances.

Smart meter infrastructure adjustments

What we said in our draft determinations. At draft determinations smart metering infrastructure costs (in lines CW3.87-CW3.89) could not be assessed separately. To remove inconsistency, we apportioned the expenditure in the smart infrastructure lines (CW3.87-CW3.89) to other metering lines (CW3.60-CW3.86) using driver data to proportion costs.

Stakeholder representations. In its representations, most companies agreed with the approach, but flagged infrastructural costs can also be driven other factors such as population density, geography and differing financial models (such as opex using "data as-a-service" or upfront capex).

South West Water and Portsmouth Water had concerns that the approach would disadvantage smaller companies and was too simplistic. South West Water requested their full infrastructure costs are assessed outside of the modelled process. Portsmouth Water requested part of their infrastructure costs are assessed outside of the modelled process.

Our assessment and reasons. Companies have not allocated like for like infrastructure costs consistently, and some companies have not submitted any infrastructural costs. The adjustment is to address this issue so that infrastructural costs can be assessed like for like. Most companies have flagged that it is subject to the enhancement model identifying the work mix type in the assessment. We have tested alternative models to account for work variation and discuss this further below in section 9.2 below.

In response to South West Waters request to deep dive the full infrastructure costs, we have assessed the evidence, and the company has not provided sufficient or convincing evidence that infrastructural costs are not accounted for, and outside of the modelled scope.

In response to Portsmouth Waters request to deep dive part of their infrastructural costs, we have assessed the evidence, and the company provides sufficient and convincing supporting evidence in its narrative that some of its enhancement costs are not covered by the modelled approach.

Our final determination. We retain our draft determination approach to assessing smart meter infrastructure costs together with new installation and meter upgrade costs.

We reject South West Waters request to assess the full infrastructural costs through a deep dive and assess the costs through the model.

We accept Portsmouth Waters request to assess part of their infrastructure costs through a deep dive and allow a partial uplift. Further details of the deep dive can be found in the metering enhancement model (PR24CA32).

Base adjustments

What we said in our draft determinations. At draft determinations we had concerns that costs submitted for meter upgrades were not like for like, there was a wide range of meter upgrade unit costs, and cost categories were allocated inconsistently across enhancement and base.

To address the base overlap issue for meter upgrades, we funded meter upgrade activities associated with the technological uplift through enhancement, and other costs through a base uplift. The enhancement elements included the smart device, communications technology, meter data management systems, fixed networks/masts and other associated hardware. The base element included transport costs, programme management costs, labour, assumptions for abortive visits and excavations for digs. For several companies we concluded that elements of cost of an AMI upgrade should be funded through the sector wide base uplift for meter replacements and not within enhancement.

For new AMI meter installations, we funded the whole cost of the activity through enhancement.

Stakeholder representations.

In its representations, some companies supported the approach, stating it was more comparable and that enhancement upgrade costs should be similar across the sector. Some companies pushed back to the approach, stating it was too simple and did not account for the proportion of external digs.

Anglian Water pushed back on the approach to base allocations, they said they had already removed base costs from their PR24 upgrades request, and that their submitted work mix costs had not been through an assurance process and should not be used for the base allocation.

Our assessment and reasons. We have assessed the feedback from Anglian Water. In its representations Anglian Water has submitted an unchanged cost for its meter upgrade programme, we retain the allocation we made at draft determinations. Further details on the allocation can be found in the enhancement model under the tab called "base adjustments". The company has not provided convincing or sufficient evidence to support a company specific approach to meter upgrade cost estimation. We have accounted for upgrade costs across the base uplift for meter replacements and the enhancement upgrade allowance.

Affinity Water have reduced the meter upgrades request in their representations. Based on the reduced meter upgrade request, we have reduced the allocation to base significantly. Further details are within the enhancement model, under the tab called "base adjustments". In its representation, the company states their metering allowances across base and enhancement do not account for their work mix which has comparatively more external digs. We have assessed allowances across base and enhancement and set out how we address these concerns in our econometric analysis in section 9.2.

Our final determination. In representations companies resubmitted meter upgrade costs that are not consistently allocated across base and enhancement. Given the scale of the meter upgrades programme, we still have concerns that this will impact the model results. The methodology addresses this issue, so the cost of the AMI upgrades is comparable across companies. We therefore retain our approach to the base allocation at final determinations.

Other adjustments

Thames Water Bulk Meter deep dive. At draft determinations we excluded Thames Waters Bulk Meters from the new installation meter model because their costs are not comparable to those of other meters. We assessed these costs through a deep dive, and we applied the same efficiency challenge that we used for company's modelled new meter installation costs. In its representations the company has provided more evidence that the meters are not covered by the model scope, we therefore reduce the challenge made at draft determinations. We still have minor concerns that costs are efficient. Further details can be found in the metering enhancement model (PR24CA32).

Dŵr Cymru AMR adjustment. Dŵr Cymru has proposed a large-scale programme using only AMR technology. The company stated at draft determinations that the cost of setting up AMI metering in their region outweighed the benefits. At draft determinations we allowed enhancement funding to Dŵr Cymru; but made an adjustment which removed AMI infrastructure costs, which is not required for an AMR programme. The company has not made a representation on this approach, we therefore retain this at final determinations.

9.2 Models considered

What we said in our draft determinations

9.2.1 New meter installations

At draft determinations we used the number of new meter installations to explain differences in the scale of efficient new meter installation costs between companies.

We also tested the inclusion of population density and meter penetration as explanatory variables but did not include them in the proposed model. The estimated population density coefficient was counterintuitive (negative instead of positive) and was not statistically significant. The estimated coefficient on meter penetration was also counterintuitive (negative instead of positive) and was not statistically significant.

We used a log-log functional form to model the relationship between number of installations and installation costs.

9.2.2 Meter upgrades

At draft determinations we used the number of meter upgrades to explain differences in the scale of efficient meter upgrade costs between companies. We tested population density and meter penetration as alternative cost drivers. We did to include these drivers in our preferred model as they were not statistically significant.

We used a log-log functional form to model the relationship between number of upgrades and meter upgrade costs.

Stakeholders' representations

Six companies argued that our proposed models are too simplistic and should account for other relevant factors[32]. The companies asked us to take account for the variation in the mix of installation types (eg external and internal installations) across companies. They argued that unit costs will be higher for external installations which require digging compared to those that do not. Thames Water suggested that internal installations could be more expensive given that often these installations require more than one engineer visit given that customers are not always at home or cancel these visits.

Thames Water also asked for our models to take account of population density. It argued that new installation costs may be higher in more densely populated areas, due to higher labour costs, aborted visits and joint supplies. Thames Water stated that the inclusion of the density variable improves the overall fit of the model and reduces the range of efficiency scores. Anglian Water asked for population density and total meter penetration to be included as cost drivers in the model. It argued that the inclusion of these drivers is supported by engineering rationale. Affinity Water explained that installing new meters in a region that has a high meter penetration will be more difficult and expensive, compared to regions with low meter penetration.

Affinity Water and Thames Water argue that the model should also account for cost differences between non-household and household meters. The companies argued that the

[32] Northumbrian water, United Utilities water, Thames water, Yorkshire water, Affinity water and South East water.

variation in non-household installation costs is more pronounced due to size and complexity of the planning and installation work required. This was supported by MOSL and Wave who express concerns that an average funding model would not incentivise companies to replace the more expensive non-household meters.

United Utilities water and Affinity water stated that the model does not account for boundary boxes. Affinity Water argue that installation required to replace boundary boxes are more costly than those that do not require replacement.

United Utilities stated that the models do not appropriately correct for correlation between Severn Trent and Hafren Dyfrdwy data points. They argued that the conditions do not hold for them to be treated independently in the case of smart metering activity. They believe that the two companies have the same procurement strategy and each company has projected the same unit cost to fit a new AMI meter. Therefore they argue that including the two companies separately will effectively double the weight of a single procurement strategy. Therefore, they believe in practice the two companies should be treated as a single entity for the purpose of cost assessment.

Thames Water and Affinity Water further stated that only a few companies have implemented large-scale smart metering programmes or engaged with markets to secure contracts. They argued that some company cost forecasts are based on actual contractual market prices, and others are based on assumptions/estimates. For this reason they suggested that cost forecasts based on actual contractual market prices should carry more weight.

Our assessment and reasons

New Installations

We have considered the arguments laid out by companies to consider additional explanatory variables in our models.

We have analysed the information provided by companies on installation types (external dig, external no dig and internal install). We find that the mix of installation types or work mix is weakly correlated with per meter unit costs across companies. We are concerned that work mix is influenced by factors that are both within and outside company control. Although we recognise that work mix will be partly determined by external factors such as population density, it can also be determined by company strategy (eg a company can target easier installs, more difficult installs or a mix of both). Our general approach to cost assessment is to take account of factors that are outside company control. Companies that have asked for work mix to be included as control in our models have also argued that work mix is mainly impacted by population density and meter penetration. Therefore, rather than using work mix as an explanatory variable in our models we have tested controlling for factors such as population density and meter penetration.

We have rerun our models using the latest data that companies have provided since draft determinations. We tested the inclusion of three population density variables:

- population density;
- weighted average density (WAD) MSOA[33]; and
- weighted average density (WAD) LAD[34].

We find that the three population density variables are statistically significant and have the expected sign. To decide which population density variable to use in our model we have assessed the robustness of the results to the inclusion/exclusion of company outliers in relation to population density (ie Thames Water). We find that the WAD MSOA variable is the only one that remains statistically significant regardless of whether Thames Water is included or not. Therefore for final determination we include WAD MSOA in our preferred model for new installations.

We also tested the inclusion of meter penetration in our new installations model. We test this with and without population density as an additional control. We find that that the estimated coefficient does not have the expected sign. While we would expect unit costs to increase with higher meter penetration levels, our cost model suggest the opposite relationship. This is not supported by engineering rationale and therefore we do not include meter penetration in our new installations model.

We also tested controlling for the proportion of non-household meters in our new installations model. We find that the impact of non-household meters on new installation costs is not statistically significant and does not have the expected sign (suggesting that non-household meters are cheaper to install than household meters). This is likely to be due to companies planning to do little non-household meter installations in PR24 as meter penetration for non-households is already high. Therefore, we did not control for non-household meters in our new installations model.

In response to the ask to control for boundary box costs in our new installations model, our model already provides an implicit allowance for these costs. This is because companies already assume a proportion of new installations will require a boundary box replacement in their cost forecasts. Variations in boundary box replacements across companies may be explained by differences in work mix and asset health. Companies with poorer asset health are likely to require more boundary box replacements. As already mentioned we do not want to control for factors that are within the company control. Therefore we reject the ask to explicitly account for boundary box replacements in our cost modelling.

[33] Weighted average density – Middle Super Output Area (MSOA). This measure uses granular MSOA level data, mapped directly to company boundaries. Population density data is weighted by the population of the MSOA.
[34] Weighted average density – Local Authority Districts (LADs). This measure uses MSOA level data, mapped first to Local Authority Districts (LADs), and then from LADs to company boundaries. Population density data is weighted by the population of the LAD.

Meter upgrades

Similarly to our new installations cost modelling, we tested the inclusion of population density and meter penetration in our meter upgrades model. We do not find a statistically significant relationship between these drivers and meter upgrade costs. Therefore we do not include these variables in our upgrades model.

We also tested controlling for non-household meter upgrades in our cost modelling. Different to new installations, companies are planning to upgrade a considerable number of non-household meters (11% of all meter upgrades planned for PR24 are non-household). We find that per meter unit costs are not statistically different between households and non-households.[35] Therefore we do not include proportion of non-household upgrades in our meter upgrades model.

In response to United Utilities ask to treat Severn Trent Water and Hafren Dyfrdwy as a single entity we require these companies to report separately precisely to aid our cost benchmarking. Having more data points in our analysis improves the robustness of our benchmarking. The costs of smart metering can be separated out between the two companies. Therefore we continue to treat the two companies as separate entities in our cost modelling.

We also reject the ask to apply different weight to companies based on whether they already have contracts in place with meter suppliers. Most companies will be starting their smart metering rollout in PR24 so they may not have completed their procurement processes yet. This does not mean that their cost forecasts are not based on realistic meter pricing as companies do not need a contract in place to get quotes from meter suppliers. A large portion of the rollout costs will be accounted for by installation costs (which don't have a smart element to them) and all companies have experience in installing and replacing meters. We also do not see evidence that low cost companies are those with no experience in rolling out smart meters. For example, Severn Trent Water has relatively lower unit costs and is already installing smart meters in PR19. Therefore we continue to apply equal weight to all companies.

Our final determination

New installations

We are changing our position in draft determinations and now use the number of new meter installations and WAD MSOA to explain new meter installation costs across companies.

We continue to use a log-log functional form to estimate the relationship between cost drivers and new meter installation costs in our preferred model. This is supported by

[35] This could be explained if companies are planning to focussed non-household upgrades on small businesses which meters are more akin to household meters.

engineering rationale. Although we would expect some economies of scale in the rollout of smart meters, we would expect fixed costs to be low and for most of the costs to be driven by the quantity of meters.

Meter upgrades

We continue to use number of meter upgrades to explain differences in the scale of meter upgrade costs across companies.

We also continue to use a log-log functional form to estimate the relationship between number of meter upgrades and meter upgrade costs in our preferred model. This is supported by engineering rationale. We would expect fixed costs to be significantly lower for meter upgrades than for new installations. So even for small rollout we would expect fixed costs to be low and a log-log function al form can capture this relationship.

9.3 Model estimation method

What we said in our draft determinations

At draft determination we estimated our new meter installations model and meter upgrades model using random effects to recognise the panel structure of the data. The dataset included data for all water companies over the 2023-24 to 2029-30 period, with one observation per year and per company to increase number of observations in the model.

Stakeholders' representations

Anglian Water disagreed with our proposed approach to use a panel data due to the lack of variation in unit costs. Affinity Water stated that the panel structure is most likely failing to identify true variation in metering costs within companies over time, but rather tracking 'noise' instead. It proposed to use a simple unit cost model approach instead.

Our assessment and reasons

New installation

At draft determinations we used random effects to remove time invariant omitted variables from our analysis. This avoids capturing potential cost inefficiencies from factors omitted in our modelling (eg factors within the company control) that could be correlated with cost drivers included in the model. To achieve this, random effects aims to exploit the 'within company' variation or variation across time. This means that random effects places more weight on the variation across time (than across companies) compared to OLS.

We accept that the results of random effects could be biased if the estimated relationship between drivers and costs is reflecting data issues as opposed to the true relationship between these variables. We have considered the reliability of the cost data by looking at the pattern of the cost data across time. We have also assessed the robustness of the results to changes in the data.

On the cost data, we observe different unit cost patterns across the different companies. While unit costs are relatively flat over time for some companies, they are increasing for others. These patterns could be supported by different company strategies such as some companies targeting cheaper installations first and others assuming a mix of easy and difficult installations across the period. However they could also be affected by companies using different methodologies for allocating costs between different cost lines (particularly between installation costs and smart infrastructure costs).

To verify the robustness of the results we tested running the new installations model for different sub periods within the analysed period. We did this using both random effects and pooled OLS. We find that our random effect results are significantly sensitive to the period considered. Some of our testing produced counterintuitive results, suggesting decreasing returns to scale (ie coefficient for the log of new installations was higher than 1). By contrast, the pooled OLS results were more stable across different periods and always consistent with engineering rationale. We therefore use pooled OLS to estimate our new installations model for our final determination.

Meter upgrades

We have done similar testing for our meter upgrades modelling. Different to new installations we find that the pattern of the data is more consistent across companies with unit costs being flat across the analysed period. This is due to the adjustments we applied to company data to remove base related expenditure.

Our random effects results are robust to different sub-periods and are consistent with engineering rationale (suggesting constant returns to scale). We consider that there is less scope for economies of scale in relation to meter upgrades compared to new meter installations as meter upgrade costs are mainly driven by meter device costs (as labour costs for replacing meters are captured in base expenditure). We therefore retain our approach in draft determinations to use random effects to estimate our meter upgrades model.

Our final determination

New installation

We have changed our approach from draft determination and now estimate our new meter installations model using a pooled OLS method (rather than a random effects method). We continue to estimate this model for the period from 2023-24 to 2029-30, using one observation per year and per company to increase number of observations in the model.

Meter upgrades

We continue to estimate our meter upgrades model using a random effects method. We do this for the period from 2023-24 to 2029-30, using one observation per year and per company to increase number of observations in the model.

9.4 Selected models

What we said in our draft determinations

At draft determination we selected a simple econometric model for our new installation model which included a single explanatory variable (ie number of new meter installations). For our meter upgrades model we selected a econometric model which also includes a single explanatory variable (ie number of meter upgrades).

Stakeholders' representations

Affinity Water and Anglian Water disagreed with our proposed approach. They called for the use of a unit cost benchmarking rather than a econometric model given that there is evidence of constant returns to scale. The companies argue that there is constant returns to scale present due to the model coefficients outlined at draft determinations being close to one for both the new installations and meter upgrade models. Therefore they argue there is limited engineering rationale supporting non-constant returns to scale.

Our assessment and reasons

We accept that our cost modelling does not reject the presence of constant returns to scale. We find that some companies assumed unit costs that are constant across the period. We also find that the variation in unit costs does not seem to be explained by differences in the scale of rollout. Therefore we consider appropriate to place weight on the median unit cost.

Given that the econometric results suggest a cost-volume elasticity that is close to one we place equal weight on our econometric model and median unit cost to calculate allowances. We apply this approach for both the new installations model and meter upgrades model.

Our final determination

We have changes are position from draft determinations and now triangulate between our econometric model and median unit cost to calculate allowances.

We set out the results of the selected econometric model in table 52 for our new installation model and table 53 for our meter upgrade model. The estimated coefficient has the correct sign, is of a reasonable magnitude (less than one indicating economies of scale) and is statistically significant.

Table 52: New meter installation enhancement totex model

Explanatory variable	New meter installation
Ln New meter installation	0.927*** {0.000}
Ln WAD MSOA	0.434** {0.020}
Constant	2.675* {0.053}
Adjusted R-squared	0.962
Observations	72
Dataset	Forecast

Table 53: Meter upgrade enhancement totex model

Explanatory variable	Meter upgrade model
Ln Meter upgrade	1.000*** {0.000}
Constant	4.393*** {0.000}
Adjusted R-squared	0.931
Observations	76
Dataset	Forecast data

As discussed in section 2, the log-log model underestimates modelled costs at the sector level. We apply the PR19 log bias adjustment factor so that industry model predicted costs align to the industry requested expenditure.

9.5 Efficiency benchmark

What we said in our draft determinations

At draft determinations we did not apply an additional catch-up efficiency challenge on top of the mean efficiency benchmark implied by our modelled costs. We considered that the average efficiency benchmark provided a sufficiently stretching catch-up efficiency challenge to companies.

Stakeholders' representations

Companies made no representation on this area.

Our final determination

We retain our proposed approach at draft determinations to not apply an additional catch-up efficiency challenge on top of the mean efficiency benchmark implied by the triangulation between the cost model and the median unit cost. We continue to consider that the average efficiency benchmark already provides a sufficiently stretching catch-up efficiency challenge to companies.

Table 54 below compares our metering enhancement allowances with business plan requested costs, before the application of frontier shift efficiency and real price effects. Overall, our allowance is 4% greater than business plan requested costs. A median challenge would reduce allowances by 5% and a quartile challenge by 8%.

Table 54: Total metering totex allowances (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	116.11	107.56	-8.55	-7%
Dŵr Cymru	116.28	119.74	3.45	3%
Hafren Dyfrdwy	1.50	2.84	1.34	89%
Northumbrian Water	119.41	117.91	-1.50	-1%
Severn Trent Water	209.19	280.90	71.71	34%
South West Water	67.11	61.14	-5.97	-9%
Southern Water	78.82	82.77	3.95	5%
Thames Water	295.70	280.64	-15.06	-5%
United Utilities	245.46	225.71	-19.75	-8%
Wessex Water	38.37	34.67	-3.70	-10%
Yorkshire Water	125.57	165.86	40.29	32%
Affinity Water	63.04	57.90	-5.13	-8%
Bristol Water	24.96	23.70	-1.26	-5%
Portsmouth Water	58.09	53.26	-4.83	-8%
SES Water	24.92	18.99	-5.93	-24%
South East Water	20.18	25.19	5.01	25%
South Staffs Water	45.30	63.50	18.21	40%
Total	**1650.01**	**1722.28**	**72.27**	**4%**

10. Lead communication pipe replacement

This section sets out our approach to assessing efficient expenditure to replace or reline lead communication pipes.

We set allowances for the replacement or relining of lead communication pipes by triangulating between an econometric model and the industry median unit cost. We applied the same approach at PR19. The key change in our approach for PR24 is that we assess lead communication pipe replacement and relining expenditure separately from other lead reduction activities. We now have more granular data that allows separating out these activities and so improve the robustness of our cost assessment.

10.1 Data used

10.1.1 Historical data

What we said in our draft determinations

At PR24 draft determinations we reviewed historical data from APR tables 4L and 6D. We did not propose to use this data directly to set allowances as we had concerns around the consistency in data reporting and cost allocation methodologies between the APRs and business plans in relation to this cost activity. However, we proposed to use this historical data to challenge and validate business plan cost forecasts.

Stakeholders' representations

We received no representations on this area.

Our final determination

We retain our approach from draft determination not to use historical data to set allowances for lead communication pipe replacements but to use this data to challenge and validate the forecast cost data provided by companies in business plans.

10.1.2 Forecast data

What we said in our draft determinations

At draft determinations we used forecast expenditure data from business plan table CW3 (2025-26 to 229-30) and CW12 and CW17 (2022-23 to 2024-25) for transitional and accelerated expenditure. We also used number of communication pipes replaced or relined for water quality reasons from business plan data tables CW6 (2025-26 to 2029-30) and CW6a (2022-23 to 2024-25). However, the dataset used for our econometric model excluded data from Portsmouth water as the costs provided by the company looked like an outlier and the company did not provide sufficient and convincing evidence to justify these higher costs.

Stakeholders' representations

We received no representations on this area.

Our final determination

We retain our approach from draft determination to assess forecast expenditure from business plan tables CW3, CW12 and CW17 and number of communication pipes replaced or relined for water quality reasons from business plan tables CW6 and CW6a.

10.1.3 Data adjustments

What we said in our draft determinations

At draft determinations we reallocated expenditure to the correct expenditure line. This is due to companies having used different approaches to allocate forecast expenditure across the different lead reduction activity expenditure lines. We identified these allocation issues through our query process.

Also, we removed the base-related expenditure and associated activities from our analysis since we found problems in the allocation between enhancement and base activities. This is because some companies reported base cost as enhancement which lead to customers paying twice for the same activity.

Stakeholders' representations

We received no representations on this area.

Our final determination

We continue to apply our approach as at draft determinations. We continue to exclude Portsmouth water from our analysis. The cost per lead communication pipe replacement implied by the company data is relatively high compared to all other companies. The company is proposing to replace lead communication pipe replacements in schools and nurseries exclusively. We do not expect lead communication pipe replacement unit costs to vary by property type. The length of communication pipes tends to be standard across all properties so we consider Portsmouth Water's unit costs to be an outlier. Therefore, we have removed the company from our model dataset and median unit cost calculation. However we have set out an allowance for this company based on our cost benchmarking.

10.2 Models considered

10.2.1 Selected cost drivers

What we said in our draft determinations

At draft determination we used the quantity of lead communication pipes replaced or relined to explain the differences in efficient expenditure to replace or reline lead communication pipes between companies.

We also tested the inclusion of average length of lead communication pipes replaced and population density as explanatory variables in the econometric models. We found that the average length of lead communication pipes replaced was statistically significant in some of the models we tested. However, we did not consider it better at explaining differences in the scale of efficient costs than the number of lead communication pipes replaced or relined. We found that the population density variable was not statistically significant and therefore we did not include this in our selected model.

Stakeholders' representations

Most companies did not submit representations on the proposed approach.

Anglian Water argued that population density should be taken into account in the models. It believes that, although the current dataset used for modelling does not clearly establish a relationship between population density and lead pipe replacement/relining. Anglian Water argue that the workloads in both remote and very dense, urban areas are expected to be relatively more costly.

Our assessment and reasons

At draft determination we considered the variable population density within our econometric model. We found that the variable was not statistically significant. In response to Anglian Water's request to include the variable in our cost model, we have tested this variable again with the new data. We find that density is only statistically significant at the 10% level and only when including Thames Water in the analysis. When excluding Thames Water the variable becomes statistically insignificant. Thames Water has the highest population density in the sample but its requested unit cost is in line with the median unit cost. Therefore we are not convinced that the statistical relationship found when including Thames Water is indicative of a genuine relationship between population density and costs. Given that the significance of the variable is not robust to the exclusion of outliers, we reject Anglian Water's request to include population density in our econometric model.

Our final determination

We retain our approach as laid out in our draft determination. We continue to use the quantity of lead communication pipes replaced or relined to explain differences in efficient expenditure to replace or reline lead communication pipes between companies. We use this driver for both our econometric model and to calculate unit costs.

10.2.2 Functional form

What we said in our draft determinations

At draft determination we used a log-log function form to assess the relationship between costs and number of lead communication pipe replaced or relined. We tested a linear model but this produced counterintuitive results. The linear model suggested significantly higher average unit costs for smaller-scale programmes. This is inconsistent with our engineering judgment that average unit costs should be similar across companies as we expect economies of scale to be small.

Stakeholders' representations

Anglian Water disagree with the proposed functional form but do not provide a reasoning for this.

No other stakeholder made representations on this area.

Our assessment and reasons

A log-log model allows for a non-linear relationship between number of lead communication pipe replacements and costs. The estimated coefficient in the model can be interpreted as the cost-volume elasticity. A coefficient with a value lower than one indicates increasing returns to scale. A coefficient with a value equal to one indicates constant returns to scale and a value higher than one indicates decreasing returns to scale. Engineering rationale can support both increasing returns to scale and constant returns to scale. Therefore we disagree with Anglian Water that a log-log model does not add value to our analysis when using an univariate panel data structure.

Our final determination

We retain our proposed approach in draft determination to use a log-log function form to assess the relationship between number of lead communication pipe replaced or relined and costs in our econometric model.

10.2.3 Model estimation method

What we said in our draft determinations

At draft determination we estimated lead communication pipe replacement and relining cost model using random effects to recognise the panel structure of the data.

Stakeholders' representations

Anglian Water disagree with our proposed approach to use a panel data as they argue it does not add value as unit costs should not vary over time. It argues that the year-on-year panel introduces noise and that company variation within unit costs observed over time is due to a mismatch between when the company expects to start making the relevant expenditure relative to when the corresponding volumes are delivered. Anglian Water argues that Ofwat's modelling approach misinterprets the different time profiles. In turn it suggests using a simple collapsed model, regressing companies total costs on the total number of pipes replaced.

Our assessment and reasons

For the same reasons explained in section 9.3 in draft determinations we proposed to use random effects to assess the relationship between the number of communication pipes replaced and costs. As explained in section 9.3, random effects places more weight on the variation across time (within company) to avoid the results being biased by omitted variables.

We have assessed Anglian Water's concerns that the variation across time in the data may not capture the true relationship between volumes and costs but instead could capture data issues. The trend in unit costs is mixed across companies. Some companies have relatively constant unit costs across the period, others have increasing unit costs, others have decreasing unit costs, and others have unit costs that go up and down across the period. It is plausible that some of this variation in unit cost trends is driven by data allocation issues. We find that the results of our random effects model are sensitive to these trends. We therefore consider appropriate to place less weight on variation across time by using a pooled OLS model.

Our final determination

We have changed our approach from draft determination and now estimate a pooled OLS model.

10.3 Selected models

What we said in our draft determinations

At draft determinations we built on our approach used in PR19, where we assessed expenditure by triangulating between the industry median and a log-log random effects model. We applied a 50%/50% weightings to the log-log model and the industry median unit cost.

Stakeholders' representations

Anglian Water disagreed with our proposed approach of triangulating between the median unit cost and an econometric model. They argued that it is not intuitive for us to assume that there are no economies of scale, when modelling shows that to not be the case.

Our assessment and reasons

From an engineering perspective communications pipe replacement/reline activity generally captures reactive responses to failures in lead water quality testing. We would expect little scope for economies of scale in relation to reactive activities, as companies are less able to plan in advance. Where companies replace lead pipes more proactively this is likely to be part of a wider programme, for example as part of a smart metering programme. Therefore, we do not expect a higher number of lead pipe replacements to necessarily result in economies of scale.

We have rerun our econometric analysis using the pooled OLS model and suggests a cost-volume elasticity close to one which is consistent with constant returns to scale. We therefore continue to place weight on the median unit cost.

Our final determination

We retain the approach set out in the draft determination to triangulate between the median unit cost and the econometric model. We continue to place equal weight on the industry median unit cost and log-log model.

We set out the results of the selected econometric model in table 55. The estimated coefficient has the correct sign, is of a reasonable magnitude (less than one indicating economies of scale) and is statistically significant.

Table 55: Lead communication pipe replacement model

Explanatory variable	Communication pipe replacement model

Lead pipes replaces (Nr)	0.921*** {0.000}
Constant	-5.821*** {0.000}
Adjusted R-squared	0.919
Observations	70
Dataset	Forecast

As discussed in section 2, the log-log model underestimates modelled costs at the sector level. We apply the PR19 log bias adjustment factor so that industry model predicted costs align to the industry requested expenditure.

10.4 Efficiency benchmark

What we said in our draft determinations

At draft determination we did not apply a more stretching catch-up efficiency benchmark than the efficiency challenged implied by the triangulation between the cost model results and the median unit cost. We decided to not apply an additional efficiency challenge as the median company was already receiving a challenge based on our modelled costs using mean costs. Therefore we considered that our modelling approach was already providing a sufficient challenge to companies.

Stakeholders' representations

Companies made no representations on this area.

Our final determination

For final determination we are now applying a median efficiency challenge on top of the mean efficiency challenge implied by the triangulation between the cost model results and the median unit cost. The median company now looks efficient compared to our modelled costs and is getting an uplift on its requested expenditure. Consistent with our approach in other areas, we consider appropriate to apply an additional catch-up efficiency challenge to reflect the efficiency of the median company.

Table 56: Total communication pipes replaced/relined totex allowances (£ million, 2022-23 prices)

Company	Request	Allowance	Allowance minus request	
			£m	% of request
Anglian Water	5.78	7.96	2.18	38%

Dŵr Cymru	6.34	7.05	0.71	11%
Hafren Dyfrdwy	1.81	1.50	-0.31	-17%
Northumbrian Water	15.67	19.69	4.01	26%
Severn Trent Water	16.52	30.89	14.37	87%
South West Water	12.04	12.39	0.34	3%
Southern Water	10.65	7.45	-3.20	-30%
Thames Water	85.43	85.43	0.00	0%
United Utilities	75.26	48.58	-26.68	-35%
Wessex Water	11.79	9.88	-1.92	-16%
Yorkshire Water	15.90	15.24	-0.66	-4%
Affinity Water	4.47	4.92	0.45	10%
Bristol Water	4.00	5.60	1.60	40%
Portsmouth Water	0.30	0.14	-0.16	-54%
SES Water	0.00	0.00	0.00	
South East Water	0.00	0.00	0.00	
South Staffs Water	4.02	3.49	-0.53	-13%
Total	**269.99**	**260.20**	**-9.79**	**-4%**

A1 Further details on enhancement cost assessment

A1.1 Wastewater enhancement

A1.1.1 WINEP / NEP – event duration monitoring

This enhancement cost line includes expenditure on schemes listed in WINEP to provide new discharge operation monitoring at sewage treatment works storm tanks (under driver code U_MON3 /W_U_MON3). This includes MCERTS certified flow passed forward (FPF) overflow operation monitoring at WwTW; last in line Sewage Pumping Station overflows; any Event Duration Monitors installed at PR19 that are not yet MCERTS certified; and any EDMs that were not installed at PR19.

What we said in our draft determinations

For draft determination we assessed the investment for this line using a shallow dive approach based on the materiality of the TOTEX requested. Consideration was given to linear regression modelling. However, following query responses it was determined that there was too much variation in the scope covered under this line to enable robust comparison of costs and driver data.

Stakeholders' representations

There was broad sector support for our draft determination approach. Six companies made no representation, Wessex Water and Thames Water challenged our shallow dive approach.

Our assessment and reasons

Our approach to shallow dive efficiency challenges is set out in PR24 final determinations: Expenditure allowances document, section 3.2.3.

We retain our draft determination approach for final determination.

Our final determination

We assess the investment for this line using a shallow dive approach based on the materiality of the TOTEX requested. Nine companies received allowances based on shallow dive assessments.

The total investment allowed under this line is £28 million, a slight increase from £26 million at draft determination.

A1.1.2 WINEP / NEP – flow monitoring at STW

Companies are legally required to provide MCERTs certified pass forward flow monitoring at sewage treatment works or last in line sewage pumping station overflows, under WINEP driver U_MON4.

Investment for this enhancement line can be split into three types of interventions; permit changes only; simple meter installations or complex civils installations. We asked companies to provide a breakdown of how their costs and number of schemes spread across these three categories so that we could benchmark costs at a more granular level.

What we said in our draft determinations

For draft determination a modelled approach was not considered suitable due to the broad range of costs and numbers of schemes submitted in business plans, and there was potentially some misallocation of schemes between categories. We assessed the investment for this line using a shallow dive / deep dive approach, informed by how closely companies were to the industry median unit costs for each of the three subcategories.

Stakeholders' representations

In response to our draft determination, Wessex Water state that they should be subject to a deep dive and passed through as efficient, providing additional evidence.

Severn Trent Water and Southern Water provide additional evidence in response to the deep dive assessments.

Our assessment and reasons

Although we continue to consider that the modelled approach is not sufficiently robust to determine allowances, we deem the indicative benchmark to provide a reasonable indication of efficiency. We therefore remove the shallow dive challenge, giving companies that are efficient against the indicative benchmark their full request, and undertaking a deep dive of companies that are inefficient against the indicative benchmark.

Our final determination

We continue to assess the investment for this line using a shallow dive / deep dive approach based on cost proximity to the indicative industry median unit cost for each subcategory. As we have reasonable confidence in the indicative benchmark we pass through all companies below the indicative benchmark as efficient.

Eight companies received the full request due to being efficient against the indicative benchmark. Three companies received allowances based on deep dive assessments.

The total investment allowed under this line is £268 million, compared with £237 million at draft determinations.

A1.1.3 WINEP / NEP – Continuous Water Quality Monitors (CWQM)

The Environment Agency stated that Decisions relating to the Continuous Water Quality Monitoring programme (Section 82 of the Environment Act 2021). This is a dynamic programme and water companies are waiting for policy decisions and guidance from Defra. It is important that Ofwat's final determination enables water companies to comply with their legal obligations under this programme following the decisions made by Defra.

This enhancement covers expenditure on schemes listed under the WINEP / NEP to provide continuous river water quality monitoring (under driver codes EnvAct_MON1 to MON5). The new duties in section 141DB of the Water Industry Act 1991 will require sewerage undertakers operating wholly or mainly in England to continuously monitor the quality of the receiving water upstream and downstream of their assets. This will allow sewerage undertakers to assess the impact of discharges from their assets on the receiving watercourse. Water companies will be required to have completed rollout of 25% of all sites by 2030. This initial rollout should focus on high priority sites.

What we said in our draft determinations

We assessed the investment for this line using a cost benchmarking approach, applying the median unit cost per monitor to the number of monitors to be installed. We considered linear regression but discounted it due to a lack of evidence to support a constant (such as initial setup cost). All companies were queried to understand the variation in costs between companies. However, there was not sufficient and convincing evidence as to why the median cost allowances would be insufficient. All companies received an allowance based on the median unit cost.

Stakeholders' representations

There were minimal representations made by companies for this cost line.

Dŵr Cymru stated that the Environment Act drivers for continuous water quality monitors do not apply in Wales and that it does not believe its costs should be assessed through the cost benchmarking approach applied to other companies.

Thames Water considers there are material variations in costs for this driver depending on land purchase/rental prices for siting monitors, with monitors in areas of higher land access/purchase prices subject to significantly larger costs. However, the company accepted our draft determination median modelled allowance and plans to review the scope and associated cost requirements.

Our assessment and reasons

We retained our cost benchmarking approach from draft determinations, for all companies apart from Dŵr Cymru.

We agree that the requirements in Wales are different to those under the Environment Act drivers, and therefore accept that Dŵr Cymru should be assessed via a different approach. Given the low materiality we apply a shallow dive approach.

We do not change our modelled approach for Thames Water as it accepted our approach at draft determination.

Our final determination

We assess the investment for this line using a cost benchmarking approach, aside from for Dŵr Cymru. The benchmark is based upon the median unit cost per monitor from the number of monitors installed. Nine companies received allowances based on cost benchmark modelling. Dŵr Cymru received an allowance from a shallow dive assessment.

The total investment allowed under this line is £651 million, compared with £928 million at draft determinations. The reduction in allowances relates to companies aligning the requested number of monitors to the requirement for 25% rollout by 2030. Previously this was 40% rollout by 2030.

A1.1.4 WINEP / NEP – MCERTS-PS-EO

MCERTs certified monitoring of emergency overflow operation on network sewage pumping station is a statutory WINEP / NEP requirement under driver code U_MON6. It requires that event duration monitors (EDM) are installed to record the frequency and duration of sewage discharges made in emergency situations, and also where a pumping station has a storm overflow, that pass forward flow (PFF) is monitored to distinguish between compliant wet weather discharges and emergency discharges. The solutions included in companies' business plans are spread across four subcategories; EDM only, EDM requiring civils works, EDM and PFF, and EDM with PFF and civils works.

Ahead of business plan submissions, English companies were advised by the Environment Agency that they should plan to deliver 25% of their WINEP MCERTs monitoring of emergency overflows at pumping stations programmes. Defra then provided a steer that 50% of the programme should be delivered by 2030, resulting in an increase in requested expenditure for final determination from £326 million to £378 million. This increase is not double the original programme across the industry, as might be expected, due to some companies not accounting for the original 25% steer, and some companies reassessing their programme costs as part of their representations. We queried English companies to ensure the programmes we assess for final determination align with the requirement to deliver 50% by 2030.

What we said in our draft determinations

At draft determination we assessed the investment using a shallow dive / deep dive approach, partially informed by how closely companies were to the industry median unit costs for each of the subcategories.

We asked companies to provide a breakdown of how their costs and number of schemes spread across the four subcategories of U_MON6 so that we could benchmark costs at a more granular level. However, a modelled approach was still not suitable due to the broad range of costs and number of schemes submitted in business plans, and potentially some misallocation of schemes between categories.

Five companies received allowances based on shallow dive assessments and six companies received allowances from deep dives.

Stakeholders' representations

Representations from companies focused on the application of our shallow dive efficiency challenge. This included Severn Trent Water which stated that we should not apply a shallow dive challenge as their costs are efficient against the indicative benchmark.

Due to the Defra steer that 50% of the programme should be delivered by 2030, most companies increased costs, though there was significant variation in the level of increase across companies.

Our assessment and reasons

Our approach to shallow dive efficiency challenges is set out in PR24 final determinations: Expenditure allowances document, section 3.2.3.

We retain our approach from draft determinations, of assessing companies against the indicative benchmark unit costs for each of the subcategories of installation.

As we have reasonable confidence in the indicative benchmark we pass through all companies below the indicative benchmark as efficient.

Where companies appear inefficient against the indicative benchmark, we apply a deep dive.

Due to the company cost requests changing significantly, the companies deep dived has changed since draft determination, with more companies suitable for the deep dive assessment.

Our final determination

We assessed the investment for each company against the indicative benchmark unit costs for each of the subcategories of installation.

Those companies above the indicative benchmark were assessed through a deep dive. As we have reasonable confidence in the indicative benchmark we pass through all companies below the indicative benchmark as efficient.

Three companies were passed through as efficient, with eight companies assessed through deep dive approach.

The total investment allowed under this line is £298 million, compared with £194 million at draft determinations.

A1.1.5 WINEP / NEP – Flow to full treatment

The expenditure for flow to full treatment is for schemes listed in the WINEP / NEP to increase the flow to full treatment under driver code U_IMP5 or W_U_IMP5. These drivers are related to increasing the flow to full treatment at sewage treatment works that were identified as having a low permitted flow to full treatment and dry weather flow ratio. Schemes were agreed with the Environment Agency and Natural Resources Wales at PR19, but following agreement with the environmental regulator some schemes were deferred to PR24.

What we said in our draft determinations

We assessed the investment for this line using a shallow dive / deep dive approach.

We considered econometric modelling and cost benchmarking; however, these options were discounted due to the low number of companies with flow to full treatment expenditure that related to U_IMP5 driver delivery. Storm overflow related flow to full treatment expenditure for South West Water, Southern Water, Thames Water and Yorkshire Water was reallocated to storm overflow enhancement lines as the expenditure was related to storm overflow spill reduction, and not WINEP U_IMP5 flow to full treatment schemes.

Anglian Water received an allowance based on shallow dive assessment and Dŵr Cymru received an allowance based on deep dive assessments.

Stakeholders' representations

There were moderate representations made by companies for this cost line, with companies retaining costs within this cost line, despite reallocation at draft determinations.

Our assessment and reasons

We have taken into account the representations from companies and changed our approach at final determination to apply scheme level modelling in combination with storm overflow FFT schemes. Further reasoning and details are provided within section 3.

Our final determination

We changed our draft determination approach to combine WINEP / NEP flow to full treatment U_IMP5/W_U_IMP5 schemes and storm overflow spill reduction flow to full treatment schemes into a single dataset, and model against forecast and historical flow to full treatment data. Further reasoning and details are provided within section 3.

A1.1.6 WINEP / NEP – Storm overflows (costs not assessed using scheme level econometric models)

Some elements of requested storm overflow costs were not included within the scheme level econometric models (discussed in section 3 above) and were assessed separately, which we describe below.

What we said in our draft determinations

At draft determination we set out how we assessed the elements of storm overflow schemes not covered under the scheme level econometric models.

Green only

Storm overflow storage schemes that included both grey and green storage were assessed in the network grey/hybrid or the STW grey/hybrid econometric models (discussed in section 3). Where schemes had only green storage they were assessed separately in the green storage model.

The green model used the total equivalent storage against the total requested cost to calculate a unit cost for green storage. This unit cost was then used to benchmark companies against each other to establish an efficient cost per m^3 green storage. The second highest unit cost was established as the upper limit of green storage. Thames Water's unit cost was significantly higher than the indicative benchmark, and a deep dive challenge applied.

Wetland schemes

Schemes that were confirmed by the company to be a wetland solution, aimed at treating storm overflow spills to a sufficient standard before discharge to a watercourse, rather than reducing the spill frequency, were assessed separately. Wetlands were assessed using number of schemes, total wetland equivalent storage and total wetland area (ha).

The costs per scheme, per storage volume and per area varied significantly between companies. We considered modelling the storm overflow wetlands alongside the nature-based solutions wetlands for tightened sanitary or nutrient (N or P) permits model (PR24CA61 – WW – Nutrients or sanitary dets NbS), however relationships between the two appeared limited.

We assessed costs in relation to an indicative benchmark. As the application of wetlands to treat storm overflows is currently being trialled, and is therefore being encouraged, and the scheme details varied significantly, we based the benchmark on the second highest unit rate. All costs below the benchmark were passed through as efficient. Thames Water were given an efficiency challenge to align more closely with the benchmark.

Screen only

The majority of storm overflow storage schemes had costs for EnvAct IMP5 6mm screen improvements included, so were assessed within the grey/hybrid models. Where companies provided screen costs separately, but the storm overflow also had a storage solution, the costs were combined and assessed as a single solution. For storm overflows that were included with a provision for a screen only, and no storage, the schemes were assessed as a screen only solution. Screen only schemes were given an allowance based on the median unit cost.

Pass forward flow

At draft determination, we set out that we considered that where increases in pass forward flow are a direct alternative to storage, schemes should be assessed via cost per m^3 equivalent storage, through the grey hybrid model, as the main decision making criteria is considered to be cost efficiency. However, we acknowledged that in some instances it may not be appropriate to assess these schemes in terms of equivalent storage, particularly when the equivalent grey storage solution is unfeasible because for example it could not be drained down. Where these elements are required, they tend to have a significant impact on overall cost. To ensure that we are able to make a like for like comparison between schemes, we separated the cost of these elements from any combined storage and pass forward flow schemes.

We assessed the key driver information such as l/s increases in pass forward flow, but found this to be inconsistent and insufficient to enable cost benchmarking to be undertaken. We applied the combined grey storage efficiency challenge to the pass forward flow schemes, on the basis that companies are likely to be similarly efficient/inefficient given the similarity of scheme type.

We requested that companies provide further supporting information on pass forward flow schemes in their draft determination responses. We also highlighted concerns about overlaps with permit compliance and growth related expenditure.

Stakeholders' representations

Companies did not provide specific representations on our approach to screen only, or green-only scheme assessments beyond comments on the Price Control Deliverables, which are discussed in PR24 final determinations: Expenditure allowances document, section 3.3.2.

Flow-to-full treatment/pass forward flow: Thames Water and United Utilities commented on the use of flow-to-full treatment (FFT) schemes to complement storage solutions. Thames Water stated that the scale of FFT solutions could be measured better with alternative drivers such as litres per second (l/s) rather than equivalent storage. United Utilities challenged the robustness of the dataset in relation to treatment of flow to full treatment (FFT) schemes. The company said that the schemes may not be treated consistently between companies with different assumptions of how litres per second (l/s) capacity converts to equivalent storage.

Our assessment and reasons

We retain our draft determination approach for screen only, green only and wetlands.

FFT/pass forward flow – we agree with stakeholders that FFT schemes have different characteristics compared to storage schemes as they represent additional capacity to treat effluent at sewage treatment works. We have gathered and utilised additional information collected alongside the draft determinations to enable the cost and cost driver (litres per second) of FFT schemes to be consider in a standalone FFT dataset that we have used to create an FFT model.

At final determination we have changed our approach to combine WINEP / NEP flow to full treatment U_IMP5/W_U_IMP5 schemes and storm overflow spill reduction flow to full treatment schemes into a single dataset, and model against forecast and historical flow to full treatment data. Further reasoning and details are provided within section 3.

Our final determination

Green only

For final determination, where schemes had only green storage we retain our approach from draft determinations, of assessing companies against the indicative benchmark unit costs for green only solutions. We allow a higher than median unit cost as the benchmark for green storage to encourage companies to deliver green schemes at PR24, so that the lessons learnt can be established for future price controls.

Given the support for green solutions, and the variation in scope of company proposals, we pass through all companies below the indicative benchmark as efficient.

Where companies appear inefficient against the indicative benchmark, we apply an efficiency challenge to align with the indicative benchmark.

This led to five out of six companies receiving their requested allowance in full, with United Utilities receiving an efficiency challenge.

The total allowance for the green-only sub-model was £197.5 million.

Screen Only

For storm overflows that were included with a provision for a screen only, and no storage, the schemes were assessed as a screen only solution.

Five companies presented screen-only schemes, with a total allowance of £27.9 million. A median unit cost was used to calculate a screen only allowance which was applied to the total number of screen only schemes to calculate the allowance per company.

Storm overflow pass forward flow

At final determination we have revised our approach to combine WINEP / NEP flow to full treatment U_IMP5/W_U_IMP5 schemes and storm overflow spill reduction flow to full treatment schemes into a single dataset, and model against forecast and historical flow to full treatment data. Further reasoning and details are provided within section 3.

Wetlands

For final determination, Wetlands were assessed using number of schemes, total wetland equivalent storage and total wetland area (ha).

Seven companies provided costs for wetlands, however costs per scheme, per storage volume and per area varied significantly between companies. As the application of wetlands to treat storm overflows is currently being trialled, and is therefore being encouraged, and the scheme details varied significantly, we retained the benchmark of the second highest unit rate. All costs below the benchmark were passed through as efficient.

Six of the seven companies had unit costs per ha broadly in line with the indicative benchmark, or had non material costs, and were passed through as efficient. One company, Thames Water, had material costs above the industry benchmark. An efficiency challenge was applied to align the allowance with the indicative benchmark.

The total allowance for this sub-model was £373.8 million.

Companies must comply with their legal obligations including environmental permits and those under regulation 4 of the Urban Waste Water Treatment (England and Wales) Regulations 1994. If wetlands are determined not to be a suitable storm overflow spill reduction solution by reference to these legal requirements, then the companies must deliver an alternative solution to meet their legal obligations.

A1.1.7 WINEP / NEP – chemicals-removal

This enhancement area covers expenditure on schemes listed under the WINEP / NEP to achieve good chemical status or to prevent deterioration in chemical status or to achieve standstill limits for chemicals to meet the objectives of the Water Framework Directive (WFD). The permits under these drivers can be for a range of determinants which have historically not been permitted but are viewed as persistent in the environment. Some of the determinants include heavy metals (such as dissolved zinc, cadmium, copper, nickel, mercury etc), cypermethrin, PFAS, PFOS, tributyltin. The permit limits are generally in µg/l or ng/l and cannot currently be measured by online monitors. Permit limits for the no deterioration load standstill limits (NDLS) actions are based on sample data (generally 20 samples) from the Chemical investigations Programme (CIP) sampling. For NDLS actions companies may be permitted to gather further sample data which may lead to the Environment Agency changing the permit level, but this is only an option for NDLS_CHEM2 actions. CHEM1 actions will not have the permit reviewed so companies may have proposed capital solutions where they believe the risk on permit compliance is too great based on sample data.

What we said in our draft determinations

Companies submitted cost driver data in CWW20 for current population equivalent (PE) served by STWs with tightened/new permits for chemicals / hazardous substances and the total number of schemes with tightened/new chemicals/hazardous substances permits.

We split out treatment and non-treatment solutions, due to the different implementation costs. For costs associated with treatment solutions we asked for information on the PE per site and solution type proposed.

For the non-treatment solutions the costs were not material for any company so we use a shallow dive approach.

For the costs associated with treatment solutions we based company allowances on a linear regression utilising PE cost driver data at a company level, including data from the outlier company, Thames Water.

Six companies received a modelled allowance based on this analysis.

For the outlier company we give an allowance based on a deep dive.

Stakeholders' representations

In their representations, Anglian Water and Severn Trent Water stated that the single cost driver utilised in the modelled approach was overly simplistic and not representative of the schemes proposed.

Northumbrian Water stated that there was a rounding error within the model that was impacting all allowances, as well as stating that Severn Trent Water costs were disproportionately affecting the modelled allowances.

Our assessment and reasons

We acknowledge the limitations with the modelling approach at draft determination. We accept Northumbrian Water's representation on rounding and remove any rounding from the model. We agree that Severn Trent Water skews the model, as did Thames Water prior to being excluded from the model as an outlier. The removal of Severn Trent Water leads to skewing by Anglian Water, and removal of both companies, in addition to Thames Water leads to an insufficient number of data points.

As there were model limitations, we have assessed all companies against the indicative benchmark. We allow companies that are efficient against the indicative benchmark their full expenditure request, and undertake a deep dive of companies that are inefficient against the indicative benchmark (Thames Water and Severn Trent Water).

Our final determination

For final determination we have removed the modelled approach and assessed all companies against the indicative benchmark.

We allow companies that are efficient against the indicative benchmark their full expenditure request, and undertake a deep dive of companies that are inefficient against the indicative benchmark.

We have used the additional evidence provided by Severn Trent Water and Thames Water to deep dive costs for both companies. Both companies are deep dives based on the scale of investment and their higher costs than our indicative benchmark.

The total investment allowed under this line is £387 million, compared with £168 million at draft determinations.

A1.1.8 WINEP / NEP – chemical-investigations

This enhancement area covers expenditure on the monitoring, investigation and options appraisal of chemicals and emerging contaminants (including microplastics and other Chemical Investigation Programme 4 contaminants). The costs covered under the Chemical Investigations lines cover desk-based studies, surveys, simple and complex modelling.

What we said in our draft determinations

We assessed the investment for this line using a combination of shallow dive and deep dive as the expenditure was not material, and a significant proportion of the investment is comprised of defined company contributions to the joint industry UK Water Industry Research (UKWIR) coordinated Chemical Investigations Programme (CIP). One company proposed investment that was material (>£10m) and proportionally higher than other companies, so we assessed this by means of a deep dive.

Nine companies received an allowance based on a shallow dive (a company-specific efficiency factor being applied to their requested allowance), and one company received an allowance based on a deep dive.

Stakeholders' representations

In their representations, both companies and the Environment Agency confirmed that the Chemicals Investigation Programme (CIP) has 11 national UKWIR-led projects which already have the full budget committed and tendering underway, and so these should be excluded from any cost efficiencies

Our assessment and reasons

We agree with the representations from companies and the Environment Agency that the application of a shallow dive efficiency challenge across all companies is not appropriate for this cost line, due to a significant portion of the costs agreed and set with UK Water Industry Research.

Due to the significant cost request from Anglian Water, we retained a deep dive approach and partially accept the new evidence provided in their representations

Our final determination

For final determination we remove the shallow dive efficiency challenge for this cost line and pass through the costs for all companies except Anglian Water as efficient.

We assessed Anglian Water through a deep dive approach for final determination.

The total investment allowed under this line is £73 million, compared with £60 million at draft determinations.

A1.1.9 WINEP / NEP – N-removal

Total nitrogen removal is required at sewage treatment works (STW) to meet levels set out in environmental discharge permits. There are several WINEP / NEP drivers that require TN removal, with some sites also having phosphorus and sanitary determinand requirements at the same site.

What we said in our draft determinations

Companies submitted cost data in CWW3 for treatment of total nitrogen removal (biological) and treatment of total nitrogen removal (chemical). We assessed the investment for both the chemical and biological cost lines together as only one company requested expenditure under biological N removal.

We tested benchmarking expenditure using both total number of schemes with new/tightened N permits, and population equivalent (PE) served by STWs with new/tightened N permits. As there were only four companies that requested expenditure under these cost lines, there was low confidence in the benchmark due to limited number of observations. We therefore discounted this approach. We also tested benchmarking using the scheme level data from cost Table CWW19. In addition to the same cost drivers used at company-level (total number of schemes with new/tightened N permits and PE served by STWs with new/tightened N permits), we considered solution type and enhanced permit level.

We discounted this approach as there was little or no relationship between the cost drivers and the requested expenditure across the industry, or at a company level.

All companies received an allowance based on the efficiency challenge determined through the deep dive process. We based our draft determinations on the latest release of companies WINEP / NEP in September 2023 by Environment Agency and Natural Resources Wales.

Stakeholders' representations

Companies generally agreed with our application of a deep dive approach for assessing total nitrogen removal expenditure.

Wessex Water requested the Poole WwTW costs associated with the phosphorus removal and nitrogen removal be assessed as one scheme. In its representation the company provides detailed additional evidence on the complexity of the scheme, stating that the scale of permit tightening across multiple measures, means that the models do not adequately reflect the required investment.

The Environment Agency recognised that, due to timing, Ofwat had based its draft determinations assuming that company proposed variations to meet the requirements introduced by the Levelling Up and Regeneration Act 2023 (LURA). It requested that final determinations should reflect decisions on amendments made by Defra to enable water companies to comply with their legal obligations.

Our assessment and reasons

Given broad support for the deep dive approach we maintain this approach for final determination. We have updated our assessment for final determination to reflect Levelling Up and Regeneration Act (LURA) decisions made by Defra.

Our final determination

For final determination we continue to apply a deep dive approach to all companies.

This covers £780 million of the requested expenditure. Our approach for final determination has remained the same as at draft determination. Expenditure for total nitrogen removal has been assessed through technical deep dives.

Due to changes in legislation introduced by the Levelling Up and Regeneration Act 2023 (LURA), companies have made scope changes to their total nitrogen removal programme. Northumbrian Water have requested expenditure in this cost line for only one new scheme to install a long sea outfall (LSO) at Bran Sands, totalling £246 million. Given the option is fixed, we acknowledge that the scheme may be developed to stage gate ones and two as per our large-scheme gated process (see section 4.7.3 PR24 final determinations: Expenditure allowances document), in our view there remains a high level of uncertainty around scope and delivery risks. In the interest of reducing uncertainty and firming up the cost of the scheme through further investigations, we are therefore allowing 12% of the scheme cost to be used as development allowance. This is twice the standard amount for development allowance because we recognise the high upfront costs associated with a scheme of this nature.

We assess Wessex Water's Poole scheme as an enhanced engagement scheme, combined with the Phosphorus removal elements. Further details are provided within the PR24CA60 Phosphorus removal model.

The total investment allowed under this line is £510 million, compared with £338 million at draft determinations.

A1.1.10 WINEP / NEP - NTAL

There is a growing need to consider more ambitious levels of nitrogen (N) reduction, to contribute to WFD good status, as well as meeting biodiversity targets. The PR24 nitrogen technically achievable limit (NTAL) WINEP / NEP driver is classified as non-statutory (NS) but is mandated by Defra and Welsh Government as 'must do'.

What we said in our draft determinations

We assessed expenditure requested under N-TAL investigations cost line through shallow dive due to low materiality.

Stakeholders' representations

There were no specific representations from companies for this cost line beyond wider commentary on our shallow dive approach.

Our assessment and reasons

Our approach to shallow dive efficiency challenges is set out in PR24 final determinations: Expenditure allowances document, section 3.2.3.

We retain our approach from draft determination and assess through a shallow dive approach.

Our final determination

We retain our approach for N-TAL investigations, where companies will receive a shallow dive efficiency challenge due to low materiality.

The total investment allowed under this line is £71 million, compared with £67 million at draft determinations.

A1.1.11 WINEP / NEP - nutrients-or-sanitary-determinands-nature based solutions

This line covers schemes for new or tightened permits for nutrients or sanitary determinands, where the costs are entirely for nature-based solutions (NBS). Although using NBS is not a statutory WINEP / NEP obligation, their use is encouraged. NBS could be used as a complete solution, or part of a solution under a variety of different WINEP / NEP driver codes requiring the removal of phosphorus, total nitrogen or sanitary determinands.

What we said in our draft determinations

We assessed investment for this line using a combination of shallow dive and deep dives. We considered linear and multiple regression using cost driver data (from CWW20) for number of wetlands and surface area of wetlands. We also considered basing the allowance on a median unit cost for companies who had proposed between 90 to 100% wetlands under this expenditure.

However, as only a proportion of the proposed expenditure for a subset of companies was for integrated constructed wetlands and some companies classified reedbeds as wetlands, benchmarking did not prove viable. A unit cost approach is only viable for assessing similar solution types.

Five companies received an allowance based on a shallow-dive and three companies received an allowance based on a deep dive.

Stakeholders' representations

Companies did not make representation with regards to our shallow dive / deep dive approach.

Some companies including Southern Water, Thames Water and Wessex Water challenged our shallow dive policy.

Our assessment and reasons

Our approach to shallow dive efficiency challenges is set out in PR24 final determinations: Expenditure allowances document, section 3.2.3.

Given low confidence in the indicative benchmark we retain the use of shallow dive efficiency challenge.

Our final determination

For final determination we assess this cost line using a combination of deep dive and shallow dive assessments.

The total investment allowed under this line is £120 million, compared with £123 million at draft determinations. This is due to a reduction in company requests under this line.

A1.1.12 WINEP / NEP – nutrient-balancing

Catchment nutrient balancing can be considered as a solution for the removal of phosphorous or nitrogen for some WINEP / NEP drivers. Some WINEP drivers, such as nutrient neutrality actions (HD_IMP_NN) relating to the Levelling-up and Regeneration Act 2023

(LURA) do not allow the use of catchment solutions. For WINEP Environment Act phosphorus removal actions (EnvAct_IMP1) CNB are not appropriate because the target is against the treated load at the STW. This is a new line for PR24 and was included to allow companies to detail costs separately for these solutions.

Nutrient balancing addresses the requirement for nutrient reduction by considering the entire catchment in terms of nutrient sources. In addition to discharges from STW there may be agricultural and other sources of nutrients. These may be reduced by changing land management practices and this may be less expensive and have greater wider environmental outcomes, resulting in a best value solution. For water companies to propose this as a solution they may request funding in part to fund working with landowners, either in supporting them or via grant funds, or employing catchment staff. They may combine this approach with on-site solutions to meet overall outcomes.

What we said in our draft determinations

We assessed the investment for this line using a combination of shallow dive and deep dive. As only three companies proposed investment it was not possible to adopt a modelling approach. Severn Trent Water and United Utilities were assessed through shallow dive approach, with Northumbrian Water assessed through deep dive approach.

Stakeholders' representations

There were no representations from companies on the approach to assessing this cost line.

Severn Trent Water challenged the shallow dive efficiency applied and provided additional supporting evidence.

The Environment Agency stated that it is reviewing its catchment nutrient balancing (CNB) policy and is progressing this through its internal decision process.

Our assessment and reasons

As there were no representations from companies on the approach to assessing this cost line, we retain our approach from draft determination and assess through a deep dive / shallow dive approach.

We consider that concerns raised in the representations made by Severn Trent Water have been partially addressed through the reduction in the shallow dive challenge for final determinations.

We continue to support catchment and nature-based solutions where they are deemed to be acceptable by the Environment Agency. However, given that the Environment Agency is reviewing its catchment nutrient balancing (CNB) policy, we have considered mechanisms to ensure that alternative options can be delivered if these schemes are no longer supported.

Our final determination

For final determination we assess this cost line using a deep dive / shallow dive approach. Northumbrian Water were assessed through deep dive approach due to a material cost request. Severn Trent Water and United Utilities were assessed through shallow dive approach due to a non-material cost request.

The total investment allowed under this line is £112 million, compared with £111 million at draft determinations.

A1.1.13 WINEP / NEP – catchment-permitting

Catchment permitting can be considered as an option for some WINEP / NEP drivers that require the removal of total phosphorus, total nitrogen or sanitary determinands. The purpose of catchment permitting is to reduce the nutrient load in receiving water bodies by setting up discharge permits collectively across a catchment. This can be beneficial in comparison to implementing an individual permit per discharge, as nutrient concentrations across the water body can be reduced while avoiding the disproportionate cost of treatment at specific STWs. This is a new line for PR24 and was included to allow companies to detail costs separately for these solutions.

What we said in our draft determinations

We assess the investment for this line using a deep dive. As only one company proposed investment it was not possible to adopt a modelling approach.

Stakeholders' representations

There were no representations made on the cost assessment approach for this cost line.

Our assessment and reasons

As there were no representations from companies on this cost line, we retain our approach from draft determination and assess through a deep dive approach.

Our final determination

For final determination we assessed this cost line using a deep dive approach. Northumbrian Water were assessed through deep dive approach due to a material cost request and no change was made to the cost challenge.

The total investment allowed under this line is £19 million, compared with £19 million at draft determinations.

A1.1.14 WINEP / NEP – habitat-restoration

Catchment management – habitat restoration expenditure is for schemes listed under the WINEP / NEP for the restoration of habitats in catchments.

What we said in our draft determinations

We assess the investment for this line using a combination of shallow and deep dive assessments. Econometric modelling was discounted due to the limited number of companies with expenditure for this line.

Stakeholders' representations

Companies did not make representation with regards to our shallow dive / deep dive approach in this cost line.

Our assessment and reasons

Our approach to shallow dive efficiency challenges is set out in PR24 final determinations: Expenditure allowances document, section 3.2.3.

Given low confidence in the indicative benchmark we retain the use of shallow dive efficiency challenge.

Our final determination

For final determination we assess this cost line using a shallow dive / deep dive approach. Anglian Water, Northumbrian Water and Wessex Water were assessed through shallow dive approach as the cost request was not material. Dŵr Cymru were assessed through both shallow dive and deep dive. The shallow dive approach was used on costs within this cost line not related to the South East Coastal Strategy mains renewal scheme. The deep dive approach was used on costs within this cost line related to the South East Coastal Strategy mains renewal scheme, due to the scale and scope complexity involved in the scheme.

The total investment allowed under this line is £98 million, compared with £40 million at draft determinations.

A1.1.15 WINEP / NEP – Microbiological treatment

Under the WINEP / NEP, companies can be subject to new or tightening permit conditions for microbiological parameters for coastal or inland bathing water schemes. Solutions to meet these requirements may include ultraviolet (UV) treatment, nanofiltration, ozonation, and other chemical treatments

What we said in our draft determinations

We assessed the investment for this line using a combination of shallow dive and deep dives.

We considered using unit cost modelling for this cost line based on population equivalent served by sewage treatment works (STWs) with tightened or new microbiological standards, the total number of schemes with tightened or new microbiological standards and the total number of STWs with new and existing microbiological treatment. However, this was discounted due to the variation in treatment solutions proposed by companies.

When testing benchmarking across companies, United Utilities appeared to be a consistent outlier across all cost drivers. Therefore, six companies received an allowance based on a shallow-dive (ie a company-specific efficiency factor being applied to their requested allowance) and United Utilities received an allowance based on a deep dive.

We recognised that there would be further changes to the WINEP / NEP, notably around bathing waters, with the designation of new bathing waters and that we expected companies to reflect any changes required to their submissions because of updated requirements within their response to draft determinations.

Stakeholders' representations

In their representations, companies did not challenge our draft determination approach.

Anglian Water increased its cost request from £34 million to £194 million from draft determination because of increase in scope to meet the target log reductions at twelve wastewater treatment sites in line with the latest version of the UV design guidance.

Severn Trent Water and Yorkshire Water increased their cost requests because of new designated bathing waters.

Our assessment and reasons

As there were no representations from companies on this cost line, we retained our approach from draft determination of assessing costs with consideration to efficiency against the indicative benchmarks using two cost drivers, number of schemes and population equivalent.

Where companies are deemed inefficient against both benchmarks we undertake a deep dive. This includes Anglian Water and United Utilities.

For the remaining companies, where deemed efficient against both indicative benchmarks we apply no challenge. Where efficient against one benchmark we apply the shallow dive challenge.

Severn Trent Water requested a significant increase in cost. The majority of this has been allocated to the large gated scheme process, and so we have pass through these costs as efficient.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line against the indicative benchmarks using two cost drivers, number of schemes and population equivalent.

We assess Anglian Water through a deep dive. We remove the efficiency challenge we applied at draft determination to United Utilities' cost request since the company has aligned its final cost request with our draft determination deep dive challenge.

For the remaining companies, where deemed efficient against both indicative benchmarks we apply no challenge. Where efficient against one benchmark we apply the shallow dive challenge.

We apply no efficiency challenge to Severn Trent Water's cost request, and the majority of this has been allocated to the large gated scheme process as development costs.

The total investment allowed under this line is £407 million, compared with £114 million at draft determinations. This is due to an increase in the number of schemes related to the designation of new bathing waters, and an increased cost request from Anglian Water.

A1.1.16 WINEP / NEP - septic-tank

Septic tank replacements – treatment solution expenditure under the WINEP / NEP is for schemes to replace septic tanks with a treatment solution or drainage field. Septic tank replacements – flow diversion expenditure under WINEP / NEP is for schemes to divert flows from a septic tank site to another sewage treatment works and for any additional storm treatment.

What we said in our draft determinations

We assessed the combined investment for these lines using econometric modelling based on population equivalent served by septic tank replacement schemes.

We considered applying a linear regression model but retained the median unit cost model on the basis of simplicity.

Stakeholders' representations

In its representations, Severn Trent Water requested that the unit cost model used at draft determinations should not be used for its cost request at final determinations. Severn Trent Water stated that this is due to the PE cost driver not being a representative cost driver for smaller sites, therefore skewing the model towards larger septic tank solutions.

South West Water requested within their representations that their allowance be capped at the £14.4 million requested, rather than the £19.97 million allowed at draft determinations.

Our assessment and reasons

Through the query process, we confirmed that Severn Trent Water had incorrectly retained £18 million of costs within this cost line, that should have been reallocated to Nature Based Solutions.

Due to limited representations from companies, we have maintained our unit cost modelling approach utilised for draft determinations. We acknowledge concerns raised by Severn Trent Water, however we believe this to be the most appropriate method to determine allowances.

For South West Water, we agreed to cap the allowance within this cost line at the requested amount.

Our final determination

For final determination we maintain the draft determination approach of assessing the combined investment for these lines using econometric modelling based on population equivalent served by septic tank replacement schemes.

We do not provide a positive adjustment for South West Water and give an allowance at its requested amount.

The total investment allowed under this line is £101 million, compared with £106 million at draft determinations.

A1.1.17 WINEP / NEP – fish-screen

Outfall screens can be installed at wastewater treatment work (WWTW) outfalls to prevent fish and eel entrainment. Improvements in water quality have seen fish and eels return to parts of rivers where they have been previously absent. As a result, existing outfalls may need new or improved screening

What we said in our draft determinations

We assessed the investment for this line using shallow dive. We considered the unit cost of the investment compared to screens installed in previous asset management periods (AMP). The company was queried to better understand the scope of the proposed investment. The company received an allowance based on a shallow dive efficiency challenge.

Stakeholders' representations

There were no representations made by any company within this cost line.

Our assessment and reasons

Due to no representations from companies, we have maintained our shallow dive approach utilised for draft determinations.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line using a shallow dive approach.

The total investment allowed under this line is £2 million, compared with £2 million at Draft determinations.

A1.1.18 WINEP / NEP – 25-year-environment-plan

The 25 Year Environment Plan expenditure under WINEP / NEP is for locally significant environmental measures within driver code 25YEP_IMP, which are not eligible under any other driver and have clear evidence of customer support.

What we said in our draft determinations

We assess the investment for this line using deep dive and shallow dive assessments.

We discounted econometric modelling to limited number of companies with 25 Year Environment Plan expenditure.

Three companies received an allowance based on deep dive and shallow dive assessments.

Stakeholders' representations

Companies did not make representation with regards to our approach to use shallow dive and deep dives.

Our assessment and reasons

Our approach to shallow dive efficiency challenges is set out in PR24 final determinations: Expenditure allowances document.

Given low confidence in the indicative benchmark we retain the use of shallow dive efficiency challenge.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line using a deep dive / shallow dive approach.

The total investment requested under this line is £73 million, compared with £60 million at draft determinations.

A1.1.19 WINEP / NEP – investigations

This enhancement area covers investment required to deliver all WINEP / NEP wastewater investigations with driver codes _INV and _NDINV, excluding chemical / emerging contaminants and N-Tal investigations which are covered under their own enhancement line.

What we said in our draft determinations

We assessed the investment using shallow dives and deep dives, informed by how closely companies were to the industry median unit costs for each of the three subcategories. Investment for this enhancement line was split into three types of interventions; desk-based investigations; simple monitoring / modelling investigations; and complex modelling /monitoring / multiple surveys. We asked companies to provide a breakdown of how their costs and number of schemes spread across these three categories so that we could benchmark costs at a more granular level.

We did not consider a modelled approach was suitable due to the broad range of costs and numbers of schemes submitted in business plans, and potentially some misallocation of schemes between categories. Four companies received allowances based on shallow dive assessments and seven companies received allowances from deep dives.

Stakeholders' representations

There were various representations in this area, with Anglian Water and United Utilities raising concerns about mis-categorisation of complexity categories. Northumbrian Water challenged the Environment Agency view that not all Storm Overflow investigations will be complex. Wessex Water and Thames Water agreed with concerns about the complexity category and reallocated investigations,

There were also large changes in cost requests between original business plan data and company representations. Anglian Water, Severn Trent Water, United Utilities and Yorkshire Water all increased their cost requests, while Northumbrian Water, Thames Water and Wessex Water all reduced their cost requests.

Those companies that have revised the size and cost of their investigations programme in their representations, have done so either to better align with their WINEP actions or to address the need for additional or more complex storm overflow investigations following the Environment Agency's review of the SOAF2 guidance. Further updates to companies' investigations programmes following the SOAF2 guidance release will be handled through the storm overflow uncertainty mechanism.

Our assessment and reasons

We have taken note of the significant representations in this cost area and have had ongoing discussions with the Environment Agency and companies over the allocation of investigations between different complexity categories. While some companies made reasonable estimates of the percentage of investigations likely to be within lower complexity categories, others maintained that all investigations would be complex. The Environment Agency was unable to confirm what proportion of investigations should be allocated to each category under the revised investigation guidance.

Given the combined risk of over/underfunding companies, we have fully funded company requested allowances but adjust the cost sharing rates to 40:10 to ensure that customers do not overpay should the investment not be required, while retaining some protection should companies incur higher costs.

Our final determination

For final determination we are allowing companies requested costs in full. We adjust the standard cost sharing rate to 40:10.

The total investment allowed under this line is £508 million, compared with £327 million at draft determinations.

A1.1.20 WINEP / NEP – third-party-schemes

This line includes expenditure under the WINEP / NEP for water company contribution(s) to third party schemes.

What we said in our draft determinations

We assess the investment for this line using shallow dive assessments.

Econometric modelling was discounted due to limited number of companies with contribution to third party schemes expenditure under WINEP / NEP.

Two companies received an allowance based on shallow dive assessments.

Stakeholders' representations

There were no representations made by any company within this cost line.

Our assessment and reasons

Due to no representations from companies, we have maintained our shallow dive approach utilised for draft determinations.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line using a shallow dive approach.

The total investment allowed under this line is £0.2 million, compared with £0.2 million at draft determinations.

A1.1.21 WINEP / NEP – river-connectivity

River connectivity expenditure under the WINEP / NEP is for river connectivity schemes such as fish passages.

What we said in our draft determinations

We assess the investment for this line using shallow dive assessments.

We discounted econometric modelling due to the limited number of companies with river connectivity expenditure. Two companies received an allowance based on shallow dive assessments

Stakeholders' representations

There were no representations from companies for this cost line.

Our assessment and reasons

As there were no representations, we have maintained our shallow dive approach utilised for draft determinations.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line using a shallow dive approach.

The total investment allowed under this line is £7 million, compared with £7 million at draft determinations.

A1.1.22 WINEP / NEP – restoration-management access-and-amenity

Restoration management expenditure under the WINEP / NEP is for restoration management schemes such as marine conservation zones.

What we said in our draft determinations

We assessed the investment for this line using shallow dive assessments.

We discounted econometric modelling due to limited number of companies with restoration management expenditure. Two companies received an allowance based on shallow dive assessments.

Stakeholders' representations

There were no representations from companies for this cost line.

Our assessment and reasons

As there no representations, we have maintained our shallow dive approach utilised for draft determinations

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line using a shallow dive approach.

The total investment allowed under this line is £14 million, compared with £13 million at draft determinations.

A1.1.23 WINEP / NEP - advanced-WINEP

This enhancement covers expenditure relating to Advanced WINEP (A-WINEP), where this is not already covered elsewhere in business plans. A-WINEP is a WINEP initiative (not for the Welsh NEP) which invited companies to propose innovative approaches that are not possible within WINEP framework and yet clearly offer greater benefits for customers and the environment.

What we said in our draft determinations

Anglian Water and United Utilities are progressing wastewater related A-WINEP projects. The A-WINEP proposals that are being progressed are being assessed by a specific appraisal and governance process.

The only company considered under this line was Anglian Water with total investment requested of £26.3 million. United Utilities included its A-WINEP project costs under another cost line, so they are not assessed within this line.

We assessed the investment for this line using a deep dive.

Stakeholders' representations

Companies did not make any representation with regards to our deep dive approach.

Our assessment and reasons

For the final determination we retain our deep dive approach to assessing this cost line.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost line using a deep dive approach.

The total investment allowed under this line is £26.3 million, compared with £24 million at draft determinations.

The expenditure for United Utilities Advanced WINEP programme is assessed under the storm overflows cost line.

A1.1.24 WINEP / NEP - sludge-storage-tank

This line covers expenditure on schemes listed under the WINEP / NEP (SUiAR) to improve resilience in the sludge supply chain and/or prevent deterioration in soil and water quality. The investments proposed included tank storage for sludge for both pre-treatment and post-treatment. We assess the investment for the two sludge-storage-tank cost lines together, for effective comparison purposes.

What we said in our draft determinations

In the draft determination, we assessed the investment for these lines using a unit cost benchmarking approach. Dŵr Cymru was queried to understand unit cost variation between the two cost lines. However, there was no sufficient and convincing evidence provided as to why there were significant differences in unit cost between the cost lines. We did not consider an econometric model to be suitable due to the small number of companies requesting investment within these cost lines. We set the allowance based on the lower unit cost of sludge storage (£/m^3) between the two cost lines.

We are aware that the total sludge storage volume provided is subject to some change and therefore companies must confirm the final proposed numbers and cost as part of their Draft Determination response.

Stakeholders' representations

We received no representation from Dŵr Cymru, the only company requesting the same funding under this cost line.

Our assessment and reasons

Given there was not representation for this cost line, we retain our draft determination method of unit cost benchmarking for final determination.

Our final determination

For final determination we maintain the draft determination approach of assessing the cost using a unit cost benchmarking approach. We assess the investment for the two sludge-storage-tank cost lines together, for effective comparison purposes.

Dŵr Cymru, the only company submitting cost under these WINEP action, receives an allowance based on the lower unit cost of sludge storage (£/m^3) between the two cost lines.

The total investment allowed under this line is £31 million.

A1.1.25 WINEP / NEP – sludge-storage-cake

This line covers expenditure on schemes listed under the WINEP / NEP (SUiAR) to improve resilience in the sludge supply chain and/or prevent deterioration in soil and water quality. The investments proposed included cake pad storage for treated sludge product.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a median unit cost approach, with a % uplift applied to companies allowances to allow for differences in scope. This unit cost (£/m^2) is based upon the area of cake pad required (m^2).

We considered approaching the cost assessment by separating the submissions into categories according to scope complexity. However, there was a broad range of interventions submitted, ranging from uncovered cake pads to odour-controlled buildings and several interventions combining both solutions. This made separation of the proposals challenging and therefore, we discounted this approach. We considered using linear or log regression models, however due to the significant variation in unit costs (£/m^2) and poor correlation, the models were deemed unsuitable, and the approach was discounted.

All companies received an allowance based upon the median unit cost, with a small number of companies allowances uplifted to allow for scope complexity.

We were aware that the total cake pad area provided could be subject to change and therefore requested companies to confirm cake pad areas and costs in response to draft determinations.

Stakeholders' representations

We received several representations from companies in this cost area. Northumbrian Water, United Utilities and Wessex Water challenged our modelled approach but also reduced their cost and scope from their business plan submission. United Utilities stated that any assessment of the cost efficiency should be undertaken on a like-for-like basis and that the cost per tonnes of dry solids (TDS) might be used as an improved cost driver.

Wessex Water stated that if a company proposes a mix of open and covered storage solutions, this requires an indication of the proportions to each so that the solutions can be separated and assessed accordingly. Wessex Water suggests that due to the small number of submissions based on odour-controlled sealed barns/buildings and the associated distinct drivers of cost for these solution types, this type of increased scope is treated as an outlier and assessed through a deep dive.

Northumbrian Water considers that a deep dive might have been more appropriate to reflect the different approaches companies have used.

Our assessment and reasons

We agree with Northumbrian Water, United Utilities and Wessex Water that the modelled approach we applied at draft determinations did not sufficiently take account for variations in scope. We did not differentiate between covered and uncovered storage solutions or additional scope such us odour control. To address this, we have altered our approach to account for both uncovered and covered cake pad storage and used an indicative benchmark of both types of storage to generate allowances for each company.

As per company representations, we considered alternative costs drivers (such as TDS) but by assessing the two main types of cake storage separately (covered and uncovered) and using surface area as the main cost driver. We obtained a reasonable unit cost correlation across companies' proposals.

Our final determination

For final determination we have amended our draft determination shallow dive approach, and utilise a median unit cost approach, using a different unit cost for each storage type.

We provide an allowance to all companies requesting funding under this line. We assessed requests using a median unit cost and generated a unit cost for both types of storage, to generate indicative benchmark allowances for each company. As Yorkshire Water were proposing a blend of covered and uncovered storage, the average unit cost of both covered and uncovered storage was used to generate the indicative allowance.

We provided companies with their requested costs if costs were efficient compared to the indicative benchmark. Companies were given their draft determination allowances if costs were higher than the indicative benchmark. We provided South West Water with their requested costs as their cost and scope an outlier compared with other companies.

The total investment allowed under this line is £308 million, compared with £264 million at draft determinations.

A1.1.26 WINEP / NEP – sludge-treatment-thickening

This line covers expenditure on schemes listed under the WINEP / NEP (SUiAR) schemes to improve resilience in the sludge supply chain and/or prevent deterioration in soil and water quality. The investments proposed included thickening/dewatering improvements to deliver treated biosolids to a higher quality.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line by separating companies according to unit cost against the indicative benchmark. Companies with efficient unit costs against the indicative benchmark were assessed through a shallow dive approach. Companies with inefficient unit costs were assessed through deep dive. This unit cost (£/tTDS/yr) is based upon the capacity of thickening/dewatering added (tTDS/yr).

We considered approaching the cost assessment by separating the submissions into categories according to dewatering extent (% Dry Solids change), however there was a broad range of interventions submitted, and there was not a notable difference in unit cost from those companies carrying out thickening/dewatering/enhanced dewatering. We also considered approaching the cost assessment using the Target Dryness % as a secondary driver in a multiple regression model. The model was deemed unsuitable due to poor predictive power and the approach was discounted.

Stakeholders' representations

Companies did not make representation on our shallow dive / deep dive approach.

Our assessment and reasons

For final determination we have retained our shallow dive / deep dive approach for this cost line.

We assessed companies through a deep dive if companies had a high unit cost on a throughput basis (£m/tTDS/yr). We assessed costs through a shallow dive for companies with a low unit cost.

We retain the shallow dive challenge for those companies below the indicative benchmark due to low confidence in the benchmark.

Our final determination

For final determination we retain our draft determination approach of assessing the cost line using a shallow dive / deep dive approach based on cost in relation to the indicative benchmark (median unit cost). Companies with costs below the indicative benchmark were assessed via shallow dive, companies with costs above the indicative benchmark were assessed via deep dive.

The total investment allowed under this line is £148 million, compared with £133 million at draft determinations.

A1.1.27 WINEP / NEP – sludge-treatment-other

This line covers expenditure on schemes listed under the WINEP / NEP (SUiAR) schemes to improve resilience in the sludge supply chain and/or prevent deterioration in soil and water quality that do not fit into any of the other cost categories.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investments.

We discounted econometric modelling due to the range in type of schemes proposed and scheme drivers.

Stakeholders' representations

Companies did not make any representation on our shallow dive / deep dive approach.

We assess company representations on our specific deep dive challenges in the cost model.

Our assessment and reasons

For final determination, we retain our shallow dive / deep dive approach.

Our final determination

Due to the nature and variety proposals under these lines, we assessed the investment for these lines by deep dive.

The total investment allowed under this line is £210 million, compared with £103 million at draft determinations.

A1.1.28 WINEP / NEP – sludge-investigations

This line covers expenditure on NEP (SUiAR) schemes to investigate emerging contaminants in sludge and alternative disposal routes. As the NEP is applicable only in Wales, only Dŵr Cymru submitted costs against this line.

What we said in our draft determinations

We assessed this investment for this line using a deep dive approach.

Stakeholders' representations

The company did not make representation on our draft determination approach.

Our assessment and reasons

As per our draft determinations, due to the nature of the proposal under this line, we retain our draft determination approach and assessed the investment by deep dive.

Our final determination

For final determination, we assessed the investment for these lines by deep dive.

The total investment allowance under this line is £19 million, compared with £17 million at draft determinations.

A1.1.29 First-time-sewerage

First time sewerage enhancement includes activities related to connecting new properties to the sewerage system (referred to as S101A schemes).

What we said in our draft determinations

We assess the investment for this line using econometric modelling. We use historical and forecast data to model efficient costs. This is similar to our PR19 approach. The PR24 first time sewerage model explains variations in costs well with an R-squared of over 80%. We have revised the PR19 approach to use cost and cost drivers per price control period (AMP5-AMP8) instead of triangulating between historical and forecast models as we did in PR19. We consider this leads to a more robust cost model as it allows us to use more data to estimate the model parameters.

Ten companies received an allowance based on the econometric modelling.

Stakeholders' representations

South West Water states that the modelled approach should not apply to the Isles of Scilly investment.

The Duchy of Cornwall also state that the modelled allowance would not be sufficient for the Isles of Scilly given the challenges of freight and construction and highlights the environmental need for schemes.

Our assessment and reasons

In general we retain our draft determination modelled approach for final determination.

We acknowledge that there are some unique features of South West Water's Isles of Scilly investment that are unlikely to be covered by our modelled allowance, and undertake a deep dive assessment of this proposal.

Our final determination

We assess the investment for this line using econometric modelling. We use historical and forecast data to model efficient costs. This is similar to our PR19 approach. The PR24 first time sewerage model explains variations in costs well with an R-squared of over 80%.

We have revised the PR19 approach to use cost and cost drivers per price control period (AMP5-AMP8) instead of triangulating between historical and forecast models as we did in PR19. This leads to a more robust cost model as it allows us to use more data to estimate the model parameters.

Nine companies received an allowance based on the econometric modelling. South West Water received an allowance based on a deep dive assessment of its requested costs.

The total investment allowed under this line is £156 million, compared with £137 million at draft determinations.

A1.1.30 Odour-and-nuisance

Odour and nuisance expenditure is for schemes where the primary objective is to deliver a step-change improvement above base standards. This could include reducing complaints about odour, noise, flies and other nuisance.

What we said in our draft determinations

At draft determination we assessed the investment for this line using deep dive assessments.

We discounted econometric modelling due to the limited number of companies with odour and nuisance expenditure.

Stakeholders' representations

Companies did not make representation with regards to our deep dive approach.

Our assessment and reasons

For final determination we have retained our deep dive approach for this cost line.

Our final determination

For final determination we assess this cost line via a deep dive approach.

One company received an allowance.

The total investment allowed under this line is £16 million, compared with £24 million at draft determination.

A1.1.31 Resilience

Expenditure to enhance resilience relates to investment to manage increasing risks, or changing acceptance/acceptability of risk, from hazards that are beyond company control and are not covered by other enhancement areas.

What we said in our draft determinations

We assessed the investment for this line using a combination of shallow dive and deep dive, based on the key subjects identified from companies' submission.

At draft determination, we allowed a sector wide enhancement uplift for companies to prioritise their biggest climate related risks and requested all companies set out what they would deliver for the additional allowance in their responses to the draft determination. We calculated the uplift based on 0.7% of modelled base allowances (for water and wastewater services).

We also made allowance to two companies based on the deep dive assessments.

Stakeholders' representations

Companies did not make representations on our shallow dive / deep dive approach.

In its representation, three companies forego the climate change resilience uplift allowance.

Three companies disagreed with our deep dive assessments. In its representation, one company reinstated two schemes that had been rejected in our draft determination and added a new scheme. The other two companies reinstated the rejected deep dive schemes in its representation and provided additional evidence.

One company accepted the deep dive allowance in its representation.

Our assessment and reasons

For the final determination, we continue to assess the investment for this line using a combination of shallow dive and deep dive, based on the key subjects identified from companies' submission. This includes company responses to the climate change resilience uplift.

For climate change resilience uplift allowance, we apply a high level review against the climate change resilience uplift requirements and deep dive approach to assess the companies' representations for this area. Further details see section '4.8.2 Climate change resilience' uplift in 'PR24 final determination – Expenditure allowance'.

As two companies provide sufficient and convincing evidence in their representation, we made allowances with reduced adjustments to reflect this.

One company did not provide additional supporting information in its representation, therefore we retain our draft determination and reject the proposed investment request.

Our final determination

The total investment request under this line at final determination is £346 million.

We calculate the climate change resilience uplift based on 0.714% of modelled base allowances (for water and wastewater services).

Fourteen water and wastewater and water-only companies receive this sector-wide climate change resilience uplift allowance totals £277 million based on the climate change resilience uplift requirements set out in “Our assessment and reason” in section 4.8.2 Climate change resilience uplift in ‘PR24 final determination – Expenditure allowance”’.

Three companies receive £50 million enhancement expenditure allowance determined through deep dive assessment.

A1.1.32 Freeform

Freeform investment lines cover a range of requested investments, across the entirety of wastewater enhancement, where the investment does not fit any of the specified cost lines.

What we said in our draft determinations

We assessed the investment for all freeform Lines by initially assessing the need for enhancement through a deep dive challenge. If the company did not provide sufficient and convincing evidence of the need for enhancement, the freeform line would receive no investment. If the company provided evidence that the need for enhancement was justified, the freeform line would be assessed through the other deep dive cost adjustment criteria. We considered an econometric modelled approach for some freeform lines, however, due to the variable nature of investment requests this approach was discounted.

Stakeholders' representations

Companies did not make specific representation with regards to our approach to assessing deep dive investment.

Our assessment and reasons

We have retained our deep dive approach for this cost line for final determination.

Our final determination

For final determination we retain our approach of assessing all freeform line requests against the need for enhancement through a deep dive challenge. If the company did not provide sufficient and convincing evidence of the need for enhancement, the freeform line would receive no investment. If the company provided evidence that the need for enhancement was justified, the freeform line would be assessed through either a shallow dive or deep dive assessment.

The total investment allowed under this line is £769 million, compared with £560 million at draft determination.

A1.2 Water enhancement

A1.2.1 WINEP / NEP Drinking water protected areas

Investment on Drinking Water Protected Areas is for enhancement activity listed in WINEP/NEP to implement catchment schemes to prevent deterioration or to make improvements following a deterioration in water quality to avoid an increase in the level of water treatment.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment. We used the median unit cost benchmark per action as an indication of efficiency.

Stakeholders' representations

Several companies, including Severn Trent Water, Southern Water and Wessex Water, raised points on the use of the indicative benchmark as an indication of cost efficiency.

Southern Water stated that it was unreasonable to apply a shallow dive efficiency challenge when its proposed investment is efficient against the indicative benchmark. Wessex Water raise that it is nominally about the indicative benchmark and that this demonstrates efficient costing for more enhanced catchment measures. Severn Trent Water raise whether a deep dive is required when its proposed investment is slightly above the £10m threshold. Severn Trent Water also state that catchment area or number of farms would be a better scale variable for a benchmark.

The Environment Agency highlighted that benchmarking must account for the bespoke nature of some WINEP interventions, for example, Drinking water protected areas schemes.

Southern Water and SES Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all companies requests against the agreed WINEP/ NEP.

In response to the Environment Agency, we agree that some types of WINEP interventions are more bespoke in nature. In response to the points raised by the Environment Agency and companies on benchmarking, we do test companies requests against the median unit cost benchmark per action. This is to support identifying which companies to deep or shallow dive, or particular outliers, but we do not use it to set allowances and instead apply the shallow or deep dive approach.

For the eight companies with low materiality costs (or where the cost appears efficient against the indicative benchmark) we allow the costs after applying a 'company specific efficiency factor' set at between a minimum 0% and 10%. Further information on our shallow dive approach for the final determination is set out in 'PR24 final determinations: Expenditure allowances'.

For the six companies with high materiality costs (or those where the cost appears inefficient against the indicative benchmark) we have assessed the evidence provided by the company on need (including overlap with base allowances and previously funded activity), options appraisal and robustness and efficiency of costs. We use the outcomes of the deep dive assessment to determine the overall allowance for a company.

Our final determination

We assess the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment.

The final determination allowance under this line is £140 million, compared with £119 million at draft determination.

A1.2.2 WINEP / NEP Biodiversity and conservation

Investment related to Biodiversity and conservation is for enhancement activity listed in the WINEP / NEP to deliver biodiversity improvements, including restoring or preventing deterioration of Sites of Special Scientific Interest and/ or ensuring European sites are in a favourable condition.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment.

Stakeholders' representations

Northumbrian Water, Thames Water, Severn Trent Water, Southern Water, United Utilities, Wessex Water and Yorkshire Water provided specific feedback and additional evidence in representations on points raised in our draft determination deep dive assessments. We summarise these and respond to evidence provided in representations in our deep dive assessments for final determination.

Anglian Water, South East Water and South West Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all companies requests against the agreed WINEP/ NEP.

Econometric modelling and unit cost benchmarking was discounted due to the range in types of schemes proposed and number of WINEP drivers. As this investment area did not lend itself to statistical modelling, we relied on the evidence provided by companies in business plans and representations. We set allowances following a risk-based process of having a lighter touch ('shallow-dive') assessment for low materiality costs (covering seven companies) and a more detailed assessment of the evidence ('deep dive') for high materiality costs (covering eight companies).

For the seven companies with low materiality costs, we allowed the request after applying a 'company specific efficiency factor' set between 0% and 10%. For the eight companies with higher materiality costs, we assessed the evidence provided by the company on need (including overlap with base allowances and previously funded activity), options appraisal and robustness and efficiency of costs. We use the outcomes of these deep dives to determine the overall allowance for each company.

Our final determination

We assess the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment.

The total investment allowed under this line is £202 million, compared with £132 million at draft determination.

A1.2.3 WINEP / NEP Water Investigations

Investment related to Water Investigations is for enhancement activities listed in the WINEP/ NEP to deliver investigations and or options appraisals. Investigations aim to identify actions or determine impacts, costs and/or technical feasibility of meeting targets. Investigations costs have been separated out into three separate lines to capture those that are desk-based, those that require a survey, some monitoring or simple modelling, or those requiring multiple surveys, monitoring, and/or complex modelling.

What we said in our draft determination representations

In the draft determination we assessed the investment for water investigations using a combination of unit cost benchmarking and outlier deep dive assessments to confirm model outputs. Assessment of costs was based on the triangulation of industry unit-cost benchmarking and WINEP group (driver) benchmarking. For one company an outlier deep dive was completed to determine whether compelling econometric or engineering evidence had been provided to justify the higher costs presented for its WINEP Investigations programme. We tested other cost drivers as part of our draft determination development, such as investigation complexity. This approach was found to be unsuitable, potentially due to the misallocation of investigations between categories.

Stakeholders' representations

Multiple companies submitted representations on the investigations modelled approach. These representations can broadly be categorised into the following areas.

- Investigation line complexity (desk-based, simple and complex);
- Geographical scale;
- WINEP action components;
- 'Grouped' investigations;
- Invasive Non-Native Species (INNS) Raw Water Transfer Biosecurity schemes; and
- Requests for scheme-specific consideration or the application of a deep dive approach.

We also received feedback from non-water company stakeholders, including the Environment Agency, Natural England and Water Resources East (WRE).

See 'PR24 final determinations: expenditure allowances' section 3.3.6 for more detail on representations on the water investigations modelled approach.

Our assessment and reasons

In the final determination we have adjusted our approach to water WINEP investigations to address the concerns raised by companies, the Environment Agency, Natural England and WRE. See 'PR24 final determinations: expenditure allowances' section 3.3.6 for more detail on the adjustments to the water investigations modelled approach.

Our final determination

For the final determination we have updated our assessment to take account of investigation complexity by investigations line, geographical scale (by WINEP scale grouping) and investigation driver type (by WINEP group). Allowances are determined for each investigation through triangulated unit-cost benchmarking across these three drivers. We have capped allowances at requested levels if costs are deemed efficient. We have deep dived requests where companies receive a modelled challenge greater than 10% and uplifted allowances where companies provide compelling evidence for additional costs.

The total investment allowed under this line is £229 million, compared with £197 million in the draft determination.

A1.2.4 WINEP / NEP Eels and fish screens

Investment on Eels and fish screens is for enhancement activities listed in the WINEP/ NEP to prevent the entrainment of eels and migratory fish in existing abstraction intakes and outfalls.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line through a shallow dive approach. We used the median unit cost benchmark per action as an indication of efficiency.

Stakeholders' representations

Companies did not make specific representation on our draft determination approach.

United Utilities, South West Water and SES Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all company requests against the agreed WINEP/ NEP.

This investment area does not lend itself to statistical modelling and we have relied on the evidence provided by companies in their business plans and representations. We have set allowances following a risk-based process of having a lighter touch ('shallow dive') assessment for low materiality costs (covering seven companies).

For the seven companies with low materiality costs, we allow the costs after applying a 'company specific efficiency factor' capped between a minimum 0% and 10%.

Our final determination

We assess the investment for this line using a shallow dive approach.

The total investment allowed under this line is £28 million, compared with £26 million in the draft determination.

A1.2.5 WINEP / NEP Eels and fish passes

Investment on Eels and fish passes is for enhancement activities listed in the WINEP/ NEP to address physical barriers to the passage of eels and migratory fish.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line through a shallow dive approach. We used the median unit cost benchmark per action as an indication of efficiency.

Stakeholders' representations

Companies did not make specific representation on our draft determination approach.

Anglian Water, South East Water, South West Water and Wessex Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all company requests against the agreed WINEP/ NEP. This investment area does not lend itself to statistical modelling and we have relied on the evidence provided by companies in their business plans and representations.

For the eight companies with low materiality costs we allow the costs after applying a 'company specific efficiency factor' capped between a minimum 0% and 10%. For the two companies with high materiality costs, we have assessed the evidence provided by the company on need (including overlap with base allowances and previously funded activity), options appraisal and robustness and efficiency of costs. We use the outcomes of the deep dive to determine the overall allowance for a company.

Our final determination

For the final determination we update our draft determination approach and assess the cost line using a deep dive / shallow dive approach.

The total investment allowed under this line is £50 million, compared with £37 million in the draft determination.

A1.2.6 WINEP / NEP Invasive Non-Native Species (INNS)

Investment on Invasive Non-Native Species (INNS) is for enhancement activities listed in the WINEP/ NEP for surveillance, action to prevent deterioration and improvement schemes to reduce risk of spread and impacts of INNS.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment.

Stakeholders' representations

Companies did not make specific representation on our draft determination approach.

Southern Water, Wessex Water, SES Water and South East Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all company requests against the agreed WINEP/ NEP. This investment area does not lend itself to statistical modelling and we have relied on the evidence provided by companies in their business plans and representations.

For the thirteen companies with low materiality costs we allow the costs after applying a 'company specific efficiency factor' capped between a minimum 0% and 10%. Further information on our shallow dive approach for the final determination is set out in ‘PR24 final determinations: Expenditure allowances’.

For the two companies with high materiality costs, we have assessed the evidence provided by the company on need (including overlap with base allowances and previously funded activity), options appraisal and robustness and efficiency of costs. We use the outcomes of the deep dive to determine the overall allowance for a company.

Our final determination

For the final determination we maintain the draft determination approach of assessing the cost line using a deep dive / shallow dive approach.

The final determination allowance under this line is £41 million, compared with just over £33 million in the draft determination.

A1.2.7 WINEP / NEP Water Framework Directive (WFD)

Investment on Water Framework Directive (WFD) is for enhancement activity listed in the WINEP /NEP for schemes to improve, achieve, protect or prevent deterioration of water body status or ecological status within a catchment due to water company assets and operations. The activities identified can include habitat improvements, river restoration, barrier removal, compensation flow regime changes or abstraction reductions, which do not result in zonal supply demand balance impact.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment. We used the median unit cost benchmark per action as an indication of efficiency.

Stakeholders' representations

Anglian Water, Severn Trent Water, Thames Water, Affinity Water and South East Water provided specific feedback and additional evidence in representations on points raised in our draft determination deep dive assessments. We summarise these and respond to evidence provided in representations in our deep dive assessments for final determination.

Southern Water, Wessex Water, United Utilities, SES Water and South West Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all companies' requests against the agreed WINEP/ NEP.

Although not suitable for setting allowances, we see value in the benchmarking for this enhancement area. We continue to use the median unit cost benchmark per action as an indication of cost efficiency. This has been updated based on new data submitted.

As this investment area did not lend itself to statistical modelling, we relied on the evidence provided by companies in business plans and representations. We set allowances following a risk-based process of having a lighter touch ('shallow-dive') assessment for low materiality costs (covering twelve companies) and a more detailed assessment of the evidence ('deep dive') for high materiality costs (covering five companies).

For the twelve companies with low materiality costs (or where the cost appears efficient against the indicative benchmark), we allowed the request after applying a 'company specific efficiency factor' set between 0% and 10%. For the five companies with high materiality costs (or those where the cost appears inefficient against the indicative benchmark) we assessed the evidence provided by the company on need (including overlap with base allowances and previously funded activity), options appraisal and robustness and efficiency of costs. We use the outcomes of these deep dives to determine the overall allowance for each company.

Our final determination

For the final determination we maintain the draft determination approach of assessing the cost line using a deep dive / shallow dive approach.

The total investment allowed under this line is £550 million, compared with £328 million in the draft determination.

A1.2.8 WINEP / NEP Discharge monitoring

Investment on Trade effluent discharge flow monitoring is for enhancement activity listed in the WINEP /NEP for MCERTS flow monitoring to protect the environment from the effects of water treatment works trade effluent discharges.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line using a combination of deep dives and shallow dives depending on the materiality of the investment.

Stakeholders' representations

Companies did not make specific representation on our draft determination approach.

Southern Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all company requests against the agreed WINEP/ NEP. This investment area does not lend itself to statistical modelling and we have relied on the evidence provided by companies in their business plans and representations. We have set allowances following a risk-based process of having a lighter touch ('shallow dive') assessment for low materiality costs (covering three companies) and a more detailed assessment of the evidence ('deep dive') for one company where the request was high in comparison to other company requests.

For the three companies with low materiality costs, we allow the costs after applying a 'company specific efficiency factor' capped between a minimum 0% and 10%. Further information on our shallow dive approach for the final determination is set out in 'PR24 final determinations: Expenditure allowances'.

For the company we deep dived, we have assessed the evidence provided to determine the overall allowance for the company.

Our final determination

For the final determination we maintain the draft determination approach of assessing the cost line using a deep dive / shallow dive approach.

The final determination allowance under this line is just over £4 million, compared with £2.5 million in the draft determination.

A1.2.9 WINEP / NEP 25 Year Environment Plan

Investment on 25 Year Environment Plan is for enhancement activity listed in the WINEP/NEP for locally significant environmental measures (25 YEP driver code) not eligible under any other driver, but with clear evidence of customer support.

What we said in our draft determinations

In the draft determination, we assessed the investment for this line through a shallow dive approach.

Stakeholders' representations

Companies did not make specific representation on our draft determination approach.

Wessex Water and South East Water challenged the shallow dive efficiency applied.

Our assessment and reasons

We have validated all company requests against the agreed WINEP/ NEP. This investment area does not lend itself to statistical modelling and we have relied on the evidence provided by companies in their business plans and representations. We have set allowances following a risk-based process of having a lighter touch ('shallow dive') assessment for low materiality costs (covering three companies).

For the three companies with low materiality costs, we allow the costs after applying a 'company specific efficiency factor' capped between a minimum 0% and 10%.

Our final determination

For the final determination we maintain the draft determination approach of assessing the cost line using a shallow dive approach.

The total investment allowed under this line is £11 million, compared with £10 million in the draft determination.

A1.2.10 WINEP / NEP Wetland Creation

Investment on Wetland Creation is for enhancement activity listed in the WINEP / NEP for wetland creation schemes that improve, achieve, protect and/or prevent deterioration of water body objectives or ecological status within a catchment due to water company assets and operations.

What we said in our draft determinations

In the draft determination we received no enhancement cost request for wetland specific schemes to deliver benefits to water WINEP drivers.

Stakeholders' representations

There were no representations from companies for this cost line.

Our assessment and reasons

We received no enhancement cost request for wetland specific schemes to deliver benefits to water WINEP drivers. We had anticipated seeing some requests here and were prepared to assess them separately to more traditional / grey infrastructure solutions.

Our final determination

The total investment requested under this line is £0 million, as in the draft determination.

Ofwat (The Water Services Regulation Authority) is a non-ministerial government department. We regulate the water sector in England and Wales.

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December 2024

PR24 final determinations

Aligning risk and return

Ofwat

PR24 final determinations: Aligning risk and return

Summary

The water sector needs to finance a large scale investment programme to deliver necessary improvements for customers and the environment. In order to attract investment into the sector, debt and equity investors need to earn a reasonable return that provides fair compensation for the risks associated with their investment. The allowed return and the calibration of the overall risk and return package supports companies to meet their obligations, while incentivising companies to be efficient and deliver improving levels of service to customers. By linking outturn returns to how companies perform for customers and the environment, we seek to ensure the costs customers bear reflect the performance they receive.

We have calibrated the risk and return package so that equity investors in an efficient company have a reasonable prospect of earning the base allowed return that is set in accordance with the notional capital structure. Our determinations provide opportunities for equity investors to earn higher returns where companies outperform our cost and service benchmarks. Underperformance adjustments will reduce investor returns where companies underperform our determinations.

Overall balance of risk and return

We have considered carefully the overall balance of risk and return in our final determinations. In their response to our draft determinations, companies and investors raised concerns about the level of allowed costs, the level of stretch within the outcomes package, the level of the allowed return, and expressed views about the need to provide greater downside protections.

We have recalibrated the allowed return, cost allowances and the outcomes package. The recalibration for the final determination takes account of information provided by companies and other stakeholders in draft determination representations. It takes account of more recent data from the financial markets and the outturn performance and financial information reported by companies in their 2024 Annual Performance Reports. The increased funding provided for base and enhancement cost allowances will underpin delivery and should reduce perceptions of risk compared with our draft determinations.

We have revisited the outcomes package, refreshing the judgements we have made across the range of parameters, including the level of stretch in performance commitment levels, the level of ODI incentive rates, and our use of caps and collars. We have increased cost allowances, including to provide upfront allowances for business rates and energy, and we have taken account of improved information provided by companies in support of their enhancement cost claims. We have updated our assessment of the cost of embedded debt to take account of recent debt issued by the sector, and included a benchmark adjustment to the cost to new debt, reflecting the increased debt spreads that have been observed this year, even for companies with stronger levels of credit quality.

For final determinations we have made a number of targeted amendments to the overall risk and return package. These amendments aim to provide greater protections to companies and customers than were in place for the 2020-25 period. These amendments reflect the need to support significant levels of investment while protecting customers where companies do not deliver.

Our PR24 final determinations extend the protection for changes in costs that are over and above those reflected in general inflation (also referred to as relative price effects). In addition to labour costs, we extend these protections to energy expenditure allowances and plant and material enhancement costs. We extend standard cost sharing to bioresources and we have also introduced or amended bespoke cost sharing arrangements for expenditure on enhancements, Industrial Emissions Directive expenditure allowances, and some other large investment areas.

For PR24 we have introduced an aggregate sharing mechanism (ASM) for outcomes which will reduce the impact on customer bills and equity returns of extreme levels of out- or underperformance. The ASM for outcomes covers the equity returns generated from the outcomes package, including C-MeX, D-MeX, BR-MeX[1] and business customer experience in Wales. We have also introduced an ASM that protects customers and companies from material out or under performance against our wholesale cost allowances.

Reflecting concerns raised about the overall risk and return package in company and investor representations, we take forward a proposal first proposed in a consultation we published in October 2024 to introduce an Outturn Adjustment Mechanism (OAM) for the outcomes package. Our aim in setting the final determinations has remained to set a balanced outcomes package. However, we introduce the OAM as a mechanism that is designed to adjust the returns of all companies in the event of materially different sector performance than expected.

To address concerns raised in responses to our consultation, we have made some amendments to our consultation proposal. This includes applying the mechanism on an annual basis, separately for water and waste, and to introduce a deadband before the trigger of the OAM mechanism.

[1] Customer measure of experience (C-MeX), developer measure of experience (D-MeX) and business customer and retailer measure of experience (BR-MeX).

Overall, the additional mechanisms and the adjustments we propose to the risk and return package provide additional protections for both customers and investors. They will continue to encourage companies to deliver stretching levels of performance, while supporting them to raise necessary levels of finance, by constraining the impact of extreme out- and underperformance on customer bills and equity returns that might otherwise arise. We consider this to be in the longer-term interests of customers as our determinations aim to strike a balance between creating incentives to outperform while continuing to incentivise investment where companies underperform.

In addition, we have expanded the coverage of uncertainty mechanisms for cost items where there is insufficient certainty in the efficient cost allowances for them to be included in the final determinations. This includes mechanisms for PFAS (so-called forever chemicals) and cyber security, and the possibility of additional base expenditure allowances, if necessary, following further collaboration with the sector to better understand asset condition.

Taken together, the changes we have made for the final determinations result in a material change to the overall risk and return package that was set in our draft determinations.

Allowed return

The base allowed return aims to provide reasonable compensation to investors for the risks associated with their investment. The allowed return set in our final determinations is 4.03%: higher than our draft determination figure of 3.72% and our PR24 methodology 'early view' of 3.29%. It is also higher than the allowed return of 2.96% set at PR19 for the 2020-25 period.

The increase to the allowed return reflects targeted changes to our methodology, as well as more recent market data suggesting a higher cost of finance.

Since our draft determinations, we have updated the cost of embedded debt to reflect updated data on debt issued by the sector in 2023-24 and to take account of debt issuance and forecast issuance in 2024-25. The allowed return on new debt has been amended to reflect data for the month of September 2024. It now includes a positive 30 basis point benchmark adjustment to reflect sector-wide increases experienced by water companies in 2024. This increase should also support companies to raise increasing levels of finance in international markets, which could become an increasingly important source of finance in the future. As for the PR19 period, the cost of new debt is subject to a reconciliation mechanism that will be applied at PR29 to reflect changes in the market cost of finance.

Our allowed return on equity of 5.10% represents an increase on our draft determinations figure of 4.80%. It is a figure that is at the top end of our cost of equity range, which – together with amendments to the overall PR24 incentive package – will help to support a level of investment that looks to be higher than any 5 year period since privatisation. Our cost of equity allowance is also higher to reflect improvements to our estimation approach by placing weight on the most credible data sources, and to better align our allowance with likely financing conditions over 2025-30.

We note also that the allowed return set in our final determinations (4.03%) aligns with the median (3.98%) and mean (4.00%) of return expectations of equity analysts (range 3.81% to 4.14%) surveyed ahead of our final determinations.

Cost recovery

For our final determinations, we have applied the PAYG rates set out in company business plans, subject to technical adjustments to reflect the outcome of our cost challenge.

In response to our PR24 methodology and the challenges to customer bills, companies proposed lower run-off rates for PR24 than were applied at PR19. In most cases, companies proposed run-off rates that were lower than the upper limits set in our PR24 final methodology. However, we have made targeted interventions to reduce the run-off rates in accordance with our assessment framework where companies were identified as outliers and where there is headroom to do so in accordance with the assessment framework set out in our PR24 methodology.

Overall, the average run-off rates in our determinations are 4.15%, resulting in an average period over which the cost of the RCV will be recovered of 24 years.

Financeability assessment

We assess that our determinations will allow efficient companies, under the notional capital structure, to be financeable, such that they will be able to raise the necessary levels of debt and equity to deliver the required investment. We set the allowed return and made our financeability assessment based on a capital structure that is underpinned by 55% debt finance. The financial ratios assessed in our draft determinations support credit ratings that are well within the investment grade at a target credit rating of at least Baa1/BBB+.

We have revised our approach to the financeability assessment for the final determinations to include a base dividend yield of 4%. RCV growth will need to be financed by new debt and equity, and we support the provision of additional equity by provided an allowance for equity issuance costs.

Our financeability assessment is based on the notional capital structure. But by revising our approach to apply a 4% dividend yield in our financeability assessment, our approach supports companies, under a range of financial structures, to raise equity to support investment in the 2025-30 period. Companies have a choice as to how that equity is delivered: through retained earnings and through fresh equity. In most cases, companies will need to revisit their financing plans for the 2025-30 period now that they have the certainty of the final determination.

In some cases companies will need to continue to take steps to strengthen their levels of financial resilience. We consider that the equity financing requirement is therefore likely to be higher than the c.£7 billion forecast in representations. But it could be lower than the £12.7 billion we included in our financeability assessment, to the extent that companies choose to support the required equity financing requirement through retained earnings rather than equity injections.

The reconciliation adjustments, which include a sector wide uplift of £1.5 billion to allowed revenue and £4.2 billion increase to RCV (which includes an adjustment of £0.3 billion carried over from 2019-20), provide additional cashflow and financing headroom in the 2025-30 period.

To further support companies to raise the necessary levels of new equity, we confirm that we will provide funding for the net efficient costs of a company raising that equity through a new stock market listing, by means of a logging up adjustment to the RCV at PR29. We encourage companies to engage with us at an early stage where they may contemplate claiming such costs.

Allowances for tax

Our calculation of allowed revenues includes an allowance for corporation tax. However, the large investment programme at PR24 along with the ability to deduct the full capital expenditure from taxable revenue means that the tax allowance is a zero contribution to allowed revenues and customer bills for all but one company for the 2025-30 period.

We have adjusted PR19 tax reconciliations and PR24 tax allowances where companies have surrendered tax losses to group companies ensuring that customers continue to receive the benefit of any tax losses.

Dividend expectations

We confirm our expectation that a base dividend yield of 4% is reasonable for a company whose in-the-round performance aligns with our determinations. We will expect to see that companies demonstrate clearly how performance against our determinations, including out and underperformance on matters such as totex and

ODIs are taken into account in the design of dividend policies and their application.[2] Each company remains responsible for ensuring that their dividend policy and dividend decisions are compliant with the relevant licence condition, and that they align with our guidance and company law.

As companies remain responsible for their financing decisions within the context of our determinations. We would expect some companies to adopt lower dividend yields, or even pay zero dividends where financial resilience is at risk and the provision of new equity investment needs to be made through retained earnings.

In all cases, companies will need to continue to justify their dividend decisions in the context of their performance, financing needs and obligations to customers and the environment.

Financial resilience

Companies are responsible for maintaining their own levels of financial resilience in the context of the final determinations, their licence and company law. In most cases, companies will need to revisit their financing plans for the 2025-30 period now that they have the certainty of the final determination, but also to take account of other factors.

Companies must be able to raise debt and equity finance on reasonable terms if they are to deliver their investment programmes efficiently for customers. The increased levels of investment, together with the need to refinance existing debt as it matures, means that companies will need to raise increased levels of debt. And the amount companies forecast they need to raise in 2025-30 represents a 60% increase to the level of debt raised in the current regulatory period (2020-25).

Individual companies may need to restrict dividends, even to zero, where necessary to ensure they are able to raise finance at efficient cost to support investment and to financial resilience. And in some cases, further steps may need to be taken where financial resilience is at risk.

We set out our assessment of each company in our recent Monitoring Financial Resilience report.[3] We expect to maintain our existing monitoring and engagement arrangements through the 2025-30 period.

The evidence arising from the challenges posed by companies with the weakest levels of financial resilience and the more recent actions taken by the credit rating agencies

[2] Further details on our expectations is set out in IN 23/04 Guidance on factors Ofwat considers in assessing dividends declared or paid.
[33] Ofwat, Monitoring Financial Resilience report 2023-24.

further supports our view supports our view remains that gearing levels that exceed 70% may not be sustainable in the long term. However, we are not pursuing the options set out in our draft determinations to introduce licence amendments, or other interventions, that would restrict companies from paying dividends beyond a set gearing threshold at this time. We will consider these issues separately, as part of our further, forward looking work on financial resilience in 2025.

Delayed delivery cashflow mechanism

Our determinations include a suite of measures to encourage timely delivery of the enhancement programmes. We set out the details of the Delayed Delivery Cashflow Mechanism (DDCM) that operates alongside other measures to incentivise delivery. The DDCM is designed to operate as a customer fairness mechanism that would allow customer bills to more fairly reflect the actual delivery profile where enhancement investments are delayed.

Contents

1. Our response to challenges made about the 'investability' of our determinations

In their representations to the draft determinations, companies, investors and investor representatives raised a number of concerns about the overall balance of risk and return in our draft determinations, and whether our draft determinations were sufficient to attract the necessary levels of finance to support investment in the 2025-30 period.

Concerns were raised that:

- the calibration of the determination did not provide a reasonable balance of risk and return;
- the overall level of risk exposure was too great;
- the base allowed return was not sufficient to incentivise investors to commit capital;
- our interventions to RCV run-off meant that equity investors would be contributing to fund day to day company costs; and,
- our decision to make use of dividend restrictions to support equity funding of RCV growth did not recognise the needs of certain investors.

Oxera, in a report commissioned by WaterUK, and Anglian Water's representation considered that a framework for assessment of these issues needed to be put in place. In addition, companies provided comments, supported by a range of papers prepared by their consultants is matters relevant to the balance of risk and return and allowed return set in the draft determinations. We respond to the points raised throughout this document and the accompanying appendices.

In sections 2 and 3 we explain how our final determinations result in a material recalibration of the risk and return package for PR24 compared with the 2020-25 period, as a result of changes to our cost allowances, outcomes performance targets and application of cost sharing and risk protection measures.

We confirm that setting a balanced package of risk and return, that is underpinned by reasonable cost allowances, a reasonable allowed return on capital and reasonable performance benchmarks and risk protections is central to our aim of setting a determination package that fairly balances the interests of customers on one hand and companies and their investors on another.

In section 4 we summarise our approach to setting the allowed return. Our approach to setting the allowed return on equity includes a number of revisions to our assessment of the underlying CAPM parameters. This results in a higher allowed return on equity than would apply if we followed precisely the approach we adopted at PR19. In addition, we adopt an allowed return on equity that is towards the high end of our plausible range and apply a positive benchmark index adjustment of 30 basis points to derive our cost of new debt allowance.[4] This adjustment reflects our assessment of the market data, which shows that debt spreads for the water sector have been elevated in 2024. It also recognises that companies may need to make increasing use of international markets to support an increased debt financing requirement, which companies have forecast to be 60% greater than the current regulatory period.

There are reasonable arguments why the allowed return on capital should be lower. However, our decision on the overall allowed return on capital is balanced in the context of the need to support companies to deliver a significant investment programme in 2025–30.

We have cross checked our cost of equity range against the range of returns inferred by our Market to Asset Ratio (MAR) analysis and we have applied the analytical framework proposed in UKRN guidance for choosing a point estimate.[5] The allowed return on equity in our final determination (5.1%) sits well within the MAR range (4.3% – 6.3%). Overall, the process we have followed leads us to conclude that an allowed equity return of 5.1% is reasonable for the risks we are expecting investors to bear for the PR24 final determinations.

We note also that the allowed return set in our final determinations (4.03%) aligns with the median (3.98%) and mean (4.00%) of return expectations of equity analysts (range 3.81% to 4.14%) surveyed ahead of our final determinations.

The accompanying 'PR24 final determinations: Aligning risk and return – Allowed return appendix' and accompanying reports from our economic[6] and academic[7] advisers consider the issues raised on the allowed return in further detail.

In section 5, we set out our approach to the assessment of cost recovery rates. Our interventions have been targeted in accordance with the assessment framework that was subject to consultation in development of the PR24 methodology. The interventions focus on companies whose cost recovery rates are outliers under our assessment framework and when compared to the rest of the sector. We note also that the full transition to CPIH at PR24 provides upward pressure on customer bills and additional cashflow headroom than had a portion of the RCV continued to be indexed to RPI as has been the case in the 2020–25 period.

Contrary to views expressed in response to our draft determinations, our interventions to alter cost recovery rates are not the same as requiring investors to fund day-to-day activities. Where this is the case under a company's actual structure, this is likely the result of inefficiency, poor performance or excessive gearing.

In section 6, we summarise our approach to the financeability assessment. For our final determinations we have applied a base dividend yield of 4% and set out an approach to

[4] Compared with a 15 basis point negative adjustment at PR19 and no adjustment in our PR24 draft determinations
[5] UKRN, 'Guidance for regulators on the methodology for setting the cost of capital', March 2023
[6] CEPA 'PR24 Cost of equity'.
[7] Mason, Robertson and Wright 'Responses to KPMG's August 2024 report on the cost of equity'.

ensure that RCV growth is supported by new debt and equity (underpinned by an increased allowance for equity issuance costs).

Our financeability assessment is based on the notional capital structure. By revising our approach to apply an increased dividend yield of 4% in our financeability assessment, our approach supports companies, under a range of financial structures, to raise equity to support investment in the 2025-30 period. Companies have a choice as to how that equity is delivered: through retained earnings or through fresh equity. In most cases, companies will need to revisit their financing plans for the 2025-30 period, now they have the certainty of the final determination.

We comment on financial resilience in section 8. In some cases companies will need to continue to take steps to strengthen their levels of financial resilience. We consider that the equity financing requirement is likely to be higher than the c.£7 billion forecast in representations to fund RCV growth and to support those companies that need to improve financial resilience. But it could be lower than the £12.7 billion we included in our financeability assessment, to the extent that companies choose to support the required equity financing requirement through retained earnings rather than equity injections.

Companies are responsible for maintaining their own levels of financial resilience in the context of the final determinations, their licence and company law. And they will be responsible for ensuring dividends paid in the 2025-30 period meet their licence requirements, including to reflect financing needs and performance delivered for customers and the environment. Individual companies may need to restrict dividends, even to zero, where necessary to support investment or financial resilience. And in some cases, further steps may need to be taken where financial resilience is at risk.

Since 2020, companies in this sector have raised over £4.6 billion of equity. Our assessment is that roughly two-thirds of this has been to support companies with weak levels of financial resilience and one-third has been to support investment growth. PR24 will provide significant opportunities for investors to finance growth of the asset base, to contribute to improved levels of service for customers and to deliver improved environmental performance.

But to do so, companies and their investors need to be realistic about the equity valuations. Our incentive regime is designed to align investors interests with customers by linking their returns to performance improvements. Companies have a responsibility to maintain resilient financial structures without excess levels of debt. Where financial resilience is at risk, the appropriate allocation of risk and return means that investors, rather than customers, should bear the consequences of past financing choices. We consider this necessary to ensure the longer term interest of customers and ultimately investors are best served.

2. Our overall approach to risk and return

Our determinations aim to:

- align the interests of companies and investors to those of customers by setting the appropriate balance of risk and return;
- incentivise companies to deliver stretching levels of efficiency and levels of service that improve over time; and
- ensure that investor returns in 2025-30 fairly reflect the levels of service and cost efficiency that are delivered for customers.

We allow companies a reasonable return on capital based on a notional capital structure. However, as we seek to align the interests of investors and companies with customers, the outturn return on capital will vary depending on each company's performance against its cost allowance and performance commitments in 2025-30. Where a company outperforms our allowed costs or expected service levels it should earn a higher equity return; where a company underperforms our allowed costs or expected service levels it should earn a lower return.

The notional capital structure that underpins our determination provides an important signal to companies and their investors about the allocation of risk between customers on one hand and the companies and their investors on the other. The allowed return and our financeability assessment are based on the 55% gearing level first signalled in our PR24 methodology.[8] Companies have had significant time and opportunity (given the tendency of high inflation to place downward pressure on gearing) to amend their capital structures to align with the notional structure, should they want to do so, ahead of PR24.

Companies may choose the capital structure suitable for their circumstances, within the context of our determinations and the licence. But, the evidence arising from the challenges posed by companies with the weakest levels of financial resilience and the more recent actions taken by the credit rating agencies further supports our view that gearing levels that exceed 70% may not be sustainable in the long term, taking account of the balance of risk and return in our determination package.

[8] In addition, we have signalled our position on risky financial structures on many occasions over the past two decades. We signalled a need, well before PR19, for companies to consider carefully the need to manage their financial structures in the context of the need to maintain long term financial resilience.

2.1 Risk and return package for PR24

The regulatory regime contains many arrangements that are designed to support companies to raise efficient finance and support delivery of investment programmes. These arrangements include:

- the independence of the regulatory regime, underpinned by the legislative and licence framework;
- price control decisions made every five years, with the option for companies to appeal a decision to the Competition and Markets Authority (CMA);
- the regulatory commitment to the RCV, which has been used to calculate the net stock of investment contributed by investors over successive price controls, and commitment to remunerate cost over- and under-spends subject to cost sharing rates;
- the use of Direct Procurement for Customers (DPC) or the Special Infrastructure Projects regime (SIPR)[9] for large infrastructure spend, which reduces delivery and financing risk faced by regulated companies; and
- comprehensive application of risk and uncertainty mechanisms, including:
    - inflation-linked revenue allowances and investor returns;
    - price control determination reopening mechanisms (Substantial Effects Clause and Interim Determinations);
    - revenue reconciliation mechanisms which remove uncertainty associated with revenue over- and under-recovery; and
    - indexation mechanisms for the cost of debt and labour costs.

Our PR24 final determinations include a number of targeted amendments to the risk and return package compared with the arrangements in place for the 2020-25 period. These aim to support companies to deliver the step increase to the financing and investment requirement in the 2025-30 period, while also seeking to protect customers from a miscalibration of the price determination package. These amendments include:

- strong financial incentives on companies to achieve good performance with greater financial protection for both customers and companies if performance goes beyond what we have seen in the past. Our calibration of the final determination package includes performance commitment levels that are reflective of sector median forecasts rather than the upper quartile targets set at PR19. We have made revisions to the approach set out in our PR24 draft determinations to take account of information provided in representations and to reflect on the levels of performance reported by companies in their 2024 Annual Performance Reports;
- increased protection for real price effects through the indexation of energy costs (wholesale base expenditure) and materials, plant and equipment costs

[9] The full name is: 'Water Industry (Specified Infrastructure Projects) (English Undertakers) Regulations 2013)'

(enhancement expenditure), in addition to labour costs. In total, about 55% of total cost allowances for the water resources and network plus controls will be indexed to changes in benchmark rates, compared to about 30% if only labour costs were indexed as at PR19;

- recalibration of retail and wholesale cost allowances, taking account of the effect of inflation. Base cost allowances are 19% higher than our PR19 base allowances, and 7% more than what companies have spent in the past five years, after the application of frontier shift efficiency and real price effects. For wholesale base costs, we also adopt a change in the level of frontier efficiency (we apply a 1.0% per year efficiency challenge compared with 1.1% at PR19);
- the extension of the DPC and SIPR regimes, where we propose 27 major projects to be suitable for funding under a commercial model;
- the introduction of formal gated allowances for 13 larger complex investments projects that had a requested combined cost of £2.3 billion. We have allowed development funding in the PR24 settlement. Given the uncertainty associated with these schemes we will provide further funding after companies have developed final designs and we are confident in their costings. This will protect both customers and companies from significant changes to allowed expenditure at PR24;
- expansion of the coverage of uncertainty mechanisms for cost items where there is insufficient certainty in the efficient cost allowances for them to be included in the final determinations. This includes uncertainty mechanisms for PFAS (so-called forever chemicals) and cyber security and will allow us to provide additional enhancement expenditure allowances during the 2025-30 period if new investment requirements arise.
- the possibility of additional base expenditure allowances, if this is necessary following improvement in our understanding of asset condition in the water sector. Our plan is to work collaboratively with the sector to better understand asset condition with the main first output in 2027. While the focus of this exercise is forward looking to PR29, we will also assess if there are any sector wide asset condition issues that need to, and can be, addressed ahead of the next price review period (PR29);
- the introduction of a delivery mechanism for Thames Water and Southern Water that will allow them to claim additional expenditure allowances in 2025-30 for additional schemes, not able to be included in expenditure allowances;
- the introduction of standard cost sharing to the bioresources control, and a reduction to cost sharing rates that apply across other wholesale controls so that the company share of cost overspends is within the 50% - 60% range (compared with up to 75% applied at PR19);
- the lowering of cost sharing rates for enhancement costs to a 40% company share to increase protection for customers in relation to enhancement underspends and the exposure of companies to enhancement cost overspends;
- the introduction of enhanced (25%) cost sharing rates for investments associated with the Industrial Emissions Directive , environmental permitting regulation (EPR)

permits, abstraction charges, discharge consents, schemes included in enhanced engagement and the large scheme gated process;
- the introduction of 40% company share of cost overspends on continuous water quality monitoring and investigations, which is greater protection for companies than standard cost sharing on base costs, but customers will receive 90% of any underspends;
- a reducing the sharing rate for business rates (10% compared with 25% at PR19);
- the introduction of separate aggregate sharing mechanisms for outcomes and costs, which will reduce the impact of extreme levels of out- and underperformance on customer bills (beyond an equity return threshold of 300 basis points for outcomes and 200 basis points for totex), and support ongoing investment in cases of extreme underperformance. In a change to the PR24 methodology we include the customer (C-MeX), developer (D-MeX), and business customer retailer (BR-MeX) measures of experience within the aggregate sharing mechanism threshold for outcomes;
- the introduction of the outturn adjustment mechanism for outcomes that would be triggered if there was a significant shift away from anticipated sector level returns. If the performance of the median company passes an equity return trigger threshold of +/-50 basis points, we will apply an adjustment to all companies as the difference between the median company and the trigger threshold;
- a decision to apply the RCV reconciliation adjustments to the RCV that will be stated in our annual RCV update on 31 March 2025, to support ongoing investment in 2024-25;
- a decision to cap the PR19 cost sharing rate that applies for 2024-25 to 60% to provide continued support to the delivery of investment ahead of the start of the PR24 period;
- the option for companies to accept adjustments associated with the outcome of the quality and ambition assessment and Outcome Delivery Incentive (ODI) as adjustments to the RCV rather than revenue; and
- a decision to commit to fund the efficient costs of water companies establishing and raising new equity via an exchange listing where companies demonstrate this to be efficient and in the long-term interest of customers and the environment.

Companies will be responsible for delivering the investment programme and meeting their legal obligations. Each company will need to be accountable for its actions in delivery against its determination and in securing its own long-term financial resilience. In some cases companies will need to continue to take steps to strengthen their levels of financial resilience.

3. Our approach to aligning risk and return

3.1 Overall balance of risk and return

We aim to set a balanced package of risk and return that allows efficient companies with a notional capital structure to have a reasonable prospect of achieving a return that is commensurate with the base allowed return. The distribution of achieved returns around the base return will depend on levels of performance. Companies outperforming their targets on average can expect higher returns, while underperforming companies can expect returns to be lower.

In their representations to our draft determinations, most companies express concern that the overall risk was skewed to the downside due to our draft determinations setting a combination of cost allowances that were too low, performance commitments that were too stretching and concerns that the allowed return was too low.

Taking account of information set out in representations, updated financial data and information reported by companies about their performance and debt issuance in the their 2024 Annual Performance Reports, we have made changes that will alter the overall package of risk and return in the final determinations.

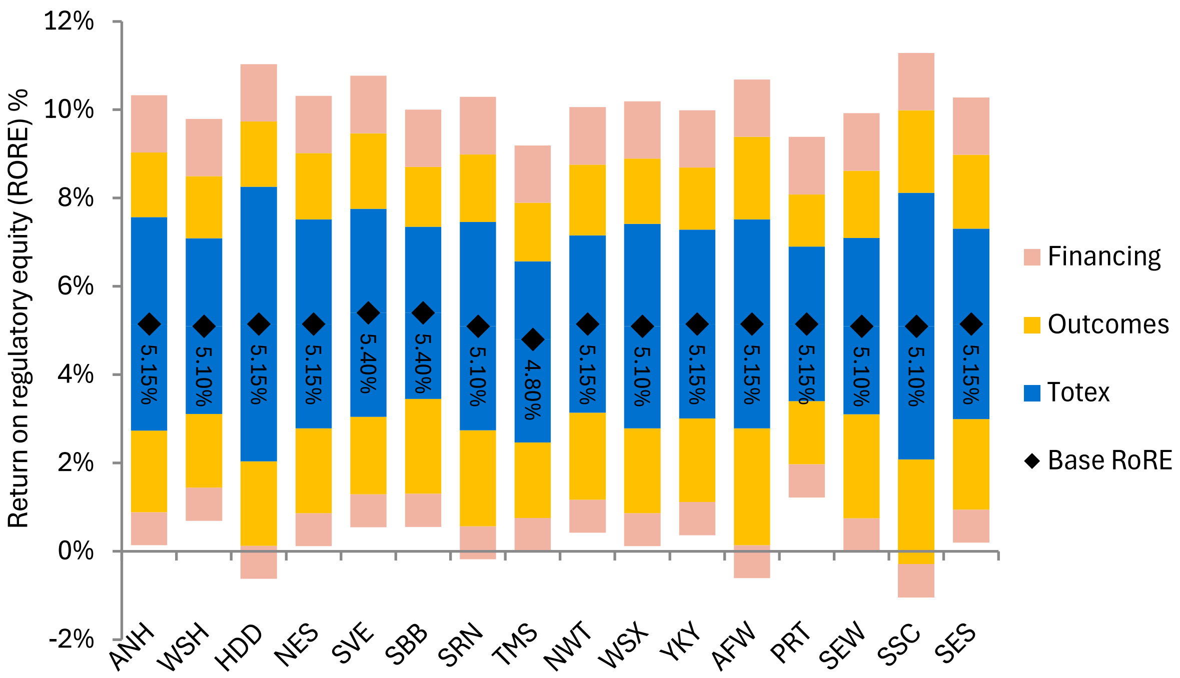
- We have increased our base cost allowances by £5 billion. Overall, our base cost allowance of £60 billion is 7% more than companies have spent over the past five years.
- We have increased enhancement cost allowances, closing the gap to what companies requested between draft and final determinations by £6 billion.
- We have recalibrated the outcomes package.
- We have increased the allowed return from 3.72% to 4.03% at the appointee level. And we have increased the retail margin to 1.5% from 1.2% in our draft determinations.

Together these adjustments represent a material change to the risk and return balance that was set in our draft determinations. They reduce the overall downward skew that companies may have perceived to the expected return on equity by c.360 to 480 basis points had the draft determination been unchanged (114 to 228 basis points for cost allowances after cost sharing, 182 basis points for outcomes and 69 basis points for the allowed return). In addition, we have expanded the use of uncertainty mechanisms to provide additional scope for revenue allowances to be adjusted in-period to provide additional funding for uncertain cost items and we have expanded the categories of cost items that will be subject to more protective cost sharing arrangements.

We assess that the calibration of our final determinations results in a package of incentives, cost allowances and uncertainty mechanisms so that the final determination package is broadly balanced for an efficient company.

We present our assessment of the overall risk range in Figure 1. These risk ranges take into account evidence of past company performance and the targeted amendments proposed to the risk and return package that are set out in section 2.1.

Figure 1: PR24 final determination risk ranges based on additive P10 and P90 ranges, calculated as a percentage of regulatory equity[10]



We provide further details in the 'PR24 final determinations: Aligning risk and return appendix'.

[10] The chart is likely to slightly overstate the range of risk as the respective risk ranges from totex, outcomes and financing are simply added together, whereas there is likely to be a portfolio effect so that the overall range of risk may be less than the total shown. The base RoRE and cost sharing for totex include the effect of the rewards and contingent penalties from our quality and ambition assessment. If Thames Water makes sufficient progress under the Turnaround Oversight Regime, we will reverse its financial penalty and apply standard 50:50 cost sharing rates on its base expenditure. Severn Trent Water and South West Water will only retain the highest level of QAA rewards if they meet their environmental and affordability commitments during the control period, otherwise we will reduce the financial adjustment component of their QAA rewards from 30 to 5 basis points, which is the QAA reward eight other companies receive. Differences in the range of risk faced by each company depend principally on the ratio between cost allowances and regulated equity and/or differences in company specific characteristics such as variations in population or network length compared to the number of households that leads to ODIs having slightly different impacts per company.

3.2 Return adjustment mechanisms

Our PR24 draft determinations proposed the introduction of an aggregate sharing mechanism for outcomes and wholesale cost allowances. The inclusion of aggregate sharing mechanisms are designed to protect customers and companies from extreme levels of out- and underperformance. They also provide greater certainty to companies and investors about the overall range of impact the financial incentives for the 2025-30 period given the step change to investment that is required at PR24.

Aggregate sharing mechanisms reduce the impact of extreme levels of outperformance which could otherwise have significant impacts on customer bills, and support ongoing investment in cases of extreme underperformance. In their representations to our draft determinations some company and investor responses requested changes to our aggregate sharing mechanisms. In some cases, responses requested a reduction in the applicable thresholds or to combine the mechanisms under a single risk adjustment mechanism (RAM), similar the one applied by Ofgem in its recent determinations.

We have considered carefully the proposals put forward in representations, however, we have retained separate mechanisms for costs and outcomes as we consider there to be merit in retaining the integrity of the separate cost and outcomes incentives.

We have also decided not to narrow the trigger thresholds for the incentive mechanisms. We consider there to be benefits to customers from maintaining incentives that are sufficiently high powered to encourage companies to focus on performance delivery for customers. We have designed the aggregate sharing mechanism thresholds to allow for the exhaustion of the real allowed return on equity in circumstances of exceptionally poor performance, and conversely, by maintaining the principle of symmetry, to allow double digit equity returns where companies deliver exceptionally high levels of outperformance. If the incentives for performance are too low, then the incentives on equity investors to demand performance improvements would be diluted, and this may actively encourage companies to adopt financial structures that are more highly debt financed.

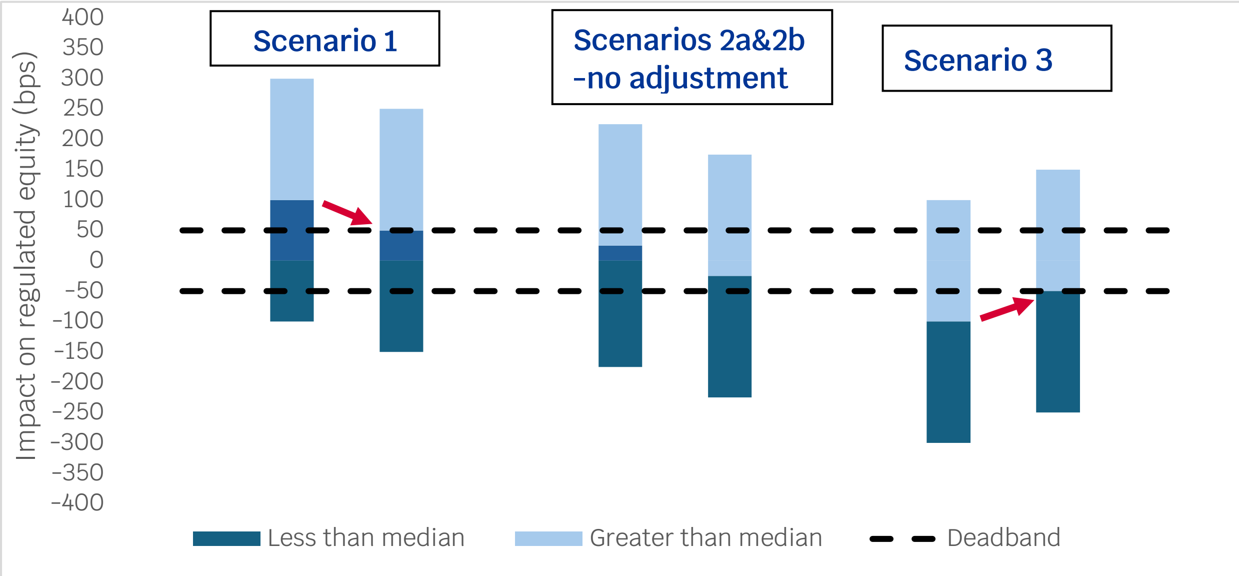
The outcome mechanism triggers on an annual basis where net ODI payments exceed a threshold of 300 basis points of regulated equity. The costs mechanism applies to costs incurred over the full five years of the price control where the net return on equity out/underperformance due to wholesale costs performance exceeds a trigger of 200 basis points of the return on regulated equity return over the five years. In each case, any excess beyond these thresholds is halved, reducing potential extremes for both companies and customers.

We apply a higher threshold for outcomes compared with costs to maintain the relative strength of the incentives on companies to improve services to customers and the environment. In addition, for the outcomes mechanism, if returns exceed 500 basis points of regulated equity in a year the excess beyond this threshold would be reduced by 90%. We do not apply a second threshold for the cost mechanism as this risks leading to a perverse incentive, for example if it introduced an incentive for companies to incur inefficient capital spend.

Following stakeholder representations to the draft determination we considered if there were further ways we could provide confidence to customers and investors that we would achieve our aim that customers would only pay for additional returns for surpassing stretching targets, but efficient companies will be able to achieve the allowed return. We published a short, open consultation on a potential new mechanism, the outturn adjustment mechanism (OAM), on 15 October 2024. We have decided to adapt a version of the OAM in our final determinations, modified to take comments into account when specifying the mechanism for our final determination.

Our aim in setting the final determinations is to set a balanced outcomes package. However we have introduced the OAM as a mechanism that is designed to recalibrate investor returns in the event there is systematic out or underperformance across the sector, thereby providing protection for customers and companies against the potential for miscalibration of the outcomes package. The OAM is intended to trigger in the rare circumstance that there is a significant shift away from anticipated sector level returns. If the median performance of the sector passes an equity return trigger threshold of +/-50 basis points, we will apply an adjustment to all companies calculated as the difference between the median OAM benchmark and the trigger threshold. The OAM will apply separately for wholesale water and wastewater activities and on an annual basis. Its operation is illustrated in Figure 2.

Figure 2: Application of the OAM in our final determinations (blue bars represent spread of company performance)



We provide further details in 'PR24 final determinations: Aligning risk and return appendix'.

4. Allowed return on capital

The allowed return is an important component of overall allowed revenue and customer bills, comprising around 24% of allowed revenues. It is necessary to provide debt and equity investors with a return that is commensurate with the risk of being invested in an efficient company adopting our notional capital structure.[11] The allowed return applied in our final determinations is summarised in Table 1.

The allowed return applied in our final determinations is 4.03% (real, CPIH), calculated at the level of the appointee. This is an increase from 3.72% set in our draft determinations and 2.96% that applied in the 2020-25. The increase against the allowed return set at PR19 mainly reflects an increase in the cost of finance. But it also reflects revisions to the weight we place on data we use to inform our decisions on the allowed return and our decision to apply an allowed return on equity towards the upper end of our stated range, in order to support the delivery of increased investment in the 2025-30 period.

We have increased the allowed retail margin to 1.5%, compared with 1.0% applied at PR19 and 1.2% applied in our draft determinations, reflecting in particular our assessment that the sector's working capital needs have increased and the cost of financing this has also gone up.

We allocate risk compensation in the allowed return between wholesale and retail controls. We avoid double-counting retail risk compensation provided in the retail margin by adjusting down the appointee allowed return for the remaining wholesale controls by 0.06%. This gives a wholesale allowed return on capital of 3.97%.

4.1 Notional capital structure

We set our determinations by reference to an efficient company with a notional capital structure. The use of a notional capital structure protects customers from bearing much of the risk of companies' actual financing decisions. It provides an important signal to companies and investors about the regulatory, and ultimately customer, backing for a level of debt in company structures. It sets out a view about the prudent level of risk within the capital structure, reflecting that companies need to raise significant amounts of finance to meet their obligations and deliver their investment programmes, and these investments should be financed efficiently.

[11] That is, a company which spends according to its totex allowance and hits its performance commitments in the round (but with no out- or underperformance), with gearing of 55%.

Table 1: The allowed return for PR24 final determinations

	PR24 draft determinations	PR24 final determinations
Allowed return on debt	2.84%	3.15%
Allowed return on equity	4.80%	5.10%
Notional gearing	55%	55%
Allowed return – Appointee	3.72%	4.03%
Allowed return - Wholesale	3.66%	3.97%

Companies have freedom to deviate from the notional capital structure, within the constraints of the price control determination, the licence and their wider obligations. However, they do so at their own risk. We consider that gearing levels that exceed 70% may not be sustainable in the long term. Therefore we signal more firmly than before our view that gearing levels that exceed 70% are above the level that is consistent with water companies meeting the requirement of maintaining long-term financial resilience.

We have retained the notional capital structure that underpinned the allowed return for draft determinations, with notional gearing set at 55% for 2025-30. While a number of companies raised issues with the reduction in notional gearing from 60% at PR19, our view remains that there is a stronger role for equity in the notional capital structure than used in our recent determinations. We first signalled our proposal to set notional gearing at 55% in our PR24 draft methodology in 2022. This has provided companies with opportunity to better align their capital structures with the notional gearing level of 55%, should they wish to.

A higher equity buffer than applied at PR19 will support investment and help ensure the notional capital structure is resilient to the challenges placed on the sector, noting the level of revenue that is at risk as a result of service performance. Finally, we note that a five percentage point change in notional gearing from one price review to another is not unprecedented in the determinations we have set and is well within the range of 50% to 62.5% that we have set previously.

The current period of elevated inflation has resulted in downward pressure on gearing levels for the notional company and for companies under their actual structures where nominal fixed rate debt is in place. This is because gearing is measured as net debt divided by RCV, and where a proportion of net debt is fixed rate debt (such as in the notional capital structure), high levels of inflation mean that RCV can grow faster relative to net debt, leading to a reduction in gearing. We consider this supports the ability of companies, under the notional capital structure, to achieve the five percentage point reduction in gearing compared with that applied at PR19.

We also note that companies will log-up certain PR19 reconciliation adjustments to the value of nearly £4.2 billion to the RCV ahead of PR24.[12] Across the sector this will reduce gearing by 2.5% at a notional level, within a range of 0.3% to -6.1%, and provide scope for downward movements on gearing under company actual structures.

Further detail is set out in the 'PR24 final determinations: Aligning risk and return appendix'.

4.2 Allowed return on equity

The allowed return on equity is the long-horizon (10-20yr) return we assess equity investors require for being invested in an efficiently-run water company at our notional gearing of 55%, over 2025-30. In setting an allowed return on equity, we have drawn on guidance agreed by the UK Regulators' Network,[13] and the advice of our economic and academic advisers.

Our primary approach to setting the cost of equity is the Capital Asset Pricing Model (CAPM), which has three inputs:

- **Risk-free rate (RFR):** the return expected by the market for investment in a riskless asset.
- **Total Market Return (TMR):** the return expected by the market for being invested in a well-diversified portfolio of assets.
- **Equity beta:** a measure of relative risk which is used to estimate the required risk premium for a given equity, relative to the risk-free rate.

In representations, companies and their advisors tended to argue that the allowed return on equity should be higher than the figure allowed in our draft determinations. Reasons cited included downwards-biased parameter ranges, asymmetric risk from our draft determinations incentive regime, a perception of heightened water sector risk, and more attractive returns available elsewhere - particularly other regulated sectors.

We were directly challenged on aspects of our PR24 methodology which we had used to produce a cost of equity range, using the CAPM. Representations challenged our estimation methodologies, the relative weight we had assigned to different methodologies, and the data used in our calculations. It was also argued more

[12] This includes £0.3 billion of reconciliation adjustments that update for outturn data for the period 2019-20.
[13] UK Regulators Network, 'UKRN guidance for regulators on the methodology for setting the cost of capital', March 2023

forcefully that we should place weight on a range of non-CAPM cross-checks to inform our overall cost of equity allowance.

Having carefully considered the information put forward in representations, we were persuaded in some areas that our PR24 methodology could be improved. This has led us to increase the weight placed on our most credible sources and more recent data. However, we have not accepted a number of company arguments which we found not to take a balanced assessment of the evidence, that were underpinned by a lack of convincing evidence or statistical robustness, or which failed to acknowledge the importance of long-run incentives and consistency in the apportionment of risk between customers and companies.

We have updated the allowed return on equity to take account of market data up to the end of September 2024. Taken together with our methodological changes, this has led to a higher allowed return on equity range compared to draft determinations. Given the significant investment needs of PR24, we have also retained the decision made in our draft determinations to adopt an allowed return at the upper end of the CAPM-derived cost of equity range. This has informed our rounded allowed return on equity of 5.1%.

Our decision on picking a point estimate that is high in the range reflects the importance of setting determinations that support investment and investor confidence at a time when all companies (whether good or poor performers) are expected to continue to raise significant amounts of debt and equity finance, while competing with other sectors both in the UK and internationally for the allocation of that capital.

We explain the issues raised and our responses in detail in the 'PR24 final determinations: Aligning risk and return - Allowed return appendix'

4.3 Allowed return on debt

The cost of debt is observable. There are four main inputs to the cost of debt calculation:

- **Cost of embedded debt:** the rate on debt issued in prior control periods, and which will remain on sector balance sheets for at least part of the 2025-30 control period. We have set the cost of embedded debt based on debt instruments relevant for the notional company that are observed on company balance sheets for the larger companies that we regulate.
- **Cost of new debt:** the rate on debt to be issued in the current control period. The allowance we set is based on a benchmark index including an adjustment to reflect how water companies issue debt compared to the index. The allowance is indexed so that companies and customers are protected from changes in the benchmark

interest rates over which they have no control. Differences in the cost of new debt due to changes in the benchmark index will be reconciled at PR29.
- **Share of new debt:** the average share of new debt over 2025-30 is influenced by required levels of debt refinancing and RCV growth. As for previous determinations, we set a sector-wide average over the PR24 period (2025-30).
- **Issuance & liquidity costs:** this covers non-interest costs associated with borrowing. We set out that our allowance for these costs should be based on high quality evidence relevant to the water sector.

Stakeholder representations generally support our broad approach. Company representations mainly focused on the detail of how we would apply our approach, such as the debt instruments that should be included in our analysis; how we should model the costs over the 2025-30 period; suggestions of a positive benchmark index adjustment for new debt; and representations that the issuance and liquidity cost allowances should be higher.

We have broadly applied the approach we set out in the PR24 methodology for our final determinations. However, since our draft determinations, we have updated the cost of embedded debt to reflect updated data on debt issued by the sector in 2023-24 and to take account of debt issuance and forecast issuance in 2024-25. The allowed return on new debt has been amended to reflect data for the month of September 2024.

- The balance sheet approach provides a point estimate for the embedded cost of debt expressed in CPIH-deflated terms of **2.77%**.
- Our assessment of current evidence through 2024 suggests that companies with a credit rating that aligns with our target for the notional company are issuing debt above our benchmark index.[14] We include a positive 30 basis point benchmark adjustment to reflect sector-wide increases experienced by water companies in 2024 and to support companies to raise increasing levels of finance in international markets, which could become an increasingly important source of finance in the future. Applying our long-term CPIH assumption of 2.0% gives a new debt point estimate of **3.74%** based on data to 30 September 2024.
- Based on calculations of debt refinancing requirements in company balance sheets and new debt for RCV growth, we calculate an average share of new debt at the sector level for the 2025-30 period is **24%**.
- We apply an adjustment to the calculated cost of debt of **0.15%** reflecting our assessment of reasonable issuance and liquidity costs based on cost of debt allowances for the 2025-30 period.

Overall, our cost of debt for the draft determination in CPIH-deflated terms is **3.15%.**

[14] A synthetic index based on the average of the 'A' and 'BBB'-rated iBoxx £ non-financials 10+ indices

The cost of new debt is subject to an indexation mechanism. At PR29 we will reconcile our allowed cost of new debt against movements in the benchmark index so that customers are protected if the cost of debt falls.

We explain the issues raised and our response in detail in the 'PR24 final determinations: Aligning risk and return – Allowed return appendix'.

4.3.1 Company specific adjustments to the cost of debt

Four companies applied for a company-specific adjustment (CSA) to their cost of debt in their business plans,[15] reflecting higher costs faced due to their relatively small size. We set out in our PR24 methodology that any claimed uplift should only compensate for financing diseconomies of scale at the point of debt issuance, rather than factors more directly under management control (such as timing and tenor), and that we expected high quality and compelling evidence that customers supported funding the higher cost.

Following review of representations to our draft determinations, we continue to consider a CSA uplift of 30 basis points to the cost of debt as a reasonable reflection of higher costs a small notional company may face. We have applied this uplift to both the allowed cost of embedded and new debt, subject to a sense check that actual costs for successive applicants are likely to be higher than our sector benchmarks.

We also retain the uplift of 5 basis points for issuance and liquidity costs in line with the PR19 CMA panel's decision to allow Bristol Water this uplift as part of its PR19 redetermination. We have allowed the combined **0.35%** uplift to Portsmouth Water and South Staffs Water, which satisfied our assessments to receive a CSA.

Pennon Group acquired SES Water on 10 January 2024, and on 14 June the CMA accepted Pennon Group's undertakings in lieu of a Phase 2 investigation.[16] As one of these undertakings was to waive SES Water's CSA request or seek Ofwat's consent to disapply any CSA already awarded, we accordingly consider the company's request to be waived and we have not applied a CSA in our final determination.

South East Water is not a small company, and we were not persuaded that its evidence on the costs of infrequent issuance justified allowing it the proposed 30 basis points uplift it had requested. In addition, we were not convinced the company's customer

[15] Portsmouth Water, SES Water, South East Water, and SSC Water
[16] CMA, ' Completed Acquisition by Pennon Group Plc of Sutton and East Surrey: Decision on acceptance of undertakings in lieu of reference', 14 June 2024

engagement evidence compellingly demonstrated that its customers supported funding the cost of its proposed uplift through higher bills.

We provide further detail on our assessment of company-specific adjustment requests in the 'PR24 final determinations: Aligning risk and return – Allowed return appendix'.

4.4 Retail margin

Since PR14, we have remunerated the financing costs of the retail control with a **retail margin,** which aligns with its status as an asset-light control. This margin is intended to cover the cost of financing fixed assets, working capital, and it also provides compensation against systematic risk. To avoid double-counting compensation for undiversifiable risk in both the appointee allowed return on capital and the retail margin, we make a **retail margin adjustment** to the former, based on to retail margin revenue minus the revenue attributable to the return on fixed assets and working capital.

We have updated the retail margin for our PR24 final determinations to reflect our view that the working capital requirement is higher than we assessed at draft determinations, and also to reflect changes in financing costs which impact on the cost items which constitute the retail margin. A net increase in these components' cost impact suggests that retaining a retail margin of 1.2% applied in our draft determinations (and 1.0% in PR19) would have resulted in an unrealistically compressed allowance for undiversifiable risk, and so we have scaled this cost item by growth in retail costs from PR19 final determinations to PR24 draft determinations.[17] Recomposing our retail margin using the scaled-up risk compensation and updated assumptions on fixed asset and working capital revenues gives a rounded retail margin of 1.5%. We calculate a retail margin adjustment based on this margin of 0.06%.

We provide further detail on our assessment of the retail margin in the 'PR24 final determinations: Aligning risk and return – Allowed return appendix'.

[17] We have used the ratio of allowed household retail revenues at PR24 (based on company submitted financial models) relative to allowed household retail revenues at PR19 to scale up revenues for systematic risk compensation. See the 'PR24 draft determinations: Aligning risk and return – Allowed return appendix' for more detail on our approach.

5. Cost recovery

Totex allowances determine how much expenditure companies have to deliver commitments to customers and the environment, maintain the asset base and progress the agreed enhancement programmes. Expenditure may be funded initially through a mix of revenue allowances, retained earnings and finance from the capital markets. Companies recover the allowed costs through customer bills over time in one of two ways:

- expenditure can be recovered in the year it is incurred through pay-as-you-go (PAYG); or
- it can be added to the RCV and recovered over a longer period through RCV run-off.

PAYG and RCV run-off rates set the speed at which companies receive the revenue, which balances recovery of costs from customers over time. In proposing PAYG and RCV run-off rates, we expected companies to provide evidence setting out how they have identified appropriate rates for each wholesale control. We have taken account of the evidence provided in setting PAYG and RCV run-off rates for our final determinations.

PAYG and RCV run-off rates are an important component of allowed revenues. At a sector level, they comprise 39% and 26% respectively of allowed revenues and the household bill.

5.1 PAYG rates

PAYG rates in our final determinations are, on average, lower than PR19 reflecting the increase in investment over PR24, with consequently more totex added to the RCV to be recovered from customers over a longer period. We have adjusted PAYG rates to reflect our final determination totex allowances, drawing on information provided by companies in their representations and business plans to ensure PAYG allowances balance company and customer interests to allow a reasonable level of recovery in 2025-30. We accepted the proposals put forward by two companies in their representations who proposed an amendment to their approach for determining PAYG rates compared with the approach set out in business plans.[18]

[18] Most companies set PAYG rates as operating costs as a percentage of total costs. Some companies also included capitalised infrastructure renewal expenditure in the calculation of PAYG rates, as allowed in our PR24 methodology. We applied this approach for Affinity Water and South West Water in our draft determinations, and accepted the revised proposals put forward by Wessex Water and SES Water in our final determination.

Table 2: Sector average PAYG rates

	Final determinations	Draft determinations	PR19
Water resources	59.7%	65.3%	69.4%
Water network plus	51.4%	52.2%	62.0%
Wastewater network plus	30.3%	32.8%	46.6%
Bioresources	46.5%	46.4%	61.5%

Source: final and draft determination financial models, PR19 final determinations / CMA redeterminations

We set out further detail on our assessment of PAYG rates in the 'PR24 final determinations: Aligning risk and return appendix' where we comment on the interventions we have made for each company.

5.2 RCV run-off rates

The RCV represents the net stock of investment contributed by investors to the control and the RCV run-off allowance represents the recovery of that investment over time. Our aim is to ensure the recovery of investment that is included in the RCV is recovered from customers over a time period that broadly aligns with the benefits they receive from that investment.

The PR24 methodology set out how we would assess RCV run-off rates having regard to a framework which took account of intertemporal fairness, affordability and financeability. Our PR24 methodology set out that we expected RCV run-off rates to be no higher than those allowed at PR19, and we set out guidance on acceptable upper limits.

Overall, companies proposed material reductions to the run-off rates applied at PR19, taking account of both the increased scale of the investment programme but also in response to the increased focus and guidance we set out in our PR24 methodology. For most companies, we have applied the RCV run-off rates proposed in their representations in our final determinations. Across the sector this represents a material reduction to run-off rates compared with PR19.

While most companies proposed run-off rates that were within the upper limits set out in our PR24 methodology, we challenged further the levels of the run-off rates in our draft determinations. This had the consequence of extending slightly the period over which the cost of the RCV was recovered for some companies. This reflected that small adjustments to the period over which the RCV is recovered from customers can help manage step changes in bills. We set out that we may apply similar adjustments at final determinations where we identified headroom in RCV run-off rates against our assessment framework.

We have intervened to reduce RCV run-off rates where these were significantly above our guidance for upper limits. However, reflecting actions taken by credit rating agencies since our draft determinations and evidence provided by companies, investors and CCW in response to our draft determinations, we have taken a more cautious approach to assessing headroom in our final determinations.

Our interventions focus on companies whose cost recovery rates are outliers under our assessment framework and when compared to the rest of the sector. Our approach recognises the need for companies to maintain adequate levels of headroom within our financeability assessment, while supporting the need for investment, noting company arguments about funding of maintenance activities.[19] Overall, compared with the original business plan submissions, the effect of our interventions and challenge is to reduce the run-off rates for five companies. We recognise this will reduce revenue for these companies within the period and lead to slightly higher bills for customers beyond 2030. However, we consider the resulting increase in RCV over the 2025-30 period provides capacity for companies to continue to fund investment, and any increase to customer bills beyond 2030 will be spread over a number of years.

We note also that the full transition to CPIH at PR24 provides upward pressure on customer bills and additional cashflow headroom in the shorter term than had a portion of the RCV continued to be indexed to RPI as has been the case in the 2020-25 period.

Overall, following our interventions, the RCV run-off rate for the sector in our final determinations is on average 4.15% (within a range of 3.51% - 4.65%). This implies an average remaining life of 24 years.

Table 3 sets out the average RCV run-off rates for the sector in our final and draft determinations. These are split for RCV existing on 31 March 2025 and for new investment over 2025-30 for each wholesale control. The table also compares sector averages to average rates for PR19.

[19] Recent and potential changes to credit rating assessment criteria has eroded headroom in our financeability assessment against our target credit rating of two notches above minimum investment grade for the notional company

Table 3: Sector average RCV run-off rates

	Final determinations		Draft determinations		PR19
	Pre-2025	Post 2025	Pre-2025	Post 2025	
Water resources	3.91%	3.95%	3.78%	3.97%	5.10%
Water network plus	4.30%	4.10%	4.14%	3.99%	4.75%
Wastewater network plus	4.17%	3.52%	4.05%	3.39%	4.63%
Bioresources	6.84%	5.76%	6.51%	5.52%	7.88%

Source: Final and draft determination financial models, PR19 final determinations / CMA redeterminations.

We set out further detail on our assessment of RCV run-off rates in the 'PR24 final determinations: Aligning risk and return appendix', where we comment further on the interventions we have made for each company.

6. Financeability

Our approach to financeability is designed to assess whether revenues, relative to efficient costs, are sufficient for a company with the notional capital structure to finance its investment on reasonable terms, while protecting the interests of customers now and in the long term.

The financeability assessment considers whether, when all of the individual components of our determination are taken together (including allowed expenditure, allowed return and retail margin, PAYG rates and RCV run-off, but before reconciliation adjustments), an efficient company with the notional capital structure will be able to generate cashflows sufficient to meet its financing needs. As part of this we carry out an assessment of financial ratios in setting our determinations.

We have assessed that the final determinations are financeable for all companies on the basis of the notional company, such that the financial metrics in our determinations are compatible with a credit rating that is comfortably at least two notches above the minimum investment grade except for Portsmouth Water.[20]

In carrying out our financeability assessment, we have followed the approach set out in our PR24 methodology and draft determinations, commencing with an opening notional gearing of 55%, an opening proportion of index linked debt of 33% and to carry out our financeability assessment ahead of the application of reconciliation adjustments for past performance to maintain the integrity of the incentive regime.

However, for our final determinations we have amended our approach to reflect changes announced by credit rating agencies since publication of our draft determinations, which reflect on wider, sector wide concerns that are linked to wider political and public scrutiny. And to ensure the sector remains attractive to the widest range of investors, we decided not to restrict the 4% dividend yield applied in our determinations to support RCV growth. Where further equity is required, we have assumed this is all provided in the form of new equity, we provide an allowance for equity issuance costs, which we have increased to 2.5% (from 2.0% in the draft determinations), to reflect further information from recent issuances from regulated companies.

In our determinations, the RCV grows by 32% in real terms across the sector from £96.7 billion at 31 March 2025 to £127.9 billion in 2030. To support this growth, our

[20] We assess that the final determination for Portsmouth Water is consistent with a credit rating one notch below our target credit rating. This is consistent with its current Moody’s rating where the scale of investment related to the Havant Thicket Reservoir relative to its RCV means Moody's effectively apply an upper limit to the achievable credit rating during the construction phase. It is also consistent with the company's expectations in its business plan.

financeability assessment is underpinned by a 4% dividend yield and we include new equity of £12.7 billion under the notional structure, with dividends of £11.9 billion. This is higher than the draft determinations reflecting the increase in investment allowances between draft and final determinations and the change to maintain the dividend yield as stated above. We have provided an allowance of £0.3 billion for equity issuance costs.

It is also above the c.£7 billion of equity companies forecast they required under their actual financial structures. Some companies have also suggested they would forego or reduce dividend payments. However, our final determinations provide each company with sufficient funding to raise the equity required to support the growth in RCV over 2025–30.

Overall, our financeability assessment and the assessment of downside sensitivities suggests that our determinations provide sufficient headroom for companies to withstand reasonable downside risk. In severe cases this could be mitigated through further reductions to dividends or the provision of additional equity injections. We note that most companies have received additional revenue from PR19 reconciliations (£1.5 billion) which will provide additional headroom in the 2025–30 period.[21]

Our conclusion that our determinations are financeable on the basis of the notional capital structure is underpinned by the levels of new equity issuance that is included in our financeability assessment. The recalibration of expenditure allowances and performance targets, together with the material changes we have made to the overall risk and return package (summarised in section 2) and our decision to set an allowed return on equity towards the top of our range aim to support companies to raise the necessary levels of equity finance in the 2025–30 period. Where that equity is not forthcoming, a dividend restriction, even to zero, will provides material additional support across the sector for companies to meet their investment requirements.

The levels of investment growth in 2025–30 and beyond provide significant opportunities for investors. And there are opportunities for investors to earn enhanced returns where companies deliver high levels of performance to customers and where companies outperform, this will support equity financeability and support companies to raise necessary finance at efficient cost. Our protections in our risk and return package are calibrated to allow the real allowed return on equity to be exhausted where companies deliver relatively extreme levels of underperformance. And in these cases, the incentive regime aims for companies and/or their investors to take corrective

[21] This includes £0.3 billion of reconciliation adjustments that update for outturn data for the period 2019–20.

action to minimise the impact of underperformance on investor returns over the longer term.

We provide further detail in the 'PR24 final determinations: Aligning risk and return appendix'.

7. Tax

Our calculation of allowed revenues includes an allowance for corporation tax. Our approach to taxation is largely consistent with the approach that we have used in previous price reviews.

We have calculated a tax allowance reflecting the corporation tax that each company expects to pay in 2025-30. We calculate the tax allowance using our financial model based on the projected taxable profits of the appointed business and the current UK corporation tax rates and associated reliefs and allowances.

Our calculations assume that companies take account of all available reliefs and allowances including full expensing for capital allowances where applicable. The large investment programme at PR24 and beyond, along with the ability to deduct the full capital expenditure means that the contribution from tax to allowed revenues and customer bills is zero for all but one company.

We introduced a new policy at PR19 to make an adjustment at PR24 if companies surrendered tax losses to group companies. We set out that we would deduct the full value of any losses surrendered from the appointed business to another group company to ensure that customers do not lose out as a result of losses being transferred out of the company that could otherwise be offset against tax liabilities in the future.

To recognise the payments received by the regulated companies for tax losses surrendered, we have adjusted PR19 tax reconciliations and PR24 tax allowances to ensure customers benefit from the surrender of tax losses. We have updated the calculations made for draft determinations to take account of further information in 2023-24 annual performance reports. We have capped the adjustments at the level of the PR19 and PR24 tax allowances.

We provide further details of our tax allowances and the adjustments to PR19 reconciliations, to the PR24 tax allowance, and the amount held over to PR29 in respect of the surrender of tax allowances in the 2025-30 period in the 'PR24 final determinations: Aligning risk and return appendix'.

8. Financial resilience

Companies have considerable discretion to make decisions about their financing and capital structure arrangements within the boundaries set by the price determination, their licence and company law.

Companies must be able to raise debt and equity finance on reasonable terms if they are to deliver their investment programmes efficiently for customers. The increased levels of investment, together with the need to refinance existing debt as it matures, means that companies will need to raise increased levels of debt.

In total, company business plans project a need to raise over £45 billion debt in the 2025-30 period to finance investment programmes and refinance existing debt as it matures. This is an increase to the level of debt raised in the current regulatory period (2020-25).

In their representations, companies forecast that over £7.0 billion equity is required to support their investment requirements by 2030, with some companies additionally proposing to restrict dividends, in some cases to zero, to support delivery of investment. It is important that water companies are able to demonstrate that they can maintain financial resilience over the long-term if they are to raise required levels of debt and equity on reasonable terms. We expect companies will need to revisit their financing plans for the 2025-30 period now they have certainty of the final determination.

In some cases, companies will need to take steps to strengthen their levels of financial resilience and we consider the equity financing requirement is likely to be greater than the c.£7 billion forecast in representations. Our final decisions provide support for companies to raise the finance necessary to deliver their investment programmes and a commitment to support the costs of introducing a new equity listing where relevant. Where companies do not raise the equity necessary to finance their investment programmes, they will need to restrict dividends – even to zero – and they may need to take further steps to maintain adequate levels of financial resilience and secure the necessary finance to meet their obligations.

Water companies are required by their licence to maintain a minimum of two credit ratings that are within the investment grade.[22] The financeability assessment carried out in our determinations targets a credit rating two notches above the minimum of the investment grade for the notional company. We use this target as we consider it to provide adequate levels of headroom for companies to cope with most cost shocks and maintain access to debt and equity finance at reasonable levels on an ongoing basis.

[22] Hafren Dyfrdwy, SES Water and Portsmouth Water currently are permitted to hold a single credit rating.

Some companies targeted credit ratings for their actual structures that were below the notional structure. In other cases, we were not convinced that the evidence supporting the financial resilience submissions in business plans was sufficient to demonstrate that the levels of financial resilience were sufficient in downside scenarios recognising also the need to deliver necessary investment programmes.

While a number of companies updated their commentary and plans for maintaining financial resilience in their representations, as flagged also in our latest 2024 Monitoring Financial Resilience report,[23] we continue to actively engage with a number of companies where actions will need to be made, proactively and promptly, to secure long term financial resilience. In our latest report, three companies, South East Water, Southern Water and Thames Water, remain in our action required category. Seven companies are in our elevated concern category. The three companies in the action required category will receive the highest priority for our monitoring and engagement.

We have set out our specific financial resilience considerations for each company, in the company specific documents that accompany our final determination and we expect each company to consider if their plans remain sufficient in light of our final determinations, the actions of rating agencies and any other factors relevant to that company. It is each company's responsibility to maintain adequate levels of financial resilience if it is to continue to raise the capital, on reasonable terms, that is necessary to support the investment programme.

We will continue to monitor the financial resilience of the water sector outside of the price review and will engage with companies as necessary and to set out our assessment in our annual monitoring financial resilience reports

We have previously expressed that gearing levels that exceed 70% are above the level that is consistent with the need for a water company to meet the requirement of maintaining long-term financial resilience. The evidence arising from the challenges posed by companies with the weakest levels of financial resilience and the more recent actions taken by the credit rating agencies further supports our view.

We set out in draft determinations that we were considering the need for additional steps to strengthen the customer protections against poor levels of financial resilience. We have decided not to take forward these proposals in the final determinations as we consider there to be benefits from considering separately the regulatory protections in place to protect customers from the consequences of companies maintaining weak levels of financial resilience. We will consider these issues separately, as part of our further, forward looking work on financial resilience in 2025.

[23] Ofwat, 'Monitoring financial resilience report – 2023-24', November 2024

Finally, in our draft determination, we set out that we have observed challenges arising with the ability of some consortium-owned companies to raise new equity where investors have competing interests. We set out that there are benefits associated with the greater levels of transparency and commentary on the performance of companies with an equity listing. Therefore, to further support companies to raise the required levels of new equity, we proposed that we would provide funding for the net efficient costs of a company raising that equity through a new stock market listing.

We received support for this proposal in response to our representations as a means ensuring companies have access to the broad range of finance to support investment in the 2025-30 period. Therefore we confirm we will log-up the efficient costs of introducing a new exchange listing at PR29. Where companies envisage making a claim under these arrangements, we encourage them to engage with us at an early stage.

We set out further commentary on financial resilience in the 'PR24 final determinations: Aligning risk and return appendix'.

9. Delayed delivery cashflow mechanism

In previous price control periods, investment has tended to get delayed from the earlier years of the price control period, with companies catching up in later years. During the current price control period to date, several companies are materially underspent on enhancement relative to their allowances with the sector spending only 73% of enhancement allowances by the end of the third year. Although companies have increased spending in year four, investment remains behind schedule.

The scale of enhancement allowances for PR24 creates a risk that the companies underspend to a greater extent than at PR19 and are unable to catch up, meaning that customers have paid up front for investment that is not delivered.

We have introduced a suite of measures to our final determinations that are designed to incentivise companies to deliver services and enhancement programmes in line with, or ahead of, the timelines scheduled in their determinations. They are also designed to protect customers from paying for service improvements that are not delivered or where delivery is delayed. These measures include price control deliverables and gated allowances. For Thames Water and Southern Water, we also include a delivery mechanism and the requirement to provide and report against a delivery action plan.

While delivery mechanisms require action from companies to release customer funding, other delays to delivering investment related to funding that is provided in the 2025-30 determination period will result in adjustments at PR29. These delays mean it is possible that customers will have provided some funding up front for investment that has not been delivered and this is the reason we consider the introduction of a new mechanism.

In draft determinations, we consulted on a sector wide Delayed Delivery Cashflow Mechanism (DDCM). The DDCM is designed to act as a customer fairness mechanism to return money to customers in-period in the event that companies materially underspend their enhancement totex allowances. The DDCM claws back a proportion of revenue associated with unspent wholesale expenditure allowances through an adjustment to allowed revenues later in the period if companies are behind in their delivery. This would allow customer bills to more fairly reflect the actual delivery profile.

CCW and some water companies recognised a legitimate concern that customers would be paying in advance towards investment that is delayed or not delivered, although companies generally considered the mechanism was unnecessary and introduced further complexity to the determinations. And in some cases, companies considered that the DDCM would introduce additional penalties, duplicating the incentive arrangements that applied already under the price control deliverable mechanisms.

We consider it is important that revenue recovered from customers fairly reflects the delivery of enhancements in the 2025-30 period. Therefore, we have included the DDCM in our final determinations. We have made a small adjustment to the threshold at which the mechanism applies at the end of year three to ensure it only applies in the most significant cases of delayed delivery.

As we set out in the draft determinations, we reconfirm that the DDCM is purely a cash-flow mechanism affecting revenue with no 'penalty' element. The DDCM will operate separately and independently of the price control deliverables, which already incentivise timely delivery, and cost sharing arrangements which already incentivise cost efficiency. The DDCM does not alter expenditure allowances or cost sharing incentives, and any revenue foregone would automatically be reversed before other reconciliation mechanisms are applied at PR29. Therefore, companies would remain funded to meet their legal obligations, whilst providing customers with a reduction to their bills before the end of the period where companies are materially underspent.

We provide further detail on the specific operation of the DDCM in the 'PR24 final determinations: Aligning risk and return appendix’.

Ofwat (The Water Services Regulation Authority) is a non-ministerial government department. We regulate the water sector in England and Wales.

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Biological waste treatment: appropriate measures for permitted facilities

From: **Environment Agency (/government/organisations/environment-agency)**
Published 21 September 2022
Updated: 2 February 2024 - **See all updates**

Contents

Appropriate measures for permitted waste management facilities that handle organic waste, also known as biowaste.

This guidance explains the standards (appropriate measures) that are relevant to permitted waste management facilities that handle organic waste, also known as biowaste. Facilities that operate under a relevant waste exemption can also use this guidance.

This guidance applies to aerobic and anaerobic processes.

[2. Definition of biodegradable and sewage sludge (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/2-definition-of-biodegradable-and-sewage-sludge)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/2-definition-of-biodegradable-and-sewage-sludge)

How the Environment Agency defines the terms 'biodegradable' and 'sewage sludge'.

[3. Bespoke wastes suitable for biological treatment (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/3-bespoke-wastes-suitable-for-biological-treatment)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/3-bespoke-wastes-suitable-for-biological-treatment)

The source segregated biodegradable wastes the Environment Agency considers to be generically suitable for biological treatment.

[4. Site location, design and capacity (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/4-site-location-design-and-capacity)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/4-site-location-design-and-capacity)

Issues to consider relating to site location, design and capacity, reducing or preventing contamination and primary and secondary containment for new and existing sites.

[5. General management appropriate measures (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/5-general-management-appropriate-measures)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/5-general-management-appropriate-measures)

General management appropriate measures and the process they apply to.

[6. Waste pre-acceptance, acceptance and tracking (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/6-waste-pre-acceptance-acceptance-and-tracking)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/6-waste-pre-acceptance-acceptance-and-tracking)

Appropriate measures for waste pre-acceptance, acceptance and tracking.

[7. Waste storage, segregation, transfer and handling (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/7-waste-storage-segregation-transfer-and-handling)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/7-waste-storage-segregation-transfer-and-handling)

Appropriate measures for waste storage, segregation, transfer and handling.

[8. Waste treatment (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/8-waste-treatment)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/8-waste-treatment)

Appropriate measures for waste treatment.

[9. Outputs (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/9-outputs)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/9-outputs)

Appropriate measures related to the outputs from the waste treatment process.

[10. The Control of Major Accident Hazard Regulations 2015 (COMAH) (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/10-the-control-of-major-accident-hazard-regulations-2015-comah)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/10-the-control-of-major-accident-hazard-regulations-2015-comah)

COMAH related appropriate measures for biological waste treatment.

[11. Emissions control (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/11-emissions-control)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/11-emissions-control)

Emissions control related appropriate measures for biological waste treatment.

[12. Process efficiency (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/12-process-efficiency)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/12-process-efficiency)

Process efficiency related appropriate measures for biological waste treatment.

[13. Bespoke waste assessment (/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/13-bespoke-waste-assessment)](/guidance/biological-waste-treatment-appropriate-measures-for-permitted-facilities/13-bespoke-waste-assessment)

Inhibition values for aerobic and anaerobic processes.

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Contents

1. When appropriate measures apply

Assessing the appropriate measures that will apply to a permitted facility that handles biowaste.

This guidance applies to aerobic and anaerobic processes including:

- composting in open-air and closed (in vessel) systems
- aerobic processing of organic fractions by mechanical and biological treatment (MBT) and mechanical heat treatment (MHT)
- thermophilic aerobic digestion (TAD)

- anaerobic digestion (AD) including the combustion or upgrading of the resulting biogas and treating the digestate (anaerobic treatment can include wet, dry and dry-batch digestion)
- aerated lagoons and activated sludge (as a waste water treatment)
- collecting and storing methane from lagoons and tanks and upgrading to biomethane
- treating sewage sludge using any of these biological processes
- storing feedstock, compost and digestate
- receiving wastes destined for biological treatment

There is overlap between best available techniques (BAT) for waste installations and necessary measures for waste operations. The Environment Agency uses the term ‘appropriate measures’ to cover both sets of requirements.

This guidance sets out what you must consider when you assess the appropriate measures for your facility. It is not definitive and it does not replace your obligation to assess appropriate measures fully for your site.

Some measures may not be suitable for or relevant to your operation. Appropriate measures will depend on the:

- complexity of the activities being carried out
- size and nature of the activities
- location of the site

Where an operator wants to propose an alternative measure, this must achieve the same level of environmental protection. The operator must also provide evidence of why the alternative is equivalent to (or better than) what this guidance proposes.

In certain situations, a higher standard of environmental protection may be needed, for example:

- where there are local sensitive receptors (https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit#identify-receptors)

- if the facility is affecting the local environment or human health despite using appropriate measures
- if there is a risk that you may breach an Environmental Quality Standard

Other technical guidance relating to emissions, odour and noise (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit) may also apply.

Where the biological treatment is directly connected or associated with another regulated activity or process, specific technical guidance (https://www.gov.uk/government/collections/technical-guidance-for-regulated-industry-sectors-environmental-permitting) may apply.

Operations that are permitted to accept, store, handle, treat or transfer the following wastes must also comply with the requirements in Chemical waste: appropriate measures for permitted facilities (https://www.gov.uk/guidance/chemical-waste-appropriate-measures-for-permitted-facilities):

- hazardous waste
- mirror entry waste
- laboratory smalls
- chemicals

Combustion plant with a rated thermal input equal to or greater than 1 megawatt (but less than 50 megawatts) must have a permit and comply with the relevant requirements of the Medium Combustion Plant Directive (Directive (EU) 2015/2193). Specified generators which are used to generate electricity must also have a permit and comply with the relevant requirements of the specified generator regulations. Additional guidance (https://www.gov.uk/guidance/medium-combustion-plant-when-you-need-a-permit) is available from the Environment Agency.

1.1 The waste water treatment activities this guidance applies to

This guidance applies to the following activities for the waste water treatment sector, the:

- biological treatment of waste water not covered by the Urban Waste Water Treatment Directive (UWWTD)
- biological treatment of sludges, centrate liquors and other wastes generated by the waste water treatment process
- importation of wastes or effluents (excluding sewage, sewage sludge and septic tank sludge) to the works where they are fed into the UWWTD biological treatment process

1.2 When this guidance applies to a specific process

Where measures apply to all processes and operations this is stated. Where measures are process-specific this is stated.

1.3 Implementing appropriate measures at new and existing facilities

The appropriate measures in this guidance apply to both new and existing facilities that treat biodegradable and organic waste.

New facilities

All new facilities must implement the relevant appropriate measures, or a fully justified equivalent. These must be in place before waste treatment operations start.

New installations (including new or replacement plant at existing facilities) must comply with any relevant best available technique (BAT) associated emission level (AEL) as set out in the published Waste Treatment BAT Conclusions document (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.208.01.0038.01.ENG&toc=OJ:L:2018:208:TOC). They must do this from the start of their operations, unless we approve a derogation (https://www.gov.uk/guidance/best-available-techniques-environmental-permits#how-to-propose-an-alternative-technique).

Existing facilities

Installations permitted after 17 August 2018 must already be BAT compliant.

Existing installations permitted before 17 August 2018 must comply with the BREF and BAT AELs by 17 August 2022.

Where operators are unlikely to comply with a BAT AEL by 2022 they must apply for a derogation (https://www.gov.uk/guidance/best-available-techniques-environmental-permits#how-to-propose-an-alternative-technique). If you cannot comply, you must contact the Environment Agency as soon as possible.

Existing waste operations should already be applying appropriate measures depending on their risk.

Where we have identified that an operator needs to (and can) improve the facility, or there is significant environmental risk or actual pollution, we will require the operator to apply appropriate measures.

We have reviewed and revised our standard rules to reflect these measures and will review all bespoke permits to make sure all necessary appropriate measures are applied. We will vary bespoke permits to meet the required standards.

Operators can deliver some improvements by reviewing and amending their management system and progressing a voluntary scheme of improvement.

Improvements at existing facilities are likely to fall into 1 of the following 2 categories.

1. Standard ‘good practice’ requirements

Where improvements are relatively low cost, operators should prioritise them based on the risk posed by their facility. They should implement these improvements as soon as possible and no later than 12 months after the publication date of this guidance. For example, these improvements could be:

- updated management systems
- waste pre-acceptance, acceptance, handling techniques and waste transfers off site
- equipment and infrastructure maintenance
- measures to prevent fugitive or accidental emissions
- appropriate monitoring equipment
- waste, water and energy efficiency measures

2. Longer term and capital-intensive improvements

Where local environmental impacts are affecting sensitive receptors an operator may have to take action immediately. The Environment Agency may require operators to complete improvements within the timeframe it sets. These may include capital-intensive improvements.

There is an existing requirement for operators to comply with their permits. Operators should periodically review, modify and update management, process systems or equipment in line with existing permit conditions. This may include periodic capital investment.

Examples of capital-intensive improvements include:

- reviewing, revising and installing abatement equipment
- significantly redesigning the layout of the facility, including, for example, the design and installation of new buildings or treatment plant to prevent ongoing pollution or reduce the risk of pollution
- replacing tanks or other primary infrastructure
- installing secondary containment where there is a significant risk

Capital-intensive projects may need permission from other regulators and the Environment Agency will take this into account when considering improvement timescales. It expects operators to send their permission requests to other regulators in a timely manner. In some cases, the Environment Agency will be a consultee (for example as part of the planning process).

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2. Definition of biodegradable and sewage sludge

How the Environment Agency defines the terms 'biodegradable' and 'sewage sludge'.

These definitions apply to all processes and operations.

2.1 Biodegradable

Biodegradable waste is material that can undergo biological anaerobic or aerobic degradation leading to the production of the following, depending on the environmental conditions of the process:

- carbon dioxide (CO_2)
- water (H_2O)
- methane (CH_4)
- compost or digestate
- mineral salts

The biological treatment of waste uses biological processes and agents to bring about a change in that waste. This may be for recovering the waste, remediating a contaminated material, or as a pre-treatment before disposal.

Biological treatment does not include physical treatments like dewatering, mechanical separation or chemical treatments such as lime dosing.

The term ‘biowaste’ is often used to describe biodegradable, organic waste. Biowaste is defined in Article 3 of the Waste Framework Directive to mean, “Biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants”.

Biowaste can also be called ‘organic matter’ which is a collection of complex humic substances and other organic compounds generally of animal or vegetable origin.

2.2 Sewage sludge

Sewage sludge means residual sludge from sewage plants treating domestic or urban waste waters. It also includes sewage sludge from other sewage plants treating waste waters that have a similar composition to domestic and urban waste waters.

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3. Bespoke wastes suitable for biological treatment

The source segregated biodegradable wastes the Environment Agency considers to be generically suitable for biological treatment.

Most organic waste streams of biological origin sent for biological treatment are well understood. The source segregated biodegradable wastes the Environment Agency considers to be generically suitable for biological treatment are included in the:

- [biowaste treatment standard rules permits (https://www.gov.uk/government/collections/standard-rules-environmental-permitting#anaerobic-digestion-including-use-of-the-resultant-gas-and-storing-digestate)](https://www.gov.uk/government/collections/standard-rules-environmental-permitting#anaerobic-digestion-including-use-of-the-resultant-gas-and-storing-digestate)
- [composting and AD quality protocols (https://www.gov.uk/government/collections/quality-protocols-end-of-waste-frameworks-for-waste-derived-products)](https://www.gov.uk/government/collections/quality-protocols-end-of-waste-frameworks-for-waste-derived-products)

1. The Environment Agency recognises the potential to use biological processes to treat other 'non-standard' or 'bespoke' wastes. However, any waste sent for biological treatment must be capable of being treated by the process. Dilution is not considered a suitable waste treatment.

2. Biological processes can degrade complex synthetic organic substances. The products resulting from these biological degradation processes may pose a significant threat to human health and the environment. You must therefore fully characterise and assess all bespoke wastes before introducing them into a biological treatment process.

3. If you accept a bespoke waste type your site permit must have the relevant list of waste (LoW) code (https://www.gov.uk/how-to-classify-different-types-of-waste) and description as set out in the technical guidance (WM3) (https://www.gov.uk/government/publications/waste-classification-technical-guidance). Typically, this applies to waste from a single producer. If you accept similar waste from a different producer it will require its own pre-acceptance assessment and you may need to apply for a permit variation to make sure these pre-acceptance processes are part of your operational techniques.

Additional guidance on characterising and assessing waste is available in WM3 (https://www.gov.uk/government/publications/waste-classification-technical-guidance) and the waste pre-acceptance and acceptance section of this guidance. Inhibitory ranges are provided in section 13 Bespoke waste assessment as guidance for aerobic and anaerobic processes. These are aimed at helping operators fully assess whether treatment will be effective, and any requirement for pre-treatment and additional process control measures. Operators may need to test the resulting outputs to make sure the material has been fully treated.

3.1 Animal by-products

Biological treatment facilities may need to comply with The Animal By-Products (Enforcement) (England) Regulations 2013 (ABPR) to accept and treat animal by-products. This is regulated by the Animal and Plant Health Agency (https://www.gov.uk/government/organisations/animal-and-plant-health-agency) (APHA). More information is available from the APHA on the definition and categorisation of animal by-products. Biological, organic treatment facilities can be authorised to accept category 3 animal by-products.

3.2 Energy crops and by-products (residues)

1. AD plants, where the only feedstock is grown energy crops such as maize or by-product from food waste productions (some crop residues), do not currently need an environmental permit or exemption for the digestion process.

2. Operators will need a permit for any combustion unit (engine, boiler or generator). Time lines for compliance with emission limits may vary for combustion units. For more information please refer to guidance on medium combustion plant and specified generators (https://www.gov.uk/guidance/medium-combustion-plant-when-you-need-a-permit).

3. AD plants taking mixed feedstocks (energy crops, slurry, manure and waste) require an environmental permit for the digestion process and any associated combustion unit or specified generator.

3.3 Wash down waters, liquor and leachate

1. Materials produced incidentally to a process, for example clean down or wash waters, leachates and liquors from feedstock storage, are waste. For example, where water has:

- permeated through a material
- resulted from that material being stored (such as silage liquor)
- resulted from composting

2. Transfer and disposal of waste must comply with the duty of care code of practice (https://www.gov.uk/government/publications/waste-duty-of-care-code-of-practice) under section 34 (7) of the Environmental Protection Act 1990.

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4. Site location, design and capacity

Issues to consider relating to site location, design and capacity, reducing or preventing contamination and primary and secondary containment for new and existing sites.

This section applies to all processes and operations.

4.1 Site location

1. You should consider the potential impacts on local sensitive receptors when selecting a new site.

2. You must choose the location of your site so you prevent or minimise fugitive emissions to air. This includes dust, bioaerosols, odours and other gaseous emissions including ammonia.

3. You should also consider the possible impact of climate change, especially:

- flood risk
- drought
- extreme temperatures
- other extreme weather events

Existing sites must consider the risk of climate change on their existing facilities and as far as possible have contingency measures in place.

4.2 Site design

1. The storage and handling of waste on site must be located as far as technically and economically possible from any sensitive receptors.

2. When designing your biological treatment site you must consider minimising the unnecessary handling of waste between each step in the process, from receipt, during treatment, and during storage of the final material.

3. All biological treatment facilities must be designed by a suitably qualified or experienced person. Facilities must be built to recognised industry standards.

4. You must design your plant to minimise emissions during the transfer of waste from one step to another. For example, the transfer of feedstock from reception to a feed hopper.

You must consider at the design stage where there is an opportunity to cover storage areas and where possible contain, treat and abate air using appropriately engineered plant.

5. To prevent emissions (including ammonia) you must cover digestate stores and compost liquor. Where fixed covers are used these must have a system that can remove and effectively treat emissions.

6. You must consider the location of access doors in relation to sensitive receptors to prevent loss of containment.

Reducing or preventing contamination

7. Good site design and process flow reduces the risk of cross-contamination of pasteurised or sanitised and stabilised materials.

8. You must consider the design, process flow and intended use of outputs during the planning and design stage of your plant to prevent cross contamination of treated and untreated material.

Preventing cross contamination by segregation relies on both the:

- physical separation of waste
- procedures that identify when and where wastes are stored

Primary and secondary containment

New facilities

9. When designing new plant, you must make sure that you assess the environmental impacts from the plant's operating life and eventual decommissioning.

10. All critical structures should be designed and built to construction and design regulation.

11. All secondary containment must meet the requirements of the Construction Industry Research and Information Association (CIRIA) report C736 (https://www.ciria.org/ItemDetail?iProductCode=C736F&Category=FREEPUBS&WebsiteKey=3f18c87a-d62b-4eca-8ef4-9b09309c1c91) or an equivalent standard.

12. A chartered civil or structural engineer must provide construction quality assurance (CQA) and validate the construction of all facilities. You can use a chartered geotechnical or structural engineer for lagoon design and construction. All pipe work must be designed to allow for inspection or integrity checks, or both.

13. Drainage and vessels must be accessible to allow cleaning and maintenance.

14. You must design underground tanks to allow inspection and must have secondary containment with leakage detection.

15. You must consider the life of all plant and its decommissioning at the design stage. This includes tanks, pipework and drainage and lagoon structures.

Existing sites

16. Operators of existing sites must use a chartered engineer to carry out a detailed assessment of primary and secondary containment where it has not previously been validated to industry recognised standards.

17. You must assess containment structures against CIRIA 736. This is a risk-based assessment. Where you have not used CIRIA 736, the assessment must be an equivalent approved standard. Where improvements are identified, you must propose an improvement programme or process monitoring to make sure there are no uncontrolled process releases.

18. You should monitor underground pipe work or ducting and drainage to make sure there is no leakage.

19. Underground tanks should have secondary containment. You must implement a method of inspection and leakage detection as a minimum.

4.3 Site capacity

1. You must determine the actual physical capacity needed to manage, treat and store waste on your

site without causing pollution.

2. You must include factors like seasonal changes in feedstock supplies and in markets for outputs.

Exceeding the site capacity will significantly increase the risks of pollution. This includes the capacity of storm tanks.

3. You must provide enough space on site to operate your plant and equipment safely, and to allow easy and environmentally safe storage and treatment.

4. Environmental permits set limits on the amount of waste you can:

- bring onto site on an annual basis
- treat at any one time
- store at any one time

To determine the daily and annual throughput, you must establish the following critical volumes or tonnes:

- waste storage capacity at any one time for both incoming waste and processed material
- residence time for waste to be fully treated and recycled

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5. General management appropriate measures

General management appropriate measures and the process they apply to.

5.1 Management system

1. The following measures apply to all processes and operations. You must have an up to date, written management system (https://www.gov.uk/guidance/develop-a-management-system-environmental-permits). The level of detail you

need will be related to the size of your operation, site location and complexity. Your management system must aim to improve the overall environmental performance of the site.

2. You must have management commitment, including from senior managers (where applicable) to develop an environmental policy that is defined by senior managers (where applicable). This policy must include the continuous improvement of the facility's environmental performance, so you can identify pollution risks and minimise them through appropriate measures and make best and most efficient use of resources.

Your management system must also incorporate the features that follow.

3. You plan and establish the resources, procedures, objectives and targets needed for environmental performance alongside your financial planning and investment.

4. You implement your environmental performance procedures, paying particular attention to:

- staff structure and relevant responsibilities
- staff recruitment, training, awareness and competence
- communication (for example, of performance measures and targets)
- employee involvement
- documentation
- effective process control
- maintenance programmes
- emergency preparedness and response
- making sure you comply with environmental legislation

5. You check environmental performance and take corrective or preventative action (or both), paying particular attention to:

- monitoring and measurement
- investigating and learning from incidents, near misses and mistakes including those of other organisations

- records maintenance
- independent (where practicable) internal or external auditing of the management system to confirm it has been properly implemented and maintained

6. Senior managers and or operators must periodically review the management system to check it is still suitable, adequate and effective.

7. You review the development of cleaner technologies and their applicability to site operations. The Environment Agency would expect you to consider cleaner technologies:

- as a result of substantiated pollution incidents
- when reviewing management systems
- when planning investment decisions, for example new items of plant

8. When designing new plant, you must assess the environmental impacts from the plant's operating life and eventual decommissioning. You must make sure that new plant is authorised by your environmental permit.

9. You must have a written procedure for proposing, considering and approving changes to procedures or infrastructure related to storing or treating waste or pollution control. This is so you can track and control the process of change.

10. You consider the risks a changing climate presents to your operations and have appropriate contingency plans in place to assess and manage future risks.

11. You compare your facility's performance against relevant sector guidance and standards on a regular basis, known as 'sectoral benchmarking'.

12. You document and implement appropriate waste stream management.

13. You have and maintain a site condition report (https://www.gov.uk/government/publications/environmental-permitting-h5-site-condition-report) for installations. For waste facilities the Environment Agency

recommends that you carry out a site condition assessment during the life of the site. You would need to carry out this assessment on surrender. Please read the guidance Environmental permitting: H5 site condition report (https://www.gov.uk/government/publications/environmental-permitting-h5-site-condition-report).

14. You have and maintain:

- an inventory of waste water, waste gas streams or fugitive emissions
- a product and residues management plan
- an accident management plan
- a site infrastructure plan
- an odour management plan
- a bioaerosol risk assessment (https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit) and management plan
- a fire prevention plan, if required
- a noise and vibration management plan, if required
- a pest management plan, if required
- a dust, mud and litter management plan (emissions management plan) if required
- a leak detection and repair plan, if required

By 'inventory' we mean a complete and detailed list of all waste water and waste gases produced, handled and treated by your process or plant. Where possible, for example from channelled emissions points (point-sources), your inventory must quantify characteristics such as:

- substance concentration
- load value and variability of each waste water and waste gas stream

5.2 Inspection, maintenance and monitoring

The following measures apply to all processes and operations.

1. You must have a schedule of inspection, maintenance and monitoring programmes for all plant and equipment (including the impermeable surfacing and drainage systems).

2. You must inspect, maintain and monitor plant, equipment and infrastructure in accordance with manufacturer or design guidelines.

3. Where manufacturers' guidelines are not available, or where you have modified them, you must provide evidence that there are sound reasons for not following these guidelines, and that you have a robust alternative.

4. You must be able to produce proof of all inspection and maintenance through records of maintenance and inspection when requested.

5. If the site is more complex (AD, IVC and MBT plants) you must do a Hazard and Operability Study (HAZOP) or a similar study or risk assessment.

6. You must consider stocking or holding a list of critical spare parts and chemicals. You must be able to procure and install spares without undue delay.

7. You must have a programme of review and consider design improvements which take into account future de-commissioning (for existing plants). These improvements may include:

- improving or replacing underground tanks and pipework – or proposing an inspection regime
- installing secondary containment or instigating a suitable monitoring programme depending on the risks identified and the sensitivity of the potential receptors
- inspecting, draining and cleaning out vessels and pipework (especially before decommission and before dismantling)
- inspecting and reviewing lagoons to make sure there is no leakage or damage – you must consider the life of the facility and any future decommissioning and clean up
- reviewing insulation – this should be easy to dismantle without producing dust or causing a

hazard to staff and local receptors

- using recyclable materials, taking into account operational or other environmental objectives

5.3 Staff competence

The following measures apply to all processes and operations.

1. Your site must always be operated or monitored (or both) by an adequate number of staff who have appropriate qualifications or training (or both) and competence (https://www.gov.uk/guidance/develop-a-management-system-environmental-permits#managing-staff-competence-and-training-records).

2. If you operate a 24-hour process, for example an in vessel or AD facility you must have:

- remote or telemetric systems in place to make sure an alarm would be raised in the event of an incident during unmanned hours
- appropriate personnel on call to deal with such incidents

3. You must adequately explain these procedures in your management system and make sure they are implemented.

4. The design, installation and maintenance of infrastructure, plant and equipment must be carried out by competent people, including using CQA where appropriate.

5. You must have appropriately qualified managers for your waste activity who are members of a government-approved technical competence scheme (https://www.gov.uk/guidance/legal-operator-and-competence-requirements-environmental-permits#how-much-time-your-technically-competent-manager-must-be-on-site).

5.4 Accident management plan

The following measures apply to all processes and operations.

1. As part of your written management system you must have a plan for dealing with incidents or accidents that could result in pollution, including near misses.

2. Your accident management plan must identify the hazards, risk and mitigation measures that will protect the environment in the event of an accident or event.

3. Particular areas to consider may include:

- waste types and reactions of mixed waste
- transferring substances, for example filling (including overfilling) or emptying of vessels and containers, over pressure of vessels and pipework, blocked drains
- preventing incompatible substances coming into contact with each other
- failure of plant and equipment, for example storage tanks and pipework, or blocked drains
- failure of containment, for example bund failure or drainage sumps overfilling
- making the wrong connections in drains or other systems
- failure to contain firefighting water
- failure of abatement systems
- hazardous atmospheres in confined spaces
- failure of main services, for example power, steam or cooling water
- checking the composition of effluents before their emission
- vandalism and arson
- operator error
- accessibility of control equipment in emergency situations
- extreme weather conditions, for example flooding or very high winds
- having a contingency arrangement to divert waste feedstock when your ability to spread outputs to land, or inject gas to grid, is limited

4. You must assess the risk of accidents and their possible consequences. To help you do this you can either use:

- the Environment Agency's risk assessment guidance (https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit)
- a HAZOP or a similar detailed assessment that identifies hazards through possible deviations from the design intention

5. Risk is the combination of the likelihood that a hazard will occur and the severity of the impact resulting from that hazard. Having identified the hazards, you can assess the risks by addressing 6 questions:

- how likely is it that the accident will happen?
- what may be emitted and how much?
- where will the emission go – what are the pathways and receptors?
- what are the consequences?
- what is the overall significance of the risk?
- what can you do to prevent or reduce the risk?

6. The depth and type of accident risk assessment you carry out will depend on the complexity of your facility and its location. The main factors to take into account are the:

- scale and nature of the accident hazard presented by the facility and its activities
- risks to areas of population and the environment (the receptors)

7. Through your accident management plan, you must also identify the roles and responsibilities of the staff involved in managing accidents. You must provide them with clear guidance on how to manage each accident scenario, for example as a result of a spillage of a potentially polluting liquid.

8. You must have a suitably trained facility employee available at all times who will act as an emergency co-ordinator and will take responsibility for implementing the accident management plan.

9. You must train your employees so they can perform their duties effectively and safely and know how to respond to an emergency.

10. You must also:

- establish how you will communicate with relevant authorities, emergency services and neighbours (as appropriate) before, during and after an accident
- implement emergency procedures, including for safe plant shutdown and site evacuation
- implement post-accident procedures that include doing an assessment of the harm an accident caused (or may have caused) and actions you will take to prevent further accidents
- consider the impact of accidents on the function and integrity of plant and equipment
- have contingency plans to relocate or remove waste from the facility and suspend incoming waste
- test the accident management plan by carrying out emergency drills and exercises

11. Following a flooding event you must inspect and assess the integrity of affected plant and equipment, in particular infrastructure that may have been in contact with floodwater or groundwater. Tank inspections should include non-destructive testing methods to verify their integrity.

12. Storage and drainage lagoons must have adequate storage capacity to make sure structural integrity is not compromised during extreme weather events.

5.5 Preventing accidental emissions

The following measures apply to all processes and operations.

1. You must have a drainage plan and in the event of an emergency this must be available to emergency services. The drainage plan should clearly identify clean and dirty or foul drainage.

2. You must make sure that in an emergency you can contain on site:

- process waters
- contaminated site drainage waters

- emergency firefighting water
- chemically contaminated waters
- spillages of chemicals

3. You must put spill contingency procedures in place to minimise the risk of an accidental emission of raw materials, products, and waste materials, and to prevent their entry into water, land and air.

4. Your drainage and collection system must take account of additional firefighting water flows or firefighting foams. You may need emergency storage to prevent contaminated firefighting water reaching a receiving water body.

5. You must consider and reduce the risk of accidental emissions from:

- loss of containment – all polluting matter
- vents
- safety relief valves – making sure these are checked and maintained (preventing sticking and over feeding, see site capacity in section 4)
- bursting discs and seals
- tank wall penetrations
- storage containers

6. Liquids or fire water held in the buffer storage must be removed from site.

5.6 Security measures

The following measures apply to all processes and operations.

1. You must have security measures in place (including staff) to prevent:

- entry by vandals and intruders
- damage to the equipment
- theft
- fly-tipping
- arson

2. Facilities must use one or a combination of the following measures:

- security guards
- total enclosure (usually with fences)
- controlled entry points
- adequate lighting
- warning signs
- 24 hour surveillance such as CCTV

5.7 Fire and explosion prevention

The following measures apply to all processes and operations.

1. You must have a fire prevention plan that meets the requirements of the Environment Agency's fire prevention plan guidance (https://www.gov.uk/government/publications/fire-prevention-plans-environmental-permits/fire-prevention-plans-environmental-permits). The plan should include:

- preventing the uncontrolled decomposition and self-heating of stored waste by managing and monitoring temperature and moisture
- implementing written systems to prevent unsafe situations during site operations, repair and maintenance
- having a 'permit to work' system in place for maintenance and repairs, such as hot work on plant and equipment, and where the risk of unsafe conditions could occur
- having appropriate systems in place for fire and explosion prevention, detection and suppression or extinction – you must document these measures in your accident management plan or fire prevention plan, if required, to comply with your permit conditions

2. You must prevent the build-up of loose combustible material (including dust and waste) particularly around treatment plant, equipment and other potential sources of ignition.

3. You must:

- make sure that all the measurement and control devices you would need in an emergency are easy to access and operate in an emergency situation

- maintain plant in a good state through a preventive maintenance programme and a control and testing programme
- use techniques such as suitable barriers to prevent moving vehicles damaging equipment
- put procedures in place to avoid incidents due to poor communication between operating staff – during shift changes, periods of cover by temporary staff and following maintenance or other engineering work
- where relevant, use equipment and protective systems designed for use in potentially explosive atmospheres

4. You must be mindful of alarm fatigue and make sure all alarms are appropriately set and promptly responded to.

5. You must make sure that critical safety equipment, for example sprinklers, pressure relief valves and flares are maintained and kept in good working order.

6. Workers on site must be protected and monitored in line with the Health and Safety Executive (HSE) guidelines and regulations.

7. You must carry out all assessments in line with your facility's occupational exposure process and health and safety guidelines.

Fire prevention – composting plants only

8. The following measures only apply to composting plants including when storing oversize (tail ends) material from composting and maturing composted material.

You must:

- size your treatment and maturation piles (windrows) to make sure that passive heat convection is not inhibited – you must prevent persistent high temperatures and over-heating

- monitor temperatures daily during sanitisation and stabilisation
- monitor the temperature of all waste on site in storage, including oversized and screened material weekly
- make sure that you obtain a representative core temperature and that temperature probes are long enough to monitor the core temperature
- make sure you optimise moisture levels
- make sure there is enough space between windrows for turning so material can cool down and for safe access in the event of a fire
- have sufficient water, leachate or liquor available on site to give adequate moisture to your composting waste

Fire prevention and explosion – AD plants only

9. The following measures only apply to AD plants.

All AD facilities must comply with The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR). More information is available from HSE (https://www.hse.gov.uk/fireandexplosion/dsear-regulations.htm). All AD plants must undertake a DSEAR risk assessment. This is not only for facility staff but for those attending the site in an emergency.

If a DSEAR risk assessment has identified potential explosion hazards you must make sure the design and planning of your plant includes appropriate structural, technical and organisational fire protection measures.

10. You must install protective measures on your site and implement procedures such as:

- a permit to work system
- using specialised personal protective equipment (PPE)
- health and safety protection signage
- using ATEX-rated equipment

11. Organisational protective measures include regular maintenance of the plant, systems and components.

12. You must follow national guidelines and standards on fire protection when designing and planning your site.

13. You must consider whether the Control of Major Accident Hazard (COMAH) Regulations 2015 apply to your activities, for example, the quantity of flammable gas (biogas) in combination with any other dangerous substances stored on site.

14. You must risk assess your site in line with BS EN 62305-2 to determine the lightning protection level. Where you have assessed that lightning protection measures are not necessary, you must make an assessment against transient over voltage, complying with BS7671. Where lightening condition systems are in place, they must comply with BS 62305 (part 1 to 4). A competent person must validate the system.

15. You should share your accident management and fire prevention plans, and liaise, with your local fire and rescue service.

16. You must maintain plant control in an emergency using one or a combination of the following measures:

- alarms
- process trips and interlocks
- automatic systems based on microprocessor control and valve control
- tank level readings such as ultrasonic gauges, high level warnings, process interlocks and process parameters
- using a flare to manage biogas in AD systems

5.8 Firefighting

The following measures apply to all processes and operations.

1. Your accident plan must clearly state what actions are taken to extinguish fires on site and

operators must be trained in these procedures.

2. Your facility must have access to water supplies to extinguish fires. In remote locations where water supplies are not available you must seek advice from your local fire service.

3. In the event of a fire on site, your accident plan must consider how you will prevent firefighting run-off leaving site. Where possible you should have the capability to collect, contain and store firefighting water run-off.

4. You must isolate drainage systems from flammable waste storage areas to prevent fire spreading along the drainage system by solvents or other flammable hydrocarbons.

5.9 Record keeping and procedures

The following measures apply to all processes and operations.

1. You must:

- keep an up to date record of all accidents, incidents, near misses, changes to procedures, abnormal events, and the findings of maintenance inspections
- carry out investigations into accidents, incidents, near misses and abnormal events and record the steps taken to prevent their reoccurrence
- maintain an inventory of substances, which are present (or likely to be) and which could have environmental consequences if they escape
- record and hold a critical plant and equipment asset register, including a register of equipment installed in explosive atmospheres (ATEX-rated equipment)

2. You must notify the Environment Agency without delay if you detect any of the following events and they are causing, or may cause, significant pollution:

- a malfunction
- a breakdown or failure

- an accident
- an emission of a substance not controlled by an emissions limit
- a breach of an emissions limit

5.10 Contingency plans and procedures

The following measures apply to all processes and operations.

1. You must have and implement a contingency plan which makes sure that you:

- comply with all your permit rules and operating procedures during maintenance or shutdown, or critical failure at your site or elsewhere
- do not exceed limits in your permit and you continue to apply appropriate measures for waste storage, handling and treatment
- stop accepting waste unless you have a clearly defined method of recovery or disposal, and enough permitted storage capacity when land bank availability is limited, for example, during exceptional weather events such as prolonged rain or snowfall, deep frosts and severe drought
- plan for any restrictions that will affect the spreading of digestate or compost to land, for example, nitrate vulnerable zones (NVZ) closed periods

2. You must have the following information in your contingency plan:

- a description of each waste and material and the correct LoW code for each waste (inputs and outputs)
- details of permitted waste facilities that could accept and manage your waste if site holding capacity will be exceeded – you must obtain a copy of the site permit to make sure it can accept your waste type
- the capacity (volume) of all contingency options and the length of time for which it would be available or needed

- potential environmental and health and safety risks and hazards of all contingency options (for example, odour and emission generation, or leachate production from longer-term storage)
- any legal restrictions or constraints for each contingency option

3. You must identify your contingency options for use over the short term (1 to 2 weeks), medium term (4 to 6 weeks) and the long term (up to 6 months).

4. Your management procedures and contingency plan must also:

- identify known or predictable malfunctions associated with your technology and the procedures, spare parts, tools and expertise needed to deal with them
- make sure you have the spare parts, tools, and competent staff needed before you start maintenance
- record where you can get critical spare parts from and how long it would take to obtain them if you cannot hold them on site
- have a defined procedure to identify, review and prioritise items of plant which need a preventative regime
- include all equipment or plant whose failure could directly or indirectly lead to an impact on the environment or human health
- identify non productive or redundant items such as tanks, pipework, retaining walls, bunds, reusable waste containers, ducts, filters and security systems

5. You must make your feedstock suppliers and customers aware of your contingency plan, and of the circumstances in which you would stop accepting waste from them.

6. You must consider whether the sites or companies you rely on in your contingency plan:

- can take the waste at short notice
- are authorised to do so in the quantities and types likely to be needed in addition to carrying

out their existing activities – if in doubt contact your local Environment Agency office for advice

7. You must not include unauthorised capacity in your contingency plan. If your contingency plan includes using temporary storage for additional waste on your site, then you must make sure your site is authorised for this storage and the appropriate infrastructure is in place.

8. Your management system must include procedures for auditing your performance against all the contingency measures detailed above and for reporting the audit results to the site manager.

9. If you produce an end of waste material at your facility, your contingency planning must consider storage capacity for end of waste products and materials that fail the end of waste specification.

Contingency plans – AD plants only

This additional measure only applies to AD plants.

10. You must stop accepting waste or reduce feeding rates unless you have a clearly defined method of gas management when national grid capacity is restricted.

5.11 Plant commissioning, validation and decommissioning

The following measures apply to all processes and operations.

1. The term commissioning means to bring an item of plant or equipment into working condition. You must notify the Environment Agency before you start commissioning. You must consider communicating with local communities during the commissioning phase, to comply with your management system and odour management plan.

2. You must consider the arrangements for commissioning your plant at the design stage. You must have a commissioning plan in place before you start commissioning to minimise the risks of pollution and harm to human health and the

environment. The level of detail can be based on the complexity of, and risks associated with, the process.

3. You must define the suite of indices you will use to determine and monitor process performance and efficiency.

4. You must review and refine the relevant monitoring parameters during the facility's operation as part of an on-going process of system optimisation.

5. You must test and validate all systems and components of your plant and building(s) against operational requirements identified at the design stage. This must include, for example, the air extraction and abatement system and containment structures.

6. You must have completion certificates (for each commissioning phase) in place, signed by an appropriately qualified person.

7. Commissioning must be carried out to relevant industry standards where they are available, or follow manufacturers' guidelines. As a minimum, the commissioning plan must include summaries of:

- commissioning phases (and sequences) including milestones and timeframes (for example pre, cold, hot commissioning)
- procedures and mechanical tests at each phase including relevant industry test standard (or otherwise), for example manufacturers' guidelines

Mechanical tests could include, for example:

- tests for leaks
- pressure tests of piping and equipment
- purging or inerting requirements
- pressure and vacuum safety relief where required
- temperature
- flow and pressure control
- mixing

- air flow ventilation
- extraction

8. Your commissioning plan must also include the:

- scope of performance tests, for example, acceptance criteria, measurement requirements, sampling requirements, reference to analytical procedures, chemical and biological analysis
- identification of potential releases to the environment of displaced and generated emissions and measure to mitigate these, for example, lean burn flares
- scope of responsibilities of the person(s) related to the test procedures, including the sign-off process
- qualifications of the responsible person(s) involved
- process for dealing with failed tests and problems that you may encounter
- health and safety precautions and protective measures employed

Plant commissioning – AD plants only

The following measures only apply to AD plants.

9. When commissioning AD plants that have mixing systems installed, you must test the mixing system is effective. You should document the methodology in the commissioning plan.

10. You can only seed and commission AD plants using waste after the Environment Agency has issued your environmental permit. The permit must contain the relevant LoW code and description for the seeding material.

11. You must allow enough time for the Environment Agency to issue your permit when planning the start of your commissioning and any tariff guarantee date. Sending correct and exact information with your application means that the Environment Agency can issue your permit more quickly.

12. You should source the biomass (inoculum) used in seeding a digester that matches the type of feedstock the facility is designed to process. This will provide a more stable substrate.

5.12 Decommissioning and mothballing

The following measures apply to all processes and operations.

1. You must consider plant decommissioning or ceasing activities (mothballing) at the design stage.

2. You must have plans that minimise risks during the time decommissioning or mothballing takes place. This includes removing or replacing individual items of plant throughout the life of the facility.

3. Before you decommission plant you must notify the Environment Agency and provide a copy of your decommissioning plan.

4. Once decommissioning is complete you must provide a written report to the Environment Agency verifying that you have carried out activities in line with your plan.

5. If you bring plant back into service after a period of dormancy you must follow the commissioning requirements set out in this document or be directed by a suitably qualified person.

6. You must have a decommissioning plan to demonstrate that:

- plant can be decommissioned without causing pollution
- the site will be returned to a satisfactory condition, for example in line with your site condition report (https://www.gov.uk/government/publications/environmental-permitting-h5-site-condition-report)

7. The decommissioning plan must include details of (but not limited to):

- removing or flushing out pipelines and vessels where appropriate and completely emptying any potentially harmful contents
- drawings showing all the underground pipes and vessels
- the method and resources needed for clearing lagoons
- how you will dismantle buildings and other structures in a way that protects surface water and groundwater at construction and demolition sites
- the soil testing needed to understand the degree of any pollution caused by the site activities, and information on what remediation is needed to return the site to a satisfactory state as defined by the initial site report
- the measures proposed, once activities have ceased, to avoid any pollution risk and to return the site to a satisfactory state (including, where appropriate, those covering the design and construction of the plant)
- how you will clear any residues, waste, and any contamination resulting from the waste treatment activities

Decommissioning and mothballing – AD plants

The following measures only apply to AD plants.

8. Decommissioning plant and equipment, where there are potentially explosive atmospheres, is a specialist activity. You must make sure you have written procedures in place and follow it to support the safe removal or closure of plant on site.

9. You must make sure that equipment permanently taken out of use is decontaminated and removed from the site.

10. You must have a procedure and follow it for inspecting, maintaining and validating the recommissioning of plant and equipment following periods of dormancy.

Biological waste treatment: appropriate measures for permitted facilities

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Contents

6. Waste pre-acceptance, acceptance and tracking

Appropriate measures for waste pre-acceptance, acceptance and tracking.

The following measures apply to all processes and operations.

1. Wastes accepted at sites must be capable of biological treatment and be fully recovered and suitable for their intended end use.

2. A waste is only suitable for biological treatment if your treatment process is designed to:

- treat the types of wastes included on your environmental permit
- manage variability in feedstock and optimise process conditions
- make sure there is sufficient capacity to treat waste within the retention time of the process

3. You must implement waste pre-acceptance and acceptance procedures for all new waste streams so that you know enough about a waste (including its composition, characteristics and predicted age) before it arrives at your facility. You need to do this to assess and confirm the waste is technically and legally suitable for your facility.

4. You must document you waste pre-acceptance and acceptance procedures in your management system.

5. You must assess waste on initial acceptance and periodically to ensure constancy.

6. You must obtain representative test data and undertake upstream auditing of the production process to fully characterise the waste and identify the substances it contains.

7. You must not include wastes in the process solely for dilution.

8. You must have a system in place to track waste from receipt, handling on site and transfer off site.

9. You cannot accept waste containing animal by-products unless your facility has been validated following the regulations and approved by the Animal and Plant Health Agency (https://www.gov.uk/government/organisations/animal-and-plant-health-agency) (APHA). You must monitor your process in line with animal by-products regulations where required to do so.

6.1 Waste pre-acceptance and characterisation

1. You must use WM3 technical guidance on waste classification (https://www.gov.uk/government/publications/waste-

classification-technical-guidance) to be able to assign the correct waste classification code.

2. When you receive a customer enquiry and before the waste arrives at the facility, you must obtain the following in writing or in an electronic form:

- details of the waste producer including their organisation name, address and contact details
- the source and nature of the waste, at the point of production (the process that gives rise to the waste)
- a description of the waste including its physical form
- the full characteristics of the waste including the variability of each waste (for example, liquid effluents must be individually assessed and tested, understanding of the waste's composition and characterisation must be based on representative samples)
- a description of any hazardous properties including potential risks to process safety, occupational safety and the environment
- the odour potential
- the type of packaging and risks of contamination
- an estimate of the quantity you expect to receive in each load and in a year
- the potential for self-heating, self-reactivity or reactivity to moisture or air
- the age of the waste

3. During pre-acceptance you must consider how you will manage and control the nutrient balance of the waste feedstock, the moisture and any toxic compounds which may inhibit biological activity.

4. You must verify the pre-acceptance information by contacting or visiting the producer. Dealing with staff directly involved in waste production can help to fully characterise a waste.

5. You must keep pre-acceptance records for at least 3 years (in a computerised waste tracking system) following receipt of the waste. If an enquiry does not lead to receipt of the waste, you do not need to keep records.

6. You must reassess the information you had at pre-acceptance yearly. You must also reassess information required at pre-acceptance if the:

- waste changes
- process giving rise to the waste changes
- waste received does not to conform to the pre-acceptance information

Before you accept waste you must consider its potential odour and emissions impact (description and intensity), for example:

- mercaptans, ammonia or other volatile organic compounds (VOCs)
- low molecular weight amines, for example, decaying fish or meat
- other high-nitrogen and odorous materials or chemicals, for example from highly decomposed food waste or poultry manure

You can only accept odorous wastes using special handling and storage arrangements such as in adequately covered or air contained and abated areas.

7. You must keep separate the roles and responsibilities of sales staff and technical staff. If sales staff are involved in waste enquiries then technical staff must carry out a final assessment before approval.

8. You must use this final technical check to make sure that you:

- only accept wastes that are suitable and permitted for the site
- avoid over accumulating waste
- have enough storage and treatment capacity

When you agree that you will accept waste from a customer, you must decide and record what parameters you will check at the acceptance stage. The checks could be visual (for example colour, phase, fuming), physical (for example pumpability, temperature, form) and chemical (for example pH, metals content) parameters.

9. You must also record the criteria for non-conformance or rejection.

10. You must make sure that your facility can comply with other regulatory requirements, for example the Animal By-Products Regulations.

11. You must advise your customers that they must avoid contaminating waste because it can cause handling difficulties and inhibit the biological treatment process. You must tell them what wastes are likely to contaminate your process.

12. You must not transfer waste unnecessarily between waste facilities.

13. You must obtain a representative sample or analysis, or analyse a representative sample of a waste, if:

- the chemical composition or variability of the waste is unclear from the information supplied by the customer
- there are doubts about whether the sample analysed is representative of the waste
- you will treat the waste at your facility (this will allow you to carry out tests to determine if the planned treatment will be safe and effective)

Where you rely on a customer sample you must record that you have done this and the reason why the customer sample is acceptable.

If the customer has a number of containers holding the same waste, you can apply the industry standard applying the square root of (N)+1 rule to sampling those containers.

For example: N = 28 containers +1 = √28 = 5.29
You would need to take 5 samples.

If the waste is variable, you must take a sample from each container.

You may not need a sample analysis at the pre-acceptance stage where the waste is:

- packaged food waste from food manufacturers or food retailers – however, you must have confirmation of its origin and enough information to understand how it will affect your biological treatment process

- biodegradable agricultural waste direct from the agricultural premises – however, you must have confirmation of its origin and enough information to understand how it will affect your biological treatment process
- green waste
- food waste and co-mingled green and food waste from local authority collections only
- a pure product chemical or where the chemical composition and hazardous properties are available in a REACH compliant safety data sheet, for example manufactured glycerol product

14. You must make sure that feedstock testing and testing frequency reflects the nature of the material, how it arises and any potential variation within it. For example, taking account of seasonal variations.

After fully characterising a waste, you must technically assess the waste's suitability for treatment and storage to make sure you can meet your permit conditions and any other regulatory requirements. You must make sure that the waste complies with the site's treatment capabilities and capacities.

Waste types for standard rules permits

The wastes listed on the biowaste treatment standard rules permits have already been characterised and risk assessed. The Environment Agency considers that they are generically suitable for the biological treatment process allowed by the permit. You must make sure that all the waste types you received match and comply with those wastes listed and described in the standard rules permits.

6.2 Bespoke wastes

The biological treatment process must be capable of fully treating the waste feedstock received. For example, within the time-temperature conditions of your process, the biodegradation of any packaging and full recovery of the waste should take place.

1. You must fully assess and manage:

- any effects or inhibition on the biological treatment process and quality of the final waste or product – critical where you accept novel waste streams or multiple waste streams as it may prevent or delay associated landspreading deployments
- the effects of any potential carry-over of residual chemical components into the outputs and on using the final outputs

For novel or water based liquid waste, you may perform laboratory scale tests to predict the treatment's performance, for example on breaking emulsion or biodegradability.

Personnel and waste acceptance

The following measures apply to all processes and operations.

Non-hazardous wastes

2. For non-hazardous wastes, someone with enough training to determine if the waste is suitable and permitted at the site can do the technical appraisal.

3. At sites where the waste needs only a visual check, for example green waste, the person receiving the waste must have received training to recognise and deal with non-conformant loads

Mirror entries and hazardous waste

4. If you accept hazardous, mirror-entry hazardous, or bespoke wastes, you must follow the requirements of Technical Guidance WM3 Waste Classification (https://www.gov.uk/government/publications/waste-classification-technical-guidance) and the Chemical waste: appropriate measures for permitted facilities (https://www.gov.uk/guidance/chemical-waste-

appropriate-measures-for-permitted-facilities), in addition to this guidance.

If you are permitted to accept mirror entries or hazardous wastes, the person carrying out the technical appraisal of a waste's suitability for receipt (at pre-acceptance) must be competent.

If you receive multiple hazardous wastes then the person carrying out the technical appraisal must have the minimum of an HNC in chemistry (or equivalent qualification). You must keep training records of qualifications or relevant experience of staff for all waste acceptance processes.

5. You must comply with our guidance on Chemical waste: appropriate measures for permitted facilities (https://www.gov.uk/guidance/chemical-waste-appropriate-measures-for-permitted-facilities) when receiving, handling, storing and treating hazardous waste.

6.3 Waste acceptance and reception

The following measures apply to all processes and operations.

1. You must implement waste acceptance procedures to check the characteristics of the waste received matches the information you obtained during waste pre-acceptance. This is to confirm the waste is as expected and you can accept it, or that you must reject it.

Your procedures must follow a risk based approach, considering:

- the source and nature of the waste
- the variability of a waste (for example, liquid effluents) – you must carry out individual assessment and testing
- any hazardous properties the waste may have
- potential risks, process safety, occupational safety and the environment (for example from odour and other emissions)
- knowledge about the previous waste holder(s) and the age of the waste

- the waste's potential for self-heating, self-reactivity or reactivity to moisture or air

2. You must identify the effects of any seasonal variance on the waste's composition.

3. You must only receive bespoke waste onto site that you have pre booked and that matches the pre-acceptance information.

If you need to take samples on site, they must be representative of the waste and taken by a technically competent person. This means they must be appropriately trained or hold the relevant qualifications.

4. You must visually check wastes and verify them against pre-acceptance information and transfer documentation before you accept them on site. The extent of the initial visual check is determined by the waste type and how it is packaged.

5. You must check and validate all transfer documentation and resolve discrepancies before you accept the waste. If you believe the incoming waste classification and description is incorrect or incomplete, you must address this with the original waste producer during waste acceptance.

6. You must record any non-conformances.

If you have assessed the waste as acceptable for storage or treatment at your facility, you must document this.

7. You must have clear criteria that you use to identify non-conforming wastes and wastes to be rejected.

8. You must also have written procedures for recording, reporting and tracking non-conforming and rejected wastes. These must include:

- using quarantine storage
- notifying the relevant customer or waste producer
- recording a summary of your justification for accepting non-conforming waste in your electronic (or equivalent) system

9. You must take measures to prevent the recurrence of non-conforming and rejected wastes.

10. You must weigh and record each load of waste on arrival to confirm the quantities against the accompanying paperwork, unless there are other reliable systems (for example, based upon density and volume). You must record the weight in a system that enables tracking.

The person carrying out waste acceptance checks must be trained to effectively identify and manage any non-conformances in the loads received.

After the initial visual inspection and confirmatory checks, you must offload the waste into a dedicated reception or storage area to wait for detailed checks or sampling. Wastes that do not require further checking can go into the appropriate storage area.

11. You must not offload wastes if you do not have enough space and capacity to treat the waste at that time.

12. Tankered wastes must not be discharged to the head of a waste water treatment works when storm tanks are in operation as this may result in the waste discharging directly into the watercourse.

If you need to offload feedstock deliveries to inspect them, or carry out acceptance sampling before treatment, you must segregate the reception areas (typically into bays).

13. You must verify the waste is compliant as soon as possible.

14. If you use a bay every day you must clean it at least weekly. You must clean it more often (depending on the waste) if weekly cleans do not deal with the risk of vermin or fugitive emissions.

15. The waste reception area must be inside an enclosed building for the following:

- if receiving, storing or pre-treating (for example, de-packaging food waste) as the waste may lead to fugitive emissions
- for food waste

- for all waste containing animal by-products

A building is a covered structure, enclosed on all vertical sides, that is designed to provide sheltered cover and contain emissions of noise, particulate matter, odour and litter.

16. You must design enclosed buildings with an air extraction that is capable of negative pressure within the waste reception area and have air-lock controls. You must make sure the ventilation extraction and air treatment is suitably designed and engineered.

17. You must collect and treat all emissions in an appropriately engineered abatement system or air suction system close to the source. For in vessel systems, you can use exhaust air to aerate composting piles before treatment and discharge.

18. If you accept food and putrescible wastes, you must fit existing reception buildings with fast-acting roller shutter doors to allow delivery and other vehicles to enter and leave. You may need additional measures to minimise fugitive emissions, for example installing an airlock entry system.

19. You must design and maintain buildings used for feedstock reception and storage in a way that minimises fugitive emissions.

A reception building should have enough space to minimise the time waste is held before treatment, and to allow you to follow the first-in, first-out principle for waste treatment.

You should operate an alternate bay system or single bay all-in, all-out approach.

All bays used to segregate wastes must have defined and visibly clear storage demarcation boundaries.

Where there is a likelihood you will generate bioaerosols and dust you must treat the air with a dust filter before releasing emissions.

If you accept and store large volumes of ammonia-rich feedstock, for example poultry litter and manures, you must store it in a way that minimises the release of ammonia. You can do this by:

- covering it with a sheet or with an organic layer such as straw or compost to form a 'biofilter'
- using a 3-sided walled area

You may need additional measures to reduce odour or ammonia if your site is located in sensitive areas.

20. You must design reception areas for easy cleaning and include contained drainage so you can collect wash-water separately for disposal or reuse.

21. If you are permitted to accept animal by-products you must:

- segregate these from other waste
- keep liquors and leachate separate and provide wheel-wash facilities for disinfecting delivery vehicles on exit from the reception building

You may need additional cleaning methods, for example steam cleaning. You must carry this out in an enclosed area.

22. You must characterise wash-down water containing cleaning chemicals, for example disinfectants, and dispose of them appropriately.

23. For outside reception areas, you must have impermeable surfacing and a contained drainage system.

24. You must minimise the time you store putrescible waste in reception before treatment and hold it for no longer than 5 working days. You must treat waste promptly and within 24 hours if there is risk of:

- attracting vermin
- causing fugitive emissions such as odour

You can store green waste and agricultural wastes for longer providing you follow all other appropriate measures to prevent uncontrolled decomposition and emissions.

You may store stable waste material for longer periods as long as it does not degrade and is stored in a way that does not encourage vermin or result in fugitive emissions.

Once offloaded, and as soon as is practicable to do so, you must assess the waste and verify it for acceptance, following your procedures.

25. You must put non-conforming containers and wastes into quarantine and deal with them immediately. You must record all non-conformances.

26. Where pallets are used to hold containers, you must stack them no more than 1.8m high (including the height of the pallet) and secure them with clear or transparent shrink-wrap.

The containers must not extend beyond (over-hang) the sides of the pallet. The shrink-wrap must be clear or transparent so that you can identify waste types, damaged containers, leaks or spillages and incorrectly stacked containers.

27. If you identify a non-conforming waste during a spot check, you must take measures to prevent a recurrence (including contacting the customer).

6.4 Waste acceptance – AD plants

The following measures only apply to AD plants.

1. Operators of AD plants must characterise the feedstock to understand its effect on the biological treatment process.

This includes understanding, for example:

- particle size distribution and physical contaminants
- total solids and volatile solids
- biogas potential
- total organic carbon (TOC)
- chemical oxygen demand (COD)
- nutrient analysis
- fibre content

- pH and alkalinity
- volatile fatty acids (VFA)
- ammonia and total nitrogen content – carbon to nitrogen (C to N) ratio
- heavy metals and potentially toxic elements (PTEs)
- carbohydrates and lipids

Where the waste is from a known supplier and is consistent you can carry out these checks on initial acceptance and then periodically.

6.5 Waste acceptance – aerobic plants

The following measures only apply to aerobic plants.

1. Operators of composting and aerobic treatment plants must characterise the feedstock to understand its effect on the biological treatment process. This includes understanding, for example:

- particle size distribution and physical contaminants
- total moisture
- TOC
- pH and alkalinity
- ammonia and nitrogen content (kjeldahl nitrogen)
- heavy metals and PTEs

6.6 Waste acceptance – bespoke wastes

The following measures apply to all processes and operations.

These measures cover assessing the suitability of accepting waste that is not listed in the standard rules permits or quality protocols.

The waste producer must follow the guidance document WM3 when characterising and classifying waste. Producers must fully characterise the waste to include all the chemical components so you can adequately assess whether the waste is suitable for biological treatment.

1. You must understand and be able to demonstrate what happens to the substances in the bespoke waste material when it undergoes biological treatment. You must demonstrate that these substances will completely degrade during the treatment process.

2. You must provide details of any pre-treatment or additional process control measures needed.

Treating non-standard or bespoke wastes must result in full mineralisation and stabilisation of the waste. Mineralisation is the advanced stage of decomposition where organic matter completely breaks down into available nutrients, water (H_2O) and carbon dioxide (CO_2).

Treating non-standard or bespoke wastes must also result in recovery of the waste or must benefit the biological treatment process itself.

3. For each bespoke waste type you must fully describe or demonstrate the:

- source and process that gives rise to the waste
- characteristics, including chemical, physical and biological make-up of the waste
- variability potential, considering source production methods
- biodegradability rate or biogas potential
- inhibition effects on the biological process
- residual by-products
- substances within the waste are biodegradable and recoverable under the conditions of the biological treatment process

4. Using the information in these bullet points (point 3), you must have a sampling and testing plan to demonstrate how you will make sure the waste is as described and remains suitable for treatment.

Sampling plans must meet the requirements of BS EN 14899:2005.

The testing plan must adequately reflect the waste and include the:

- objectives of the testing
- details of the testing needed
- test parameters based on chemical and physical characteristics
- the sampling approach including population, number of sampling events, number of samples, sample weight and reliability of the outcome
- sampling methodology

5. You must demonstrate the additional measures you will take if the waste is not within the suggested inhibition values. Guideline references are given in section 13 Bespoke waste assessment.

6.7 Removing packaging and plastic

1. If you accept a waste load and only identify a non-conformance after the waste has been deposited, for example loose green waste with high levels of metal or plastic, you must remove and quarantine the contaminants.

You must address the non-conformance with the waste producer as part of your waste acceptance procedures and record these events. You should tell them the actions you have taken, for example, removed it for disposal.

2. You must remove packaging and non-biodegradable packaging items that are not independently certified as industrially or home compostable (or both). You must do this before and during treatment to minimise the contamination of outputs.

Non-packaging items include:

- non-biodegradable materials integral to the product, for example tea bags
- items used when consuming food or drink, for example straws, single-use tableware
- plastic bags, used for example, in a kitchen caddy, food bin liners, or garden waste sacks

You can accept industrially compostable packaging and non-packaging items that are independently certified as compliant with at least one of the following:

- EN 13432
- EN 14995
- ASTM D6400

You can accept home compostable packaging and non-packaging items that are independently certified as compliant with at least one of the following:

- EN 17427
- AS 5810-2010
- NF T51-800
- TUV Austria's certification requirements for home compostable packaging under their 'OK compost HOME' scheme

3. You must only accept separated loads of plastic packaging and non-biodegradable packaging items (for example, from closed loop sources such as festivals, coffee shops or individual buildings) if both of these apply, the:

- packaging is independently certified as industrially or home compostable (or both)
- load complies with your permit acceptance criteria

6.8 Acceptance of bulk loads, drums and intermediate bulk containers (IBCs)

1. You must only offload bulk loads (liquid, sludge or solid) after they have been fully verified. You must not accept a non compliant bulk load for interim storage except in an emergency.

Verification testing must include:

- checking consistency with the pre-acceptance information
- compatibility with the receiving vessel contents

- where appropriate, checking treatability by using laboratory scale simulation

Deliveries in a bulk road tanker must be accompanied by a ‘wash-out’ certificate or a declaration that previous loads do not pose a risk of cross contamination. This will not apply to dedicated tankers carrying only one type of waste.

2. You must take representative samples when sampling from:

- tankers of chemical production waste or hazardous waste
- new customers
- emergency deliveries

3. You must sample from each compartment if the tanker is divided into multiple compartments. If you have to take a sample from the back valve, you must avoid spillages.

When storing drummed waste, each drum must have a contents identification label.

Mixing wastes (by bulking, blending or repackaging)

4. You must take operational and design precautions when mixing or blending wastes, depending on their composition and consistency.

5. Mixing must have a clear and defined benefit to the process (for example, adjusting moisture content or solid fraction). You must only mix wastes together under controlled and safe conditions. You may need air handling, extraction and treatment.

6. You must complete a pre-acceptance and acceptance process that assesses the compatibility of wastes in the mixing process. You must not allow dangerous reactions to take place, for example those caused by:

- polymerisation
- gas evolution
- exothermic reaction

- decomposition
- crystallisation
- precipitation

7. You must understand the compatibility effects before:

- combining waste batches
- discharging from a tanker to bulk storage
- tank to tank transfer
- transfer from a container to a bulk tank
- bulking into drums or intermediate bulk containers
- bulking solid waste into drums or skips

If you do not clearly understand the compatibility effects, you must not blend or mix the waste until you can demonstrate compatibility.

Compatibility tests are risk based considering, for example:

- the hazardous properties of the waste
- the risks posed by the waste in terms of process safety
- occupational safety and environmental impact
- the knowledge of the previous waste holder(s)

8. You must prevent substances mixing if they react strongly with each other (causing heat, fire or gas formation). Mixing must not lead to increased risks to human health or the environment, either during the mixing operation itself or during the subsequent treatment process. Before wastes are combined, you must assess whether this combination can take place safely.

9. You must guarantee the traceability of wastes when mixing wastes.

10. You must only mix or blend waste in a dedicated area.

11. Mixing wastes must lead to the best possible level of waste management. For example, you must not mix:

- a waste which could be recovered with other wastes, meaning that the waste must now be sent for disposal or a lower form of recovery
- liquid wastes with other wastes for the purpose of landfilling
- waste to deliberately dilute it

12. When mixing wastes you must follow the joint Environment Agency and HSE Compatibility Testing Guidance for Bulking Operations in the Waste Treatment Industry (https://www.hse.gov.uk/chemicals/chemical-waste.htm).

Acceptance sampling

This does not apply to:

- green wastes
- food wastes and co-mingled food and green wastes from local authority collections
- food slurry that has been pre-treated and pre-pasteurised at separately permitted facilities
- biodegradable wastes from agriculture
- sewage sludge and septic tank sludge

13. You must still visually check the waste and carry out periodic audits of the waste against pre-acceptance and duty of care criteria. You must record the reason why you did not sample the waste in your waste tracking system.

14. You must representatively sample bulk or containerised waste (including from every container). You do not need to do this if the waste you receive has been representatively sampled and fully characterised during the pre-acceptance stage and you have verified the information as correct.

You can make a composite sample if each of the containers holds the same waste and you know the waste is not variable.

15. You must obtain a representative sample by taking a core sample down to the base of the container.

16. You must make sure that you replace lids, bungs and valves immediately after sampling.

17. You must have a sampling and analysis procedure. You must design it based on the risk factors for the waste, including:

- the type of waste (for example hazardous or non hazardous)
- knowledge of the customer (for example waste producer)
- the impact of potential mixing or blending and the possibilities for subsequent treatment

A representative sample is one that considers the full variation and any partitioning of the load so you can account for worst case scenarios.

Qualified staff must supervise on site sampling.

You must have suitable absorbents and spill kit material available to deal with any spills.

18. Where a driver arrives at the site with a sample taken from elsewhere, you must verify the sample as representative, reliable and obtained by a person technically competent to take it.

On site sampling may not be possible for health or safety reasons, for example, where you have previously taken a sample and there are specific risks regarding the waste handling.

Sampling must not increase the risk of incompatible substances coming into contact with one another, for example within a sump serving the sampling point, or because of contaminated sampling equipment.

19. Apart from packaged waste you must make sure that all waste is free from visual contaminants as far as practicable.

20. You must keep a record of the sampling regime, process, and justification in your waste tracking system.

Depending on the constancy, variability and confidence in the waste stream, you may need to keep samples on site after you have:

- treated a waste and removed its treatment residues from the facility
- transferred a waste from your site

21. You must customise sampling procedures for bulk liquids.

22. You must determine and record the following information:

- the sampling regime for each load, together with your justification for selecting each option
- a suitable location for the sampling points
- the capacity of the sampled vessel (for samples from drums, an additional parameter would be the total number of drums)
- the number of samples and degree of consolidation
- the operating conditions at the time of sampling

23. Wherever possible, you must sample waste in accordance with:

- EN 14899 Characterization of waste – Sampling of waste materials – Framework for the preparation and application of a sampling plan
- CEN/TR 15310 1 Characterization of waste – Waste Collection – Part 1: Guide on the selection and application of criteria for sampling under various conditions
- CEN/TR 15310 2 Characterization of waste – Waste Collection – Part 2: Guide on sampling techniques
- CEN/TR 15310 3 Characterization of waste – Waste Collection – Part 3: Guide on procedures for sub sampling in the field
- CEN/TR 15310 4 Characterization of waste – Waste Collection – Part 4: Guide to the packaging procedures for storage, conservation, transportation and delivery of samples
- CEN/TR 15310 5 Characterization of waste – Sampling of waste – Part 5: Guide on the process of developing a sampling plan

Testing and analysis

24. Where you sample a waste, you must test the waste for acceptance according to the parameters decided at pre-acceptance. You must record the results of the tests in the computerised waste tracking system. You must note and investigate any discrepancies.

Laboratory samples must be analysed by a UKAS approved laboratory.

Quarantining waste

25. Your facility must have a dedicated waste quarantine area.

Where there is a risk of fugitive emissions from quarantined waste you must store it in closed or covered containers or within a building or covered skip.

Your quarantine storage must be separate from all other storage and clearly marked as a quarantine area.

26. You must not keep quarantined waste longer than 5 working days.

27. You must have written procedures in place for dealing with wastes held in quarantine, together with a maximum storage volume. The maximum storage time must take account of the potential for odour generation, pest infestation and storage conditions such as temperature effects. If the waste is infested or odorous you must remove it as soon as possible and in any event within 24 hours.

28. The waste off-loading area, any sampling points, and quarantine areas, must have an impermeable surface with self contained drainage. This is to prevent any spillage entering the storage systems or escaping off site.

29. You must design all surfaces to allow effective cleaning.

6.9 Waste tracking

The following measures apply to all processes and operations.

1. You must use a waste tracking system which records information about the available capacity of the waste quarantine, reception, general and bulk storage areas of your facility. Your information must include treatment residues and end of waste product materials.

Your tracking system must hold all the information produced during:

- pre-acceptance
- acceptance
- non-conformance or rejection
- storage
- repackaging
- treatment
- removal off site

This information must be in a readily accessible format. Where possible this should be computerised.

2. You must create records and update them to reflect deliveries, on site treatment and despatches. Your tracking system will operate as a waste inventory and stock control system. It must include this information as a minimum:

- the date the waste arrived on site
- the original producer's details
- all previous holders
- a unique reference number
- the pre-acceptance and acceptance analysis results
- the package type and size
- the intended treatment or disposal route
- the nature and quantity of wastes held on site
- where the waste is physically located on site

- where the waste is in the designated disposal route
- staff (name and position) who have taken any decisions about accepting or rejecting waste streams and who have decided on recovery or disposal options
- details that link each waste container accepted to its consignment or transfer note
- non-conformances and rejections

The tracking system must be able to report:

- the total quantity of waste present on site at any one time and how that compares with the limits authorised by your permit
- the total quantity of end of waste product materials on site at any one time
- a breakdown of the waste quantities you are storing pending on-site treatment or waiting for onward transfer
- a breakdown of the waste quantities by hazardous property
- where a batch or load of waste is located based on the site plan
- the length of time a waste has been on site

3. You must store back up copies of computer records off site. Records must be easily accessed in an emergency.

4. You must hold acceptance records for a minimum of 2 years after you have treated the waste or removed it off site. You may have to keep some records for longer if they are required for other purposes, for example hazardous waste consignment notes.

Biological waste treatment: appropriate measures for permitted facilities

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Contents

7. Waste storage, segregation, transfer and handling

Appropriate measures for waste storage, segregation, transfer and handling.

The following measures apply to all processes and operations.

1. Your facility must have enough physical and permitted capacity for the wastes, raw materials and 'end of waste' materials that you store on site.

2. You must comply with the limits set in your environmental permit and with any additional

regulatory requirements that may apply, for example, the:

- Animal By-Products (Enforcement) (England) Regulations 2013
- COMAH regulations

3. You must store all waste on an impermeable surface with contained drainage that meets the recommendations of CIRIA 736.

4. Storage area drainage must:

- contain all possible contaminated run off
- prevent incompatible wastes coming into contact with each other
- make sure that fire cannot spread
- be designed to allow access for inspection and cleaning

5. Where possible you must keep clean rainwater separate from wastes and waste waters to limit storage requirements.

6. You must store waste in locations that minimise handling waste and have handling procedures in place.

Only competent staff must handle waste. They must use appropriate equipment.

7. Where possible, you must locate storage areas away from watercourses and sensitive perimeters (for example those close to public rights of way, housing or schools).

8. You must store all waste within the security protected area of your facility to prevent unauthorised access and vandalism.

9. Your management system and odour management plan must clearly state the maximum storage capacity of the site and the designated storage areas.

10. You must provide signage that clearly states the maximum quantity and types of waste that can be

stored in an area. You must communicate these maximum capacities to site operatives.

11. You must define capacity in clear terms, for example:

- maximum tank or vessel capacities
- tonnage
- number of pallets or containers

12. You must regularly monitor the quantity of waste stored on the site and in designated areas to check you do not exceed the maximum storage capacities.

13. For in vessel composting and AD, available storage capacity and throughput will be influenced by the period of time the waste is in the treatment vessels. You must make sure you have sufficient capacity to store waste inputs and outputs, taking account of the loading rate and capacity for treatment. Information on determining capacity is available in Regulatory Guidance Note 2 (https://www.gov.uk/government/publications/rgn-2-understanding-the-meaning-of-regulated-facility).

14. You must store highly putrescible wastes, including odorous and ammonia-rich wastes and wastes containing animal by-products, in a contained or enclosed building.

The building should be fitted with an appropriately engineered extraction and ventilation system, with the air extracted and directed to a suitable abatement system. You can install localised point source air extraction in buildings to minimise a source emission from that locality.

For liquid wastes this is either:

- a sealed tank fitted with an air control system which may include air circulation
- local extraction to a gas recovery plant or engineered abatement system

15. Your storage areas must be large enough to manage foreseeable changes in feedstock supply

and your ability to despatch outputs without causing pollution. For example, during:

- public holidays
- periods of adverse weather
- seasonal peak volumes of waste acceptance

16. You must not over accumulate wastes. You must treat wastes or remove them from the site as soon as possible. You must prioritise the treatment or off-site transfer of waste based on:

- its type
- its age on arrival
- date of arrival
- duration of storage on site

17. Storage area surfaces used for putrescible waste must be of a type and quality suitable for effective cleaning and or disinfection. You must put procedures in place and use them to make sure that surfaces are regularly cleaned or disinfected (or both).

18. You must design your storage facilities and procedures to make sure there is no cross-contamination between inputs and outputs of the process, and during the treatment cycle (where applicable). For example, during the sanitisation and stabilisation of composting waste.

19. For waste in storage you must follow the first-in, first-out principle. You must also identify and prioritise dealing with wastes with a higher risk of causing odour, litter or pest problems. You can do this by filling and emptying bays alternately or operating an all-in, all-out approach.

20. You must make your on-site waste inventory readily available.

21. You site must have safe pedestrian and vehicular access (for example, for forklifts) (at all times) to storage areas so that you can retrieve waste safely.

22. You must design bunkers, bays and pits so that waste and debris does not build-up in inaccessible

areas such as corners. You must regularly clean bunkers, bays and pits.

7.1 Above ground tank and ‘bulk’ storage

The following measures apply to all processes and operations.

1. You must locate all above ground tanks used for storing and treating waste on an impermeable surface with secondary containment.

2. You must have a drainage plan.

3. You must use tanks and associated equipment that are suitably designed, constructed and maintained.

4 You must do a risk assessment to validate the design and operation of bulk storage systems.

5. You must make sure any new tanks and equipment are leakproof and working correctly before using them.

6. You must cover all bulk storage tanks. Where possible you must contain and vent tanks and vessels through suitable abatement, or direct emission to a gas recovery system.

7. Storage systems must conform to the following CIRIA guidance:

- C535 Above ground proprietary prefabricated oil storage tank systems (where relevant)
- C736 Containment systems for the prevention of pollution

8. You must locate bulk storage vessels on an impermeable surface which is resistant to the material being stored. The surface must have self contained drainage to prevent any spillage entering the storage systems or escaping off site. Impermeable surfaces must have sealed construction joints.

9. Secondary containment (bunds) must:

- be constructed to CIRIA 736 Containment systems for the prevention of pollution (https://www.ciria.org/ItemDetail?iProductCode=C736F&Category=FREE)
- have regular visual inspections – you must pump out or otherwise remove any contents under manual control after checking for contamination
- be fitted with a high level probe and an alarm
- have tanker connection points within the bund or provide adequate containment for spillages or leakage
- have programmed engineering inspections (extending to water testing if structural integrity is in doubt)
- be emptied of rainwater regularly to maintain the containment capacity

10. You must be able to close all connections to vessels, tanks and secondary containment using suitable valves. You must fit a valve close to the tank if you have bottom outlets and have at least 2 isolation points in case of valve failure.

11. You must direct overflow pipes to a contained drainage system (for example the relevant secondary containment) or to another vessel where suitable control measures are in place.

7.2 Submerged or underground tanks

The following measures apply to all processes and operations.

1. All below-ground tanks (including those partially and fully submerged) used for storing and treating waste must be constructed with secondary containment and an engineered leak detection system. They must be constructed in accordance with CIRIA 736 or an alternative recognised standard.

2. All tanks must have alarms and cut-out systems or an inspection process designed to prevent and detect over topping and leakage.

3. All storage tanks that require additional management, including agitation, active gas

collection or aeration, must be contained and the air collected and appropriately abated or recovered.

7.3 Lagoon storage

The following measures apply to all processes and operations.

1. You must make sure lagoons and tanks used for storing composting liquors and digestate have enough capacity to account for times when the landbank is unavailable. Document these procedures in your management system. You must prearrange a contingency so you have adequate storage.

2. Lagoons must have a freeboard of at least 750mm at all times.

You must cover new lagoons with an engineered, impermeable, rigid or flexible cover. They must have gas collection and extraction to abatement or a gas recovery system. All new lagoons must be constructed in accordance with CIRIA 736.

3. Existing lagoons must be risk-assessed by a suitably qualified engineer. You must maintain the structural integrity of the lagoon. You must address and resolve any problems identified during the assessment.

4. Existing lagoons can use floating covers or a crust (formed where there is a high dry matter content) to manage emissions. Coverage must be sufficient to minimise the surface to air ratio to prevent emissions.

5. Floating covers must:

- be applied in line with manufacturers' recommendations and re-applied as necessary
- cover the whole surface area

6. You must design fixed lagoon covers to prevent emissions. Use them to prevent rainwater ingress and reduce the volume of material stored. More information on how to control emissions specifically from slurry stores is available in the intensive

[farming environmental permitting guidance (https://www.gov.uk/government/publications/intensive-farming-introduction-and-chapters)](https://www.gov.uk/government/publications/intensive-farming-introduction-and-chapters).

7.4 Storage in containers, IBCs and drums

The following measures apply to all processes and operations.

1. You must store all waste containers, for example drums and IBCs in a way that allows safe access and inspection.

2. Where practicable, you must store containerised waste under cover. Covered areas must have good ventilation. This applies to any container held in storage, reception (pending acceptance) or quarantine.

Under cover storage provides better protection for containers than open air storage and minimises production of contaminated water. Covered storage also:

- lowers temperature fluctuations that can cause a pressure build-up in containers
- reduces container degradation through weathering

3. Where wastes are known to be sensitive to heat, light, air or water, you must make sure they are protected from such ambient conditions. These storage provisions apply to any container held in any storage area, or which is being emptied, sorted, repackaged or otherwise managed.

4. You must empty, re-package or otherwise manage containerised waste under cover. If this activity could produce emissions, you must carry it out in an enclosed building with suitable air extraction, abatement and drainage.

5. All waste containers must be fit for purpose, that is:

- undamaged
- not corroded, if metal

- have well fitting lids
- suitable for the contents
- with caps, valves and bungs in place and secure
- within the manufacturers' use by date, particularly for plastic containers (this does not apply to certified compostable packaging destined for treatment)

6. You must check on a daily basis any containers (and pallets they may be stored on) for leaks and spills.

7. Containers and pallets must be made safe where there is evidence or risk of spills.

8. You must label all containers during storage in the way they were labelled at acceptance. You must handle and store containers so that the label is readily visible and continues to be legible.

9. You must deal with poorly labelled or unlabelled containers, for example, by re labelling, over drumming and transferring the container's contents.

10. You must not use containers, tanks and vessels beyond their specified design life. You must only use them for the purpose, or substances, they were designed for.

11. To minimise emissions and reduce spills, you must maintain the integrity of waste packaging at all times, until it enters the treatment process.

12. You must never throw, walk on or handle wastes in a way that might damage the integrity of the packaging.

13. You must train forklift drivers in how to handle palletised goods to minimise forklift truck damage to the integrity of containers.

14. You must design and operate your facility in a way that minimises waste handling.

15. All containers must have a lid, and the lid must be closed except when the container is being sampled, loaded or unloaded.

16. You must not stack skips containing waste.

17. You must inspect storage areas, containers and infrastructure on a daily basis. You must deal with any issues immediately. You must keep written records of the inspections. You must rectify and log any waste spills.

18. You must only move wastes between different locations on site (or load for removal off site) following written procedures. You must amend your waste tracking system to record these changes where necessary.

19. You must not carry out activities with a clear fire risk within any storage area. Examples include:

- grinding
- welding or brazing metal
- smoking
- parking normal road vehicles, except while unloading
- recharging forklift truck batteries

20. If you need to carry out maintenance which may involve for example, grinding and welding, you must first remove all flammable materials. You must then carry out a detailed risk assessment following safe systems of work or permit to work.

7.5 Transfer of waste into and from sealed tankers and containers

This section also applies to the transfer of liquid effluents, digestate and slurries.

The following measures apply to all processes and operations.

1. You must transfer the waste from or to a tanker, or to a drum or tank, in a dedicated area.

2. You must have a documented process and make sure staff are trained on how to complete checks and transfers.

3. Your staff must supervise tanker discharges or transfers.

You should book in tankers and allow the appropriate amount of time for safe transfer.

4. You must have a system to prevent a vehicle pulling away whilst still coupled. You must have measures for making sure couplings are correctly fitted. This will prevent couplings from loosening or becoming detached.

5. You must provide, maintain and clean your own couplings to guarantee their integrity and fitness. You must also:

- make sure that a coupling can withstand the maximum shut valve pressure of the transfer pump
- maintain a sound coupling at each end of the transfer hose, even when a gravity feed system is in place, and you must protect the transfer hose
- contain all leaks or drips from coupling devices using as a minimum drip trays

6. You must make sure that transfers from tankers only take place after you have completed waste acceptance checks and then only with the approval of a responsible person. You must record:

- which batch or load of material is for transfer
- the receiving storage vessel
- the equipment required, including spillage control and recovery equipment
- any special provisions relevant to that batch or load, including minimising fugitive emissions

7. You must have measures for preventing over filling such as a shut-off valve.

8. You must only transfer waste after completing a suitable verification and after compatibility testing.

9. You must unload tankers containing animal by-products using a sealed pipe. You must do this in a building fitted with an appropriately designed and engineered air collection and abatement system.

10. You must carry out routine maintenance checks on pump seals and filter pots.

11. You must have emergency containment areas for leaking vehicles to prevent pollution.

You should have a lockable isolating valve fitted to the loading connection. This is kept locked during periods when the unloading points are not supervised.

12. If you use a delivery tanker to collect and transport digestate (from AD or TAD), you must make sure there is no risk of cross-contamination, for example delivering mixed food waste and leaving with pasteurised digestate.

13. You must have systems and procedures for making sure that wastes for transfer comply with [The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (CDG) (https://www.hse.gov.uk/cdg/regs.htm)](https://www.hse.gov.uk/cdg/regs.htm) when they are packaged and transported.

14. You must retain spillages within the contained areas and collect those promptly using pumps or absorbents. You must record any spillages.

15. If you use rotary type pumps, they must be equipped with a pressure control system and safety valve.

16. You must pump liquids and sludges instead of using open movement.

7.6 Drainage

The following measures apply to all processes and operations.

1. You must inspect on a weekly basis all drainage channels, aeration channels and collection sumps to identify blockages caused by debris and condensate.

2. You must remove debris and clean the channels and sumps to prevent odour, pest infestations and maximise drainage and air flow through aeration channels.

3. You must appropriately characterise leachate or liquors sent for off-site recovery or disposal in line with WM3 (https://www.gov.uk/government/publications/waste-classification-technical-guidance). This waste is coded as either 16 10 01* or 16 10 02 depending on assessment and characterisation.

7.7 Tank inspection and maintenance

The following measures apply to all processes and operations.

1. You must monitor substrate levels in all storage tanks, vessels and lagoons used to hold liquids, sludge's and digestate.

2. Storage vessels used for liquids, sludges and digestate must have a freeboard as recommended by the plant manufacturer.

3. You must equip all storage tanks with an automatic level monitoring system and an associated alarm and cut-out out system to protect against over-filling. These systems must be sufficiently robust (for example, be able to work if sludge and foam are present) and regularly maintained.

4. A competent person must inspect tanks, pipework and fittings, following a written programme of inspection. A competent person must also determine the scope and frequency of the examination. You must work out how often to carry out these internal examinations using a risk assessment approach. This should be based on the:

- design, specified design life and intended use of tank, pipework or fittings
- age, maintenance and service history
- known and potential damage mechanisms and their rates of occurrence
- operational and thermal stresses
- influence of cyclic and pressure loadings
- bio-chemical influence of the substrate stored or carried

5. You must act on the results of all inspections and carry out any necessary repairs to make sure the tanks remain fit for service. You must keep records of the results of inspection and any repairs.

6. You must have systems in place to make sure that loading, unloading and storage are safe, considering any associated risks. This can include:

- having pipework and instrumentation diagrams
- using ticketing systems
- using key locked coupling systems
- having colour coded points, fittings and hoses
- using specific coupling or hose sizes for certain waste transfers

7. If you operate a new facility, you must cover tanks, vessels or lagoons that store or treat hazardous or liquid wastes with fixed covers.

8. The following must be fit for purpose and resistant to the wastes being stored and carried:

- pipes
- hoses
- connections
- couplings
- transfer lines

9. You must use a suitable pipework coding system (for example RAL European standard colour coding).

10. You must monitor the transfer of liquids and sludges between tanks and this must be linked to an alarm or cut-out system.

11. Your staff must supervise loading and unloading activities, either directly or using CCTV.

12. You must work out how often to carry out external inspections using non-destructive testing (NDT) methods.

13. You must schedule removing grit and sediment from storage tanks and lagoons at appropriate intervals, determined by a written programme of

inspection. Grit and sediments removed from tanks and grit traps will be a waste when discarded and therefore subject to waste regulatory control. You must not deposit them into lagoons.

Biological waste treatment: appropriate measures for permitted facilities

From: **Environment Agency (/government/organisations/environment-agency)**

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Contents

8. Waste treatment

Appropriate measures for waste treatment.

The following measures apply to all processes and operations.

1. You must not receive waste if you do not have enough capacity to store and treat it in line with your design criteria.

2. For all stages of the process, you must manage the waste to make sure the process is stable and to minimise the risk of:

- over-heating

- re-heating
- foaming
- uncontrolled biological activity
- leachate breakout

3. Waste treatment must have a clear and defined benefit and result in a fully recovered material. You must fully understand, monitor and optimise the waste treatment process to make sure that you treat waste effectively and efficiently. The treated output must be suitable for its intended use.

4. You must identify risks and characterise emissions from the process and take appropriate measures to control them at source or abate them.

5. You must have accurate and up-to-date written details of your treatment activities and process controls. The complexity of the waste you treat and the processes on site will determine the level of detail. You should include:

- information about the control system philosophy and how the control system incorporates environmental monitoring information
- simple process flow sheets that show the origin of emissions
- process instrumentation diagrams
- process flow diagrams (schematics) for waste, water and air and gas flow
- descriptions of process integrated techniques and waste water or waste gas treatment at source including their performances
- an equipment inventory, detailing plant type and design parameters, for example, time, temperature, pressure
- details of chemical reactions and the rate of reaction and energy balance
- venting and emergency relief provisions
- operating and maintenance procedures

6. You must use material flow analysis to identify potential contaminants in waste inputs, outputs and emissions; in particular where you accept packaged or bespoke waste streams.

7. You must ensure you fully understand the fate of any contaminants to make sure that you minimise, remove and recover them from the process.

You may need pre-treatment methods to minimise the carry-over of contaminants through to the treatment process.

8. You must not dilute undesired materials into the recycling or product cycle.

9. You must not proceed with the treatment if your material flow analysis indicates that losses from a process will cause:

- a breach of an Environmental Quality Standard or your permit
- a breach of a benchmark
- a significant environmental impact
- an issue in using the end material beneficially

10. You must clearly define the objectives and reaction (chemical, physical or biological) steps for each treatment process. You must define the end point to the process so that you can monitor and control the reaction.

11. You must define the suitable inputs to the process, and the design must consider the likely variables expected within the waste stream.

12. You must sample and analyse the waste to check that you have reached an adequate end point.

13. You must manage the pre-treatment of waste and biological treatment activities in a way that minimises the risk of pollution from:

- odour
- bioaerosols
- dusts
- other emissions

14. You must use plant and equipment that you can contain to minimise fugitive emissions.

8.1 Abnormal operating conditions

The following measures apply to all processes and operations.

1. You must assess the likelihood of abnormal operating conditions. You must make sure you continue to comply with permit conditions by taking steps to prevent, alert and mitigate these events. Abnormal operating conditions include:

- unexpected releases or loss of containment
- start up
- unplanned stoppages and breakdowns
- shutdown

8.2 Pre-treatment

The following measures apply to all processes and operations.

Pre-treatment may include one or more of the following:

- hand-sorting
- de-packaging
- removing contaminants, for example using screening, separation, sifting, pressing or floatation
- mixing and blending – to obtain correct carbon to nitrogen or substrate characteristic ratios
- screening and thickening, for example adding polymers
- using additives, for example trace elements
- optimising particle size, for example using shredding or maceration

1. You must make sure you carry out particle size reduction where required:

- by the animal by-products regulations for sanitisation or pasteurisation
- to optimise substrate characteristics for effective and efficient processing

2. You must make sure that particle size reduction does not simply result in smaller contaminants entering the biological treatment process.

3. You must also:

- apply the correct technology to pre-treat the waste to provide optimal substrate characteristics
- retain the correct biological conditions to biodegrade the feedstock into an output that meets expectations and is suitable for its intended end use
- comply with additional regulatory requirements, for example, animal by-products regulations

4. You must carry out the pre-treatment of putrescible wastes in a suitably designed building. This must have an air ventilation and extraction system designed to make sure you comply with any associated emission limit in your permit. The ventilation and extraction system must be connected to an appropriately engineered air abatement system or gas recovery plant. Putrescible wastes include odorous wastes, ammonia-rich wastes and wastes containing animal by-products.

You can apply a risk-based approach when designing air containment for the pre-treatment of agricultural wastes only.

5. You must demonstrate that all process equipment is made of materials suitable for use and is being used according to its design capability and the manufacturers' design life.

6. A qualified and competent person must justify and verify the use of operating plant and equipment beyond its design life, to demonstrate there is no additional risk of failure.

7. You must remove all non-compostable plastic and other contaminants in the feedstock, or reduce them to levels that are as low as reasonably practicable.

8. You must not rely solely on post-treatment technology to remove known contaminants. Where

you use hammer mills to treat packaged waste you must take additional measures to make sure that you remove non-compostable or digestible plastics before or during the process.

9. You must take measures to remove any remaining non-compostable or digestible contaminants from the final material.

10. You must be able to demonstrate the removal technology is effective at removing contaminants.

11. You must consider your pre-treatment requirements at the design stage. Pre-treatment methods must give you the flexibility you need to process the types of feedstock you plan to accept at the facility.

12. Pre-treating waste feedstock may be done off-site from a treatment facility but there must be a process to ensure that feedstock is of a high quality.

8.3 Process monitoring systems

1. You must install and operate a manual or automatic monitoring system that supports effective operational management and minimises operational difficulties. For example by displaying (visually and audibly) early warning signals to prevent system failures.

2. You must calibrate monitoring equipment and maintain your plant and equipment in line with manufacturers' recommendations and your maintenance and inspection programme. This includes, for example, doing daily and weekly inspection checks and holding records of completion.

8.4 Mechanical treatment

The following measures apply to all processes and operations.

1. You must segregate and condition the waste inputs before biological treatment. This may include:

- using shredders for opening bags
- using metal separators to extract undesirable components that might obstruct later processes
- using sieves or shredders to optimise particle size and segregate biodegradable fractions
- using air separation to segregate high calorific materials such as textiles, plastics and paper
- homogenising materials
- sterilising waste in an autoclave – before mechanical treatment

8.5 Aerobic treatment and process control

The following measures only apply to aerobic treatment.

An aerobic treatment waste facility may include the following processes (or combination of processes):

- in vessel composting (including rotating drum systems, containers and vertical towers)
- open-air windrow composting (animal by-products excluded)
- hall (housed) composting
- static aeration
- bio drying and bio stabilisation (MBT)
- thermophilic aerobic digestion (TAD)
- aerated lagoons and activated sludge (for waste water treatment)

Vessels used for batch processing of solid waste (for example in vessel composting or bio stabilisation for MBT) must be able to carry out continuous, representative temperature monitoring during sanitisation. You must link monitoring to an alarm system that you can check remotely and that gives a remote alarm notification.

To improve environmental performance and reduce emissions to air, you must monitor and control the main waste and process parameters, including:

- waste input characteristics (for example, C to N ratio, particle size, pH, porosity)

- temperature and moisture content (at different points if in a windrow)
- aeration (for example, through windrow turning frequency, O_2 and CO_2 concentrations, air stream temperatures for forced aeration)
- for windrow composting, the height and width of composting piles
- a visual and olfactory assessment of the material, to detect actinomycetes, fly infestation and odours

You can monitor the moisture content for enclosed processes before loading the waste into the enclosed composting stage. You can adjust it when the waste exits the enclosed composting stage, or when you move it from stage 1 to 2 to meet the requirements of the animal by-products regulations.

1. You must maintain optimal parameters to these ranges:

- pH 5.5 to 8.0
- particle size 10mm to 50mm
- temperature $55^{o}C$ to $70^{o}C$ (reducing after sanitisation and during stabilisation and maturation)
- moisture 60% to 65% (start of the process), 30% to 65% (during the process)
- carbon to nitrogen ratio 20:1 to 40:1

These ranges are advised optimal parameters. If you operate outside these ranges, you must justify your reasons and demonstrate there is no adverse impact on the treatment process or the environment as a result.

Temperature and moisture

2. You must monitor moisture and temperature during both treatment and storage and adjust the moisture in dry periods to prevent dusty conditions. You must keep records of monitoring data.

3. As a minimum you must monitor daily the temperature of composting waste during sanitisation and stabilisation. This can reduce to

weekly during maturation if you can demonstrate the material is stable.

4. You must install continuous monitoring where it is required in your permit or under the animal and by-products regulations (such as for catering and food waste).

5. You must locate your monitoring points so they give representative data. If you insert monitoring probes into windrows and static piles you must first work out what length of probe you will need to get representative data, based on the size of the waste pile.

6. You must get data from within the core of the pile. For example, for a 4m stack you will need a probe that is over 2m long to make sure you can take a representative sample of the core temperature. Longer windrows will require more monitoring points.

7. You must control moisture using visual control and one of the following methods, a:

- squeeze or fist test (when carried out by an experienced operator)
- moisture monitoring device with read-out or connectivity to a data capture system
- an accurate oven-drying method

8. You must periodically validate your monitoring methods, for example, by drying if you rely on squeeze tests. You must keep records of your validation tests.

If you use portable aeration pipework you must clean it after each treatment batch.

9. You must assess all the monitoring data you collect to make sure you have a continually effective and stable process and that you can:

- take action and make safe and informed processing adjustments where needed
- minimise operational difficulties
- prevent creating anaerobic conditions

10. You must minimise oxygen deficiency and avoid anaerobic conditions occurring during the composting process.

11. You should take measures against excessive moisture in the waste by:

- adding input materials with high carbon to nitrogen ratio
- balancing the mix of materials and maximising porosity
- making sure windrows are appropriately structured and the construction allows for passive drainage and temperature convection
- placing oversized material at the base of the windrow

12. You must keep a record of:

- your temperature and moisture assessments
- the watering date and the origin of water used, for example composting liquor or roof water

Sanitisation and stabilisation periods

13. You must clearly segregate composting batches undergoing sanitisation, stabilisation or maturation.

14. You must clearly label batches to allow traceability from the receipt of the waste to its despatch from site.

15. You must not combine multiple stabilising or maturing waste piles or windrows into single larger piles that could result in:

- the inability to carry out representative monitoring and safe handling
- increased fugitive emissions, odour or over-heating
- anaerobic conditions developing

The Environment Agency does not consider lock composting or deep clamp systems to be an appropriate measure because they do not allow adequate monitoring or process control.

Leachate and liquors

16. You must stop composting liquors from pooling at the base of waste piles and windrows. You can do this by:

- installing sloping ground infrastructure and appropriate drainage
- regular cleaning
- minimising over-watering

17. To minimise the risk of cross contamination, you must keep the run-off from composting liquors separate from sanitising and stabilising waste if you want to reuse liquor on stabilising waste.

18. You must not use liquor drained from waste in sanitisation and reception areas on stabilising or maturing waste.

8.6 Open air composting

The following measures only apply to open air composting.

1. To minimise dust, odour and bioaerosol fugitive emissions to air from open air composting processes, you must:

- actively manage material to prevent anaerobic conditions developing and to prevent overheating
- prevent dry and dusty conditions occurring

2. You must work out the appropriate dimensions of your windrows taking account of:

- waste type
- heat generation and loss
- space availability
- effective retention time
- aeration requirements
- monitoring capability
- seasonal variation

3. You must provide enough space between composting windrows so that:

- there is sufficient passive aeration
- plant and equipment can access the windrows without compacting the waste or causing cross-contamination

4. You must adapt your operations to the meteorological conditions. For example, by:

- avoiding turning waste, screening or shredding during adverse weather conditions
- orientating windrows so that the smallest possible area of composting mass is exposed to the prevailing wind
- locating windrows and piles at the lowest elevation within the overall site layout

5. You must:

- maintain adequate moisture and control high temperatures to prevent anaerobic conditions, bioaerosols and odour plume dispersal
- dampen roadways and working areas

6. You must also consider using one or a combination of the following techniques where bioaerosols, dust or odour are a problem:

- cover actively composting windrows using semi-permeable membranes (particularly if there is an increased risk to receptors) – using alternative targeted containment may be acceptable
- use purpose made windrow turners
- use dust and bioaerosols suppressants during turning, shredding and screening, for example, back actor water sprayers or aprons on plant
- install static aeration with an aeration system that is the correct size to deliver enough air to the waste to prevent anaerobic conditions developing

Static-pile aeration

7. You must design your aeration system to cope with differences in feedstock and the demands of the treatment process. The system must be able to treat emissions from the process.

Positive or forced aeration is not considered by the Environment Agency to be an appropriate measure to control fugitive emissions. Forced aerated piles should be additionally covered with semi-permeable membranes to prevent fugitive emissions.

Negative aeration means drawing air down through the waste into the base of the waste and provides improved control and opportunity to treat emission.

8. You must remix statically aerated composting waste periodically to prevent preferential pathways developing. Your procedures must minimise emissions during this activity.

Remixing static piles is not usually a routine operation if the windrows and aeration systems are maintained and the windrow is well-constructed.

8.7 In vessel and enclosed systems aerobic processes

The following measures only apply to in vessel and enclosed systems.

1. Batch operated treatment vessels must have localised air control and extraction systems.

2. An in vessel batch system must incorporate air extraction above the loading and unloading doors. This minimises the emissions released when the doors are opened, directing them to appropriate abatement.

3. You must regularly inspect and maintain your aeration and exhaust system to make sure it remains fit for purpose, this means it is both:

- free from debris
- functioning correctly at all times in line with designed performance specifications

8.8 Mechanical and biological treatment and mechanical heat treatment

The following measures only apply to mechanical and biological treatment (MBT) and mechanical heat treatment (MHT).

1. You must characterise your process air and gas stream inventory and manage and treat it to reduce emissions.

2. You must only recirculate waste air with a low pollutant content in the biological process.

3. You may need to condense the water vapour contained in the waste air gas before reuse. In this case, cooling is necessary. Recirculate the condensed water when possible or treat it before discharge.

4. You must treat air from negatively aerated piles and enclosed systems with an appropriately designed and engineered air abatement system. The design must treat the maximum air flow and the full range of chemical contaminants and bioaerosols the exhaust air may contain.

8.9 AD and TAD plants treatment and process control

The following measures only apply to AD and TAD plants.

1. The anaerobic treatment of waste may include a combination of multiple and complex activities. You must ensure these are listed in your permit.

2. You must identify and define all operational parameters and limits in your management system.

Digester stability

3. To reduce emissions to air and to improve the overall environmental performance, you must monitor manually or automatically to:

- make sure digesters are stable
- minimise operational difficulties

- provide sufficient early warning of system failures which may lead to containment failing and explosions

4. To demonstrate digester stability you must monitor and control the main waste and process parameters, including:

- pH and alkalinity of the digester feed
- temperature – continuously
- digester operating temperature
- hydraulic and organic loading rates of the digester feed
- concentration of volatile fatty acids (VFA) and ammonia within the digester and digestate
- biogas quantity, composition and pressure – continuously
- liquid and foam levels in the digester

5. You must define the optimum operating temperature depending on the digester's biology and system design. You must keep the digester within the optimal operating temperatures and document this in your management system.

6. You must maintain a stable temperature in the digester preventing overheating and cooling.

You should consider insulating the digester.

7. You must understand the process parameters and make changes in the feedstock and micro-nutrient dosing to:

- maintain the digester to optimum performance
- be able to demonstrate maximised efficiencies for volatile solids reduction or chemical oxygen demand (COD) reduction in the substrate

8. You must install an alarm mechanism that is interlocked so that reactor feeding automatically stops when a gas pressure alarm condition occurs.

9. You must use Supervisory Control and Data Acquisition Equipment (SCADA) to monitor, record and display data for continuously monitored parameters.

10. You must carry out a daily visible inspection of your digesters using inspection ports.

11. Feeding systems installed inside buildings must have a hazardous gas warning system. You must consider these areas as part of your HAZOP and DSEAR risk assessment.

Preventing foaming and over topping tanks

12. You must take all measures to prevent and detect foaming by:

- actively managing the assessment and digester feeding rate
- monitoring the digestate stability
- fitting high level probes or sensors on tanks used for the treatment

13. If you use foam suppressants, you must have procedures in place to support their deployment.

14. If you use chemical additions, you must have appropriate controls and procedures in place for chemical storage, handling and use.

15. You must avoid decanting sacks or drums of chemicals directly into treatment tanks or vessels. You must monitor any reactions and make sure control mechanisms are in place to manage such reactions.

16. You must equip vessels and tanks used for liquid-based waste treatment, for example anaerobic and TAD digesters, with continuous temperature and level monitoring capability.

17. You must install pressure monitoring if there is a risk of pressurisation in the vessel.

18. You must link all monitoring to an alarm system that you can monitor remotely. The alarm system must give you an audible and remote alarm notification in the event of over or under-heating and over-filling.

19. You must install mixing systems to all liquid-based treatment vessels, these may include one (or

a combination) of the following:

- mechanical stirrers using agitators
- hydraulic mixing using pumps that recirculate the substrate
- pneumatic mixing by recirculation (for example biogas in AD digesters)

20. Mixing or stirring mechanisms must be appropriate for the type of vessel used and the feedstock you are processing. This is to make sure there is:

- efficient mixing
- adequate oxygenation (TAD)
- uniform heat transfer
- sedimentation prevention

21. You must know the mixing efficiency and sediment loading in your vessels. Sediment must not impede mixing, which may lead to pressurisation or plant failure. You can demonstrate this by, for example:

- monitoring the agitation ampage of your mixing system
- using lithium tracing
- heat conduction thermal imaging

22. Tank design must:

- allow for sludge draw-off, debris and grit removal
- account for routine and expected pressure variations

23. You must also install pressure monitoring if there is a risk of over or under pressurisation in the vessel.

24. Vessels used for batch processing in solid waste systems (for example dry AD) must be able to carry out continuous temperature monitoring

8.10 Biogas production and management – AD plants

The following measures only apply to AD plants.

1. You must manage gas production volumes within the processing constraints of the facility.

2. You must have contingency measures in place and appropriately manage any excess gas produced, including when there is limited gas to grid availability during low demand periods.

3. You must use measures such as decreasing loading rate and diverting feedstock if gas demand is compromised.

4. When determining gas storage capacity, you must consider how changes in climatic conditions, such as high temperatures in the summer, affect the volume of gas for storage.

5. You must protect your biogas upgrading and energy recovery plant with flame arrestors and slam shut valves.

6. You must install a permanent back-up generator to power critical plant and equipment in the event of power failure. Critical plant and equipment would include, for example:

- lighting
- maintain the integrity of gas storage systems
- flares for preventing plant failure and to manage health and safety risks

Leak detection and repair (LDAR)

7. You must implement a leak detection programme that identifies and controls methane slippage from all processes and storage on site.

8. Your procedures must make sure propane and odorants (for example mercaptans) are handled safely.

Combustion units

9. You must inspect and maintain all gas utilisation plant and equipment, as a minimum, following

manufacturers' recommendations. You must record all routine and non-routine inspection and maintenance.

10. Gas combustion stacks must be vertical and unimpeded by cowls or caps.

11. Stacks for releasing point source emissions must have an 'effective stack height' unless otherwise stated in your permit, for example, if you operate under a standard rules permit.

12. You must monitor emissions following the requirements in your permit.

13. You must submit a record of each combustion unit and fuel type yearly.

14. You must consider whether you can use the heat from processing or combustion.

Combustion plant – medium combustion plant, specified generators and boilers

The guidance medium combustion plant and specified generators: environmental permits (https://www.gov.uk/guidance/medium-combustion-plant-and-specified-generators-environmental-permits) has more information about complying with the medium combustion plant directive and specified generator regulations.

15. You must comply with the emission limits in your permit and you must use the relevant monitoring standards.

8.11 Pressure and vacuum relief control – AD and TAD plants

1. You must install pressure relief and vacuum relief valves (PVRVs) on all tanks where there is a risk of over or under pressurisation.

2. An appropriate qualified engineer must design the PVRVs and gas pipework fitted to your biogas storage vessels.

3. You must demonstrate that PVRVs are able to and can cope with the anticipated maximum gas production volumes and pressures to operate within the design of the plant.

4. For all tanks, pipes and vessels where PRVs are fitted the plant manufacturer must provide design pressures.

5. You must only use PVRVs designed, tested and manufactured in line with recognised standards such as BS EN ISO 28300:2008 or API2000.

6. You must design and monitor gas production rates and organic loading so the excess pressure in the tank does not exceed the ISO28300 or AP12000 certified leak test rate of the PVRV.

7. Pressure relief valves and gas pipe work must be able to cope with the anticipated maximum gas production volumes and pressures. Under the highest gas flow scenario, back pressure on tanks containing biogas must be less than the maximum allowable operating pressure and more than the minimum operating vacuum.

8. When determining pressure set points you must consider:

- that maximum operating pressure must be no higher than the certified leak test pressure
- the pipework dimensions

9. You must incorporate gas production rates in the calculated maximum flow rates for the following conditions:

- changes in temperature
- changes in atmospheric conditions
- safety requirements.

10. Valves must be set so that they do not produce fugitive emissions during normal tank pressure fluctuations.

11. You must fit pressure sensors to your digestion tanks and gas storage vessels. You must maintain

safe operating pressure by managing gas production and directing biogas to:

- gas storage
- treatment
- utilisation plant
- flare

12. You must specify a maximum pressure for each digester above which there is no further feed to the digesters.

13. If excess gas pressure builds up in the tanks this must trigger an alarm which immediately instigates the venting systems.

You should locate pressure relief and vacuum devices independently from gas off-take lines and install stand-by valves to allow for down time during maintenance.

14. You must inspect, maintain and calibrate PRVs regularly and after foaming or over topping events. You must inspect and protect PVRVs against environmental and climatic conditions, for example by providing frost protection and barriers to prevent damage.

15. You must incorporate isolating valves so you can remove PVRVs from a live system for maintenance without producing large fugitive emissions or compromising site safety.

16. You must locate isolation valves before a fully bolted spool under PVRVs so they can be removed without affecting security of the isolating valve.

17. You must record the gas pressure.

18. Data logging on SCADA must be in place to record release events within operational pressure ranges. You must record the date, time and duration of the release. You must not make modifications to the PVRV without manufacturer's approval or you will void the ATEX classification and you will not meet DSEAR Regulations.

19. You must record gas pressure events that are out of the expected operating range, including the date, time and duration of the pressure relief events.

PRVs inspection and calibration

20. You must correctly calculate the safety set point of PRVs. You must review these when there are changes to the operating process. You must then do any required adjustments.

21. A competent person must correctly set and fit each PVRV.

22. All PVRVs must be correctly maintained and inspected, following manufacturers' recommendations. You must have an agreed, written scheme of examination in place for their inspection and maintenance.

23. You must be able to demonstrate that a qualified engineer checks PRV function, and caries out testing and maintenance.

24. You must give your personnel safe access to all PVRV's.

25. The PRV manufacturer must provide the certified capacity flow curve of the PRV and demonstrate that the test was completed according to BS EN ISO28300 or API2000 on approved test apparatus.

26. Each PVRV must have a current functional test certificate based on BS EN ISO28300 or API2000 procedures for production testing. This certificate will include details of the retained pressure at specified flow rates. This figure must exceed 75% of the set point using calibrated and independent measurement technology.

27. The test certificate is valid for 3 years from the date of production or the previous test. You will need to get an earlier revalidation and certification if the following is evident or has occurred:

- maintenance inspections indicate that the contamination build up is excessive
- corrosion
- a foaming incident
- tank overfill

8.12 Biogas treatment and storage – AD plants

The following measures only apply to AD plants.

1. You must prevent the emission of uncontrolled release of biogas and biomethane.

2. You must inspect, maintain, routinely test and keep a record of all gas storage and treatment plant and equipment following the manufacturers' recommendations or your inspection regime.

3. You must identify the intended end use of the biogas to determine the appropriate treatment method. You must consider the following factors:

- dewatering
- removing hydrogen sulphide which may corrode gas engines
- removing oxygen and nitrogen
- removing ammonia
- removing siloxanes, particularly from digesting sewage sludge
- removing particulates
- removing carbon dioxide particularly when upgrading from biogas to biomethane
- adding propane to improve calorific value for biomethane gas grid injection

4. You must assess hydrogen sulphide levels in the biogas to determine the efficiency of the removal methods applied. You should do this by monitoring gas quality before and after using gas cleaning equipment.

5. You must continuously monitor biogas flow, quality, pressure and composition. Monitoring systems must be interlocked where possible and have remote alarm capability.

6. You must remove water (condensate) from the biogas to protect the collection system, energy recovery plant and auxiliary flare. Condensate must be discharged into a contained drainage system or recirculated back into a digester. Condensate storage must not produce odorous emissions.

7. You must collect biogas from all digesters and all other treatment and storage vessels where methane is actively generated.

8. Biogas storage facilities must be gas tight, pressure-resistant, weather proof, and resistant to ultraviolet light and fluctuations in temperature.

9. You must not allow biogas and air to mix unless it is used for desulphurisation. If you use oxygen to desulphurise biogas you must automatically monitor oxygen levels. You must also use high-level alarms which are set to automatically stop adding air before the lower explosive limit is reached.

10. If you use carbon filters, for example to clean gas before combustion, you must use procedures that minimise the risk of exothermic reactions during their maintenance, for example, by purging with nitrogen. You must contain and treat purged gases.

Flares or surplus gas burners

11. You must install or have a gas flare available for use at all times. You must not routinely use flares or vent directly to the atmosphere.

12. You should use enclosed (ground) design flares on all new plants. They should be capable of achieving a minimum of 1,000^{o}C with 0.3 seconds retention time at this temperature.

13. On existing sites where shrouded or open flare are installed you must make sure that gas can effectively combust to destroy trace elements.

14. You must make sure that the finish on the exterior of the flare is weatherproof as well as heat-resistant. The structure of the flare must be designed to withstand wind stresses.

15. You must protect ancillary items such as control and instrumentation equipment, including cabling. Providing housing makes maintenance tasks easier, but you must consider any explosion hazards.

16. You must minimise the operation of the flare and use it only for emergencies and during maintenance to protect the integrity of the plant (for example, during start-ups or shutdowns).

17. You must specify measures in your procedures to minimise flare use during routine maintenance. This includes, for example, to:

- reduce feed rates to lower gas production
- increase the safe storage of gas where capacity is available
- install stand-by gas utilisation plant

18. You must monitor and record the use of your flare. Your records must include the date, duration and number of flaring events.

19. Your SCADA systems must be able to continuously monitor gas flow and when the flare is activated.

20. You must be able to quantify emissions if required and identify any potential improvements that would reduce flaring events.

21. You must routinely measure other parameters, for example:

- composition of gas flow
- gas temperature
- ratio of assistance
- velocity
- purge gas flow rate

22. You must routinely measure pollutant emissions, for example:

- oxides of nitrogen (NOx)
- carbon monoxide (CO)
- VOCs

23. Monitoring and interlocking must be linked to your SCADA system.

24. Flares must be automatically activated when the quantity of biogas exceeds a set maximum limit and before venting of biogas occurs.

25. During commissioning, you should consider lean burn flares where gas quality is poor to prevent venting and pollution.

Flare noise

26. Flares can cause noise. This can come from the vents, the combustion process and smoke suppressant injection. You must design new flares to minimise noise emissions.

Noise avoidance can include the following measures:

- reducing or attenuating the high-frequency steam jet noise by using multi-port steam injectors – designing the orifice to cope with potential coke formation is essential
- installing the injectors in a way that allows the jet stream to interact and reduce the mixing noise
- increasing the efficiency of the suppressant with better and more responsive forms of control
- restricting the steam pressure to less than 0.7MPa gauge
- using a silencer around the steam injector as an acoustic shield for the injectors
- using enclosed ground flares

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9. Outputs

Appropriate measures related to the outputs from the waste treatment process.

9.1 Record keeping for treatment outputs and residues

The following measures apply to all processes and operations.

1. You must record in the waste tracking system:

- that you have treated a waste

- what output materials you have produced and their weight
- what the treatment residues are and their weight

2. You must keep records of recovered and certified 'non-waste' materials leaving the site, including the:

- type of material
- batch number
- date of export off-site
- tonnage exported off-site
- area dispatched to

9.2 Outputs from aerobic processes – compost

The following measures apply to all processes and treatments from aerobic processes.

1. Material stored after composting and screening must not cause pollution and you must demonstrate it is stable.

2. You must use the correct LoW code and description for the waste outputs you produce.

3. You must only describe your waste compost as 'off-specification' using LoW 19 05 03 if it has completed the composting cycle and 1 or more of the following criteria apply, it:

- does not meet a market specification such as publicly available specification (PAS) 100 – for example, it has failed a PAS 100 test parameter
- is composed of waste not listed in the Compost Quality Protocol
- is composed of waste not considered typically suitable for biological treatment, for example from the waste types listed in relevant standard rules permits
- is not certified compliant with the Compost Certification Scheme

You cannot describe your compost as 'off-specification' for waste that has only been through sanitisation (and not stabilisation). This is because it has not completed a full compost treatment. It must be sanitised and stabilised before you can be described it as compost.

4. You must correctly characterise and describe partially treated (sanitised) waste that will be transferred off-site to complete the composting process elsewhere. This waste is either 19 05 01 or 19 05 02. LoW 19 05 03 should not be used for classifying sanitised only waste.

9.3 MBT and MHT outputs

Waste outputs from MBT or MHT are described as either compost like output (CLO) or refuse derived fuel (RDF).

These outputs are not suitable for use on agricultural land. For more guidance on applying these outputs to non-agricultural land read the guidance How to comply with your landspreading permit (https://www.gov.uk/guidance/landspreading-to-improve-soil-health).

The waste code for these outputs is 19 12 12 – compost like output derived from residual waste streams.

If you export RDF you will need to notify this under the transfrontier shipment regulations – see the guidance about importing and exporting waste (https://www.gov.uk/guidance/importing-and-exporting-waste#waste-shipment-controls).

9.4 Outputs from anaerobic processes – digestate

1. You must test your digestate to confirm that it is stable and has minimal biogas potential to prevent fugitive emissions.

Digestate separation

2. You must separate digestate in a way that prevents or mitigates emissions.

3. Where digestate is from food waste, you should treat it in a building with an appropriate air ventilation and extraction system. This must direct exhaust air to an abatement system or for recovery. You must design the extraction system so that:

- it provides a safe working environment
- air exchanges meet the recommended ventilation standards

4. You must effectively minimise fugitive emissions from dewatered digestate fibre and digested sewage sludge cake. This applies to all stored material. For example, you must store it:

- under a suitable cover
- in an enclosed building fitted with an air ventilation and extraction system
- in field stores in line with farming rules for water (https://www.gov.uk/government/publications/applying-the-farming-rules-for-water/applying-the-farming-rules-for-water)

5. You must separate and process digestate on an impermeable surface with a contained drainage system that meets CIRIA 736.

Composting digestate fibre

6. If you compost digestate fibre, you must compost it following the requirements for the aerobic treatment of waste.

7. You must compost digestate fibre to promote aerobic conditions either in:

- an enclosed building fitted with a suitably designed ventilation, extraction and air abatement system
- the open, either with negative aeration connected to an appropriate air extraction system with abatement, or a suitable covered system

8. You must control the risk of bioaerosols and demonstrate this by carrying out a site specific risk assessment.

Drying digestate

9. You must contain, collect, extract and treat all the emissions generated when drying digestate by applying heat.

10. All extraction and abatement systems must be appropriately engineered, sized and designed to a relevant industry standard to treat the emissions produced. These emissions may include:

- ammonia
- residual biogas
- odorous chemicals
- particulates and bioaerosols

11. You must consider within your risk assessments any health and safety hazards associated with all of your digestate treatment and storage areas. For example:

- biogas release from processing digestate
- potentially creating confined spaces within bunds and buildings

12. You must comply with health and safety regulation concerning DSEAR and confined spaces.

Ammonia recovery from drying digestate

13. You must have the activity in your permit and comply with any relevant emission limits.

14. Raw materials used in this process must be stored in areas with secondary containment. Ammonia must be stored safely in a building.

15. The end user must comply with the farming rules for water and landspreading guidance.

Contingency measures

16. You must have contingency measures for managing any untreated or unscreened digestate in the event of technology failure. You must consider potential hazards (for example the release of

residual biogas emissions and ammonia) and manage these in line with appropriate measures.

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10. The Control of Major Accident Hazard Regulations 2015 (COMAH)

COMAH related appropriate measures for biological waste treatment.

The following measures apply to all processes and operations.

The COMAH regulations apply to establishments holding dangerous substances above certain quantities, known as thresholds.

The thresholds for dangerous substances at which the COMAH regulations apply can vary. It depends on the combination of quantities of dangerous substances you store on site.

Examples of dangerous substances include:

- diesel and other petroleum products
- LPG (liquefied petroleum gas) including propane and butane
- raw and treated biogas

You must work out if the COMAH regulations apply to your activities. To do this, check the Health and Safety Executive (HSE) guidance on the COMAH regulations (https://www.hse.gov.uk/pubns/books/l111.htm). This lists all the substances covered by the regulations.

Contact HSE (https://www.hse.gov.uk/contact/index.htm) if you need more information on the COMAH regulations.

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11. Emissions control

Emissions control related appropriate measures for biological waste treatment.

1. You must review your activities to identify opportunities to minimise and where possible contain, treat and abate emissions.

2. All air and emissions treatment (including gas clean-up) must be engineered, commissioned and validated by a chartered engineer.

3. Equipment must be tested, operated and maintained following manufacturers

recommendations, operational requirements and design criteria.

4. When determining the complexity of the control measure you need to apply you must consider if you need to comply with mandatory AEL. Otherwise you can follow a risk based approach and must consider the:

- inventory of emissions
- type or composition of emissions, for example dust, bioaerosols, odour, organic compounds or litter
- source of emissions
- site location and proximity to sensitive receptors
- the impact on any sensitive receptors
- likelihood of release, taking account of seasonal and process variations
- measures you can take that will break the source pathway receptor relationship

11.1 Emissions inventory

The following measures apply to all processes and operations.

1. You must identify, characterise and control all emissions (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit) from your activities that may cause pollution. This includes all emissions to air and water (including emissions to sewer) from your facility.

2. Your emissions inventory must include information about the relevant characteristics of the emission to air and water, such as:

- flammability, lower and higher explosive limits and reactivity
- other substances present that may affect the waste gas treatment system or plant safety (for example, oxygen, nitrogen, water vapour, dust)
- average and maximum values and variability of flow, pH, temperature, and conductivity
- average and maximum concentration and load values of relevant substances and their variability

– for example, COD and TOC, nitrogen species, phosphorus, metals, priority substances or micro pollutants speciated organic compounds and ammonia
- data on bio eliminability – for example, BOD, BOD to COD ratio, Zahn Wellens test, biological inhibition potential (such as, inhibition of activated sludge)

11.2 Emissions monitoring and limits

The following measures apply to all processes and operations.

We may set emission limits and monitoring requirements in your permit, based upon your emissions inventory and environmental risk assessment (https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit). We may set additional limits and monitoring requirements for certain processes, for example dust and total volatile organic compounds.

1. Where you are required to monitor emissions to comply with the requirements of your environmental permit you must follow our monitoring guidance (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#monitoring-your-emissions).

2. For relevant emissions to water or sewer identified by the emissions inventory, you must monitor key process parameters (for example, waste water flow, pH, temperature, conductivity, or BOD) at key locations. For example, these could either be at the:

- inlet or outlet (or both) of the pre treatment
- inlet to the final treatment
- point where the emission leaves the facility boundary

11.3 Meteorological conditions

1. You must monitor and record meteorological conditions or have access to meteorological data

for the site location. This is so you can forecast wind speed, air temperature and wind direction.

2. You must put weather monitoring stations at appropriate locations on your site.

3. You should calibrate meteorological monitoring equipment every 4 months or follow manufacturers' recommendations.

11.4 Bioaerosols

1. You must take measures to minimise the release of bioaerosols from your process.

2. You must document potential bioaerosol emission sources and identify measures to minimise their release. Measures include, for example:

- processing waste promptly and monitoring it according to defined processing conditions
- taking corrective measures to address unfavourable conditions
- using slow-speed shredders in sensitive locations with misting devices fitted or carrying out these activities in covered areas
- taking into account meteorological conditions when managing activities
- avoiding activities such as turning and shredding in unfavourable meteorological conditions
- stopping activities when the wind is blowing in the direction of sensitive receptors
- dampening haul roads and processing areas and stopping activities when the wind is blowing in the direction of sensitive receptors
- using static aeration and covering piles where possible and practicable

3. If your facility is within 250 metres of a sensitive receptor, you must:

- write and implement a site specific bioaerosol risk assessment
- monitor bioaerosols to make sure that the control methods you have stated are effective

4. You must implement the control measures identified in your risk assessment. You must also consider the exposure of staff and visitors and take measures to avoid or reduce prolonged exposure to bioaerosols.

11.5 Emissions of odour

The following measures apply to all processes and operations.

1. You must develop and implement an odour management plan (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#odour).

2. Where you expect odour pollution at a sensitive receptor, or it has been substantiated, you must monitor:

- using dynamic olfactometry following EN 13725 to determine the odour concentration
- to EN 16841 1 or 2 to determine the odour exposure
- to an alternative ISO, national or other international standards

3. You must review your odour management plan as part of your environmental management system. It must include all of the following elements:

- actions and timelines to address any issues
- a procedure for doing odour monitoring
- a procedure for responding to identified odour incidents, for example, complaints
- an odour prevention and reduction programme designed to identify the source(s), to characterise the contributions of the sources and to implement prevention and reduction measures

11.6 Point source emissions to air

The following measures apply to all processes and operations.

The Environment Agency views all abatement and gas clean up systems as point source channelled emissions regardless of whether they are open or have a stack.

1. To reduce point source emissions to air (for example ammonia, dust, organic compounds and odorous compounds) from your biological treatment process, you must use one or more of the relevant abatement techniques, such as:

- bio filtration, bio trickling or bio scrubbing
- scrubbing (for example wet or chemical)
- adsorption, for example activated carbon
- thermal oxidation
- fabric filter – for mechanical biological treatment to remove dust

2. You must assess the fate and impact of the substances emitted to air, following the Environment Agency's air emissions risk assessment methodology.

3. To make sure the abatement system is effective in treating odorous and other emissions you must monitor and maintain your abatement to achieve optimum conditions at all times.

To demonstrate effective control, monitoring and assessment may include the following parameters:

- gas flow or loading rate
- bacterial viability (applicable to bio-oxidisation treatment systems)
- pH
- acid growth (indicated by pH)
- gas temperature
- pollutant removal efficiency rate
- chemical injection (redox potential – applies to chemical scrubbing and bio-oxidisation systems)
- spent solutions (for waste recovery or disposal)
- humidity or moisture content
- back-pressure
- thatching and compaction of media in biofilters (thatching is forming a natural barrier to prevent

the ingress of additional water to the surface layer)

- channelling (preferential pathways for gas flow) and vegetation growth in biofilters
- ammonia, hydrogen sulphide and odour concentrations (in both input and exhaust gas streams)
- energy requirements for providing adequate and continuous airflow

4. You must observe trends and changes over time which could indicate that additional maintenance or replacement is needed.

5. You must have:

- procedures to deal with a loss in abatement efficiency due to toxic compounds
- a program of filter media replacement which is informed by performance and condition
- a program to replenish chemical reagents in abatement scrubbers
- procedures for commissioning new filter media or abatement

6. At least once a year, you must carry out an efficiency assessment of your abatement system.

Biofilters (open and closed fixed bed systems)

The following measures apply to all processes and operations.

7. You must use a filter bed material that is suitable for maintaining bacterial communities and that will hold its structure integrity.

8. You must consider water retention capacity, bulk density, porosity, surface area, nutrient viability and particle size.

9. The biofilter must be connected to a suitable ventilation and air circulation system. It must provide uniform waste gas distribution through the bed and enough residence time to make sure treatment takes place.

10. You may need to pre-treat the waste gas before it enters the biofilter, for example, with a water, acid or alkaline scrubber. You must make sure you pre-treat the waste gas if chemicals in untreated gas can poison the biofilter, for example ammonia.

11. You should design biofilters on a modular basis so they can keep operating during staged refurbishment.

12. You must drain any liquid which accumulates in the base of the biofilter to an appropriate leachate collection or treatment system.

13. The pipework to the biofilter must be made from corrosion resistant materials. It must incorporate low drain points to prevent the build-up of condensate, corrosion and loss in efficiency.

14. You must monitor your biofilter for the following:

- gas inlet temperature (inlet and outlet on closed systems)
- gas inlet flow rate (inlet and outlet on closed systems)
- filter media moisture
- thatching and compaction using back-pressure measurement
- pH (this should be monitored from the biofilter drainage effluent)
- gas inlet humidity
- gas inlet and outlet concentrations for ammonia, hydrogen sulphide and odour
- bacterial viability

15. You must visually monitor your biofilter for:

- vegetation, moss and fungus – the media must be in good condition and clear of vegetation, you can use a photographic record of the media bed to see how it changes over time
- media depth to identify decomposition and compaction over time – you can do this using vertical rulers located in the biofilter bed
- surface condition – to identify any channelling, gaps or signs that the biofilter bed is shrinking

- irrigation – to identify wet and dry spots and the uniformity of any sprinkler systems

16. You must maintain your biofilter with a vigorous and healthy microbial community operated at optimum designed values. You should periodically review:

- media health, for example bacterial viability, particle size distribution and depth
- volumetric air flow or surface air flow distribution in open biofilters
- emission removal efficiency, for example odour removal

Calculate removal efficiency using the concentrations sampled from the biofilter inlet and outlet.

17. You must carry out periodic sampling to make sure your abatement system is functioning as designed and is able to treat and mitigate emissions.

18. You must re-mix or replace biofilter media, either during planned routine maintenance or more frequently if your monitoring assessment identifies it is needed.

For other key monitoring parameters and information on biofilters, see Understanding Biofilter Performance and Determining Emission Concentrations under Operational Conditions (https://www.sniffer.org.uk/er36-final-report-for-publication-pdf).

Pre-treatment abatement scrubbers

The following measures apply to all processes and operations.

19. You must select the most appropriate aqueous absorbing solutions for treating pollutants in the waste gas stream. Where you have identified a mix of pollutants you may require a multi-stage process.

Flow rates must allow for sufficient gas residence time and minimise carry-over of scrubbing solution into the waste gas stream.

20. You must monitor your abatement scrubber for the following:

- gas temperature and flow rate, inlet and outlet
- moisture content or humidity
- back-pressure, for packing scrubbers
- pH of scrubber solution
- chemical injection rate (redox potential)

21. You must continuously monitor the scrubber solution for:

- flow rate
- pressure
- temperature
- pH

You should periodically measure the inlet and outlet of the scrubber for:

- ammonia
- hydrogen sulphide
- odour.

Activated carbon

The following measures apply to all processes and operations.

22. You must monitor your activated carbon filter for the following parameters:

- inlet and outlet gas temperature and flow rate by continuous monitoring
- inlet moisture content or humidity
- back-pressure
- carbon bed temperature
- ammonia
- hydrogen sulphide
- odour

23. You must make sure you either replace or regenerate the carbon before saturation.

24. You must make sure the concentrations of volatile organic compounds within the gas stream are below their lower explosive limit.

25. You must make sure you follow the manufacturers' recommended maximum operating temperature.

26. You must use a cooling system if you exceed the upper temperature limit.

27. You must minimise particulates in the waste gases before they reach the carbon filter.

28. You must not allow exothermic reactions when maintaining activated carbon filters.

29. You must store activated carbon safely to prevent spontaneous combustion. You must store it following supplier or manufacturers' recommendations.

Stacks and vents

The following measures apply to all processes and operations.

30. Stack or stack and vents must release at an appropriate height, temperature and velocity to make sure the emissions disperse well. You must use dispersion modelling to demonstrate the emissions do not impact on sensitive receptors.

31. You must install a suitable monitoring point on stacks and vents with appropriate safe access.

32. You must monitor emissions following the Environment Agency guidance on monitoring stack emissions (https://www.gov.uk/government/collections/monitoring-stack-emissions-environmental-permits).

11.7 Masking agents, chemical neutralising agents and topical barriers

The following measures apply to all processes and operations.

1. You must only use masking agents, chemical neutralising agents and topical barriers together with comprehensive process management control. Any topical chemical barrier must be approved for use.

You should use masking or chemical treatments (for example neutralising agents) to destroy or to reduce odorous compounds.

2. Using chemical treatments must not affect the quality of the compost or digestate.

3. You must take care when using masking agents (for example deodorisers) as these may cause pollution and amenity impacts.

4. You must only use topical barriers, where you can achieve the following conditions, you:

- can demonstrate you apply the barrier in line with manufacturer's instructions
- maintain records of the application rate, time and conditions
- continue to monitor other process parameters for example, temperature and moisture

5. You must review your water-efficiency measures when considering the use of neutralising agents and topical barriers.

11.8 Fugitive (diffuse) emissions to air

The following measures apply to all processes and operations.

1. You must use appropriate measures to prevent emissions of odour, ammonia, dust, bioaerosols and particulates, mud and litter (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#dust-mud-and-litter).

2. You must design, operate and maintain plant in a way that prevents or minimises fugitive emissions to air, for example by:

- limiting drop heights
- using wind barriers
- using gravity transfer rather than pumps

This also applies to associated equipment such as:

- screeners
- shredders
- conveyors
- skips or containers
- building fabric, including doors and windows
- pipework and ducting

3. You must use high integrity components, for example seals or gaskets or leak test certificated PVRVs.

4. You must have a programme of work that covers the maintenance of all plant and equipment. This must also include protective equipment such as curtains and fast action doors used to prevent and contain fugitive releases.

5. You must identify the frequency of maintenance in your management system. As a minimum you must follow manufacturers' recommendations.

6. To identify and manage wastes that could cause, or are causing fugitive emissions to air, you must do:

- pre-acceptance checks
- waste acceptance checks
- site inspections

7. When you identify any such wastes you must:

- take appropriate risk-assessed measures to prevent and control emissions
- prioritise their treatment or transfer

8. Where necessary you must use a combination of one or more of the following measures:

- cover any conveyers, hoppers, container that are outside
- store and handle the waste within a suitably enclosed area (for example bays), a building or enclosed building
- keep doors closed except when access is needed
- use an appropriate abated air circulation or extraction system to keep enclosed buildings and equipment under adequate negative pressure, locating air extraction points close to potential emission sources
- use fast-acting or 'airlock' doors that default to closed
- use suitable covers (these can include textile sheeting, synthetic membranes and organic materials such as straw and woodchip) – the choice of cover depends on the risk to receptors

You should install localised containment, for example air extraction over a waste shredder, to minimise and treat air.

You should install ventilation to BS EN 13779:2007 or follow the HSE Exhaust Ventilation Guide (https://www.hse.gov.uk/pubns/books/hsg258.htm).

You must use suitably qualified engineers to design and install systems and make sure relevant standards are applied. The HSE provides guidance on selecting, using and maintaining local exhaust ventilation (LEV) correctly (https://www.hse.gov.uk/pUbns/indg408.htm).

9. You must review the integrity and containment effectiveness of any building, covers and contained air systems during commissioning. You must then do this periodically following manufacturers guidelines, or at least every 2 years.

10. You must carry out assessments to recognised standards, for example BS EN ISO 9972:2015.

You can use a smoke test to identify emission leaks from buildings. This may show where you need to make improvements before you carry out a more thorough survey.

11. You must replace or repair damaged building, containers covers as soon as possible.

12. You must stop using any vessel or tanks immediately if their integrity is compromised.

13. You must regularly inspect and clean all waste storage and treatment areas and equipment, including conveyor belts. You must identify the frequency of inspection and cleaning in your management system.

14. You must take measures to prevent plant and equipment, conveyors and pipes corroding. This includes using appropriate construction materials, corrosion inhibitors and regularly inspecting and maintaining plant.

15. You must consider dampening potential sources of fugitive dust emissions with water or fog, for example when turning open windrows or on areas where traffic moves.

16. You must prevent or minimise litter.

17. You must stop outdoor processing activities, for example waste shredding or windrow turning when weather conditions may either:

- increase the risk of impact on local receptors
- cause wind-blown litter, dust, odour or bioaerosols

If you need a dust management plan (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#emissions-management-plan-for-dust), you must develop and implement it following our guidance.

11.9 Leak detection and repair

The following measures only apply to:

- anaerobic digestion (AD)
- mechanical-biological treatment (MBT)
- thermophilic anaerobic digestion (TAD)

1. You must implement a leak detection and repair (LDAR) plan. It must link to your regular monitoring, maintenance and Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) plan. You must use it to quickly identify and carry out repairs, or to replace plant and equipment.

2. The LDAR plan must include:

- a map of the site and an inventory that identifies locations (point and area sources) for potential emissions
- a method for locating unknown emission sources
- estimates of the type and volume of release from each leak location
- prioritised locations (from highest risk to lowest risk) based on the potential quantity of release, its environmental impact, and DSEAR
- your monitoring methods and frequency to quantify significant emissions
- mitigation measures

3. You must consider all potential sources of leakage within your LDAR plan, for example:

- double membrane roofs (air blower vent)
- roof and cover fixings
- pressure relief valves and vents
- feeding and digestate separation units
- gas pipes
- conveyors and presses
- compressor
- combined heat and power plant (methane slippage)
- gas upgrading plant
- grid injection
- reception storage
- digestate storage
- pits and sumps, for example condensate pits
- building containment

4. You must identify and reduce emissions of volatile organic compounds and other substances to air.

Methods for identifying leaks include:

- sniffing using organic compound analysers and bag sampling, carried out to the requirements of EN15446 standards and the US Environmental Protection Agency (EPA) Protocol for Equipment Leak Emission Estimates (https://www3.epa.gov/ttnchie1/efdocs/equiplks.pdf) referenced within this international standard
- optical gas imaging (OGI) using hand-held cameras to enable visualisation of gas leaks

Methods for quantifying emissions include:

- solar occultation flux (SOF)
- differential absorption light detection and ranging (DIAL)

EN 17628 provides guidance on using multiple monitoring techniques for LDAR programmes.

Information on methane leakage from AD plants is available in:

- the Department of Business, Energy and Industrial Strategy's Methodology to assess methane leakage from anaerobic digestion plants (https://www.gov.uk/government/publications/methodology-to-assess-methane-leakage-from-anaerobic-digestion-plants)
- the International Energy Agency's Methane emissions from biogas plants (https://www.ieabioenergy.com/wp-content/uploads/2018/01/Methane-Emission_web_end_small.pdf)

5. You must include the following LDAR survey details in your LDAR plan.

Details of the site where the LDAR survey was carried out, conditions at the time of the survey, and measurement objectives, including:

- site name
- operator name
- permit number
- site processes (under normal operating conditions)

- date of the survey
- site operation on the date of the survey (for example, operating at full capacity or reduced load due to X and Y)
- weather conditions (including temperature, wind speed and wind direction)
- measurement objectives (for example, targeted processes, site areas)

Details of the organisation and personnel carrying out the LDAR survey, including:

- name and address of the monitoring organisation
- names, experience and qualifications of the personnel carrying out the monitoring
- accreditation status of the monitoring organisation
- documented procedures used for the LDAR campaign and reporting
- quality assurance or quality control criteria
- name of the person approving the report for the monitoring organisation
- the signature of the person approving the report

Details of the detection equipment used for the survey, including:

- make, model and serial number of the detection equipment used for the survey
- methane detection limit of the detection equipment (for example, ≤60g/hr (OGI cameras), <10ppm (sniffer devices))
- if an OGI camera is used, the spectral range of the camera (μm)
- certification or verification status of the OGI camera (for example, to US EPA OOOOa specifications)
- calibration certificates for the equipment (if applicable)

Details of the survey carried out, including:

- areas of the site that were surveyed
- areas of the site that were not surveyed – including a reason why those areas were not

surveyed

- leak definition used for the survey (for example, 500ppm, or detectable by the specified OGI camera at Xm)
- distance from which components were surveyed
- duration of measurements, at individual components and specified site areas

Details of result monitoring, including:

- list of leaks identified during the survey
- annotated plan of site (or piping and instrumentation diagram) showing the precise locations of the identified leaks
- time when each leak was identified
- a description of each leaking component identified (for example, valve, flange and so on) – include the component reference number where available
- a photograph of the leaking component showing the leak location
- severity of the leak – the measured methane concentration or leak rate, or the risk posed due to the component type and location (or both)
- emission estimate in kg/h for each component surveyed
- total site emission rate in kg/h, including uncertainty
- any non-conformities against the quality assurance or quality control procedures

The repair schedule must include a proposed timescale for repairing the identified leaks, with justification (based on the severity of the leak or potential risk).

6. You must produce the LDAR plan using the techniques included in the following standards:

- BS EN 15446:2008, Fugitive and diffuse emissions of common concern to industry sectors – Measurement of fugitive emission of vapours generating from equipment and piping leaks
- BS EN 17628:2022, Fugitive and diffuse emissions of common concern to industry sectors – Standard method to determine diffuse

emissions of volatile organic compounds into the atmosphere.
- BS ISO 15259:2023, Air Quality – Measurement of stationary source emissions – Requirements for measurement sections and sites and for the measurement objective, plan and report

11.10 Pests

The following measures apply to all processes and operations.

1. You must manage waste in a way that prevents pests and vermin.

2. You must make your pest and vermin management plan (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#pest-management-plan) part of your environmental management system and it must include procedures for:

- inspecting for pests and vermin and for controlling them
- rejecting loads of infested waste
- treating pest and vermin infestations promptly
- storing, handling and using approved pest and vermin control products

Information on using pest control chemicals at work is available from the HSE (https://www.hse.gov.uk/chemicals/using.htm).

Fly prevention and management

3. Making sure you implement fully all appropriate measures will proactively decrease the incident of flies on site.

4. You must have a process to count and record the number of flies on site.

5. You must have a process to investigate and resolve fly infestation.

6. You must reject maggot and fly infested waste.

7. You must make sure you have effective cleaning and housekeeping.

8. You must use fly treatment equipment and chemicals where approved and appropriate.

The HSE require that anyone using pesticides professionally should have received adequate instruction, training, and guidance in their correct use.

9. Under the COSHH Regulations (2002) you must document all activities involving pesticides (for example, storage, use and disposal). You must keep these records for a period of at least 3 years.

10. You must use all knockdown sprays, pesticides and larvicides according to the manufacturer's instructions and licence.

You may be required to submit a pest management plan for approval by the Environment Agency.

11.11 Emissions of noise and vibration

The following measures apply to all processes and operations.

You should locate potential sources of noise (including building exits and entrances) away from sensitive receptors and boundaries.

1. You must locate buildings, walls, and embankments so they act as noise screens.

2. You must use measures to control noise, including:

- maintaining plant or equipment parts which may become more noisy as they wear out (for example, bearings, air handling plant, the building fabric, and specific noise attenuation kit associated with plant or machinery)
- closing doors and windows to prevent noise breakthrough
- avoiding noisy activities at night or early in the morning

- minimising drop heights and the movement of waste and containers
- using white noise reversing alarms and enforcing the on site speed limit
- using low noise rated equipment (for example, drive motors, fans, compressors, pumps)
- adequately training and supervising staff
- providing additional noise and vibration control equipment for specific noise sources (for example, noise reducers or attenuators, insulation or sound proof enclosures)

3. You should have a noise and vibration management plan (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#noise-and-vibration-management-plan). This must be part of the environmental management system and must include:

- actions and timelines to address any issues
- a procedure for doing noise and vibration monitoring
- a procedure for responding to identified noise and vibration events, for example, complaints

For noise, a noise impact assessment using the BS 4142:2014+A1:2019 ‘Methods for rating and assessing industrial and commercial sound’ methodology must inform your plan.

For vibration, a vibration impact assessment using the BS 6472-1:2008 ‘Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting’ methodology must inform your plan.

11.12 Point source emissions to land and water (including indirect discharge to sewer)

The following measures apply to all processes and operations.

1. You must ensure you have the relevant trade effluent consents in place with your local water

company.

2. You must reduce emissions to water (direct or indirect) using an appropriate combination of techniques, for example:

- neutralisation
- adsorption
- stripping
- flotation
- filtration

3. You must assess the fate and impact of the substances emitted to water and sewer following the Environment Agency's risk assessment guidance) (https://www.gov.uk/guidance/risk-assessments-for-your-environmental-permit).

4. Discharges to water or sewer must comply with the conditions of an environmental permit or trade effluent consent.

Relevant sources of waste water include:

- process water
- condensate collected from a treatment process
- waste compactor run-off
- vehicle washing
- vehicle oil and fuel leaks
- washing containers, tanks and vessels
- spills and leaks in waste storage areas
- loading and unloading areas

5. If you need to treat waste water before discharge or disposal, you must use an appropriate combination of these techniques:

- preliminary or primary treatment – for example, equalisation, neutralisation or physical separation
- physico chemical treatment – for example, adsorption, distillation or rectification, precipitation, chemical oxidation or reduction, evaporation, ion exchange, or stripping
- biological treatment – for example, activated sludge process or membrane bioreactor

- nitrogen removal – for example, nitrification and denitrification
- solids removal – for example, coagulation and flocculation, sedimentation, filtration or flotation

6. You must direct wash waters from cleaning vessels to foul sewer or a contained drainage system for off site disposal or re-circulation.

You may need to pre treat the wash waters to meet any limits on the effluent discharge consent. The degree of recirculation will be limited by the water balance of your plant, the content of impurities, or characteristics of the water streams, for example nutrients.

Discharges to surface water or storm drains (except for clean, uncontaminated rainwater) are not permitted.

You should use all of the following techniques:

- segregate leachate seeping from compost piles and windrows from surface water
- re-circulate process water streams – for example, from de-watering liquid digestate, or by using water streams like surface water run-off as much as possible
- optimise the waste's moisture to minimise generating leachate

11.13 Fugitive emissions to land and water

The following measures apply to all processes and operations.

1. You must use appropriate measures to control potential fugitive emissions (https://www.gov.uk/guidance/control-and-monitor-emissions-for-your-environmental-permit#emissions-to-water) to land and water and make sure they do not cause pollution.

2. You must have the following measures in place in operational areas:

- an impermeable surface

- spill containment kerbs
- sealed construction joints
- connection to a contained drainage system

3. You must collect and treat separately each water stream generated at the facility, for example, surface run off water or process water. Base how you separate it on the pollutant content and the treatment needed.

4. You must make sure that you segregate uncontaminated water streams from those that need treatment.

5. You must use suitable drainage infrastructure to collect surface drainage from areas of the facility where you store, handle and treat waste. You must also collect wash waters and any spillages. Depending on the pollutant content, you must either recirculate what you have collected or send it for further treatment.

6. You must take measures to prevent emissions from washing and cleaning activities, including:

- directing liquid effluent and wash waters to foul sewer, or collecting them in a contained system for off site disposal – you must not discharge them to surface or storm drains
- using biodegradable and non corrosive washing and cleaning products
- storing all detergents, emulsifiers and other cleaning agents in suitable bunded or containment facilities within a locked storage area, or in a building away from any surface water drains
- preparing working strength cleaning or disinfection solutions in contained areas of the site and never in areas that drain to the surface water or groundwater

7. Container washing equipment must be purpose built, located in a designated area of the facility provided with self-contained drainage.

8. You must design the container wash to collect and contain all wash waters, including any spray.

9. You must use trained staff to operate the container wash and you must inspect and maintain it regularly.

10. You must have measures to prevent pollution from the on-site storage, handling and use of oil and fuel.

11. You must produce and implement a spillage response plan and train staff to follow it and test it.

12. You must have procedures and associated training in place to make sure that you deal with spillages immediately.

13. You must locate spill kits close to areas where spillages could occur and make sure relevant staff know how to use them. You must replenish the kits after use.

14. You must stop spillages from entering drains, channels, gullies, watercourses and unmade ground. You must have the following available, to use when needed:

- proprietary sorbent materials
- sand
- booms or drain mats (or both)

15. You must make sure your spillage response plan includes information about how to recover, handle and correctly dispose of all waste produced from a spillage.

16. For subsurface structures, you must:

- establish and record the routes of all site drains and subsurface pipework
- identify all sub surface sumps and storage vessels
- engineer systems to minimise leaks from pipes and make sure you can detect them quickly if they do occur, particularly for hazardous substances
- provide secondary containment and leakage detection for sub surface pipework, sumps and storage vessels

- establish an inspection and maintenance programme for all subsurface structures, for example, pressure tests, leak tests, material thickness checks or CCTV

17. You must design appropriate surfaces and containment or drainage facilities for all operational areas, taking into account:

- collection capacities
- surface thicknesses
- strength and reinforcement
- falls (of the land)
- materials of construction
- permeability
- resistance to chemical attack
- inspection and maintenance procedures
- available relevant standards of construction

18. You must have a documented inspection and maintenance programme to review the integrity of impermeable surfaces and water containment facilities. This must consider the plant and equipment manufacturers' recommended maintenance practices.

Biological waste treatment: appropriate measures for permitted facilities

From: **Environment Agency (/government/organisations/environment-agency)**

Published 21 September 2022

Updated: 2 February 2024 - **See all updates**

Contents

12. Process efficiency

Process efficiency related appropriate measures for biological waste treatment.

The following measures apply to all processes and operations.

1. You must monitor and review how much:

- water, energy and raw materials you use each year
- residue and waste water you generate each year

Residues include the waste and non-waste classified composts and digestate produced.

12.1 Energy efficiency

The following measures apply to all processes and operations at installations only.

1. You must create and implement an energy efficiency plan at your facility in accordance with BAT reference document BAT 23.

2. You must regularly review and update your energy efficiency plan as part of your facility's management system.

3. You must have operating, maintenance and housekeeping measures in place to make sure you use energy efficiently, for example for:

- air conditioning, process refrigeration and cooling systems (leaks, seals, temperature control, evaporator or condenser maintenance)
- motors and drives
- compressed gas systems (leaks, procedures for use)
- steam distribution systems (leaks, traps, insulation)
- space heating and hot water systems
- lubricating to avoid high friction losses
- boiler operation and maintenance, for example, optimising excess air
- other maintenance relevant to the activities within the facility

4. You must have basic, low cost physical techniques in place to avoid gross energy inefficiencies. These may include for example:

- insulation
- containment methods (such as seals and self closing doors)
- avoiding the unnecessary release of heated water or air (for example, by fitting simple control systems such as timers and sensors)

5. You must regularly review and update your energy balance record as part of your facility’s management system, alongside the energy efficiency plan.

12.2 Raw materials

The following measures apply to all processes and operations.

1. You must keep a list of the raw materials you use at your facility and their properties. This includes materials and other substances that could have an environmental impact.

2. You must check if you can use raw materials new to the market that have less environmental impact. This must include, where possible, substituting raw materials with waste.

3. You must justify why you continue to use any substance which has a beneficial alternative.

4. You must have quality assurance procedures in place to control the content of raw materials.

12.3 Water use

The following measures apply to all processes and operations at installations only.

Whilst this is an IED requirement for installation operations, all operations should consider using potable and clean water efficiently and reducing its use.

1. You must take measures to make sure you optimise water use to:

- reduce the volume of waste water generated
- prevent or, where that is not practicable, reduce emissions to soil and water

2. Measures you must take include:

- implementing a water saving plan (which involves establishing water efficiency objectives, flow diagrams and water mass balances)

- optimising how you use water for washing (for example, dry cleaning instead of hosing down, using trigger control on all washing equipment)
- recirculating and reusing water streams within the plant or facility, if necessary after treatment
- where relevant, reducing water used for vacuum generation (for example, using liquid ring pumps with high boiling point liquids)

3. You must carry out a review of water use (water efficiency audit) at least every 4 years.

4. You must also:

- produce flow diagrams and water mass balances for your activities
- establish water efficiency objectives and identify constraints on reducing water use beyond a certain level (usually this will be site specific)
- have a time-tabled improvement plan for implementing additional water reduction measures

5. To reduce emissions to water, you must apply these general principles in sequence:

- use water efficient techniques at source where possible
- reuse water within the process, by treating it first if necessary – or if not practicable, use it in another part of the process or facility that has a lower water quality requirement
- if you cannot use uncontaminated roof and surface water in the process, you must keep it separate from other discharge streams – at least until after you have treated the contaminated streams in an effluent treatment system and have carried out final monitoring

6. You should establish the water quality requirements for each activity and identify whether you can substitute water from recycled sources and where you can, include it in your improvement plan.

7. Where there is scope for reuse (possibly after some form of treatment) you must keep less

contaminated water streams, such as cooling waters, separate from more contaminated streams.

8. You must directly measure fresh water use and record it regularly at every significant usage point – ideally on a daily basis.

12.4 Waste minimisation, recovery and disposal

The following measures apply to all processes and operations at installations only.

1. You must create and implement a residues management plan that:

- minimises residues generated from treating waste
- optimises the reuse, regeneration, recovery, recycling or energy recovery of residues, including packaging
- makes sure residues are disposed of properly if recovery is technically or economically impractical

2. Where you must dispose of waste, you must carry out a detailed assessment identifying the best environmental options for waste disposal.

3. You must review, on a regular basis, options for recovering and disposing the waste produced at the facility. You must do this as part of your management system. This is to make sure you are still using the best environmental options and promoting the recovery of waste where technically and economically viable.

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Biological waste treatment: appropriate measures for permitted facilities

From: **Environment Agency (/government/organisations/environment-agency)**
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Contents

13. Bespoke waste assessment

Inhibition values for aerobic and anaerobic processes.

Waste you accept must be suitable for biological treatment. This section applies to bespoke waste types which are more novel, for example chemical process waste and sets out inhibition values.

Inhibition values for aerobic and anaerobic processes

Table A: general inhibitors for anaerobic processes

Determinant	Threshold
pH hydrolysis and fermentation acido and aceto genesis	Optimal pH 5 to 7
Methanogenesis	Optimal pH 7 to 8, Operational 6.5 to 8.5
Temperature below optimum (mesophillic optimum temperature 37°C, thermophillic optimum temperature 55°C)	The rate of activity will drop by approximately 50% for every 10 degrees below the respective optimum temperature (Caine, 1990).
Temperature above optimum (mesophillic optimum temperature 37°C)	Where the temperature is raised gradually above the mesophillic optimum, the cultures will adapt and thermophiles will become established. During this period performance will be reduced. Where temperature is raised suddenly by 10°C performance may reduce significantly.
Temperature above optimum (thermophilic optimum temperature 55°C)	Performance of thermophiles will drop if temperature is raised above the optimum values but will survive extreme increase up to 100°C
Ammonium inhibition	Ammonium build up may inhibit the anaerobic process.

Table B: general inhibitors for aerobic processes

Determinant	Threshold
Moisture content	Optimal range of 50 to 70%

Determinant	Threshold
pH	Optimal range of 6 to 8
C/N	Optimal range of 25:1 to 40:1

Table C: specific guideline inhibitors for aerobic treatment

The following table contains indicative inhibitive concentrations for a range of substances for aerobic treatment processes.

Blanks mean that no data is available in literature.

The first column of data for aerobic treatment is based on the inhibition of respirometric activity, the second is based on the inhibition of nitrification.

You must show that where you receive waste that falls within these inhibition ranges you can manage and maintain a stable process.

The waste must be capable of being treated and recovered by the aerobic process.

This table does not list every substance which may be inhibitory to aerobic or anaerobic organisms. You must also consider the potential inhibitory effect of other substances used or generated at your facility.

Parameter	Aerobic treatment threshold mg/L	
	Activated sludge	**Nitrification**
Anthracene ug/l	500	
Arsenic (As)	0.1	1.5
Cadmium (Cd)	1 to 10	5.2

Parameter	Aerobic treatment threshold mg/L	
	Activated sludge	**Nitrification**
Chloride mg/kg		180
Chromium (Cr) III	10 to 50	
Chromium (Cr) total	1 to 100	0.25 to 1.9
Chromium (Cr) VI	1	1 to 10 (as chromate)
Copper (Cu)	1	0.05 to 0.48
Cyanide	0.1 to 5	0.34 to 0.5
Iodine (I)	10	
Lead (Pb)	1 to 5 or 10 to 100	0.5
Mercury (Hg)	0.1 to 1; 2.5 as Hg(II)	
Naphthalene	500 (EPA); 29 to 670	IC50 (mg/L) for Nitrosomonas and aerobic heterotrphs respectively
Nickel (Ni)	1.0 to 2.5; 5	0.25 to 0.5; 5
Phenantherene ug/l	500	
Sulphide	25 to 30	
Total ammonia nitrogen	480	

Parameter	Aerobic treatment threshold mg/L	
	Activated sludge	Nitrification
Zinc (Zn)	0.3 to 5; 5 to 10	0.08 to 0.5

Table D: specific inhibitors for anaerobic treatment

The following table contains guideline indicative inhibitive concentrations for a range of substances for anaerobic treatment processes. Blanks mean that no data is available in literature. You must show that where you receive waste that falls within these inhibition ranges you can manage and maintain a stable process. The waste must be capable of being treated and recovered by the anaerobic process. This table does not list every substance which may be inhibitory to aerobic or anaerobic organisms. You must also consider the potential inhibitory effect of other substances used or generated at your facility.

Parameter	Anaerobic treatment threshold g/l
Acrylates	62 to 150 mg/l
Alcohols	22 to 43000 mg/l
Alkylbenzenes	160 to 580 mg/l
Aluminium (Al)	1 (2% inhibition of methane production after 59 days)
Amines	13000 1-methylpyrrolidine mg/l
Arsenic (As)	0.0016
Cadmium (Cd)	0.15 to 0.33

Parameter	Anaerobic treatment threshold g/l
Calcium (Ca)	2.5 to 4
Chlorinated aliphatics	0.5 to 600 mg/l
Chromium (Cr) total	0.2
Copper (Cu)	0.009
Fluoride (F)	0.018
Halobenzenes	20 to 750 mg/l
Halogenated alcohols	0.3 to 630 mg/l
Halogenated carboxylic acids	< 0.001 to 0.01 mg/l
Halogenated phenols	2-300 for mono,-di and trichloros; 0.04 and 0.13 for penta and tetra mg/l
Ketones	6000 to 50000 mg/l
Lead (Pb)	3.2 to 8
Magnesium (Mg)	12
Nickel (Ni)	0.1 to 1.6
Nitriles	90 to 28000 Acrylonitrile and Acetonitrile respectively mg/l
Nitrobenzenes	13 nitrobenzene
Nitrophenols	4 to 12 mg/l
Phenol and alkylphenols	phenol 1850; o,m,and p-cresol 850, 925, 975 mg/l
Potassium (K)	2.8 to 14

Parameter	Anaerobic treatment threshold g/l
Silver (Ag)	0.1
Sodium (Na)	5.6 to 53
Sulphate	Methane production is reduced by one mole for every mole of sulphate added due to sulphate reduction dominating over methanogenesis
Sulphide	100 to 800
Surfactants	For example, alkyl dimethylbenzylammonium chloride: 6.7; sodium alkyl ethersulfate: 11 mg/l
TiO2 (mg/gTS)	150
Total ammonia nitrogen	1.7 to 14
Zinc (Zn)m as ZnO nanno particles	0.03

(Inhibitory values are under review. Subject to that review, substances may be added or removed, or values amended).

IED Permit Applications

Phase/ Tranche	Date of submission	Site	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22	Sep-22	Oct-22	Nov-22	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23	Jan-24	Feb-24	Mar-24	Apr-24	May-24	Jun-24	Jul-24	Aug-24	Sep-24	Oct-24	Nov-24	Dec-24	Jan-25	Feb-25	Mar-25
Phase 1	31/03/21	Camberley	Sub		RFI			D / Sch			Sch			Sch				Sch				Sch				Sch			Sch			Sch		Sch	✓																
Phase 1	31/03/21	Slough	Sub										RFI	X						Resub/ RFI	X									ReSub					RFI		D						Sch								
Phase 2	30/06/21	Reading				Sub											W		ReSub						RFI / D		Sch	Sch	Sch	Sch	✓																	ReSub	ReSub		
Phase 2	30/06/21	Maple Lodge				Sub											W		ReSub						RFI	RFI	D / Sch			Sch	Sch		Sch						✓												
Phase 1	31/03/21	Hogsmill	Sub												RFI		X		ReSub						RFI	RFI	Sch		Sch		Sch																✓				
Phase 2	30/06/21	Long Reach				Sub											W		ReSub													RFI	RFI	RFI / D									Sch	Sch				✓			
	#N/A	ong Reach STW(Finnings)																														RFI	RFI																		
Phase 3	30/09/21	Banbury							Sub																				ReSub				RFI	RFI	RFI / D		Sch						RFI				✓				
Tranche 6	30/09/22	Oxford																			Sub											ReSub			RFI			Sch		Sch							✓				
Phase 3	30/09/21	Aylesbury							Sub																											ReSub	Triag										RFI / D	Sch			
Tranche 6	30/09/22	Didcot																			Sub															ReSub	RFI									RFI	D	Sch			
Tranche 6	30/09/22	Wargrave																			Sub															ReSub	RFI										RFI / D		Sch		
Phase 5	31/03/22	Beddington													Sub																				ReSub			Triag	RFI / D								✓			
Phase 1	31/03/21	Chertsey	Sub												RFI	X			ReSub																	ReSub		Triag	RFI	RFI							RFI				
Phase 4	24/12/21	Rye Meads										Sub																								ReSub		RFI								RFI	✓				
Phase 4	24/12/21	Swindon										Sub																								ReSub		RFI									RFI				
Phase 4	24/12/21	Beckton										Sub																								ReSub			RFI	RFI / D					Sch				Sch		
Phase 5	31/03/22	Bishops Stortford													Sub																					ReSub			RFI / D	RFI						Sch		RFI			
Phase 5	31/03/22	Crawley													Sub																					ReSub			RFI	RFI / D					Sch			✓			
Tranche 6	30/09/22	Deephams																			Sub															ReSub			RFI	RFI / D							Sch				
Phase 3	30/09/21	East Hyde							Sub																											ReSub			RFI	RFI / D					Sch			✓			
Phase 4	24/12/21	Basingstoke										Sub																								ReSub			RFI	D	Sch						✓				
Phase 2	30/06/21	Crossness				Sub											W		ReSub																	ReSub			RFI	D	Sch		Sch				✓				
Phase 5	31/03/22	Bracknell													Sub																					ReSub			RFI	D					Sch			RFI			
Phase 3	30/09/21	Mogden							Sub																											ReSub											RFI				
Phase 4	24/12/21	Riverside										Sub																								ReSub												RFI	Sch		

Legend

Sub	submission of application
ReSub	resubmission of application
RFI	RFI received from EA
Sch	Schedule 5 questions from EA
Triag	Triage questions from EA
X	IED permit application rejected by EA
W	IED permit application withdrawn by TW
✓	IED permit issued
D	Duly Made
	Draft

Stages of Permit Application

Submission		RFIs	Duly Made	Sched	Draft	Final
Sub		RFI	D	Sch		✓

Environmental Permitting (England and Wales) Regulations 2016/1154

Schedule 5 Environmental permits
para. 4 Further information in respect of a duly-made application

Law In Force

Version 1 of 1

1 January 2017 - Present

Subjects
Environment

4.— Further information in respect of a duly-made application

(1) If the regulator considers that it requires further information to determine a duly-made application, it may serve a notice on the applicant specifying the further information and the period within which it must be provided.

(2) If the applicant fails to provide the further information in accordance with the notice, the regulator may serve a further notice on the applicant stating that the application is deemed to be withdrawn, upon which the application is deemed to be withdrawn.

(3) If an application is deemed to be withdrawn, the applicant is not entitled to the return of any fee which accompanied it.

Schedule 5 Environmental permits > Part 1 Grant, variation, transfer and surrender of environmental permits > para. 4 Further information in respect of a duly-made application

Water Resources Act 1991 c. 57
s. 15 General duties with respect to the water industry.

Law In Force

Version 3 of 3

1 April 2013 - Present

Subjects
Environment

Keywords
Environment Agency; Powers rights and duties; Water industry

15.— General duties with respect to the water industry.

(1) It shall be the duty of the [Agency] [1] [and the NRBW] [2] , in exercising any of [their] [3] powers under any enactment, to have particular regard to the duties imposed, by virtue of the provisions of Parts II to IV of the Water Industry Act 1991 , on any water undertaker or sewerage undertaker which appears to the [Agency] [1] [or the NRBW, as the case may be,] [4] to be or to be likely to be affected by the exercise of the power in question.

(2) It shall be the duty of each of the Ministers, in exercising—

(a) any power conferred by virtue of [the 1995 Act,] [5] this Act, the Land Drainage Act 1991, the Water Industry Act 1991[, the Water Act 1989 or the Natural Resources Body for Wales (Establishment) Order 2012 (S.I. 2012/1903)] [6] in relation to, or to decisions of, the [Agency] [1] [or the NRBW] [7] ; or

(b) any power which, but for any direction given by one of the Minister, would fall to be exercised by the [Agency] [1] [or the NRBW] [7] ,

to take into account the duty imposed on the [Agency] [1] [and the NRBW] [8] by subsection (1) above.

Notes

1 Words substituted by Environment Act 1995 c. 25 Sch.22 para.128 (April 1, 1996)
2 Words inserted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.265(2)(a) (April 1, 2013: insertion has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)
3 Word substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.265(2)(b) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)
4 Words inserted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.265(2)(c) (April 1, 2013: insertion has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)
5 Words added by Environment Act 1995 c. 25 Sch.22 para.130 (April 1, 1996)
6 Words substituted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.265(3)(a) (April 1, 2013: substitution has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)
7 Words inserted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.265(3)(b) (April 1, 2013: insertion has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

Notes

8 Words inserted by Natural Resources Body for Wales (Functions) Order 2013/755 Sch.2(1) para.265(3)(c) (April 1, 2013: insertion has effect subject to transitional provisions and savings specified in SI 2013/755 art.10 and Sch.7)

I have passed to our permitting and engineering teams - we will review and come back with areas of further clarification and where you have requested specific feedback.

This should then allow us to ensure we have a final position regarding IED for the wash up session on 25th January.

In terms of Reading and Didcot, we have also received similar questions from the local EA team and will provide detailed responses. I will provide a summary for this group.

Regards

Steve Spencer
PR24 Wholesale Programme Director

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Cc: Jonathan1 Read <Jonathan1.Read@thameswater.co.uk>; Angela Barugh <angela.barugh@thameswater.co.uk>; Jonathan Hagan <Jonathan.Hagan@thameswater.co.uk>; Tim Griffiths <tim.griffiths@ofwat.gov.uk>
Subject: RE: IED/Defra Call Slides

Hi Steve

Yes earlier this week I received feedback from colleagues and lawyers on credible scenarios as appears in CIRIA 736 – attached for information.

I was also tasked with commenting on the slides you presented at our earlier meeting and I've focused on slide 3 – see attached.

Thanks for the update I've made some notes in red below. You should also be receiving feedback from the Water UK IED Task and Finish Group which met earlier today where we worked through the remaining elements of the 46 technical queries received in September.

I have been speaking to Area colleagues about the ongoing discussion regarding extensions to improvement condition deadlines in the Reading permit. We should be able to agree an extension to the liquor sampling and analysis ICs as we've identified some technical challenges that need to be bottomed out. I'm visiting the ALS lab in Coventry next Tuesday to talk to the company. I'm less convinced by the case for an extension to the secondary containment IC and support the Area's decision to reject the proposal for deploying temporary defences in the event of a loss of containment.

I'm also concerned to learn that over 50% of the biogas produced at Didcot is being flared off rather than being used to generate power. Not only is this a waste of a valuable energy source it is not possible to issue a permit for the site unless an acceptable solution is proposed. Please can you update me on your plans for Didcot.

Regards

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Creating a better place
for people and wildlife

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Subject: RE: IED/Defra Call Slides

Clive, I was wondering whether you had any feedback on the query I raised regarding secondary containment.

As an update following the workshop we have been able to progress the following key actions, (and by way of an update for all), is allowing us to reshape our IED programme.

- Tank Covering – we are developing an integrated, delivery plan aligning with the need to maintain throughput across our 25 Sludge Treatment Centres and our digester refurbishment programme. This will allow us to share a "deliverable/best endeavours" investment programme. Our aim is to share this with you, so that we can agree appropriate timescales for improvement conditions. For clarity… the ICs will all have a 31 March 2025 deadline, and best endeavours will be considered after that date should the conditions not be complied with. Best endeavours will be your principal mitigation if deadlines are not met. It will be for Area operational teams to decide whether and what enforcement action is appropriate.
- Cake Barns – we have recognised that this investment will no longer be needed in AMP8 and will be revisited in AMP9 as appropriate. Thank you

- Waste acceptance and return liquor monitoring – your guidance and subsequent input from the local EA team, is allowing us to significantly reduce our sampling programme, and we are finalising our approach which we will share with the local EA team as part of the ongoing permit application process. Please note that we are working on a national solution which recognises the technical limitations of analysing particularly dirty samples such as AD return liquors. I'm meeting Area colleagues tomorrow to update them on progress.

The final element is the secondary containment. Currently we are drafting an option to follow CIRA C736 which recommends a risk based approach, but would welcome confirmation this indeed is acceptable to the EA. Also, I can confirm we have received confirmation from the local EA team that containment does not necessarily need to be via concrete structures, and alternative can be considered. Please see comment above about temporary defences.

Our aim is to confirm as much of the above at the "wrap up" session planned for 25th January.

If you have points of clarification or queries please don't hesitate to drop me a line.

Regards

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Subject: RE: IED/Defra Call Slides

Thanks Steve I'll look into the references you've provided and get back to you as soon as I'm able.

Regards

Clive

Clive Humphreys
Senior Advisor, Environment and Business

TECHNICAL NOTE

Thames Water Industrial Emissions Directive

SUBJECT	PROJECT NO.	DATE
Maple Lodge delivery programme	100101720-600	29 January 2025

AUTHOR	DISTRIBUTION	REPRESENTING
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DOCUMENT REFERENCE

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1.1	Second draft	GS				
1.2	Third draft	GS				
2.0	Final	GS	SJW/BL	AJ	REL	29-01-25

Client signoff

Client	Thames Water		
Project	Thames Water Industrial Emissions Directive	**Project No.**	100101720-600
Client signature / date			

Maple Lodge IED Intervention Programme

1 Introduction

Maple Lodge Sewage Treatment Works (STW) is a large sewage works in Maple Cross, Hertfordshire, northwest of London. The site is situated in an area surrounded on the north and east by River Colne (a tributary of the River Thames) and its brooks, on the south by Lynsters lake and on the west by Maple Lodge Nature Reserve. Maple Lodge STW serves nearly 500,000 residents and businesses, receiving up to 300,000m^3 of wastewater per day, and has an outfall to the Grand Union Canal and the River Colne.

There are 30 tanks as part of the sewage sludge and bioresources treatment area with an approximate total operational sludge volume of 62,400m^3. The site processes around 55 tonnes dry solids of sludge every day including liquid sludge imported from other smaller sites.

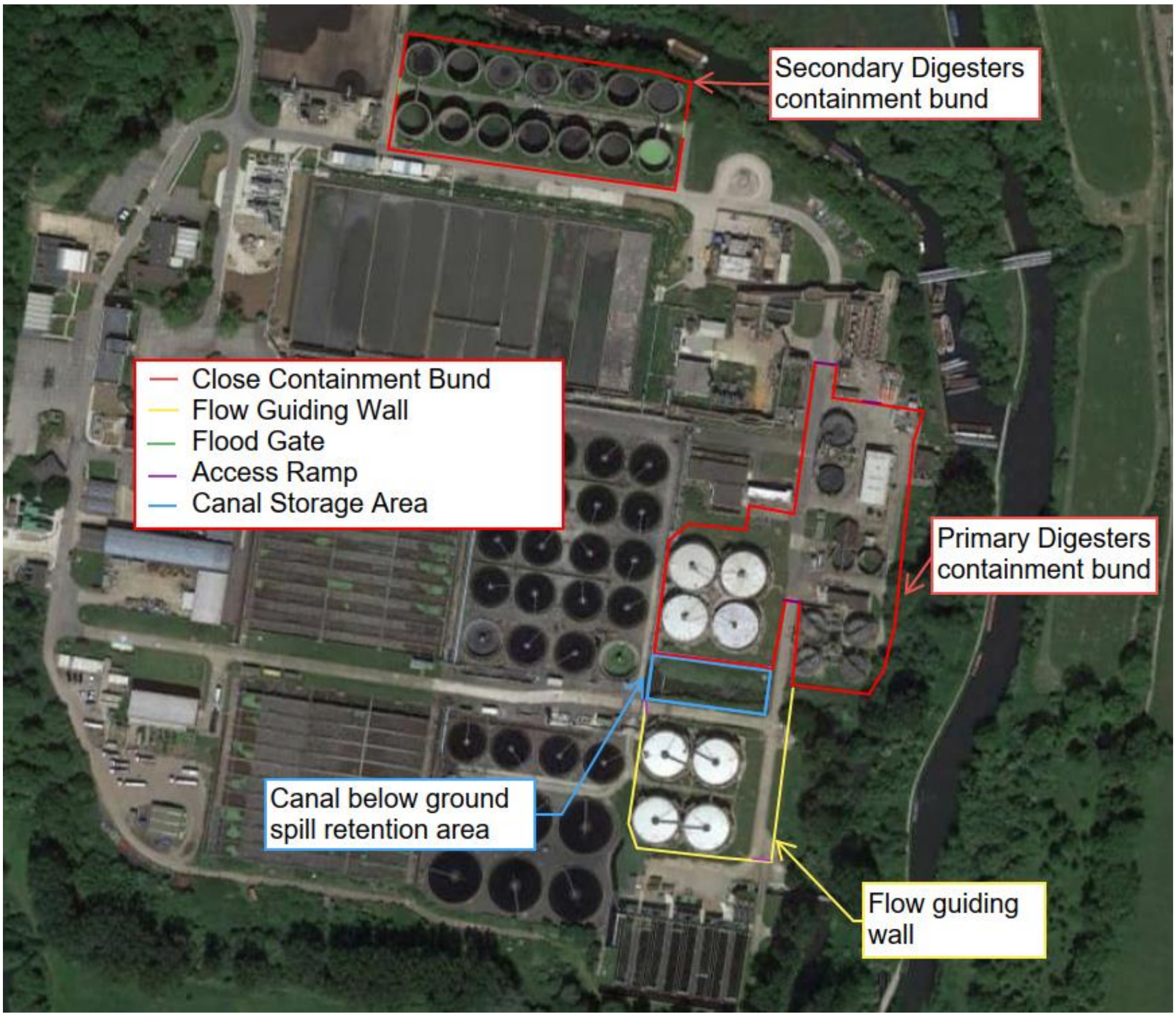
There is a significant amount of development work planned for AMP8. This work includes a major expansion of the effluent stream including new aeration lanes, storm tanks and associated growth around the sludge stream. In addition, it will include general upgrades to the electrical and supervisory control and data acquisition (SCADA) networks to comply with Water Industry National Environment Programme (WINEP) drivers.

In addition, the sludge stream is now subject to compliance with the Industrial Emissions Directive (IED), as transposed into the Environmental Permitting Regulations (EPR), and as such a permit for the operation of the works has been submitted to the Environment Agency. This permit has now been granted with improvement conditions associated with it. Investment is now needed to upgrade the sludge stream to comply with the permit and as such various assets in the sludge stream will need to be upgraded and refurbished. This includes:

1. New requirements for covering of open storage tanks (specifically upstream of the primary digesters) and covering the secondary digesters
2. Secondary containment bunding around all sludge containing tanks
3. Refurbishment /replacement of the existing floating roofs on the primary digesters.
4. Additional biogas will be captured requiring biogas consumers in the form of a biomethane plant to utilise the extra biogas captured by the covered secondary digesters.

Maple Lodge is one of 25 sludge treatment facilities across the Thames Water region. This is a resilient system of sites structured such that sludge can be redistributed across it when plant outages result in reduced treatment capacity at one site.

1.1 IED Area of work



2 Primary Digester Refurbishment

The existing primary digesters are approximately 50 years old and comprise of a c3400m^3 concrete tank with a steel floating roof. There are eight tanks arranged into two banks of four. Under normal operation, all tanks are in service and receive c150m^3/d of raw sludge and when one is out of service this feed flow can increase to c200m^3/d. The digesters are connected to a gas system which stores the biogas (a methane-rich gas) and transfers it to the combined heat and power (CHP) engines for conversion into heat and electricity. The heat is used to raise hot water that is in turn used to heat the sludge in the digesters and the electricity is used to run the Maple Lodge site.

Sufficient capacity is required to treat the incoming sludge to Maple Lodge to the appropriate standard to allow the final treated biosolids to be recycled to agriculture (e.g., in accordance with the Sludge (Use in Agriculture) Regulations 1989 and Biosolids Assurance Scheme etc.). Consequently, a maximum of one digester can be taken out of service at any time, to allow the required inspection and remedial work to be undertaken (e.g., structural repairs, leak sealing, floating roof replacement, mixing and heating system repairs, process monitoring instrumentation replacement). Taking more than one digester out would result in not being able to process the incoming sludge to the required standard to allow it to be satisfactorily recycled to agriculture.

There are several important parameters which must be maintained to ensure the anaerobic digestion process can operate effectively. The three most important parameters are temperature (keeping the 'good' bacteria alive, generally between 36-40°C), the hydraulic retention time (HRT) (the period of time the sludge is retained in the digester to enable the various 'good' bacteria to operate) and Organic Loading Rate (OLR) (defined as the amount of organic matter that can be fed into the digester per unit volume of its capacity per day – this is essentially the maximum amount of 'food' the 'good' bacteria are able to consume in a day).

The industry agreed standard process for taking a digester out of service and undertaking remedial works, including civils refurbishment (e.g. digester walls, roof replacements), mechanical refurbishments (e.g. heat exchangers, mixers, valves etc) and electrical / ICA replacements (e.g. level sensors) is:

- Stop feeding the digester and isolate the tank from the sludge feed. The sludge being normally fed to a digester is gradually redistributed over the remaining tanks in service to prevent shock overloading (i.e., the 'good' bacteria need a period of time to acclimatise to the change in feed volume). This gradual transfer occurs over a period of two to three weeks.
- Continue heating and mixing the digester until the biogas production ceases. This can take several weeks depending on the biological activity in the tank (effectively the sludge will continue to release methane until the 'good' bacteria are inhibited through lack of 'food' or loss of temperature).
- Isolate the digester from the gas system.
- Purge the digester gas space with nitrogen gas to remove any residual biogas. The roof space of the digester is classed as a gas storage system and to ensure a safe working environment the gas contained within this space needs to be replaced with an inert gas. This is a time-consuming process as the biogas created by the digestion process continues to be created by the microbes which cannot just be turned off. This purging needs to continue until the level of methane is less than 3% to ensure the headspace is not within the explosive limit for methane.
- Open the top of the digester to allow atmospheric ventilation and to ensure pressures are equal when drawing out the sludge.
- Pump out the sludge within the digester back into the sludge treatment process at a rate that is suitable to ensure shock loading does not occur on the receiving tanks.
- Once the liquid sludge is removed, there will be material that has settled in the base of the digester. This material will be generally solidified sludge, grit and other detritus such as screenings that have passed through the wastewater process. This material needs to be agitated and mixed with water before being pumped through a screening unit. The liquid fraction is returned to the wastewater process for retreatment whilst the grit and screenings are discharged to a skip for disposal to landfill.
- Once the tank is emptied it can be cleaned by pressure washing the internal walls. The interior is then inspected firstly at the base and then scaffolded to the full height of the wall and roof so that a full internal inspection can be carried out.
- Any deficiencies that are identified from the inspection then need to be repaired; this is typically minor cracking, spawling of concrete, damage to internal mixing pipe work etc.
- Following erection of the scaffold the floating roof needs to be removed. Given the weight of this structure (c20 tonnes) and the distance from accessible roads on site, this will need to be done using a substantial crane. There is limited space to allow the roof to be lifted as a single segment and as such it is probable that it will need to be cut into sections

before lifting off. The dismantled roof sections then need to be transported off site for recycling.

- Once the roof is removed the concrete tank will need to be repaired and strengthened locally to allow the new roof to be installed.
- The new membrane roof will be installed by lifting via crane into position on top of the concrete wall. In position, the membrane roof can be inflated using the new external air pump system.
- The refurbished tank can now be re-commissioned this will require repeating the decommissioning process but in reverse. This will involve gradually filling the tank with final effluent to ensure there are no leaks (should this occur, the tank needs to be drained, and the cause of the leak repaired). Following a successful hydraulic test the final effluent will gradually be displaced with sludge. Once the tank is full the headspace is purged with nitrogen, and the tank connected back to the biogas system. At this point the tank can be heated to start the digestion process.

Based on previous experience of similar tank refurbishment and floating roof replacement (such as has recently occurred at Slough and Oxford sewage treatment works where several tanks of a similar design and age to those at Maple Lodge were refurbished and had steel bell floating roofs replaced) the typical duration for this work is around 15 months per tank.

It is expected that this work will be permitted development.

3 Secondary digesters

There are 14 secondary digesters of a concrete construction with a capacity of 2200m^3 each. Two of the tanks are buffer storage tanks upstream of the dewatering plant, and a further two tanks are currently disused. The sludge from the primary digesters is batch fed to the tanks, where it is held for c12 days to ensure pathogen reduction before being fed to the buffer tanks.

To ensure compliance (i.e., to allow the minimum of 12 days retention time across the remaining tanks), 8 tanks are required under normal operation. Therefore, up to 4 of the tanks can be refurbished simultaneously. Taking more than 4 secondary digesters out of service will overload the remaining tanks resulting in failure of the required treatment standards.

The process to take a bank of secondary digesters out of service and undertake the remedial works is:

- Stop feeding the tank and isolate the tank from the sludge feed.
- Pump out the sludge within the tank back into the sludge treatment process at a rate that is suitable to ensure shock loading does not occur within the receiving tanks.
- Once the liquid sludge is removed, there will be material that has settled in the base of the digester. This material will be generally solidified sludge, grit and other detritus such as screenings that have passed through the primary digestion process. This material needs to be agitated and mixed with water before being pumped through a screening unit. The liquid fraction is returned to the wastewater process for retreatment whilst the grit and screenings are discharged to a skip for disposal to landfill.
- Once the tank is emptied it can be cleaned by pressure washing the internal walls. The interior is then inspected firstly at the base and then scaffolded to the full height of the wall so that a full internal inspection can be carried out.
- Any deficiencies that are identified from the inspection then need to be repaired; this is typically minor cracking, spawling of concrete, damage to pipe work etc.
- Once the concrete tank has been repaired, the top of the walls need to be raised and strengthened locally to allow the new roof to be installed.

- The new membrane roof will be installed by lifting it via crane into position on top of the concrete wall. In position, the membrane roof can be inflated using the new external air pump system.
- The refurbished tank can now be re-commissioned this will require repeating the decommissioning process but in reverse. This will involve gradually filling the tank with final effluent to ensure there are no leaks (should this occur the tank needs to be drained, and the cause of the leak repaired). Following a successful hydraulic test the final effluent will gradually be displaced with digested sludge. Once the tank is full, the headspace is purged with nitrogen, and the tank connected to the biogas stream.
- Once the bank of tanks is successfully recommissioned, the process can commence on the next bank of tanks, continuing through them sequentially.

It is estimated that the first bank of 4 tanks will take 16 months to complete following the design and procurement activities (subsequent tanks are expected to be a different duration as they are not being linked directly to the biomethane plant delivery – see below). The initial secondary digester upgrades could be done while work is undertaken on the primary digesters. This is based on the following activities having to be undertaken with the durations based on previous experience across similar tank cleaning, inspection and refurbishment activities within Thames Water – tank cleaning, inspection and refurbishment is carried out across all 25 treatment facilities on a regular basis:

• Drain, clean, remove residual grit and screenings across four tanks	3 months
• Internal structural assessment	1 month
• Remedial structural works (e.g., repairs to damaged concrete, leaks, pipework, valve replacement etc) - *dependant on condition of the asset once accessed*	3 months
• Install mixing facility	2 months
• Install membrane roofs	6 months
• Connection to biogas stream	1 month

3.1 Biogas consumer

Once the first bank of tanks are covered and connected to the biogas stream, there must be sufficient biogas consumers available for the sludge to be processed. If these are not available, biogas will be flared, or the tanks cannot be recommissioned. An alternative would be to divert sludge to another site; however, the volumes would be 10-15% of Maple Lodge's throughput which is impractical due to the number of vehicles needed and the lack of spare capacity at other sites.

At Maple Lodge, the existing CHP engines are sized for the current biogas make and have insufficient capacity to take the extra biogas that will be generated from the covered secondary digesters. As such an additional biogas consumer will be required.

There are existing constraints with the electrical network external to Maple Lodge within the feed grid – the capacity of which is at the maximum load of the incoming cable. Upgrading this would require replacing the cable from Maple Lodge STW to the primary distribution transformer near Watford along with upgrading the main grid transformer and would likely take 5-7 years based on feedback from the network operator. Consequently, an additional CHP is not feasible at Maple Lodge and a biomethane upgrading facility will need to be procured to process the additional biogas.

The construction of a biomethane upgrading plant will comprise a chiller unit (to remove water from the saturated biogas), hydrogen sulphide removal filter, a membrane filtration unit (to separate the methane from other gases such as carbon dioxide), a propane and odorant injection facility, a grid injection unit and supporting electrical infrastructure. Alongside these assets a new gas pipeline will need to be laid between Maple Lodge STW and an appropriate location on the gas grid network - which is approximately 4km from the works. A pipeline of this length and with the issues likely to occur on the route (e.g., road and river crossings) it will take approximately 15-18 months to complete. The installation of this biomethane plant will run ahead of and concurrently to the secondary digester works to ensure the plant is operational when the first tanks will need to be connected to the biogas pipework.

Given the complexity of this activity, it is likely that this new gas-to-grid facility will require a full planning application and negotiation with landowners to lay the gas pipeline across their land as well as Agreement with the Gas Network Operator. Typically, this can take 9 months to agree, and this will need to be in place before the commencement of works.

4 Pre-digestion tanks

The covering of tanks upstream of the primary digesters (sludge holding tanks, liquid reception tanks, picket fence thickeners and SAS storage tanks) can all commence independent to other works on the sludge stream. However, before they are modified a structure assessment needs to be undertaken to assess the suitability of installing a new roof, this can only be finalised once the tank is emptied, and internal structural measurements can be taken. Should this identify an issue the existing tanks they will need to be decommissioned and replaced adding to the overall programme. If they are satisfactory for a new roof these can be lifted via crane onto the tank and the headspace connected to new odour control units that will need to be installed.

It is not anticipated that these works will sit on the critical path of site activities. It should be noted that as part of the WINEP effluent upgrade, additional tanks will be needed in this area of the site to process additional sludge.

5 Secondary containment bunding

To avoid pollution to land and water it is expected by the Environment Agency that all water companies are to provide suitable interventions in line with CIRIA C736, with secondary containment being required around the tanks identified as part of the sludge treatment process at Maple Lodge. Due to the location of the relevant tanks at Maple Lodge this has been designed as two separate containment bund arrangements

- around the pre-AD and primary digestion tanks
- around the secondary digestion tanks

These containment solutions will comprise of reinforced concrete walls, kerb bunding, road humps and 'flood gates' to contain and direct flows. Given that there are required works to cover the tanks in these areas, these bund walls cannot be constructed until the roofs are installed. Due to the length, height and location of the bund walls to enable the appropriate containment volume to be provided they will hinder the ability to site the crane in the required locations to access each of the tanks to allow the tank covers to be safely installed.

The duration to construct the containment walls is location and solution specific at Maple Lodge. Around the primary digesters the containment wall will be built in two phases around each bank of 4 tanks after the roof replacement has been completed. This is reflected in the diagram below at IDs 61 and 62. The construction of the wall is currently anticipated to be an in situ reinforced concrete structure, which will need foundations to be excavated, buried services found and rerouted to avoid damage, permeable surfaces excavated and replaced as well as the wall formation. The in situ concrete wall will need to be formed in short sections to allow the concrete to harden; this means it cannot be poured in one single section and will take several months to complete. Around this area of the site the existing old outfall channel will need to be modified and isolated from the canal to act as a storage sump for the spill to flow into.

Around the secondary digesters the bund wall will be a simar design requiring the same construction activities. However, it has the added complexity of running along the canal edge, so will likely need sheet pile installation to strengthen the riverbank from collapse.

6 Delivery Programme

The programme below shows the rolled-up activity schedule showing the indicative timescales for each major activity block.

Maple Lodge is a major sludge treatment centre for Thames Water treating between 55 and 65 tonnes dry solids per day (TDS/d). To ensure the continuation of best value for both the environment and our customers, this sludge must continue to be treated. There are system capacity constraints due to similar work being required at the other Thames Water Sludge Treatment Centres, and so the continuation of sludge treatment at Maple Lodge is critical.

We have created the indicative programme to show that we will deliver as many interventions concurrently as is possible, whilst maintaining the appropriate treatment capacity for Maple Lodge and all Health and Safety requirements. In summary, this is a conservative circa 10-year programme of work, and this does not take into account any significant programme influences outside of Thames Water's control on a site of this scale (e.g. finding significant issues with tanks, severe weather).

ID	Task Mode	Task Name	Duration
1		**Maple Lodge IED Improvements**	**2605 days**
2		IED Permit received	0 days
3		Internal Governance	0 days
4		Conceptual design	4 mons
5		Detail Design / Procurement	6 mons
6		Planning (Permitted Development)	2 mons
7		**Construction**	**2140 days**
8		**Biomethane plant**	**480 days**
12		**Secondary Digesters**	**1240 days**
13		**tanks 1-4**	**500 days**
20		**tanks 5-8**	**280 days**
27		**tank 9-12**	**300 days**
34		**tanks13-14**	**160 days**
39		**Pre-AD tanks (3No)**	**600 days**
59		**Secondary Containment**	**1540 days**
60		Around pre-AD tanks	4 mons
61		Around primary digesters 1-4	12 mons
62		Around primary digesters 5-8	12 mons
63		Around secondary digesters	6 mons
64		**Digester Inspection (Primary Digesters)**	**2400 days**
65		**Maple Lodge 1**	**300 days**
68		**Maple Lodge 4**	**300 days**
71		**Maple Lodge 7**	**300 days**
74		**Maple Lodge 2**	**300 days**
77		**Maple Lodge 3**	**300 days**
80		**Maple Lodge 5**	**300 days**
83		**Maple Lodge 8**	**300 days**
86		**Maple Lodge 6**	**300 days**