FOREWORD

This report is Anglian Water’s draft Drought Plan 2019. It has been prepared four years and three months after the approval and publication of our Drought Plan 2014, in line with the Drought Plan Direction 2016. It provides an overview on how we propose to manage water resources during a drought to protect public water supplies, whilst minimising any environmental impacts that may arise as a result of our activities.

We have presented this draft Drought Plan to the Secretary of State for Environment, Food and Rural Affairs, to seek permission to publish the draft plan for consultation. We have now received this approval, without any changes required. This draft Drought Plan is now available for consultation for an eight week period to gain the views of all key stakeholders and customers. The consultation period will run from 22 February 2019 to 19 April 2019.

We will consider all representations and produce a Statement of Response to outline any changes we have made to our plan within 15 weeks of the publication of this draft Drought Plan 2019. The Secretary of State will then consider whether a Public Hearing is required and whether to issue any directions for the final Drought Plan prior to publication.

There have been no major drought events since the Drought Plan 2014 so the 2010-12 drought period still remains our most recent reference drought. However this draft Drought Plan has been updated to reflect wider developments in our drought and water resources planning.

We published our draft Water Resources Management Plan 2019 in March 2018 for consultation, and we are now working towards publishing our final WRMP in Spring 2019. This presents a revision to our Levels of Service, ensuring that by the end of AMP7 no customer will be exposed to rota cuts during a severe drought. A severe drought is defined a drought event with an approximate 1 in 200 year return period.

To ensure alignment of the two plans, we have reviewed the measures that we have in place to maintain secure water supplies during both the worst recorded drought and 1 in 200 year drought for all our water sources. The draft Drought Plan sets out the management actions that we will take before, during and after a drought. The Drought Plan is not strategic but outlines a framework for managing a drought were it to occur under present circumstances with existing infrastructure.

An additional change considered in this draft Drought Plan is that in April 2017 the water retail market opened. As a result, business customers no longer buy water services from us directly and we work with retailers via our Wholesale Service Centre. As the wholesaler, we maintain our commitment to ensuring a secure supply of water for all customers.

Our draft Drought Plan 2019 is structured in three parts:

- Part 1, Drought Plan Framework and Regional Overview
- Part 2, Drought Plan Technical Background
- Part 3, Operational Drought Plan

These can be read in order or separately.
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PART ONE

DROUGHT PLAN FRAMEWORK AND REGIONAL OVERVIEW
Part One of our draft Drought Plan 2019 presents the framework and relevant regulation for water company drought planning. It also provides an overview of our region and water sources.

1.1 Introduction

There is a statutory requirement for all water companies to prepare and maintain a Drought Plan that sets out how we will ensure continued supply to customers when water resources may become depleted during periods of low rainfall.

This is Anglian Water’s draft Drought Plan 2019 that has been prepared to update our Drought Plan 2014. It builds on developments in our drought and water resources planning approaches, as well as feedback received during the pre-consultation phase.

This is the fifth formal Drought Plan that we have produced since the first in 2000. This plan has been prepared following the Environment Agency’s ‘Water Company Drought Plan Guideline’ (as updated in July 2015). In accordance with the guidelines we completed pre-consultation with key stakeholders and have sought approval from the Secretary of State for publication of the draft plan for public consultation.

The draft Drought Plan 2019 is consistent with our revised draft Water Resources Management Plan (dWRMP) 2019 which sets out how we intend to secure water supply over the next 25 years. Our draft Drought Plan 2019 considers our drought response for the Anglian Water region and Hartlepool, as shown in Figure 1.1 below.

The Drought Plan is a technical document written primarily for our regulators, as well as other technical stakeholders, following principles set out in the guideline. A separate Summary document will provide a non-technical overview of our plan, which will be made available when we publish our draft Drought Plan 2019.

Figure 1.1: The Anglian Water region including Hartlepool
Our draft Drought Plan 2019 is structured in three parts; each can be read in order or separately.

Table 1.1: Structure of our draft Drought Plan 2019

<table>
<thead>
<tr>
<th>Drought Plan Part</th>
<th>Title</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part One</td>
<td>Drought Plan Framework and Regional Overview</td>
<td>• purpose of plan&lt;br&gt;• regulatory framework&lt;br&gt;• regional overview</td>
</tr>
<tr>
<td>Part Two</td>
<td>Drought Plan Technical Background</td>
<td>• previous drought investment&lt;br&gt;• vulnerability analysis&lt;br&gt;• scenario testing&lt;br&gt;• links to the revised dWRMP 2019</td>
</tr>
<tr>
<td>Part Three</td>
<td>Operational Drought Plan</td>
<td>• our drought management strategy&lt;br&gt;• drought monitoring, triggers and forecasting&lt;br&gt;• measures we would take to manage supply and demand during a drought&lt;br&gt;• environmental mitigation</td>
</tr>
</tbody>
</table>

1.2 Purpose of Plan

Our Drought Plan has been developed in accordance with the requirements of the Water Industry Act 1991, as amended by the Water Act 2003, to describe how we as a “water undertaker will continue, during a period of drought, to discharge our duties to supply adequate quantities of wholesome water, with as little recourse as reasonably possible to drought orders or drought permits”. The purpose of our Drought Plan is, therefore, to protect public water supplies whilst minimising any environmental impacts that may arise, as a result of our activities, during a prolonged period of low rainfall.

Every water company in England and Wales is required, by law, to prepare and maintain a statutory Drought Plan. Whilst Drought Plans are prepared in accordance with prescribed guidelines, they will each be different due to the different supply system characteristics of each water company. We will always seek to work together with other water companies, and especially with our neighbouring companies, to ensure that during times of drought we provide a clear message to our customers. This is especially important during times when we may need to impose water use restrictions, as our customers experienced during the 2011-12 drought. We carefully follow the legislation regarding water restrictions, and seek as an industry to ensure consistent interpretation and application through an increased focus on regional water resources planning; and liaison with Water UK and the EA managed National Drought Group. However, approaches to demand management will vary between different water companies.

In April 2017 the water retail market opened. As a result, business customers no longer buy water services from us directly and we work with retailers via our Wholesale Service Centre. As the wholesaler, we maintain our commitment to ensuring a secure supply of water for all customers.
Each drought varies in terms of intensity, duration, geographical coverage and impact. Our Drought Plan draws on previous experience in our region, alongside consideration of stochastically generated drought events, to represent both historical droughts and worse than historically experienced. This is in line with Water Resource Planning guidance from the Environment Agency and Defra requiring water companies to consider system resilience to the effects of severe drought (defined as an event with an approximate 1 in 200 year return period).

We have reviewed the measures that we have in place to maintain secure water supplies during both the worst recorded drought and 1 in 200 year drought for all of our water sources. The Plan sets out the management actions that we will take before, during and after a drought. The Drought Plan is not strategic but outlines a framework for managing a drought were it to occur under present circumstances with existing infrastructure.

The Environment Agency is responsible for producing its own Drought Plan to protect the environment, water abstractors and the interests of other users of the environment. It has both a strategic drought response framework and regional Drought Plans which we seek to engage and align with as much as possible.

The Environment Agency acts as a technical advisor to government and as such, advises government on water companies’ Drought Plans and publishes technical guidance on preparing Drought Plans. They are a statutory consultee in the development and review of both our Water Resources Management Plan and Drought Plan.

It should be recognised that a water resources drought will usually only develop after several months of below-average rainfall. This is different from an agricultural drought when unseasonably dry soils may arise from only weeks of dry weather over the growing season. It is possible, therefore, that the Environment Agency may choose to announce that the region is in drought due to wider environmental or agricultural concerns, as opposed to a concern over the security of public water supplies. We will continue to work closely with the Environment Agency during such times to explain and clarify our individual roles and responsibilities to our customers.

The effectiveness of our management in previous droughts can be measured by the adoption of timely measures and responses that have enabled us to maintain the security of public water supplies. We believe that this current Drought Plan provides a robust approach to drought management and we are confident that it provides the flexibility we require to maintain future public water supplies.

1.3 Regulatory Framework

Drought Plans are a statutory requirement under Section 39B of the Water Industry Act 1991, as amended by the Water Act 2003. Our Drought Plan 2019 has been prepared in line with the legal framework for Drought Planning as set out in:

- Water Industry Act 1991
- Water Act 2003
- Drought Plan (England) Direction 2016
- Drought Plan Regulations 2005
- Drought Direction 2011
- Flood and Water Management Act 2010
- Water Use (Temporary Bans) Order 2010
- Environmental Assessment of Plans and Programme Regulations 2004; from Strategic Environmental Assessment Directive 2001
- Conservation of Habitats and Species Regulations 2017

In accordance with the Security and Measures Direction 1998 (SEMD), the Drought Plan has been formally reviewed by an independent SEMD certifier who has provided a certified statement of compliance. This confirms that our Drought Plan 2019 meets the requirements of ‘The Control of Sensitive Water Company Information – Advice Note 11 Edition 1,’ as published by Defra in November 2006.

The Water Act 2014 contains provisions that amends the Drought Plan requirements in the Water industry Act 1991. Section 28(4) of the Water Act 2014 was commenced on 14 July 2014, so that in accordance with section 39(6) of the Water Industry Act 1991, we are required to prepare and publish a revised plan by 22 August 2019, or sooner if there has been a material change of circumstances or as directed by the Secretary of State.

In accordance with section 39B(6)(c) of the Act, a water undertaker must send a draft of its Drought Plan to the Secretary of State within 4 years and 3 months after the date on which its Drought Plan, or its last revised Drought Plan, is published.

1.4 Consultation

1.4.1 Pre-consultation

In line with guidance, we undertook a pre-consultation phase. This was shared with the Environment Agency, Natural England and Defra as well as key stakeholders including our inset suppliers. Comments were received back from the Environment Agency.

In addition, we have and continue to work closely with the Environment Agency and Natural England to assess the potential environmental impact of the measures in our Drought Plan and to develop detailed Environmental Assessment Reports (EARs) for our Drought Permit options.

We have also carried out consultation on our Strategic Environmental Assessment (SEA) screening and scoping phases to inform the SEA report, which will be issued for consultation at the same time as the draft Drought Plan 2019. Responses on the SEA approach were received from the Environment Agency, Natural England, and Historic England.

1.4.2 Public consultation

We have sought approval from the Secretary of State for publication of the draft Drought Plan 2019 for public consultation.

We have now had this approval, without any required changes needed. Our draft Drought Plan is now available for consultation for an eight week period to gain the views of all key stakeholders and customers. The consultation period runs from 22 February 2019 - 19 April 2019.

We will consider all representations and produce a Statement of Response to outline any changes we have made to our plan within 15 weeks of the publication of this draft Drought Plan 2019. The Secretary of State will then consider whether to issue any directions for the final Drought Plan prior to final publication.

1.5 Regional Overview

1.5.1 Our Region

Anglian Water currently provides water or wastewater services to more than 6 million customers in the east of England and the town of Hartlepool in the north-east. The region we supply, in the East of England, covers 22,000km² and is bounded to the north by the Humber Estuary and extends west to Northampton and Milton Keynes.

The East of England is the driest region in the UK, with low rainfall (71 per cent of the UK average) and high evaporation losses. Our water resources are already under pressure: the region is designated by the Environment Agency as an area of serious water stress, and opportunities for new water resources are limited. Therefore effective water resource planning and drought management is vital to ensure that we achieve and maintain the security of our public water supplies during drought events and peak demands, whilst taking due consideration of any associated environmental concerns.

Our region is predominantly agricultural, producing half of the UK’s sugar beet, a third of its potatoes and a quarter of its wheat. It is also one the fastest growing. The number of households we supply has grown by over 30 per cent since the water industry was privatised in 1989, and is expected to grow rapidly in coming decades.

In addition, it is recognised as being particularly vulnerable to the impacts of climate change. Climate change projections show our region is expected to experience lower summer rainfall and increased evaporation, leading to lower groundwater recharge in the future. More frequent and intense downpours are also predicted. These could result in increased nitrate and pesticide run-off from fields, impacting the water quality of our region’s rivers and groundwater.

We have an ever increasing responsibility to maintain secure supplies of water. However, it is essential we do this in a sustainable way. Our business depends on a healthy, flourishing environment to supply clean water and receive recycled water after treatment. The region is characterised by a high number of internationally designated wetland conservation sites (see Figure 1.2), including 40 Special Areas of Conservation (SAC)\(^3\), 28 Special Protection Areas (SPA)\(^4\) and 28 Ramsar\(^5\) wetland sites. In addition, many unique habitats are located within our area, including reedbeds, inter-tidal mudflats, and grazing marshes. We work closely with the Environment Agency, Natural England and environmental groups to ensure we continue to manage water resources and the environment across our region in a sustainable way.

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\(^3\) SAC is an area classified under the EC Habitats Directive and agreed with the EU to contribute to biodiversity by maintaining and restoring habitats and species.

\(^4\) SPA is an area classified under the EC Birds Directive to provide protection for birds, their eggs, nests and habitats.

\(^5\) An area of international conservation importance classified at the ‘Convention on Wetlands of International Importance’ 1971, ratified by the UK Government in 1976.
Figure 1.2: Map of conservation sites across the Anglian region*

* Rutland Water is also designated as an Site of Special Scientific Interest (SSSI), SAC and Ramsar site, but sits just outside the Anglian region and is not included on the map.
1.5.2 Our water sources

We abstract from a combination of groundwater and surface water sources across the region, as displayed below in Figure 1.3. On average we supply 1,050 Ml of water per day (Ml/d) to our customers. This can peak up to approximately 1,400 Ml/d during high demand periods, as was experienced during the recent hot, dry weather of summer 2018.

Figure 1.3: Map of Anglian Water’s water sources

In the west of our region, water supply is mainly provided by the large pumped storage reservoirs of Rutland Water, Grafham Water and Pitsford Water, and two natural catchment reservoirs, Ravensthorpe and Hollowell. These form a partially integrated supply system known as Ruthamford, whereby the reservoirs can be used to support each other if needed. We provide supplies from Grafham Water to Affinity Water (Central) under the provision of the Great Ouse Water Act.

To the east, we also operate pumped storage reservoirs at Covenham, Alton Water and Ardleigh. Ardleigh Reservoir is jointly owned with Affinity Water (East) and operated under the provisions of the Ardleigh Reservoir Order under the governance of the Ardleigh Reservoir Committee.
We hold abstraction licences for seven operational direct supply river intakes, which along with the reservoirs account for approximately 50 per cent of our supply.

The remaining 50 per cent of supply is provided by groundwater abstracted from 200 sources comprising over 450 operational boreholes. These range in depth from 10m to 500m, and penetrate several major aquifers across the region, each of which will respond differently in a drought.

Our principal source of groundwater is from the Chalk, but the other aquifers we abstract from include the Lincolnshire Limestone, Sherwood Sandstone, Magnesian Limestone, Lower Greensand, Spilsby Sandstone, Sandringham Sands and a combination of Crag, sands and gravels.

The Hartlepool Water supply area to the north of the region generally has higher average annual rainfall than the rest of our supply area. In Hartlepool we abstract water from the deeply confined aquifer of the Magnesian Limestone. The nature of this aquifer combined with more rainfall means it is higher resilient to changes in climate or water quality issues, and historically, there have been no reported issues with low rainfall conditions affecting the availability of supplies.

Water Resource Zone integrity

The uneven nature of climate, drought, growth and environmental impacts across our region means we have developed Water Resource Zones (WRZs). WRZs are the geographical areas used to develop forecasts of supply and demand and supply-demand balances. The WRZ describes an area within which supply infrastructure and demand centres are linked such that customers in the WRZ experience the same risk of supply failure. These were reviewed in the revised dWRMP 2019 and have changed since the last WRMP and Drought Plan.

Some of the challenges we face, especially supply-side impacts such as sustainability reductions, occur in discrete parts of some of our larger WRZs. This means that the risks within WRZs become imbalanced and therefore WRZs need to be split or adjusted in order to isolate spatial deficits so that schemes are identified to bring these areas back into balance. Overall we have increased the number of WRZs from 19 at WRMP 2015 to 28 for WRMP 2019, including the addition of South Humber Bank which is a non-potable WRZ that sits within Central Lincolnshire (see Figure 1.4 below).
1.5.3 Bulk Supply Agreements and Inset Appointments

We have long-standing statutory agreements for bulk exports with Affinity Water (Central) and Severn Trent Water. It has been agreed with both water companies that these arrangements will remain in force as reported in our revised dWRMP 2019. We also have agreements for bulk imports from Essex and Suffolk Water and Cambridge Water. Details of the quantities are detailed in Table 1.2.

Table 1.2: Bulk supply agreements in the revised dWRMP 2019

<table>
<thead>
<tr>
<th>Transfer type</th>
<th>Associated WRZ</th>
<th>Company</th>
<th>Volume (Ml/d) in 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>Bulk export</td>
<td>Ruthamford North (Rutland - Wing)</td>
<td>Severn Trent Water</td>
<td>18</td>
</tr>
<tr>
<td>Bulk export</td>
<td>Ruthamford South (Grafham)</td>
<td>Affinity Water</td>
<td>84.6</td>
</tr>
<tr>
<td>Bulk import</td>
<td>South Essex (Tiptree)</td>
<td>Essex &amp; Suffolk Water</td>
<td>3</td>
</tr>
<tr>
<td>Bulk import</td>
<td>Thetford (Barnham Cross)</td>
<td>Cambridge Water</td>
<td>0.25</td>
</tr>
</tbody>
</table>

We also have a shared water resource with Affinity Water (East) at Ardleigh Reservoir.

In addition, we have a number of small net transfers with Yorkshire Water, Cambridge Water, Thames Water and inset appointments with Independent Water Networks Limited (IWNL) Icosa, Scottish and Southern Energy (SSE) and Albion Water.

Under the terms and conditions of the bulk supply arrangements, there is no formal requirement for these companies to impose the same restrictions, although in practice companies plan for similar restrictions when experiencing the same drought conditions.

In the event of a drought these imports and exports would be subject to the same levels of service as the donor company. Close liaison will be necessary during the onset of a drought to minimise any impact to respective supply areas.

Details of our current major trades and trading options considered in the revised dWRMP 2019 are presented in Figure 1.5.
PART TWO

TECHNICAL BACKGROUND
PART TWO

TECHNICAL BACKGROUND

Part Two of our draft Drought Plan 2019 presents the technical background to our drought planning, and how this links to our draft Water Resources Management Plan 2019. It details our drought vulnerability analysis and historic drought investment.

2.1 Water Resource Planning

2.1.1 Relationship with the Water Resources Management Plan

Water companies have a statutory obligation to prepare and maintain a Water Resources Management Plan (WRMP), published every five years. In the WRMP, companies must set out how they will ensure that they have sufficient water resources to meet the current and future demands of their customers, over a minimum 25 year period.

We published our draft WRMP (dWRMP) 2019 in March 2018 for consultation, and our revised draft is now with Defra for approval. The overall aim of our WRMP is to develop a system of supply that is reliable, affordable and sustainable. This includes meeting customer and government expectations and complying with all statutory obligations. We propose to achieve this through a twin track approach of an ambitious demand management programme and investing to improve the resilience of public water supplies to climate change, more severe drought and environmental pressures.

The revised dWRMP ensures we have a long term plan to be resilient to drought, and sets out how we will secure supplies for a drought event of up to a 1 in 200 year severity from 2024. This is in line with new guidance, requiring water companies to consider droughts beyond the historic record.

Our draft Drought Plan complements this, setting out actions we will take if a drought of 1 in 200 year severity occurs before this time, as well as considering droughts worse than this. Our draft Plan also details the shorter-term management actions that we will take as a drought progresses.

2.1.2 Levels of Service

Since the 2011-12 drought, we have been concerned that parts of our system are vulnerable to drought and we would not be able to maintain supplies to customers without imposing severe restrictions, such as rota-cuts.

As a result, in preparing our revised dWRMP we thought carefully about what Levels of Service are appropriate for our customers and our region. We believe that our Levels of Service for Temporary Use Bans (10 per cent annual average risk) and Non-Essential Use Bans (2.5 per cent annual average risk) are appropriate and are not proposing to make any changes to them in either our revised dWRMP 2019 or draft Drought Plan 2019.

However, we do not believe that our current Level of Service for severe restrictions (one percent annual average risk) is appropriate or acceptable – this is supported by our customers as demonstrated through our revised dWRMP 2019 consultation. As a result, our objective is to ensure that from 2025 onwards, our customers will not be at risk of rota cuts in droughts up to 1 in 200 year severity. We are therefore proposing to move to a new Level of Service for severe restrictions (less than 0.5 percent annual average risk) by 2025.

Through analysis in our revised dWRMP 2019, we identified that the majority of our WRZs are resilient against a 1 in 200 year drought event, as a result of previous drought investment. We have identified five WRZs which remain at risk of severe restrictions before we have completed additional investment by 2024/25. These are shown in Figure 2.1.
We have developed interim options to support these WRZs should a 1 in 200 year drought occur before the AMP7 investment is completed. Additional analysis on these zones has identified existing supply surplus within either the zone itself or adjacent zones, which can be utilised to mitigate this risk. This is detailed further in Appendix 3.

2.2 Drought Management and Investment to Date

Our water resources and supply systems have been developed over the last 150 years to meet increasing demands for water and to cope with severe droughts. This has been achieved through the construction of strategic storage reservoirs with long retention periods and development of local groundwater supplies. The volume of water that we have supplied to our customers is referred to as distribution input.

There have been a number of droughts that have affected the Anglian region, described in turn below. Each of these periods of exceptionally low rainfall has affected water supplies to various extents, with some affecting parts of our region more severely than others. It was the prolonged drought experienced in 1975-76 that received widespread attention and began to underpin future water resource drought planning for the Anglian region.

The lessons we have identified from our response to previous droughts have informed our current drought plan. Most recently, our drought response was tested during the 2011-12 drought in the Anglian region. We are confident that our drought plan provides a robust framework to enable us to maintain supplies to our customers.

Parts of the region are well served through the interconnection of strategic trunk water mains, adding to the security and flexibility of the system. We continue to invest in the distribution system in order to improve integration that will enable us to meet local growth in demands, improve security of supply and manage groundwater quality, notably as a result of increasing diffuse source contaminants such as pesticide compounds and nitrates.

2.2.1 Pre-privatisation

The very low rainfall experienced during the early part of the summer of 1976, following the dry autumn and winter of 1975, resulted in supply issues at many abstraction sources.
Most serious water supply problems were experienced in Northampton, Peterborough, Lincoln and Bedford. Plans were drawn up to reduce consumption and secure additional or alternative supplies to maintain essential supplies. Conservation measures were well under way throughout June 1976, and at the beginning of July hosepipe bans covered most of the region served by Anglian Water Authority. This was supported by intensive publicity campaigns.

The Drought Bill as published on 14 July 1976 introduced a range of emergency measures for conserving water further and maintaining supplies. A selection of these schemes is presented in Figure 2.2.

**Figure 2.2: Pre-privatisation investment in the Anglian region**

2.2.2 Post-privatisation

Our policy on water supply since privatisation in 1989 has been to follow a twin track approach, reducing demand and investing in supply-side schemes to ensure security of supplies against drought and to minimise potential environmental impacts resulting from our abstractions.

Since privatisation of the water industry in 1989, there have been four periods of drought: 1988 to 1992; 1995 to 1997; 2005 to 2006; and 2011 to 2012. These are described in detail below. We have been working with the University of East Anglia Climatic Research Unit to better understand the meteorological patterns of these historical droughts. During this period, Anglian Water has invested extensively in drought mitigation schemes including: transfer schemes to improve the connectivity of our distribution system; additional treatment capacity; and new boreholes to allow us to maximise the use of our existing abstraction licences.

For reservoirs in Ruthamford, which are partly connected, we continue to explore integration through system modelling so we can optimise the balance of storage and conjunctive use to minimise the severity of drought impacts on any one reservoir.

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6 University of East Anglia Climatic Research Unit, 2018, Observed droughts in the greater Anglian Water area-of-interest since 1920
The key schemes are summarised in Figure 2.3, with further description of each drought event below.

Figure 2.3: Post-privatisation investment in the Anglian region
1988 to 1992

This drought followed the restructuring of the industry, during a period when both the National Rivers Authority (now the Environment Agency) and the newly privatised water company were both developing new strategies. Water levels in aquifers fell to record low values, and there were increasing concerns about supplies to areas dependent on groundwater, notably in Lincolnshire, Norfolk and Suffolk. Investment of £37 million was made in new assets in the form of satellite boreholes, inter and intra planning zone transfers and additional treatment capacity, specifically to maintain supplies.

Key investments during this drought included the Wing to Etton trunk main duplication; Maltby to Mumby trunk main and booster; the Glentham to Welton main and booster; the Bucklesham transfer; the Whittlesey to March trunk main; and groundwater sources.

The introduction of demand management was achieved via publicity campaigns. At the request of the National Rivers Authority, hosepipe bans were also imposed between 1990 and 1992 for customers living in the east of the region. This drought did not have an impact on the surface water sources to the west of our region, where we were able to avoid customer restrictions.

1995 to 1997

The joint communications strategy for water conservation between the newly formed Environment Agency and Anglian Water was improved using learning from the previous drought. Together with an increased number of measured customers this ensured that we were able to successfully manage demand and avoided the need to introduce any restrictions.

We also invested a further circa £42 million in specific drought schemes. Key investments during this drought included the Kenwick – Raithby – Stenigot main duplication; the Wing to Peterborough main duplication; the Newton to Grove trunk main; the Kings Delph / March main and booster; water treatment works upgrades and additional satellite boreholes.

The prospect of the drought continuing for a third year led to a precautionary application for two drought orders in September 1997 to assist with the winter refill of Grafham Water and Pitsford Reservoir. The Planning Inspector’s report on the Public Inquiry supported the need for both drought orders, but the Secretary of State withheld his decision in order to further consider the implications of the newly implemented Habitats Directive. The above-average rainfall during the summer of 1997 continued into the winter and it was possible to withdraw the applications in February 1998. Reports from the Environment Agency during the Public Inquiry highlighted the apparent lack of connectivity between the major reservoirs in the Ruthamford region.

2005 to 2006

The dry winter of 2005-06 resulted in conditions requiring our Drought Management Team to meet in January 2006 to review forecasts of the effect of a continuing period of below average rainfall and to agree appropriate actions. These included a widespread publicity campaign to encourage water efficiency and manage demand, along with enhanced leakage control focused in the south of the region.

We were concerned with the potential onset of a third dry winter in 2006-07 affecting our groundwater and surface water resources. As a result we implemented an £18 million investment programme for advancing planned schemes, and developed further schemes to commission additional boreholes and links within our water distribution network in order to maintain the security of water supplies.

Key investments during this drought included the installation of new abstraction pumps to maximise the refill opportunities to Rutland Water; the Stoke Ferry to Downham Market main; and investment in groundwater sources in Ipswich and Newmarket. During this time we maintained regular liaison with neighbouring water companies and the Environment Agency to review the water resource situation and to co-ordinate action in managing supplies and demand. The Anglian Region Drought Liaison Group meetings were also attended by Consumer Council for Water (CCWater), Natural England and the National Farmers Union.

The Environment Agency and neighbouring water companies also implemented their drought plans in response to the 2005-06 drought. We maintained regular liaison to review the water resource situation and to co-ordinate action in managing supplies and demand.

2011 to 2012

This event is our most recent drought to date. The details of the drought event and our response are summarised overleaf.
What happened in the 2011-12 drought

2011

• On the 10 July 2011 the Secretary of State announced that the Environment Agency’s Anglian region had moved to drought status, as a result of nearly 6 months of exceptionally low rainfall and the soil moisture deficit being at its highest recorded level.

• This exceptionally low rainfall in 2010 and 2011 had a significant impact on flows in the River Nene, and affected our ability to refill Pitsford Reservoir and Rutland Water.

• As a precautionary measure, we applied successfully for two drought permits on the River Nene to maximise the water available for abstraction. Both drought permits were issued in December 2011 and expired in April 2012.

2012

• By March 2012 it was being reported as the driest 18 months ever recorded.

• The low reservoir storage situation in March 2012 was compounded by low river flows across the Anglian region impeding refill opportunities. In addition, the drought area was starting to extend into our groundwater system.

• On 5 April 2012 we imposed Temporary Use Bans on our customers for the first time in 20 years, alongside six other water companies in the south and east of England.

• At that time, we were growing increasingly concerned about the potential impact of a third-dry winter, and that we would not be able to maintain supplies to customers in our Ruthamford WRZs without imposing severe restrictions.

• We responded to this risk by:

  • Reducing our leakage to record low levels (189Ml/d, 10% below our target of 211Ml/d)

  • Launching Drop 20, our biggest ever water-saving campaign, where we asked every customer to reduce their daily use by 20 litres

  • Identifying and delivering a £47 million programme of capital investment to increase our resilience and protect customers’ supplies, and

  • Leading the industry-wide response through the National Drought Management Team

  • Thankfully, the drought was brought to a rapid conclusion by six months of record-high rainfall between April and September 2012.

  • We lifted the restrictions on 14 June 2012, just 10 weeks after they had started.

In response to drought conditions, we carried out extensive publicity campaigns before implementing Temporary Use Bans on our customers for the first time in 20 years, alongside six other water companies in the south and east of England.

We invested significant capital expenditure to increase our resilience and protect customers’ supplies. The capital programme to 2015 included investment opportunities to commission a number of our licensed abstraction sources, although the requirement to conform with the Water Framework Directive impacted the viability of some schemes.

Key investments during this drought included new groundwater sources, a river augmentation main, booster pumps, Rutland Water refill schemes, leakage enhancement and pressure management. Capital investment was prioritised at three vulnerable groundwater sources in Lincolnshire and Norfolk, and to enhance interconnection in the Ruthamford region through the Hannington to Pitsford link.

Lessons Identified from Previous Droughts

Our experiences of previous droughts show that our water resources respond differently to different types of drought, and therefore successful management actions need to reflect this.

A short intense summer drought will require a different approach to a sequence of winters with below-average recharge to water resources in aquifers and pumped storage reservoirs. The 1988-92 drought was characterised by the impact on groundwater resources and base flows to rivers during the summer of 1991, whereas the 1995-97 drought placed greater stress on surface water storage. The 2011-12 drought primarily impacted the rivers in the west of our region.
Our region often experiences periods of low rainfall, which will initially affect our surface water sources over a single season. In general our supply system is relatively insensitive to short-duration droughts, like 1976, except in a few locations where river abstractions go directly into treatment. Where possible in this scenario we would actively seek to maximise conjunctive use of our groundwater sources to reduce demand on surface water sources.

Assessment of our groundwater sources and their behaviour in drought scenarios has enabled us to identify and classify boreholes which are inherently more vulnerable to drought. This has allowed us to invest to secure these sources for future droughts. These boreholes and mitigation actions are described further in Part 3 and Appendix 6.

Experience of previous drought sequences in our region has underpinned the importance of effective and timely customer and stakeholder communication at the onset of prevailing drought conditions – an example is presented in the case study below. The requirement for effective engagement with customers via publicity campaigns has been highlighted and we have experience of developing successful campaigns to promote our water efficiency messages (Appendix 9). The importance of an effective campaign to manage demand cannot be under-estimated.

We have a good baseline to launch our campaigns from due to the ongoing programme of other demand management measures, such as successful meter penetration, enhanced metering and water efficiency programmes described further in Part 3.

Historically droughts have all ended sharply in response to a period of above-average rainfall, for example the heavy rainfall in the winters of 1976-77, 1992-93 and 1997-98. This pattern was repeated with the heavy rain of 2012 following the 2011-12 drought. Demand restrictions and drought order applications have been withdrawn as soon as the prevailing conditions allowed.

The 2011-12 drought highlighted how the severity of a drought can change over a small distance, such that even within the Ruthamford WRZs the River Great Ouse and the River Nene responded very differently to the low rainfall. This is why our Grafham Water reservoir, which relies on refill from the River Great Ouse, remained in a healthy state whilst storage levels in both Rutland Water and Pitsford Reservoir declined as a result of the low flows in the River Nene.

The importance of collaborative working with key stakeholders was highlighted during the later stages of the summer of 2011. Regular drought liaison meetings between the Environment Agency and Anglian Water were instigated shortly after the Anglian region was announced as being in drought in July 2011. Concerns expressed by the Environment Agency regarding rainfall and river flows in the Nene catchment prompted detailed reservoir storage projections to be undertaken for a range of flow scenarios, which led us to take the precautionary step of applying for two winter drought permits.

We continued to work closely with regional contacts in the Environment Agency to ensure that we addressed all of their concerns in a timely manner. We engaged in early discussions with Natural England and reached agreement on appropriate mitigation measures to ensure that we fulfilled Habitats Directive requirements. We consulted widely and further discussions were also necessary with a number of key stakeholders including angling clubs, district councils and internal drainage boards.

The successful and timely outcome of the drought permit application to enable us to secure public water supplies, whilst minimising any environmental impacts and effects on other water users, was helped significantly by the good working relationships between all of our key stakeholders.

Case Study: River Nene Drought Permits 2011

The importance of collaborative working with key stakeholders was highlighted during the later stages of the summer of 2011. Regular drought liaison meetings between the Environment Agency and Anglian Water were instigated shortly after the Anglian region was announced as being in drought in July 2011. Concerns expressed by the Environment Agency regarding rainfall and river flows in the Nene catchment prompted detailed reservoir storage projections to be undertaken for a range of flow scenarios, which led us to take the precautionary step of applying for two winter drought permits.

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The successful and timely outcome of the drought permit application to enable us to secure public water supplies, whilst minimising any environmental impacts and effects on other water users, was helped significantly by the good working relationships between all of our key stakeholders.
2.3 How drought affects our resources

Our resources are dependent on both the intensity and the duration of a rainfall deficit.

We have summarised the different drought responses of our sources in Table 2.1.

<table>
<thead>
<tr>
<th>Resource</th>
<th>Source of water</th>
<th>Resource type</th>
<th>Response to rainfall</th>
<th>Drought resilience*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoirs</td>
<td>Water pumped from nearby rivers/natural inflow/direct rainfall</td>
<td>Small and single-season secure e.g. Ardleigh reservoir</td>
<td>Storage responds quickly to changes in rainfall and reservoir levels can quickly drop. However they also tend to recover quickly once river flows pick up</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Large multi-season secure e.g. Rutland Water</td>
<td>Greater storage volume means reservoir storage depletes slower and can withstand longer periods of low flows. However it takes longer to recover once levels have declined</td>
<td>High</td>
</tr>
<tr>
<td>Rivers</td>
<td>Surface water runoff from land and groundwater base flow</td>
<td>Overland runoff dominated e.g. River Welland, Trent</td>
<td>Flashy and responds quickly to high or low rainfall situations. This means flows can decline quickly but also refill quickly</td>
<td>Typically low, except for larger rivers or those supported by effluent returns</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overland runoff/base flow split</td>
<td>Combination of overland and baseflow rivers</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Base flow dominated e.g. River Wensum</td>
<td>Slower response to rainfall changes as these rivers are bolstered by groundwater. This means they can maintain higher flows for longer but take longer to recover from low flows</td>
<td>Medium</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Underground aquifers</td>
<td>Chalk e.g. Marham/Sandstone e.g. Raithby/Limestone e.g. Aslackby. Confined e.g. Spilsby sandstone/unconfined e.g. Chalk outcrop</td>
<td>Groundwater responds more slowly to rainfall patterns because there is a lag time between rain falling on the ground and percolating through to the aquifer. This generally means groundwater sources are more resilient to shorter dry spells, but it depends on the type of aquifer and its degree of confinement and we have identified where sources are drought vulnerable.</td>
<td>Generally high (except for drought vulnerable boreholes).</td>
</tr>
</tbody>
</table>

*Drought resilience refers to resilience against dry winters as detailed in Table 2.3. A source with low resilience indicates it is more vulnerable to shorter drought events and is more likely to be affected more often.
2.4 Drought testing

2.4.1 Reference drought

We assess the drought vulnerability of our sources against a reference drought. In previous drought and water resources planning cycles, this has always been the worst historic drought on record.

However, guidance now requires water companies to consider droughts beyond than the historic record, specifically droughts of 1 in 200 year severity.

During our revised dWRMP 2019 preparations, we undertook a drought vulnerability analysis to understand and quantify the risk to our system from a range of drought events. This included developing a suite of stochastically generated drought events to test droughts more severe than historically experienced - this is discussed further in Section 2.4.2.2. This analysis showed that many of the historic drought events experienced in our region were more severe than previously understood and, due to significant investment in drought schemes, many of our systems are already resilient.

We commissioned the Met Office to produce estimates of rainfall and a measure of aridity called the Standardised Precipitation-Evapotranspiration Index (SPEI), for different return periods and locations. We have compared this with observed historical data to estimate the return period of seven historical droughts back to 1920. We have concluded that the 1930s drought in Ruthamford was of the order of a 1 in 200 year event and the 1989-92 drought was more severe than 1 in 200 year for Lincolnshire, whilst also affecting parts of Norfolk and Suffolk. However much of the eastern part of our region has not experienced a severe drought before and some areas remain vulnerable to a 1 in 200 year event.

In the revised dWRMP 2019 we reviewed drought risk at a WRZ-level. The reference drought and associated return periods are in Table 2.2 below. We have maintained the historic reference drought where our system modelling showed there was no additional drought impact from a stochastic severe drought.

We have also considered more extreme drought events, up to 1 in 500 year severity, to which nearly the entire region shows some degree of vulnerability. However the nature of these droughts makes them both extremely unlikely and uncertain and therefore we will continue to develop our understanding of our system to such events, and are not at present proposing to invest against this level of risk.

Drought Terminology

Historic drought – refers to the worst historic drought on record, which we planned to in our 2015 WRMP and Drought Plan. This was previously assumed to be drought events with approximately a 1 in 100 year return period, which we describe as having a 25 % chance of occurring over a 25 year planning period.

Severe drought – refers to drought events with approximately a 1 in 200 year return period. We describe these events as having a 12 % chance of occurring over a 25 year planning period.

Extreme drought – refers to a drought events with approximately a 1 in 500 year return period. We describe these events as having a 5% chance of occurring over a 25 year planning period.

Table 2.2: Summary of up to 1 in 200 year drought DO impact, reference design drought and estimated return period

<table>
<thead>
<tr>
<th>WRZ</th>
<th>Severe drought Vulnerable sources</th>
<th>Drought type</th>
<th>Reference drought (reported worst year)</th>
<th>Estimated return period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bourne</td>
<td></td>
<td>Historical</td>
<td>1989-92</td>
<td>&gt; 1 in 200 year</td>
</tr>
<tr>
<td>Bury-Haverhill</td>
<td>Risby</td>
<td>Stochastic</td>
<td>Nominal Year 1949</td>
<td>&gt; 1 in 200 year</td>
</tr>
<tr>
<td>Central Essex</td>
<td>Trent intake</td>
<td>Historical</td>
<td>1989-92</td>
<td>1 in 50 to 1 in 150 year</td>
</tr>
<tr>
<td>Central Lincs</td>
<td>Trent intake</td>
<td>Historical</td>
<td>1976</td>
<td>&gt; 1 in 200 year</td>
</tr>
<tr>
<td>Cheveley</td>
<td>Lower Links</td>
<td>Stochastic</td>
<td>Nominal Year 1949</td>
<td>1 in 200 year</td>
</tr>
<tr>
<td>East Lincs</td>
<td></td>
<td>Historical</td>
<td>1989-92</td>
<td>&gt; 1 in 200 year</td>
</tr>
<tr>
<td>East Suffolk</td>
<td></td>
<td>Historical</td>
<td>1997</td>
<td>1 in 200 year</td>
</tr>
<tr>
<td>Ely</td>
<td></td>
<td>Historical</td>
<td>1991-3</td>
<td>1 in 50 to 1 in 150 year</td>
</tr>
<tr>
<td>Happisburgh</td>
<td></td>
<td>Historical</td>
<td>1990-92</td>
<td>1 in 50 to 1 in 100 year</td>
</tr>
<tr>
<td>Ixworth</td>
<td></td>
<td>Historical</td>
<td>1996-98</td>
<td>1 in 50 to 1 in 150 year</td>
</tr>
<tr>
<td>Newmarket</td>
<td>Ashley Rd, Long Hill, Southfields, Moulton</td>
<td>Stochastic</td>
<td>Nominal Year 1949</td>
<td>1 in 200 year</td>
</tr>
<tr>
<td>Norfolk Rural North</td>
<td></td>
<td>Historical</td>
<td>1991-2</td>
<td>1 in 50 to 1 in 100 year</td>
</tr>
<tr>
<td>Norfolk Rural South</td>
<td></td>
<td>Historical</td>
<td>1991-2</td>
<td>1 in 50 to 1 in 100 year</td>
</tr>
<tr>
<td>North Fenland</td>
<td></td>
<td>Stochastic</td>
<td>Nominal Year 1923</td>
<td>1 in 200 year</td>
</tr>
<tr>
<td>North Norfolk Coast</td>
<td></td>
<td>Historical</td>
<td>1990-92</td>
<td>1 in 50 to 1 in 100 year</td>
</tr>
<tr>
<td>Norwich &amp; the Broads</td>
<td></td>
<td>Stochastic</td>
<td>1992</td>
<td>1 in 50 to 1 in 100 year</td>
</tr>
<tr>
<td>Nottinghamshire</td>
<td></td>
<td>Historical</td>
<td>1975-6</td>
<td>- 1 in 200 year</td>
</tr>
<tr>
<td>RHF Central</td>
<td></td>
<td>Historical</td>
<td>1934</td>
<td>- 1 in 200 year</td>
</tr>
<tr>
<td>RHF North</td>
<td></td>
<td>Historical</td>
<td>1934</td>
<td>- 1 in 200 year</td>
</tr>
<tr>
<td>RHF South</td>
<td></td>
<td>Historical</td>
<td>1934</td>
<td>- 1 in 200 year</td>
</tr>
<tr>
<td>RHF West</td>
<td></td>
<td>Historical</td>
<td>1934</td>
<td>- 1 in 200 year</td>
</tr>
<tr>
<td>South Essex</td>
<td></td>
<td>Historical</td>
<td>1934</td>
<td>1 in 50 to 1 in 150 year</td>
</tr>
<tr>
<td>South Fenland</td>
<td>Marham (GW)</td>
<td>Stochastic</td>
<td>Nominal Year 1923</td>
<td>1 in 200 year</td>
</tr>
<tr>
<td>South Lincs</td>
<td></td>
<td>Historical</td>
<td>1989-92</td>
<td>&gt; 1 in 200 year</td>
</tr>
<tr>
<td>Sudbury</td>
<td></td>
<td>Historical</td>
<td>1989-92</td>
<td>1 in 50 to 1 in 150 year</td>
</tr>
<tr>
<td>Thetford</td>
<td></td>
<td>Historical</td>
<td>1996-98</td>
<td>1 in 50 to 1 in 150 year</td>
</tr>
</tbody>
</table>
2.4.2 Production of drought events

2.4.2.1 Historic droughts

Surface water

Historic droughts have been identified for each of our surface water sources. Monthly mean cumulative flow deficits were compared to historic recorded monthly means for each particular intake. A ‘short’ drought was selected by assessment of the greatest 12-month flow deficit in the relevant composite river flow series that resulted in reservoir storage draw down. A ‘medium’ drought was selected from 18-month flow deficits, starting in April or May; and ‘long’ droughts from the greatest 36-month flow deficit in the series that would cause significant and prolonged resource pressures.

The reference drought is taken to be the drought which results in the lowest reliable yield.

We assess direct intake yields (Stoke Ferry, Marham, Heigham, Clapham and Hall) using statistical analysis on simulated flows. Almost 100 years of continuous flow data are generated using bespoke HYSIM rainfall-runoff models.

Reservoir yields are assessed using OSAY (Operating Strategy for Assessing Yield), an in-house reservoir assessment model. Inflows are modelled using the SIMFLOW rainfall-runoff model, which uses rainfall and PET data to generate surface runoff, percolation to groundwater and river flow.

The models were updated in 2016 in preparation for the revised dWRMP 2019. Rainfall and potential evapotranspiration (PET) input data sets were extended to the end of 2015 (from 1920) in line with available data. Special consideration was given to the Grafham SIMFLOW model to account for a change in the Environment Agency’s method of deriving flows at Offord, the abstraction point for Grafham reservoir on the River Great Ouse. The exception is for our Cadney intake, for which the flows and yield are calculated as part of the Environment Agency’s Trent-Witham-Ancholme scheme assessment, as it is a supported source.

Groundwater

Historic droughts for groundwater sources are also identified through comparison with historical averages, but for groundwater levels. The worst historic drought in Table 2.2 for groundwater WRZs has been identified through a review of nearby Environmental Agency observation borehole groundwater levels.

The potential yield for each of our groundwater sources is a measure of how much water the source can reliably provide for supply during a drought. The yield assessment applied to all AWS groundwater sources follows the standard industry-accepted UKWIR methodology, involving the relationship between total source abstraction rates against measured and predicted drought water levels, and comparing them with the deepest advisable pumping water level (DAPWL). Detail of the assessment methodology is included in Appendix 6.

2.4.2.2 Stochastic droughts

We used output from the monthly, spatially coherent rainfall generator used in the Water Resources East project to produce stochastic drought data sequences. The rainfall generator produces a very large number of statistically plausible sequences of monthly rainfall which are spatially coherent. Post-processing produces daily rainfall and PET, for input into hydrological models.

There is no single definition of drought, and therefore we have used both rainfall accumulation (and deficit) and SPEI, over a range of magnitudes, and for 6, 12, 18, 24, 30, 36 and 60 month durations. We used the following criteria to guide the drought selection process, and to ensure the selected design drought is consistent with ensuring system resilience and the WRPG:

- Droughts of greater severity than those observed in the historic record, as measured by rainfall deficit and SPEI and system performance metrics (e.g. reliability, resilience);
- Droughts with a range of durations;
- Droughts with different characteristics (e.g. combination of magnitude and duration; preceding conditions);
- Droughts which are significant for particular parts of the region;
- Droughts which vary in geographical occurrence across the region.

We reviewed the 200, 91-year sequences from the Water Resources East (WRE) project to produce a shortlist of droughts. This was based on ranking of sequences using meteorological and water resource system metrics (based on a run of the WRE simulator), followed by simple frequency-based return period analysis of droughts.

We subsequently used the rainfall and SPEI of the shortlisted droughts, in combination with the Met Office extreme value analysis, to more accurately estimate the return period of these stochastic droughts and identify a range of 1 in 200 year events to test our system and drought response against
using our water resource system model Aquator. We extended this analysis to identify an indicative 1 in 500 year drought for all WRZs.

Further details on the stochastic drought analysis and selection can be found in our revised dWRMP 2019 Supply Forecast supporting technical report.

### 2.4.3 Scenario testing

**Surface water**

We have undertaken scenario modelling of different drought events on our reservoir sources, as these determine our Levels of Service drought responses.

We have tested how our drought management actions for surface water reservoirs would be implemented over a range of drought scenarios detailed in Tables 2.3 and 2.4. Our preliminary analysis has shown that stochastic droughts do not cause additional impact on reservoir WRZs (Table 2.2), and therefore we have continued to use historical drought sequences for this assessment.

We are currently continuing this analysis to further investigate reservoir responses to a range of both historic and stochastic drought scenarios.

We are also using our water resources system model, to undertaking a pilot project to review the control curves of our reservoirs under more severe droughts and considering a more conjunctive system.

Further details of the assessments can be found in **Appendix 4**.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Drought duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-season drought (typically 6 to 12 months)</td>
<td>Short</td>
</tr>
<tr>
<td>Multi-season drought (1-2 years, typically 2 dry summers and an intervening dry winter)</td>
<td>Medium</td>
</tr>
<tr>
<td>Multi-season drought (typically lasting over two years)</td>
<td>Long</td>
</tr>
</tbody>
</table>

Table 2.3: Drought response scenarios with associated source vulnerability
Groundwater

To understand the impact of severe droughts on our groundwater sources, we have undertaken a severe drought groundwater yield assessment.

Through the WRE project, 200 simulated weather data sets were run through a lumped parameter model (LPM) for each regional aquifer to output time series of LPM groundwater storage which could then be used to estimate stochastic drought groundwater yields. To determine the relevant drought yields, the first stage was to identify storage values from the stochastic series. Historical modelled LPM storage vs observed groundwater level was plotted for key observation boreholes across the region in aquifers potentially vulnerable to drought, and used to identify severe drought groundwater level responses, taking account of uncertainties in the level - storage relationship.

A workshop involving experienced members of Anglian Water’s Water Resource Management Team was held to determine severe drought yield at every groundwater source, following the baseline UKWIR source reliable output summary diagram approach. Possible water quality effects were also accounted for, through expert judgement, which could limit yield unless significant additional investment in treatment infrastructure was undertaken. This approach was subject to an independent peer review.

The results have been used to review the drought vulnerable borehole list detailed in Appendix 6.

We have also commissioned a modelling pilot project into the response of the aquifers in the Newmarket area, which we have identified as being vulnerable to drought. The Newmarket sources lie within the area covered by the Environment Agency’s North-East Anglian Chalk (NEAC) regional groundwater model. A more detailed sub-model will be built using a MODFLOW6 unstructured grid, to model aquifer and borehole response under low piezometry and under severe and extreme drought events. This will allow us to better understand the impacts of severe and extreme droughts on individual sources in the area.

2.4.4 Managing the impact of drought

Our revised dWRMP 2019 drought analysis identified there are some parts of our system where vulnerabilities remain and during a severe drought event there is a risk that we would have to implement demand restrictions such as rota-cuts in order to maintain supplies. In Cheveley, Bury St Edmunds, Newmarket and South Fenland WRZs, there are modelled impacts on groundwater that reduce baseline supplies at WRZ level. There is also an impact in the Central Lincolnshire WRZ, due to vulnerability at our River Trent surface water intake.
To ensure we can maintain supplies to all of our customers, without having to impose severe restrictions such as rota-cuts, in our revised dWRMP 2019 we have proposed the investment we need to develop an equivalent capacity from new supplies by the end of AMP7.

In the interim, we have developed localised options for these WRZs should a severe drought occur between now and 2024. These are detailed in Appendix 3.

We have also considered our drought risk to extreme drought events, up to 1 in 500 year severity, to which nearly the entire region shows some degree of vulnerability. However the nature of these droughts makes them both extremely unlikely and uncertain and therefore we will continue to develop our understanding of our system to such events, and are not at present proposing to invest against this level of risk.

To manage this risk, we have considered wider WRZ level options such as tankering, conjunctive use, bulk supplies and inter-catchment transfers. These are discussed further in Section 3.5.2.4. In a very extreme drought, we may also have to consider employing severe restrictions such as rota cuts. We do not consider standpipes to be a practicable option.

### 2.4.5 Drought and Climate Change

The combined effect of drought with increasing climate change also needs to be considered. We have looked at this in the revised dWRMP 2019 through a climate change yield assessment of all Anglian Water’s groundwater and surface water sources. We considered the elements conjunctively to assess the combined impact throughout the revised dWRMP analysis.

The inclusion of climate change in our assessments is complex, as we know we are starting to see evidence of climate change signals in our daily weather. We are therefore looking to better understand the representation of climate change and drought, PET, and other variables going forwards.

#### 2.5 Regional drought planning

The 2011-12 drought led to a high degree of collaboration and co-operation within the water industry and with the Environment Agency and Defra. The Secretary of State set up the National Drought Group (NDG) in February 2012 in which Anglian Water took a leading role. The purpose and remit of the NDG was to create a single coherent, cross sector team, which was able to manage coordinated delivery of drought management activities, communications and risk mitigation. The NDG was chaired by the Chief Executive of the Environment Agency and other attendees included the Cabinet Office, Defra, National Farmers Union, UK Irrigation Association, Association of Drainage Authorities, Natural England, Blueprint for Water, Water UK, Anglian Water, Thames Water and the Country Land and Business Association. The key recommendations from the NDG included:

- Improve resilience for future droughts
- Promote best practice in communications
- Improve operational management and environmental protection
- Develop governance arrangements for national water resource management
- Prepare for future droughts.

This need for collaborative and joined-up drought thinking has continued to grow. We remain part of the National Drought Group, attending regular meetings as required and providing input into the Prospects reports. We continue to work closely with the Environment Agency and other stakeholders, as well as our water company neighbours through groups such as WRE, Water Resources South East (WRSE) and Water Resources North (WRN).
PART THREE

OPERATIONAL DROUGHT PLAN
3.1 Drought Management Process Overview

Droughts differ in terms of location, intensity, duration and severity. Therefore our drought management process needs to provide a flexible framework of options that will allow us to respond most effectively to a drought for a wide range of situations. Our drought management process has been developed for our region; it is relevant and realistic for our unique operating systems and circumstances.

Figure 3.1 outlines the framework for our drought management process.

Figure 3.1: Drought management framework

Part Three of our drought plan presents the strategy and operational detail around how we propose to manage public water supplies during the onset and prevailing conditions of a drought. It details the drought management actions we would undertake as a drought develops.
We consider the development of a drought to have three key stages:

- normal/non-drought conditions
- potential drought
- actual drought

These require different responses, so we have developed drought triggers to help identify when we cross into these stages and when actions need to be taken in a timely fashion, from its onset to its end.

During normal (non-drought) conditions we routinely monitor weather metrics and our resources to understand our baseline conditions and what rainfall we need to ensure secure supplies. By routinely monitoring the resources situation we have developed a clear understanding of our baseline resources situation, from which we can identify any regional or sub-regional variations in weather that may indicate the potential onset of drought.

We have early warning indices to signpost changes to weather that may indicate a drought is developing. Aquifer recharge and reservoir refill are the most critical issues in autumn and winter, whereas surface water flows are the most critical in spring and summer. Low rainfall during winter and spring provide an early indication of potential drought conditions.

We have created drought triggers for our operational sources to allow identification of where our sources deviate from their normal operating range due to low rainfall, so we can respond appropriately in line with our drought actions to maintain security of supply. Not all our sources will respond to drought in the same way so we have developed source specific triggers for our reservoirs, direct abstraction river intakes and vulnerable groundwater sources.

The type of drought also influences the response of our sources. This is because of the different characteristics of each source and how it reacts to drought conditions. We have summarised the different vulnerabilities in Part 2, Section 2.3.

Our drought triggers have been designed to allow appropriate lead-in time for the preparation and implementation of specific actions. This is especially important for the following drought management actions:

- Customer communications strategy
- Implementation of temporary restrictions
- Application process for drought permits and drought orders

We will also undertake modelling to forecast the possible impacts of a drought on our resources and security of supply.

Figure 3.2 outlines the high level drought management actions we will undertake as drought conditions develop, with Figures 3.3, 3.6, and 3.15 showing these actions in more detail. These actions are phased in as the drought continues, dependent on its severity. The actions are cumulative and routine measures or those introduced during less severe drought conditions will continue to be in place as further actions are considered and implemented. We consider the complexity, lead times, and implications on customers and the environment of the actions when developing and implementing this phased approach.

Part 3 of the draft Drought Plan 2019 discusses these stages and their associated actions in detail.
Figure 3.2: Anglian Water drought action plan showing drought management actions taken as a drought develops
3.2 Normal / non-drought conditions

3.2.1 Routine monitoring

During normal (non-drought) conditions we routinely receive and collate various meteorological (Table 3.1) and hydrometric (Table 3.2) data to allow us to monitor the resources situation in the rivers, reservoirs, boreholes and aquifers across the Anglian region. We also closely monitor our groundwater levels and reservoir storage levels through telemetry and liaise with operational staff, to assess the status of resources available for water supply. By monitoring the resource situation we can identify any regional or sub-regional variations in climate that may indicate the potential onset of drought. These data are used to routinely monitor the state of our resources, summarised in a monthly water resources situation report shared within Anglian Water. We also review the Environment Agency’s own monthly situation reports, the Met Office three month weather forecast, Centre of Ecology and Hydrology (CEH) reports and the National Hydrological Summary to provide a comprehensive overview of the current climatic conditions.

Table 3.1: Meteorological and climatic data collected routinely under normal (non-drought) conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Frequency</th>
<th>Source</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Rainfall (mm)</td>
<td></td>
<td>Weekly</td>
<td>Met Office MORECS data</td>
<td>Compare to long term average (LTA) rainfall to track rainfall patterns</td>
</tr>
<tr>
<td>Mean Potential Evaporation (PE) (mm)</td>
<td>A measure of the ability of the atmosphere to remove water from the surface through the processes of evaporation and transpiration</td>
<td>Weekly</td>
<td>Met Office MORECS data</td>
<td>Understand water demand from soils and vegetation and as indicator of water balance</td>
</tr>
<tr>
<td>Mean Actual evaporation (AE)(mm)</td>
<td>The quantity of water that is actually removed from a surface owing to the processes of evaporation and transpiration</td>
<td>Weekly</td>
<td>Met Office MORECS data</td>
<td>Understand water demand from soils and vegetation and as indicator of water balance</td>
</tr>
<tr>
<td>Mean Soil moisture deficit (SMD) (mm)</td>
<td>The amount of rainfall required to replenish water loss due to plant growth and evaporation</td>
<td>Weekly</td>
<td>Met Office MORECS data</td>
<td>Understand water demand from soils and vegetation and as indicator of water balance</td>
</tr>
<tr>
<td>Mean Temperature (°C)</td>
<td></td>
<td>Weekly</td>
<td>Met Office MORECS data</td>
<td>Demand profiling, water quality issues</td>
</tr>
</tbody>
</table>

Table 3.2: Hydrometric data collected routinely under normal (non-drought) conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Frequency</th>
<th>Source</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater levels from EA observation boreholes</td>
<td>Monthly/ Daily</td>
<td>Manual dips from EA / telemetry where available</td>
<td>Monitor groundwater levels at indicator boreholes</td>
</tr>
<tr>
<td>Groundwater levels from AW observation boreholes</td>
<td>Monthly/ Daily</td>
<td>Manual dips from operational staff/telemetry where available</td>
<td>Monitor levels at AWS drought vulnerable operational boreholes</td>
</tr>
<tr>
<td>River flows</td>
<td>Monthly/ Daily</td>
<td>River flows from EA gauging stations / telemetry where available</td>
<td>Monitoring changes in river levels for routine abstraction</td>
</tr>
<tr>
<td>Reservoir levels (% storage and Ml/day)</td>
<td>Daily</td>
<td>Telemetry</td>
<td>Monitoring fluctuations in reservoir storage against a normal ‘target’ reservoir storage curve</td>
</tr>
</tbody>
</table>
3.2.2. Abstraction licence compliance

We monitor our daily abstraction data to manage abstraction licence compliance and to monitor the approach of any cessation limits or associated licence conditions. The implementation of licence cessation conditions is triggered by notification from the Environment Agency, based on data gathered via their hydrometric network.

To maintain our abstraction, a number of our abstraction licences have clauses requiring us to operate river support schemes where otherwise we may be having an environmental impact. We have 15 river support schemes across the region (as listed in Table 3.3). The triggers are usually conditions written into our abstraction licences and are based on river flows or water quality as monitored and advised by the Environment Agency. The schemes comprise non-public water supply boreholes or surface water that pump water into a local river to support flows and river ecology at times of stress. Owing to the localised nature of these schemes, it is possible that some may be operational during times that we would classify as normal (non-drought) conditions.

Table 3.3: River support schemes across the Anglian region

<table>
<thead>
<tr>
<th>River support source</th>
<th>Source type</th>
<th>Supported River</th>
<th>Associated AWS source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scole</td>
<td>Groundwater</td>
<td>River Waveney</td>
<td>Billingford</td>
</tr>
<tr>
<td>Laceby WRC</td>
<td>Groundwater</td>
<td>Laceby Beck</td>
<td>Laceby</td>
</tr>
<tr>
<td>Barnoldby borehole 2</td>
<td>Groundwater</td>
<td>River Freshney</td>
<td>Barnoldby</td>
</tr>
<tr>
<td>Debenham WRC</td>
<td>Groundwater</td>
<td>River Deben</td>
<td>Winston</td>
</tr>
<tr>
<td>Dunston Common –</td>
<td>Groundwater</td>
<td>River Tas</td>
<td>Caistor St Edmunds &amp; Bixley</td>
</tr>
<tr>
<td>Stoke Holy Cross</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Houghton borehole 3</td>
<td>Groundwater</td>
<td>River Stiffkey</td>
<td>Binhum &amp; Houghton St Giles</td>
</tr>
<tr>
<td>Great Yeldham</td>
<td>Groundwater</td>
<td>River Colne</td>
<td>Colne sources</td>
</tr>
<tr>
<td>Balkerne</td>
<td>Groundwater</td>
<td>River Colne</td>
<td>Ardleigh</td>
</tr>
<tr>
<td>Coldham Hall</td>
<td>Groundwater</td>
<td>Ditch system adjacent to River Bure</td>
<td>Coldham Hall</td>
</tr>
<tr>
<td>Cley Hall Farm borehole</td>
<td>Groundwater</td>
<td>Cley Hall Marshes</td>
<td>Glandford</td>
</tr>
<tr>
<td>Bowthorpe borehole 1</td>
<td>Groundwater</td>
<td>West Earlham &amp; Bowthorpe Marshes</td>
<td>Bowthorpe</td>
</tr>
<tr>
<td>Bures Road</td>
<td>Groundwater</td>
<td>Cornard Mere</td>
<td>Bures Road</td>
</tr>
<tr>
<td>Tinwell to Stamford</td>
<td>Surface water</td>
<td>Stamford Mill Stream</td>
<td>Tinwell</td>
</tr>
<tr>
<td>Mill Stream</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costessey Pit No.2</td>
<td>Surface water</td>
<td>Taverham Mill Lake</td>
<td>Costessey</td>
</tr>
<tr>
<td>Cut-Off Channel</td>
<td>Surface water</td>
<td>River Wissey</td>
<td>Stoke Ferry</td>
</tr>
</tbody>
</table>
3.3 Recognising the start of a drought

3.3.1 Early warning indicators

We have developed a number of hydrometric indicators to provide an early warning that a drought could be developing. We use these indicators as a decision making tool to review the situation and determine if we are moving into potential drought conditions and need to convene the Drought Management Team (DMT). These precede our operational drought triggers, which are discussed in Section 3.5.

As each drought is unique, there is no single trigger that will indicate a change of status from normal to potential drought status and a combination of factors will be considered. We may also consider convening the DMT, before entering a drought or potential drought situation in our region, as a reflection of the wider resource situation, such as a prolonged period of below average rainfall, or wider drought impacts elsewhere in the country.
The time of year also influences the significance of the early warning indicators. Groundwater resources and reservoir storage are dependent upon winter rainfall for recharge and refill. Low rainfall during winter and spring provide an early indication of potential drought conditions. High SMD and low rainfall in the autumn is an indicator the recharge season is slow to start, causing us to review our resource situation and potentially increase monitoring as needed. After a dry winter, we would reassess the impacts on our resources and consider convening the DMT. The DMT is chaired by the Director of Water Services and include senior representatives from across the organisation. It is are responsive for managing our drought response. Further details are in Section 3.7.

Rainfall

Historical rainfall records are used to identify periods of exceptionally low rainfall events that may precede a drought. We have used historic rainfall accumulations and extreme value analysis carried out by the Met Office\(^1\) and Atkins\(^2\) for our WRMP to determine 1:5, 1:10, 1:50, 1:100 and 1:200 return periods (RPs) of 12, 24 and 36 month rainfall accumulation totals for the Ruthamford, Lincolnshire, Trent, Norfolk and Suffolk sub-regions.

A rolling rainfall accumulation for 12, 24 and 36 months is calculated from weekly MORECs data. Deviation from the long term average is monitored and compared to the Met Office return periods (Figure 3.4). The use of 12, 24 and 36 month timescales allows the pattern and magnitude of both annual and longer term rainfall deficits (e.g. 1 or 2 dry winters) to be measured.

---

\(^1\) Technical Note: Extreme Value Analysis of long duration droughts using Bayesian methods (Met Office, Oct 2017)  
Standardised Precipitation Index

We can also use the Standardised Precipitation Index (SPI) to indicate the severity of low rainfall and if a drought may be developing. SPI would be calculated for a range of timescales (12, 24 and 36 months), using relevant MORECS squares as the base data.

SPI values can be classified as shown in Table 1 following McKee et al. (1993)\(^3\). The World Meteorological Organisation (WMO)’s user guide\(^4\) defines a drought event as occurring any time the SPI is continuously negative, and reaches an intensity of -1.0 or lower. The drought event ends when the SPI becomes positive. The sum of the SPI for all the months within a drought event can be termed the drought’s ‘magnitude’. The guide also provides an estimate of the return periods of a drought by SPI (Table 3.5).

Table 3.4: SPI Values

<table>
<thead>
<tr>
<th>SPI</th>
<th>Rainfall scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0+</td>
<td>extremely wet</td>
</tr>
<tr>
<td>1.5 to 1.99</td>
<td>very wet</td>
</tr>
<tr>
<td>1.0 to 1.49</td>
<td>moderately wet</td>
</tr>
<tr>
<td>-0.99 to 0.99</td>
<td>near normal</td>
</tr>
<tr>
<td>-1.0 to -1.49</td>
<td>moderately dry</td>
</tr>
<tr>
<td>-1.5 to -1.99</td>
<td>severely dry</td>
</tr>
<tr>
<td>-2 and less</td>
<td>extremely dry</td>
</tr>
</tbody>
</table>

Table 3.5: SPI probability of recurrence

<table>
<thead>
<tr>
<th>SPI</th>
<th>Category</th>
<th>Severity of event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to -0.99</td>
<td>Mild dryness</td>
<td>1 in 3 yrs.</td>
</tr>
<tr>
<td>-1.00 to -1.49</td>
<td>Moderate dryness</td>
<td>1 in 10 yrs.</td>
</tr>
<tr>
<td>-1.5 to -1.99</td>
<td>Severe dryness</td>
<td>1 in 20 yrs.</td>
</tr>
<tr>
<td>&lt; -2.0</td>
<td>Extreme dryness</td>
<td>1 in 50 yrs.</td>
</tr>
</tbody>
</table>


Soil Moisture Deficit

Soil moisture deficits (SMDs) reported for our region are monitored against historical seasonal variations. We consider SMD below 20mm as an indication that recharge is commencing; high SMDs during winter would indicate delayed seasonal recharge to groundwater resources.

Standardised Streamflow Index

As part of the ENDOWS About Drought project we have worked with CEH to produce graphs which use the Standardised Streamflow Index (SSI) as an indicator to the onset of drought. We monitor 14 rivers from across our region. The historical flow record for each river have been categorised in the SSI at 1 month and 3 months intervals. We are able to plot current river flow SSI against the historic flow range and compare this to flows in the lowest drought years. This allows a relative assessment of the severity of the SSI value. The use of the WMO standardised indices metric as detailed above also allows classification of the current SSI.

Where the current river flow SSI is approaching known historic drought SSI curves, or a drought SSI indicator, this would trigger a review of the drought situation. See the example of the River Colne at Lexden approaching historic SSI values in Figure 3.5. These plots also indicate the historic range of all SSI values.
3.4 Drought Management Actions – Potential Drought

Where our early warning indicators signpost we have moved into a potential drought conditions, we will undertake additional actions, summarised in Figure 3.6.

In this stage the drought is not yet fully established, and it could be that the dry weather breaks and does not progress into a full drought. Alternatively drought conditions could continue, leading to potential impact on supplies and triggering further actions. This is why we have a variety of indicators but do not want to be overly prescriptive, as each drought is different.

Experience from previous droughts in our region has outlined the importance of effective internal and external management, enabling us to respond effectively and responsibly to the onset and development of a drought. One of the first management actions that results from a move to Potential Drought status is to convene the Drought Management Team. The Drought Management Team represents all areas of the business and is experienced in drought management. It is responsible for making key business decisions that may be required as a direct result of the impact of drought. This enables us to respond effectively and responsibly to the onset and development of a drought.

Early communications to our customers is essential at this stage in order to update on drought conditions and our activities. The Drought Management Team includes a communications lead that will deliver key drought messages and actions both rapidly and effectively. Our Drought Management and Communications plan is detailed in Section 3.7 and further in Appendix 10.

We work closely with the Environment Agency, and it is possible that there will be occasions when the environmental indicators are such that the Environment Agency may request us to complete drought actions ahead of our own indicators due to wider pressures on water resources across the country.

There is also increased expectation of regional cooperation for water resources planning and management. We routinely liaise with our colleagues in other water companies, especially neighbouring companies, and would increase this during potential drought to discuss cross-border issues, coordinated demand measures and resource sharing. We also attend National Drought Group meetings to ensure we are aware of the wider water resource situation and can align actions or provide support as appropriate.

There are a number of water resources actions we can undertake to understand the impact of low rainfall on our resource situation and how likely this is to impact on our security of supply. These are highlighted in Figure 3.6. Further detail of how we use resource trigger curves and forecasting are detailed below.
Figure 3.6: Management actions during potential drought conditions

- **Potential drought conditions**

  - Monitor daily abstraction date, monthly water levels and flow for licence compliance
  - Manage river support and augmentation schemes and comply with Section 20 agreements
    - Maintain and operate augmentation schemes
    - Manage licence restriction clauses
  - Maintain telemetry and monitoring equipment for data capture
  - Increase environmental monitoring as required for drought permits
  - Daily monitoring of reservoir storage and hydrometric data
    - Monitor river flows at intakes and compare indicators
    - Monitor reservoir storage for approach to trigger curves
    - Determine likely need for drought permits and prepare application
  - Initiate modelling of reservoir predictions and report to DMT
  - Extend borehole monitoring to drought vulnerable BHs and track water level approach to DAPWL
    - Review BH pumping water levels and prioritise BH replacement programme
  - Optimise source works operation to maximise security of water resources
  - Drought liaison with Environment Agency water resources area teams
  - Consider opportunities to reduce leakage/additional leakage detection and repair
    - Respond to external information requests and customer concerns (with Water Resources)
    - Commerce comms drought strategy
      - Increase demand management awareness
  - Convene Drought Management Team
    - National Drought Group attendance
    - Review supply-side management options
      - Prioritise investment programme

- **Actual drought**

- **Key:**
  - WATER SERVICES TEAM
  - COMMUNICATION TEAM
  - DROUGHT MANAGEMENT TEAM (DMT)

- **Triggers:**
  - Early warning indices and time of year
  - Operational triggers and recommendation of DMT

Dashed line indicates support from/decision by
3.4.1 Reservoir Management Actions

3.4.1.1 Operational Drought Triggers

Control curves

We have defined control curves for each of our reservoirs, which act as a reference against which we can track changes in reservoir storage levels. These define the refill target and response to drought and are demonstrated in Figure 3.7. Continuous monitoring records the storage levels at each of our operational reservoirs and the data are collated to provide a continuous profile of historical storage levels. Understanding the potential onset of a drought is achieved by assessing the current storage relative to the target level expected for that time of year. Where reservoir storage sees a continued decline due to low rainfall and river flows, this is evidence that our supplies may be affected by drought.

Details of the methodology used to produce the reservoir control curves are provided in Appendix 4.

Figure 3.7: Example of reservoir control and trigger curves

Normal Operating Curve

The normal operating curve is an optimum storage ‘target’ or ‘control’ to ensure security of water supply should the reservoir subsequently experience a drought of equivalent to its reference drought (Table 2.2, Part 2). It also aims to avoid overfilling the reservoir resulting in costly over-pumping and losing water to wind and wave action.

Drought Management Curves

For each reservoir there are four drought management curves, an upper drought alert curve (DAC) and three trigger curves associated with our Levels of Service (LoS).

Drought Alert Curve

The drought alert curve is the highest of the four curves and is a signal that reservoir storage is declining to the point that supplies may be affected if we do not take action. This would initiate internal liaison within Anglian Water about the convening of the Drought Management Team and indicates we should increase publicity and customer communications over and above our business as usual water efficiency programme. The DAC has been calculated to allow approximately 6 weeks of storage above the LoS trigger curve 1, providing time to reassess the situation and prepare, if necessary, for further drought actions to prevent reservoir drawdown such that it reached the LoS...
curves. These are summarised in Figure 3.6 and could include river augmentation (to increase the water available for pumped reservoir refill), treated water rezoning (to off-set demand to alternative sources) and increased public awareness.

Levels of Service Trigger Curves

We have three trigger curves associated with our Levels of Service (LoS):

LoS Trigger curve 1: further publicity and impose temporary use bans
LoS Trigger curve 2: further publicity and ban on non-essential use
LoS Trigger curve 3: rota cuts.

If storage declines such that we cross any of the three LoS trigger curves, we would consider our situation to have moved from a potential to actual drought. Further actions would be required to reduce demand and prolong the security of supply. These are discussed further in Section 3.5.2. The actions would be subject to approval by the Drought Management Team and/or the Anglian Water Management Board, following close liaison with the Environment Agency, other regulators and our customers.

The levels of service are consistent with our revised dWRMP 2019 and have been developed to enable effective and timely responses to the onset of potential drought conditions. An example of how the drought actions would be commenced in response to reservoir storage crossing the curves is shown in Figure 3.8.

More details on our reservoir drought management and control curves can be found in Appendix 4.

Figure 3.8: Demonstrative example of drought actions being triggered as reservoir storage declines
The bulk supplies provided from Grafham Water to Affinity Water and from Rutland Water to Severn Trent are subject to bulk supply arrangements agreed with respective recipient companies. For the purpose of reservoir operation and yield analysis we assume the same demand restrictions will be introduced to all supplied customers.

Testing the reservoir curves and actions

Historical and stochastic drought sequences have been used to demonstrate how our drought management actions for surface water reservoirs would be implemented over a range of drought scenarios. These assessments are detailed in Appendix 4.

We have considered the following scenarios:

- Short duration, single-season drought (typically 6 to 12 months).
- Medium duration, multi-season drought (1-2 years, consisting of two dry summers and an intervening dry winter).
- Long-term drought (typically lasting over two years).

3.4.1.2 Reservoir Drought Forecasting

Understanding the potential impact of a drought is achieved by assessing current or predicted storage relative to the target level expected for that time of year. Forecasting future reservoir levels allows us to assess the potential impacts of a drought and take proportionate action. In periods of prolonged rainfall deficit we would complete reservoir projections on a routine basis to inform the Drought Management Team. The results of the modelling are used as part of our decision analysis when assessing the future drought risk and required actions.

We use a water system model of our reservoirs (MISER) to project reservoir storage under a range of river flow and rainfall scenarios, to inform our assessment of the security of our supplies to the respective supply areas. Storage is modelled using current river abstraction pumping constraints, licence constraints, current demand and expected planned asset outages.

We input river flows and rainfall to reflect lower percentage rainfall scenarios. These are compared to average rainfall and resulting storage for the time of year. Lower rainfall is used to stress test the reservoir allowing us to forecast different potential futures.

Figure 3.9: Example reservoir forecast at 80% and 60% rainfall scenarios
Reservoir levels are also compared to the Environment Agency category values for Exceptionally Low to Normal as detailed below in Table 3.6, allowing us to understand the relative severity of different forecasts.

Table 3.6: Environment Agency reservoir level categorisation with associated colours

<table>
<thead>
<tr>
<th>Category</th>
<th>% from Normal Operating Curve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptionally Low</td>
<td>≤-15%</td>
</tr>
<tr>
<td>Notably Low</td>
<td>-10 to -14%</td>
</tr>
<tr>
<td>Below Normal</td>
<td>-5 to -9%</td>
</tr>
<tr>
<td>Normal</td>
<td>4 to -4%</td>
</tr>
<tr>
<td>Above Normal</td>
<td>5 to 9%</td>
</tr>
</tbody>
</table>

3.4.2 Direct Supply River Intakes management actions

3.4.2.1 Drought triggers

Direct river abstractions rely on river flows and have no associated seasonal storage in the form of reservoirs. Therefore they can react quickly to changes in rainfall. To protect the environment, our river intakes have a licence condition that specifies a Minimum Residual Flow (MRF) or Hands Off Flow (HOF), and Hands Off Level (HOL), below which we are not authorised to abstract water. During periods of low flows we liaise closely with the Environment Agency and monitor flow or level conditions associated with the licences at each of our direct river intakes.

To ensure the output of our direct intakes remains secure against up to a 1 in 200 year drought event, we have developed a sequence of operational actions for drought management. These are discussed further in Section 3.5.2.2 and Appendix 5.

3.4.2.2 Direct River Intake Drought Forecasting

River forecasting is completed on all our direct surface water intakes using the ensemble stream flow method. This method uses simulated flows from our rainfall runoff models (described in Part 2, Section 2.4.2) and rainfall accumulations which we calculate from MORECS data received from the Met Office. The output is then compared to the historic river flow events for that river to identify if there is any risk under the forecast conditions.

Figure 3.10: Example of River Intake Forecasting
The direct intake forecasts are compared to Environment Agency river flow categories to understand the relative severity of the low flows. These are summarised in Table 3.7.

Table 3.7: Environment Agency river flow categorisation with associated colours

<table>
<thead>
<tr>
<th>Category</th>
<th>Return period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptionally Low</td>
<td>&gt;1 in 20 year</td>
</tr>
<tr>
<td>Notably Low</td>
<td>1:8 - 1:20 year</td>
</tr>
<tr>
<td>Below Normal</td>
<td>1:4 - 1:8 year</td>
</tr>
<tr>
<td>Normal</td>
<td>1:4 year</td>
</tr>
<tr>
<td>Above Normal</td>
<td>1:4 - 1:8 year</td>
</tr>
<tr>
<td>Notably High</td>
<td>1:8 - 1:20 year</td>
</tr>
<tr>
<td>Exceptionally High</td>
<td>&gt;1 in 20 year</td>
</tr>
</tbody>
</table>

All of our groundwater sources are continuously monitored and regularly reviewed for indications of any changes in key parameters. Where groundwater levels begin to decline in combination with early warning indicators described in Section 3.3, we will begin to increase this monitoring and undertake potential drought actions as summarised in Figure 3.6.

The potential for reductions in yields for groundwater supplies is particularly acute during periods of drought when low groundwater levels increase the risk of operational pumping water levels approaching or breaching their defined deepest advisable pumping water levels (DAPWLs) as illustrated in Figure 3.11. The DAPWL may be set at the point where a principal flow horizon starts to dewater when the piezometric surface lowers. Groundwater sources that rely on discrete high level flow horizons may be particularly vulnerable to the onset of a drought.

3.4.3 Groundwater systems management actions

3.4.3.1 Groundwater triggers

We have 200 groundwater abstraction sources comprising, in total, 450 operational boreholes. These range in depth from 10 to 500m and penetrate a variety of aquifers.

The potential yield for each of our groundwater sources is calculated in accordance with the industry-accepted UKWIR methodology\(^5\), and we have calculated this for both the worst historic drought experienced and a 1 in 200 year event, in line with our revised level of service (as detailed in the revised dWRMP 2019). In Lincolnshire where we have historically already experienced a 1 in 200 year groundwater drought event, we have also calculated yields for a drought worse than 1 in 200. Detail of the assessment methodology is included in Appendix 6.

\(^5\) A methodology for the determination of outputs Groundwater sources, UKWIR, 1995
Drought Vulnerable Groundwater Sources

We have identified 17 operational sources that are considered to be drought vulnerable to varying degrees. The risk that drought may result in a loss of yield or supply at each of these sources has been reviewed for 1 in 200 year drought, for both the revised dWRMP 2019 and this draft Drought Plan 2019. The drought vulnerability has been evaluated based on previous behaviour of the sources under drought conditions, drought investment, and groundwater modelling. A list of these boreholes is below in Table 3.8, and further details are included in Appendix 6.

We have developed drought management actions for each of these sources to ensure there is no risk to supply in a drought of up to 1 in 200 year severity – these are discussed further in Section 3.5.2.3.
<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Water Resource Zone</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risby</td>
<td>Bury Haverhill</td>
<td>New drought vulnerable borehole due to severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Goxhill 2</td>
<td>Central Lincs</td>
<td>No change</td>
</tr>
<tr>
<td>Welton</td>
<td>Central Lincs</td>
<td>No change</td>
</tr>
<tr>
<td>Winterton Holmes</td>
<td>Central Lincs</td>
<td>Potential to remove from list – dependent on performance of new borehole</td>
</tr>
<tr>
<td>Lower Links</td>
<td>Cheveley</td>
<td>Severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Belstead</td>
<td>East Suffolk</td>
<td>General risk due to saline intrusion particuarly at peak demand/low groundwater levels</td>
</tr>
<tr>
<td>Westerfield</td>
<td>East Suffolk</td>
<td>No change</td>
</tr>
<tr>
<td>Whitton</td>
<td>East Suffolk</td>
<td>No change</td>
</tr>
<tr>
<td>Ashley Road</td>
<td>Newmarket</td>
<td>Severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Long Hill</td>
<td>Newmarket</td>
<td>Severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Moulton</td>
<td>Newmarket</td>
<td>Severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Southfields</td>
<td>Newmarket</td>
<td>Severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Congham</td>
<td>North Fenland</td>
<td>Spring flow licence condition</td>
</tr>
<tr>
<td>Gayton</td>
<td>North Fenland</td>
<td>No change</td>
</tr>
<tr>
<td>Metton</td>
<td>North Norfolk Coast</td>
<td>No change</td>
</tr>
<tr>
<td>North Walsham</td>
<td>North Norfolk Coast</td>
<td>New drought vulnerable borehole due to severe drought risk to yield and potential supply impacts identified in the revised dWRMP19</td>
</tr>
<tr>
<td>Marham</td>
<td>South Fenland</td>
<td>Severe drought risk to yield and supply impacts identified in the revised dWRMP19</td>
</tr>
</tbody>
</table>
Groundwater Drought Alert Curves

The Environment Agency has a network of observation boreholes that are used to monitor regional groundwater levels, across various aquifer units. Groundwater drought alert curves have been developed for each aquifer monitoring borehole that is in close proximity to one of our drought-vulnerable sources (see Figure 3.12).

Figure 3.12: EA observation boreholes and AWS drought vulnerable boreholes

The aim of this alert curve is to provide an early indication of the potential onset of drought at least 6 to 12 months in advance, taking account of natural seasonal variation. Given the complex nature of most of the distribution systems supplied by groundwater sources, the groundwater drought alert curves are not designed to result in any specific drought restrictions to customers. Crossing a groundwater alert curve would, however, instigate the framework for drought management actions as the severity of the drought increases or recedes.

Drought alert curves consider aquifer characteristics and individual trends in water levels. The drought alert curves for each observation borehole have been calculated using the worst historical drought recession curve for each corresponding observation borehole.

For those boreholes that have significant seasonal variation in water levels and large annual recessions where a drought could occur with only a 3 to 4-month warning the drought alert curve has been calculated statistically by determining the worst level experienced in each month that is exceeded once in every 5-year period. This approach provides an early indication of the potential for drought conditions to occur in sources that are sensitive to summer demands and are at greater risk of drought.

We have also undertaken a pilot study to develop groundwater curves for a drought vulnerable borehole itself, and also develop a curve to reflect a 1 in 200 year or worse than historic drought. This enables the relationship between the worst historic drought and worse than historic drought alert curves to be explored in more detail, and can be used to identify the severity of the groundwater recession. For example, if groundwater levels cross the worst historic drought curve in the winter months, and continues into the summer, there is a high risk we would cross the worse than historic curve and see a reduction in source yield.

Further detail of this pilot study and drought alert curves for all our drought-monitoring boreholes are provided in Appendix 6.

Figure 3.13: Example groundwater alert curves for worst historic and 1 in 200 year/worse than historic droughts

3.4.3.2 Groundwater Source Drought Forecasting

Groundwater forecasting is completed using the groundwater level forecasting tool (GWLF) on all our drought vulnerable groundwater aquifers. This tool relies on the collection of accurate historical water level data which we receive via our own telemetry systems and monthly from the Environment Agency. It also uses rainfall accumulations which we calculate from MORECS data received from the Met Office.

The GWLF uses recession analysis to predict groundwater levels in the short and medium term (up to 18 months). The output is then compared to the drought alert curve for the respective source to identify if there is a risk to the source yield under the forecast conditions. An example output is below in Figure 3.14.
The groundwater level forecasts are also compared to Environment Agency groundwater level categories to understand the relative severity of the water level. These are summarised in Table 3.9.

### Table 3.9: Environment Agency groundwater level categorisation with associated colours

<table>
<thead>
<tr>
<th>Category</th>
<th>Return period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptionally Low</td>
<td>&gt;1 in 20 year</td>
</tr>
<tr>
<td>Notably Low</td>
<td>1:8 - 1:20 year</td>
</tr>
<tr>
<td>Below Normal</td>
<td>1:4 - 1:8 year</td>
</tr>
<tr>
<td>Normal</td>
<td>1:4 year</td>
</tr>
<tr>
<td>Above Normal</td>
<td>1:4 - 1:8 year</td>
</tr>
<tr>
<td>Notably High</td>
<td>1:8 - 1:20 year</td>
</tr>
<tr>
<td>Exceptionally High</td>
<td>&gt;1 in 20 year</td>
</tr>
</tbody>
</table>

### 3.5 Drought Management Actions – Actual Drought

At the stage when a drought develops to the extent that it is having an impact on our operations, or when we may have to implement drought restrictions, we will have entered actual drought conditions. Our efforts to safeguard public water supplies will increase significantly and will include the management actions detailed in Figure 13. The overall responsibility for agreeing all of these associated actions will rest with the Drought Management Team, informed by technical experts.
Figure 3.15: Management actions during a full drought

**Actual drought**

- Monitor daily abstraction data, monthly water levels and flow for licence compliance
- Manage river support and augmentation schemes
  - Operate Section 20 agreement conditions
- Manage licence restriction clauses
- Maintain telemetry and monitoring equipment for data capture
- Increase environmental monitoring as required for drought permits
- Carry out mitigation measures as required
- Daily monitoring of reservoir storage and hydrometric data
- Increase frequency of resource forecasting and reporting to DMT
  - Recovery forecasting
- Apply for drought permits and orders as required
- Initiate borehole replacement programme where required
- Optimise source works operation to maximise security of water resources
- Drought liaison with EA water resources teams
- Promote opportunities to reduce leakage
- Respond to external information requests and customer concerns (with Water Resources)
- Establish Strategic Comms Group through Water UK to coordinate customer and media information
- Drought Management Team
  - National Drought Group attendance
- Consider implementing supply side options and drought related investment
  - Consider implementing demand restrictions

**Drought conditions**

- Triggers: Operational triggers and recommendation of DMT

**Normal conditions return**

- Triggers: rainfall and early warning indices recover

**Drought ended**

- Triggers: Resources have returned to normal range

**Key:**
- WATER SERVICES TEAM
- COMMUNICATION TEAM
- DROUGHT MANAGEMENT TEAM (DMT)
- Dashed line indicates support from/decision by
As with long term water resources management planning, we will follow a twin-track approach to managing our supplies during a drought. In the first instance we will seek to manage demand, before we instigate any of the available supply-side measures.

Any supply or demand-side measures will be implemented as a result of timely and proportionate decisions taken by the Drought Management Team. Actions will aim to secure supplies during the drought period with minimal disruption to customers, the environment and other water users.

In Section 3.5.1 we detail the activities that we would undertake to manage demand. These include enhanced customer communications, water efficiency, metering and leakage management, through to implementation of restrictions on customer use through application of powers afforded to water companies under the Water Use (Temporary Bans) Order 2010.

Section 3.5.2 details the supply-side drought management actions we would undertake for our surface water abstractions and vulnerable groundwater sources. A number of these actions may have potential environmental impacts and as such will require a drought permit or drought orders. In Section 3.6 we provide further detail regarding the associated environmental assessments and monitoring requirements.

**Demand management strategy**

Our commitment to demand management and in particular the promotion of water efficiency is a central objective in our revised dWRMP 2019.

Customers strongly support some demand management activities (such as fixing leaks) and reflecting this, since privatisation we have focused on managing demand for water and have proven our ability to do this. We put less water into our system now than we did in 1989 despite supplying 30% more people in the Anglian Water region.

**Water metering programme**

- Increasing our meter penetration to the feasible maximum (95%) and encouraging all customers to move to a measured water supply (with the consumption savings this facilitates).
- Introducing a smart metering programme: this will replace our entire meter stock over 10 years (2 AMPs), potentially saving an additional 3% over and above the savings achieved through ‘dumb’ metered customers.
- The information revolution resulting from ‘smart metering’ will help inform our customers regarding water usage and assist in our ability to influence this behaviour. It will also help with our ability to detect leakage and understand our system.

**Leakage reduction**

- Our aim is to build upon our industry leading status and reduce leakage by more than 70 ML/d by 2045 (Including 28ML/d of CSPL reductions). Leakage currently represents 16% of distribution input (DI) and will represent 9.5% of DI in 2045.
- Taking 2017-18 as a base year, we are targeting a reduction of 22% from 182.66 ML/d to 142 ML/d in 2024-25.
- We are aiming to reduce leakage by targeting both losses in our distribution system and losses due to customer supply pipe leakage and internal plumbing losses.
- We will continue to invest in new detection technologies, including our effective new Integrated Leakage and Pressure Management systems and actively pursue the possibilities for leakage detection that should emerge from the introduction of ‘smart meters’

**Water efficiency measures**

- New technologies and our interventions will help promote the careful use of water by both our household and non-household (business) customers.
- Additional water efficiency programmes will include: A Multi-utility web-portal; Leaky Loos campaign; Rewards schemes ‘Bits and Bobs campaign’; A water butts programme; Rebates to replace old toilets; Promotion of ‘Smart’ devices (taps etc.)
- We are currently working on the next iteration of our engagement with Retailers on demand management, which is in development. This will include a dedicated Wholesale website section providing targeted information for Retailers and also content to be directed towards their end users.
3.5.1 Demand Side Management Actions

The following section outlines all of our demand-side management actions. These range from our ongoing commitment to ‘water wise’ behaviour to increased activities as a drought progresses from publicity campaigns, through to more formal restrictions on demand and ultimately rota cuts.

Figure 3.16: Water supplied and leakage since 1998 to the present

During periods of potential drought and drought there are a number of demand-side options that could be introduced. These include:

- Drought related publicity campaign to use water wisely. This will be significantly enhanced with the rollout of the smart meter programme and associated mobile apps/website.
- Further effort to encourage meter optants. Despite the high level of meter penetration, there are still some customers who have meters, but are not paying measured charges (and, therefore, still display high consumption).
- Additional targeted leakage reduction.
- Temporary use ban (LoS 1).
- Non-essential use ban (LoS 2).
- Rota cuts (LoS 3).

The potential savings for each demand measure are considered further in Appendix 2, which also includes as assessment of the potential savings that would be realised in each WRZ. The tables presented in Appendix 2 are in accordance with the Environment Agency guidelines.

Each measure is discussed in detail in the following sections.

3.5.1.1 Publicity Campaigns


A consistently high level of water efficiency-related communications is maintained with our customers. This is achieved via a continuous programme of direct and indirect communications encouraging domestic customers to reduce their water use. Details of the promotion of water efficiency measures that we undertake in our normal business contact with customers are provided in our Communication Strategy in Appendix 9.

During potential drought conditions we would increase the level of communication and awareness well in advance of any water usage restrictions being implemented. We would maintain our activities undertaken under normal conditions, but focus additional effort to increase awareness of these activities. We would seek to maximise coverage of our water efficiency activities and increase media communication media of proactive messages, encouraging features, regular resource updates and radio phone-ins.

With the onset of drought conditions we would maintain a flexible approach for effective communication with customers and the community at large. The Drought Management Team will be responsible for developing an appropriate drought communication package in line with our Communication Strategy as outlined in Appendix 10. This would be fully integrated with our ongoing communications strategy and would be adapted in response to the severity of the drought. We would review the need to set up regional or national drought groups with neighbouring companies and/or Water UK, to ensure consistency of messages to our customers and the media.

The assumed demand savings resulting from direct publicity campaigns is 3-10 per cent dependent on the time of year.
Currently (2017/18) 8% of our customers are metered (but not measured ‘billed’), with 89% of our customers being metered and 81% of our customers being metered and measured.

During periods of potential drought and drought we would look to target the conversion of customers from unmeasured to measured status (with the associated potential savings in demand that this would generate).

3.5.1.3 Leakage

Leakage is a particular concern for our customers, who see it as wasteful and a sign that we are not ‘doing our bit’ to conserve water and invest in infrastructure. This can be a strong disincentive to customers adopting more water efficient behaviours and customers often associated leaks with service interruptions.

We have cut leakage by more than a third since privatisation in 1989 and it is now at record low levels; around half the national average based on the amount of water lost per kilometre of main.

Our three-year average has continued to fall from 191Ml/d at the start of the AMP.

- In 2016/17 we achieved 184.72 Ml/d, and
- In 2017/18 and we recorded a leakage level of 182.66Ml/d.

Thus, we are taking significant steps towards our AMP6 target of 172Ml/d in 2019/20 (with a three year rolling average of 177Ml/d). Over AMP6 we will invest £124 million in people and in state-of-the-art technologies to drive leakage even lower.

However, we do not believe it is good enough to stop at the targets set by our regulator, especially when reducing leakage is such an important issue for our customers and so vital for us in this dry part of the country. Consequently, we are setting a more ambitious target of reducing leakage by 30Ml/d by 2025.

3.5.1.2 Meter Optants

As part of our commitment to water efficiency we continue to promote the household metering programme based on providing meters on request. This is accompanied by a water meter leaflet that provides water efficiency information with additional information available on request.

It has been shown that measuring (and billing) consumption provides an incentive of more efficient use of water and also serves to reduce customer supply pipe leakage by highlighting high levels of consumption.

We aim to achieve full meter penetration (95%) of domestic customers to have a measured/metered account during the 2020-2045 WRMP period, with a full ‘smart meter’ rollout by 2030.

Up until 2020 we have a programme of ‘enhanced metering’ that involves proactive meter installations in targeted areas of our water supply that have been identified as being in serious or moderate water stress. Once the meter is fitted the customer has the option to be charged on a measured basis. After any change of occupancy the meter will automatically become effective.
We recognise that credible leakage performance influences customers’ trust in the water company and our actions in times of drought. During the 2004-06 drought and during the winter of 2011-12, substantial additional resources were invested into leakage detection and the repair programme. This policy contributed to our success in promoting the water conservation message.

Therefore, in periods of potential drought and drought, we will continue to intensify our leakage efforts, increasing gangs in the field, reducing ‘find and fix’ times and prioritising workloads whilst continuing the main activities in our leakage programme.

The Drought Management Team will co-ordinate a leakage response programme to ensure that in drought periods when we are trying to conserve water supplies that we invest proportionately in conserving our own supplies.

As the smart meter installation rollout continues, this will also allow us to accelerate the targeting of our customers, using the newly developed communication tools (mobile app, web-portal) to identify customers who may be experiencing instances of plumbing loss or customer supply pipe leakage.

3.5.1.4 Temporary Use (Hosepipe) Bans (Level of Service 1)

This section details the demand restrictions that we may impose on domestic customers via a hosepipe ban under the Water Use (Temporary Bans) Order 2010 and how we would propose to implement them in the event of a drought.

The original ‘hosepipe use’ restriction under Section 76 of the Water Industry Act (WIA) 1991 applied only to the watering of private gardens and the washing of private motor cars. Other activities such as filling a paddling pool or cleaning windows using a hosepipe were still permitted. Following the imposition of hosepipe bans by some water companies during the 2004-06 drought it was recognised that the existing legislation did not provide water companies or their customers with suitable transparency on restricting activities that involved the use of hosepipes.

Defra and the Welsh Assembly Government undertook a comprehensive review of these powers and in October 2010 approved amendments to Section 36 of the Flood and Water Management Act 2010. This updated legislation on temporary use restrictions now extends the activities that may be prohibited and allows us to take proportionate action to protect public water supplies. These powers may allow us to delay or avoid the need for a Drought Permit or Order under the Water Resources Act 1991 and will ensure a balance is struck between the needs to conserve water for essential domestic purposes, whilst ensuring that any potential environmental impacts are minimised.

The Water Use (Temporary Bans) Order 2010 has modernised and widened the scope of the hosepipe ban powers to enable water companies to potentially realise more water savings without the need to apply for Drought Orders. The activities that can be restricted under these powers primarily affect domestic customers only.

In accordance with the Water Use (Temporary Bans) Order 2010 the activities that may be restricted are as follows:

• Watering a garden using a hosepipe.
• Watering plants on domestic or other non-commercial premises using a hosepipe.
• Cleaning a private motor-vehicle using a hosepipe.
• Cleaning a private leisure boat using a hosepipe.
• Filling or maintaining a domestic swimming pool or paddling pool.
• Drawing water using a hosepipe for domestic recreational use.
• Filling or maintaining a domestic pond using a hosepipe.
• Filling or maintaining an ornamental fountain.
• Cleaning walls or windows of domestic premises using a hosepipe.
• Cleaning paths or patios using a hosepipe.
• Cleaning other artificial outdoor surfaces using a hosepipe.

Most of the uses of water that may be prohibited under these powers only apply to the use of water drawn through a hosepipe or similar apparatus (by definition this would include sprinklers and pressure washers). The exception to this is filling or maintaining a domestic swimming pool or paddling pool and filling or maintaining an ornamental fountain, in which the use of water which may be prohibited extends to all means of filling (except for handheld containers), including fixed or permanent plumbing.

The new powers do not:

• Restrict commercial, agricultural or horticultural use.
• Include any activities that are necessary for health and safety reasons (i.e. necessary to remove or minimise any risk to human or animal health/safety or prevents/control the spread of causative agents of disease).
Before imposing any temporary restriction we must be confident that a serious deficiency of water for distribution exists or is under threat. Hosepipes and sprinklers use large amounts of water and are often left unattended, so a restriction would be effective in conserving water for public water supplies. The temporary ban would restrict use of domestic hosepipes and sprinklers; however, these powers do not restrict any of the above activities being undertaken using:

- A bucket or watering can filled by hand.
- Grey water use (bath/wash water).
- Rainwater collected in a water butt.

**Implementation of the 2010 powers**

Our interpretation is in accordance with the guidance presented in the UK Water Industry Research (UKWIR) Code of Practice, as updated in 2013 to incorporate lessons from the 2011-12 drought. Under the new powers water companies have the flexibility to prioritise and sequence different categories of restrictions. This could mean the restriction of different activities at different times and in different areas, which in turn would involve protracted and complicated consultation with our customers in order to consider comments and requests for exemptions.

Effective management of this approach would be challenging. If a multi-phased approach were adopted we would need to be confident that we could ensure an effective consultation process and implement any phasing of restrictions without bias or prejudice to any specific groups.

We also feel that a phased approach to customer restrictions could lead to confusion and the risk that the message is diluted such that potential water savings are reduced. As a result, we believe a single phased temporary restriction of all hosepipe activities as detailed in the Water Use (Temporary Bans) Act 2010 would provide the most unbiased and effective approach for all of our customers.

We are confident that a single restriction would be best placed to meet challenges faced in our region and provide a fair and reasonable way to ask all customers to conserve water supplies during a period of drought.

If the situation deteriorates further and requires us to consider the application for non-essential use bans through a drought order, this early restriction on all hosepipe usage would demonstrate that we as a water company had taken all necessary steps to conserve water supplies and protect the environment in a timely and effective manner. Any temporary restriction would be preceded by a rigorous publicity campaign that would proactively engage with our customers about the deteriorating situation and the need to conserve water.

We would allow an appropriate consultation period in which any representations could be made via our website, contacting a customer services representative or writing directly to us. Following the consultation period we would formally publish a statement of response outlining our consideration to any representations received. Restrictions would be imposed for the minimum period required and would be lifted with immediate effect once the situation had improved.

**Concessions and exceptions**

As a water undertaker we plan on the basis that on occasion, we may have to impose restrictions during long periods of very dry weather or drought. No compensation will be awarded in the event of a temporary restriction on water usage.

Anglian Water grant the following Discernmentary Exceptions without the need to make representation or obtain permission:

- Those with severe mobility problems or who hold a Blue Badge as issued by their Local Authority;
- Use of a plant which conserved water, such as a pressure reducing valve and a timer, that are not handheld and which place water by drip directly onto the soil surface or beneath the soil surface, without the surface run-off or dispersion of water through the air using a jet or mist.

We will liaise with our Non-Household Retail partners, regarding exceptions for businesses whose commercial activity would be affected by the imposition of restrictions, although the exception may be withdrawn if the water resources situation were to deteriorate further or non-essential use restrictions were imposed. Businesses that we may consider are those users of water engaged in cleaning of private motor-vehicles using a hosepipe and cleaning of walls, or windows of domestic premises using a hosepipe as a service to customers.

In order to provide transparency, any other exceptions would need to be managed and approved via the representation process. All applications for exceptions must be made within the prescribed consultation period and a formal response will be published to identify exceptions that have been approved.

**Monitoring and review of temporary restrictions**

A post-implementation review of the impacts and demand savings of these provisions will be completed after a drought period. The review will identify predicted and actual water savings achieved through these powers. Analysis of representations and evidence of impacts received throughout the
onset of a drought will support future restrictions and give customers confidence that their interests are being considered and that effective measures will be taken to minimise the impact on water supplies and on the environment during future droughts in our region.

We currently assume a demand saving of 3 to 10 per cent as a result of the temporary use restrictions and associated activities as detailed in Appendix 2. The review of savings following the restrictions that were imposed in 2012 proved a demand saving of 6 per cent.

3.5.1.5 Non-Essential Use Ban Restrictions (non-domestic customers) (Levels of Service 2)

This section details the demand restrictions that we may impose on non-domestic customers and how these would be implemented as drought conditions worsen.

**Water efficiency, business customers and ‘Retail’ separation**

As a part of the draft WRMP 2019 pre-consultation process we engaged with non-household, business, retailers, with regard to non-household water efficiency measures.

Since the non-household market opened in 2017, we have been actively engaging with retailers in our region to develop effective communication strategies relating to operational matters. We have engaged directly with each individual retailer and provided an awareness of where we hold relevant information in our plans and specific characteristics of our region.

Each Retailer has a dedicated ‘Wholesale Account Manager’ and water efficiency a common theme, reflecting our keenness to engage on innovative ways of collaboration, to ensure the efficient use of water. In addition, we have launched our Shop Window project in Newmarket, which includes Retailers on our water efficiency efforts in this particular area. Retailers have been provided with direct access to the Shop Window project manager and, in turn, retailers have been supportive of our engagement directly with their end user customers in this area. A number of retailers have shown a considerable appetite to do more and go further.

We are currently working on the next iteration of our engagement with retailers on demand management, which is in the early stages of development. This will include a dedicated section on our Wholesale website providing targeted information for retailers and, also, content which can be directed towards their end user non-household customers. In recognising that the retailer owns the relationship with the end-user non-household customer and that they will, in most case, have a greater understanding of water consumption for their customers, we have a scheme which seeks to work with retailers in helping us manage demand and optimise our network. This is advertised on our Wholesale website.
Drought orders can be sought by a water company to restrict the use of water in the form of a restriction of non-essential use. In addition to domestic customers, these restrictions would also affect commercial customers and businesses. Drought orders to restrict non-essential use must be granted by the Secretary of State. Further details on this process are included in Section 3.5.3.

Restrictions on non-essential use are determined by our reservoir control curves at a frequency of not more than 1 year in 40 on average. Our reservoir control curves are discussed in Section 3.7.2.1. The application of drought orders to restrict the use of water in areas supplied by groundwater sources is determined in response to local conditions of supplies and demands.

Activities that potentially would be restricted under a non-essential use ban are as follows:

- Watering outdoor plants on commercial premises
- Filling or maintaining a non-domestic swimming or paddling pool
- Filling or maintaining a pond
- Operating a mechanical vehicle washer
- Cleaning any vehicle, boat, aircraft or railway rolling stock
- Cleaning non-domestic premises
- Cleaning a window of a non-domestic premises
- Cleaning industrial plant
- Suppressing dust

Under drought conditions we would liaise with the Non-household Retail Sector, regarding the potential imposition of such restrictions and would only apply for specific restrictions where we were confident that we would realise appropriate demand savings.

With the exception of those customers on our WaterSure tariff due to a medical condition, we would not propose the permission of any other exemptions or concessions unless on the grounds of health and safety in line with Section 3.5.1.4. The process of representation would also be consistent with that discussed in Section 3.5.1.4.

The estimated demand savings for non-essential use restrictions range from 14 to 20 per cent as detailed in Appendix 2.

3.5.1.6 Emergency Drought Order (Level of Service 3)

This section details the most severe customer restrictions that we could impose in a drought. These would only ever be considered in the event that water supplies were severely depleted due to an exceptional shortage of rain.

Under the scope for emergency drought orders we may apply to the Secretary of State to limit or prohibit the use of water for any purpose we consider appropriate or the introduction of rota cuts to conserve water supplies. Further details on this process are included in Section 3.5.3.

The application and enactment of rota cuts would result only if the drought was of sufficient intensity and duration to exceed the worst recorded conditions. These are currently included in our reservoir control curves at a frequency of not more than one year in 100, and form the basis of the level of service 3 trigger curve. From 2024/25 we have committed to avoiding the need for severe restrictions for any event less than a 1 in 200 year drought.

These severe restrictions would only be implemented in the most extreme of circumstances and only where it would be necessary to impose the use of rota cuts as a result of drought conditions. Where customers experience interruptions to supply as a result of an emergency drought order we would award compensation, in accordance with Condition Q in our Instrument of Appointment.

Appendix 2 estimates demand savings that would result from the use of rota cuts as ranging from 34 to 52 per cent.

Through analysis in our revised dWRMP 2019, we identified the majority of our WRZs are already resilient against 1 in 200 year drought event, as a result of drought investment we have previously completed. We have completed additional analysis on these zones and have identified existing supply surplus within either the zone itself or adjacent zones, which can be utilised to mitigate this risk. These are shown in Figure 3.15.
Figure 3.17: WRZs identified as at particular risk of severe restrictions before 2025

3.5.1.7 Other Demand Management Options

During periods of drought we may consider the suspension of our planned maintenance programmes including mains flushing. Some level of flushing is required to maintain water quality and to ensure health and safety is not jeopardised; however, we would undertake a review to understand if there was potential to minimise this to conserve water supplies. In the event of a drought, we would also minimise the test pumping of boreholes, minimise treatment losses and review blend options. During the 2011-12 drought we also identified ‘extreme pressure management’ as a potential option, this would be reviewed on a case-by-case basis. This would include consideration of any reductions in supply to fixed fire hydrants.

3.5.2 Supply Side Drought Management Actions

Supply-side management actions are the measures that we may employ to increase supply during a drought, over and above the activities we ordinarily undertake.

We have developed supply side options at source and WRZ level. We discuss the source level options below. These are actions which will allow resource to be maintained when river flows or groundwater levels are low. They provide localised, temporary options to increase supply during a drought, beyond our normal operations. Some actions require a change to our abstraction licence, and therefore require a Drought Permit application. Where required these are highlighted and are discussed further in Section 3.6.

Implementation of these actions would be decided by the Drought Management Team, after consideration of the drought management actions and drought triggers described in Section 3.4.

More general WRZ level supply-side drought management options have been outlined in Appendix 3 where we provide details on the option implementation assessment, triggers, implementation timeframe, permissions and yield saving in each zone.

3.5.2.1 Reservoir Drought Management Actions

Actions have been developed for all our reservoirs, with the exception of the small and naturally filled Ravensthorpe and Hollowell.
Table 3.10: Drought management actions for our reservoirs

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Water Resource Zone</th>
<th>Drought Management Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alton Water</td>
<td>East Suffolk</td>
<td>Additional transfer of water from the Bucklesham abstraction point on the Mill River (dependent on river levels)&lt;br&gt;Permit to reduce minimum residual flow condition by 50% at the abstraction point on the River Gipping</td>
</tr>
<tr>
<td>Ardleigh</td>
<td>South Essex</td>
<td>River augmentation scheme using Balkerne and Aldham boreholes&lt;br&gt;Drought permit to increase augmentation volumes by 50%&lt;br&gt;Utilise Ely-Ouse Essex Transfer Scheme (EOETS)– this is operated by the Environment Agency and would need further discussion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Potential transfer from Essex &amp; Suffolk Water using a direct discharge from the EOETS transfer pipeline to Abberton Reservoir, owned by Essex &amp; Suffolk Water. Discussions with Essex and Suffolk Water have been previously held identify opportunities to use this transfer to support Ardleigh Reservoir, if required as a contingency under exceptional circumstances.</td>
</tr>
<tr>
<td>Covenham</td>
<td>East Lincs</td>
<td>Section 20 management agreement with the Environment Agency to utilise transfer scheme from Great Eau into the Louth Canal, for abstraction at Covenham</td>
</tr>
<tr>
<td>Grafham Water</td>
<td>Ruthamford South</td>
<td>Two staged drought permit to alter the minimum residual flow condition at the abstraction point on the River Great Ouse</td>
</tr>
<tr>
<td>Rutland Water</td>
<td>Ruthamford North</td>
<td>Drought permit to reduce minimum residual flow condition by 50% at the abstraction point on the River Nene</td>
</tr>
<tr>
<td>Pitsford</td>
<td>Ruthamford North</td>
<td>Drought permit to reduce minimum residual flow condition by 50% at the abstraction point on the River Nene</td>
</tr>
<tr>
<td>Ruthamford reservoirs</td>
<td>Ruthamford</td>
<td>Conjunctive use of reservoirs in our partly integrated Ruthamford region, to allow optimisation of storage across the region. This would be modelled using our water resource system model.</td>
</tr>
</tbody>
</table>

3.5.2.2. Direct Intakes Drought Management Actions

We have assessed our direct intakes against the worst historic and 1 in 200 year drought events, which has identified that there are occasions at our Wissey and Nar intakes when we would not be able to rely on these intakes during a drought, under existing abstraction licence constraints. We also have concerns at our Wensum intake. We have therefore identified supply-side drought permit options for these locations.

Drought management actions for our direct intakes, to ensure supply remains secure (up to a 1 in 200 year drought event), are detailed in Table 3.11 below. A map of the drought permit locations is included in Section 3.6.
### Table 3.11: Drought management actions for our direct intakes

<table>
<thead>
<tr>
<th>Direct intake</th>
<th>Water Resource Zone</th>
<th>Drought management action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>River Ancholme at Cadney</strong></td>
<td>Central Lincs</td>
<td>Supported by the Trent-Witham-Ancholme scheme (TWAS). Analysis shows this intake is secure against the worst historic and modelled 1 in 200 year droughts.</td>
</tr>
<tr>
<td><strong>River Great Ouse at Clapham</strong></td>
<td>Ruthamford South</td>
<td>Low flows do not generally occur at this abstraction point owing to the extent of effluent returns in the upstream catchment; therefore, abstraction is unlikely to be affected during drought. Should low levels threaten abstraction supplies we would switch to Grafham Water.</td>
</tr>
<tr>
<td><strong>River Wensum at Heigham</strong></td>
<td>Norwich &amp; the Broads</td>
<td>We have invested in a new membrane treatment plant to increase the resilience of our Heigham intake. The HOF at Heigham is very low, and flow analysis of worst historic and modelled 1 in 200 yr droughts suggest it is unlikely we would reach this HOF and the intake is reliable. However in the event of a more extreme drought or unknown water quality concerns we propose a drought permit to increase the annual abstraction quantity from the boreholes at Costessey, allowing us to utilise the adjacent bankside Pits.</td>
</tr>
<tr>
<td><strong>River Nar at Marham</strong></td>
<td>South Fenland</td>
<td>Water would be pumped from neighbouring North Fenland WRZ to support. This action was tested during the 2018 dry summer. The Wellington Wellfield drought permit in North Fenland can also be used to support this zone if needed.</td>
</tr>
<tr>
<td><strong>River Wissey at Stoke Ferry</strong></td>
<td>North Fenland</td>
<td>Transfer of water from the adjacent Cut-Off Channel for release as compensation to the River Wissey, depending on water quality. This resource is considered to be resilient during a drought. We can also augment supply from local groundwater sources (Wellington Wellfield). We propose a drought permit to temporarily increase the Wellington Wellfield abstraction licence.</td>
</tr>
<tr>
<td><strong>River Trent at Hall</strong></td>
<td>Central Lincs</td>
<td>This is a new intake which entered supply since the 2014 Drought Plan. We have assessed it to be resilient against a 1 in 100 year drought event but for anything more severe we would seek a drought permit to lower the MRF to increase our abstraction. This is a short-term measure (until 2025) whilst the revised dWRMP 2019 strategic investment is completed.</td>
</tr>
<tr>
<td><strong>Bath Spring, Saltersford and Cringle Brook</strong></td>
<td>South Lincs</td>
<td>During normal operation these intakes are supported via a raw water transfer from Rutland Water. No current plans to reinstate intakes.</td>
</tr>
</tbody>
</table>

---

6 Atkins (2017) Trent Witham Ancholme Assessment Memo
3.5.2.3 Drought Management Actions for Groundwater Sources

The majority of groundwater sources tend to be more resilient against drought as the aquifers act as a buffer against rapid changes in rainfall. However as detailed in Section 3.4.4 we have identified a number of more drought vulnerable boreholes. The drought alert curves developed for these boreholes provides an indication 6 to 18 months in advance of the potential onset of drought, and triggers mitigation actions at each source.

Mitigation actions include:
- additional monitoring
- maximise conjunctive use from more secure sources to alleviate pressure on the drought-vulnerable source
- Assign drought mitigation schemes as required; these could include fast-tracking existing borehole maintenance or replacement schemes or new schemes.

We have also developed drought management actions specific to each drought vulnerable borehole (Table 3.12), to ensure the source remains resilient up to a 1 in 200 year drought event. For the majority, this is through investment in supporting boreholes, or utilising other sources within the WRZ.

Moving to a 1 in 200 year Level of Service has increased the drought risk at a handful of boreholes. Where this has resulted in a reduction to supply at a WRZ level, we have proposed drought investment in the revised dWRMP 2019. To mitigate the risk to supply before this investment is completed in 2025, we have identified interim options, which are detailed in Appendix 3.
### Table 3.12: Drought vulnerable groundwater sources and associated actions

<table>
<thead>
<tr>
<th>Source</th>
<th>Water Resource Zone</th>
<th>Drought Management Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risby</td>
<td>Bury Haverhill</td>
<td>Interim options until 2024 WRMP investment</td>
</tr>
<tr>
<td>Goxhill 2</td>
<td>Central Lincs</td>
<td>Support from adjacent sources within supply zone. Recommissioning of Goxhill 1 could be investigated.</td>
</tr>
<tr>
<td>Welton</td>
<td>Central Lincs</td>
<td>Support from adjacent sources within supply zone.</td>
</tr>
<tr>
<td>Winterton Holmes</td>
<td>Central Lincs</td>
<td>New borehole to support continued abstraction - became operational in 2018 following implementation of pesticide scheme</td>
</tr>
<tr>
<td>Lower Links</td>
<td>Cheveley</td>
<td>Interim options until 2024 WRMP investment</td>
</tr>
<tr>
<td>Belstead</td>
<td>East Suffolk</td>
<td>Monitoring of sentinel boreholes. Utilise surface water within zone if low water levels cause salinity to spike.</td>
</tr>
<tr>
<td>Westerfield</td>
<td>East Suffolk</td>
<td>New borehole drilled and commissioned in 2006 to support continued abstraction</td>
</tr>
<tr>
<td>Whitton</td>
<td>East Suffolk</td>
<td>Three new boreholes drilled and commissioned in 2006 to support continued abstraction, new WTW also installed</td>
</tr>
<tr>
<td>Ashley Road</td>
<td>Newmarket</td>
<td>New borehole drilled and commissioned in 2006 to support continued abstraction. Import from Cambridge Water also available for this WRZ. Additional severe drought risk managed by interim options until 2024 WRMP investment</td>
</tr>
<tr>
<td>Long Hill</td>
<td>Newmarket</td>
<td>New borehole drilled and commissioned in 2006 to support continued abstraction. Import from Cambridge Water also available for this WRZ. Additional severe drought risk managed by interim options until 2024 WRMP investment</td>
</tr>
<tr>
<td>Moulton</td>
<td>Newmarket</td>
<td>New borehole drilled and commissioned in 2006 to support continued abstraction. Import from Cambridge Water also available for this WRZ. Additional severe drought risk managed by interim options until 2024 WRMP investment</td>
</tr>
<tr>
<td>Southfields</td>
<td>Newmarket</td>
<td>New borehole drilled and commissioned in 2006 to support continued abstraction. Import from Cambridge Water also available for this WRZ. Additional severe drought risk managed by interim options until 2024 WRMP investment</td>
</tr>
<tr>
<td>Congham</td>
<td>North Fenland</td>
<td>Support from adjacent sources within supply zone</td>
</tr>
<tr>
<td>Gayton</td>
<td>North Fenland</td>
<td>Support from adjacent sources within supply zone</td>
</tr>
<tr>
<td>Metton</td>
<td>North Norfolk Coast</td>
<td>Satellite borehole drilled and commissioned in 2006 to support continued abstraction</td>
</tr>
<tr>
<td>North Walsham</td>
<td>North Norfolk Coast</td>
<td>New borehole to support continued abstraction. AMP7 investment to join up vulnerable works.</td>
</tr>
<tr>
<td>Marham</td>
<td>South Fenland</td>
<td>Emergency standby from Wellington Wellfield. Additional severe drought risk managed by interim options until 2024 WRMP investment</td>
</tr>
</tbody>
</table>
3.5.2.4 Additional Supply Side Management Options

Management of Inter-Company Transfers

We are a net exporter of water through the historical provision of statutory bulk supplies from Grafham Water to Affinity Water (Central) and from Rutland Water to Severn Trent Water. There is a small net import of water from Essex & Suffolk Water in the Braintree and Colchester areas. Agreement has been made with Cambridge Water to provide a supply from the Thetford to Cambridge main during a drought. We maintain liaison with all neighbouring water companies in the preparation of our drought plans and WRMPs.

There are no other specific cases where additional water supplies could be provided between companies during a drought; however, companies would provide mutual assistance dependent upon the characteristics of the prevailing drought and their respective availability of water resources and treated water supplies. There are no bulk supplies between Hartlepool Water and Northumbrian Water and no existing provisions for emergency cross connections.

Conjunctive use

Some of our WRZs contain both groundwater and surface water zones which can be used conjunctively. In these zones, it may be possible to take more water from groundwater in order to reduce abstraction from reservoirs to conserve storage, or vice versa, depending on the type of drought and resources affected. During a drought these scenarios would be modelled using our water resources supply system model, Aquator.

Alternative Options

Our drought plan provides a framework for drought management against the worst historical droughts experienced in our region to date, as well as those of a 1 in 200 year drought severity (if not previously experienced). As part of our continued long-term water resource and drought planning, we are also considering the feasibility of additional demand- and supply-side options we may need in future should a more extreme drought occur, such as a 1 in 500 year return period or beyond.

The following options may be considered to secure additional supplies; however, specific details of the location, cost and technical complexity have not yet been assessed. Their general environmental impacts have been assessed as part of our Strategic Environmental Assessment (SEA)\(^7\).

- Road tankering and local emergency supplies
- Desalination of brackish water
- Return of tidal effluent
- Inter-catchment transfers
- Bulk transfers from other water companies.
- Conjunctive use

An evaluation is now being undertaken to understand the feasibility of delivering supply side options that could maintain deployable output under an extreme drought (RP 1:500 years) but on a reactive rather than planned basis. The planning scenario is a deficit of 20 Ml/d for a period of six months. The evaluation will draw conclusions on the feasibility of delivering major water resources schemes after the onset of a drought event and, if appropriate, recommend pre-planning and up front delivery activities that would be required to meet critical deadlines for potable supplies. Pre-planning activities could extend to environment impact assessments, land acquisition and early procurement of key materials.

The evaluation focuses on our South Essex and East Suffolk WRZs with detailed focus on the following supply side options:

- Desalination (seawater)
- Effluent re-use
- Groundwater and surface water - conjunctive use
- Sea tankering

The output data from the report will be applicable to other coastal WRZs in the Anglian Water operating area.

3.6 Drought Permits and Drought Orders

Drought orders and permits can be sought by a water company to secure additional water resources or to restrict the use of water. These would only be considered under periods of exceptional shortages of rainfall which result in serious deficiencies in our water supplies. These are all drought management actions that if granted can allow greater flexibility to manage water resources and minimise the effects of a drought on public water supply and the environment.

The Water Resources Act 1991 as amended by the Environment Act 1995 and the Water Act 2003 allows for three legislative ways for dealing with drought situations:

- drought permits
- drought orders – ordinary
- drought orders – emergency

There are a number of key differences between drought permits and drought orders that have been summarised in Table 3.1\(^8\).

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\(^7\) SEA Environmental Report, Mott MacDonald, November 2018

\(^8\) Based on the summary included in the ‘Drought permits and drought orders’ Defra document, May 2011
Before we apply for a drought permit or drought order we will have taken the necessary measures to conserve supplies and reduce demand on the affected sources, as detailed in Section 3.5.1. In particular we would have increased engagement with our customers through publicity campaigns, imposed temporary restriction on domestic hosepipe use, and increased leakage control reduction.

Table 3.13: Summary of drought permit / ordinary and emergency drought orders

<table>
<thead>
<tr>
<th></th>
<th>Drought permit</th>
<th>Ordinary drought order</th>
<th>Emergency drought order</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legislation</strong></td>
<td>WRA 1991 Section 79a</td>
<td>WRA 1991 Section 74</td>
<td>WRA 1991 Section 75</td>
</tr>
<tr>
<td><strong>Applicant</strong></td>
<td>Water company</td>
<td>Water company or Environment Agency</td>
<td>Water company or Environment Agency</td>
</tr>
<tr>
<td><strong>Authorised by</strong></td>
<td>Environment Agency</td>
<td>Secretary of State</td>
<td>Secretary of State</td>
</tr>
<tr>
<td><strong>Powers</strong></td>
<td>To modify or suspend conditions on an abstraction in order to increase water supply during a drought</td>
<td>Can increase both supply and restrict non-essential use of water. This is over and above temporary restriction powers to restrict domestic hosepipe use</td>
<td>To set up and supply by means of stand pipes or water tanks</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>Up to 6 months</td>
<td>Up to 6 months</td>
<td>Up to 3 months</td>
</tr>
<tr>
<td><strong>Extensions</strong></td>
<td>For a further 6 months</td>
<td>For a further 6 months</td>
<td>For a further 2 months</td>
</tr>
<tr>
<td><strong>Period for powers to be granted</strong></td>
<td>Normally within 12 days from date of application</td>
<td>Normally made within 28 calendar days from date of application</td>
<td>Normally made within 28 days from date of application</td>
</tr>
</tbody>
</table>

**Drought Permits**

In accordance with the Water Act 2003, we have identified all possible drought permits that we would seek to secure additional supplies during a drought. Table 3.14 provides a summary of the proposed drought permits we would apply for and their benefit in expressed in yield.

Where our surface water supply drought management actions require a change to our abstraction licence, we would seek to apply for a Drought Permit. We have not identified any drought permits required to maintain supply for our groundwater sources. A map of the drought permit locations is in Figure 3.18.

Note these yield quantities are from the Drought Plan 2014 and are still under review. This also does not reflect the wider benefit to deployable output of the source, as this can be constrained by WTW output or other operational factor. Analysis for the revised dWRMP 2019 identified that there was limited WRZ level benefit; rather drought permits offer localised source-level benefits. The permits offer resilience against more severe droughts, and we would consider applying for a permit where river flows and our resources have been affected by prolonged low rainfall.
Figure 3.18: Anglian Water potential Drought Permit locations and associated sources
We have improved and updated an assessment of the environmental impacts relating to each of the individual drought permits, and a summary of the assessments is presented in Appendix 7. We have produced an environmental monitoring plan which identifies the baseline monitoring that would be required to support a future application, which is detailed in Appendix 8. We have completed these assessments in liaison with the Environment Agency and Natural England to ensure environmental impacts are fully identified and assessed. Further details can be found in Section 3.7.

We have assessed the drought permits against a 1 in 200 year drought event, but for most of our sources our reference drought remains the worst historic drought event (Part 2, Table 2.2). Therefore we do not expect the frequency of applications to increase.

We may also need to use the Grafham drought permit for supply-demand purposes. Our draft WRMP 2019 has identified a residual planning deficit from the start of our planning period in 2020, until 2024 when we complete a large amount of investment. We have identified the Grafham drought permit as a potential option to offset this residual deficit in Ruthamford South. The residual deficit is driven by potential climate change impacts, which are unlikely to materialise immediately, but to ensure our supplies are secure we will be investing in a strategic scheme to remove this risk by 2024. The drought permit option would be a temporary winter only permit to alleviate the planning deficit. As such we have developed a bespoke higher reservoir trigger for activating the permit under this scenario. The winter only timing of this permit and use at higher flows would cause less impact to the environment and therefore the current environmental assessment in Appendix 7 remains valid for this use.

**Winter drought permits**

Winter drought permit application can be made to increase winter abstractions in order to:

- Reduce the risks of drought permits or orders the following summer.
- Assist recovery of water supply resources that have been depleted as a result of drought.
- Assist the maintenance of water supply in drought affected areas.

Any winter drought permit application must satisfy the criteria for drought permits and must be applicable to circumstances where a threat to public supplies is significantly greater than the normal risk to supplies for the time of year. In these cases, we would still take appropriate mitigation measures to protect the impact on the environment and other abstractors. For any application we will work closely with the Environment Agency.

**Application process**

Drought permits must be approved by the Environment Agency. Any drought permit application we submit will be fully aligned with the requirements and will only be granted when the Environment Agency is satisfied with appropriate evidence that there is a serious deficiency of supplies of water in a given area due to an exceptional shortage of rain.

In line with the guidance, we have prepared background material to ensure we are ‘application ready’ for all our permits, should we need to apply for one. These are included in Appendix 9. They

<table>
<thead>
<tr>
<th>Source</th>
<th>Drought permit application</th>
<th>Maximum Potential Yield (ML/d) (from Drought Plan 2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alton Water</td>
<td>50% MRF reduction at intake on River Gipping</td>
<td>4.5</td>
</tr>
<tr>
<td>Arleigh Reservoir</td>
<td>Increase the groundwater abstraction licence for the augmentation boreholes</td>
<td>6</td>
</tr>
<tr>
<td>River Wensum intake</td>
<td>Increase the annual abstraction quantity for the Costessey groundwater sources</td>
<td>24</td>
</tr>
<tr>
<td>Grafham Water</td>
<td>Two staged permit to alter the abstraction and MRF conditions at the intake on the River Great Ouse</td>
<td>68</td>
</tr>
<tr>
<td>Pitsford Water</td>
<td>50% MRF reduction at intake on River Nene</td>
<td>17</td>
</tr>
<tr>
<td>Rutland Water</td>
<td>50% MRF reduction at intake on River Nene</td>
<td>62</td>
</tr>
<tr>
<td>River Wissey/</td>
<td>Increased abstraction licence for the supporting groundwater sources</td>
<td>10</td>
</tr>
<tr>
<td>River Nar intake</td>
<td>Reduction to MRF</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 3.14: Summary of potential drought permits with associated maximum potential yield
detail the methodology we will follow and evidence we will provide to justify the permit and demonstrate an exceptional shortage of rain. This will use the rainfall early warning indicators described in Section 3.3. The documents also detail all the necessary arrangements for advertising and stakeholder engagement.

Drought Orders

The environmental assessments completed for each of the permits listed in Table 3.14 have highlighted some cases where the environmental impacts of the proposed drought measure may be more significant during the summer. In these instances the Environment Agency may advise that it would be necessary to apply to the Secretary of State for a drought order.

In addition to the supply-side management options that relate to Anglian Water sources, we have identified options that could be considered in a more severe drought that would require changes to Environment Agency abstraction licences and therefore an application for a drought order. These are detailed in Table 3.15.

Table 3.15: Potential drought orders

<table>
<thead>
<tr>
<th>Scheme</th>
<th>Water Resource Zone</th>
<th>Ordinary drought order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ely-Ouse to Essex Transfer Scheme</td>
<td>South Essex</td>
<td>Increase transfer licence from the River Great Ouse</td>
</tr>
<tr>
<td>Trent-Witham-Ancholme Transfer Scheme</td>
<td>Central Lincolnshire</td>
<td>Increase transfer licence from the River Trent</td>
</tr>
</tbody>
</table>

We have not undertaken environmental assessments for these schemes and would expect to clarify with the Environment Agency to determine the requirements for an environmental assessment in advance of a drought order application. The Environment Agency includes reference to the option for a drought order application to change the Trent-Witham-Ancholme transfer scheme in its Anglian Drought Plan 2011 and states the expectation that we would provide significant input to the process.

In our 2014 Drought Plan we also included a potential Drought Order regarding lowering the MRF associated with the Gwash-Glen transfer. This is subject to an ongoing trial to be business as usual during the operation of the scheme.

3.7 Minimising the Impact of Drought on the Environment

An important part of the drought planning process is to ensure that the environmental impacts of any of the drought actions that we propose are minimised.

3.7.1 Environmental Assessments

In accordance with the Environment Agency’s guidelines, we have completed environmental assessments for our drought management activities. An environmental assessment report (EAR) has been completed for each of the supply-side drought measures where we consider that there may be a requirement to apply for a drought permit. These have been updated from our last Drought Plan, and a new one completed for the drought permit we propose at our River Trent intake. Input from the Environment Agency, and Natural England has been obtained and used to inform the updates.

These assessments are used to determine the environmental sensitivity of affected areas, the likely impact of the proposed action, compliance with environmental regulations and the Water Framework Directive (WFD), and any mitigation measures that may be required to protect the environment. They are also used to develop an environmental monitoring plan and to identify any additional information that we would require to support a future application.

We currently have eight sources where we have identified drought measures that would require an application for a drought permit to secure additional supplies in a drought, as detailed in table 3.14. A summary of the individual environmental assessments is provided in Appendix 7. Full environmental assessments have been completed for each permit identified and are available upon request. In some cases, additional work is required in order to inform the environmental assessments. Notably, there is ongoing work on the Wellington Wellfield application to determine the distribution of abstraction between boreholes under a drought permit. We continue to work closely with the Environment Agency whilst this is carried out.

In accordance with the Environment Agency’s guidelines, the assessment process includes the following stages:
3.7.2 Environmental Monitoring Plan

The environmental monitoring plan considers the output of the environmental assessments completed for all the potential drought permit sites. The report provides a summary of the monitoring that is routinely gathered, additional monitoring that would be undertaken before a permit is applied for, once in use and once the permit has been lifted. It also identifies mitigation measures required in order to ensure no environmental impact as a result of the permit. Consideration has been given to the timing and availability of data during the lead into a drought.

The environmental monitoring plan is presented in Appendix 8.

Monitoring will be annually reviewed to assess baseline conditions and identify any further actions required. This will be carried out in discussion with the Environment Agency.

3.7.3 Water Framework Directive (WFD) Assessment

We have undertaken WFD assessments for all our supply-side actions that require a drought permit application. The WFD assessments are included in each Environmental Assessment Report (EAR), and review the potential for drought permit options to impact upon River Basin Management Plan (RBMP) objectives or to cause deterioration in waterbody status.

The potential for abstraction from existing sources to be constrained over the next six years to meet WFD requirements has been reviewed in the revised dWRMP 2019. Whilst we are expecting a significant number of constraints to be put into place for groundwater abstractions in 2022 and 2024, investment has been identified in the revised dWRMP 2019 to address any resultant deficits. In addition, our peak abstraction at these sources will not be affected, and we therefore do not consider there to be potential impact upon the draft Drought Plan 2019.
3.7.4 Habitats Regulations Assessment (HRA)

All supply-side actions that require a drought permit application have been subject to a HRA Stage 1 screening assessment to review the requirement for a Stage 2 Appropriate Assessment (AA). HRA Stage 1 assessments are included within the Environmental Assessment Reports.

Where significant effects on European designated sites cannot be ruled out at the screening stage, an AA has been carried out. The following sites have been subject to an AA:

- River Great Ouse at Offord (Grafham Water)
- River Nene at Wansford (Rutland Water)
- River Wensum at Heigham
- River Trent at Hall

The AAs have been updated for the River Great Ouse at Offord and the River Nene at Wansford from the previous AA completed in 2013. From discussion with Natural England, it was concluded that an AA for the River Wensum at Heigham was also required, despite being screened out in 2013. An AA has also been completed for the River Trent at Hall. The AAs are available upon request.

The AAs outline the mitigation measures required to ensure that any likely significant effects of drought permit option upon European sites are reduced, mitigated, or avoided.

3.7.5 Strategic Environment Assessment (SEA)

We have undertaken an SEA for our drought plan. An SEA is required for plans and programmes that are likely to have a significant effect on the environment, including cumulative effects with other plans and programmes. SEA screening was carried out and helped to inform the SEA Scope. The SEA Scope underwent a 5 week formal consultation from 5th September 2018, for consultation with the Environment Agency, Natural England, and Historic England. Consultation responses have been used to inform the draft SEA report, which is in the form of an addendum to the 2013 SEA. The addendum ensures that new and changed options are assessed as part of the SEA process, whilst avoiding duplication where options have remained the same as the Drought Plan 2014.

3.8 Drought Management and Communication

Experience from previous droughts in our region has outlined the importance of effective internal and external management and communication. The following sections provide details on the management structure that would be mobilised at the onset of a drought and how this team will be best placed to manage us effectively both internally and externally.

Our communications plan sets out the actions we would undertake during a drought event and how we would communicate these with our customers, regulators and key stakeholders.

3.8.1 Drought Management Team

One of the first management actions that results from a move to Potential Drought status is to convene the Drought Management Team.

The Drought Management Team will be responsible for making key business decisions that may be required as a direct result of the impact of drought. Our management structure covers all areas of the business and members are experienced in drought management. This enables us to respond effectively and responsibly to the onset and development of a drought.

Our Drought Management Team is chaired by the Director of Water Services and includes senior representatives from across the organisation. The roles and responsibilities of the core members of the Drought Management Team are defined in Table 3.16.
Table 3.16: Roles and responsibilities of the Drought Management Team

<table>
<thead>
<tr>
<th>Role</th>
<th>Drought management action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director of Water Services</td>
<td>All activities relating to water supply, water networks, process science, leakage management and local capital delivery. Specific drought responsibility to ensure that the water supply system is operating at full capacity. All activities relating to the management of our extensive asset base, the associated investment requirements, investment programme delivery and supply chain management. Specific drought responsibility to assess appropriate investment requirements for key assets (abstraction sources, networks and water treatment works).</td>
</tr>
<tr>
<td>Regulation Director</td>
<td>Ensuring that we adhere to all the requirements of our economic, environmental and quality regulators.</td>
</tr>
<tr>
<td>Director of Brand and Communications</td>
<td>All internal and external communications. Specific drought responsibility to ensure that we adhere with the Communications Plan.</td>
</tr>
<tr>
<td>Head of Water Resources</td>
<td>To ensure that we maintain the security of upstream water resources to effectively manage all aspects of the supply demand balance and regulatory compliance. Specific drought responsibility to produce and update the drought plan, to monitor available water resources, to report on drought status, to address environmental concerns and to identify investment requirements.</td>
</tr>
</tbody>
</table>

The Drought Management Team will convene on a regular basis, as required, with minutes being maintained by a technical secretary. The Drought Management Team is supported by wider input from Emergency Planning, Investment Planning & Delivery and technical experts from across the business. Where necessary, as the drought progresses, subgroups will be set up for the delivery of specific supply or demand side drought schemes.

Experience from the 2011-12 drought highlighted the importance of creating a central team with dedicated resources to help co-ordinate the drought response. Depending on the severity of the drought, the Drought Management Team may choose to form a central Drought Response Team, with experts seconded from across the business. These resources will be made available as drought conditions develop. The Head of the Drought Response Team would have responsibility for co-ordinating the various sub-groups and multiple activities being carried out across the business, reporting directly to the Drought Management Team. The drought governance structure that was adopted during the 2011-12 drought is presented for reference in Figure 3.20.
Once convened, the Drought Management Team has overall responsibility for managing the drought through to a point when resources have been recovered to normal operating levels.

Early communications to our customers is essential at this stage in order to communicate the potential drought situation and the impacts that this could lead to in due course. The Drought Management Team includes a communications lead that will deliver key drought messages and actions both rapidly and effectively. Our communications plan is summarised in Section 3.7.4 with full details in Appendix 10.

### 3.8.2 Emergency Planning Team

As a water and wastewater company, Anglian Water has a statutory obligation to satisfy our customers’ needs, and that includes protecting the vital services that we provide for them. The role of our Emergency Planning Team is to work closely with our operations teams on a variety of resilience plans in order that our obligations are met under the Security and Emergency Measures Direction (SEMD) 1998. They will be called upon by the DMT to support our operational response in a drought.

Response and recovery plans have been prepared for every public water supply zone and these documents also include reference to plans developed to manage high summer water demands. The summer demand plans are produced and reviewed by key personnel across the entire business to ensure that all contingency measures are met in accordance with our obligations.

A number of policies and procedures have been developed to address emergency events, including increased summer demands, heat waves and drought.

At the start of each year meetings are held in preparation for the summer months and associated increased water demand.
The meeting participants consist of:

- Head of Tactical Operations or (OMC) Senior Operations Manager
- Regional Supply Manager for the area (Chair) or nominated deputy
- Regional Network Manager for the area or deputy
- Emergency Planner
- Water Managers – Supply and Network Managers for the area or deputy
- Leakage Delivery Manager for the area (or representation)
- Water Asset Planner for the area
- Operational Systems (Modelling) representative

The activity over the summer period is reviewed in October and a meeting is arranged, if required, to cover significant issues for subsequent resolution during the following winter. If there are no events causing concern over the summer, a full review meeting is not held.

3.8.3 External Drought Management

Key stakeholders will be involved in the management of all stages of a drought in the Anglian region as follows:

- A drought planning liaison group will be established with the Environment Agency and regular liaisons will allow collaborative management of any potential drought. Increased reporting requirements will be agreed to manage each individual drought and we work closely with the Environment Agency to secure consistency with their area drought plans.

- We will consult closely with the Environment Agency and Natural England to understand and mitigate any potential impacts on the environment in relation to any drought orders/permit applications.

- Liaison with other licensed water undertakings continues to occur bilaterally and via regional liaison led by the Environment Agency and other groups such as Water Resources East (WRE) in the future

- Appropriate public communication will be maintained throughout all stages of a drought to inform and engage our customers in a timely and effective manner.

3.8.4 Communications Plan

We have on-going engagement with our customers about water resource issues in our region, and have developed our Love Every Drop campaign to raise awareness about the value of water. We want to get people thinking as responsibly about water as millions already do about recycling. One of our key Love Every Drop goals is to increase customer awareness about the value of water in our region and to encourage water efficient attitudes and behaviours.

We consider the encouragement of ‘water wise’ behaviour to be a central theme to our demand management strategy. Our drought communications plan has been developed to be consistent with our Love Every Drop campaign and our water efficiency strategy. It aims to provide a flexible framework of communications that will ensure effective and timely communications with regulators and customers during a range of scenarios and allows us to be responsive to individual drought characteristics.

Our communication messages are tailored to respond as required to normal conditions, potential drought and actual drought. The approach to our communications strategy is presented in Appendix 10.

Effective communications that engage customers in a timely manner are essential to reduce demand to conserve water for water supplies and to protect the environment during a drought.

The key stakeholders that we liaise with are detailed in Table 3.17. Our communications plan outlines our liaison with regulators, customer interest groups and other partners at the different stages of a drought.
Table 3.17: Key stakeholders in our communication plan

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Liaison</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domestic customers</strong></td>
<td>Deliver continuous in direct and direct communication of the importance of 'Waterwise' behaviour and education.</td>
<td>Communication in bills. Website. Call centre representatives. Print and broadcast media.</td>
</tr>
<tr>
<td><strong>Commercial/industrial customers</strong></td>
<td>Maintain liaison regarding current situation via Wholesale Service Centre. Encourage water conservation through water efficiency assessments, leakage audits and process optimisation.</td>
<td>Face to face via Wholesale Service Centre. Website. Emails/letters Business support staff Appropriate business media</td>
</tr>
<tr>
<td><strong>Regulators – Environment Agency, Defra, Ofwat</strong></td>
<td>Close on going liaison at all levels. Sharing of data. Discussion of potential drought/drought issues and collaborative working to ensure effective and timely actions are taken.</td>
<td>Routine meetings and briefings. Email/written. Communications via WaterUK</td>
</tr>
<tr>
<td><strong>MPs, CC Water, Natural England, Local authorities</strong></td>
<td>Regular and open dialogue maintained. Situation updates. Drought situation updates available on our website. Liaison to enable the message to be communicated to a wider audience.</td>
<td>Written and verbal communication as required. Routine meetings and briefings. Website updates</td>
</tr>
<tr>
<td><strong>Neighbouring water companies, WaterUK</strong></td>
<td>Implement regional and/or national drought groups to promote collaboration and consistent messaging.</td>
<td>Workshops, meetings, telephone conferences</td>
</tr>
<tr>
<td><strong>Media</strong></td>
<td>“Waterwise” messages and interviews. Offers of briefings and interviews. Situation updates and advice as required.</td>
<td>Press releases. Interviews. Website.</td>
</tr>
<tr>
<td><strong>Internal staff</strong></td>
<td>Briefings to employees. Updates to customer-facing staff.</td>
<td>Intranet. Internal briefings.</td>
</tr>
</tbody>
</table>

Executive Summary
Our communications plan clearly demonstrates the link between the proposed demand management actions that we would take as we move from normal, to potential drought into drought.

We recognise that timely communications are key for effective consultation, advertising and encouragement of any customer-led demand restrictions, as well as the implementation of the temporary water use restrictions. The communications plan considers the appropriate lead-in times for any communications actions directly linked to demand.

The Drought Management Team will develop an appropriate drought communication package and also develop links with other bodies as necessary. The communications plan may be delivered separately for a WRZ or the region as a whole depending on the individual drought. Where temporary use bans are enforced, this will be actioned at a company wide-level, and this was the approached followed during the 2011-12 drought. Whilst the supply demand planning for drought management options is based on our WRZs, we will implement demand management options on a local authority basis, utilising Local Resilience Fora, as we consider this the most effective way of reaching our customers.

We must also consider communications with our retailers. Anglian Water works with 22 retailers who offer valuable insight about our non-household customers. We communicate regularly with them all year round, meaning there is a strong existing relationship and points of contact in place between the water company and the retailer.

We will adopt a communications approach which is appropriate and relevant for the individual retailer, rather than adopting a one-size-fits-all approach. Non-household customers will also pick up messaging from the broader media communications so messages must be aligned to the broader picture.

Our communications plan is cost-effective and has identified the most appropriate and cost-effective methods of communication. Where a drought affects our neighbouring water companies we will actively work together and with the Environment Agency to share information and best practice. We will collaboratively develop and implement collective responses and activities where appropriate, such as through the National Drought Group.

We propose to monitor and evaluate the effectiveness of drought communication activities during a drought as part of our post-drought review detailed in Section 3.8. This would consider feedback from representatives of customer groups and other institutional organisations, social media and website response rates, requests from customers for information on water efficiency or water saving devices and the associated change in demand for water during the period of drought.

The effectiveness of liaison in previous droughts can be measured in the adoption of timely measures and responses in order to maintain the security of public water supplies and effective communication with our customers and regulators.

### 3.9 Post Drought Actions

This section describes how we identify the end of a drought and return to ‘normal’ conditions. It outlines the comprehensive review of the drought management process that will be undertaken at the end of a drought and how this will be used to inform future drought management.

The end of a drought is defined as when the risks of impacts from drought on sources is no greater than those during a ‘normal year’ and where normal conditions have been monitored for a continued period of time. Indicators of the end of a drought are:

- Reservoirs have returned to their normal operating targets
- Groundwater levels are in the normal range or recharge rates are recovering
- River flows have returned to normal
- Elimination of an accumulated rainfall and SMD deficit
- SSI and SPI return to normal

The return to ‘normal conditions’ will be determined by the analysis of multiple indicators, with only recovery of all or the majority of sources signifying the end of a drought. In some cases the return to normal conditions can be difficult to determine and could be confused with a short respite in a prolonged drought sequence. Where necessary we will model of a range of possible rainfall scenarios to assess if we are still at risk of a drought, using the methodology described in Section 3.4.

We have ensured consistency between our drought triggers and drought management actions to ensure our drought management actions reflect the return to ‘normal’ conditions. Return to ‘normal’ conditions will be agreed formally in liaison with the Environment Agency. In a situation where we have implemented demand restrictions, these will be lifted with immediate effect, with communications
as detailed in our communication strategy in Section 3.7.4 and Appendix 10.

Once normal conditions have been resumed and all restrictions lifted, the Drought Management Team will undertake a review of our drought management processes against those as outlined in the drought plan. This will be achieved through evaluating the actions taken during the drought period and identifying the lessons learned for use in managing and informing future droughts.

The review will be completed in liaison with the Environment Agency together with input from other key consultees. In accordance with the guidelines, the post-drought review will include:

- A lessons learned report within 3-6 months of return to normal conditions; this will be followed up within a year with evidence that recommendations have been implemented.

- A review of the environmental impacts of drought in reference to baseline, in-drought and post-drought data.

- Assessment of whether the environmental monitoring during and after the drought was appropriate to measure the impact of any drought permits.

- A review of the effectiveness of any mitigation measures that were implemented during the drought.

- An appraisal of the success, effectiveness and costs of all drought management actions, including drought permit and drought order applications.

- An assessment of how well individual sources delivered additional water and outline where reassessments of yields are required or investment required.

- An assessment of the estimates of demand reductions from the implementation of demand-side drought management actions.

- Analysis to understand if any changes are required to our demand forecast or our longer-term demand management strategy if demand patterns experienced during a drought differ from those assumed in the drought plan.

- Identification of future investment schemes required to improve the security of the upstream and treated water resources.
ABBREVIATIONS AND GLOSSARY
### Abbreviations and Acronyms

<table>
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<th>Abbreviations</th>
<th>Definition</th>
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<tr>
<td>ADSO</td>
<td>Average Daily Sourceworks Output</td>
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<tr>
<td>AE</td>
<td>Actual Evaporation</td>
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<tr>
<td>AMP</td>
<td>Asset Management Plan</td>
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<tr>
<td>ARC</td>
<td>Ardleigh Reservoir Committee</td>
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<tr>
<td>ASR</td>
<td>Aquifer Storage Recovery</td>
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<tr>
<td>BOD</td>
<td>Biological Oxygen Demand</td>
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<tr>
<td>CAMS</td>
<td>Catchment Abstraction Management Strategy</td>
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<tr>
<td>CCWater</td>
<td>Consumer Council for Water</td>
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<tr>
<td>CROW</td>
<td>Countryside and Rights of Way Act</td>
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<tr>
<td>CSPL</td>
<td>Customer Supply Pipe Leakage</td>
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<tr>
<td>DAC</td>
<td>Drought Alert Curve</td>
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<tr>
<td>DAPWLs</td>
<td>Deepest advisable Pumping Water Levels</td>
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<tr>
<td>Defra</td>
<td>Department for Environment, Food and Rural Affairs</td>
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<tr>
<td>DI</td>
<td>Distribution Input</td>
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<tr>
<td>DO</td>
<td>Deployable Output</td>
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<tr>
<td>EA</td>
<td>Environment Agency</td>
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<tr>
<td>ELL</td>
<td>Economic Level of Leakage</td>
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<tr>
<td>EOETS</td>
<td>Ely-Ouse to Essex Transfer Scheme</td>
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<tr>
<td>GWLF</td>
<td>Groundwater Level Forecasting Tool</td>
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<tr>
<td>HRA</td>
<td>Habitats Directive Assessment</td>
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<tr>
<td>IWNL</td>
<td>Independent Water Networks Limited</td>
</tr>
<tr>
<td>ILC</td>
<td>Integrated Lake and Catchment</td>
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<tr>
<td>LoS</td>
<td>Levels of Service</td>
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<tr>
<td>MISER</td>
<td>Strategic water supply system model</td>
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<tr>
<td>ML/d</td>
<td>Megalitre per day</td>
</tr>
<tr>
<td>MRF</td>
<td>Minimum residual flow</td>
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<tr>
<td>Abbreviations</td>
<td>Definition</td>
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</tr>
<tr>
<td>MRF</td>
<td>Minimum Residual Flow</td>
</tr>
<tr>
<td>NALD</td>
<td>National Abstraction Licence Database</td>
</tr>
<tr>
<td>NEP</td>
<td>National Environment Programme</td>
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<tr>
<td>NOC</td>
<td>Normal Operating Curve</td>
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<tr>
<td>NRA</td>
<td>National Rivers Authority</td>
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<tr>
<td>OBH</td>
<td>Observation Borehole</td>
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<tr>
<td>Ofwat</td>
<td>The Water Services Regulation Authority</td>
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<tr>
<td>OMC</td>
<td>Operations Management Centre</td>
</tr>
<tr>
<td>ONS</td>
<td>Office of National Statistics</td>
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<tr>
<td>OSAY</td>
<td>Operating strategies method of assessing yield</td>
</tr>
<tr>
<td>PCC</td>
<td>Per capita consumption - consumption per head of population</td>
</tr>
<tr>
<td>PE</td>
<td>Potential Evaporation</td>
</tr>
<tr>
<td>PPC</td>
<td>Per Property Consumption</td>
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<tr>
<td>PR</td>
<td>Periodic Review</td>
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<tr>
<td>PWS</td>
<td>Public water supply</td>
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<tr>
<td>PZ</td>
<td>Planning Zone</td>
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<tr>
<td>RCS</td>
<td>River Corridor Surveys</td>
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<tr>
<td>RHS</td>
<td>River Habitat Surveys</td>
</tr>
<tr>
<td>RSA</td>
<td>Restoring Sustainable Abstractions</td>
</tr>
<tr>
<td>RSS</td>
<td>Regional Spatial Strategy</td>
</tr>
<tr>
<td>SAC</td>
<td>Special Area of Conservation</td>
</tr>
<tr>
<td>SAGIS</td>
<td>Source Apportionment Geographical Information System modelling tool</td>
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<tr>
<td>SDS</td>
<td>Strategic Direction Statement</td>
</tr>
<tr>
<td>SEA</td>
<td>Strategic Environmental Assessment</td>
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<tr>
<td>SELL</td>
<td>Sustainable Economic Level of Leakage</td>
</tr>
<tr>
<td>SEMD</td>
<td>Security and Emergency Measures Direction</td>
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<tr>
<td>SMD</td>
<td>Soil moisture deficit</td>
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<tr>
<td>Abbreviations</td>
<td>Definition</td>
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<tr>
<td>SoSI</td>
<td>Security of Supply Index</td>
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<tr>
<td>SPA</td>
<td>Special Protection Area SR Sustainability</td>
</tr>
<tr>
<td>SSSI</td>
<td>Site of Special Scientific Interest</td>
</tr>
<tr>
<td>SWORPS</td>
<td>Source Works Output Reporting System</td>
</tr>
<tr>
<td>TWA</td>
<td>Trent-Witham-Ancholme scheme</td>
</tr>
<tr>
<td>UKCP</td>
<td>United Kingdom Climate Projections</td>
</tr>
<tr>
<td>UKWIR</td>
<td>United Kingdom Water Industry Research</td>
</tr>
<tr>
<td>UWWTD</td>
<td>Urban Wastewater Treatment Directive</td>
</tr>
<tr>
<td>WAFU</td>
<td>Water Available for Use</td>
</tr>
<tr>
<td>WEMs</td>
<td>Water Efficiency measures</td>
</tr>
<tr>
<td>WET</td>
<td>Water Efficiency Target</td>
</tr>
<tr>
<td>WFD</td>
<td>Water Framework Directive</td>
</tr>
<tr>
<td>WIA</td>
<td>Water Industry Act</td>
</tr>
<tr>
<td>WREP</td>
<td>Water Resources Environment Programme</td>
</tr>
<tr>
<td>WRMP</td>
<td>Water Resource Management Plan</td>
</tr>
<tr>
<td>WRZ</td>
<td>Water Resource Zone</td>
</tr>
<tr>
<td>WTW</td>
<td>Water Treatment Works</td>
</tr>
<tr>
<td>WWTW</td>
<td>Waste Water Treatment Works</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>Abstraction Licences</td>
<td>The authorisation granted by the Environment Agency to allow the removal of water from a source.</td>
</tr>
<tr>
<td>Aquifer</td>
<td>A geological formation that can store and transmit water in significant quantities.</td>
</tr>
<tr>
<td>Available headroom</td>
<td>The difference between water available for use (WAFU) and total demand resulting in a resource surplus or deficit.</td>
</tr>
<tr>
<td>Deepest advisable Pumping Water Levels (DAPWL)</td>
<td>The deepest level to which water in a borehole should be allowed to decline to prevent undesirable effects were the level to decline further.</td>
</tr>
<tr>
<td>Demand Management</td>
<td>The implementation of policies or measures which serve to control or influence consumption of water.</td>
</tr>
<tr>
<td>Department of Environment, Food and Rural Affairs (DEFRA)</td>
<td>It is the UK government department responsible for water resources in the UK.</td>
</tr>
<tr>
<td>Deployable Output</td>
<td>The quantity of water that can be produced at a water treatment works on average and at maximum output as limited by abstraction licence, plant capacity or other constraints.</td>
</tr>
<tr>
<td>Economics of Balancing Supply and Demand (EBSD)</td>
<td>A method to assess the balance between a company’s available water resource and the demand for water by customers.</td>
</tr>
<tr>
<td>Extreme drought</td>
<td>Drought events with approximately a one in 500-year return period. These events are described as having a 5 per cent chance of occurring over a 25-year planning period.</td>
</tr>
<tr>
<td>Level of Service</td>
<td>Frequency with which the water companies can impose different types of water restrictions during water shortages.</td>
</tr>
<tr>
<td>Mega litre</td>
<td>1 million litres of water, enough to supply near 7,000 customers.</td>
</tr>
<tr>
<td>Minimum Residual Flow</td>
<td>The minimum amount of water that must be allowed to flow past a specified point in a river in order to maintain downstream flows. A condition applied to an abstraction licence to protect the environment.</td>
</tr>
<tr>
<td>Outage Allowance</td>
<td>Describes an allowance of water which represents the risk of short-term (less than 3 months) supply-side failure. This may be caused for example by pollution incidents or an unexpected need to repair a water treatment works.</td>
</tr>
<tr>
<td>Per Capita consumption (PCC)</td>
<td>The amount of water typically used by one person per day.</td>
</tr>
<tr>
<td>Potential yield</td>
<td>The yield of a source or group of sources as constrained only by hydrologic or well/aquifer properties for specified conditions and demands.</td>
</tr>
<tr>
<td>Recharge</td>
<td>Natural or artificial replenishment of an aquifer.</td>
</tr>
<tr>
<td>Resilience</td>
<td>Ability of asset networks and systems to anticipate, absorb, adapt to and/or rapidly recover from a disruptive event.</td>
</tr>
<tr>
<td>25-year Strategic Direction Statement (SDS)</td>
<td>Strategic direction for the next 25 years. Aim is to create a framework that supports the sustainable delivery of the outcomes our customers value most.</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Severe Drought</td>
<td>Refers to drought events with approximately a one in 200-year return period. We describe these events as having a 12 per cent chance of occurring over a 25-year planning period.</td>
</tr>
<tr>
<td>Source</td>
<td>A named input to a Resource Zone. A source may contain more than one abstraction point (boreholes or intakes).</td>
</tr>
<tr>
<td>Sourceworks</td>
<td>All assets between and including the point of abstraction and the point at which it is first fit for purpose.</td>
</tr>
<tr>
<td>Strategic Environmental Assessment (SEA)</td>
<td>Generic term used internationally to describe environmental assessment as applied to policies, plans and programmes. In this report, ‘SEA’ is used to refer to the type of environmental assessment required under the SEA Directive.</td>
</tr>
<tr>
<td>Sustainability Reductions</td>
<td>It is the reduction in water company deployable output due to a sustainability change (licence change). A sustainability reduction is calculated by the water company and included in its WRMP. Note that a sustainability change may not lead to a sustainability reduction if the source deployable output is limited by another constraint, such as hydrological yield or pump capacity.</td>
</tr>
<tr>
<td>Target headroom</td>
<td>It is a minimum allowance - taking into account critical risk and uncertainties - required to maintain levels of service for the supply-demand situation with a given level of confidence.</td>
</tr>
<tr>
<td>Water available for use (WAFU)</td>
<td>Deployable output plus any bulk supply imports, take away any bulk supply exports and subtract any reductions made by outage allowance.</td>
</tr>
<tr>
<td>Water efficiency measures (WEMS)</td>
<td>A proactive policy promoting water saving in the home, which is closely associated with our enhanced metering programme. Water saving advice will be provided with the option for customers to request retro-fit of water-saving devices.</td>
</tr>
<tr>
<td>Water Industry National Environment Programme (WINEP)</td>
<td>How the Environment Agency set out the environmental improvements that water companies are required to make over the following Asset Management Period.</td>
</tr>
<tr>
<td>Water Resource East (WRE)</td>
<td>A partnership from a wide range of industries, including water, energy, retail, the environment, land management and agriculture working together to safeguard a sustainable supply of water for the East of England.</td>
</tr>
<tr>
<td>Water Resource Zone</td>
<td>The WRZ is the principal building block used by companies to develop forecasts of supply and demand and produce a supply-demand balance (SDB). UKWIR/Environment Agency defines the WRZ as: “The largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which all customers will experience the same risk of supply failure from a resource shortfall.”</td>
</tr>
<tr>
<td>Water Resources Management Plan (WRMP)</td>
<td>A company’s plan for supplying water to meet demand over a 25-year period.</td>
</tr>
<tr>
<td>WFD Directive 2000/60/EC</td>
<td>A piece of EU legislation that requires all member states (including the UK) to make certain steps to protect and improve the quality and quantity of water within water bodies such as lakes and rivers.</td>
</tr>
<tr>
<td>Worst Historic drought</td>
<td>Refers to the worst historic drought on record, which we planned for in our 2015 WRMP. This was previously assumed to be drought events with approximately a one in 100-year return period.</td>
</tr>
</tbody>
</table>