Affinity Water
Your local supply, on tap

Draft Drought Management Plan 2017

Affinity Water

May 2017

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Executive Summary

This is the draft Drought Management Plan (DMP) for Affinity Water, and provides a full update of our last DMP. This plan covers all eight of our Water Resource Zones (WRZs) across our three regions. This ensures a consistent approach to drought management is taken throughout the business and provides clarity to customers and stakeholders about the actions we would take to manage a drought.

Our previous annual update incorporated small changes to reflect the outcomes of our PR14 Water Resources Management Plan (WRMP), which referred mainly to our stated Levels of Service. The update saw the introduction of a 5th Drought Trigger Zone and a re-alignment of the actions across Drought Trigger Zones 3, 4 and 5. This full update further cements these changes and incorporates the additional thinking as to what this would mean in practice for the actions that we would take in the lead up to, during and after a drought. It has provided us with an opportunity to review and where necessary update our communication plan in light of the lessons learnt from the 2011-2012 drought and 2014 flooding events and incorporates an update to our baseline environmental assessment in light of the completion of our AMP5 NEP and some of our AMP6 studies. The plan signposts the potential outcomes we anticipate that our Water Savings Programme and Sustainability Reductions will have on our drought management strategy, which will be implemented in AMP6 and AMP7.

As part of the development of this plan we have carried out scenario modelling to test our drought actions and lead-in times against a range of different drought scenarios. Droughts of different length, timing and severity were modelled to gain a full understanding of our robustness in managing these situations.

The Affinity Water DMP is built on our experience of managing a range of droughts over the last 20 years, in particular the multiple year groundwater droughts of 1990 to 1992, 1996 to 1998 and 2005 to 2007, as well as 2011 to 2012. We have a pro-active approach to managing drought and our objective is to provide secure, resilient, high quality public water supplies at all times. This will be achieved by:

- Being prepared for drought at any time and having our Plan ready to deal with it.
- Continuous monitoring of environmental conditions in partnership with the Environment Agency (EA).
- Identifying the onset of drought and mobilising additional resources as necessary.
- Assessing drought duration and severity together with the impact on water available to our customers.
- Minimising environmental impact of drought by optimising the use of our resources.
- Implementing measures to reduce the demand for water or increasing capacity of our assets to maintain security of supplies. Our actions will become more concentrated as drought deepens and lengthens.
- Acting and communicating with our customers and other stakeholders in partnership.

This Plan details the operational process that will be used to manage drought events. It provides an introduction to our supply area and water resources and demonstrates how routine hydrological data is monitored to determine the onset of a drought, which in turn triggers the formation of our Drought Management Group (DMG). The DMG is responsible for implementing actions to ensure public water supply is maintained through the drought. Our DMP links with the WRMP, which addresses investment issues relating to drought.

All droughts will vary in terms of their duration and impact on the availability of water resources. The return-to-normal conditions are unpredictable and dependent on increasing levels of rainfall, making the duration and severity of droughts difficult to forecast. We have therefore tested our DMP against a range of possible drought scenarios to ensure that the measures we propose to adopt are sufficiently robust to protect essential water supplies and minimise the environmental impact of these actions. The drought scenario testing work included modelling of drought events which are more severe than those on record. The outcomes of the work demonstrated that with our proposed drought management actions, our regions are resilient to historic drought events as well as plausible droughts of up to a 1 in 200 year return period. This work has allowed us to validate the steps we would follow in severe drought conditions when requirements for restrictions on use of water or additional abstraction could result in the mobilisation of Temporary Use Bans, drought orders for further demand restrictions and drought permits or drought orders to vary abstraction licences. A summary of these actions is shown in the diagram below. The Plan indicates how the severity and duration of drought is assessed and forecasted and when and how drought actions are implemented.

This DMP defines individual roles and responsibilities within Affinity Water during a drought and the required levels of interaction/liaison with third parties, in particular the Environment Agency. The Plan contains details of our environmental monitoring and communication plans and the actions that would be triggered under this Plan in response to breaching the drought triggers. Finally, our Plan provides an outline of how the company will identify the end of a drought and describes the associated actions required at this point.

	Demand Side Actions	Supply Side Actions	Environmental Monitoring
Trigger Zone 1	- Continuation of normal operations	- Continuation of normal operations	- Continuation of normal operations
Trigger Zone 2	- Initiate media campaign and promote internal awareness of situation - Increased water efficiency messaging - Prepare for possible implementation of Temporary Use Ban	- Source performance assessment - Assessment of internal and external transfers - Use network model to run potential scenarios	- Alert EA and agree monitoring plan - Undertake walk-over surveys to assess state of the rivers
Trigger Zone 3	- Increase active leak detection and enhance leakage reduction strategy - Implement Temporary Use Restrictions - Prepare Drought Order applications to restrict non essential use	- Optimise groundwater sources (e.g. replace or deepen pumps) - Reschedule planned maintenance and respond to unplanned events quicker - Plan for fast tracking network and infrastructure investments - Prepare drought permit applications	- Increase monitoring frequency for potential drought permit sites - Continue to monitor groundwater levels to assess drought severity and predict drought development - Consider environmental assessments required for supply side investment options
Trigger Zone 4	- Monitor effectiveness of restrictions and apply for extensions if necessary - Continue enhanced leakage reduction programme - Apply for and implement Drought Orders - Prepare applications for Emergency Drought Orders	- Implement pressure control schemes - Implement large investment measures - Apply for and implement permits to increase abstraction - Negotiate additional bulk transfers from neighbouring companies - Prepare applications for Emergency Drought Orders	- Intensive monitoring programme as set out in Environmental Assessment Reports
Trigger Zone 5	- Continue enhanced leakage programme - Apply for and implement Emergency Drought Orders to restrict essential use - Apply for extensions if necessary - Enact Emergency Plan if necessary	- Review and implement additional investment schemes to maintain the security of supply - Apply for and implement Emergency Drought Orders to increase abstraction - Enact Emergency Plan in local areas if necessary	- Continue programme of intensive monitoring

Glossary

ADO	Average Deployable Output – the average output of a source
AMP	Asset Management Period – five-yearly cycle used by water companies for management of water resources, during which price limits are set
BMA	Bulk Metered Area
ALF	Alleviation of Low Flow Scheme
AMP	Asset Management Period – 5 year investment period
AMR	Automatic Meter Reading
DD11	The Drought Direction 2011
DI	Distribution Input – the amount of water entering the distribution system at the point of production
DO	Deployable Output – the output of a commissioned source or group of sources assessed under drought conditions
Drought Order	An authorisation granted by the Secretary of State under drought conditions which imposes restrictions upon the use of water and/or allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis
Drought Permit	An authorisation granted by the Environment Agency under drought conditions which allows for abstraction/impoundment outside the schedule of existing licences on a temporary basis
DMA	District Metered Area
DMP	Drought Management Plan – Operational plan which sets out how the company will deal with a drought situation
DTZ	Drought Trigger Zone – a trigger line for groundwater levels at specific points which indicate stages at which different drought actions need to be carried out
EA	Environment Agency
EAR	Environmental Assessment Report – report to support drought permit applications, which investigates and predicts environmental impacts of permits, as well as setting out the associated monitoring and mitigation actions
EP	Effective Precipitation – the amount of precipitation which is actually added and stored in the soil. Used as an indicator of recharge
GWL	Groundwater level – level of groundwater above ordnance datum
HDZ	Hydraulic Demand Zone – zone characterised by having discrete supply and storage arrangements with strategic inter zone transfers
LTA	Long Term Average – average monthly rainfall or groundwater level calculated over a 30 year period
mAOD	Metres Above Ordnance Datum – the height of a point in metres above average sea level

MORECS	Meteorological Office Rainfall and Evapotranspiration Calculation System – operational system which provides estimates of evaporation, soil moisture deficit and effective precipitation under British climatic conditions
MOU	Memorandum of Understanding
NEP	National Environment Programme – a programme of investigations and actions for environmental improvement schemes to ensure that water companies meet their statutory environmental obligations
OASIS	Operational Assessment of Summer Impacts and Stress
OBH	Observation Borehole – a borehole drilled to monitor groundwater levels
Ofwat	The economic regulator of the water sector in England and Wales
PET	Potential Evapotranspiration - the amount of evaporation that would occur if a sufficient water source were available
PDO	Peak Deployable Output – the maximum output of a commissioned source, as constrained by (if applicable): • Environment • Licence, if applicable • Pumping plant and/or aquifer properties • Raw water mains and/or aquifers • Transfer and/or output main • Treatment capabilities • Water Quality
SAC	Special Area of Conservation – defined in the European Union's Habitats Directive, to protect habitats and species considered to be of European interest
SMD	Soil Moisture Deficit – the amount of rain needed to fully saturate the soil
SPA	Special Protection Area – a designation under the European Union Directive on the Conservation of Wild Birds
SSSI	Site of Special Scientific Interest – a conservation designation denoting a protected area in the United Kingdom
TUB	Temporary Use Ban – demand management action which temporarily restricts non-essential use of water by customers during a drought (formerly a 'hosepipe ban')
WAFU	Water Available For Use
WFD	Water Framework Directive – a European Union directive which commits EU member states to achieve good qualitative and quantitative status of all water bodies by 2027
WRMP	Water Resource Management Plan – 25 year plan which water companies use to plan ahead and manage their water resources
WRZ	Water Resource Zone – 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
WSP	Water Saving Programme

Table of Contents

Table of Figures

Table of Tables

1 Introduction

This section explains the purpose of our Drought Management Plan (DMP) (Section 1.1) and how we have structured our DMP (Section 1.2). It also explains the nature of the droughts which we plan for (Section 1.3) and our planned levels of service (Section 1.4), which form the basis for our drought planning. Finally, the section sets out the consultation process, which allows customers and stakeholders to contribute to our final plan (Section 1.5).

1.1 The Need for a Drought Management Plan

Drought plans are a statutory requirement for all water companies under Section 39B of the Water Industry Act 1991 (WIA 1991). Our DMP has been produced in line with the Drought Plan Regulations 2005 and the Drought Plan (England) Direction 2016. This DMP complies with the drought plan guidelines published by the Environment Agency[1] (the Guidelines).

The Guidelines set out the steps of the process that water companies must follow in the preparation of a DMP, and these are shown in Figure 1.

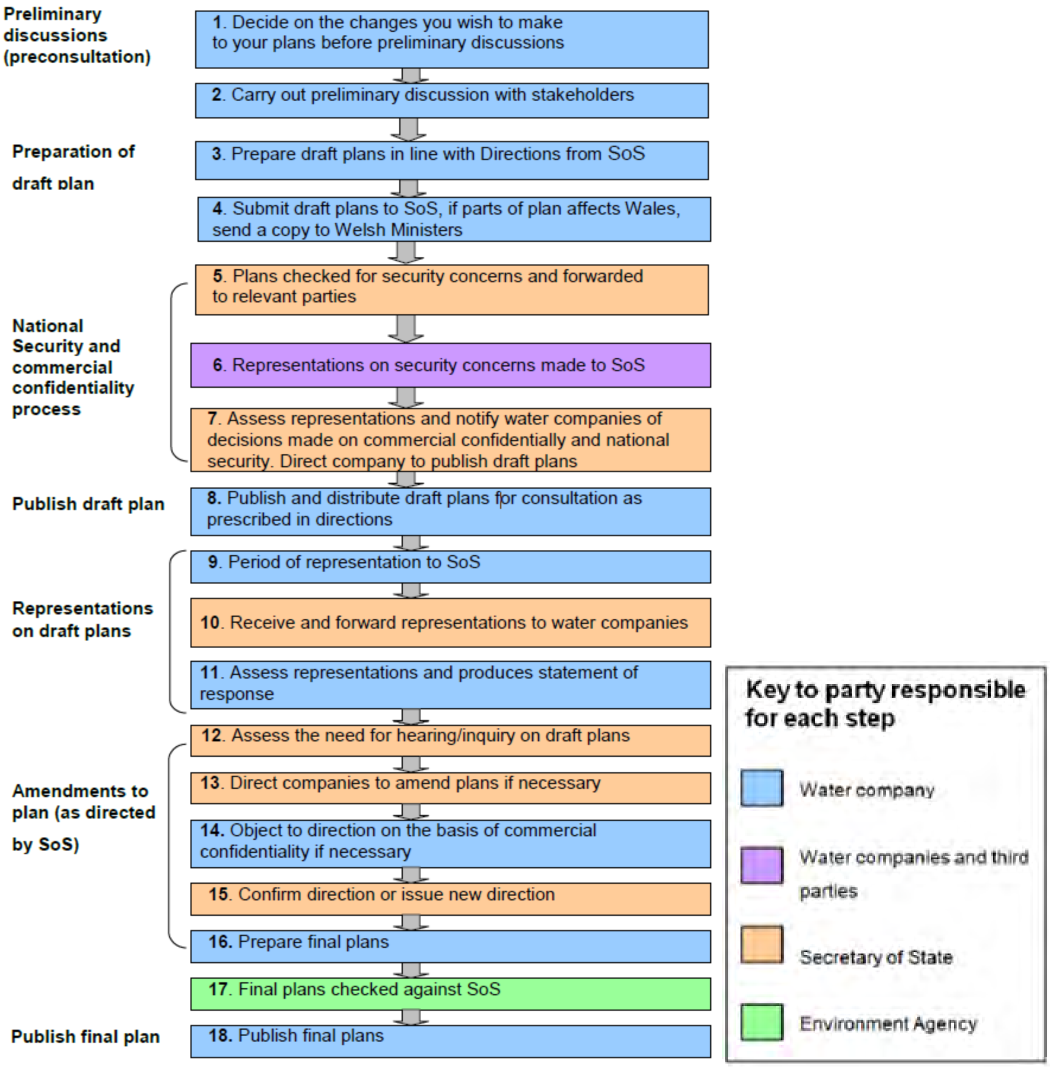

Figure 1: Statutory process for the development of water company Drought Management Plans

[1] Environment Agency, 2015, *How to Write and Publish a Drought Plan*

The purpose of a DMP is to demonstrate how a water company plans to monitor and manage future drought related events, reduce the demand for water and mobilise extra resources, whilst minimising recourse to drought orders and permits and ensuring security of supply. It is a tactical plan setting out the policy and steps we would take during a drought. The final version of this DMP will be published in 2018, and will cover five years, up to 2023.

As shown in Figure 2, our DMP is linked to our Water Resource Management Plan (WRMP), a strategic plan setting out how we will manage our water supply and demand balance over the next 25 years – this fulfils our requirement to comply with EA guidance[2]. Our last WRMP was published in 2014 and covers the period 2015-2020. We are currently developing our new WRMP, which will cover the period 2020-2025, and is due to be published in early 2018. Our DMP is also linked to our Emergency Plan, which details the measures to be taken in extreme circumstances. Within this DMP, we have signposted either the policy that has been informed by our WRMP, or more severe scenarios that are not covered by our DMP, for which we would instead invoke our Emergency Plan.

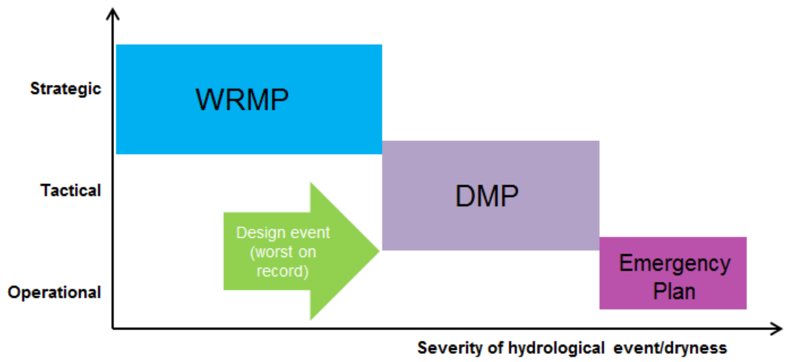

Figure 2: Approximation of current relationships between our plans

Our DMP is agreed with the Environment Agency (EA) and approved by the Secretary of State following public consultation, and provides a decision making tool for use by our Drought Management Group (DMG), which is led by the Director of Asset Strategy. The DMG is supported by a number of sub-groups, as presented in Figure 3.

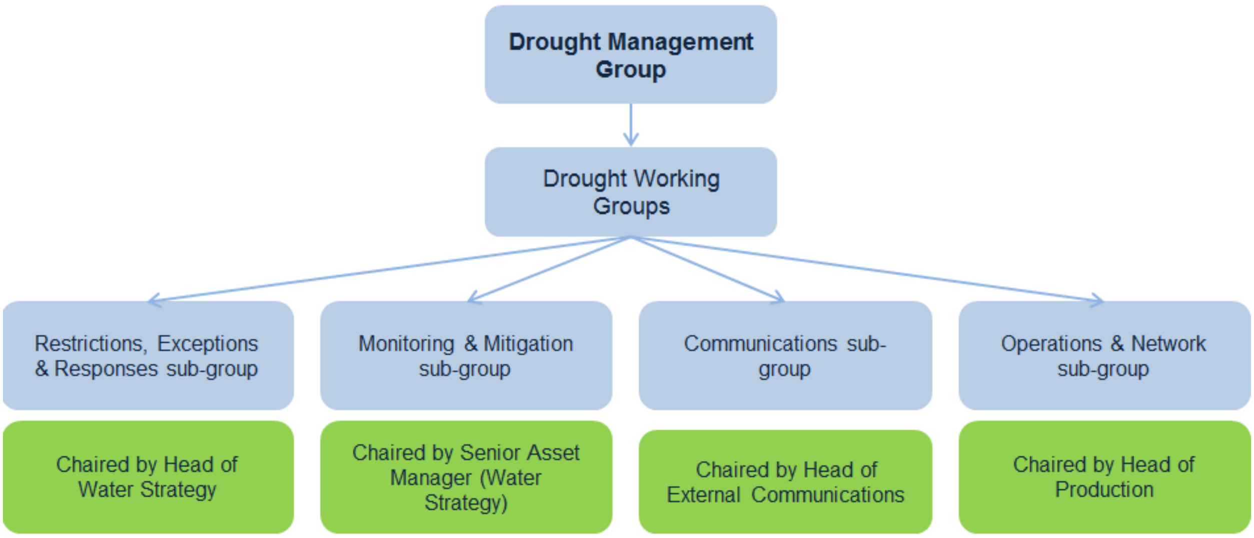

Figure 3: Drought Management Group and supporting sub-groups

[2] Environment Agency, June 2016, *Drought Plan and WRMP Links – A supporting document for the WRPG*

The overall objective of our DMP is to establish a governance framework and a comprehensive set of plans and procedures for managing public water supply in drought conditions. Our DMP includes action plans for how we will manage any restrictions on non-essential use, as well as provisions for environmental monitoring and communications.

Our DMP enables us to:

- Predict the onset of an approaching drought using defined drought triggers;
- Monitor, assess and predict potential drought severity;
- Monitor the effects of drought and the measures taken under the DMP;
- Provide drought management options based on historic experience and data, to reduce demand or supplement resources and maintain security of supply to customers;
- Minimise risk of unplanned loss of supply;
- Assign roles and responsibilities for staff within Affinity Water to manage our water supplies during a drought event;
- Efficiently manage the communications process with customers, stakeholders, other water companies, our regulators and internally within our company;
- Exercise powers on restrictions for non-essential use under The Water Use (Temporary Bans) Order 2010.

Our DMP also provides suitable levels of information to ensure:

- We have a regular dialogue and close working relationships with stakeholders;
- Our stakeholders receive accurate information directly from us;
- Co-ordinated and consistent messages are disseminated to all stakeholders and interested parties;
- Raised awareness of water issues and the need for on-going water efficiency;
- Increased understanding of peak demand and drought scenarios; and
- Communication of the steps we have taken to enable us to manage any peak demand/drought scenarios.

1.2 Plan Structure

This document forms our DMP, and is presented in nine main sections:

1. An introduction to our plan and its purpose;
2. An introduction to our supply area and water resources;
3. A description of our drought triggers and how these were developed;
4. A description of the drought scenario analysis we have conducted;
5. A description of our drought management actions;
6. A description of our potential environmental impacts;
7. An outline of our Environmental Monitoring Plan and strategy for mitigation;
8. A description of our Management and Communications Strategy;
9. An outline of post-drought actions.

The connections between the different sections and the purposes they serve are outlined in Figure 4.

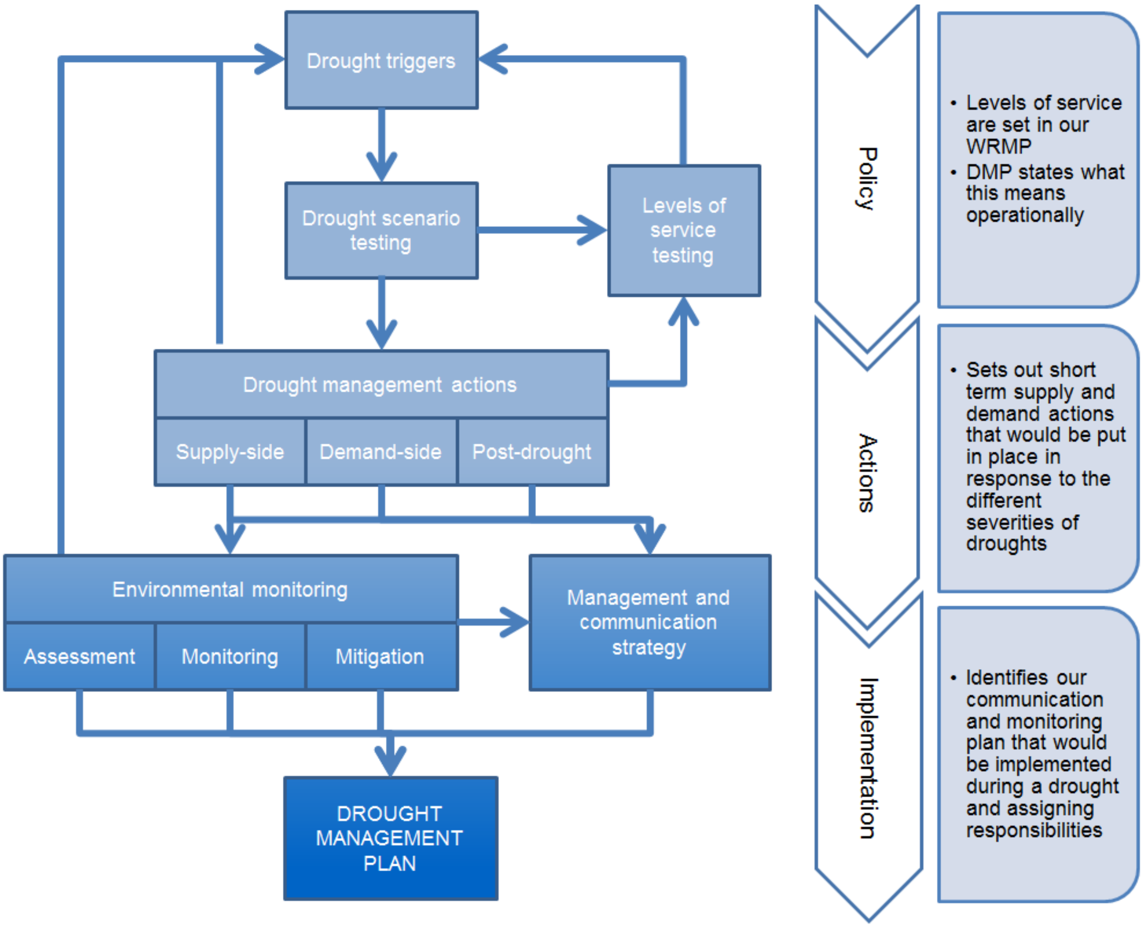

Figure 4: Components of the Affinity Water Drought Management Plan

1.3 Planned Levels of Service

Water supply levels of service are a measure of the likelihood of applying restrictions on customers during drought conditions; they set out how often on average we expect that we will need to take a specified step in response to a drought (Table 1).

Table 1: Our planned levels of service[3]

Demand Restriction	Frequency
Temporary Use Ban restrictions	1 in 10 years
Ordinary Drought Orders	1 in 40 years
Emergency Drought Orders for rota cuts and deployment of standpipes	Considered unacceptable

In developing our last WRMP (published in June 2014), we consulted with customers and a wide range of stakeholders to consider whether we should change our current planned levels of service. The outcomes of our consultation were taken into consideration when setting our

[3] From Table 1 of the Affinity Water final WRMP, June 2014

planned levels of service. We have also consulted with a range of our customers through an online panel survey in February 2017, and these results indicated that there is a high degree of customer acceptance for our Levels of Service. An improvement to our levels of service requires investment in the network in order to improve resilience and flexibility. Investment for any changes is sought through the WRMP and Business Plan process.

As described in Section 4, we have tested the soundness of our Levels of Service through drought scenario modelling, up to a 1 in 200 year return period event.

1.4 Consultation Process

1.4.1 Introduction

We have published this draft DMP for public consultation in accordance with the Guidelines, inviting views from individuals and organisations on our plan. The period of consultation will be 8 weeks, closing on [date].

In preparation for writing our new DMP we sent pre-consultation letters to our regulators, neighbouring water companies, Natural England and other key groups such as the Canal & River Trust. We have taken into account responses received as a result of this pre-consultation in the development of our DMP.

In addition to the pre-consultation process, we also carried out an online panel survey in February 2017. This aimed to test our customers' levels of satisfaction with our planned Levels of Service, and the overall response was positive.

1.4.2 The statutory consultation

This draft DMP is published on our website (www.affinitywater.co.uk), and printed copies are available on request. All regulators, stakeholders and statutory consultees are being notified of this consultation. In addition a number of stakeholder events will be held to engage with customers in the communities we serve as well as key stakeholders.

The public consultation is focusing on two key aspects of our DMP in particular. We are seeking customers' views on the supply side drought permit options we have identified, and for which we have developed comprehensive Environmental Assessment Reports (EARs). The other key area of interest for customers and stakeholders will be around the impact of water use restrictions and the Levels of Service we associate with these, either via temporary use ban restrictions or Drought Orders.

During the consultation, representations should be submitted to the Secretary of State, who will send copies of these to us. Once the consultation period has closed, we will formulate a statement of response. This will detail changes we make to the DMP as a result of representations. Where changes are not made in respect of representations, we will explain why. The statement of response will be sent to the Secretary of State. A copy of this statement will be published on our website.

The final DMP will be published on our website in 2018.

2 Affinity Water Supply Area

This section provides a summary of our three supply regions (Section 2.1), and provides information about the water resources available and demand in each of these regions (Sections 2.2 and 2.3). Finally it will provide an explanation of the nature of droughts.

2.1 Our supply regions

We supply drinking water to approximately 3.6 million people and 1.4 million properties in the South East of England. Our supply area comprises three distinct geographic regions, as shown in Figure 5:

Central Region covers parts of North London and extends into rural parts of Essex, Hertfordshire and Buckinghamshire, with a population of approximately 3.2 million people.

Southeast Region covers the towns of Folkestone and Dover, together with surrounding rural areas including Romney Marshes and Dungeness, with a population of approximately 160,00 people.

East Region covers North East Essex including the towns of Harwich and Clacton on Sea, with a population of approximately 156,000 people.

Figure 5: Affinity Water supply areas within the South East of England

For water resource planning purposes, we are required to identify 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. We have therefore subdivided our Central Region into six Water Resource Zones (WRZs) whilst our East and Southeast regions represent one WRZ each, resulting in a total of eight WRZs across the company area. Each WRZ represents one of the communities we serve and is named after a local river. The name and location of each is shown in Figure 6.

Figure 6: Map of the Affinity Water Operating Area and Water Resource Zones 1 – 8

We manage our water resources efficiently to maintain a continuous supply of high quality water to meet the demands of our customers, while ensuring the sustainability of our resources and minimising any impact on the environment. To enable this, we recognise that there are differences in the baseline water resource situation and the water usage of our customers in each of the three regions, and to some extent within the WRZs of our Central Region.

2.2 Water Resources

2.2.1 **Introduction**

We have 130 groundwater sources, four river intakes on the River Thames, one impounding reservoir and a number of bulk supply imports from neighbouring water companies. Approximately 65% of the water we abstract is from groundwater sources and the remainder is from surface water. We also provide bulk supply exports to other water companies.

We are required to update our assessments of the amount of water we can abstract from our sources following any significant changes in our sources or supply system. Following the 2012 drought and as part of the work for our PR14 WRMP, we fully reviewed and, where necessary, updated our assessments of the yield of our groundwater sources. Our current source yield assessment methodology is based on the approaches outlined by UKWIR in 1995, with subsequent modifications in accordance with the methods and recommendations from the recent UKWIR Handbook of Source Yield Methodologies. This methodology is focused on determining deployable outputs for groundwater sources under drought conditions only. We have also developed and applied an assessment methodology which is compliant with that of the UKWIR Unified Methodology for our four surface water sites and we have applied this to these sources to give a more robust evaluation of these run-of-river licences. Details of these methodologies are also included in our WRMP, which is available on our website.

The following sections identify the key differences in the baseline water resource position for each of our operating regions. They include diagrams identifying our major water sources and trunk mains as well as providing a representation of the transfers between our WRZs and Hydraulic Demand Zones (HDZs). The key to our HDZs is not publicly available for security reasons. They also identify the connections we have with our neighbouring water companies which are explained in detail in section 2.2.5. As a result, our customers benefit from a highly integrated and resilient network.

2.2.2 Central region baseline water resource position

In our Central Region we abstract 60% of water supply from groundwater sources. The remaining 40% is abstracted from surface water sources or is imported from neighbouring water companies. We also export water to neighbouring water companies, as seen in Figure 7.

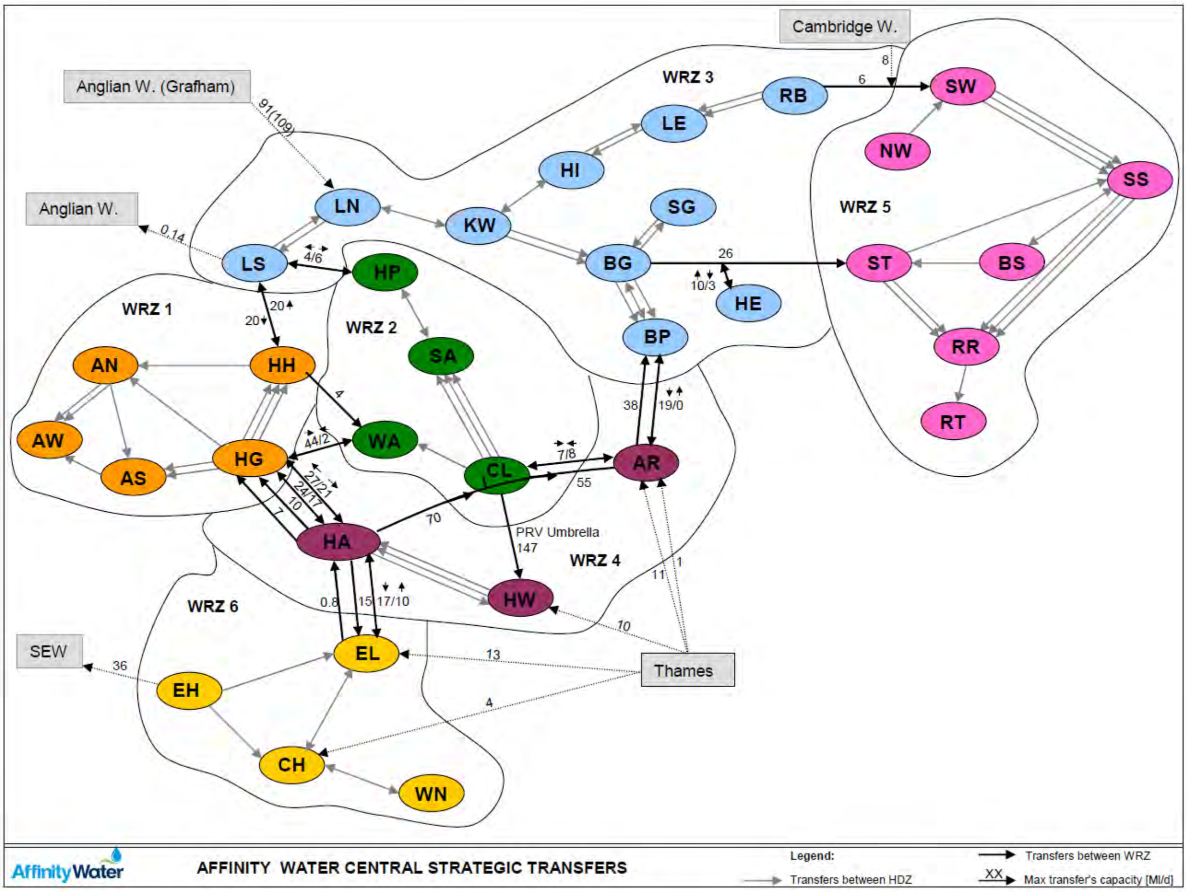

Figure 7: Map of the Water Resource Zones, connectivity and transfers in our Central region

We abstract surface water from the River Thames, which is treated at our four river water treatment works; IVER, EGHS, CHERS and WALS. The treatment works are also fed by groundwater wells, principally the gravel wells at CHERS. We do not link our drought triggers or actions to surface water conditions. Our DMP focuses on groundwater abstraction risk, as our river abstractions have permanent abstraction licences with no flow constraints under drought conditions. When combined, these are capable of providing sufficient quantities of raw water following prolonged dry spells, such as the dry period encountered during the long hot summer of 1995.

2.2.3 Southeast region baseline water resource position

In our Southeast Region we abstract 90% of water supply from chalk boreholes, with the remaining 10% supplied from the shallow gravel aquifer of the Dungeness peninsular. We continue to hold licences for small abstraction from a number of greensand sources in the Folkestone area, although these have not been used operationally for water supply for some years. The connections between HDZs and bulk imports from Southern Water and South East Water can be seen in Figure 8.

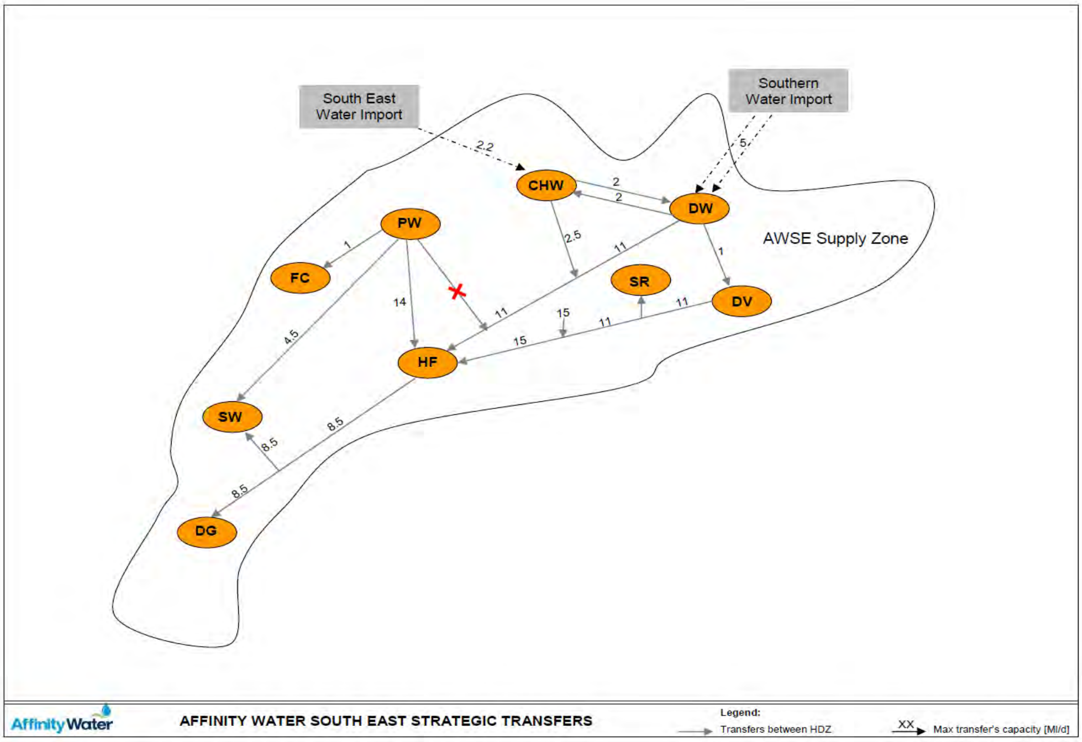

Figure 8: Map of the Water Resource Zone, connectivity and transfers in our Southeast region

There are no significant rivers in this region and therefore no surface water abstractions or surface water storage are available. Locally, the River Dour is subject to an Alleviation of Low Flow (ALF) scheme, which limits abstraction from a number of our groundwater sources at times of low flow. The operation of those sources affected is covered under an existing Memorandum of Understanding (MOU) between ourselves and the Environment Agency, and is called the Dour Operating Agreement.

2.2.4 East region baseline water resource position

In our East region, 80% of supply comes from groundwater, drawn from confined aquifer chalk boreholes in the River Stour and River Brett valleys in Essex and Suffolk. The boreholes have been proved robust and reliable during the groundwater drought conditions of 1990-1992, 1996-1998, 2006-2007 and more recently in 2011-2012. The remaining 20% is sourced from the

River Colne and stored in TARD reservoir, which is jointly owned with Anglian Water. The connections between the HDZs can be seen in Figure 9.

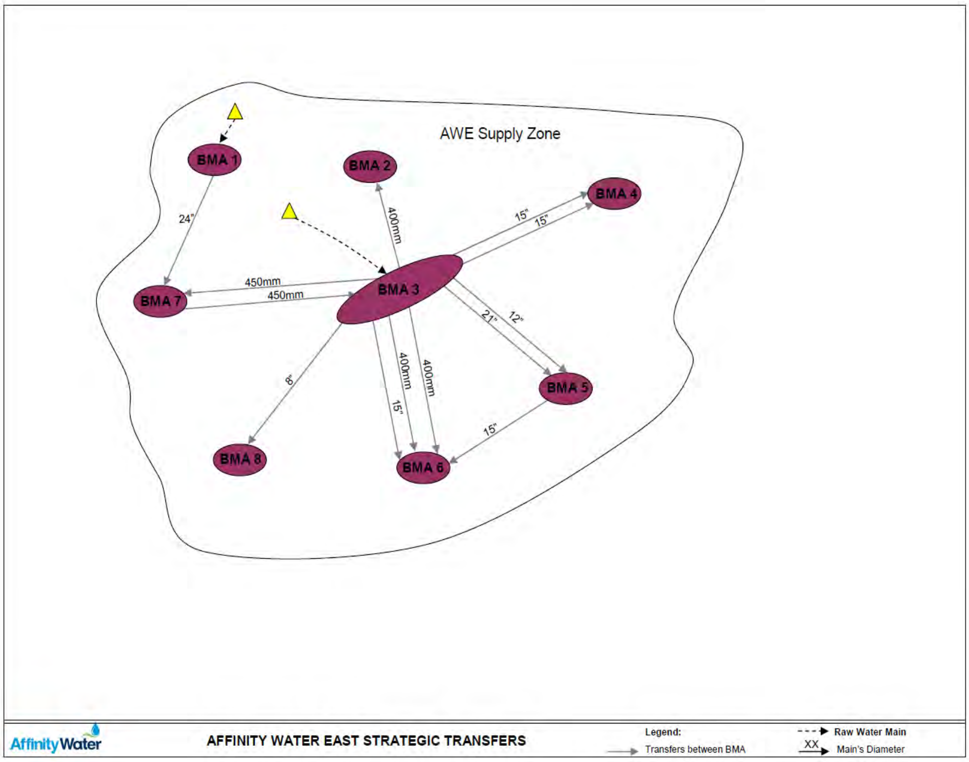

Figure 9: Map of the Water Resource Zone, connectivity and transfers in our East region

The surface water from TARD reservoir is used to meet the balance of demand with the utilisation of our groundwater sources prioritised. TARD has a reliable output of 25.6 Ml/d and can be re-filled each winter, even in a dry winter.

We have an agreement with Anglian Water to vary the water sharing arrangements at TARD from an equal 50:50 share to 70:30 in favour of Anglian Water for the period 1st April 2010 to 31st March 2020. The drought yield assumed available to us from TARD is therefore 7.7 Ml/d.

For normal operation and during a drought, either company can take extra water from TARD not required by the other company. In an extreme event, either Anglian Water or ourselves could take all of the output available from TARD, provided the water was not required by the other company, although at present we are able to supply all of our customers in our East region over sustained periods without using TARD.

In our East region, we have not needed to resort to formal restrictions on customer demand.

2.2.5 Imports and exports

We have arrangements with a number of neighbouring water companies for the bulk supply import of treated water to our WRZs and for bulk supply exports in different locations. Details of the bulk imports and exports are presented in Table 2 (excluding bulk supplies to inset appointees). The volumes represent the available capacity, not actual utilisation, which varies from year to year.

Table 2: Existing water import and export arrangements

ID	Donating Company	Receiving Company	Average Ml/d (max)	Peak Ml/d (max)
1	Anglian Water	Affinity WRZ3	91.0	109.0
2	Thames Water	Affinity WRZ4	27.0	27.0
3	Thames Water	Affinity WRZ4	0.2	0.2
4	Thames Water	Affinity WRZ4	2.0	2.0
5	Thames Water	Affinity WRZ6	2.27	2.27
6	Cambridge Water	Affinity WRZ5	0.31	0.31
7	Affinity WRZ3	Cambridge Water	0.04	0.04
8	Affinity WRZ3	Anglian Water	0.14	0.14
9	Essex & Suffolk Water	Affinity WRZ5	0.03	0.03
10	Affinity WRZ6	South East Water	36.0	36.0
11	Affinity WRZ7	Southern Water	0.1	0.1
12	Affinity WRZ8	Anglian Water	8.1	8.1
13	South East Water	Affinity WRZ7	2	2
14	Southern Water	Affinity WRZ7	0.1	4

The shared supply from Anglian Water into WRZ3 (ANGL) is governed by the Great Ouse Water Act 1961. For our WRMP 2014 we were notified by Anglian Water of expected changes in the measurement of baseline river flow which is likely to affect our dry year deployable output from ANGL. We made allowance for this volume in our headroom assessment. Consequently our DMP does not link drought action measures with the control curves for ANGL. In times of drought, we will enhance our regular liaison with Anglian Water to verify the continuing resource availability for the forecast duration of drought and to ensure Anglian Water is taking all necessary steps to protect our statutory entitlement from ANGL.

We currently have four bulk import connections with Thames Water and a number of additional emergency connection points.

We have a bulk supply import agreement with South East Water. The supply of 2 Ml/d (average daily supply, throughout the year) is available during a drought. This is a useful supplement and improves the resilience of supplies in our Chalksole zone as we anticipate that the yield from our SBRO source will decline as groundwater levels recede. If the yield from SBRO source is maintained then we would not make full use of the import. In discussions with South East Water, we have considered the possibility of increasing the 2 Ml/d import but we feel this is an unlikely scenario in drought conditions and therefore have maintained the original level for drought planning purposes.

We also have an import agreement with Southern Water for a nominal base flow of 0.5 Ml/week and a facility to take up to 4 Ml/d for a period of time. This is designed to provide resilience within our network in the case of a significant outage at one of our key sources. As there is no commitment to maintain this bulk supply during periods of drought, we have not placed reliance on this source in our drought planning.

There are no specific arrangements in place for additional water supplies, beyond those stated, to be supplied between companies during a drought; however, companies would be expected to provide mutual assistance dependent upon drought conditions and their availability of water resources.

Figure 10 shows the indicative locations of the existing import and export arrangements identified in Table 2.

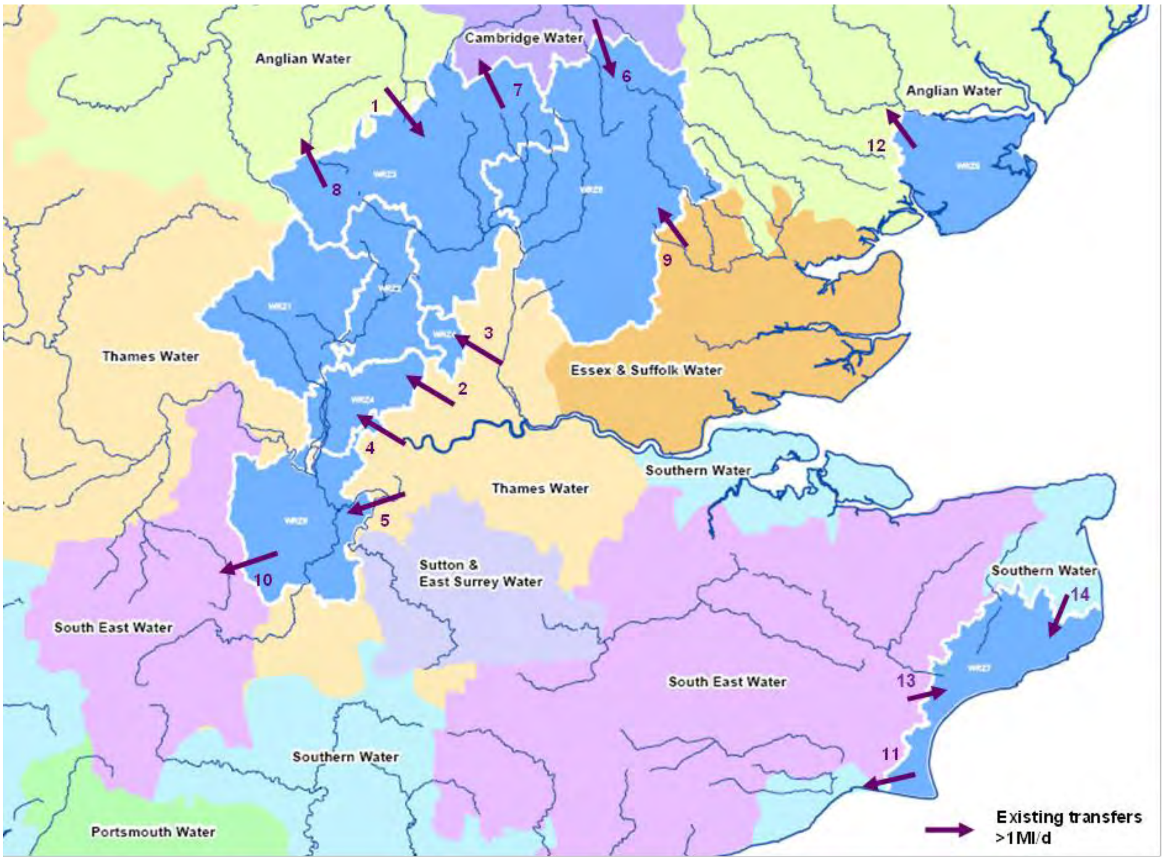

Figure 10: Location of existing import and export arrangements (numbers relate to transfer IDs in Table 2)

2.3 Baseline Demand for Water

The average demand in a typical (normal) year is approximately 950 Ml/d. In a dry year, the demand can increase to around 1000 Ml/d and we have observed a seven-day peak of over 1200 Ml/d. This compares with an annual average Water Available for Use (WAFU) of 1093.4 Ml/d and peak WAFU of 1268.5 Ml/d in a drought year as assessed for our PR14 WRMP.

Figure 11 outlines how customer demand and subsequently distribution input (DI) can vary as a result of climatic variability. During a dry year, such as 2003/04, DI reached 1233 Ml/d; in contrast, during a wet summer such as that seen in 2012/13, demand peaked at 948 Ml/d.

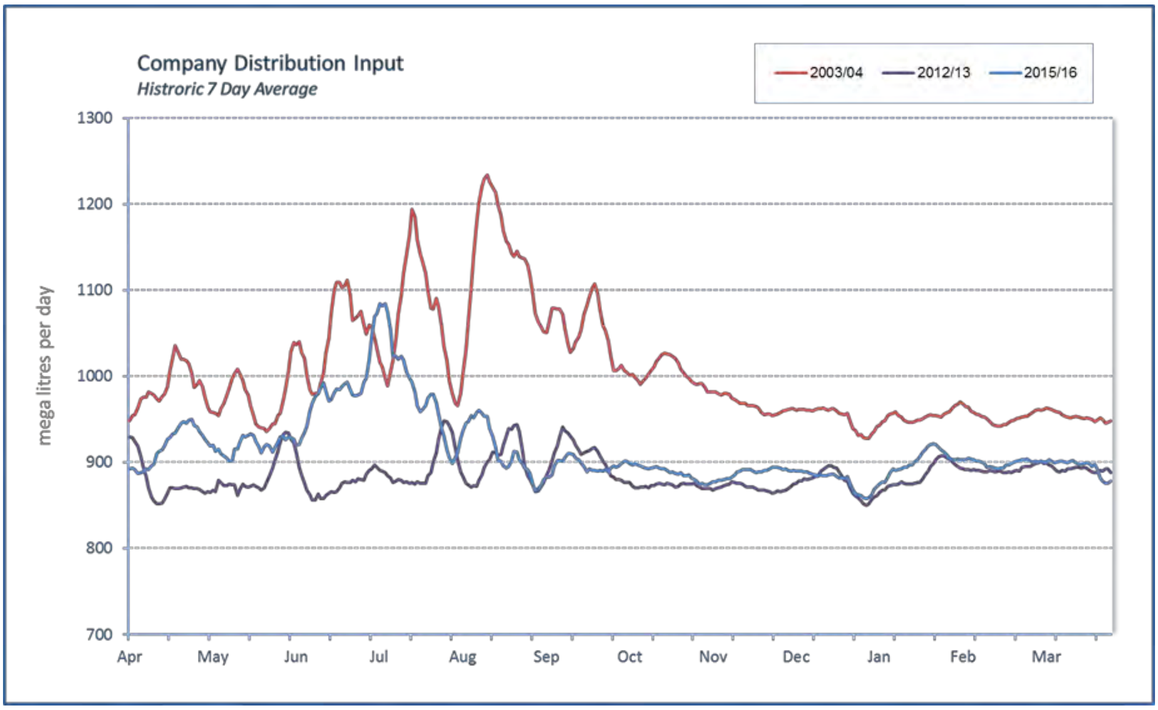

Figure 11: Distribution input variation between 2003/04, our record peak year 2012/13 a wet year and 2015/16 a relatively normal year

2.3.1 Impact of metering and long-term trends in distribution input

Our target is to increase our metering penetration in our Central Region to 72% by 2020 and 90% by 2025. Between 2015 and 2020, we will install an Automatic Meter Radio (AMR) meter on approximately 280,000 existing properties within four of the WRZs in our Central Region. Properties within the remaining two WRZs will be metered between 2020 and 2025. As part of our WSP, we intend to help our customers save water through the distribution and installation of water saving devices, as well as offering free repairs to leaks on customer supply pipes.

Within our WRZs 7 and 8 household metering penetration is already at 90% and 74% respectively. In our experience, a measured bill raises customer awareness of water use. It provides a financial incentive for customers to reduce their water usage and evidence has shown that most customers, who pay for water via a meter, use less water than those who do not, thus reducing the average per capita consumption. Evidence from our Southeast Region has shown that properties metered between 2005 and 2011 have reduced their consumption by at least 16% compared to their 2005 consumption. This has been achieved through raising awareness of water use and has made an important contribution to achieving a stable supply and demand balance within the zone.

Increased metering penetration, along with progress in our efforts to reduce leakage and improve water efficiency messaging, has resulted in a decline in long-term DI. Weekly DI for our Southeast Region from 1994-2016 is shown in Figure 12.

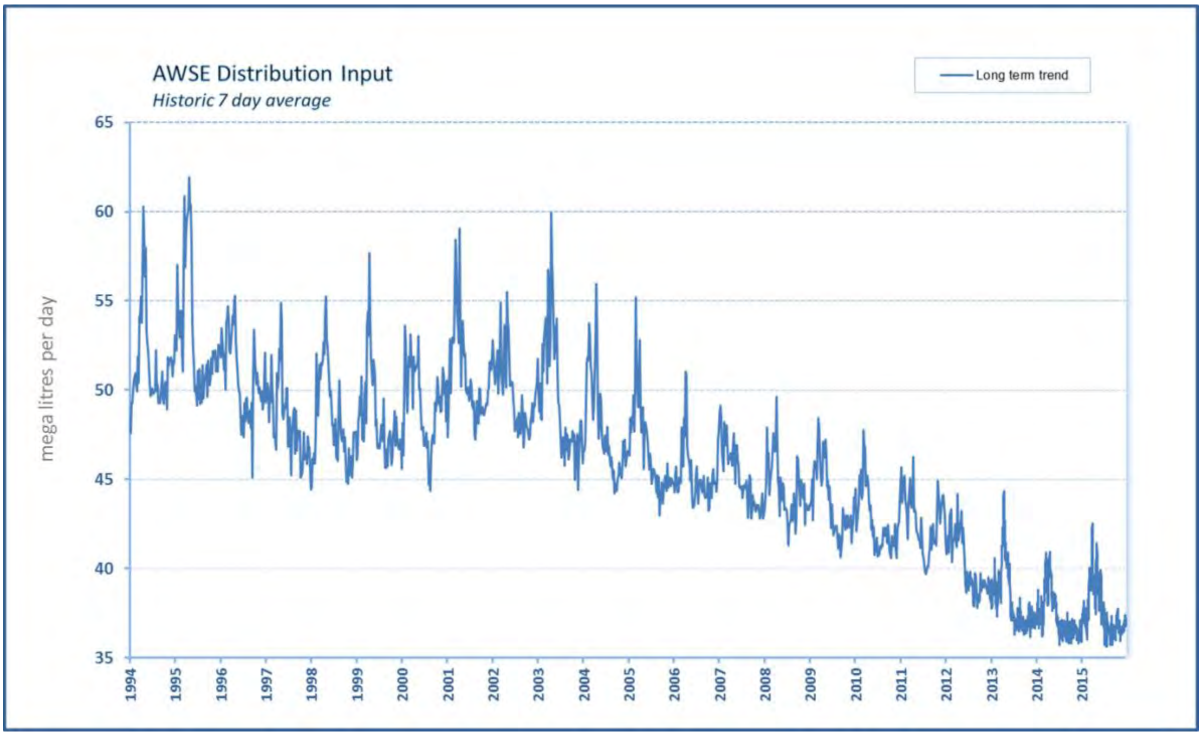

Figure 12: Southeast region distribution input, 1994 to 2016

In our East region we have seen a similar long-term decrease in DI. Comparisons of the peak DI in the summers of 1995 and 2003, which represent the closest weather conditions, show a dramatic difference, as shown in Figure 13. Peak demand in summer 2003 was approximately 20% lower than 1995 despite a 4% increase in the population supplied. Between 1995 and 2003, household meter penetration increased from under 7% to 46% and, as previously mentioned, is now at 77%, which has further reduced the peaking effect in the region.

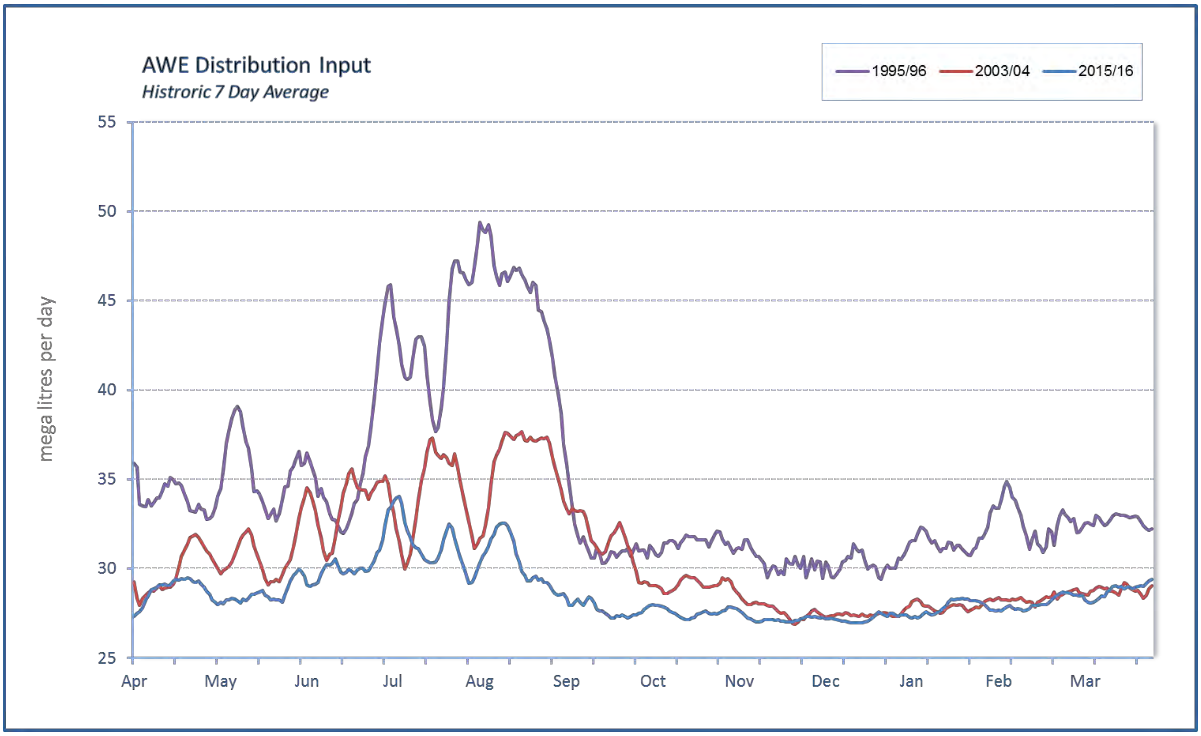

Figure 13: East region distribution input, showing 195/96, 2003/04 and 2015/16

The same long-term decline has not yet been observed in our Central region, which we believe is predominantly due to the lower household metering penetration, which is currently at 45%. Figure 14 shows the DI for the equivalent years within our Central region. We anticipate that similar results will be observed as we progress our WSP over the next 5 to 10 years.

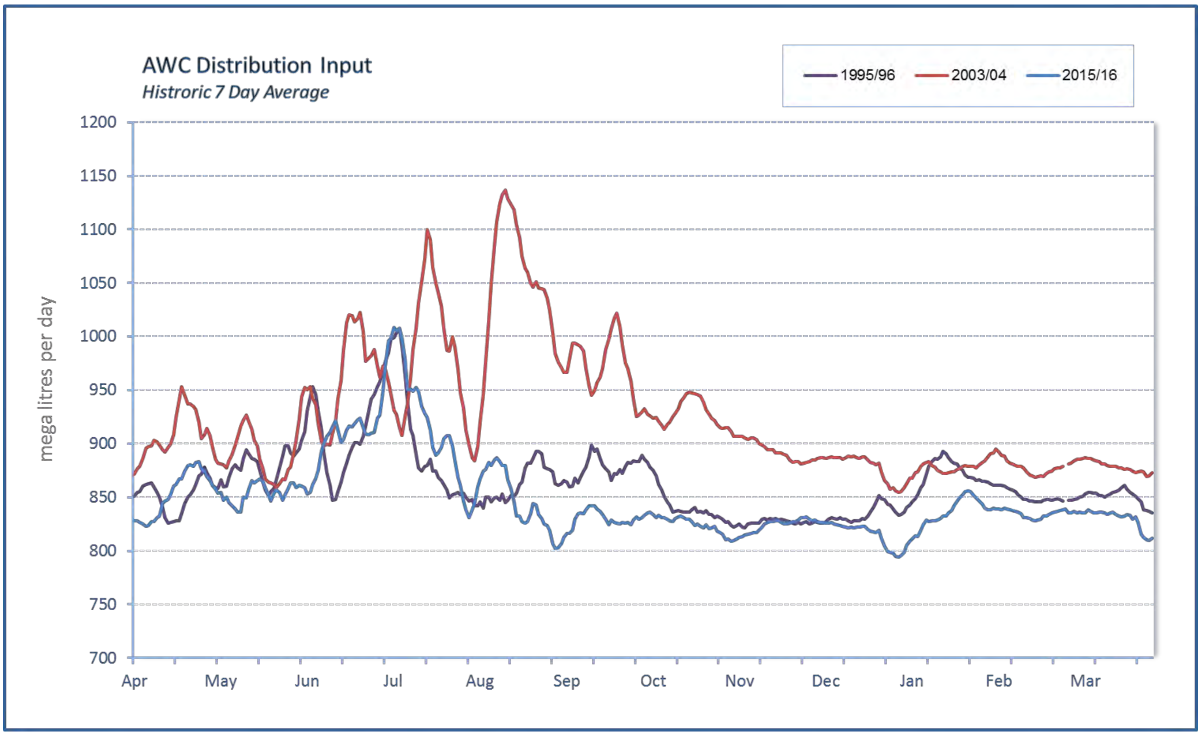

Figure 14: Central region distribution input, showing 1995/96, 2003/04 and 2015/16

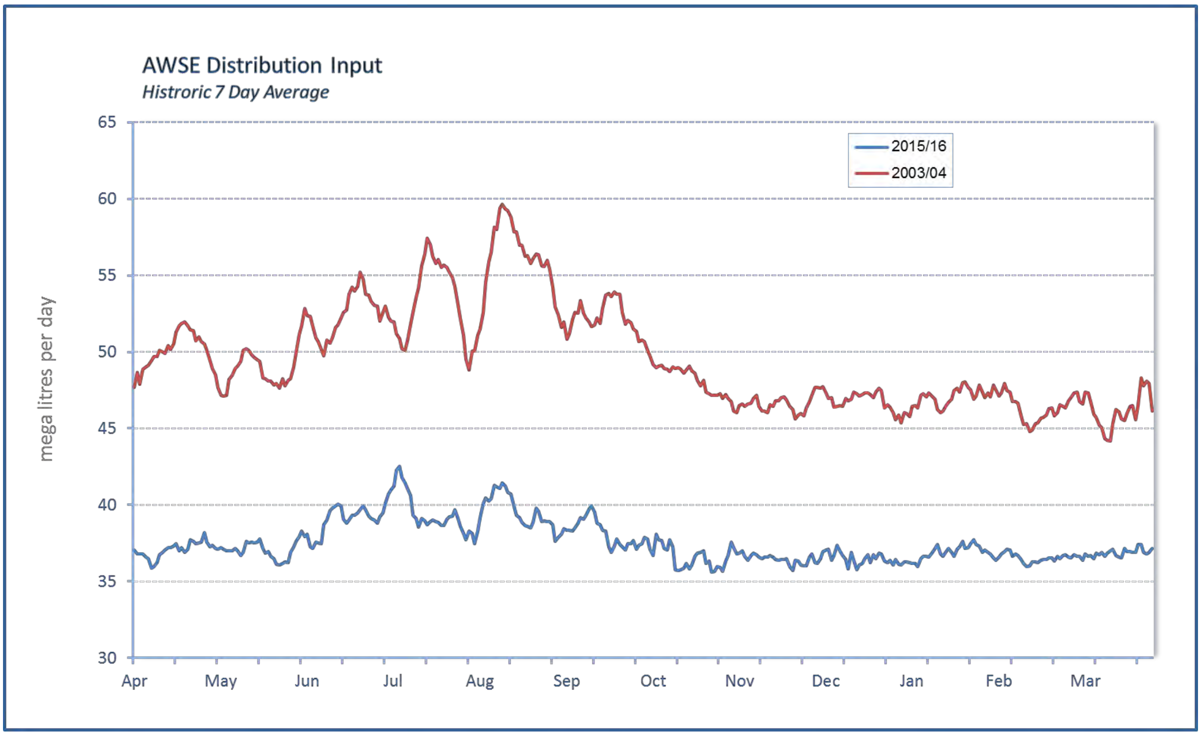

Figure 15: Southeast region distribution input, showing 2003/04 and 2015/16. Note 1995/96 has not been plotted as daily data for this period is not available

2.4 Nature of Droughts

A drought in water resources terms occurs after a number of months of below average rainfall. The amount of winter rainfall is particularly important in assessing the severity and likelihood of a drought, as it is this that replenishes most water resources. The low groundwater levels and river flows that result from such a dry period reduces water availability from rivers and aquifers, and reservoir levels fall. This poses a threat to water supply to customers.

A drought is a naturally occurring event. As a result, no two drought scenarios are ever the same in terms of severity, location, duration and ultimately impact, and can lead to different responses from neighbouring water companies as a result of the following:

- ***Differing levels of drought severity across the region:*** Whilst droughts across the South East will generally be caused by a regional trend of several months of below average rainfall, sub-regional differences in rainfall may cause different levels of drought severity across the region. The need to impose restrictions for one company may not equally apply to another company in the South East.
- ***Differing vulnerabilities at Water Resource Zone level:*** Due to the way the water supply system has developed over the years, many water company supply areas are sub-divided into Water Resources Zones (WRZs). These are defined as the largest possible zone in which all resources, including external transfers, can be shared and hence the zone in which customers experience the same risk of supply failure from a resource shortfall. WRZs can be divided into those dependent upon:
    - River abstraction only;
    - Groundwater abstraction only;
    - Reservoirs filled by abstracting local river water or by impounding river water;
    - Various combinations of the above.

Companies with a mix of WRZ types often find that even if there was no significant difference in drought severity across the region, WRZs will tend to react differently. Depending on the conditions, certain zones will experience higher levels of risk to supplies than others as a result of how the supply is fed. This difference in WRZ vulnerability has an impact both at the company level and at a regional level. It can result in a water company needing to introduce water use restrictions in its more vulnerable WRZs whilst not needing to extend the ban to the remaining zones in its area of supply. Similarly, at the regional level, it can mean that one water company may need to impose water use restrictions earlier in a drought than its neighbours as the system is more vulnerable to the observed drought conditions. As a result, flexibility needs to be built into the DMP to allow for the most efficient and effective way of responding to different drought situations.

3 Drought Triggers

This section explains the drought triggers that we have established to monitor and respond to different stages of drought.

3.1 Introduction

We have developed drought triggers that allow us to identify when we should consider implementing specific drought actions to either reduce demand or obtain extra resource to increase supply. Drought triggers are designed to allow appropriate lead in time for the preparation and implementation of specific actions. This is particularly important for the following actions:

- Customer communications;
- The implementation of temporary use restrictions; and
- Applications for drought permits and drought orders.

Drought triggers can be based on a number of different parameters including historic rainfall pattern, reservoir levels, flow levels in rivers, and groundwater levels. As identified in Section 2.2, approximately 65% of our resources are derived from groundwater sources with 35% derived from river sources, most notably the River Thames. Our licences for abstraction from the Thames are not limited by flow conditions and therefore our DMP triggers focus on the behaviour of our groundwater sources. Groundwater supplies are totally dependent on local climatic conditions providing sufficient rainfall during the autumn and winter months to naturally recharge aquifers. Groundwater droughts typically arise as a consequence of low winter rainfall. We therefore use a combination of historical rainfall and measured groundwater levels on which to base our drought trigger levels.

These triggers provide a decision making tool that we use as part of our framework for drought management, allowing us to monitor the effect of low rainfall on groundwater levels and instigate drought management actions as the severity of a drought increases and recedes.

3.2 Groundwater Triggers

3.2.1 Monitoring points – Central

We have three groundwater and one surface water monitoring point in our Central region that provide data to cover all six WRZs. The details and locations of these points are presented in Table 3 and Figure 16. The River Thames flow monitoring point helps to provide a complete picture of the situation; however, as discussed in Section 2.2.2, the Thames drought trigger is not used to inform our drought management response. We have opted to use Lilley Bottom groundwater levels to define our drought responses and triggers in our Central region but the trigger graphs and supporting information for Chalfont Centre and Elsenham Nursery Observation Boreholes (OBHs) are also given in Appendix 1 and 2.

Table 3: Water Resource Zones 1 - 6 Drought Trigger Observation Monitoring

Name	Reference	Parameter
Chalfont Centre Observation Borehole	DT1	Groundwater level (WRZ 1)
Lilley Bottom Observation Borehole	DT2	Groundwater level (WRZ 3)
Elsenham Nursery Observation Borehole	DT3	Groundwater level (WRZ 5)
River Thames flow at Kingston Lock	DM4	River Flow

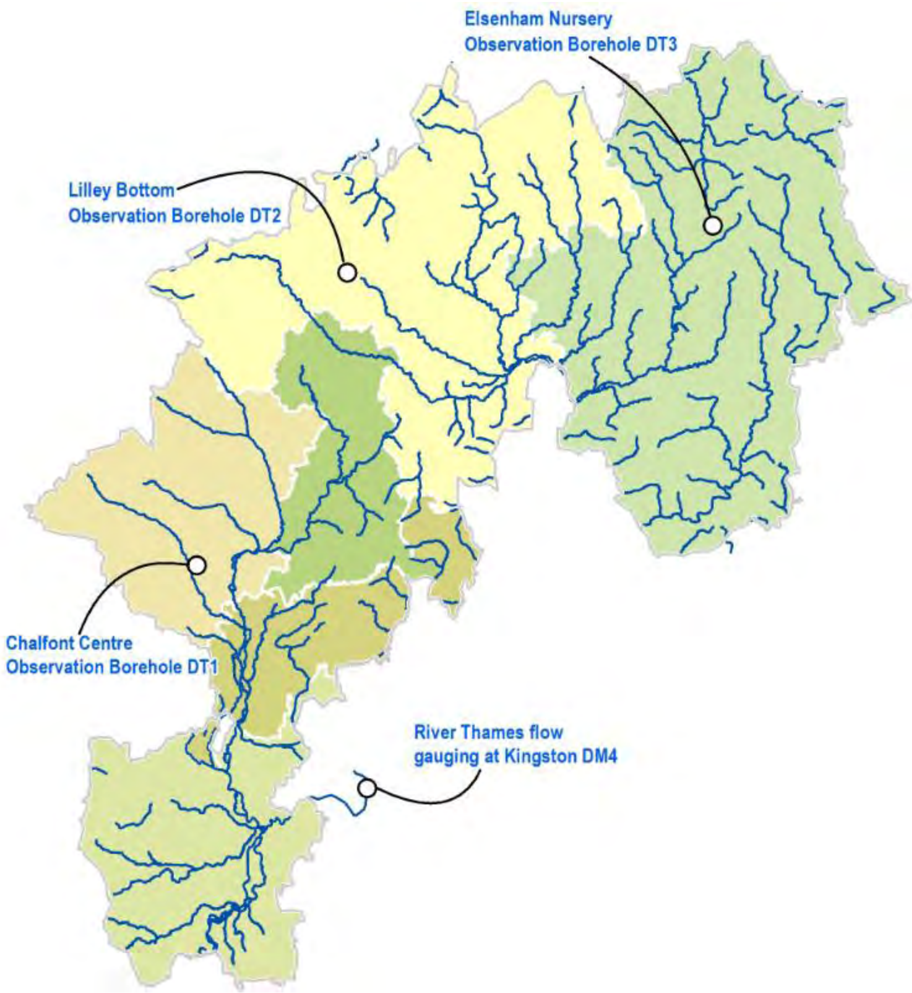

Figure 16: Location of groundwater observation boreholes and flow gauging station used for drought monitoring in our Central region

3.2.2 **Monitoring points – Southeast**

We have two monitoring sites within our Southeast region. The first is in the Dungeness area in the gravel aquifer and the second, Wolverton New, is an Observation Borehole (OBH) in the Chalk aquifer. Wolverton New is monitored by the Environment Agency and has been used for imposing new licence restrictions under the River Dour ALF scheme. The location of both points is shown in Figure 17.

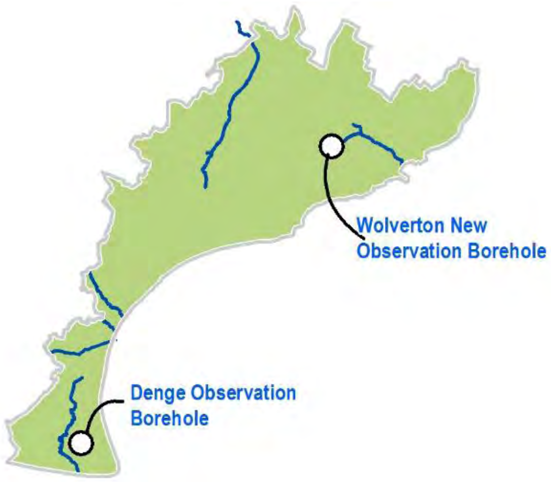

Figure 17: Location of groundwater observation boreholes used for drought monitoring in our Southeast region

During a review carried out for our 2013 DMP, Wolverton New OBH was shown to have very good correlation with five other OBHs (ELMV, Northcourt Wood, Poulton, STMG and RAKS), which were historically used as monitoring points within the Chalk. Therefore, for drought management purposes and to expedite the decision making process, we have opted only to use Wolverton New as the indicator for water levels and drought triggers.

The Denge aquifer is quite different to that of the Chalk, with much lower fluctuations in groundwater level and a much higher reliance on summer rainfall to maintain levels. It is also dominated by level control of the Denge Marsh sewer. Overall groundwater fluctuations are similar to that of the Chalk, but differ in detail and timing.

3.2.3 Monitoring points – East

In our East region we have one OBH at Lady Lane. As shown in Figure 18, this OBH is located outside of our supply area, however it is within the same Chalk aquifer and used to monitor groundwater levels by the Environment Agency.

Figure 18: Location of groundwater observation borehole used for drought monitoring in our East region

3.2.4 **Drought indicators: groundwater patterns**

The groundwater level is the indicator of water availability in the aquifer. We use historic water level fluctuations to determine the current water level relative to long-term averages. Unfortunately, groundwater level data taken from monitoring activities in both production and observation boreholes are only available for the last 30 years, and therefore not representative for long-term analysis. We have therefore used long-term rainfall sequences to establish the return period of long-term droughts and to guide water availability and frequency of potential water restrictions required.

Groundwater levels are controlled by the volumes of water entering the aquifer from rainfall recharge, and leaving the aquifer via natural or artificial (abstraction) discharges. Groundwater flows from areas of high levels (usually between river valleys) to low levels (usually river valleys or the sea). When there is an excess of recharge over discharge, groundwater levels rise and water enters groundwater storage. When recharge declines below the volume leaving the aquifer, groundwater levels decline and groundwater is released from storage. When volumes of recharge are equal to that of discharge, water levels remain the same, but importantly, groundwater continues to flow.

Figure 19 shows how groundwater levels in our Central region have fluctuated over the last 38 years. Groundwater levels will normally reach their lowest values around November/December. With low early winter rainfall, the lowest level may be delayed until January or even later, giving rise to even lower levels than normal. If this is the case, then the recharge period will be shorter and groundwater rise limited, even if the remainder of the winter rainfall is at normal amounts. The distribution of rainfall over the recharge period also controls the effectiveness of this rainfall becoming recharge. High winter soil moisture deficits will also contribute to decreasing the amount of rainfall becoming effective recharge.

Groundwater levels will normally reach their highest point around March. With low winter rainfall, they may peak before this, again decreasing the length of the recharge period and therefore limiting the amount of groundwater level rise. Shortened recharge seasons will lower the starting point of the following year's natural recession, again contributing to lower than normal levels.

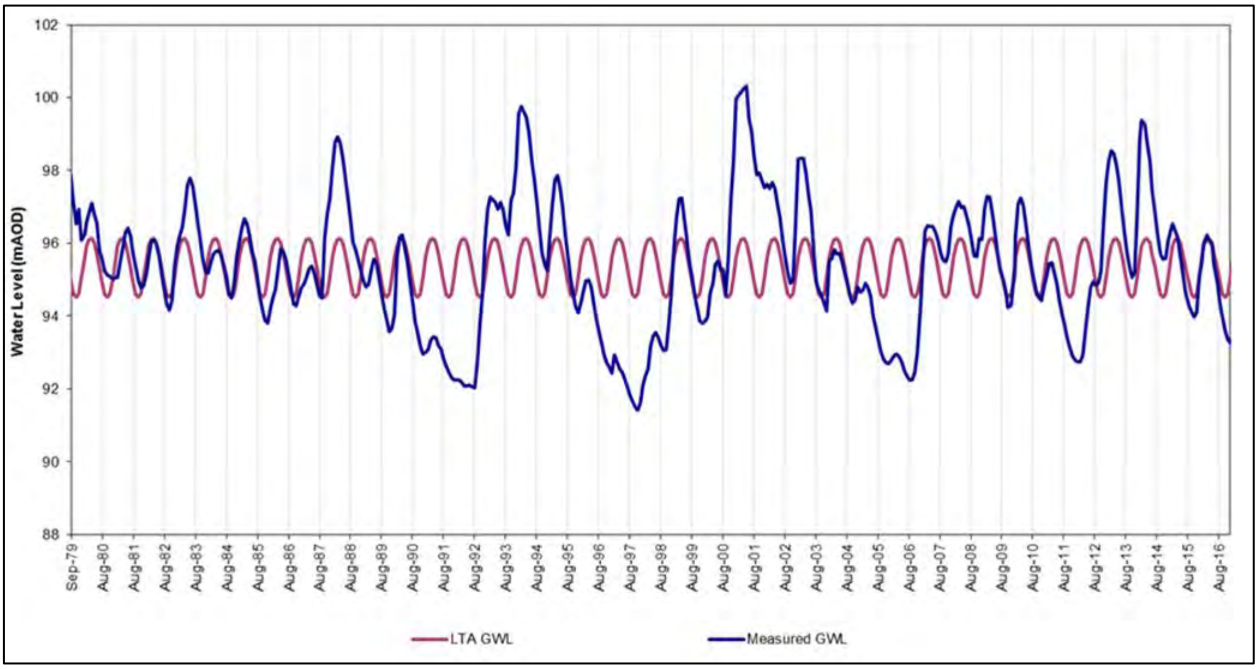

Figure 19: Groundwater levels in our Central region observation borehole since 1979

In most circumstances, summer rainfall does not impact on groundwater levels, due to higher temperatures and evapotranspiration from plants, but may support some river flows. However, in April 2012, groundwater levels were approaching all time low levels for the time of year in our Central Region due to the low winter rainfall. For the months of April to July the area then experienced rainfall of over 200% of the long-term average. This was accompanied by lower than normal temperatures and evaporation, giving unprecedented summer recharge (320%). This in turn caused groundwater levels to rise, when they would be normally falling, and within three months, groundwater levels had recovered by more than an average year's amount, which returned them close to average for the time of year.

Droughts are caused by insufficient rainfall leading to very dry conditions, progressing to low river flows and groundwater levels. These can occur at any time of the year but, for groundwater dominated systems, are most critical during the autumn and winter months. This makes the onset and likelihood of a drought relatively straightforward to predict through our regular hydrological analysis work. However, the duration and end of a drought are much more difficult to predict. We continually monitor and record groundwater levels, surface water levels and rainfall within our supply area, so that the risk of drought and its influence on water resources can be assessed and forecast so that appropriate drought measures can be implemented in good time to maintain supplies to our customers.

3.2.5 **Drought Trigger Zones**

3.2.5.1 Introduction

Our drought triggers have been calculated using historic hydrological information collected during known drought periods, including data from the most recent severe groundwater drought in 1997, where record low levels were recorded throughout our region.

The trigger lines on our hydrographs demarcate drought action zones. Triggers are reassessed regularly along with other aspects of our DMP, in light of new experience. Appendix 1 shows long-term control curves for the groundwater monitoring boreholes in our supply area. These plots consist of historic measured water levels in relation to long-term average water levels, which have a seasonal variation depending upon whether the monitoring is from winter or summer months. We then plot our trigger lines.

Following work carried out for our PR14 WRMP[4], in the update to our DMP in 2015 we reviewed and updated our drought management trigger zones by introducing a fifth zone – this relates to unprecedented drought conditions. The response curves have been aligned to reflect our experience of the use of publicity campaigns and hosepipe and temporary use bans during previous drought events. Although the past may not be a wholly accurate predictor of the future, this methodology correlates with estimated return periods of 1 in 5 years and 1 in 10 years for Drought Trigger Zones 2 and 3 respectively, in line with the basis of our WRMP.

- **Drought Trigger Zone 1** has been set at 90% of long-term average (LTA) groundwater levels (mAOD).
- **Drought Trigger Zone 2** corresponds to groundwater levels seen in a 1 in 5 year drought event.
- **Drought Trigger Zone 3** corresponds to a 1 in 10 year drought event.

[4]Affinity Water, 2014. *Technical Report 1.2: Levels of Service Hindcasting – Assessment of Frequency of Drought Restrictions*

- **Drought Trigger Zone 4** has been set just below the lowest recorded levels (1997), as we managed that drought period without having to resort to drought orders or permits at that time.
- **Drought Trigger Zone 5** has been set to reflect lowest water levels predicted from hindcasting groundwater levels as described in Technical Report 1.2 of the revised WRMP 2014.

Table 4: Drought Trigger Zones and likely outcomes

Trigger zone	Likely outcomes
Zone 1	Normal Conditions – no additional drought activity
Zone 2	Mild-Medium Drought
Zone 3	Medium-Severe Drought
Zone 4	Severe-Extreme Drought
Zone 5	Unprecedented Drought below historic low levels

3.2.5.2 Long-term trigger plots

We have developed an extensive archive of local drought activity and important information from previous droughts to aid future drought management. Hydrological information dating from 1991 includes forecasts and monthly tools relating rainfall scenarios to recharge scenarios and is used widely for baseline hydrological monitoring and management reports. Records include relevant drought documents covering the 2006 and 2012 droughts, the UKWIR Impact of Restrictions on Customer Demand report, drought management planning guidelines, drought monitoring data, and other related topics available for reference.

The long-term trigger plots for Lilley Bottom, Wolverton New and Lady Lane OBHs are shown in Figure 20, Figure 21, and Figure 22 respectively, with any periods in which the groundwater level data is missing represented with light blue sections of the line. These sequences summarise the historic observed groundwater levels under a range of rainfall conditions during the different seasons and correspond to the amount of water available for abstraction from the chalk aquifers. Onto these plots we have placed trigger lines for Zones 1 through to 5 to show historically when these have been breached and how they compare to our long-term resource levels. Figure 20 demonstrates that, within our Central region, the lowest water levels recorded in the last 25 years were in 1997. We were able to meet customer demand during this period without resorting to drought permits or drought orders.

In general terms, when groundwater levels are within the previous operational range for the time of year we can confidently predict that no drought related actions will be necessary. When groundwater levels are substantially below average for the time of year we monitor the situation more closely and assess the significance of below average levels, their rate of recession and the significance of associated data, such as rainfall and soil moisture deficit.

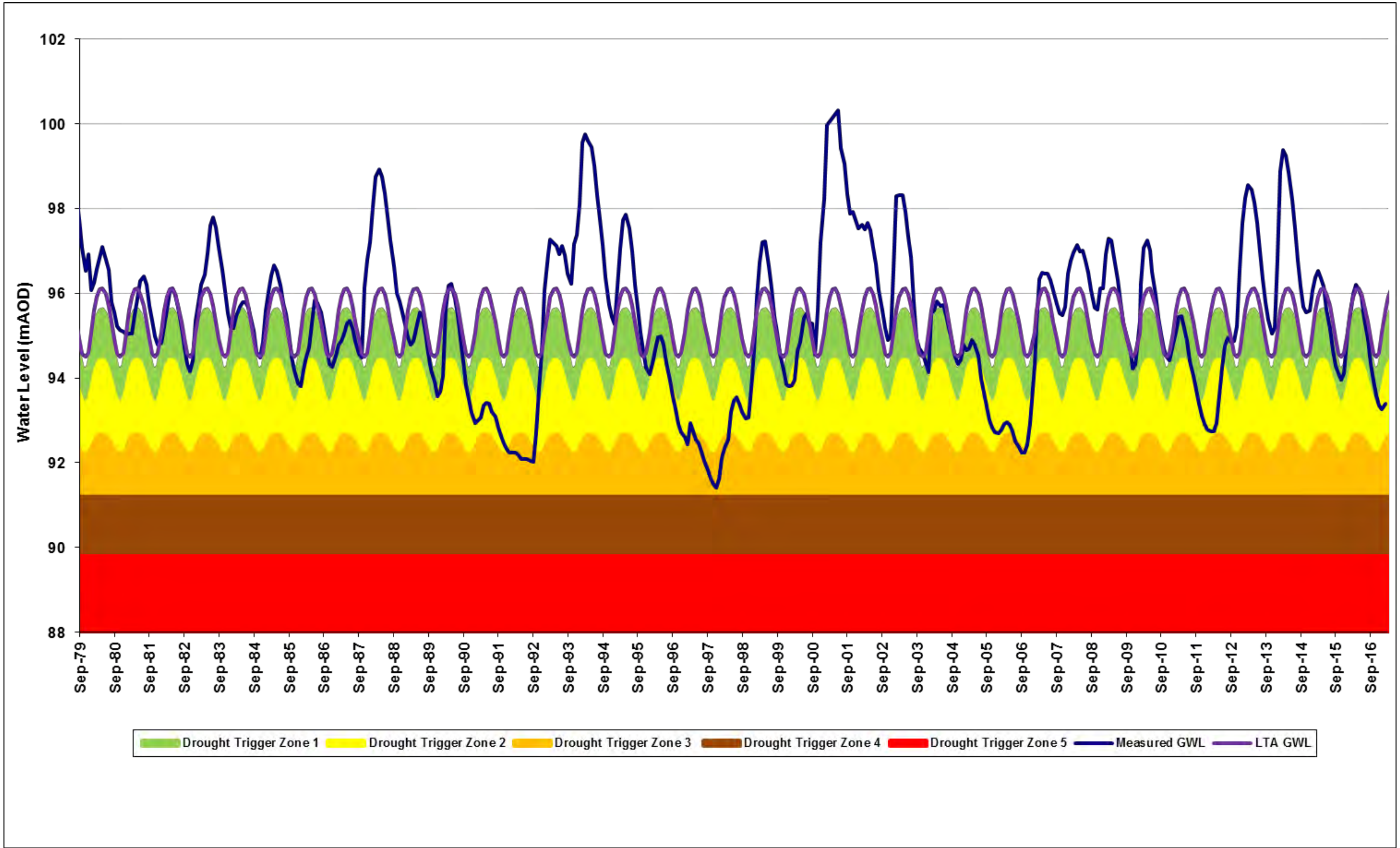

Figure 20: Water levels and drought triggers of our Central region observation borehole

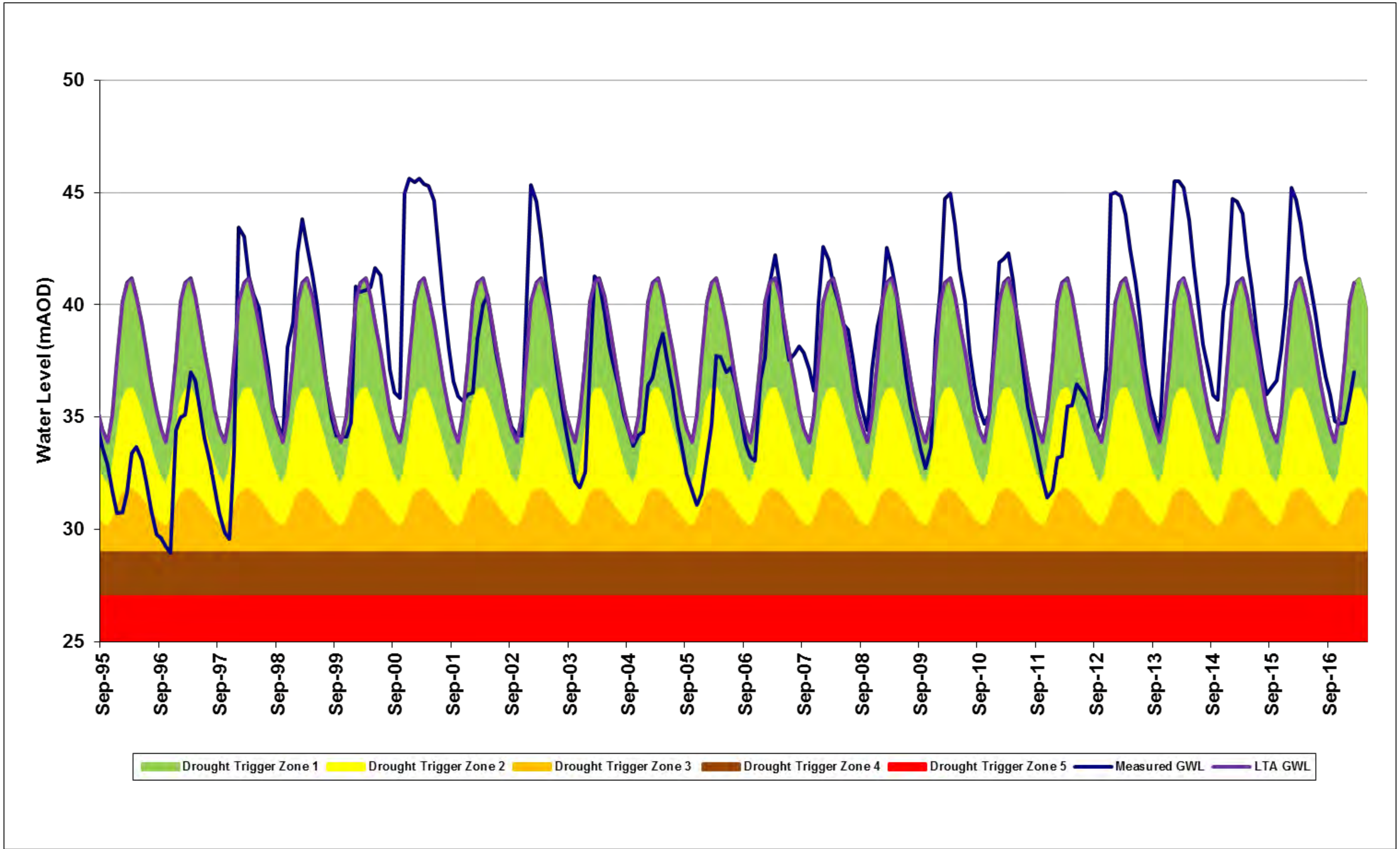

Figure 21: Water levels and drought triggers of our Southeast region observation borehole

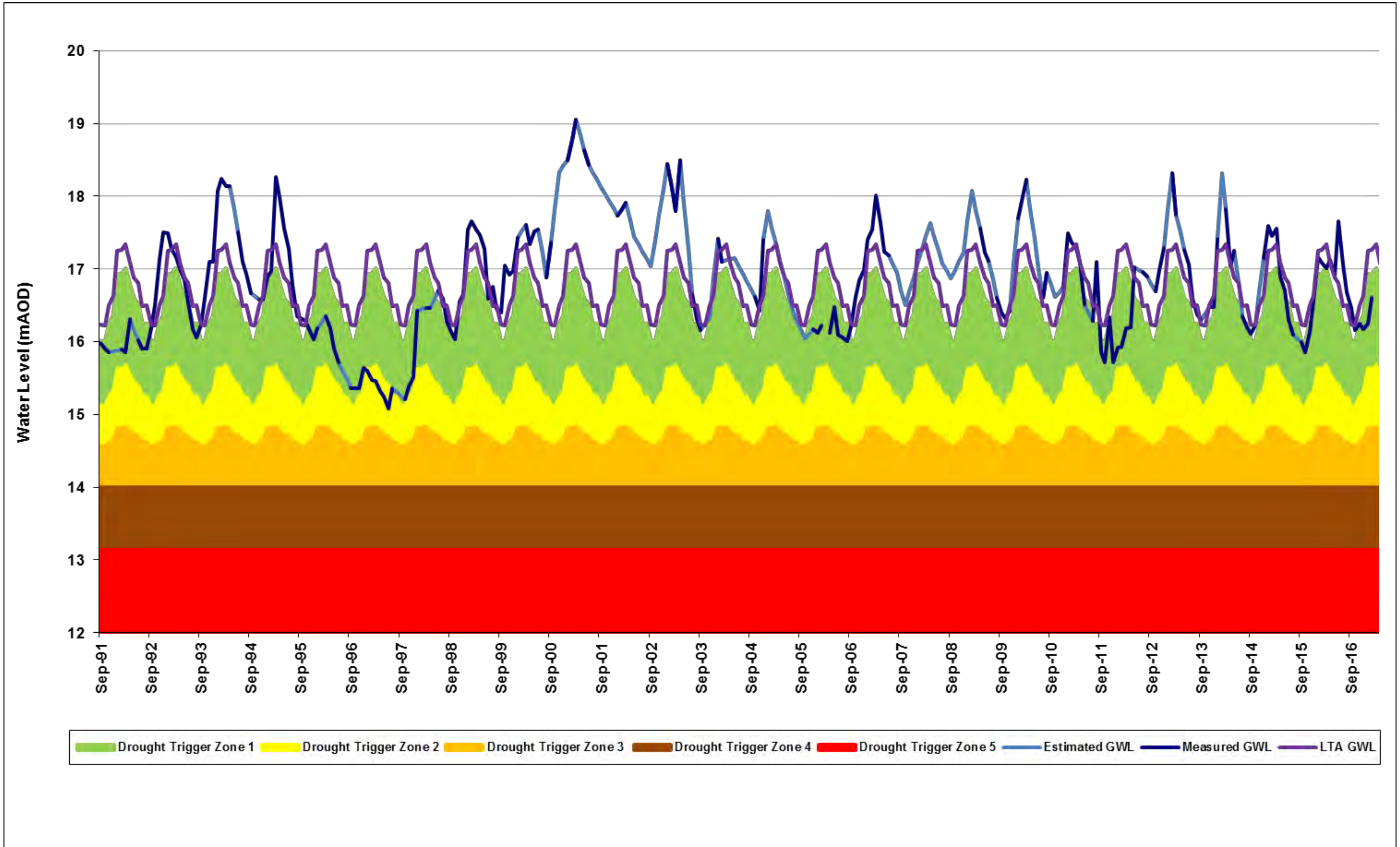

Figure 22: Water levels and drought triggers of our East region observation borehole

3.2.5.3 Short-term trigger plots

The trigger lines developed from the historical data of the long-term curves have been rescaled for a shorter period for use when focusing on recent groundwater conditions and monitoring month-by-month changes in groundwater levels. The hydrographs presented in Figure 23, Figure 24, and Figure 25 are examples of those that would be utilised by the Drought Management Group (please refer to section 8.2.2) to monitor water levels. These hydrographs are used to present potential rainfall scenarios and to allow us to predict and plan for future scenarios.

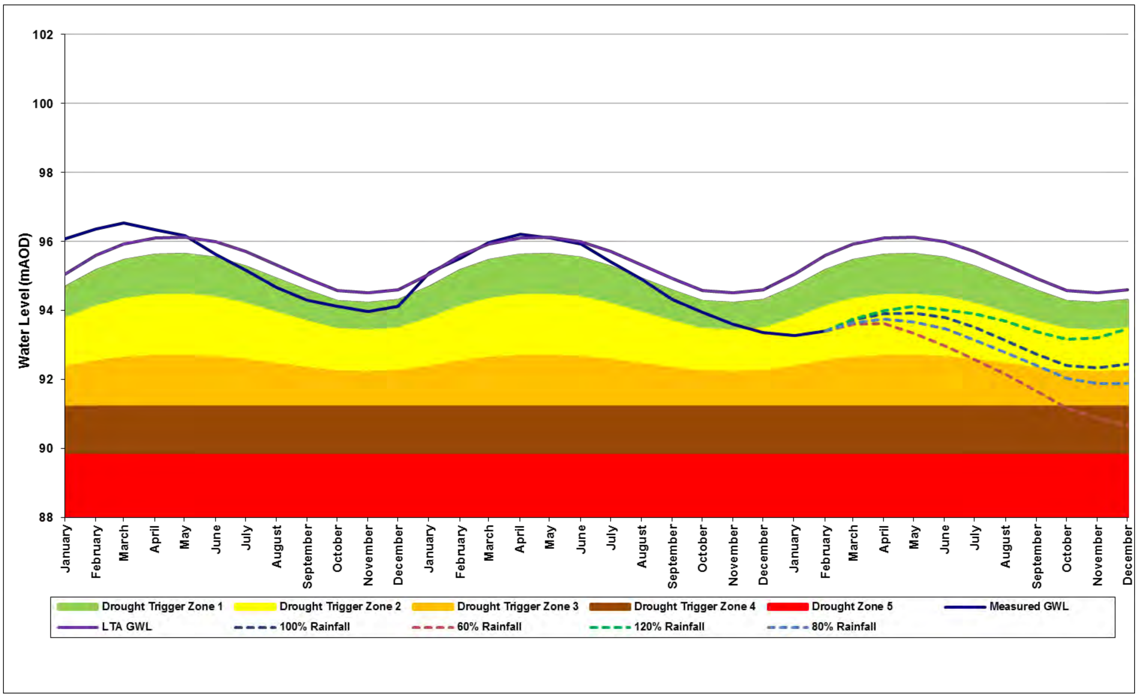

Figure 23: Short-term groundwater level monitoring hydrograph with trigger levels for our Central region

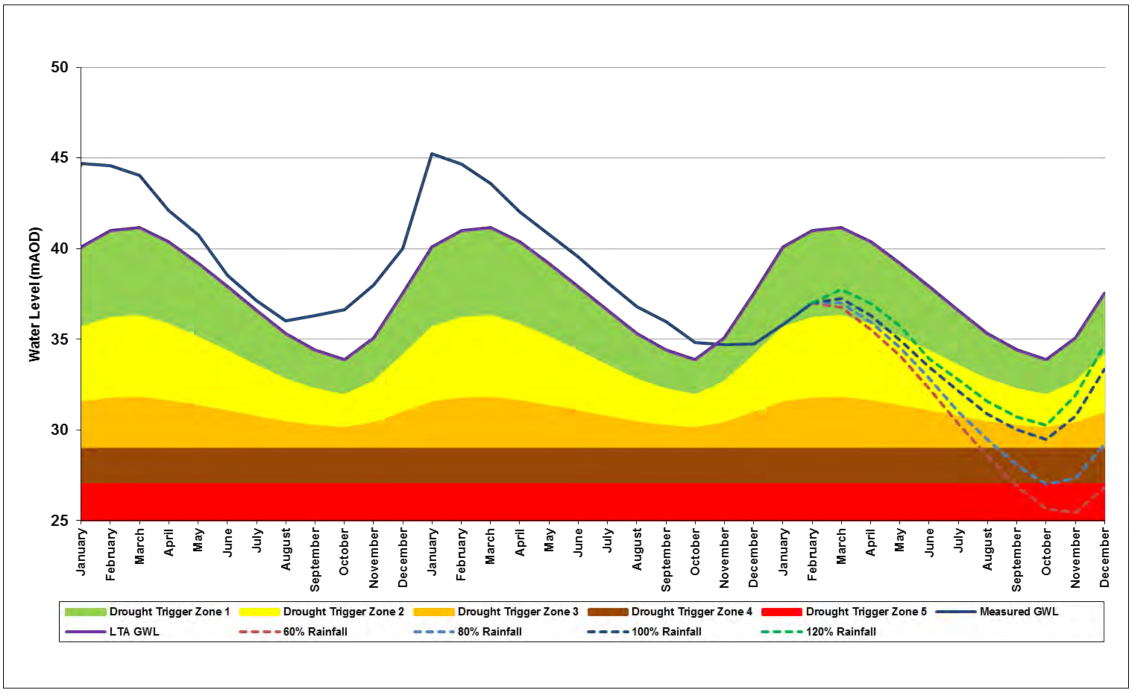

Figure 24: Short-term groundwater level monitoring hydrograph with trigger levels for our Southeast region

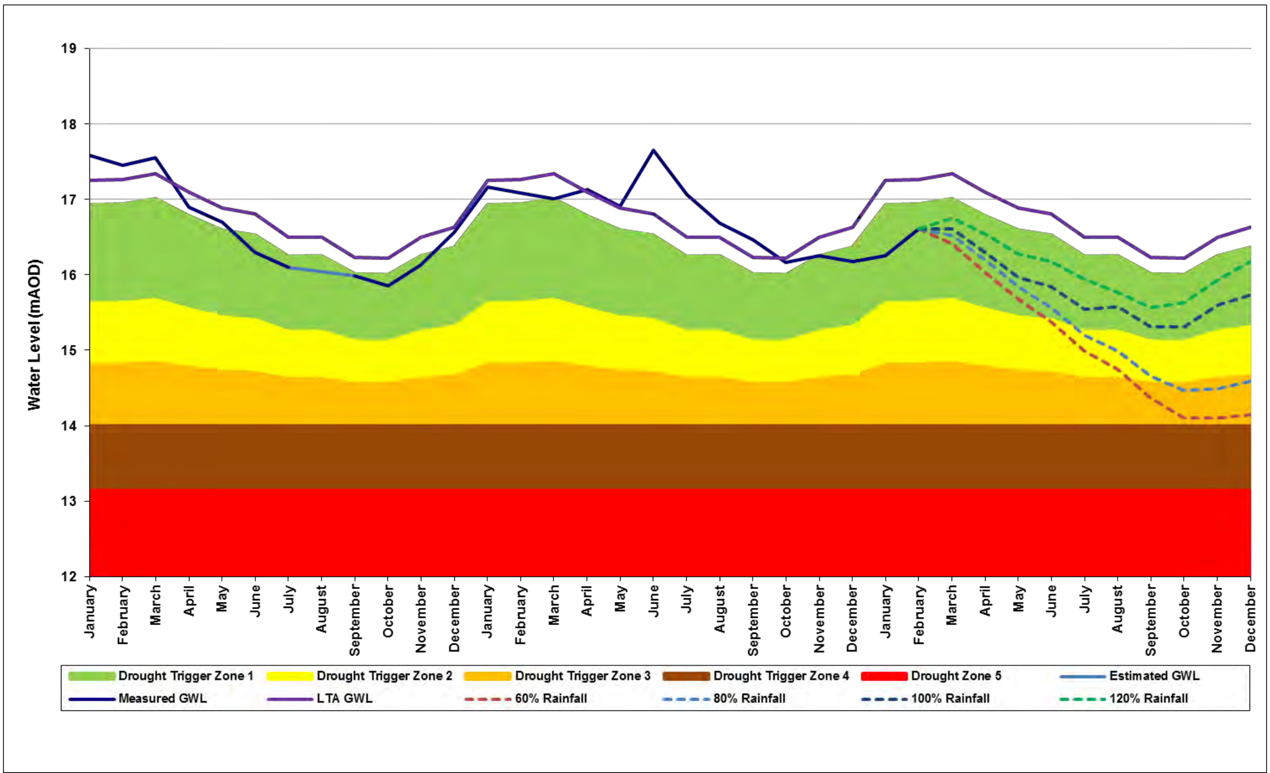

Figure 25: Short-term groundwater level monitoring hydrograph with trigger levels for our East region

3.3 Drought Forecasting

3.3.1 Introduction

The short-term drought trigger graphs presented in section 3.2.5.3 alone are not enough to inform our responses to a potential drought situation. We also take into consideration:

- Seasonal rainfall;
- Groundwater recharge; and
- Soil moisture deficit.

By looking at these in combination it is possible to provide the latest water resources position. We analyse this data and use this to produce our Water Situation Report.

3.3.2 Relationship between rainfall, recharge and soil moisture deficit

Groundwater recharge is the inflow of water to a groundwater body from the surface and naturally occurs through the infiltration of precipitation and its movement to the water table.

To forecast the likelihood and severity of a range of droughts, we have analysed the historic relationship between rainfall and recharge. Figure 26 identifies this relationship and shows that 100% of LTA rainfall is roughly equivalent to 100% LTA recharge. Further information on the analyses we have carried out can be found in Appendix 3.

However, both higher and lower percentages of the LTA rainfall have a more prominent effect on the recharge. This means that significant deficits or surpluses of rainfall compared with the LTA are magnified in terms of the consequential recharge effect. A winter rainfall pattern of 80% LTA correlates approximately to 60% recharge and conversely 150% rainfall indicates 200% of recharge.

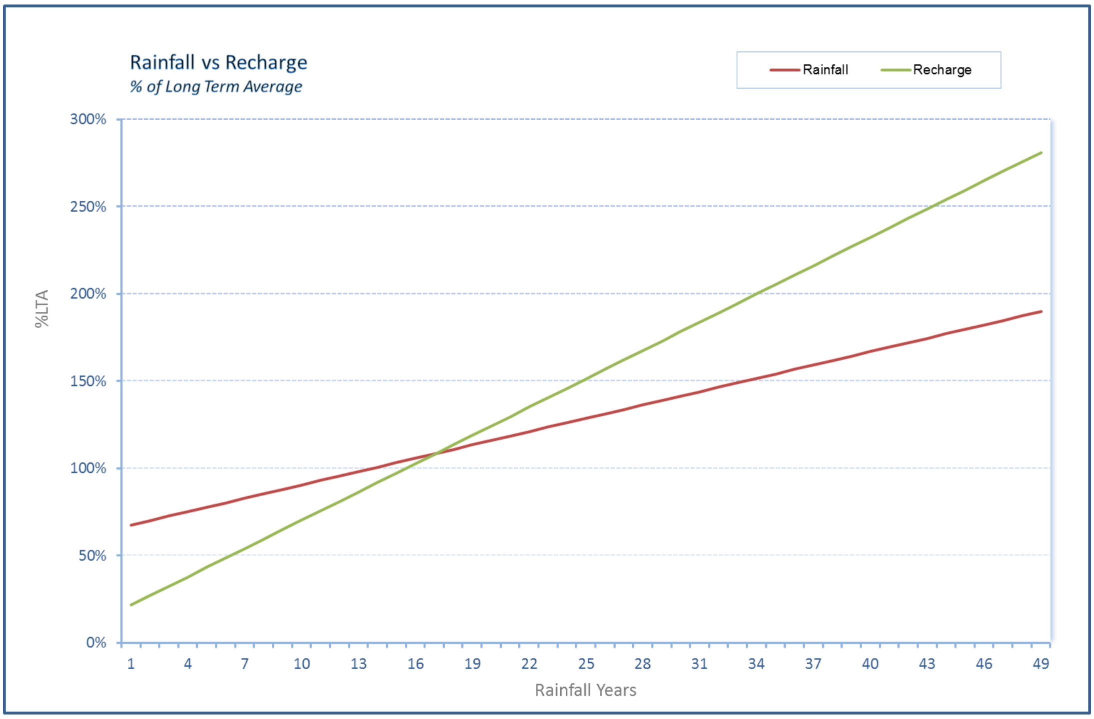

Figure 26: Comparison of Long-Term Average rainfall and recharge

Our understanding of the relationship between rainfall and recharge allows us to build tools to forecast the severity of a drought.

Soil moisture deficit (SMD) is the amount of water needed to bring the soil moisture content back to field capacity, which is the amount of water the soil can hold against gravity. Only when this deficit is satisfied can recharge occur at its maximum rate. Generally speaking, at the end of the summer, the SMD is at its greatest, as there has normally been extended periods of low rainfall accompanied by high levels of evapotranspiration. We rely on winter rainfall to replenish this deficit.

Under normal conditions, 100% of LTA winter rainfall (September to April) would provide adequate effective rainfall (rainfall available for recharge) to allow groundwater levels to recover by their average amount, increasing the volume of water in groundwater storage. However, as evidenced in Figure 26, lower than LTA rainfall delays the SMD from reaching zero and it is only after this point that maximum groundwater recharge can occur.

To calculate the expected out-turn for recharge we use Meteorological Office Rainfall and Evaporation Calculation System (MORECS) data which is supplied by the Met Office and provides 7 day rainfall, evaporation and SMD data. The evaporation and SMD data allows us to calculate the effective precipitation, i.e. the amount of precipitation that will percolate down into the aquifer and impact groundwater levels. We use squares 151 and 152 for our Central region, squares 174 and 175 for our Southeast region and square 153 for our East region, as shown in Figure 27.

Our previous work has identified the difference between a moderate drought situation (equivalent to 80% of the LTA rainfall) and a severe drought situation (classified as 60% of LTA rainfall). For example, in our Central region, the severe drought scenario is similar to water level changes that occurred in 1992, whilst the moderate drought scenario has been likened to conditions that occurred in 1991. For our Southeast region, water level changes that occurred in 2005/06 are likened to a moderate drought and 1995/96 for a severe drought. This reflects the fact that different areas respond differently to due local weather conditions experienced.

We have also categorised historic droughts into three different types, single season, multiple season and long-term, which are discussed below.

We have never had to impose restrictions in our East region (WRZ8) so the same analysis has not been conducted for this region. However, we have tested this WRZ in the scenarios, and the results are presented in Section 4.5.5.

In addition, seasonal peaks are common and reflect increasing demand for water in the summer period. A significant proportion of the increase in domestic use can be attributed to garden watering. Affinity Water has a history of managing these peaks effectively by developing 'peak' resources through our long-term operational investment plans. The balance between supply and demand for water during summer peak periods has been considered for the next 25 years as part of our WRMP. We are confident that we can continue to manage these periods as part of our day-to-day operations and therefore we have not considered it as a testing scenario for our DMP.

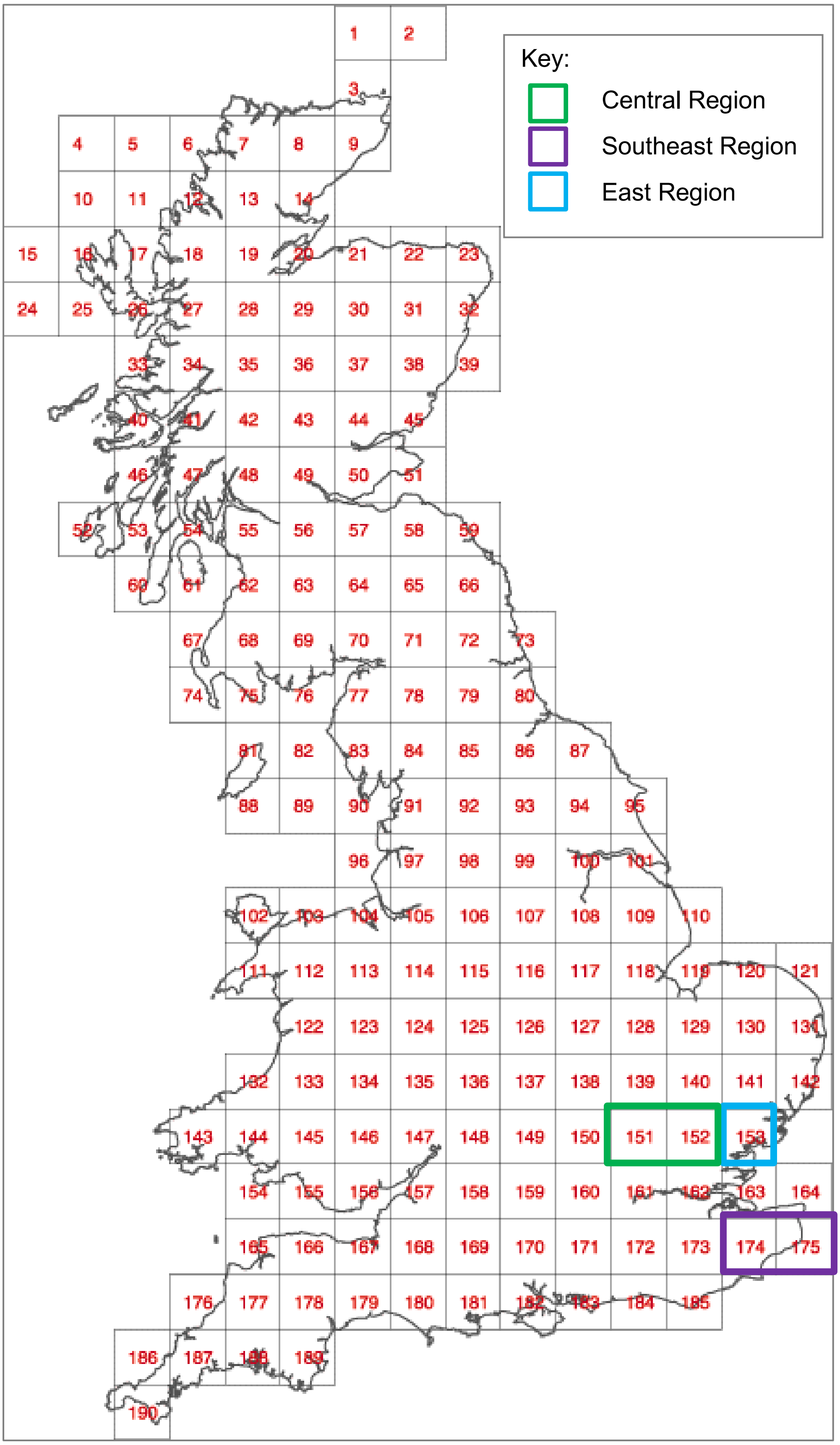

Figure 27: Location of the MORECS squares used for our three regions (shared with permission from the Met Office, licence no. 010078731)

3.3.3 Single season drought

Forecasting the out-turn 'drought scenario' is necessary for drought reporting and assessing the risks of drought in the following year.

Table 5 has been designed to aid the assessment of the probable hydrological out-turn at the end of winter recharge with reference to SMD, rainfall and effective recharge. It demonstrates the relationship between these three factors as time elapses over an autumn/winter period. The table also allows a correlation to be drawn between surface water drought conditions, which are often described in terms of expected out-turn of winter rainfall, and groundwater drought scenarios that relate to percentage recharge. This information is useful when comparing drought status information between different regions and water companies.

Table 5: Predictive tool for forecasting likely drought scenarios for drought reporting

	Winter Rainfall compared to LTA			
	40% Rainfall	**60% Rainfall**	**80% Rainfall**	**100% Rainfall**
September	>120% LTA SMD	>120% LTA SMD	>120% LTA SMD	>120% LTA SMD
October	>120% LTA SMD	>120% LTA SMD	>120% LTA SMD	zero SMD
November	>120% LTA SMD	>120% LTA SMD	zero SMD	20% LTA Cum Rainfall
December	>120% LTA SMD	zero SMD	20% LTA Cum Rainfall	40% LTA Cum Rainfall
January	zero SMD	20% LTA Cum Rainfall	40% LTA Cum Rainfall	60% LTA Cum Rainfall
February	20% LTA Cum Rainfall	40% LTA Cum Rainfall	60% LTA Cum Rainfall	80% LTA Cum Rainfall
March	40% LTA Cum Rainfall	60% LTA Cum Rainfall	80% LTA Cum Rainfall	100% LTA Cum Rainfall
Forecasted Out-turn	40% LTA Cum Eff. Rainfall	60% LTA Cum Eff. Rainfall	80% LTA Cum Eff. Rainfall	100% Cum Eff. Rainfall

Table 5 shows that with 100% of the LTA rainfall, we would expect the SMD to reach zero in October and therefore winter rainfall following this will allow for recharge of the groundwater levels. Reduced autumn and winter rainfall delays this recovery. For example, 60% of the LTA rainfall will not remove the SMD until December. This significantly reduces the time available for rainfall to become effective recharge, as only three months would be available for recharge to occur. The likelihood of reduced recharge would remain high and as a prediction, only 60% would be expected as the out-turn value. As this is only a predictive tool, a detailed assessment of the recharge situation in January would be required to provide a more reliable estimate of the out-turn value for the entire recharge period. The recovery of groundwater levels and storage is also dependent on the lowest groundwater level before recharge becomes effective. If groundwater levels are already very low, then average rainfall may not be enough for them to recover to the long-term average before the natural recession period begins again.

As mentioned above, the unprecedented summer rainfall of 2012 allowed the recovery of groundwater levels from just above Drought Trigger Zone 3 in both our Central and Southeast regions to LTA within a few months (our East region was not affected by the 2011/12 drought sequence). This is highly unusual and is therefore not a reliable indicator for any potential change to groundwater recharge patterns; we therefore have not amended our forecasting tools in light of these experiences.

Table 5 also represents a step by step predictive tool which is helpful in assessing the likely outcome of any autumn/winter cycle. For example, if SMD is greater than 120% of LTA at the end of November, then we would predict to see drought conditions no better than a '60% rainfall scenario' the following year. This is information that has been utilised in creating the control curves, discussed in Section 3.2.5 where the LTA provides a basis for the Zone 1 trigger and rainfall scenarios have been linked with our WRMP and levels of service to create the basis for Trigger Zones 2 to 5 inclusive.

The data used here reflects average conditions as the relationship between rainfall and recharge is approximately proportional and also depends on the specific rainfall pattern of any winter cycle.

3.3.4 Multiple season drought

The cumulative effective rainfall and out-turn position of the previous year will impact the groundwater starting position for the next recharge season. Table 6 illustrates the effect of rainfall year on year. We know from experience that groundwater levels are robust to a single year drought, except in extreme circumstances, however low rainfall over two consecutive winters exacerbates the situation significantly as groundwater levels can reduce to extremely low levels during the second year. For example: rainfall of 80% of LTA in year 1, followed by 60% of LTA in year 2 would equate to a 2 year average of 70%, effectively placing the company in a 70% scenario in year 2 at March out-turn. This approach enables flexibility to monitor and predict year on year rainfall impacts across our area. This tool forms the basis for our scenario testing explored in Section 4.

Table 6: Year on year effect of rainfall

% Rainfall		Year 1			
		100%	80%	60%	40%
Year 2	100%	100%	90%	80%	60%
	80%	90%	80%	70%	60%
	60%	80%	70%	60%	50%
	40%	70%	60%	50%	40%

Trigger zone	Likely outcomes
Zone 1	Normal Conditions no additional drought activity
Zone 2	Mild-Medium Drought – 80% scenario actions
Zone 3	Medium-Severe Drought – 60% scenario actions
Zone 4	Severe-Extreme Drought – New historic low levels
Zone 5	Unprecedented Drought Historic low levels

Comparing the cumulative rainfall and recharge trends with the long-term average, in order to assess the likelihood of the outcome of the winter season, is enhanced by adding the range of possible hydrological sequences for the remainder of the winter period. This representation is used as part of our internal monthly drought monitoring report. An example of how this forecasting technique was used during 2010/11 to help assess the potential severity of the forthcoming drought is illustrated in Figure 28. The graph shows what the potential impact of rainfall under average, best and worst case scenarios in relation to our LTA and extremes of 1996/97 (where rainfall was low) and 2000/01 (when rainfall was above average).

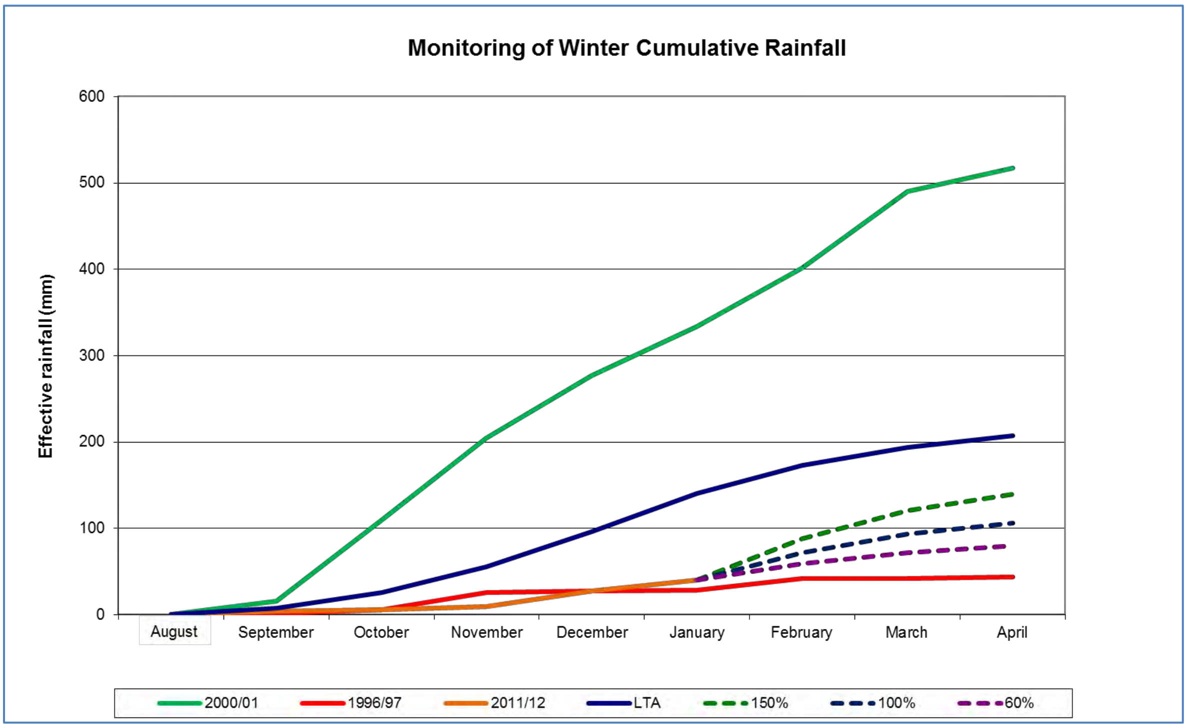

Figure 28 : Winter cumulative recharge

This information is used in determining the range of potential drought measures that may be required to balance supply and demand during the following year.

3.3.5 Long-term drought

In the event of a long-term severe drought there is a possibility of entering Drought Trigger Zone 5 – the implications of this are described in Section 5.6.

3.4 Drought Action Timings

All droughts will vary in terms of their duration and impact on the availability of water resources. The return to normal conditions is unpredictable and dependent on increasing levels of rainfall, making the duration and severity of droughts hard to forecast. Of critical importance is the starting elevation of groundwater levels at the beginning of each recharge season and the amount of rise during that recharge season, which is dependent on the amount of effective rainfall (recharge). In turn, the elevation of the groundwater level will dictate when drought management actions are required. Details of the drought management actions are described in detail in Section 5, but have been used here in abbreviated form for explanation.

As we cover three different regions, drought conditions may exist in one or more regions with different levels of intensity and timings. This is the main reason we have several different key hydrographs. Restrictions on water use and other drought management measures may well be different in different regions.

Our Drought Management Plan is based on historic water level and rainfall data over the last 40 years from the period 1976 to 2016. We have gained significant experience of managing drought events encountered in the late 1980s and early 1990s together with the severest groundwater drought of 1997 which was defined as a 1 in 200 year return event[5]. We consider

[5] Institute of Hydrology Monthly Hydrological Bulletin

our WRMP levels of service assessment (as discussed in Section 1.3) and empirical experience of drought conditions provides a robust basis for the development and application of this DMP.

Figure 29 illustrates a possible change in progressive declining groundwater levels and the likely timing of what responses would be required. Such responses would be dependent on the prevailing groundwater conditions and rates of decline/recovery of water levels. The graph shows a three year repeating sequence of overall declining levels. In reality, due to monthly variations in rainfall each year, rates of decline could be quicker or slower than indicated in this illustration. We would maintain vigilance on all our key hydrographs as well as continuing discussions with the Environment Agency and other interested parties.

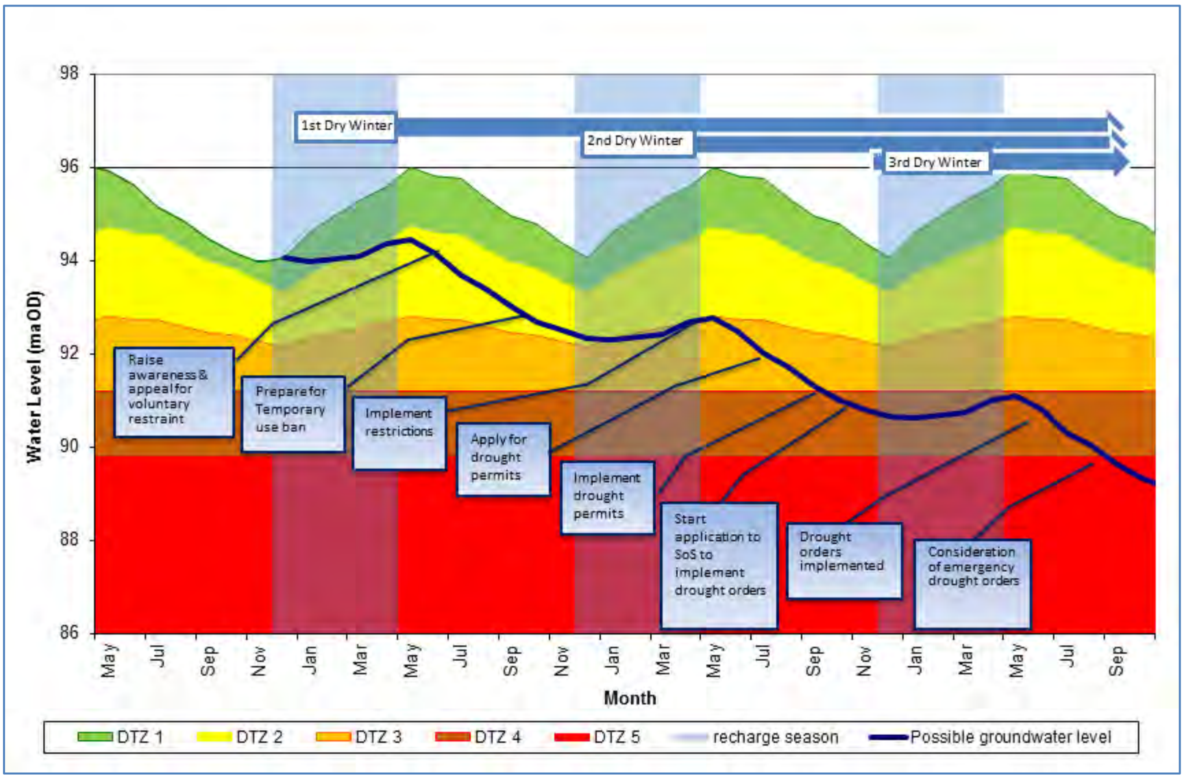

Figure 29: Illustration of possible water level changes and increasing severity of drought with associated actions

3.5 Groundwater Recovery

The recovery of groundwater will depend on the amount of rainfall recharge during one or more years, depending on what depth groundwater levels had declined to. Recharge has to be greater than average to allow groundwater levels to recover, otherwise the normal annual cycle will be repeated, but at a lower level. This is illustrated in Figure 30. It can also be clearly seen that recovery to normal groundwater levels can take several years, depending on the volume of recharge and drought management actions may need to remain in place until groundwater levels recover to above Drought Trigger Zone 3.

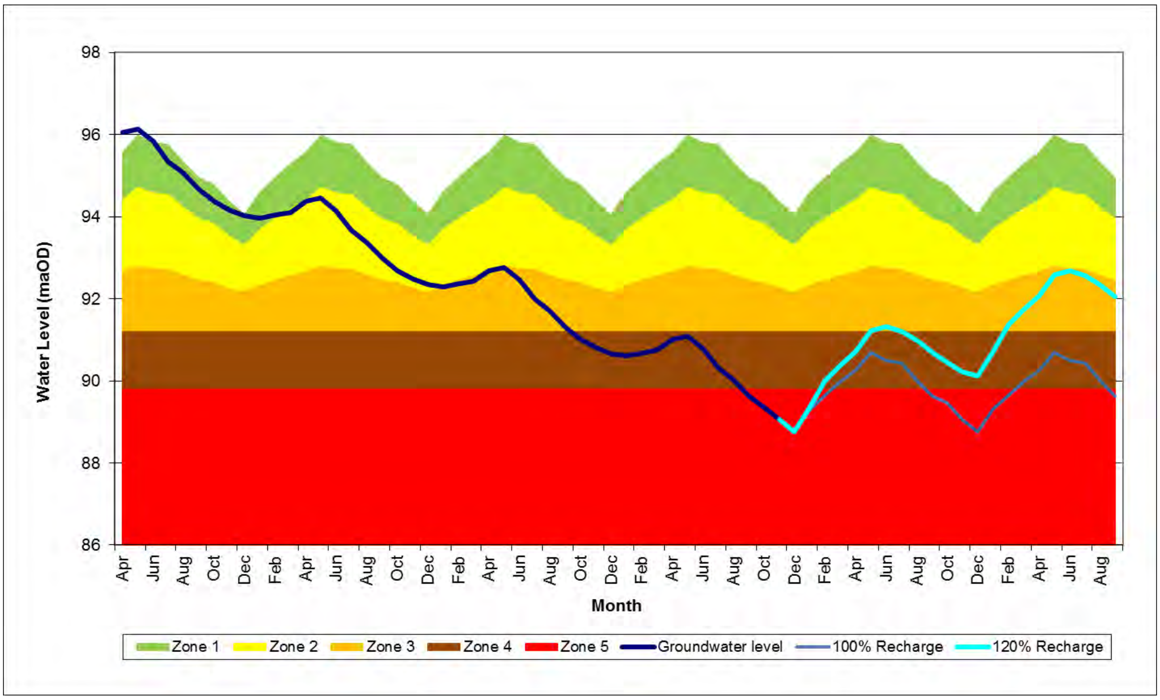

Figure 30: Illustration of possible water level changes with 100% or more recharge

3.6 Maintaining Security of Supply

As well as forecasting our water resource position, in order to identify and monitor the severity of a drought we have to forecast demand for water which can change dramatically over short periods of time in response to the weather exacerbating the situation. We monitor daily demand on a local and company-wide level. This data is also considered within our drought report updates in order to forecast the supply/demand balance at specific points in time. The impact of demand management measures can help mitigate the impacts of a drought and accordingly we regularly monitor the effect of water efficiency measures, leakage reduction and metering. The benefits are assessed on an annual basis or alternatively under the direction of the DMG during a drought.

Security of supply is maintained through the interconnection of our treatment works, pumping stations and storage reservoirs. Our integrated trunk main network incorporates both pumped and gravitational transfers and is also connected to the principal imports from and exports to other water companies (Figure 7, Figure 8 and Figure 9). This allows us to manage our groundwater and surface water sources to meet demand under normal conditions. It also means that during a drought we have the flexibility to transfer water between adjacent resource zones to ensure we can meet customers' needs. In order to monitor our ability to do this, a water balance model has been built based on the forecasted available supply and demand under long-term drought conditions for each HDZ. The supply/demand forecast is carried out for each potential drought scenario so that actions may be determined for operation under each Drought Trigger Zone.

Our imports and exports are carefully managed in conjunction with the supplying or receiving water company, to ensure optimum use of available resources for both companies, depending on the demand in each company, which maybe different in different drought conditions.

Source availability is verified by examining the actual drought conditions compared to our baseline Source Reliable Output (SRO) assessment used for our WRMP. Demand is also based initially on the normal and dry year average and peak demand scenario's from our

WRMP but reviewed and adjusted to reflect specific year forecasts. The demand in each zone will be met by the source availability in that zone plus the internal or external transfers. In order to assess potential supply deficit in a zone, transfers are based initially on the capacity data from our suite of Hydraulic Models. For each zone the security of supply is then verified by a simple simulation with every source taken out of supply at each step. A more complex scenario of two or more sources out of supply at the same time is then tested to identify any potential deficit and any requirement to replace lost output. This would be achieved by increasing local capacity, transferring from adjacent zones or by reducing demand or any combination of these measures.

As mentioned above, our Central region is partly supplied from four surface water abstractions from the River Thames. As these are not supported by surface storage reservoirs, they are all run-of-river licences, with no flow restrictions. In drought, we work closely with the other water companies who also abstract directly from the Thames, to ensure that abstraction planning is optimised to maximise flows in the different reaches of the river.

As part of the work for our PR14 WRMP, we have agreed with the Environment Agency a number of sustainability reductions that apply to our groundwater abstraction sources in three of our eight WRZs – see Table 7. Extensive work has been carried out to ensure that under normal conditions we are able to maintain our supply/demand balance, despite reductions in abstraction.

Our East region is supplied partly by surface water from a reservoir (TARD) which we share with Anglian Water. The TARD control curve has been developed by Anglian Water as part of their water resource planning. Identical control curves have been submitted by us and Anglian Water for TARD even though the supply-demand balance is not identical for each company. Similarly the onset of a drought and its relative effect on each company is likely to be different. Anglian Water may choose not to implement certain actions even though these may be indicated by the TARD control curve. Any decision to delay implementation would be based on the prevailing circumstances with particular regard to the groundwater resource position.

Table 7: Summary of AMP 6 and 7 Sustainability Reduction Programme

Water Resource Zone	Reduction Average DO Ml/d		Reduction Peak DO Ml/d	
	AMP6	AMP7	AMP6	AMP7
WRZ 1 - Misbourne	11.00	2.00	6.15	2
WRZ 2 - Colne	5.82	8.84	5.82	0
WRZ 3 - Lee	25.27	16.87	27.09	10.49
WRZ 4 - Pinn	0	0	0	0
WRZ 5 - Stort	0	0	0	0
WRZ 6 - Wey	0	0	0	0
Sub-total (Central region)	**42.09**	**27.71**	**39.06**	**12.49**
WRZ 7 (Southeast region)	0	0	0	.0
WRZ 8 (East region)	0	0	0	0
Company Total	**69.80**		**51.55**	

4 Scenario Testing

4.1 Introduction

All droughts will vary in terms of their duration and impact on the availability of water resources. The return to normal conditions is unpredictable and dependent on increasing levels of rainfall, making the duration and severity of droughts hard to forecast. It is therefore essential that Drought Management Plans are tested against a range of drought scenarios that could occur within the company supply area, to ensure that the adopted measures are sufficiently robust to protect essential water supplies and minimise the environmental impact of these abstractions.

Our DMP is based on historic level and rainfall data over the last 40 years from the period 1976 to 2016. We have gained significant experience of managing drought events encountered in the late 1980's and early 1990's together with the severest groundwater drought of 1997 which was defined as a 1 in 200 year return event[6]. We consider our Water Resource Management Plan (WRMP) levels of service assessment (as discussed in Section 1.3) and empirical experience of drought conditions provides a robust basis for the development and application of this DMP.

In accordance with Environment Agency guidance[7] on scenario testing we commissioned AECOM to construct a series of lumped parameter models, which were then used with synthetic climate data to produce synthetic groundwater levels and statistics. These in turn were used in spreadsheet-based models for each Water Resource Zone (WRZ) to test their response to drought events. This process is shown in Figure 31 and described in outline below, with the results discussed in Section 4.5. Full details can be found in the Appendix technical report[8].

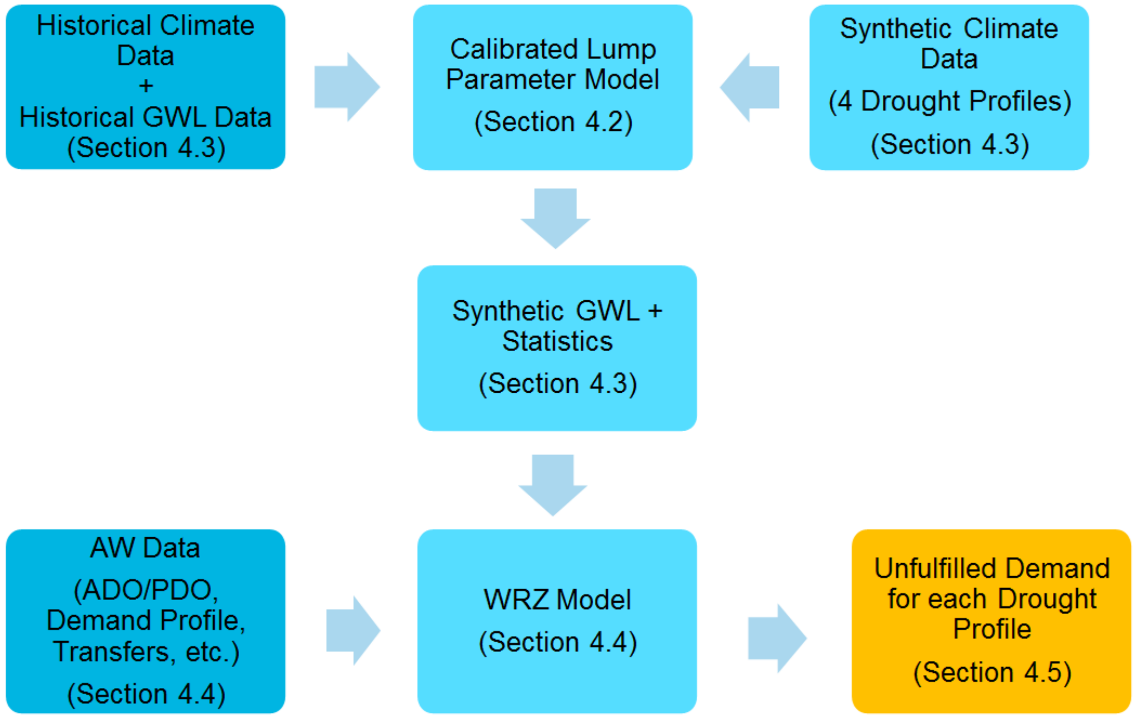

Figure 31: Drought management scenario planning methodology

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6 Institute of Hydrology Monthly Hydrological Bulletin

7 Environment Agency, 2015. *Evidence Report – Understanding the performance of water supply systems during mild to extreme droughts*

8 AECOM, 2017, *Affinity Water Drought Management Plan Technical Report – Drought Management Scenario Planning*

This process covers potential future climate changes (including droughts worse than those previously experienced), calculates the resulting groundwater levels and derives an available volume of groundwater outputs. It then compares these with demand for water, and the likely decrease in demand resulting from any restrictions at a WRZ level. It will then calculate any deficits in supply over demand, and seek transfers to meet this deficit, until all transfers are fully utilised. It uses an increasing hierarchy of internal groundwater resources, surface water sources and finally imports from neighbouring water companies to meet this demand. Three scenarios were then used to identify which zones had a deficit in the worst drought sequence. The first was only relying on internal sources, with no transfers. The second was to utilise all available transfers between water resource zones, and the third was to allow for the effects of drought management actions, both by increasing supply via drought permits, and reducing demand by imposing water use restrictions on customers. The key aspects and outcomes of this work are presented here, and are set out as follows:

- An explanation of how the lumped parameter models were developed
- An explanation of how sets of data were used to inform drought scenarios
- A description of how models were developed for each Water Resource Zone, as well as how our drought management actions were incorporated into the models
- A presentation of the key findings of the modelling work, as well as the assumptions associated with these
- An explanation of how the results should be interpreted, using WRZ3 as an example, and the implications of this for our investment requirements
- A summary of the conclusions resulting from the study

The scenario work applies only to recharge in chalk aquifers. For our shallow gravel aquifers, summer rainfall can be effective precipitation and thus water availability will be lower with a dry summer following a dry winter. However, these sources are small in comparison with the total water availability and are constrained by their drought deployable output (DO). We would not seek to abstract more than this as the wells would be incapable of producing it, and therefore they are not considered further in the modelling.

This piece of work is a significant aspect of our DMP, as it has enabled us to model and plan for droughts which are worse than those in the historic record. In cases where our drought management actions are associated with implications for investment – particularly in the cases of Sustainability Reduction sites, these will be explored further in our WRMP, alongside all of our other options identified to ensure that we are able to maintain our supply/demand balance.

4.2 Development of Lumped Parameter Models

The lumped parameter model is a spreadsheet-based model that predicts regional groundwater level from rainfall and Potential Evapotranspiration (PET), taking into account soil moisture deficit, percolation and potential recharge delays. Models were created using historical climate data for a set of observation boreholes to represent the various WRZs. The models were calibrated by visual inspection of the simulated groundwater levels against observed groundwater levels. Table 8 below summarises the observation boreholes, climate data records used and calibration periods for each WRZ.

The lumped parameter models for the observation boreholes in our Central region (Figure 16) have been calibrated based on the long-term observed rainfall record for Rothamsted, infilled based on Oxford rainfall where necessary, as per Affinity Water[9]. The observation boreholes in

[9] Affinity Water, 2014. *Technical Report 1.2: Levels of Service Hindcasting – Assessment of Frequency of Drought Restrictions*

our East and Southeast regions (Figure 17 and Figure 18), have been calibrated using hindcast catchment rainfall for the Dover Chalk coastal area.

Table 8: Lumped parameter model inputs

WRZ	Observation Borehole	Groundwater level records used for calibration	Historical Climate Data
WRZ1 / WRZ2 / WRZ4 / WRZ6	Chalfont Centre	Jan 1975 – Sep 2010	Rothamsted and Oxford
WRZ3	Lilley Bottom	Jul 1979 – Apr 2016	Rothamsted and Oxford
WRZ5	Elsenham Nursery	Jul 1966 – Sep 2010	Rothamsted and Oxford
WRZ7	Wolverton New	May 1995 – Sep 2016	Dover Chalk
WRZ8	Lady Lane	Sep 1991 – Sep 2016	Dover Chalk

The simulated groundwater levels were compared with the historical data and used to calibrate the lumped parameter models. Recession curves were derived to represent a period of no rainfall, which assisted with the prediction of severe drought groundwater levels. There is one exception to this at Elsenham Nursery observation borehole, where a secondary store of water has been used to model delayed recharge, which results from the local hydrogeological characteristics of the aquifer. Once the models were calibrated, frequency analysis was undertaken on the simulated groundwater level time series (>100 years), using both Weibull and Normal distributions. This allowed the identification of return periods for each groundwater level associated with the WRZ observation borehole. An example of the results of this calibration is shown in Figure 32[10].

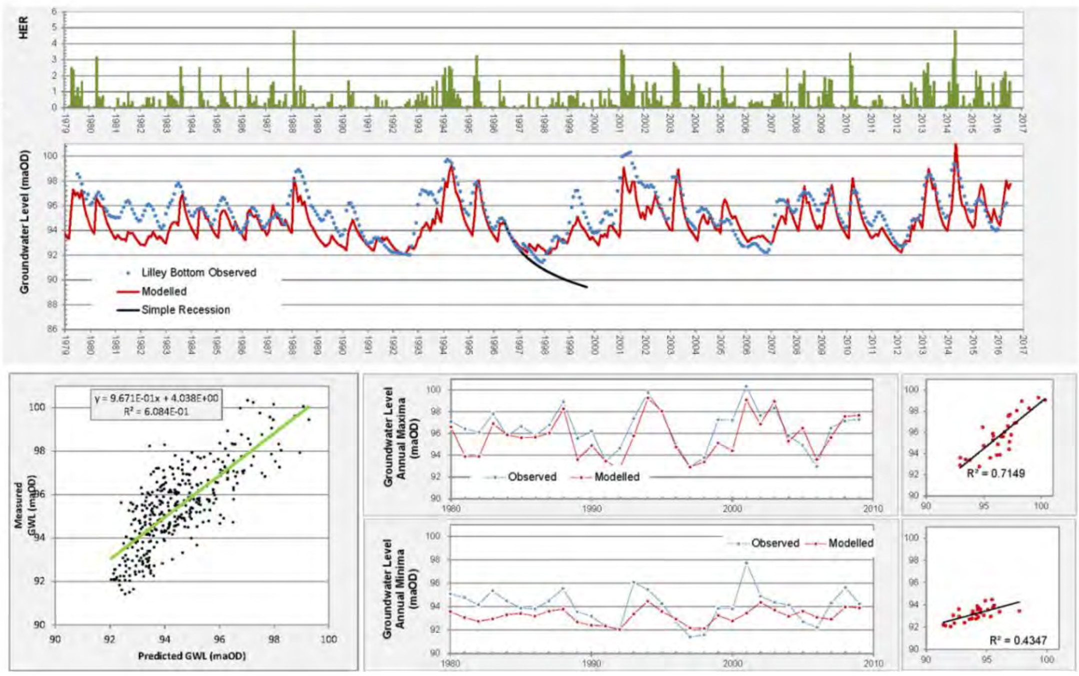

Figure 32: Calibration results for the lumped parameter model of Lilley Bottom (WRZ3)

[10] AECOM, 2017, *Affinity Water Drought Management Plan – Drought Management Scenario Planning*

Synthetic climate data was then run through the calibrated lumped parameter models to generate a synthetic groundwater level time series for each of the drought scenarios tested. This is described further in Section 4.3 below.

4.3 Development of Synthetic Time Series Data and Drought Scenarios

4.3.1 Synthetic climate data

The drought sensitivity framework used a matrix of rainfall deficit duration and intensities as per the Guidelines[11], where durations are of 6 month increments between 6 months and 5 years, and intensities range between -10% and -80% of the Long Term Average (LTA) rainfall. The LTA rainfall values are based on the Rothamsted data set (with infill as required from the Oxford data set) and Dover Chalk historic rainfall data for the Central Region and East/Southeast Regions, respectively. In addition seasonality was tested by imposing drought starts either in April or in October and two drought profiles where the deficits are uniform or seasonal i.e. with deficit concentrated in winter or summer. Therefore a total of four different drought profiles exist, each containing 80 different rainfall and PET scenarios. The following conditions are applied to the four different drought profiles:

October Profile: October start with uniform rainfall deficits and with PET always equal to 100% LTA.

April Profile: April start with uniform rainfall deficits and PET always equal to 100% LTA.

Winter Profile: October start with rainfall deficits concentrated in winter and PET always equal to 100% LTA.

Summer Profile: April start with rainfall deficits concentrated in summer and PET always equal to 120% LTA.

The seasonal deficits are calculated using a cosine function as described in the EA Evidence Report, 2015[12].

Figure 33 below presents the Rothamsted (with Oxford) synthetic seasonal rainfall deficits with their corresponding rainfall, as opposed to the uniform deficits.

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[11] Environment Agency, 2015, *Understanding the performance of water supply systems during mild to extreme droughts*

[12] Environment Agency, 2015, *Understanding the performance of water supply systems during mild to extreme droughts*

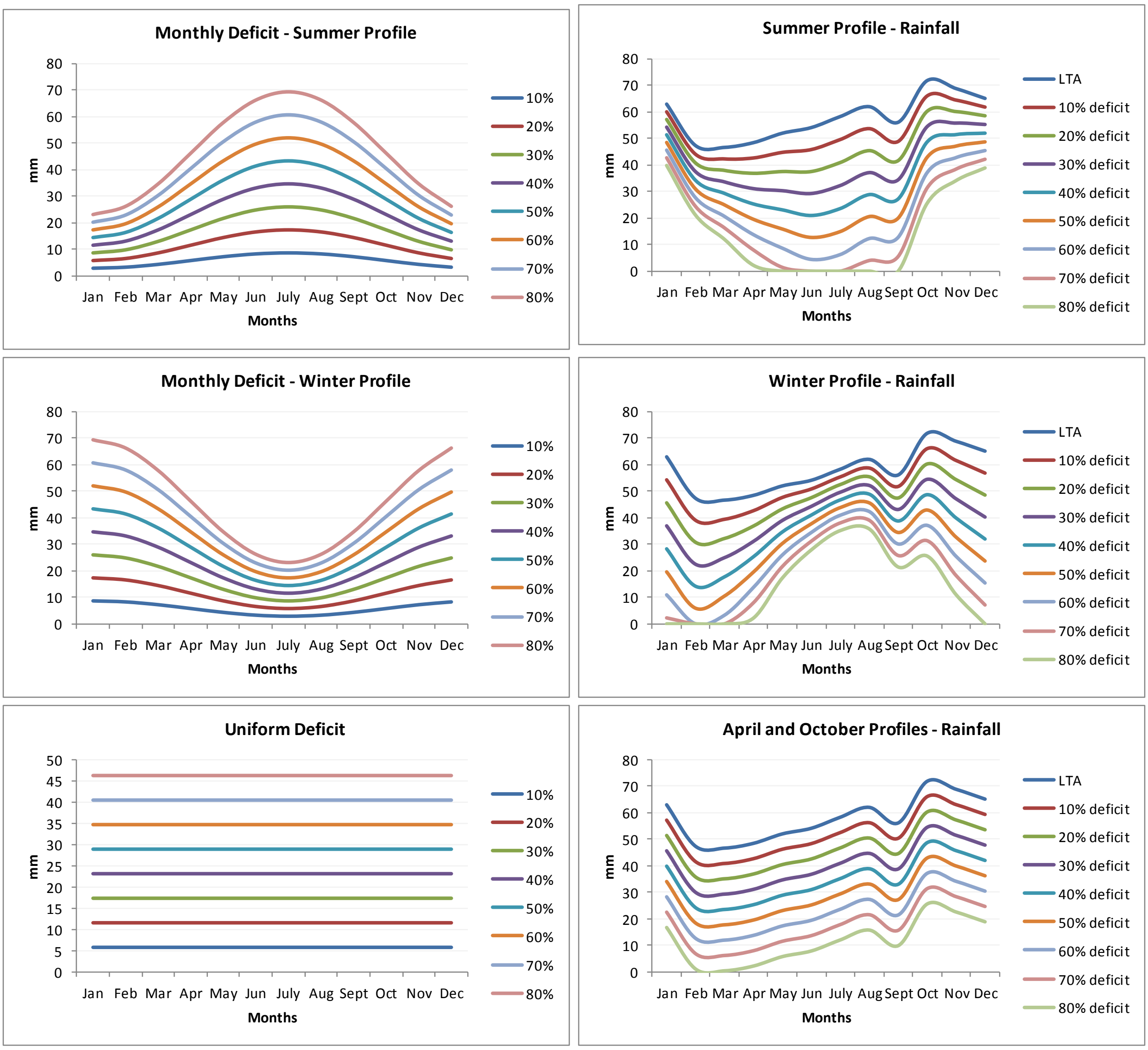

Figure 33: Rainfall deficits and corresponding rainfall profile for the Central region (based on Rothamsted with Oxford rainfall)

Each drought scenario was inserted within a longer time series of synthetic climate data, resulting in 30 years of data in total; a 10 year run-in that provides similar initial conditions before each drought scenario, followed by the drought scenario varying from 6 months to 5 years length, and then a recovery period of at least 15 years. Each period is characterised by specific rainfall and PET intensities (monthly values). The run-in and recovery periods assume rainfall and PET are equal to their respective 100% LTA.

4.3.2 Regional groundwater level time series data

The 30 year periods of synthetic climate data described above were imported into each of the calibrated lumped parameter models to create the associated simulated groundwater levels for use in the WRZ models. Each of the four drought profiles has 80 different rainfall and PET scenarios, and there is a corresponding groundwater level time series for each of these scenarios.

The first 10 years of the groundwater level series are not imported in the WRZ models as they are only a warm up period necessary to obtain similar initial conditions prior to the drought period.

4.4 Development of Water Resource Zone Models to Identify Drought Sensitivity

4.4.1 Summary of data inputs

A unique model was created in a Microsoft Excel spreadsheet for each WRZ and includes the following data inputs:

- 80 sets of synthetic groundwater level time series data (drought profiles).
- Both Weibull distribution and Normal distribution parameters calculated from a frequency analysis of modelled historic data are included within the models. Available parameters are based on a ranking of groundwater level for each month of the year (i.e. different sets of distribution parameters for each month) and also a ranking of all combined groundwater levels available (one set of distribution parameters).
- Average Deployable Output (ADO) and Peak Deployable Output (PDO) profiles for each groundwater and surface water source in a WRZ, demonstrating drought sensitivity. These originated from the Environment Agency via the Drought Scenarios Pilot in 2014 and were validated by us at that time. We have reviewed these values for the current project and have adjusted them to reflect the Asset Management Period 6 (AMP6) sustainability reductions. Where a drought scenario results in a return period that is beyond that for which DOs have been provided, the DO with the return period relationship is extrapolated based on the Normal distribution parameters in the model; the Weibull distribution parameters were initially trialled, although the return period became meaningless for severe droughts, resulting in a rapid and unrealistic decline of DO to zero.
- The available actual abstraction data for each groundwater and surface water source was used to check the validity of the model for historic droughts.

A typical demand profile for each WRZ was developed. This used the 7-day running mean data for 2010 in WRZ1 to WRZ6 (apportioned from a Central region total as 10.8% WRZ1, 15.8% WRZ2, 18.3% WRZ3, 26.7% WRZ4, 9.2% WRZ5 and 15.8% WRZ6). In WRZ7 the 2014 demand was used, and in WRZ8 the 2013 data was used. These more recent years have been selected owing to the significant increase in metering in these areas. The demand data does not contain values for headroom and outage and thus is not directly comparable with WRMP values. It should also be noted that the demand splits for the Central region do not equal 100%, as the demand from the South East Water export was excluded from WRZ6 as this is taken into account within the transfers modelling.

Maximum transfer capacities and estimated likely transfer rate ceilings were used for water imported (or exported) from (and to) other WRZs or neighbouring water companies. The maximum values are shown in Figure 6.

Assumed percentage reductions in demand and mega litre per day (Ml/d) increases in supply were used to simulate the implementation of drought management activities (demand restrictions and supply side drought permits and orders). These are explained further below.

For each daily time step the model assigns a return period to the corresponding simulated groundwater level, based on the previous analysis of the modelled historic groundwater level from the WRZ lumped parameter model. The ADO and PDO of every WRZ source for that return period is summed per time step to represent the supply available. The available supply (with or without transfers and supply side drought permits and orders) is then compared to the demand profile (with or without demand restrictions) to calculate the proportion of unfulfilled demand.

Further information on the inclusion of transfers and drought management activities is provided below.

4.4.2 Approach to including transfers

We have the ability to transfer water between our WRZs and import water from or export to our neighbouring water companies. A representation of these transfers has been incorporated within the WRZ models for this study (Figure 7). Transfer rates have been manually adjusted in the WRZ models to minimise or eliminate water supply deficits in the Central region; deficits in the East and Southeast regions were not large enough to necessitate the use of transfers. One assumption with these models is that imported water can be passed within a WRZ to fully meet the demand in that WRZ. There may be local issues with the network that prevent this at a small local scale. However, this process is to determine if there is an overall balance between supply and demand for water during droughts. The more detailed distribution balances are managed via the WRMP process and our Miser/Infoworks network models.

The transfer assumptions used in this study do not represent how we operate our transfers under normal conditions, or how we might operate and utilise such transfers under emergency conditions. Instead they represent two drought related scenarios. The first scenario assumes that DMP actions such as demand restrictions and drought permits are not available; this is an unrealistic scenario, although it provides a degree of sensitivity testing. The second scenario assumes that demand restrictions and drought permits can be implemented; it is an example of how we could transfer water between our water resource zones during a severe drought that is covered by our DMP, in order to meet demand.

Imports and exports from/to neighbouring water companies are included and available in the WRZ models, although they are not all used in all scenarios. These include a key import from Anglian Water and a key export to South East Water.

It is important to note that the models assume maximum use of groundwater first, and then surface water, before using transfers to satisfy demand in the WRZ. Where there is a net export, the ratio of groundwater to surface water exported is based on the ratio of groundwater DO to surface water DO for the 1 in 10 year drought ADO. This is demonstrated by the charts in Appendix 3, which represent the longest duration and most intense drought simulated for each WRZ.

4.4.3 Approach to including drought trigger levels and the impact of drought management activities

Our Drought Triggers are described in Section 1, but are repeated here for clarity in Table 9.

Table 9: Drought Trigger Zones and likely outcomes

Trigger Zone	Description of trigger	Likely outcome
Zone 1	90% of LTA groundwater levels (mAOD)	Normal Conditions, no additional drought activity
Zone 2	Groundwater levels seen in a 1 in 5 year drought event	Mild-Medium Drought
Zone 3	Groundwater levels seen in a 1 in 10 year drought event	Medium-Severe Drought
Zone 4	Below the lowest recorded levels of 1997	Severe-Extreme Drought
Zone 5	Lowest groundwater levels predicted from hindcasting groundwater levels.	Unprecedented Drought Historic low levels

These triggers have been derived for each observation borehole as a series of groundwater level elevations. Each lumped parameter model, for each time step, tests the derived groundwater level against the trigger point values, and where the elevation is below that for each trigger, it then adjusts the demand by the appropriate amount as described below.

Our Drought Management Plan identifies the demand side actions that it would take as a drought advances through each zone. These are provided in Section 5.

We have considered the impact of these actions on demand based on the evidence from relevant UKWIR studies and our own internal data as identified in Section 5.2.6 of our draft Drought Management Plan. The savings being modelled are for the annual average scenario; whilst the actions are likely to have a greater impact on peak demand. This complexity is not currently modelled; although the savings are conservative, they are reasonable when compared with summarised data for water companies in England[13].

The impact of demand restrictions is assumed to increase by drought zone within the modelling. The percentage demand saving varies for each of our regions, in recognition of the differing metering penetrations, which impacts the current per capita consumption and potential demand saving that could be accomplished along with the current levels of leakage.

Table 10: Demand restrictions (percentage reduction in demand) assumed within the Water Resource Zone models

Region (WRZ)	Drought Trigger Zone 2	Drought Trigger Zone 3	Drought Trigger Zone 4	Drought Trigger Zone 5*
Central (WRZ1-6)	0%	2%	5%	25%
Southeast (WRZ7)	0%	0.05%	5%	25%
East (WRZ8)	0%	0.05%	2%	5%

**Demand reductions include the impact of implementing Emergency drought orders. These are not considered to be within the remit of our Drought Management Plan and instead would be implemented following the enactment of our Emergency Plan, as a drought of this level of severity would be classified as a civil emergency. However for consistency with the severity of the droughts being modelled in this work, it was considered appropriate to include them.*

Our supply side options primarily consist of drought permits and supply-side drought orders, and these options are described in Section 5.4.

4.4.4 Approach to the presentation of model results

In our scenario modelling results, we have aimed to achieve a similar presentation to that used within the Environment Agency (2015) report. The results from the drought scenarios modelling provide three dimensions of information; drought duration, drought intensity and system performance. Results are presented on a drought 'matrix' displaying the drought characteristics or duration on the x-axis and intensity (rainfall deficit with respect to LTA rainfall) on the y-axis, with the proportion of unfulfilled demand represented by coloured squares (expressed as a percentage). A different drought matrix has been produced for each modelled drought profile; summer, winter, April and October. The drought durations are in 6 month increments between 6 months and 5 years, and intensities range between -10% and -80% of the Long Term Average (LTA) rainfall.

In order to provide some context to the drought scenarios, historical rainfall data has been analysed to calculate the same drought characteristics as those described above. The resulting

[13] AECOM, 2015. *Annex A: Water Availability Assessment. Strategic Water Infrastructure and Resilience. Final Report. Environment Agency*

points have been plotted onto the drought matrices (April profile only) and an example presentation is shown in Figure 34. Return periods from a frequency analysis of the Rothamsted (infilled with Oxford) rainfall data are also shown on Figure 35 to help demonstrate that parts of the presentation matrix represent conditions that are significantly more severe than the climate conditions experienced between 1853-2016 (the zone beyond the historic data and the 1 in 200 year return period line); in this zone the assumptions in the model may no longer be valid owing to a lack of experience with this level of drought severity, although these conditions would be dealt with via emergency planning and not the DMP (see Figure 35). The aim is therefore to demonstrate whether our WRZs are at least resilient to the rainfall deficits observed in the historic rainfall record.

The results of the modelling are presented in the technical report included along with our DMP Appendices[14] and are summarised below in Section 4.5.

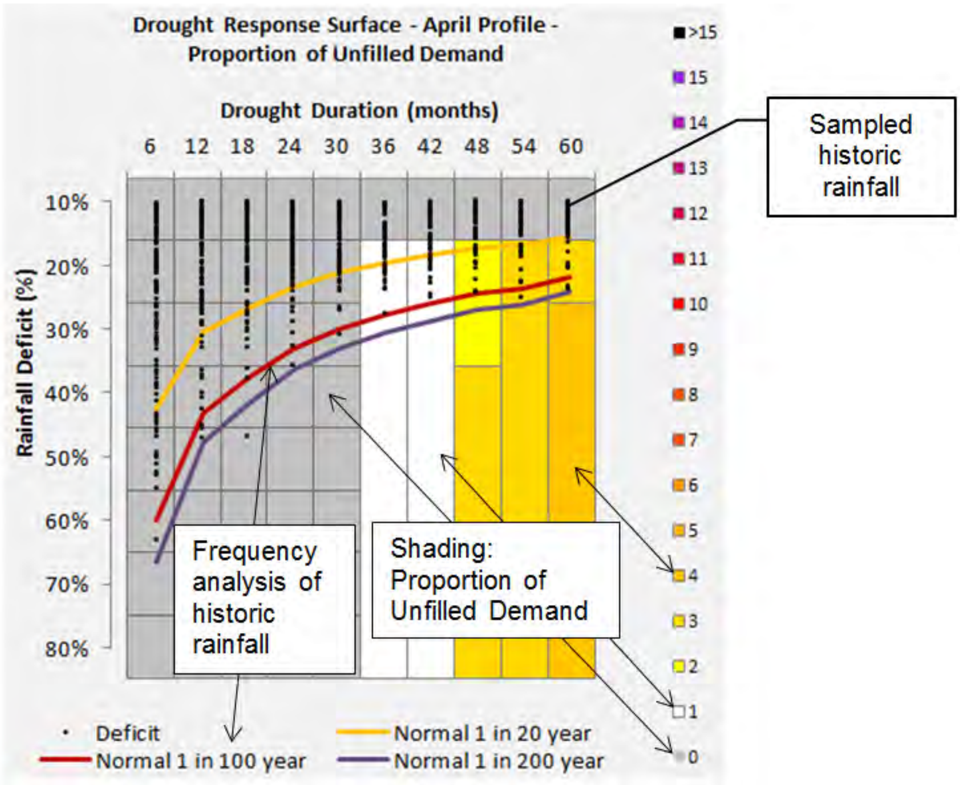

Figure 34: Example matrix presentation

[14] AECOM, 2017, *Affinity Water Drought Management Plan – Drought Management Scenario Planning*

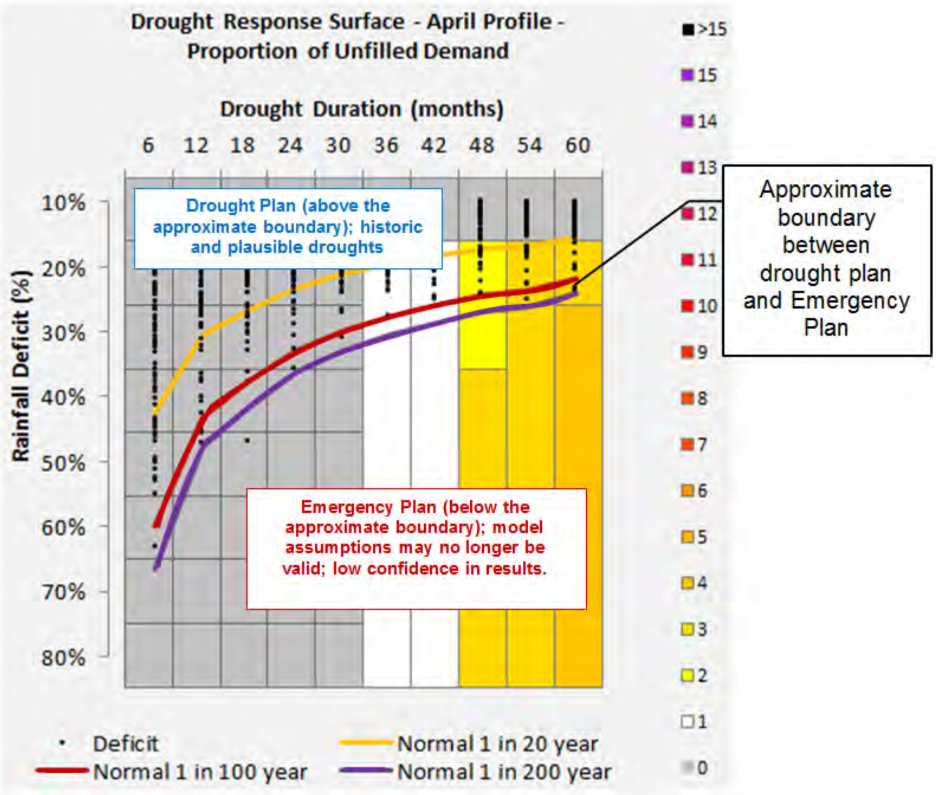

Figure 35: Drought Management Plan versus Emergency Plan scope

4.5 Results and Assumptions

4.5.1 Introduction

This section introduces the drought response of each of our WRZs according to the four different drought profiles. Three conditions are explored:

Results without transfers and without drought management activities

These results demonstrate the drought resilience of each WRZ when treating it in isolation, without the ability to move water between WRZs, and without the ability to implement drought management activities. It does not reflect how the WRZs are operated, although it helps to demonstrate the impact of transfers and management activities.

Results with transfers and without drought management activities

These results demonstrate the drought resilience of WRZs when assuming water can be moved between WRZs or imported from neighbouring water companies. However the transfer rate assumptions are based on a scenario where there are no drought management activities; it does not reflect how the WRZs are operated but provides a degree of sensitivity testing.

Results with transfers and drought management activities

These results demonstrate the drought resilience of WRZs when assuming water can be moved between WRZs or imported from neighbouring water companies. The transfer rate assumptions are adjusted to take into account the implementation of drought management activities according to our DMP; it is one representation of how we might transfer water between WRZs during a severe drought that is covered by our DMP.

A brief description of the results is provided in the sections below. Full details of the results can be found in the technical report[15].

4.5.2 Results without transfers and without drought management activities

Results from the initial runs illustrate the necessity of imports, exports and demand management activities on a WRZ basis. The results demonstrate that WRZ1 (Misbourne), WRZ2 (Colne), WRZ6 (Wey) and WRZ8 (Brett) are resilient to the most severe droughts tested (based on the assumptions in the models). In WRZ4 (Pinn) there is up to 3% deficit across all of the droughts tested; the consistency reflects the assumption that abstraction from surface water (River Thames) will always be possible regardless of drought condition. In WRZ7 (Dour) there is sensitivity to only the most severe droughts that are significantly worse than those experienced in the historic record.

In contrast to the other WRZs, WRZ3 (Lee) and WRZ5 (Stort) have significant unfulfilled demand across the full range of droughts that have been tested. This demonstrates that they are vulnerable to drought under a scenario where there are no transfers or drought management activities i.e. the WRZ is in isolation.

4.5.3 Results with transfers and without drought management activities

The models were re-run with transfers enabled and with transfer rates that aim to avoid supply deficits in droughts within the historic record. Results from the model runs with transfers (but without drought management activities) demonstrate that WRZs are resilient to historic and plausible droughts (no unfulfilled demand) with the exception of WRZ3 in longer duration droughts. Whilst there was no unfulfilled demand in the other WRZs, transferring additional water to WRZ3 was not possible owing to either a lack of transfer capacity or a lack of available water within those WRZs. The transfers required for this scenario are shown in Figure 36.

[15] AECOM, 2017, *Affinity Water Drought Management Plan – Drought Management Scenario Planning*

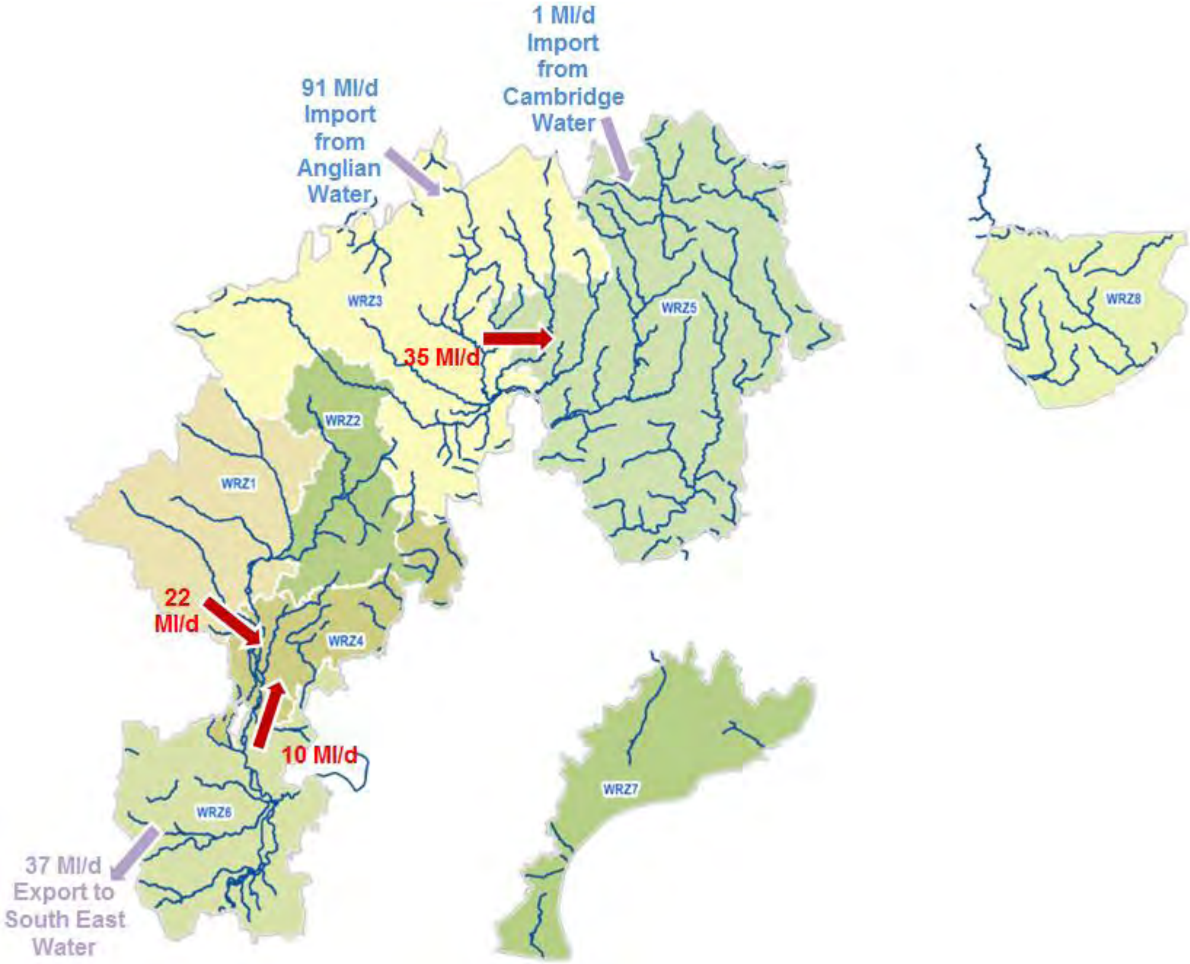

Figure 36: Transfer assumptions with no drought management activities. Note red arrows indicate internal company transfers, and purple arrows indicate inter-company transfers

4.5.4 **Results with transfers and with drought management activities**

The models were re-run to include the implementation of drought management actions. The assumptions around transfers were adjusted to reflect how the WRZs might be operated with demand restrictions and supply side permits and orders in place. At the point of mobilising supply side permits and orders, all imports to the company would already have been maximised. Details of the sequencing of these drought management actions are provided in Section 1. The results show that each WRZ would be resilient to all of the historic and plausible droughts tested (i.e. no unfulfilled demand). However, it is important to note that the model assumptions may not be valid for those scenarios representing extreme drought i.e. matrix squares below the historic data and worse than the 1 in 200 year return period line.

The transfers required for this scenario are shown in Figure 37.

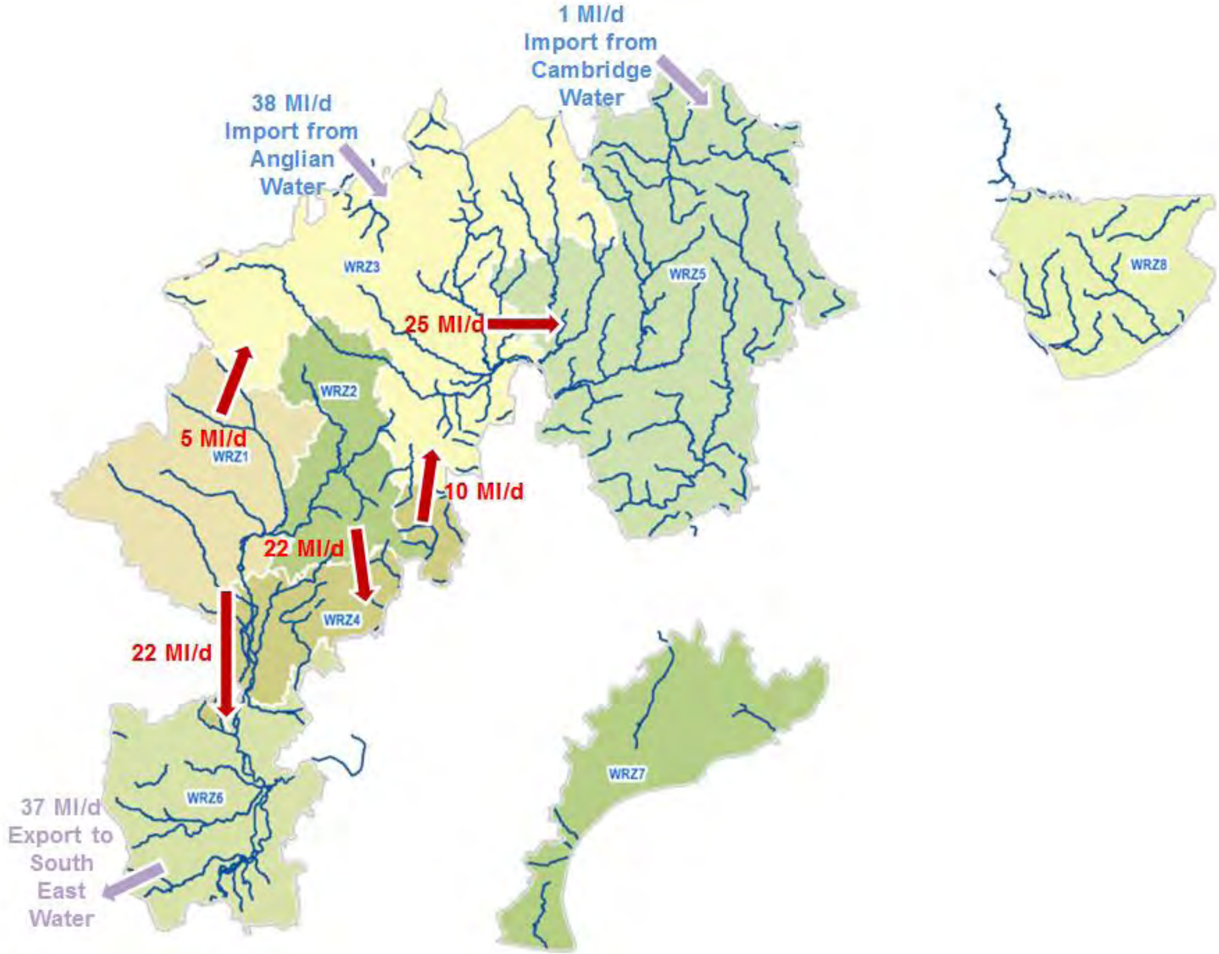

Figure 37: **Transfer assumptions with drought management activities imposed. Note red arrows indicate internal company transfers, and purple arrows indicate inter-company transfers**

4.5.5 Interpretation of results and implications for future investment

The drought sensitivity framework uses a matrix of rainfall deficit duration and intensities to present the results of the modelling, where durations are on 6 month increments between 6 months and 5 years, and intensities range between -10% and -80% of the Long Term Average (LTA) rainfall. Full details of the scenario modelling results can be found in the Appendices[16].

An example of how the scenario modelling results should be interpreted is provided below. The results for WRZ3 have been used, as this was demonstrated to be the zone most sensitive to drought conditions. The legend on the right indicates how the coloured squares represent the percentage of unfulfilled demand resulting from drought conditions. The y-axis represents intensity of drought (rainfall deficit with respect to LTA rainfall), and the x-axis represents duration of drought displayed in months.

Figure 38 shows the results matrix produced for WRZ3, with transfers included but with no drought management actions. The matrix clearly demonstrates that there are potential deficits in supply (of up to 7%), however this is only in an extreme and unlikely drought situation – lasting five years with 80% rainfall deficit. The grey squares on the matrix indicate that the WRZ is resilient to droughts of up to a three year duration at least with a 35% rainfall deficit, without any need for implementing drought management actions.

[16] AECOM, 2017, *Affinity Water Drought Management Plan – Drought Management Scenario Planning*

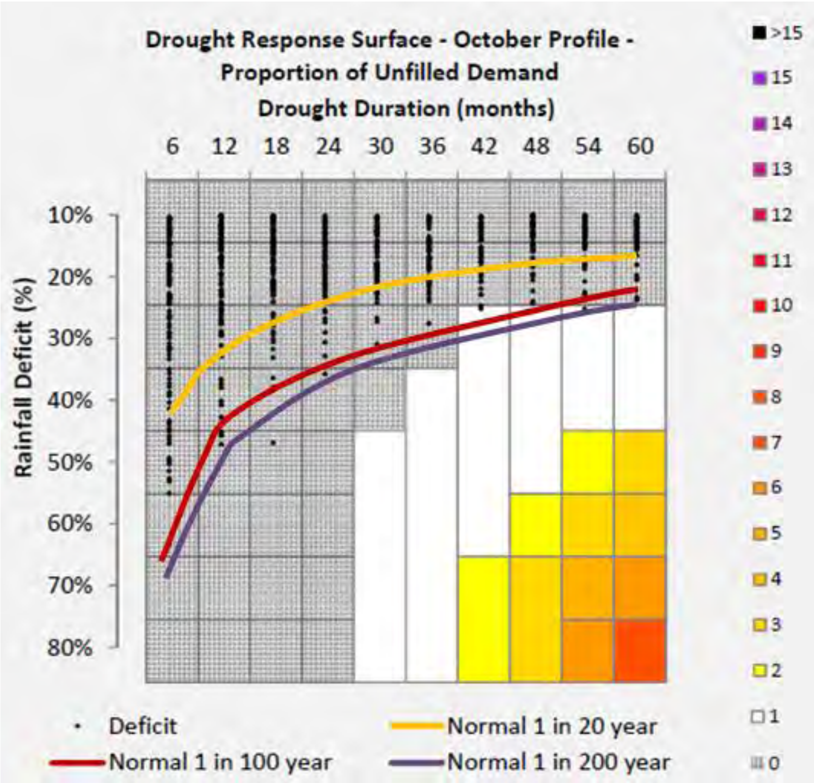

Figure 38: Scenario modelling matrix for Water Resource Zone 3 – with transfers and without drought management actions

Once the model has been re-run with drought management actions incorporated into WRZ3, the deficit is eliminated under almost every drought scenario, as shown in Figure 39. This demonstrates that our drought management actions are appropriate, and our DMP is robust.

It should be noted that some of our drought management actions will result in costs prior to implementation. Principal among these are the drought permit and drought order options for Sustainability Reduction sites, where pumping stations have been switched off and will need to be brought back into supply. These investment requirements will be dealt with in our next Water Resource Management Plan. Once this DMP is published in 2018, there will be two years remaining of AMP6, and as indicated in Figure 38, we are resilient to droughts of up to 3 years. We are therefore secure against a severe drought at least until the next AMP, when investment requirements will be reviewed.

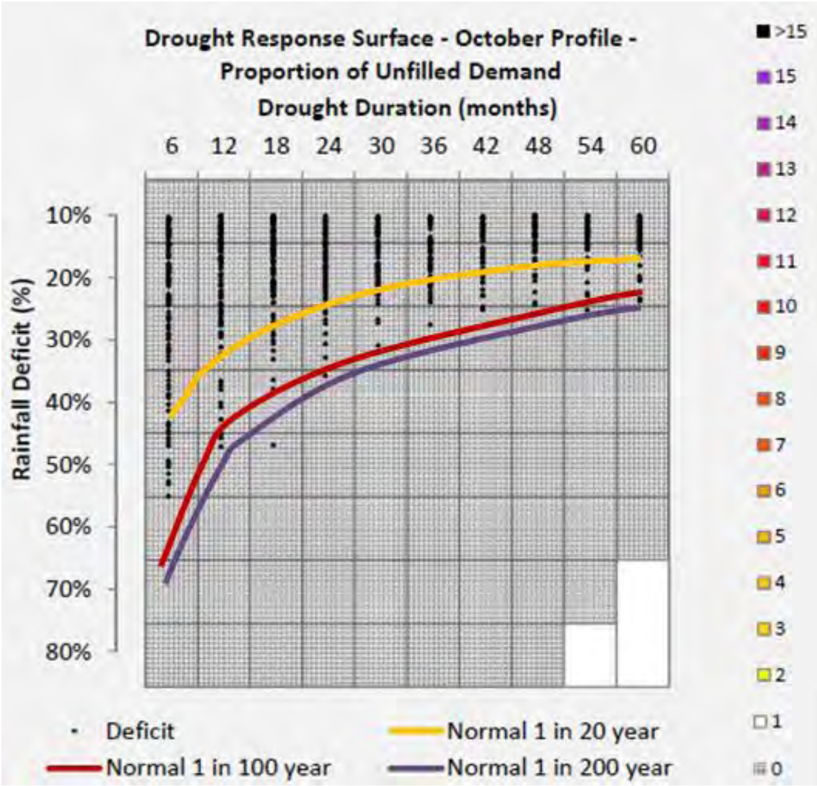

Figure 39: Scenario modelling matrix for Water Resource Zone 3 – with transfers and with drought management actions

4.5.6 **Conclusions**

Drought scenario testing has been undertaken for our Central, East and Southeast regions in line with regulator guidelines. The results of the modelling demonstrate that the degree to which our WRZs are resilient to drought is dependent on the assumptions around (i) imports and transfers between WRZs, and (ii) the drought management actions that can be implemented. Our WRZs 3, 4, 5 (Central region) and 7 (Southeast region) are the most vulnerable to drought owing to the magnitude of WRZ demand relative to WRZ supplies. However, once available transfers and demand management actions are applied, it can be demonstrated that our regions are resilient to historic droughts as well as plausible droughts slightly worse than those in the historic record.

The drought scenario testing has provided some useful high level outputs and an understanding of our resilience to various drought severities and durations. It is however important that the limitations of the modelling outlined in the full report are considered when interpreting the results. In particular, the results matrices that are below the historic data and the 1 in 200 year event line represent conditions worse than those covered by our DMP. These droughts would fall within the remit of the Emergency Plan and the assumptions within the models may no longer be valid.

5 Drought Management Actions

5.1 Introduction

During a drought, we would manage our supply and demand balance using a two tiered approach, in which we would look to reduce demands on our water resources, as well as increasing the water available for use. This is consistent with the approach we have adopted in our WRMP. We would always seek to manage demand for water first before instigating the supply-side measures that are potentially available to us. We would also implement environmental monitoring associated with Drought Permits/Orders as described in Section 6.

As no two droughts are the same, it is not possible to give precise timings for when the different measures would be implemented (see Section 3.4). The timetable is therefore informed by the severity, timing and the duration of a rainfall deficit. This section explores the different management actions available to us, in both the lead up to and during a drought event. It also identifies the relevant Drought Trigger Zones when we anticipate we would use the options and provides more detail on the actions discussed below. A summary of these actions is shown in Figure 40.

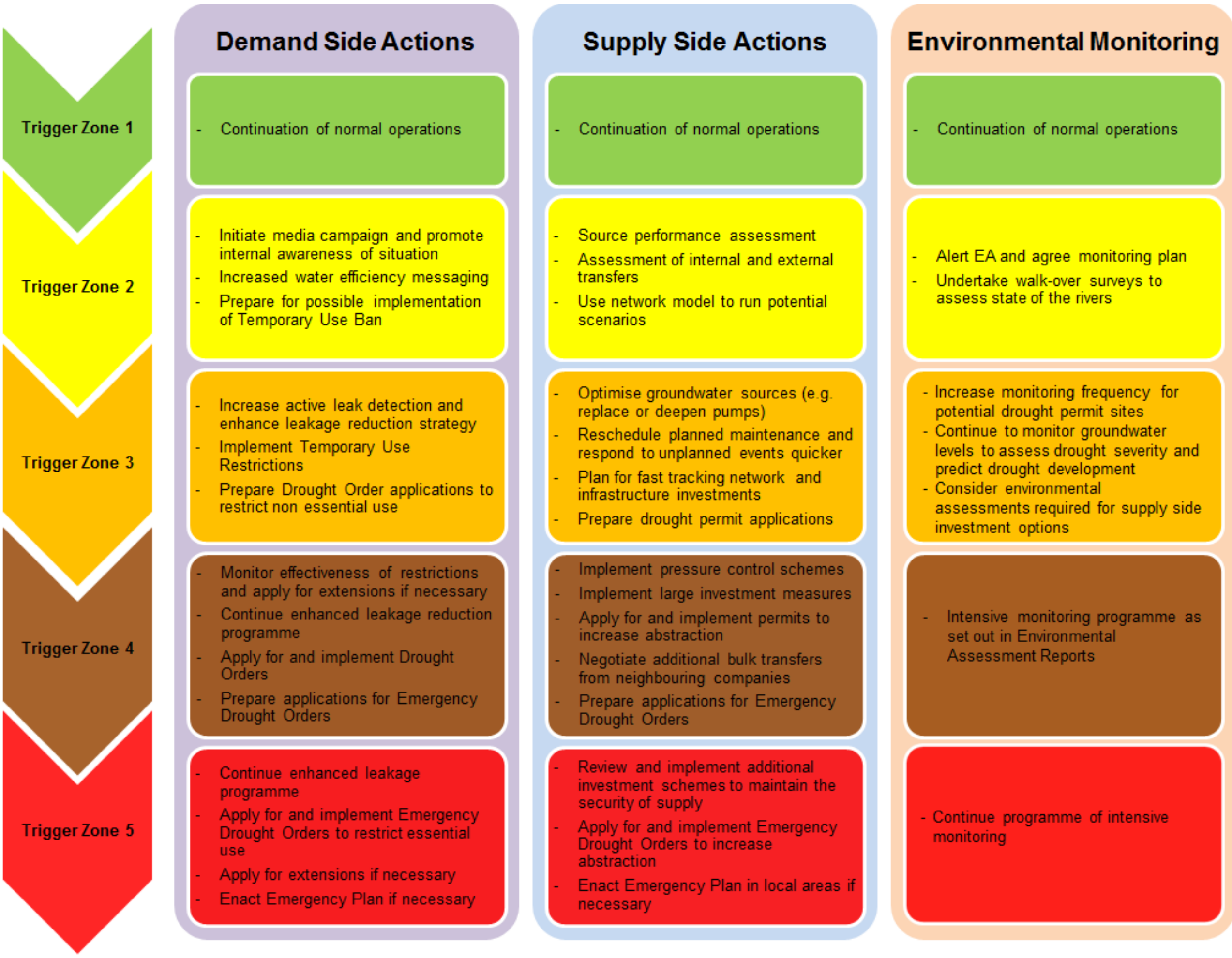

Figure 40: Summary of drought management actions

5.2 Demand Side Actions

Over the next 25 years, pressure on water supplies in our supply area is expected to increase. There are a number of factors contributing to this pressure, including:

- Changes to abstraction licences, known as sustainability reductions (SR), which will reduce the quantity of water we can abstract from sources in order to help minimise our impact on the environment.
- The effects of climate change. These are likely to include drier summers, although our latest analysis identifies that the impact of climate change on demand is lower than assessed in our previous WRMP. This analysis takes account of UKWIR (2013)[17].
- An overall increase in demand, driven primarily by the forecasted increase in population within our operating area.

Through our PR14 WRMP we have identified how we intend to maintain the balance between supply and demand over a 25 year period, which includes the implementation of a number of new measures and schemes. Demand management is a key feature of our WRMP, within which we have committed to a reduction in demand of over 50 Ml/d by 2020 through an increase in water efficiency measures, metering and reductions in leakage. This is essential to help us to maintain the balance between supply and demand for water.

During periods of drought there are a number of demand side options available to use. These include:

- Media campaigns to increase water efficiency
- Enhanced leakage reduction
- Implementation of a Temporary Use Ban
- Implementation of Ordinary Drought Orders
- Implementation of Emergency Drought Orders

The order in which we would implement these actions is identified within the following sections.

5.2.1 Drought Trigger Zone 1

The purpose of Drought Trigger Zone 1 is to act as a warning to us that the groundwater levels have dropped below the long-term average. This in itself is not a problem, as levels regularly fluctuate above and below this trigger line, so under average conditions we would expect them to naturally return to normal. However, by recognising that it has crossed into this zone it allows us to increase our monitoring of groundwater levels, and ensures that we are prepared to take further actions if they continue to decline.

We would not implement any specific demand management actions as a result of entering this zone. Instead we would continue with our baseline water efficiency, metering and leakage programmes which are explained in full detail within our WRMP. Further details of our leakage programme are detailed below.

Our target level of leakage is determined using a cost-benefit approach based on the sustainable economic level of leakage (SELL). This approach identifies the level of leakage which is most effective in minimising the combined cost of producing the water which is lost and the cost of leakage control. Leakage control above this level will cost more than the cost of replacing the water that is saved and is therefore not cost-beneficial. Through the work carried out for our WRMP, we identified that customers place a high priority on leakage reduction.

[17] UKWIR, 2013, *Impact of Climate Change on Water Demand – Main Report*

Therefore we have committed to a challenging programme of leakage reduction which will fulfil the following objectives:

- A continuous reduction in leakage throughout the 25 year planning period (2015-2040)
- Control of leakage year on year below a predetermined leakage target
- Continual improvement towards increasing efficiency in managing and controlling leakage
- Continuing our innovative implementation of fast logging to assess legitimate night use on a weekly basis, to improve our assessment of net night use and therefore improve the efficiency of our leakage reduction targeting
- Continuing the monitoring of leakage activities compared to benefits at District Metered Area (DMA) level will enhance our understanding of the natural rate of rise and the cost of reducing leakage further.
- Implementing leakage monitoring on our critical mains
- Improved assessment of leakage benefits from mains renewals
- Improved assessment of supply pipe leakage associated with our integrated metering programme

We will ensure continuous reduction in leakage levels through the careful monitoring and response to leakage outbreaks and the natural rate of rise of leakage encountered together with controlled implementation of leakage reduction measures.

5.2.2 **Drought Trigger Zone 2**

5.2.2.1 Publicity campaign

As a result of entering Drought Trigger Zone 2, we would increase the level of communication with customers and stakeholders to make them aware of the potential drought in advance of the drought impacting their water supplies. As the drought develops we would maintain a flexible approach to our communications strategy, escalating the measures we would take as outlined in Section 8.4, to ensure that we communicate the increasing severity in the most effective way possible. This would be carried out in addition to our routine water efficiency promotion.

Our on-going baseline media and communications plan provides customers with information on water efficiency measures. This is achieved through website and media communications, operating a very active Water Saving Squad, working with local authorities and talking to local groups. We also continue to promote the work done by Affinity Water Education Service, especially with student groups. We also have a strong record of distributing water saving devices directly to customers as part of our Water Saving Programme.

In addition, we support industry and academic research and development groups in order to understand the issues involved in promoting water efficiency nationally. We continue to participate in groups such as the Water Efficiency Network, Waterwise, Anglian Regional Water Efficiency Group, and the Water UK/Ofwat/Defra/Environment Agency Quadripartite.

5.2.2.2 Leakage

As stated above we have a rigorous leakage programme, which would continue as we move into Drought Trigger Zone 2.

5.2.2.3 Metering

As stated in Section 2.3.1, we have commenced our Water Saving Programme in our Central region, which will see us reach a 72% household metering penetration by 2020 and 90% by 2025, whilst in our East and Southeast regions the household meter penetration is already at 74% and 90% respectively. We therefore do not propose any drought specific actions to encourage customers to have a meter in response to a drought.

5.2.3 **Drought Trigger Zone 3**

5.2.3.1 Leakage

We would seek to enhance our leakage activity in response to entering Drought Trigger Zone 3, which would include a change to our strategy. Upon entering Drought Trigger Zone 3 and prior to implementing Temporary Use Bans, we would seek to:

- Redeploy staff to work on tackling leakage
- Reduce repair time for visible leaks
- Increase active leakage detection and repair activities

We believe this policy contributed to our success in promoting the water efficiency conservation message during the 2011/12 drought.

5.2.3.2 Temporary Use Ban

Temporary bans on water use are an important measure that water companies can use to reduce demand during a drought. They not only enable companies to maintain essential supplies but also help to conserve water resources for later in a drought, and reduce the environmental impacts of abstraction during this critical period. We support the principles and actions set out the Code of Practice and Guidance for Water Companies on Water Use Restrictions – 2013 published by UKWIR. Should circumstances require that we depart from the Code of Practice, we will explain the reasons for this.

The Water Use (Temporary Bans) Order 2010 provides detailed definitions of uses, exemptions and conditions in relation to these new powers.

The activities that would be restricted by the implementation of Temporary Use Bans are shown in Table 11. These restrictions are only applied to domestic customers.

Table 11: Summary of activities restricted through the implementation of temporary use restrictions

Zone 3 – All 11 Temporary Ban measures (WUO 2010) introduced in single phase
– Watering a garden* using a hosepipe
– Cleaning a private motor-vehicle using a hosepipe
– Watering plants on domestic or other non-commercial premises using a hosepipe
– Cleaning a private leisure boat using a hosepipe
– Filling or maintaining a domestic swimming or paddling pool
– Drawing water, using a hosepipe, for domestic recreational use
– Filling or maintaining a domestic pond using a hosepipe; and
– 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

* The definition of a 'garden' has been widened to include: a park; gardens open to the public; a lawn; a grass verge; an area of grass used for sport or recreation; an allotment garden; any area of an allotment used for non-commercial purposes; any other green space. It does not include: agricultural land; other land used in the course of a business for the purposes of growing, for sale or commercial use, any crops, fruit, vegetables or other plants; land used for the purposes of a National Plant Collection; a temporary garden or flower display; plants (including plant organs, seeds, crops and trees) which are in an outdoor pot or in the ground, under cover.

Crossing into Drought Trigger Zone 3 will not automatically result in us implementing a temporary use ban; rather it depends on the overall conditions being experienced during the drought. We may choose to delay the imposition of restrictions until a more appropriate time. For instance, if Drought Trigger Zone 3 was not reached until autumn and then tracked the trigger level, either slightly above or below, we would not aim to impose restrictions until the spring of the following year, when the pattern and amount of recharge was better understood.

We would review the situation in January and then again in April, when the recharge season was completed.

We appreciate the confusion that can be caused among customers when one company introduces restrictions but its neighbouring company does not. Where appropriate we would work with our neighbouring companies to implement restrictions in a consistent manner. With this in mind, a Drought Liaison Coordinator will be appointed by Water UK, and their role will be to act as an industry spokesperson. Figure 49 illustrates the expected role of this coordinator in liaising with interest groups during a period of drought management, to ensure consistency of public messages.

Before any restrictions are implemented under these new provisions, we will provide the opportunity for representations to be made. This will be done in line with the requirements set out in Section 76B of the WIA 1991. The process that we would follow to implement the restrictions are detailed in the following sections.

5.2.3.2.1 Publicity requirements

Before applying any restrictions, we will:

- Publish notice on our company website at the same time as we publish notice in two newspapers circulating in the affected areas
- Provide details in the notice of how to make representations about proposed restriction and exceptions
- Give notice each time the scope of any restriction is altered; and
- Give notice in relation to the lifting of any restriction on the website and in two newspapers circulating in the affected areas

5.2.3.2.2 Making representations

Before any restrictions are implemented we will provide the opportunity for representations to be made. We will allow 2 weeks for representations to be made in the first instance and one week for any subsequent notices or changes in the restrictions or the exceptions. Our proposed timescales are outlined in Appendix 4.1. Those seeking to make a representation will be able to do so by completing and returning a representation form (Appendix 4.3). Representations can be made through the following forms of media:

- Our Website
  - An E-copy of the form will be available to be completed and returned directly online
  - A paper copy will be available to download and print off, then sent to our head office
- Email
  - Email representations to a dedicated email address
- Telephone
  - A copy of the form can be requested by telephone and will be mailed to a customer address
  - A contact service advisor will be able to complete an e-copy of the form by taking customer details over the phone
- In addition to this we would review all other potential forms of media and utilise any we considered suitable.

5.2.3.2.3 *Handling representations*

Representations received into the business will be collected and reviewed on a weekly basis. A panel of three members from the Drought Management Group (described in Section 8.2.2) will convene to discuss the outcome of representations with responses proposed for approval of the DMG. A final decision will be made by all three representatives on any action to be taken as a result of the representations. Representations will be considered on an individual basis and as a whole. Exceptions from restrictions will not be granted on a case by case basis unless provision is made in the public notice. There will be no appeal process if the application for a concession or exception is denied.

5.2.3.2.4 *Implementation of restrictions*

Water companies have the flexibility to prioritise and sequence different categories of restriction, which could lead to the implementation of restriction on different activities at different times. We believe this could cause confusion among customers and would be difficult to consult upon. Instead, a single phase in which all eleven activities are simultaneously banned at the start of the Temporary Use Ban is felt to be the clearest implementation policy. The activities that would be restricted under this measure are identified above in Table 11. We are aware that the complexity of the restrictions has the potential to be confusing. We will endeavour to minimise confusion by informing our customers on what the restrictions are and what they mean.

Following the consultation period outlined above we would publish our statement of response on our website, outlining how we have responded to representations.

We feel that by imposing the full use of powers immediately we maximise the benefit of the restrictions and ensure resources remain within our ability to supply customers. This also sends out a strong and clear message to customers that the situation is deteriorating. Restrictions would be imposed for the minimum period required and would be lifted with immediate effect once the situation has recovered. Whilst there will be a lead in time for the implementation of restrictions to allow for representations, there is no such lead in time necessary for the revocation of restrictions; the lifting of a ban will take effect as soon as notice is given.

5.2.3.2.5 *Exceptions*

Table 12 provides details of activities which will be exempt from the TUB restrictions. These have been informed by the Statutory Exceptions set out in the legislation and Discretionary Universal Exceptions as agreed as part of the UKWIR Code of Practice[18]. In order to conserve water and ensure a safe and secure supply during a drought, no other exceptions will normally be granted. Where other exceptions are proposed, we will state this in our public notice.

Table 12: Temporary Use Ban exceptions

TUB Category	Exception	Note
1. Watering a garden using a hosepipe	1. Using a hosepipe to water a garden for health and safety reasons 2. To Blue Badge holders on the grounds of disability 3. Use of an approved drip or trickle irrigation system fitted with a pressure reducing valve and timer	An area of grass used for sport or recreation is included in the definition of a garden. This exception would only apply to the active strip/playing area, and not the entire ground. The remaining ground can still be watered using other methods
2. Cleaning a private-motor-vehicle using a hosepipe	1. To Blue Badge holders on the grounds of disability 2. Use of a hosepipe in the course of a business to	A private motor-vehicle' does not include (1) a public service vehicles, as defined in section 1 of the Public

[18] UKWIR, 2013, *Managing through drought: Code of practice and guidance for water companies on water use restrictions – 2013 (incorporating lessons from the 2011-12 drought). 14/WR/33/6*

TUB Category	Exception	Note
	clean private motor vehicles where this is done as a service to customers	Passenger Vehicles Act 1981 (c), and (2) a goods vehicles, as defined in section 192 of the Road Traffic Act 1988(d).
3. Watering plants on domestic or other non-commercial premises using a hosepipe	1. To Blue Badge holders on the grounds of disability 2. Use of an approved drip or trickle irrigation system fitted with a pressure reducing valve and timer	This does not include watering plants that are (1) grown or kept for sale or commercial use, or (2) that are part of a National Plant Collection or temporary garden or flower display
4. Cleaning a private leisure boat using a hosepipe	1. Cleaning any area of a private leisure boat which, except for doors and windows, is enclosed by a roof and walls. 2. Using a hosepipe to clean a private leisure boat for health or safety reasons 3. Commercial cleaning 4. Vessels of primary residence 5. Cases where fouling is causing increased fuel consumption 6. Engines designed to be cleaned with a hosepipe	
5. Filling or maintaining a domestic swimming or paddling pool	Fill or maintaining a pool: 1. Where necessary in the course of its construction. 2. using a hand-held container which is filled with water drawn directly from a tap 3. That is designed, constructed or adapted for use in the course of a programme of medical treatment. 4. Used for the purpose of decontaminating animals from infections or disease. 5. Used in the course of a programme of veterinary treatment. 6. In which fish or other aquatic animals are being reared or kept in captivity.	1. Hot tubs are not classed as pools 2. Pools with religious significance are not domestic pools 3. Pools used by school pupils for swimming lessons should be excluded but are covered by the Drought Order legislation
6. Drawing water, using a hosepipe, for domestic recreational use	None	
7. Filling or maintaining a domestic pond using a hosepipe; and	1. Filling or maintaining a domestic pond In which fish or other aquatic animals are being reared or kept in captivity. 2. Blue badge holders on the grounds of disability	
8. Filling or maintaining an ornamental fountain	1. Filling or maintaining an ornamental fountain which is in or near a fish pond and whose purpose is to supply sufficient oxygen to the water in the pond in order to keep the fish healthy	
9. Cleaning walls, or windows, of domestic premises using a hosepipe	1. Using a hosepipe to clean the walls or windows of a domestic premises for health or safety reasons 2. To Blue Badge holders on the grounds of disability 3. Commercial cleaning	1. The use of water-fed poles for window cleaning at height is permitted under H&S statutory exception 2. The restrictions do not apply where cleaning apparatus is not connected to mains supply
10. Cleaning paths or patios using a	1. Using a hosepipe to clean paths or patios for health or safety reasons	

TUB Category	Exception	Note
hosepipe	2. To Blue Badge holders on the grounds of disability 3. Commercial cleaning	
11. Cleaning other artificial outdoor surfaces using a hosepipe	1. Using a hosepipe to clean an artificial outdoor surface for health or safety reasons 2. To Blue Badge holders on the grounds of disability 3. Commercial cleaning	1. The use of water-fed poles for window cleaning at height is permitted under H&S statutory exception 2. The restrictions do not apply where cleaning apparatus is not connected to mains supply

5.2.3.2.5 Enforcement

We will publish our policy on enforcement by the date that restrictions come into effect.

5.2.3.2.6 Adjustment to charges

We do not make a charge for water used for any of the restricted uses so no reduction in charges would apply in the event of a temporary use ban.

5.2.3.2.7 Monitoring and review of temporary restrictions

A post implementation review of the impacts and demand savings of these restrictions will be completed after a drought period.

5.2.4 **Drought Trigger Zone 4**

5.2.4.1 Ordinary drought orders

Ordinary drought orders under the WRA 1991 can be sought by a water company to restrict the use of water for those categories set out in the Drought Direction 2011. These categories are identified in Table 13.

Ordinary drought orders must be granted by the Secretary of State.

Table 13: Summary of activities restricted by drought orders

Zone 4 – All 10 drought order (DD11) measures introduced in single phase
– Watering outdoor plants on commercial premises
– Filling or maintaining a non-domestic swimming or paddling pool
– Filling or maintaining a pond
– Cleaning non-domestic premises
– Cleaning a window of a non-domestic building
– Operating a mechanical vehicle-washer
– Cleaning any vehicle, boat, aircraft or railway rolling stock
– Cleaning industrial plant
– Suppressing dust
– Operating cisterns

We would not introduce the measures given in the Drought Direction 2011 legislation if the water situation was not becoming demonstrably very serious. We consider that a straightforward total ban without exemptions not only sends a clear message underlining the severity but also maximises water savings and is easier to communicate and administer. Statutory health and safety exceptions apply to some categories as set out in the Direction. The process of representations would also be consistent with that outlined in Section 5.2.3.2.3. In the unlikely event of the need to apply for an emergency drought order, such an approach would stand us in good stead for an application.

Prior to an ordinary drought order application, we would discuss the need for such a measure with Defra as well as the EA. Within the application process, the principal document submitted to Defra is the 'Statement of Reasons', which presents our case for seeking authorisation to implement these restrictions. This report would explain, in detail, why and how the exceptional shortage of rainfall is likely to lead to a serious deficiency in water supply.

Following our application, if any objections are received, the Secretary of State would hold a local inquiry or hearing unless he/she considered that the drought order must be made urgently. This could be a lengthy process and experience from the 2006 drought, when four water companies applied for drought orders, showed that the process from first advertising the intention to apply for a drought order to receiving notice of the order took around 3 months. This period of time would be taken into account when planning when to apply for any required drought orders.

5.2.5 **Drought Trigger Zone 5**

5.2.5.1 Emergency drought orders

Under the scope of 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, however we consider the use of stand pipes or rota cuts to be unacceptable and would only implement these in a civil emergency. Emergency drought orders have not been implemented in the UK by any water company since 1976, since when there has been significant investment across the water industry. If those drought conditions were experienced again there would be no need for an emergency drought order.

In an event that the drought was to reach this level of severity then we would enact our Emergency Plan and restrictions would likely only need to be implemented in particular areas of significant water stress, the scope of which is not considered as part of the remit of this Drought Management Plan. The decision to transition from our Drought Management Plan to our Emergency Plan will be made by the Drought Management Group.

5.2.6 **Savings expected from demand management measures**

We believe that the actions and prioritisation of measures that we have identified will provide the most effective approach to demand management as the drought intensifies. However, it is difficult to quantify the precise savings made directly from independent demand management measures. For example, we would expect that any accompanying media campaign will play a key role in reducing water usage both in advance and at the time of imposing TUBs. It would also potentially impact use in future years as the seriousness of the situation is highlighted to the public. There have been various studies which have tried to separate out these impacts, which we have used to inform our assumptions.

The impact of demand side measures was assessed in 2006 by the UKWIR Drought and Demand Project[19]. The results indicated that during the drought there were savings in the order of 20% on the peak day, 15% on the peak week, 7% on the peak month and 3% on the annual average. This report assessed the range of impact within the WRZs that applied the restrictions, each of which experienced differing levels of demand reductions. The range of reductions is shown in Table 14.

[19] UKWIR, 2006, *Drought and Demand: Modelling the Impact of Restrictions on Demand During Drought. 07/WR/02/3*

Table 14: Estimated Impact of Restrictions on Demand

Restriction type	Summer demand effect	Winter demand effect
Unattended hosepipe ban	4-5%	3%
Full hosepipe ban	5% - 10%	No effect – 7%
Non-essential use ban	18%	n/a

The report demonstrated that the estimated effects of restrictions must always be considered in context, taking account of:

- The different characteristics of each drought
- The customer profile and consumption characteristics of each WRZ
- Antecedent drought actions, restrictions and or other drought related actions.

Following the 2011/12 drought two further studies were undertaken:

- EA and JBA report – Quantifying the Impact of Water Company Drought Measures on Water Demand[20],
- UKWIR study – Understanding the impacts of drought restrictions [21]

During the drought, six water companies in the South East, including Affinity Water, applied TUB restrictions as shown in Figure 41. Following the implementation of the restrictions, the South East of England experienced an unprecedented amount of summer rainfall. This made it difficult to model the effects of the TUBs as the impact on demand could not be separated from the weather impacts. Although consumption during the TUB ban period was lower than the comparable period in 2013 no conclusive percentage impacts where identified.

[20] Environment Agency, 2013, *Quantifying the Impact of Water Company Drought Measures on Water Demand*
[21] UKWIR, *Understanding the impacts of drought restrictions. 14/WR/01/13*

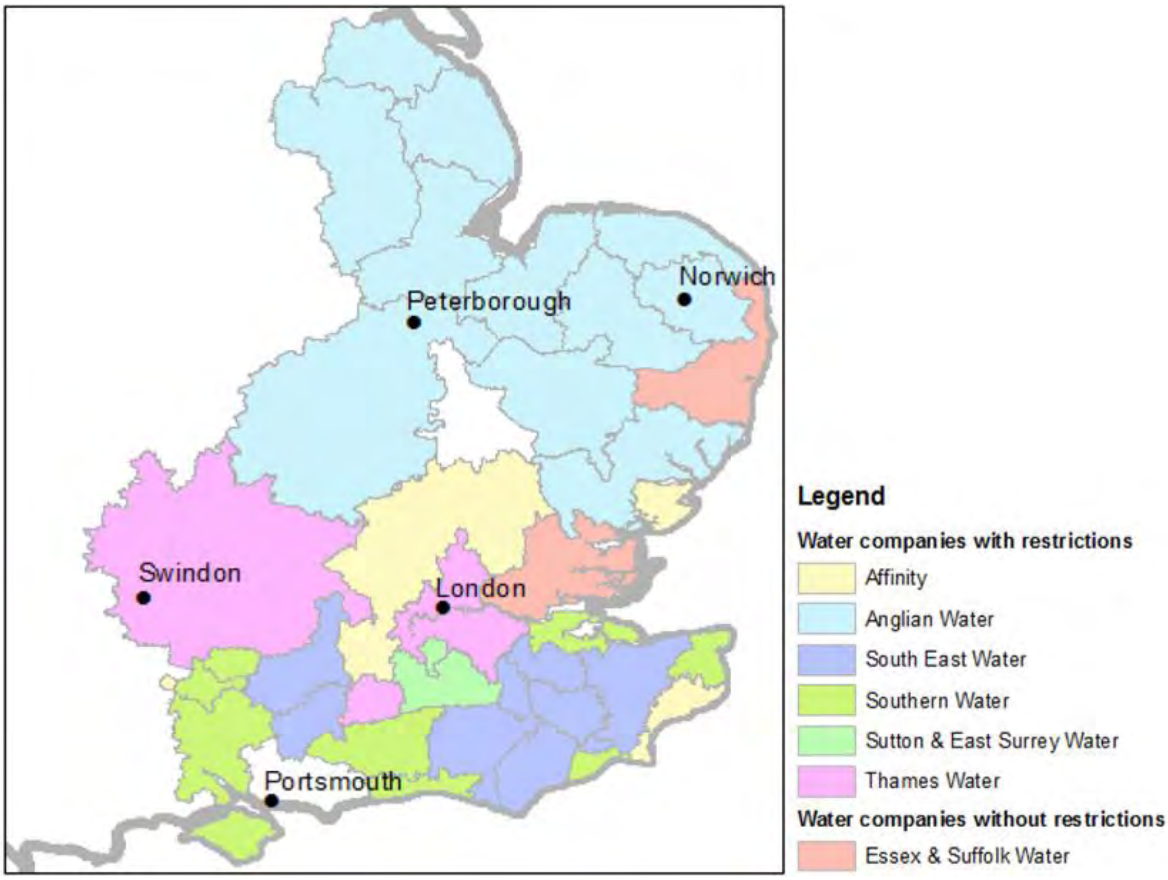

Figure 41: Water companies with Temporary Use Bans, spring 2012[22]. Note restrictions were not imposed in our East Region

In addition to these industry studies we have also developed our own internal model, working with the Met Office, in order to enhance our understanding of the weather dependent component of water demand in our supply area. This partnership with the Met Office has produced a tool to detect weather influence in water demand and was primarily developed to help us report against our Average Water Use Outcome Delivery Incentive (ODI) as we can now report each year on a consistent 'dryness' basis with the base year. However, we can also assess how well the model performed during the drought restrictions. Figure 42 shows that during a non-restricted summer, such as 2013, the model fairly accurately predicts the fluctuations in demand. During the summer of 2012 however, the red lines reflect the point in which we imposed and lifted the TUBs and it can be seen that during this time the observed demand is significantly lower than the models predicted demand. This continues for the next couple of months after the ban was lifted.

[22] Environment Agency, 2013, *Quantifying the Impact of Water Company Drought Measures on Water Demand*

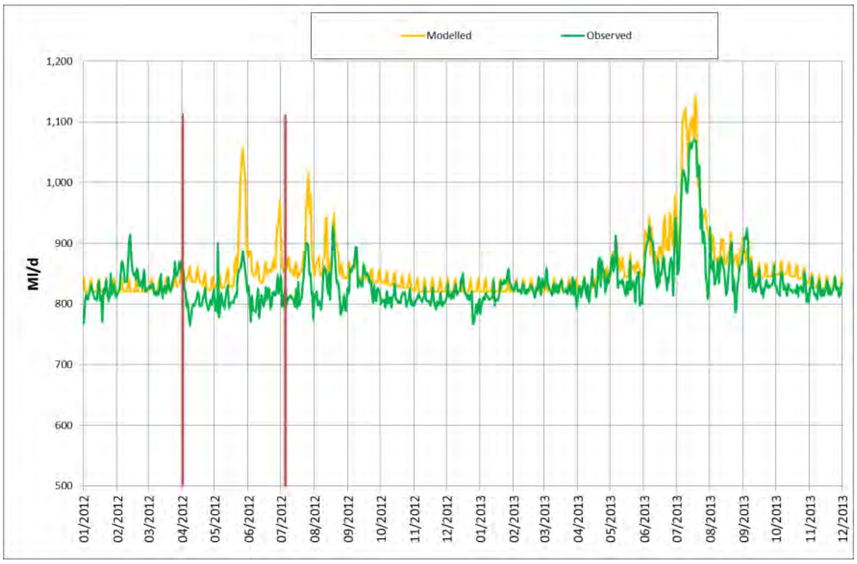

Figure 42: Comparison between measured and modelled distribution input

We have used the information from these studies along with our internal weather/demand model to inform our assumptions on the expected savings from our demand management measures. As identified in the 2006 UKWIR study, we expect the outcome of these measures to be dependent upon the scenario, level of activity and the extent of the drought. It is also worth noting that our current Water Savings Programme (outlined in Section 2.3.1) will significantly increase the metering penetration throughout our supply area and it is reasonable to expect that peak demand will reduce and we will see a reduction in the savings achieved from the implementation of the TUBs. This will therefore need to be reassessed as further information becomes available.

Figure 43 identifies the estimated cumulative impact from one Drought Trigger Zone to the next of the implementation of drought options. The graph is presented with a minimum and maximum scenario for the likely savings. This takes account of the combined effect resulting from the phased delivery of the measures as for example; we believe the implementation of temporary usage ban restrictions may not independently result in a major reduction in demand. Instead, this would be generated from a combination of the increased publicity and water efficiency awareness leading up to and after the point that the restrictions are necessary. Within this we have not tried to assess the benefits of emergency drought orders as we do not consider this to be within the scope of our DMP, as they would only be implemented in a civil emergency.

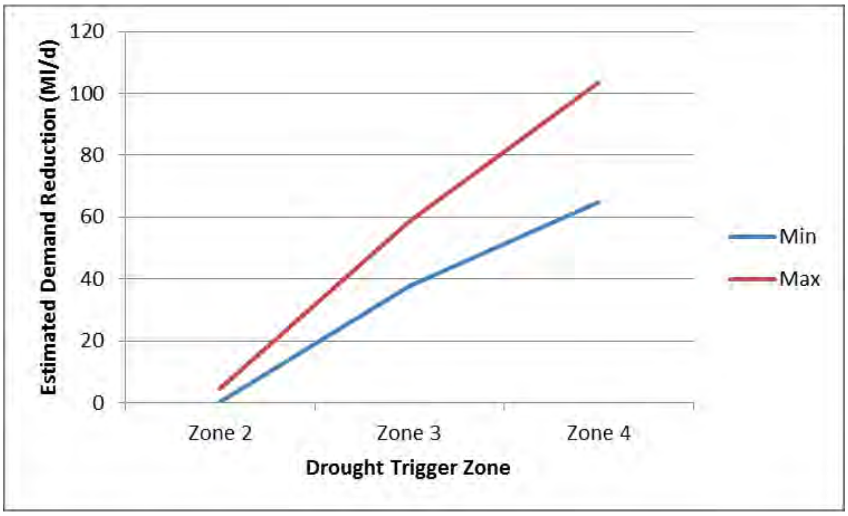

Figure 43: Cumulative demand reductions from drought options across all regions

5.3 Supply Side Actions

There are a number of supply-side actions available to us in each of our regions which would form part of our drought management response. With the exception of drought permits/orders, supply-side measures do not form part of our stated Levels of Service. Therefore the timing of these measures will be dependent on the particular drought circumstances and their implementation would be designed to increase the amount of water available for supply. Supply-side measures could include actions such as:

- Re-commissioning of unused sources
- Bulk transfers of water from neighbouring water companies
- Lowering of pumps or deepening boreholes
- Engineering works

The available actions would be investigated and assessed during Drought Trigger Zones 2 and 3 to be ready for implementation in Drought Trigger Zones 4 and 5. Whilst we believe the options identified are the most likely to be used during a drought we will continue to review and assess the options available to us as our knowledge and understanding of aspects such as the impacts of climate change, sustainability reductions and NEP studies increases. Any significant changes to the options available to us will be reported in our next full update of our plan or the subsequent annual reviews.

5.3.1 Operational performance optimisation

All operational sites are reviewed to ensure they are operating optimally in the face of drought conditions. Any maintenance work would be carried out with a view to minimising duration of outage (the temporary loss of a source). Outage events are managed through our Control Room and in order to maximise availability through the drought any capital works which would require us to switch off our sites would be rescheduled to minimise loss during critical periods. A review would be undertaken of all previous drought measures at our sites to ensure they remain in place or plans are put in to action to ensure the drought settings are restored. Instrumentation such as borehole level transducers, which we rely on to measure the groundwater levels, are checked to ensure reliable data is reported. We would also liaise with neighbouring water companies to ensure a clear understanding of the effect of the drought on the availability of imports and exports. Any loss of capacity is reviewed through our mass balance assessment to verify security of supply.

5.3.2 Utilisation of groundwater sources

Source assessments have been undertaken for all groundwater sources to identify those that are underperforming compared to their expected/licensed capacity. Water level investigation at these sources identifies possible ways to optimise the performance of the source either by changing the operational pattern or by replacing the pumps and placing the pump deeper in the borehole. Taking into account local hydrogeological characteristics and the constraints imposed on the yield of a borehole, an optimum pattern is identified in order to maximise output under peak demand conditions and establish sustainable constant rate output under average demand periods. We would then use our mass balance model to ensure that our source availability has been maximised before alternative options are sought. The assessment also allows us to identify contingency plans for any source that might go out of supply due to low water levels or reduced output.

5.3.3 Additional output

Sources are reviewed to determine the feasibility of increasing abstraction by increasing pumping capacity or drilling satellite wells. In sites where blending options are currently in place, this has the potential to trigger water quality issues and therefore additional blending options would need to be sought or installation of different treatment plants considered. Before distributing additional water from our sources we would conduct risk assessments in order to identify potential water quality issues. We know that moving water with different chemical characteristics within some of our pipes could result in deterioration in the water quality, as more "aggressive" water can erode the chalk lining in the pipes and increase turbidity. This has the potential to result in an increase in leakage as the chalk lining is being removed from the pipes. We would therefore carry out hydraulic modelling prior to making any changes to allow us to plan and mitigate any potential problems.

5.3.4 Re-commissioning of sources

This option involves re-instating dormant sources to allow us to abstract additional water. This would be done with consideration of group licences to ensure we do not exceed our abstraction allowances. Abandoned and/or disconnected sources are another option to be considered. In many cases, the local aquifer characteristics might restrict the output of a source and give a low yield at a high operational cost. However, in cases where the location of the source is critical to supply a local area, this could be a very important contingency plan. The abandoned sources were often out of supply due to water quality issues, which may be overcome by the installation of the appropriate treatment plant subject to discussion and approval of DWI.

5.3.5 Intra company transfers

We have the ability to utilise the flexibility of our infrastructure and this option would be considered based on the water balance for each Hydraulic Demand Zone (HDZ). In cases where we have a surplus in a HDZ, there is the potential to transfer the additional water to adjacent zones based on the current infrastructure. Hydraulic modelling is undertaken to identify potential transfers and the capability of the existing network configuration. Restrictions on the flow direction and the current setting of the mains have been taken into account in order to define available options. The possibility to transfer water from one zone to a neighbouring zone is already identified in most cases, (Control Room response plans and hydraulic modelling contingency plans) and used in our mass balance model to define the need for additional network reinforcements to meet forecast zonal drought deficits. Through this assessment it is also possible to identify new transfers which would further increase our flexibility and security of supply. Consideration would be given to fast tracking infrastructure improvements in places where it is very critical to move water from one zone to another. Our Asset Strategy teams have the expertise necessary to accelerate network reinforcements.

It is important to recognise that these options do not provide additional water within the company operating area but rather allow us more flexibility to be able to utilise it where it is most necessary.

Box 1: Case Study: 2011/12 Source Performance Review

The following text is an extract from a review of our sources conducted during the last drought and demonstrates how we do this work in practice:

'In order to highlight the areas that are likely to be at risk during peak demand a water balance methodology has been used that splits the company area into hydraulic demand zones (HDZ) and estimates the water balance within them. The equation that describes the above calculations in a HDZ is:

Demand = Source availability + Internal/External transfers

Demand forecasts for a third dry winter year have been estimated based on the average of the peak demand periods experienced in the past 10 years in order to be as representative as it can be at this stage. The source availability forecast for a severe drought is estimated based on historic data for our groundwater sources, pumping test data and predicted yield under lower than ever observed groundwater levels. This assessment categorises the groundwater sources using the traffic light system into 3 categories: Red, Amber and Green. The red sources are the most sensitive in changes in water levels and are expected to go out of supply. For the amber sources a 25% reduction in output has been estimated, while the green ones are expected to yield their Deployable Output (DO). The results of this assessment indicate that there will be a reduction of up to 100 Ml/d scattered throughout the supply area. This figure represents the worst case scenario assuming that water levels will decline everywhere at the same rate without any recharge taking place.

Our mass balance model has been used to evaluate potential zones at risk of supply deficit. Once preliminary investment requirements are identified more detailed design assessments are carried out using more sophisticated hydraulic models that exist for all hydraulic demand zones. The categorisation of the HDZs using the traffic light system helps to identify the critical HDZs with the higher deficit and subsequently the critical sources within that zone.

In addition to this, underperforming sources have been categorised using the traffic light system based on any pump issues experienced historically, using the our operational Production team's knowledge. Water quality issues and constraints are also included in the above assessment to verify the capability of each individual source under low groundwater conditions in order to produce a list with the viable options. The next step is to run multiple scenarios to determine first and second contingency and investment plans. The risk assessment results in a series of operational and investment recommendations to maintain security of supply in unprecedented drought and these are put forward for approval and subsequent implementation by the Drought Management Team'

5.3.6 **Bulk imports/exports**

As part of our PR14 WRMP, we reviewed potential imports and exports available from neighbouring water companies and key private borehole owners to identify if any were viable for long-term resource options. In the event of a drought, we would review these options again to identify the feasibility of short term bulk imports which would be dependent on drought conditions at the time. This option is to be considered especially in zones where the current network is operating at full capacity. Similarly if our water resource situation was healthy but there was a localised drought event affecting one of our neighbouring companies, we would expect to work with them wherever possible to support the security of public water supply for their customers. Both imports and exports with neighbouring water companies would be sought based on the capability of the infrastructure and the company's ability to move water to the area that is needed. Current options are reviewed and compared with outputs from scenario testing.

As part of our PR14 WRMP, we explored the feasibility of a number of potential 'new' imports, these included options such as Fortis Green (Thames Water), where agreement was reached to increase our import in order to increase our security or supply under emergency conditions (SEMD).

5.3.7 Pressure control schemes

Changes in network pressure can be an option, especially in the areas that are near the edges of the network. This helps us reduce the amount of water that we need to move around the network, which also reduces the risk of leakage. Risk assessments would be undertaken prior to this and hydraulic modelling would be able to simulate changes in pressure that will determine whether the scheme is viable or not. We have the understanding and capability to increase savings derived from pressure control schemes, but we are aware that these can increase the risk of compromising service standards. This risk will be addressed by the Drought Management Group (DMG). We also recognise that pressure reductions may affect some fixed fire-hydrants in our area, and will make every effort to mitigate any associated problems.

5.3.8 Increase deployable output of sources

Drought permits or orders would only be used under very severe drought scenario (Drought Trigger Zones 4 and 5). Below is an overview of the types of operations that we would apply for a permit to allow but further detail of the options that would be considered can be found in Section 5.4.

- Lifting of abstraction constraints:

  In environmentally sensitive areas where the impact of groundwater abstraction has been identified and quantified, there is the possibility of applying to lift the licence restrictions to allow for increased abstraction. In cases where river augmentation was in operation, this requirement could be lifted. In any of these cases, Drought Permits would be required from the Environment Agency to enable these to be realised and environmental assessments for target locations are included in the Appendices.

- Re-commissioning sustainability reduction sources

  Where we are de-commissioning or reducing the output of sources as part of our Sustainability Reduction (SR) Programme (see Table 7), we can apply to resume the pre-SR abstraction. This in some cases will involve installation of equipment and may take some time to implement.

  We have a long history of working closely with the EA to address the environmental impacts of our abstractions. In addition to the AMP6 and AMP7 sustainability reductions we have committed to, we have also implemented historic reductions to our abstractions, for the benefit of the environment and river catchments. These are summarised in Table 15. These sources are included in our list of drought permit options (Table 17).

- Install pumps and treatment at currently unlicensed boreholes (ours and third party):

  Potential sources are not identified at this time, but the ongoing investigation under the NEP projects has indicated areas with certain hydrogeological characteristics capable of sustaining a relatively high yield. This is to be confirmed once the appropriate boreholes have been selected and pumping tests will need to be undertaken. Moreover, the connection of the third party boreholes to our network is an issue to be considered as the location would determine the likelihood of such option. This option will be considered in areas where the forecast local demand could be met by a small source, as in places where large volumes are needed the most appropriate option is to drill a new borehole. In addition treatment and water quality issues would need to be considered before any additional sources are utilised for supply.

Table 15: Summary of historic abstraction reductions

Waterbody/Catchment	Year of implementation	Water Resource Zone	Average Reduction Volume (Ml/d)	Scheme
Ver	1993	2	12	Ver Alleviation of Low Flows
Misbourne	1998	1	8	Misbourne Alleviation of Low Flows
Hiz & Oughton	1996	3	Augmentation/ river support	Hiz Alleviation of Low Flows

The proposed timings and details of the considerations that would need to be taken into account for each of these options can be seen in Table 16.

Table 16: Supply options available during a drought

	Option Implementation Assessment (Resource Side)				Environmental Assessment			
Option Name	**Trigger**	**Implementation Timetable**	**Permissions Required & Constraints**	**Risks Associated with Option**	**Risk to the Environment**	**Summary of Possible Environmental Impacts**	**Details of Studies**	**Monitoring Requirements**
Full assessment of Source Performance, internal transfers and network model scenario runs	**Zone 2**	8 weeks preparation time	DMG and Production	Conditions of sources and network unknown, future plans risks	None	Abstraction kept within licence limits therefore no increased risk to the environment		Source assessment reports and model runs outputs
Transfer from Surplus Area via existing networks	**Zone 2**	1 week preparation time	DMG and Production	Reduced security of supply transfer and network risks	None	Abstraction kept within licence limits therefore no increased risk to the environment		HDZ/Transfer reports
Supply balancing	**Zone 2/3**	Immediate	DMG and Production	Possible network issues with change in quality of water	None	Abstraction kept within licence limits therefore no increased risk to the environment		HDZ/Transfer reports
Additional outputs	**Zone 3**	Dependent on assessment of output capacity at the time	DMG, Production and Water Quality	Serviceability of plant and availability of suitably sized pumps	None	Low as abstractions will remain within licensed limits		Normal abstraction monitoring
Bring forward engineering works to enhance existing network capability	**Zone 3/4**	Dependent on status of project and permissions to install pipework	DMG, Network and Asset Strategy	Delays in commissioning, may not deliver benefits until in zone 3 or 4. Not new water only improving utilisation of existing resources	Minor - linked with construction works	Abstraction kept within licence limits therefore no increased risk to the environment		HDZ/Transfer reports
Pressure Control Schemes	**Zone 3/4**	Dependent on assessment of pressure distribution and management at the time	DMG, Network and Asset Strategy	Delays in commissioning, may not deliver benefits until in zone 3 or 4. Not new water only improving utilisation of existing resources	None	Abstraction kept within licence limits therefore no increased risk to the environment		Zonal pressure and transfer reports

	Option Implementation Assessment (Resource Side)				Environmental Assessment			
Option Name	Trigger	Implementation Timetable	Permissions Required & Constraints	Risks Associated with Option	Risk to the Environment	Summary of Possible Environmental Impacts	Details of Studies	Monitoring Requirements
Re-commission dormant sources	Zone 4	Escalate from current WRP	Need EA approval if unlicensed, and DMG approval. May also need discharge consents from EA.	Water quality constraints could impact delivery	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Test water quality and network / connectivity studies	Normal abstraction monitoring
Intercompany Transfers/ Bulk imports above those already available	Zone 4	Subject to availability	Formal agreement with neighbouring Company	Neighbouring Company may not have water to spare due to own customer demands	None, using existing transfer links	Low as abstractions will remain within licensed limits		imports of water
Increase peak abstraction to same as average licence	Zone 4	Escalate from current WRP	Need EA and DMG approval	Environmental risk of increased abstraction. Only available for peak week	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Increased environmental monitoring as stated in DMP	Normal abstraction monitoring
Unlicensed sources	Zone 4	Escalate from current WRP	Need EA and DMG approval	Potential water quality constraints	Possible due to increase in abstraction	Reduction in local water levels and river flows. Delay onset of recovery of water levels	Thorough monitoring	Normal abstraction monitoring
Drought permits	Zone 4	Start applying for in zone 3 to use in zone 4	Need EA and DMG approval	Environmental risk of increased abstraction and delay in recovery of groundwater levels	See Environmental Assessment Statements (Appendix 5)	See Environmental Assessment Statements (Appendix 5)	See Environmental Assessment Statements (Appendix 5)	See Environmental Monitoring Plan
Drought orders	Zone 4/5	Apply for in zone 4 if drought permits refused	Need Secretary of State approval	Environmental risk of increased abstraction and delay in recovery of groundwater levels	See Environmental Assessment Statements (Appendix 5)	See Environmental Assessment Statements (Appendix 5)	See Environmental Assessment Statements (Appendix 5)	See Environmental Monitoring Plan

5.4 Drought Permits and Drought Orders

The Environment Agency may, by means of a drought permit, authorise water companies to take action under section 79A of the WRA 1991. Drought permits and drought orders are drought management actions that, if granted, allow more flexibility for us to manage water resources and the effects of drought on both public water supply and the environment. Drought permits and drought orders have to be applied for by water companies to allow for increased abstraction during times of droughts, see Figure 44. Permits are granted by the Environment Agency, whilst orders are granted by the Secretary of State and must be linked to an exceptional shortage of rain. The drought permits and drought orders (when issued) allow for abstraction to occur outside the normal Licence conditions.

Water Framework Directive (WFD) legislation provides that there should be no deterioration of water body status. Article 4.6 sets out an exception to this requirement, which allows a temporary deterioration of status where this is the result of circumstances of natural cause or *force majeure* which are exceptional or could not reasonably have been foreseen, including prolonged drought events. Where there is potential for our drought permit abstractions to cause temporary environmental deterioration, there will be requirements on us to minimise this damage and undertake mitigation to further decrease the effect of the additional abstraction.

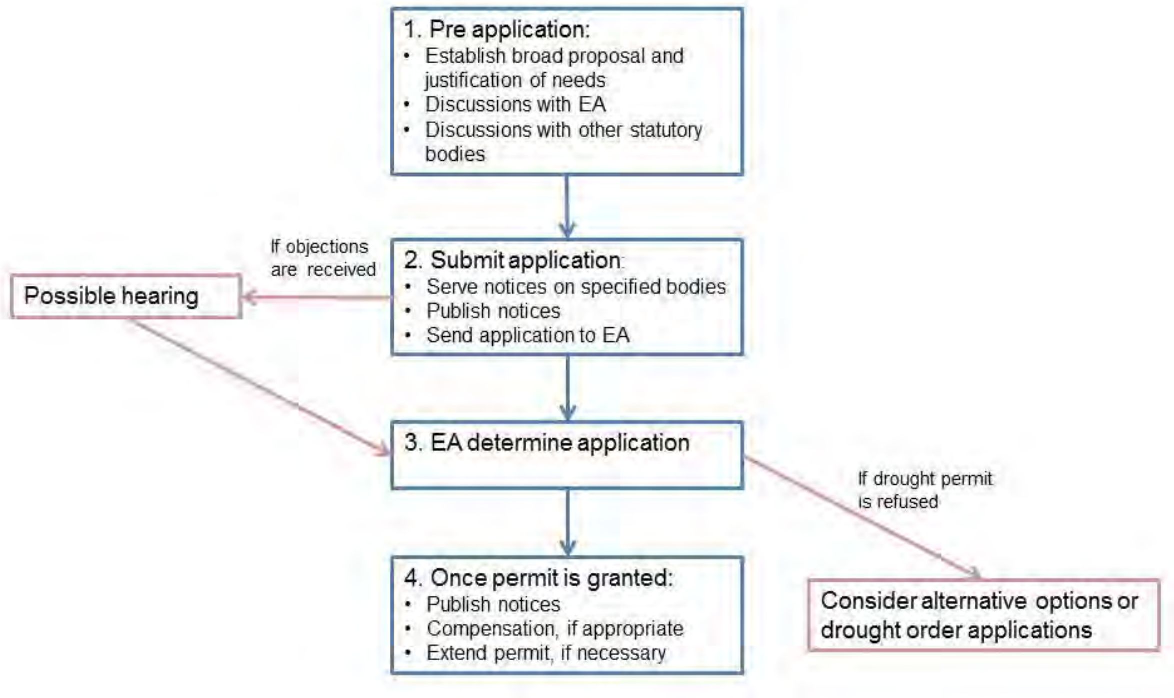

Figure 44: Flow chart of the Drought Permit application process, adapted from Defra, 2011

In the majority of cases, we believe that substantial environmental stress will already have occurred in the river catchments due to the shortage of rainfall and utilisation of such permits will only occur once all other measures to reduce the demand for water have been implemented. Due to the timescale of securing permits, we will have to start the process well in advance of them being needed. The sequence of requirement may vary with the nature and duration of the drought and we would generally apply for drought permits in batches, whilst liaising with the Environment Agency on the sequencing of their implementation.

As all droughts are unique and environmental conditions change with time, we consider that preparing full details for potential drought permits and drought orders in advance of need is not practical. However we have identified which sources we might utilise in such circumstances. A generalised sequence of their implementation and outlines of likely effects have been prepared for in our Environmental Assessment Reports (EARs) for each source. We recognise that it is important to monitor environmental impacts associated with these additional abstractions so that the timescale for compilation of drought permits and drought orders is minimised. Accordingly, environmental data will be collated for the drought permit sites as Drought Trigger Zone 2 is breached to provide a baseline prior to the need for increased abstraction or cessation of river support for public water supply. In addition monitoring will increase as we move into a drought, starting with walkovers during Drought Trigger Zone 2. Further information on this is provided in Section 7. The increased additional monitoring will support the statement of need for water for any future drought order or drought permit, and measure the potential environmental effects.

We have examined our sources in each Water Resource Zone (WRZ) to see if there is potential to increase abstraction under drought conditions. In many cases, achievable outputs are below licensed levels and this in itself imposes a limit on abstraction. Comments on the number of sources considered practicable for increases in abstraction are detailed below.

Any drought permit or drought order applications submitted would be supported by a full Environmental Assessment Report (EAR), and we have prepared these for all of our proposed sites – this is addressed in Section 6. We have currently identified twelve sources within our Central region and four sources within our Southeast region which have the capability for increased volumes for public water supply under drought orders or drought permits. Due to the robustness of the water resources situation in our East region we do not believe the use of drought permits would be required and therefore we have not identified any sites within this region.

In the event of a severe drought, drought permit applications will be submitted in batches on the basis of need, in priority order according to the type, location and nature of the drought conditions. However, based on a situation where a uniform drought was to occur across our Central region we have identified the priority order for applications and implementation drought permits and orders, based on likely severity of environmental impact. This is outlined in Table 17. Details of the identified drought permit sources and their potential to provide additional water are discussed in the following sections.

5.4.1 Central Region

Details of the licences associated with our drought permit options are provided in this section. The drought permits have been listed in priority order (Table 17), based on the expected severity of environmental impacts, as per the Guidelines. In the event of a drought we would make every effort to adhere to this prioritisation, and if any changes are necessary due to operational reasons we would communicate these with the EA beforehand.

Table 17: Drought permit and/or drought order sites in expected priority order

Source (WRZ)	Priority of Implementation	Additional Daily Volume (Ml/d)	Water body/ Catchment	Comments
THUN (WRZ5)	1	Up to 2.73	River Rib	Abstraction increase, relaxing licence flow constraint
HUNT (WRZ1)	2	Up to 2.91	River Gade	Abstraction increase, relaxing licence flow constraint
HUGH (WRZ1)	3	Up to 1.75	Hughenden Stream	Sustainability reduction site, would require bringing source back into production
PICC (WRZ1)	4	Up to 5	River Gade	Sustainability reduction site, post 2018
FRIA (WRZ 2)	5	Up to 9.79	River Ver	Abstraction increase under Section 20 agreement (Declaration of Emergency)
AMER (WRZ 1)	6	Up to 8	River Misbourne	Sustainability reduction site, post 2018
WELL (WRZ3)	7	Up to 0.3	Charlton Mill Pond River Hiz	Cessation of augmentation
OFFS/OUGH (WRZ3)	8	Up to 1	River Oughton	Reduction or cessation of augmentation
UTTL (WRZ5)	9	Up to 6	River Cam	Reduction in augmentation, which is a requirement of licence condition
FULL (WRZ3)	10	Up to 9.09	River Mimram	Sustainability reduction site, would require bringing source back into production
BOWB (WRZ 2)	11	Up to 5.82	River Ver	Sustainability reduction site, would require bringing source back into production
WHIH (WRZ3)	12	Up to 26	River Beane	Sustainability reduction site, post 2017
Total Volume		**70.39**		

5.4.1.1 THUN

This source is linked to a flow constraint on the River Rib, decreasing permitted daily abstraction from 11.82 to 9.09 Ml/d. This licence condition is currently time limited to 1st April 2018, but we will be applying to have this extended. The THUN licence is subject to an aggregation constraint with our HADH source, however the drought permit would seek to relax the flow constraint. Our AMP4 and AMP5 investigations have demonstrated that our abstraction does not significantly impact on river flows and that the lower part of the Rib is a naturally losing reach under all flow conditions. Under very low flows, the river may even be dry along this reach. Therefore short term increased abstraction under a permit should have no further measurable impact during the in-drought phase and marginally delay the recovery of river flows once recharge occurs.

5.4.1.2 UTTL

There are two sources on this licence. Currently only UTTL is used for public supply. The licence condition requires us to maintain a minimum flow in the River Cam by augmenting flows, reducing the volume available for Public Supply. We currently have the capability to augment from both SPRF and UTTL and the drought Deployable Output reflects a 50% (6 Ml/d) contribution to augmentation. By releasing this condition under a Permit, up to an additional 6 Ml/d of water could be realised from UTTL. However this will cause lower flows in the Cam.

5.4.1.3 HUNT

This source is subject to two licences. The original licence is in aggregation with other sources and has a flow constraint, reducing the permitted 12 Ml/d daily capability to 9 Ml/d. In addition to this, there is a separate licence, not linked to the flow constraint of 1.5 Ml/d. A permit to release this flow constraint will allow the full 13.5 Ml/d from this site to be realised.

5.4.1.4 FRIA

This source is one of the original sustainability reduction (SR) sites implemented under the Alleviation of Low Flows (ALF) scheme, to benefit flows in the River Ver which was implemented in 1993. The current licence variation retains the original peak of 15.91 Ml/d, but has had its average volume reduced to 3.8 Ml/d and also has an aggregation with KENS source. The operating strategy is to seek not to use FRIA unless we are unable to meet demand as a result of:

- Failure of equipment, plant or a burst
- Interruption to power supply to other sources
- Contamination of other sources
- Demand for water is in excess of maximum available from ANGL
- Deficiencies in water resources arising from drought or low groundwater levels

By declaring an emergency under the provisions of the Ver Operating Agreement, we are able to increase the annual average volume to that of the original licence volume (15.91 Ml/d) for the remainder of the year in which the emergency is declared. We are able to abstract a volume equivalent to increasing the drought Deployable Output from 2.21 Ml/d to the current licence volume of 3.8 Ml/d, which would not require an Emergency Declaration, however this could be greater should an emergency be declared – subject to agreement with the EA.

5.4.1.5 HUGH

This source will be subject to sustainability reductions in 2017, resulting in a cessation of abstraction. With a Drought Permit, the source could be re-commissioned to provide its previous Deployable Output value or even higher. Such an increase in abstraction would only take place when the river flows were naturally very low or had already ceased at this location and thus minimise the environmental impact and only marginally delay the recovery of the river flows once recharge occurred.

Returning this source to service would be a lengthy process, requiring re-commissioning of the treatment process, involving periods of pumping small volumes to waste, and flushing of pipework to ensure potable water could be delivered to customers. A lead time of a minimum of six months would be required for this process.

5.4.1.6 WELL

This source has a licence condition that requires us to augment flow in the upper part of the River Hiz via the Mill Pond. We have agreed a Memorandum of Understanding (MoU) with the EA to ensure environmental flows in the upper part of this catchment. Lining of the Mill Pond has been undertaken and now, only a small amount of water is required to maintain water levels in the pond. Overflow from the pond maintains a reach of the upper Hiz, but under very severe droughts will not maintain flow in the river downstream of the Mill Pond. Under these circumstances, augmentation would be stopped in order to direct the volume into supply.

5.4.1.7 OFFS/OUGH

These two sources have a requirement for us to support flows in the upper River Oughton under a Memorandum of Understanding (MoU). This augmentation has the capability to create a refuge in the upper part of the catchment, but under severe drought conditions may not maintain the river flows. This drought permit would seek to lift the MoU condition and cease or reduce the augmentation from OFFS and OUGH, as necessary.

5.4.1.8 PICC

This source will be subject to sustainability reductions in 2018, resulting in a significant reduction in both average and peak abstraction. With a Drought Permit, the source could be used at a higher abstraction rate again and it is suggested that a nominal 5 Ml/d increase be considered at both average and peak.

5.4.1.9 WHIH

This source will be subject to sustainability reductions in 2018, resulting in a significant reduction in both average and peak abstraction. A drought permit would be sought to increase abstraction from the post sustainability average DO of 2 Ml/d to the pre sustainability reduction peak DO of 28 Ml/d. This is a potential additional daily volume of 26 Ml/d.

5.4.1.10 AMER

This source is part of a group licence and is subject to the River Misbourne Operating Agreement. From April 2018 AMER will be subject to sustainability reductions of 3 Ml/d, making the average DO 4 Ml/d and the peak deployable output 9 Ml/d. After this date, we would need to apply for a drought permit to increase abstraction by 8 Ml/d from the post sustainability average DO of 4 Ml/d to the pre sustainability peak DO of 12 Ml/d, which has historically been proven under drought conditions.

By declaring an emergency under the Misbourne Operating Agreement, we are currently able to increase the annual average volume up to 18.18 Ml/d. After the sustainability reductions, we will be able to increase the annual average volume up to 9 Ml/d by declaring an emergency. This is another option that could be utilised in severe drought conditions.

5.4.1.11 BOWB

This source was subject to a sustainability reduction, and abstraction ceased in 2016. The licence has also been revoked.

We do not envisage the use of this source until almost all other options have been exhausted and flows in the River Ver are already very low. The benefit quoted here is a return to the pre-SR Deployable Output of 5.82 Ml/d, but the source is capable of yielding more, and the previous treatment capacity was for the average licence volume of 6.82 Ml/d.

Returning this source to service would be a lengthy process, requiring installation of treatment, involving periods of pumping small volumes to waste, reconnecting and flushing of pipework to ensure potable water could be supplied to customers. A lead time of a minimum of six months would be required for this process.

5.4.1.12 FULL

In 2015, this licence reverted back to its Licence of Right and licensed abstraction is reduced to an annual average 5.61 Ml/d (9.09 Ml/d peak). In addition, this source is scheduled to cease abstraction in 2017 as part of the sustainability reductions to improve flows in the River Mimram. A drought permit will be required to bring FULL back into supply, abstracting up to the volume of 9.09 Ml/d.

5.4.2 **Southeast region**

We have examined all our sources to see if there is potential to increase abstraction to meet the forecast demands during a drought. However, in many cases achievable outputs are below licensed levels and this in itself imposes a limit on abstraction. The granting of water scarcity status to this region recognised that there was no significant new groundwater or surface water sources that could be developed. As a result of preparing the DMP arrangements for baseline monitoring and enhanced drought monitoring have been agreed with the Environment Agency and are included in Section 7 and Appendix 6.

We have identified four sources in our Southeast region which are shown in Table 18 and discussed below. Each would be the subject of an application for a drought permit; and all these sources are located within the Dour catchment.

Table 18: Potential Drought Permitting Sites in our Southeast Region

Source	Priority for Implementation	Additional Daily Volume (Ml/d)	Water body/ Catchment	Comments
SLYE	1	3.5	River Dour	Increased abstraction
SDRE	2	2	Alkham Bourne/River Dour	Increased abstraction
SBUC	3	2	River Dour	Increased abstraction, with augmentation, MoU
SHOL	4	0.77	River Dour	Increased abstraction
Total		**8.27**		

5.4.2.1 SLYE

A drought permit application would request the release of a constraint limiting abstraction to 3.5 Ml/d and allow abstraction rates of 6 Ml/d (average) and 7 Ml/d (peak).

5.4.2.2 SDRE

A drought permit application would request the release of a constraint limiting abstraction to 8 Ml/d (average) and 8 Ml/d (peak) and allow abstraction rates of 9 Ml/d (average) and 10 Ml/d (peak), subject to pumping water levels. The CMF plant offers resilience against fluctuations in turbidity at lower groundwater levels.

5.4.2.3 SBUC

A drought permit application would request the removal of a constraint limiting abstraction to 4 Ml/d and allow abstraction rates of 4 Ml/d (average) and 6 Ml/d (peak) whilst maintaining an augmentation flow of 2 Ml/d into the Dour. We recognise the importance of this augmentation flow in maintaining a refuge in this part of the Dour, so do not propose to cease this augmentation, just increase the peak abstraction above that in the existing licence.

5.4.2.4 SHOL

A drought permit application would request the release of a constraint on peak abstraction from 2.5 Ml/d to 3.27 Ml/d. However this site is also constrained by the network to a maximum of 4.3 Ml/d in association with abstraction from SPRI, so the full peak benefit may not be realised.

All four of the above drought permits may have environmental impacts on the River Dour which we have assessed. The higher benefit associated with peak abstraction rates of an additional 8.27 Ml/d will give us considerably more scope in meeting short term peaks in demand, with a small environmental impact due to the short lived nature of such increases.

Extensive environmental impact assessment data was collated for development of the Dour Operating Agreement and is available as a basis for a drought order or permit for the River Dour. However, it was recognised that this data is now historic and further monitoring has been undertaken to supplement current information and environmental assessment. Both the locations and frequency for this further monitoring were agreed with the Environment Agency in April 2012.

A single comprehensive Environmental Assessment Report (EAR) of the River Dour has been produced to ensure that these four drought permits are as close to ‘application ready’ as possible. The scope of this assessment covers sufficient reaches of the river so that the impacts of all four potential drought permits can be evaluated.

5.4.3 **East region**

Due to the robustness of the resource available and having never had to impose restrictions on customers in this WRZ, we do not believe the use of drought permits is required in the East region and cannot envisage a situation where they would be required.

5.5 Potential Accumulation of Drought Permit and Order Options

Most of our drought permit sites are single sources on tributaries of larger rivers. Some rivers have two drought permit abstraction points on them and these are the Gade, Ver, Cam and Hiz (once the river Oughton has joined it). The sustainability reduction catchments are expected to benefit from the effects of reduced abstraction which will have been implemented, thus delaying the timing of introduction of drought permits. In most of these cases, the resulting increase in abstraction would not be much greater than historic levels.

In the case of the River Ver and the River Gade, these rivers are tributaries of the River Colne. A reduction in inflow to the River Colne would further decrease flows under drought conditions and also be affected by that of the River Misbourne. Flows in the River Colne are supported by the return of treated sewerage effluent from two large treatment works.

5.6 Emergency Drought Orders

In the event of entering Drought Trigger Zone 5 all other available drought management measures would have been implemented, and by entering this zone the drought could exceed our 1 in 120 year level of service commitment agreed with our customers through our consultation on our 2014 WRMP. In these extreme and unprecedented conditions we would apply to the Secretary of State for Emergency Drought Orders for abstraction of water potentially causing environmental damage. This is unlikely to affect the whole of our supply area uniformly and these emergency measures would only be applied in local areas in response to the unprecedented situation.

6 Environmental Impacts

6.1 Strategic Environmental Assessment and Habitats Directive

The SEA Directive deals with future developments and construction activities. Our DMP is not a development plan. It highlights short term operational actions that we would take in order to manage and, where possible, improve our water resource position to make water available to customers whilst minimising impact on the environment. Thus, this plan does not include any plans for permanent changes in the operation of the company, and parts of it may or may not be required during any given drought event. Our plan highlights potential short-term environmental impacts of its implementation and we will undertake monitoring as detailed in Section 7 to assess and mitigate these temporary impacts where possible.

Having considered the requirements of Articles 3.2, 3.3 and 3.5 in the SEA Directive, and the guidance offered by the Office of the Deputy Prime Minister in 2005, we do not consider that any Strategic Environmental Assessment is required to support this DMP. Any planned improvements to the resilience of the water supply network will be covered in the Levels of Service identified within the new WRMP, and will be dealt with in the associated SEA document.

There are no Habitats Directive sites within our supply area that would be impacted by our DMP, and thus this directive is not relevant to our activities. As a "competent authority under Regulation 7(1) of the Conservation of Habitats and Species Regulations 2010 known as the 'Habitats Regulations', under Regulation 9(5)" (Defra, 2011) we must have regard to the requirements of the Habitats Directive, this includes activities authorised by a drought permit or drought order.

Therefore before submitting a drought permit or order application we must determine and be satisfied that:

- There is no likely significant effect on any Habitat Directive sites; SAC (Special Areas of Conservation), SPA (Special Protection Areas), and Ramsar sites or;
- A conclusion of no adverse effect on the integrity of the Habitat Directive site can be ascertained from the Environmental Assessment Report (EAR) for the drought permit or drought order.

Under Section 28G of the Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000), we have a duty to take reasonable steps consistent with the proper exercise of our functions to further the conservation and enhancement of Sites of Special Scientific Interest (SSSIs). In addition, under Section 40 of the Natural Environment and Rural Communities Act 2006, we must in exercising its functions have regard so far as is consistent with the proper exercise of those functions to the purpose of conserving biodiversity.

We have produced detailed Environmental Assessment Reports (EARs) for all drought permit/order sites and have fully evaluated any associated potential impacts on Habitats Directive sites or SSSI sites of European importance. We are confident that we are fully compliant with all environmental legislation – further information on this is provided in our EARs.

6.2 Environmental Assessment

For each supply-side drought management action we have carried out an environmental assessment to determine the environmental sensitivity of the site and likely impacts from the implementation of the proposed action. The assessments have been incorporated into draft EARs, which have been produced to comply with the EA Drought Plan Guidelines[23], which also sets out the relevant regulatory requirements. The process for preparing our EARs is presented in Figure 45, as set out in the EA Guidelines.

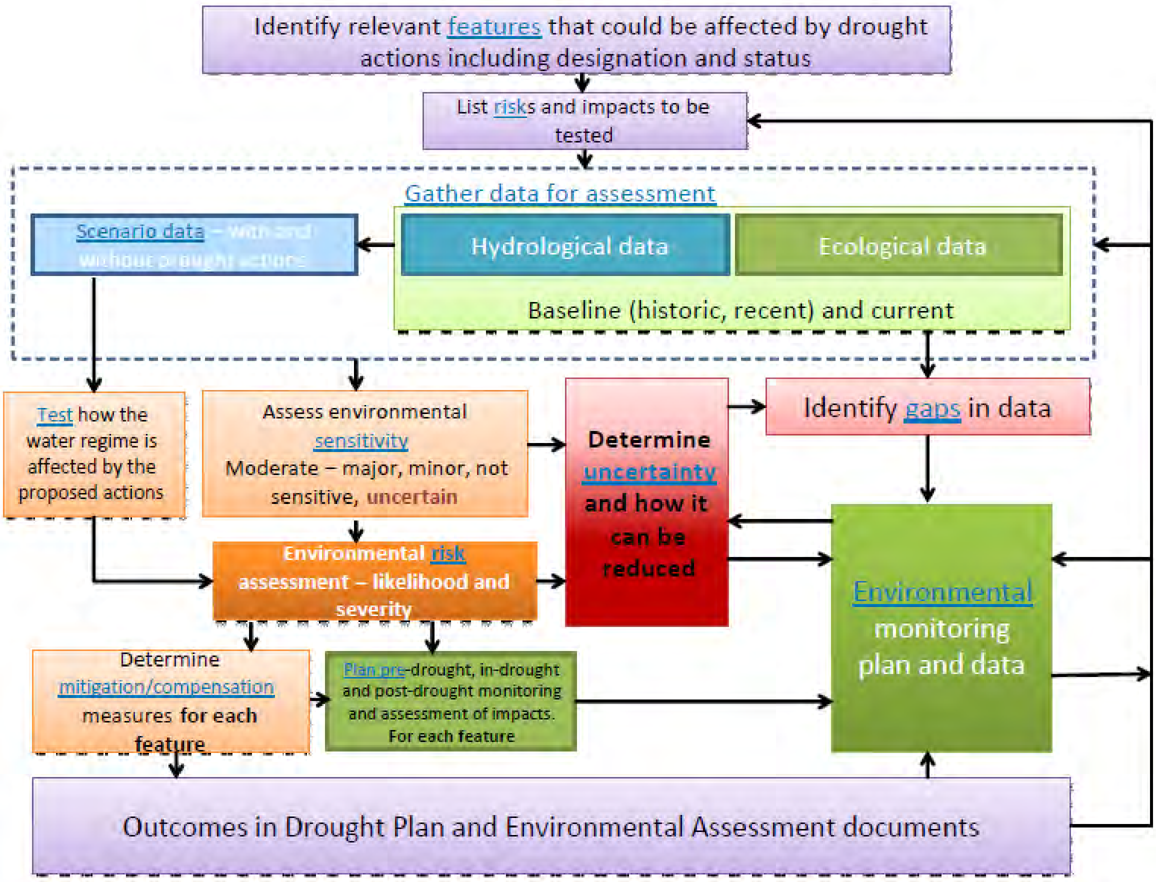

Figure 45: Flow chart of how to prepare an environmental assessment

The required level of assessment has been defined by the EA as to be based on potential damage caused and likelihood of permit use, as shown in Figure 46. All of the drought permits identified within our DMP would be required under infrequent or exceptional conditions, and most would have predicted environmental impacts which are limited to low or moderate severity. All of our draft EARs have been developed in close collaboration with the EA, and the draft reports have been reviewed by the relevant Area EA teams. We will continue to work with the EA teams to ensure that our EARs are as close to 'application ready' as possible. Summaries of the outcomes of our EARs are presented in Section 6.3, and the full documents are available to view upon request at our offices.

[23] Environment Agency, 2016, *EA Drought Plan Guideline extra information – Environmental Assessment for Water Company Drought Plans*

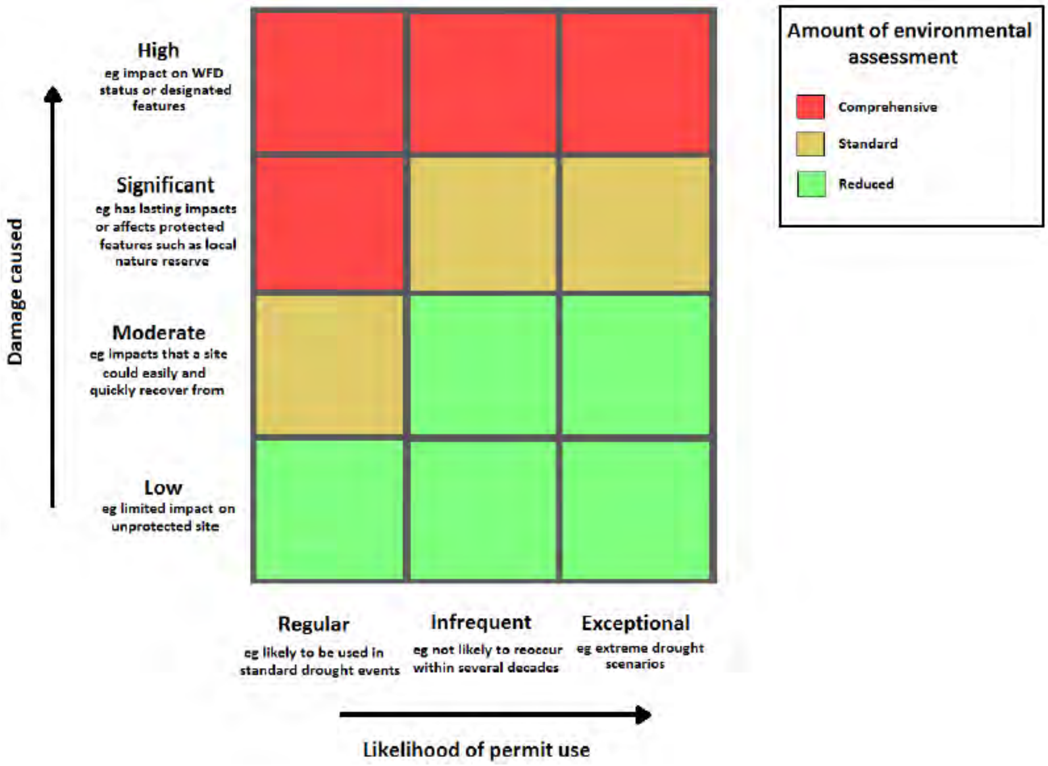

Figure 46: Environmental assessment level of effort required (Environment Agency, 2016)

The information presented in the EARs is in line with EA Guidelines[24]. Each of the reports has been summarised using tables adapted from the Guidelines, and these summaries are provided in Appendix 5.

Potential environmental impacts which may occur following the implementation of a drought action are listed in Table 19. A number of these impacts are likely to be primarily caused by the onset of the drought itself, and in some cases may be exacerbated by the use of drought permits. The investigations carried out for the EARs have attempted to differentiate between impacts of the drought and impacts of the drought permits. Many of the rivers affected will also be impacted by historical modifications and current land uses, which may affect their resilience to drought conditions. For example where weirs have historically been constructed, this can affect the downstream movement of fish, potentially resulting in stranding when water levels drop.

[24] Environment Agency, 2016, *Drought Plan Guideline Extra Information – Environmental Assessment for Water Company Drought Plans*

Table 19: Potential Environmental Impacts from supply-side drought actions

Action	Examples of Potential Impact
Increased Groundwater Abstraction	Associated reduction in river flow, resulting in potential for: • decrease in dissolved oxygen content • higher water temperatures • variations in compositions of macroinvertebrates and plants • increased concentration of pollutants • increased turbidity/sedimentation • algal blooms • fish becoming stranded in affected reaches • reduction in aesthetic appeal
	Prolonged period of no flow, resulting in potential for: • loss of aquatic macrophytes and invasion of terrestrial plants • drying of river bed and loss of habitat for aquatic fauna e.g. macroinvertebrates • fish kills
	Associated reduction in local groundwater levels, resulting in potential: • derogation of third party abstractions
Cessation of River Support	Associated reduction in river flow, resulting in potential for: • decrease in dissolved oxygen content • higher water temperatures • variations in compositions of macroinvertebrates and plants • increased concentration of pollutants, • increased turbidity/sedimentation • algal blooms • fish to become stranded in affected reach • reduction in aesthetic appeal
	Prolonged period of no flow, resulting in potential for: • loss of aquatic macrophytes and invasion of terrestrial plants • drying of river bed and loss of habitat for aquatic fauna e.g. macroinvertebrates • fish kills

6.3 Environmental Assessment of Drought Permit and Drought Order Sources

As identified in Section 5.4, following discussions with the Environment Agency, we have identified twelve sources within our Central region and four sources within our Southeast region that have the capability for either increased abstraction or cessation/reduction of river support under a drought order or drought permit (see Section 5.4). An environmental assessment has been undertaken for each river affected by these sites and EARs have been compiled. These are working documents and will be updated as and when further data becomes available. Copies of these are available to view at our offices upon request. A summary of the assessments and conclusions thus far follow in the likely priority order subject to drought conditions, location and intensity.

6.3.1 River Rib

The River Rib Environmental Assessment Report (EAR) has been produced to accompany a Drought Permit application for our THUN source. It has been written as a draft report, and will be fully updated with the latest data and information at the time that the drought permit is applied for.

It is likely that if drought conditions were severe enough to require us to apply for a drought permit at THUN, flow in the River Rib would already be significantly reduced. The environmental report has confirmed findings in the Lower Rib NEP (National Environment Programme, 2005-10) that the primary influencing factor on flow in the Lower Rib is rainfall. Flows decrease in times of low rainfall, respond quickly to rainfall events and are dependent on rainfall to maintain flows. From analysing baseline data over two past drought periods the environmental report, supported by findings from the Lower Rib NEP studies, concludes the increased abstraction at THUN of 2.64 Ml/d proposed by the permit, will have little impact on river flows, groundwater levels or ecology and is not expected to have any effect on the overall status of the river under the EU Water Framework Directive (WFD) classification.

We acknowledge that there is a degree of uncertainty as to the impacts of abstraction under drought conditions on the River Rib, as when applying for the drought permit we will be facing unprecedented lows in groundwater level. Additional monitoring to identify environmental issues would therefore be carried out, and working with the Environment Agency mitigation measures put in place.

The uncertainty surrounding unprecedented groundwater lows also places uncertainty on our sources and it is possible that some may fail. It is therefore essential that every precaution is taken, as there is a possibility of losing security of supply for the Hydraulic Demand Zones (HDZs) supplied by THUN (HDZs Rye Hill Res, Rye Hill Tower, Sibleys and Stansted, and Standon). Therefore any peaks in demand within these zones may lead to the loss of supply in other HDZs. The permit will provide an additional 2.64 Ml/d of water, which will act as a buffer to any peaks in demand, thus helping to prevent any loss of supply in these four HDZs.

The Rib EAR has been compiled and produced using historical data sets from a number of sources, such as the Environment Agency, Meteorological Office, Natural England, Hertfordshire Biological Records Centre, Herts and Middlesex Wildlife Trust and our own data records. Conclusions and synopsis of previous works completed in AMPs 4 to 6, NEP reports and other stakeholder reports have been consulted and our professional judgments used in their interpretation to draw conclusions and to summarise the impact of increased abstraction in the vicinity of THUN in drought conditions. We have also consulted regularly with the Environment Agency throughout the process of producing our DMP and EARs.

6.3.2 River Cam

To date we have not made a drought permit application for UTTL, thus the impacts of removing the river support are unknown. A drought application would be made to reduce or cease river support from these sources for the River Cam, thereby increasing the volume of water available for public supply and freeing up water to other parts of the network.

There would be no net increase in abstraction from these sites, but there would be a reduction in the environmental compensation flow to the River Cam, allowing flows to reduce below the trigger level at Great Chesterford. It would be our intention to manage these sites so that if demand could be met by other sources a support flow to the river would be made. The cessation or reduction in river support to the River Cam will reduce river flow and velocity of the reach of river downstream of the discharge point. A reduction in the river flow and depth of water in the River Cam has the potential to lead to stranding of fish behind structures or in isolated reaches within the river. We will continue to provide support as and when operationally possible as this will help mitigate some of the impacts associated with the drought application.

Flow data for the upper Cam from 2015 - 2016 has been used to show how the head of the river moves under different flow conditions at Great Chesterford. Analysis indicates that with 12.7 Ml/d of flow at Great Chesterford the river retains flow just upstream of NEWP. The lowest flow condition of 5.82 Ml/d (12th September 1997) the river head moves approximately 5.5 km downstream to the north of UTTL pumping station. Therefore the River Cam is likely to have little flow in it above UTTL during severe drought conditions.

It is likely that the historic modification of the upper River Cam has had a strong influence on flow patterns. An example of this is where the River Cam flows through the grounds of the Audley End Estate where water is held back by weirs to produce a wide, slow flowing lake feature in front of the house which is home to a large population of wildfowl. Whilst this section of the river is not a typical chalk stream habitat, it is of local importance.

Support flows were provided to the River Cam during the droughts of 1997 and 2005, which helped maintain flows above the trigger level. In the summer of 2006, flows at Great Chesterford were not recorded as having fallen below the trigger despite the drought situation in South East England. Further investigation by the Environment Agency identified an inaccuracy in the stage measurement at the gauging weir and consequently an over estimation of flow. The trigger would therefore have been reached and river support would have been required. Spot gauging undertaken at three locations upstream of the gauging weir suggests that flow was probably below the trigger for July and August 2006. During this period of low flows, we understand that the Environment Agency did not receive any calls from members of the public regarding concern over the lack of water in the river nor was it required to carry out any fish rescues.

There are no European Habitat Directive sites within the scope area of UTTL; however there is one SSSI site along the River Cam near Newport. Debden Water SSSI is located on a tributary stream of the River Cam to the east of Newport and some 2km upstream of UTTL; this site is considered to be outside the area of influence of the UTTL . We therefore conclude no adverse effect from the UTTL drought permit on Habitat Directive or other statutory designated sites.

6.3.3 **River Gade**

The River Gade draft EAR has been produced to accompany a Drought Permit application for our PICC and HUNT sources, both of which form part of a group licence. We have produced a combined environmental impact assessment for the two sources to look at the 'in combination' impacts of operating the two permits. In the event that the permits are not applied for at the same time, separate reports will be submitted.

Reviewing the available information on the River Gade catchment suggests that Chalk groundwater for the length of the river may be confined, by hard and Marly bands in the Chalk, potentially refining the conceptual understanding. It is recognised that further investigation into this is required. The technical report will therefore be updated with the best available information at the time, should it be required.

Exercising the PICC drought permit would only be required post April 2018 after the implementation of the Sustainability Reduction. During the 1995-1997 drought, two periods of lower abstraction at PICC occurred. Both were preceded by rainfall which resulted in artificially elevated river flows. Rain also fell during the periods of lower pumping rate, making it impossible to disassociate this from a response to the pumping change. Flows at Bury Mill started to decline once rainfall had passed through the system, prior to abstraction at PICC being increased, and the rate of a decline did not change in response to this. This suggests that the 1996/1997 pumping conditions, which simulate what we would apply for with this permit, do not derogate flows below their naturally occurring state. As a result, neither ecology nor designated sites are likely to be impacted by this permit. It is acknowledged that further investigation into this is required, and therefore this report will be updated with the best information available at the time of application.

Ceasing the HUNT flow constraint is expected to have no impact on flows in the River Gade. During the 2005-2007 drought, periods of lower abstraction had no impact on the recession rate of river flows. The rate of flow decrease was also seen to be maintained, following an increase in abstraction. In September 2006, flows experienced the same recession rate, whilst abstraction was constant. From analysing baseline data over two past drought periods, this environmental report concludes that the flow constraint relaxation and subsequent 3.41 Ml/d potential flow increase at HUNT, will have little impact on river flows, groundwater levels or ecology and is not expected to have any effect on the overall status of the river under the EU WFD classification.

We acknowledge that there is a degree of uncertainty as to the impacts of abstraction under drought conditions on the River Gade, as when applying for the drought permit we will be facing unprecedented lows in groundwater level. Additional monitoring to identify environmental issues would therefore be carried out, and working with the Environment Agency mitigation measures put in place.

6.3.4 River Ver

The River Ver draft EAR has been produced to accompany a Drought Permit application for our BOWB source, and a Declaration of Emergency for increased abstraction at FRIA. FRIA is one of the two sources in the KENS Group Licence and BOWB was historically part of the group but is no longer licensed following the implementation of an AMP6 sustainability reduction. We have produced a combined EAR for the two sources to look at the ‘in combination’ impacts of operating the two permits. In the likely event that the permits are not applied for at the same time, separate reports will be prepared and submitted.

Following the 1993 sustainability reduction at FRIA we have been unable to quantify the recovery in river flows from the Ml/d reduction in abstraction. Similar findings were found in the AMP6 KENS investigation, identifying that the chalk is confined in the Upper Ver and this is likely to be the reason for why we cannot trace the additional water in the river.

Reviewing the available information in the River Ver catchment suggests that in the Upper Ver hard Chalk bands and layers of Marl have the potential to confine the chalk groundwater. The hard and marly bands and drift deposits serve to contain the cone of influence and abstraction in the area around FRIA is likely to take water from local storage opposed to at the expense of the river. However, we do acknowledge that previous investigations have identified a link between BOWB abstraction and flow in the River Ver. Therefore, we will only submit a drought permit application for this site, when we are facing unprecedented levels of groundwater availability.

Where the EA declares an emergency under the Ver Operating Agreement at FRIA we do not anticipate that abstraction will directly impact flows in the River Ver beyond the natural condition at the time of our application. The upper reaches of the river dry most years and recover, and so this is represented ecologically. Flow returned following drought conditions in 1997, when we abstracted at volumes similar to those that we would be entitled to if an emergency is declared. The river also recovered following the 1976 drought, when drying of the river was expected to have been much more severe and widespread.

When applying for the drought permit at BOWB we will be already facing unprecedented levels of groundwater availability. Thus, operation under the permit will not impact river flows beyond their naturally occurring conditions. We acknowledge that operation of the BOWB drought permit has the potential to lengthen the recovery time post drought. However, a quicker recovery can be expected than seen in 1997, as when demand allows, we will cease abstraction, leaving more water in the environment. Groundwater modelling suggests increased drying of sections of the Ver, close to the confluence with the River Colne. The return of flow to these reaches is also likely to be more rapid than it has been historically, due to the cessation of our BOWB abstraction under normal conditions.

We acknowledge that there is a degree of uncertainty as to the impacts of abstraction under drought conditions on the River Ver, as when applying for the drought permit we will be facing unprecedented lows in groundwater level. Additional monitoring to identify environmental issues would therefore be carried out, and working with the Environment Agency mitigation measures put in place.

It would only be our intention to use the additional abstraction granted under the Ver Operating Agreement or by the drought permit when it is needed. We will only declare and emergency and apply for BOWB drought permit and on entering Drought Trigger Zone 4. Returning BOWB to service would be a lengthy process, requiring installation of treatment, involving periods of pumping small volumes to waste, and flushing of pipework to ensure potable water could be delivered to customers. Although we would not use the permit until we enter Drought Trigger Zone 5, a lead time of a minimum of six months would be required to enable this. We will only apply for these permits after all other supply and demand considerations have been implemented. Groundwater will therefore be at an unprecedented low level and drought conditions more severe than those experienced in 1997-98, 2005-06 and 2011-2012.

6.3.5 **River Hiz**

WELL has a licence condition requiring Affinity Water to support flows in the upper River Hiz through augmentation of the Mill Pond. Under extreme drought conditions, we would apply to reduce river support at WELL. As a result of implementing this drought permit there would be no net increase in abstraction from these sites but there would be a reduction of augmentation in the River Hiz, allowing flows to reduce further below the trigger level at the Mill Pond. The cessation in river support to the River Hiz will reduce river flow and velocity of the reach of the river downstream of the discharge point. The cessation of support to Charlton Mill Pond (Upper River Hiz) from WELL therefore has the potential to cause the upper sections of the River Hiz to dry. Stocked non-native fish species are known to be present in an isolated part of the Upper River Hiz and provision for moving these fish in the event of cessation of support would be discussed with the owner of Charlton Mill Pond. The owner of the Mill Pond has carried out extensive renovation and lining of the mill pond and operational experience to date indicates that a low input of water is sufficient to maintain pond levels. Additional support to the River Hiz below Charlton Mill Pond is possible by the EA through their river support borehole and this will supplement that from our own source.

In practice, the regional groundwater levels control the flow in the river and the augmentation has the potential to minimally extend the wetted reach, by delaying the migration of the head of the river downstream. As the augmentation effectively discharges groundwater immediately downstream of the pond, under severe drought conditions, even a maximum volume of 0.3 Ml/d would be unlikely to be sufficient to maintain a continuous wetted riverbed from the pond to the EA gauging station.

We do not expect the use of the WELL drought permit to impact any designated sites in the vicinity of the pumping station. Although some sites are located within a 3km radius of the site, and are water dependent, cessation of augmentation has not been referenced as a historic problem. The local nature reserves of Oughtonhead Common and Purwell Ninesprings are likely to suffer under natural drought conditions. They are water dependent but are fed by the River Oughton and Purwell, both of which are tributaries of the Hiz. These sites are unlikely to be affected by the cessation of river support at WELL, as they are both located on their respective rivers before they join the River Hiz.

6.3.6 **River Oughton**

The condition of transferring groundwater into the river at Oughton Head has seldom been triggered in the last 20 years. The analysis of the available data during the historic drought periods such as 2006 and 2012, as well as during normal recession periods (such as October 2008) suggests that the volumes of water transferred from the aquifer to the river did not contribute to increase or even maintain the stage elevations in the upper and middle river. Under severe drought conditions is likely that a significant fringe of unsaturated zone is present along the dry river channel and therefore any water discharged to it would easily disappear into the ground. The capacity to enlarge the wetted section of the river with the transfer would depend essentially on the groundwater levels at that time, irrespective of the abstraction regime at OUGH or OFFS. Given the geological boundaries and high transmissivity of the Chalk aquifer, it can be inferred that the cone of influence of OUGH at its average licence capacity (4.5 Ml/d) would be limited to the reaches far upstream of Westmill; the high storage capacity of the aquifer would entail that small volumes of water added to the system would not have the capacity to increase substantially the groundwater levels under the river bed. Downstream of Westmill the river is isolated from the main Chalk aquifer by the presence of relevant thickness of glacial deposits.

From analysing baseline data over past drought periods the Oughton EAR concludes that the cessation of the augmentation at OUGH and OFFS will have limited impact on the river flow, ecology, any key sensitive features or designated habitats within Oughton River and its catchment. We acknowledge that there is a degree of uncertainty to the potential benefit of the augmentation under drought conditions on Oughton Spring; additional monitoring to assess the environmental effects will therefore be carried out.

6.3.7 **River Misbourne**

The River Misbourne lies in Buckinghamshire and is a tributary of the River Colne. The river flows from its source, in the village of Mobwell, in a predominately south-easterly direction through Amersham, Chalfont St Giles, Chalfont St Peter and Denham, before joining the River Colne west of Ickenham. The river is approximately 28km in length. AMER is located in the middle of the catchment, adjacent to the River Misbourne. The vast majority of the River Misbourne reaches have been heavily modified by historic and recent human activities.

Ongoing work on the Misbourne catchment has highlighted confining characteristics in the chalk in the middle reach of the catchment between Amersham and Chalfont St Giles and possibly further downstream. Although the work has not been completed, it is extremely likely that this is the reason for AMER impacts not being shown in the river, due to the hydraulic separation between groundwater and surface water at the locations downstream of AMER.

From analysing baseline data over past drought periods, it has been concluded that the increased abstraction at AMER will not have a major impact on river flow, groundwater levels or the ecology within the River Misbourne and its catchment. The drought permit is not expected to have any detrimental effect on the overall status of the EU WFD classification for the River Misbourne. We acknowledge that there is a degree of uncertainty as to the recovery period due to the increased abstraction under drought conditions; additional monitoring to assess the environmental effects will therefore be carried out.

6.3.8 **River Mimram**

The Mimram is a groundwater fed river with average baseflows of 0.97 Ml/d at Whitwell. The primary controlling factor of both groundwater levels and hence river flow volumes in the Mimram catchment is rainfall. Rainfall controls aquifer levels and hence baseflows, and also results in flow peaks through run-off. However, it is accepted that there is evidence to suggest abstraction at FULL impacts groundwater levels and flows in the locality surrounding FULL, and results in decrease of flows by approximately ~3 Ml/d between Fulling Mill Gauging Station (GS) and Welwyn Village. It is also accepted that during drought periods abstraction at FULL may result in prolonging the no flow period.

It is likely that if drought conditions were severe enough to require us to apply for this drought permit at FULL; flow in the River Mimram would already be significantly reduced or dry to Digswell Lakes. It is reasonable to conclude that operating FULL source under a drought permit, would not impact on flows detrimentally and would not change the hydraulic regime of the River Mimram, which is strongly dominated by the recharge patterns. It also needs to be noted that the assessments we have undertaken, have not made allowance for dewatering of water in Chalk storage due to the continuous pumping prior to the assessment periods. In reality, due to the full closure of FULL source in 2017, any pumping under a drought permit would commence following fully recovered groundwater levels and storage. This should minimise any impacts on river flows even further. Obviously the duration of the pumping under the drought permit would determine any impacts but at this stage they are considered minimal.

From analysing baseline data over past drought periods it has been concluded the increased abstraction at FULL of 9.09 Ml/d, will have little impact on river flow, groundwater levels, the ecology, any key sensitive features or designated habitats within the River Mimram and its catchment. This is mainly due to the fact that a significant portion of the river will likely already be dry due to the drought. The drought permit is not expected to have any detrimental effect on the overall status of the EU WFD classification for the River Mimram. We acknowledge that there is a degree of uncertainty as to the recovery period due to the increased abstraction under drought conditions on the River Mimram; additional monitoring to assess the environmental effects will therefore be carried out.

6.3.9 **Hughenden Stream**

It is likely that if drought conditions were severe enough to require us to apply for this drought permit at HUGH; flow in Hughenden Stream would already be significantly reduced or dry to its confluence with the River Wye. The EAR investigation has confirmed the findings in the Hughenden Stream NEP Report 2011, that the primary influencing factor on flow in Hughenden Stream is rainfall. Other contributing factors also include the highly transmissive Chalk of the groundwater system underlying Hughenden Stream and the historic channel modifications.

From analysing baseline data over past drought periods it has been concluded that the increased abstraction at HUGH of 2.27 Ml/d, will not have a major impact on stream flow, groundwater levels, the ecology, any key sensitive features or designated habitats within Hughenden Stream and its catchment, above the impacts already caused by the drought conditions. The drought permit is not expected to have any detrimental effect on the overall status of the EU WFD classification for Hughenden Stream. We acknowledge that there is a degree of uncertainty as to the recovery period due to the increased abstraction under drought conditions on Hughenden Stream; additional monitoring to assess the environmental effects will therefore be carried out.

We will only apply for this drought permit on entering Drought Trigger Zone 4; after all other supply and demand considerations have been implemented.

6.3.10 **River Beane**

The River Beane is a Chalk stream and is believed to be mostly groundwater fed by the local Chalk aquifer. WHIH is located within the upper sub-catchment, north of the confluence with the Stevenage Brook. The bedrock geology is essentially composed of Upper and Middle Chalk formations, overlaying significant thicknesses of glacial deposits of variable composition.

Analysis of the data available, including historic groundwater levels and river bed elevations suggest that during severe drought the River Beane will suffer from extremely low flows. Even in the absence of pumping or under 2 Ml/d pumping conditions, the riverbed of the Beane in the reach near WHIH will be dry. The historic data also indicates that the local groundwater levels are only partially controlled by the abstraction regime at WHIH, whilst the regional aquifer fluctuation largely determines the baseline trend.

It is not possible to define in detail the area where the cone of depression for 28 Ml/d overlaps the potential wetted reach of the river under a naturalised condition. Data suggests that the effects of the abstraction in terms of river flow or stage, upstream, beside and downstream of WHIH to Watton-at-Stone are not likely to be significant. Downstream of Watton-at-Stone the effects are not quantifiable. The correlation between the groundwater levels of two key monitoring boreholes and Lilley Bottom suggest that the regional Chalk aquifer fluctuation predominantly controls the local levels and that the WHIH abstractions influence the aquifer nearby only to a minor extent.

When applying for the drought permit at WHIH we will already be facing unprecedented levels of groundwater availability. Thus, operation under the permit will not be likely to impact river flows beyond their naturally occurring conditions. We acknowledge that operation of the WHIH drought permit has the potential to lengthen the recovery time post drought. However, any impacts to the River Beane, caused by operation of the WHIH drought permit will be temporary. Flow regimes and ecology recovered following previous droughts when we were abstracting a similar volume to our request with this drought permit.

We acknowledge that there is a degree of uncertainty as to the impacts of abstraction under drought conditions on the River Beane, as when applying for the drought permit we will be facing unprecedented low in groundwater levels. Additional monitoring to identify environmental issues would therefore be carried out and, working with the Environment Agency, mitigation measures put in place.

Returning WHIH to service would be a lengthy process, requiring installation of additional treatment at SACO and diverting the water to the pre sustainability reduction areas. Therefore, a lead time of a minimum of six months would be required to enable this. We will only apply for these permits after all other supply and demand considerations have been implemented. Groundwater will therefore be at an unprecedented low level and drought conditions more severe than those experienced in 1996-1998, 2005-2006 and 2011-2012 as reviewed in the EAR.

6.3.11 River Dour

The River Dour has been part of the NEP and the Alleviation of Low Flows (ALF) schemes led by the Environment Agency. A Memorandum of Understanding (MoU) has been agreed to limit abstraction and to provide river support at times of low flow once triggers have been breached at Wolverton New OBH, Swanton Court OBH, and flows at Crabble Mill and Buckland Mill. There are four sources which will require a drought permit – SLYE, SDRE, SBUC and SHOL – to remove the flow constraints limiting abstraction, whilst still maintaining the river support flow of 2 Ml/d into the River Dour.

All four of the above drought permits may have environmental impacts on the River Dour which have been assessed.

Flows in the River Dour have been assessed along with likely impacts on designated sites and species. The main conclusion from hydrological and hydrogeological assessments is that at a time when these drought permits may be needed, this chalk stream will be dry in the upper reaches due to the naturally occurring drought conditions. It is our belief that at the time the drought permits are being sought, it is unlikely that the use of these sources would cause further adverse effects to river flows and hence ecology. There could, however, be a reduction in the rate of recovery post drought.

Additional monitoring in the form of walkovers and flow monitoring will be undertaken during and after a drought by both the Environment Agency (EA) and Affinity Water.

There are no known European Habitat Directive sites or SSSI sites in close proximity to SLYE, SDRE, SBUC and SHOL. Therefore we conclude no adverse effect of additional abstraction from the SLYE, SDRE, SBUC and SHOL drought permits on Habitat Directive sites. There are numerous areas of Ancient Woodland in proximity to the four drought permit sites but these are all located on relatively high ground and it is very unlikely that these will be impacted by putting the permits into operation. The summary for the environmental assessment of the SLYE, SDRE, SBUC and SHOL drought permits is supplied in Appendix 5.11.

7 Environmental Monitoring

We carry out routine collection of hydrometric and water quality data, irrespective of drought, throughout our operating area. We monitor the effects of our drought-related actions and the measures taken by us to mitigate these. This section details the additional environmental monitoring which we would enact prior to, and in the event of, an application for a drought permit or drought order, as described in Section 5.4. This enhanced monitoring is in addition to the business-as-usual monitoring and the NEP programme of projects for AMP6 (2015 - 2020) which is outlined in Appendix 6.

Discussions with the Environment Agency have resulted in 12 sources being identified in our Central region, which have the potential for use as drought permits or orders. These sources have been prioritised according to the magnitude of the potential environmental impact compared to the benefits in supply, and are listed in Table 17.

There was one previously identified source, SLIP, for which we anticipated potential environmental impact on a designated wildlife site; the Site of Special Scientific Interest (SSSI) at Ashwell Springs. Hence the SLIP source was been removed from the list, as we have no intention of applying for a drought permit where environmental damage on an SSSI is likely. It should be noted that the prioritisation of sources may need to be shifted should shortages of water available for supply occur in areas supplied by sources further down in the list. All decisions will be made after discussions with the Environment Agency.

We have examined the existing sources in our Southeast region to see where applications for drought permits would provide maximum benefit; there is no scope to develop any new groundwater sources. Four sources have been identified where drought permits may be applied for under a severe drought scenario i.e. Drought Trigger Zone 4. All are located in the River Dour Catchment and therefore have been incorporated into a single EAR to quantify the impact of increased abstractions on the river. A preliminary environmental assessment for the Dour will be completed ahead of any drought permit application that could impact on the river.

We have also examined all the existing sources in our East region. The supply side options included as drought management actions will not involve any environmental damage, as all options are available within the operational limits of existing abstraction licences. In addition studies such as that for the River Brett AMP3 NEP Scheme did not demonstrate any connectivity of groundwater abstraction from the semi-confined aquifer with no discernible environmental impacts on surface water features due to abstraction from our sources. Similarly the abstraction from the River Colne was reviewed for possible impacts on the downstream estuary. No further action was considered necessary and the existing licence allowing all fresh water to be abstracted at the tidal limit (within overall licence volumes) remains in place.

7.1 Existing studies of potentially affected sites

Following on from and in conjunction with the AMP3, AMP4, AMP5 and AMP6 National Environment Programmes (NEP), and the earlier Alleviation of Low Flow (ALF) Schemes, we routinely undertake project specific environmental monitoring. This monitoring encompasses groundwater monitoring, spot gauging of river flows, as well as baseline ecology surveys such as macroinvertebrates, macrophytes, River Corridor and River Habitat Surveys. Monitoring is also undertaken on sites where we hold time-limited licences which provides valuable data on the impact of our daily activities. This data may also be utilised for baseline monitoring and to enhance understanding under drought conditions. A summary of previous and current studies on the various rivers across our supply areas are shown in Table 20.

Table 20: Examples of Previous and Existing Studies of Potentially Affected Drought Permit and drought order Sites

River/Site	Previous Studies	Current Studies
Misbourne (WRZ 1)	Alleviation of Low Flow Study and AMP5 NEP Options Appraisal	AMP6 Sustainability Reduction monitoring and morphological mitigation
Ver (WRZ 2)	Alleviation of Low Flow Study and AMP5 NEP Investigation and Options Appraisal	Investigation and monitoring. AMP6 Sustainability Reduction monitoring, river support and morphological mitigation
Colne and Mid Colne Lakes (WRZs 1 & 2)	AMP5 NEP Investigation. Options Appraisal for Upper Colne	Baseline monitoring for Ver Sustainability Reduction
Rib (WRZ 5)	AMP4 NEP Investigation on lower reaches and AMP5 NEP Investigation and Options Appraisal on upper/mid reaches	Time-limited licence monitoring
Gade (WRZ 1)	AMP3 NEP Upper Gade Sustainability Study and AMP4 NEP Options Appraisal	AMP6 NEP Sustainability Reduction monitoring and morphological mitigation
Mimram (WRZ 3)	AMP3 NEP Mimram Sustainability Study and AMP4 NEP monitoring	AMP6 NEP Sustainability Reduction monitoring and morphological mitigation
Beane (WRZ 3)	AMP3 NEP Beane Sustainability Study and AMP4 NEP monitoring	AMP6 NEP Sustainability Reduction monitoring and morphological mitigation
Cam (WRZ 5)	River Cam Environmental Report (1998)	AMP6 NEP Investigations and options appraisal monitoring
Hiz (WRZ 3)	Alleviation of Low Flow Study and subsequent reviews/monitoring, various reports and data	River photo monitoring
Little Stour (Lower Nailbourne) (WRZ 7)	AMP3 Alleviation of Low Flow Study, AMP4 Sustainability study. AMP5 options appraisal study in conjunction with Southern Water, South East Water and the Environment Agency in order to determine the preferred option for improving the river flows	AMP6 river support and morphological mitigation feasibility study
Dour (WRZ 7)	Alleviation of Low Flow Study and river support	AMP6 macroinvertebrate baseline monitoring
Brett (WRZ 8)	AMP3 NEP investigation	None

The following sections describe business-as-usual routine activities for baseline monitoring and the enhanced drought monitoring to be undertaken by us and external stakeholders such as the Environment Agency and the Met Office.

7.2 Baseline Monitoring

Good data sets now exist for the Rivers Beane, Cam, Gade, Hiz, Mimram, Misbourne, Rib and Ver from previous AMP investigations, which can be fully utilised in the baseline assessment for a drought application in these catchments. We are undertaking extensive monitoring in AMP6 (2015-2020) to monitor the effect of the Sustainability Reductions on the Rivers Beane, Gade, Hughenden Stream, Mimram, Misbourne and Ver. We are also carrying out monitoring for a number of NEP investigations and options appraisals on the Rivers Cam and Ver. We will also be undertaking morphological work and monitoring on the Rivers Beane, Gade, Little Stour, Mimram, Misbourne, Upper Lea and Ver. This extensive AMP6 monitoring will add to the existing baseline data to help provide a better understanding and knowledge of these river catchments.

In previous drought situations where hydrological and ecological data records have been considered to be limited, additional data has been collected. The proposed enhanced drought monitoring schedule for each permit site is detailed within the EARs and is also identified in Appendix 6.

7.2.1 Business-as-usual groundwater monitoring

Groundwater level is the indicator of water availability in the aquifer and we use historic water level patterns to determine current water level relative to long-term averages. We routinely monitor daily groundwater levels in all of our production boreholes/wells as part of our routine operation and water resource planning. This information is used to aid the determination of the development and severity of a drought and identify any early impacts of such a drought on our resources and local environment.

We also monitor and analyse data from external sources for each WRZ. The Environment Agency undertakes routine hydrological monitoring of river flows and groundwater levels across most of our supply areas. A fundamental assumption of our DMP is that the monitoring carried out by the Environment Agency will continue and derived data will be made available. We are in regular communication with the Environment Agency to ensure that the information we hold is up to date. Groundwater monitoring of our WRZs is described as follows:

For drought monitoring purposes in WRZs 1 – 6 all parameters from the monthly hydrological report are duly considered and observed, however given our reliance on groundwater (60%) and that no drought constraints are placed on the River Thames intakes or our import of Anglian Water based on operating agreements, we have identified groundwater levels as being the main parameter for the monitoring of drought conditions.

Monitoring points selected for drought assessment are the Environment Agency observation boreholes located at Chalfont Centre (WRZ 1), Lilley Bottom (WRZ 3) and Elsenham Nurseries (WRZ 5) as identified in Section 3.2.1, Figure 16. This provides data covering the western, central and eastern regions of WRZs 1 – 6. The selected sites are unaffected by abstractions and give a good indication of the groundwater level conditions across our WRZs supply area. Many other groundwater observation points are used to verify the situation outlined by these three locations. The flow in the River Thames, at Kingston Lock, is also monitored to complete the company wide picture for WRZs 1 - 6.

For drought monitoring purposes in WRZ 7 we have identified groundwater levels as being the main parameter for the monitoring of drought conditions, given our reliance on groundwater (100%). Groundwater levels and flow in the River Dour are used to determine the severity of any drought and control our response; they are also linked to licence conditions on some of our sources.

Primary monitoring points selected for drought assessment are the Environment Agency observation borehole located at Wolverton New OBH for the Chalk in addition to one of our own

OBHs at Denge, which is a separate gravel aquifer, not related to the Chalk, identified in Section 3.2.2, Figure 17.

A series of five secondary monitoring points recording groundwater levels on a regular basis are also monitored by us to provide additional groundwater level data. These are located at ELMV, North Court Wood, Poulton, RAKS and STMG. Whilst there are subtle differences in the impact of different recharge events, Wolverton New OBH is considered to be suitably representative for the whole of the Chalk in WRZ 7. In addition, as part of the AMP5 NEP investigation on the Denge aquifer, nine loggers were installed for the continuous monitoring of both the groundwater levels and the water quality in the Denge gravel aquifer. Analysis shows that whilst there are differences in response across this aquifer, TW33 OBH on the Dungeness Peninsula is suitably representative to be used as a drought trigger point for this aquifer.

The Environment Agency manages a comprehensive groundwater monitoring network in the Dour catchment, with the majority of assets being equipped with loggers that continuously record. Whilst only one borehole is linked via telemetry, should the situation deteriorate the Environment Agency will increase the frequency in which the logged data is retrieved. Good historic baseline data sets exist for the River Dour catchment and these will be utilised in baseline assessments for drought permit applications in the catchment.

The primary monitoring point selected for drought assessment purposes in WRZ 8 is the Environment Agency's observation borehole located at Lady Lane, identified in Section 3.2.3, Figure 18. Historical data demonstrates that we can rely on abstracting the full yield of existing sources under drought conditions.

7.2.2 Business-as-usual surface water monitoring

The Environment Agency routinely monitors daily flows on all main rivers in our supply areas, at a number of permanent gauging stations. Data from these gauging stations are sent to us on a monthly basis. The Environment Agency monthly hydrological report makes reference to specific river flow licence triggers to monitor the requirement for reduced abstraction or increased augmentation under existing licence conditions.

7.2.3 Monthly hydrological monitoring reports

The Senior Asset Manager is responsible for notifying the Director of Asset Strategy if the monthly hydrological monitoring discussed in Section 1 identifies that Drought Trigger Zone 1 has been reached.

A list of business-as-usual hydrological monitoring is given in Appendix 6.1. The Water Resources team is responsible for updating and reviewing these different hydrological factors. The data covers the whole of our supply area and the outcomes include analysis of key river flow and groundwater level hydrographs, using routine monitoring data provided by the Environment Agency. MORECS (Meteorological Office Rainfall and Evapotranspiration Calculation System) data on precipitation, effective precipitation and soil moisture deficit, as measured and calculated by the Met Office are also utilised (Appendix 6.2). The analysis of this data assists in the identification of long-term weather patterns and the likelihood of aquifer recharge during the autumn and winter months. It is also used for water situation forecasts. We also review the Environment Agency's monthly hydrological summaries produced by the relevant Area and Environment Agency teams for additional information on the current hydrological situation.

7.2.4 Ecological Monitoring

The Environment Agency holds baseline information on fish, macrophytes and macroinvertebrate populations collected as part of their Restoring Sustainable Abstraction (RSA) plan and data collection for the WFD, which have confirmed that a number of ecological populations are suffering from low flows in rivers. Further ecological data is being collected by us as part of our AMP6 NEP projects, see Appendix 6.3. Where gaps in data still exist we will discuss with the Environment Agency the requirements of any additional ecological surveys required. This will be added to the enhanced drought monitoring schedules in the EARs and outlined in Appendix 6.3. This data will be utilised in the application for any drought permit or drought order.

7.2.5 Quarterly River Photos

Our Water Resources team take digital river photographs quarterly at 127 defined locations on 18 rivers considered to be environmentally sensitive within our supply areas. This has allowed the team to compile a photographic record from 1998 onwards of key locations on these sensitive rivers for reference purposes (Appendix 6.1). This also ensures that each river is visited at least once every three months through different hydrological conditions and allows the early identification of any potential low flow concerns. This record has also proved useful in our liaison and discussions with the Environment Agency and local communities over key low flow licence triggers or environmental schemes.

7.3 Enhanced Drought Monitoring

Following discussions with the Environment Agency additional environmental monitoring would be instigated in preparation for applying for a drought permit or drought order. Experience of drought conditions in our supply areas has shown that our operations are robust to a number of months of drought conditions. We anticipate at least one season of actual drought conditions to prepare and update our EARs. This additional monitoring would continue throughout the period of the implementation of the drought permit applications and until flows/levels have returned to LTA conditions. Data collected during the recovery phase will be valuable in reviewing the DMP and the Environmental Monitoring Plan ready for the next drought sequence.

7.3.1 Walkover surveys

Walkover surveys are necessary to characterise the drought conditions and effects on the river. The walkover surveys will commence in Drought Trigger Zone 2, preferably undertaken by both Environment Agency and Affinity Water staff, subject to agreement. The objective of the survey will be the identification of reaches under stress, so that a more detailed environmental impact assessment can be completed at the time and immediate mitigation measurements can be implemented.

7.3.2 Spot gauging and water quality

The monitoring schedule will comprise of business-as-usual spot gauging during Drought Trigger Zone 2 (typically monthly), fortnightly spot gauging during Drought Trigger Zone 3 and weekly spot gauging during drought permit duration. If a drought permit is in place, the post drought spot gauging frequency will be weekly reducing to fortnightly and then monthly, following agreement with the Environment Agency. If the drought permit is not used the post-drought spot gauging frequency will be monthly. If monthly spot gauging is already in place due to other projects then the frequency will be increased accordingly. The spot gauging rounds include in-situ water quality monitoring (pH, temperature, dissolved oxygen and conductivity).

7.3.3 Macroinvertebrate surveys

Spring and autumn macroinvertebrate monitoring will continue throughout a drought event to ensure continuity of data sets.

7.3.4 Supporting monitoring data

Appendix 6 contains supporting data, enhanced monitoring schedules and location maps as detailed below:

Appendix 6.1 Location River Monitoring Photographs

Table A6.1 Locations of Environmental Impact Monitoring Photographs

Appendix 6.2 External Monthly Hydrological Data

Table A6.2 External data sets received and analysed for our monthly Water Situation Report

Appendix 6.3 Potential Enhanced Monitoring Programme for each River

Table A6.3 River Rib Enhanced Drought Monitoring

Table A6.4 River Cam Enhanced Drought Monitoring

Table A6.5 River Gade Enhanced Drought Monitoring

Table A6.6 River Ver Enhanced Drought Monitoring

Table A6.7 Hughenden Stream Enhanced Drought Monitoring

Table A6.8 River Hiz Enhanced Drought Monitoring

Table A6.9 River Oughton Enhanced Drought Monitoring

Table A6.10 River Beane Enhanced Drought Monitoring

Table A6.11 River Misbourne Enhanced Drought Monitoring

Table A6.12 River Mimram Enhanced Drought Monitoring

Table A6.13 River Dour Enhanced Drought Monitoring

More detailed monitoring schedules that are associated with the drought permits can be found in the individual EARs.

7.4 External Agency Liaisons

We will liaise with the Environment Agency on a regular basis on a variety of water resources, environmental impact and water quality issues. As detailed in Section 8.2, the Asset Manager will be the primary point of contact with Environment Agency staff including their Drought Co-ordinators. The Senior Asset Manager will be supported by the Asset Strategy Department including our Asset Specialist.

We have also involved Natural England in the development of our DMP through our pre-consultation process, and taken into consideration their comments. Of our proposed Drought Permit sources, none of these have the potential of an impact on a designated habitat site.

7.5 Mitigation Measures

Every drought is different, and the timing and intensity is dependent on many factors such as: rainfall, the effective precipitation, soil moisture deficit, recharge of the aquifer. Our DMP is designed to monitor these environmental variables and to trigger incremental mitigation actions in preparation for potential drought conditions. There are five Drought Trigger Zones and mitigation measures and actions will be implemented in pre-drought (Drought Trigger Zone 2), in drought (Drought Trigger Zones 3, 4 and 5) and post-drought conditions.

The mitigation actions taken will be determined by local drought conditions as assessed by baseline monitoring and the hydrological responses of surface water and groundwater. The Environmental Assessment Reports (EARs) discuss potential mitigation actions in further detail for specific sites and these will be agreed with the Environment Agency at the time of need and implementation.

7.5.1 Pre-drought mitigation measures

We will be undertaking major morphological mitigation measures on a number of rivers in our area during AMP 6 (2015-2020) in WRZs 1 - 6. This will involve river restoration works to enhance in channel velocity dynamics, to create a variety of habitats and to reconnect the river to its surrounding environment. The re-profiling of the river bed and banks will potentially create a more resilient habitat in drought conditions and the potential for refugia to sustain the aquatic ecology for longer as the rivers move towards Good Ecological Status (GES).

During this AMP 6 period we are undertaking morphological mitigation, river restoration and habitat enhancement on the following rivers: Beane, Gade, Mimram, Misbourne, Little Stour, Upper Lea and Ver. We are also implementing Sustainability Reductions on the rivers Beane, Gade, Hughenden Stream, Mimram, Misbourne and Ver. It is anticipated that this extensive work will have a positive impact on these rivers, their habitat and ecology, helping to buffer the impacts of climate change and create resilience in drought conditions. Further details are discussed in the relevant EARs.

Our business-as-usual monitoring, such as quarterly fixed point photography of the rivers, ensures a visibility of the river network, which can potentially highlight any emerging issues and therefore mitigation can take place before escalation into bigger problems.

As described in Section 7.3.1, when Drought Trigger Zone 2 has been reached walk-over surveys on the rivers with potential drought permit and/or drought order sites will be arranged and surveyed in agreement with the Environment Agency.

Historical data demonstrates that our WRZ 8 can rely on abstracting the full yield of existing sources under drought conditions.

7.5.2 In-drought mitigation measures

After reaching Drought Trigger Zone 3 and with drought conditions becoming more severe, chalk groundwater levels would be declining, resulting in the upper reaches of chalk streams drying out, which is part of the natural chalk river process. The drying out of reaches further downstream may also occur due to the river bed being perched or no longer in contact with groundwater due to lack of rainfall and depleted groundwater levels resulting from the drought conditions. This issue is in many cases exacerbated by the fact that many sections of chalk streams in our area are not situated on their original courses. This is due to historical modifications, frequently moving the rivers into mill leats, which has resulted in disconnections from groundwater.

Walk-over surveys will continue throughout the drought period and knowledge from previous walk-over surveys will inform where fish and eel easement cannot be achieved. Therefore arrangements for fish rescues of the populations under stress will be conducted by the Environment Agency, with us providing assistance where possible.

The EARs discuss potential mitigation actions in further detail for specific sites and these will be agreed with the Environment Agency at the time of need and implementation.

7.5.3 Post-drought mitigation measures

Drought recovery is totally dependent on effective precipitation; recovery may take several years to return to normal levels or as in 2012 a couple of months. Monitoring will continue post drought to evaluate the recovery of groundwater, river flows, the ecology and associated habitats and the improving WFD status of the rivers. Mitigation measures that may be implemented at this stage of the drought process are discussed as follows:

– *Abstraction*

  The cessation of need for additional abstraction for public supply can provide the options of abstraction for augmentation or partial/full cessation of abstraction from the catchment reaches that have been most affected, to be considered. This will aid the recovery of the natural flows into the river and ultimately reduce the time of the river remaining dry.

– *Review*

  A post-drought review will be undertaken to identify what worked well and what did not work as well. Any threats and opportunities observed during the drought conditions will be reviewed, and any lessons learnt implemented in a timely fashion in readiness for subsequent drought conditions.

8 Management and Communication Strategy

8.1 Introduction

Experience from previous droughts in our region has outlined the importance of effective internal and external liaison – before, during and after a drought. This section provides details on the Drought Management Group which would be mobilised with the onset of a drought. The members of this group have been identified to be best placed to jointly manage the developing drought situation effectively, both internally and externally. This section also details the communication methods we would use to communicate with customers in response to reaching each of the drought trigger zones. Our strategy has been developed to ensure that we maintain the ability to respond effectively and efficiently in an escalating drought situation.

A drought is likely to affect neighbouring water company areas as well as our own, and as such it is crucial that we work together with all the affected water companies to ensure consistency of communications. Water UK will play a role in this process.

8.2 Management Structure

8.2.1 General

There are many different actions that need to be managed during a drought and as a result it will draw in representatives from across the business. Figure 47 provides an overview of the organisational structure in place at Affinity Water. Our business is divided into 8 directorates, each responsible for running essential parts of the business. This section of the report identifies how the directorates collaborate to ensure we provide the best level of response possible to both an emerging and escalating risk of drought.

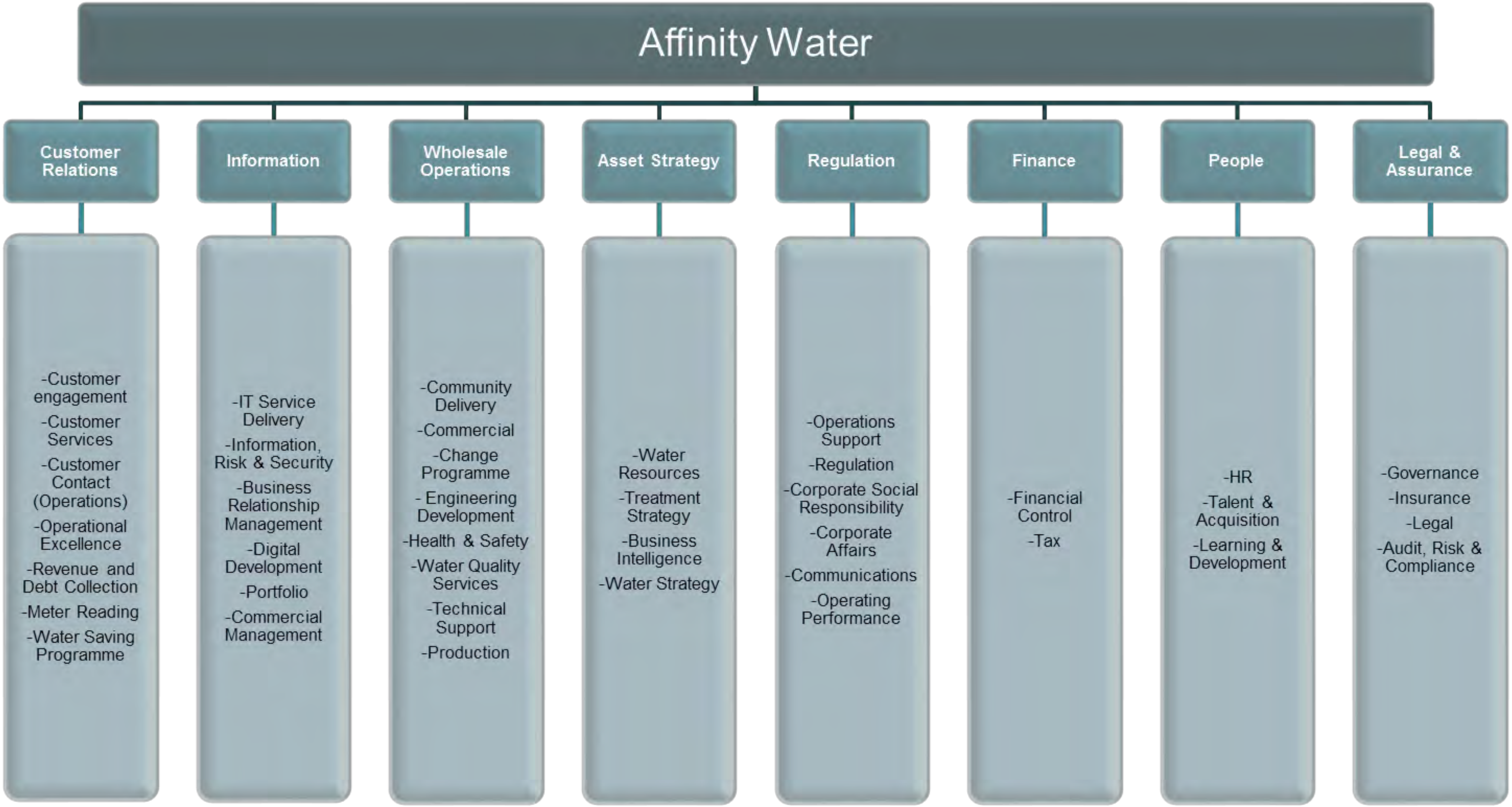

Figure 47: Overview of the Affinity Water organisational structure, identifying the directorates and departments within them

8.2.2 **Drought Management Group**

Under normal (non-drought) conditions, the Director of Asset Strategy has the responsibility for the continued hydrometric and meteorological monitoring and monthly reporting to the Executive Management Team and Board of Directors.

As the potential for a drought increases, assessed from a variety of sources but primarily our groundwater drought trigger curves, we will form our Drought Management Group (DMG).

Our DMG is chaired by the Director of Asset Strategy, and is responsible for managing our response to a drought in accordance with this DMP. The DMG is formed of senior managers from relevant departments, and includes representatives from:

- Asset Strategy, responsible for monitoring the state of available above and below ground assets, drought severity and environmental impacts.
- Production and Supply (Wholesale Operations), with specific responsibility for ensuring that our water abstraction and production capability is at full capacity during months of low rainfall and high demand.
- Network Operations (Wholesale Operations), to ensure that the network is operating as efficiently as possible to meet demand, including our leakage management strategy.
- Corporate Affairs (Regulation), who are responsible for implementing the Communications Plan (reference section 8.4). This includes the development, design and implementation of communications messaging and materials. The Head of External Communications is a member of the DMG and is responsible for the implementation of all communications activity.
- Customer Contact Centre (Customer Relations), which is responsible for responding to customers queries regarding the drought and restrictions.
- Representative of the Wholesale Service Desk, to maintain contact with non-household retailers and to keep them informed of drought development.

The DMG will meet for the duration of the drought at a frequency relative to the drought severity, i.e. the more severe the drought, the more frequently the DMG will meet.

8.2.3 **Supporting the Drought Management Group**

Our experience from the 2011/12 drought and from the flooding of 2013/14 highlighted the importance of establishing a central working group to coordinate the key activities of a developing issue, including communications, tactical operational decisions, planning, regulator and stakeholder engagement, record keeping and, where necessary, capital delivery. To support the DMG, we will establish a Drought Working Group, which will be led by a senior manager and formed of key personnel who will be taken off-line for the duration of the drought. The Drought Working Group will coordinate the activities of the four supporting groups, whose membership and purpose are outlined in Figure 48.

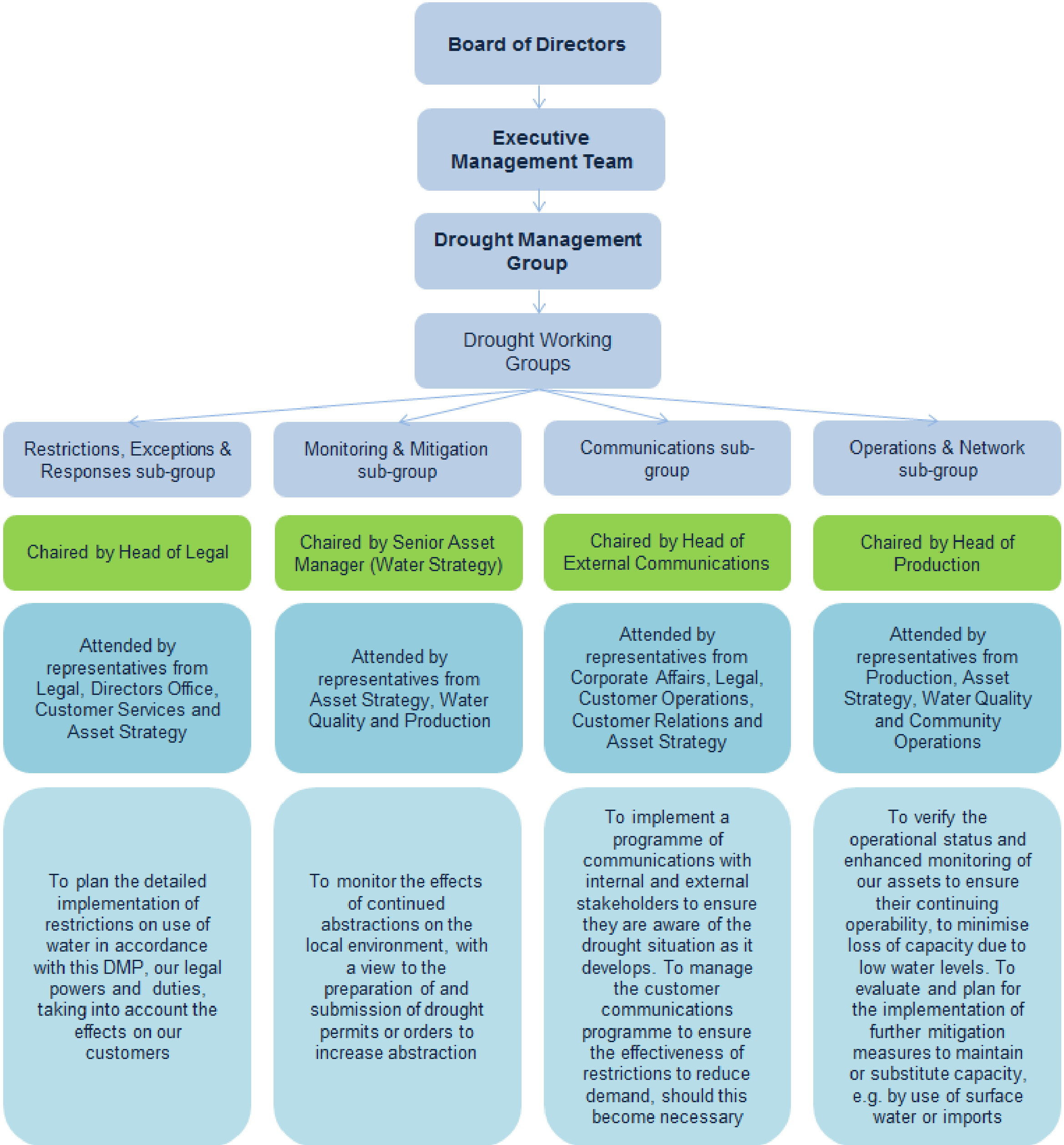

Figure 48: Structure supporting the Drought Management Group

8.3 Roles and Responsibilities

Routine hydrological monitoring, readiness of assets and general communications are continuous tasks we undertake as part of our normal operations which help us to identify the early onset of a drought. Once we enter into Drought Trigger Zone 1, and as a drought intensifies, other roles are mobilised and it is essential we understand who within the business is responsible for different actions. Responsibility for mobilising the DMP is held by the Asset Strategy Director. The DMP and the roles and responsibilities described are agreed and approved by the Affinity Water Board of Directors. The Asset Strategy Director is a member of the Executive Management Team, and reports to the Chief Executive Officer, who is the Board Director accountable for drought management. Responsibilities for actions under the DMP are detailed in Table 21 below.

Table 21: Key Roles and Responsibilities in Managing Drought

Role	Responsibility	Timescale
Drought Monitoring	Asset Specialist – Asset Strategy	Ongoing/Monthly. Enhanced during Drought
Review Drought Management Plan	Senior Asset Manager – Water Strategy	Annually
Drought Triggers Breached	Asset Specialist-Water Strategy	Upon breach of Zone 1
Convene Drought Management Group	Director of Asset Strategy	Upon breach of Zone 2
Convene Drought Working Group	Director of Asset Strategy	Under direction of DMG
Readiness of assets and Chair of the Oasis Group	Head of Production and Head of Control Operations	Ongoing
Drought Records/Filing	Asset Scientist	Under direction of DMG
Environmental Monitoring Plan (section 7 of DMP)	Senior Asset Manager	Under direction of DMG
Communication Plan (section 8.4 of DMP)	Head of Corporate Affairs	Under direction of DMG
Communications Customers, Group, Board	Head of Corporate Affairs Chief Executive Officer, Managing Director of Wholesale Operations, Director of Customer Relations, Asset Specialist-Water Strategy	Under direction of DMG
EA Liaison	Senior Asset Manager – Asset Strategy	Under direction of DMG
Ofwat Liaison	Director of Regulation and Corporate Affairs	Under direction of DMG
Defra Liaison	Director of Asset Strategy	Under direction of DMG
DWI Liaison	Head of Water Quality Services	Under direction of DMG
Capex Programme identified	Director of Asset Strategy	Under direction of DMG
Opex monitoring	Director of Finance	Cost Centre set up
Capex Delivery	Director of Wholesale Operations	Under direction of DMG
Water Quality Plan	Head of Water Quality Services	Under direction of DMG
Drought Order/Permit or Restriction removal	Senior Asset Manager	Under direction of DMG

Role	Responsibility	Timescale
Promoting efficient use of water	Head of Corporate Affairs, Water Saving Programme	Under direction of DMG
Appeals for Restraint Plan	Head of Corporate Affairs	Under direction of DMG
Restrictions on Supply	Director of Asset Strategy	Under direction of DMG
Emergency Planning	Asset Specialist-Security	Under direction of DMG
Stand down of DMG	Director of Asset Strategy	Return to 'Normal' hydrological conditions

8.4 Communication Plan

8.4.1 General

The purpose of our drought communications plan is to assist the DMG to:

- Ensure co-ordinated, regular and consistent messages are efficiently disseminated to all customers, stakeholders, the media and neighbouring water companies to gain their support and use of their communication channels as well as ensuring regular dialogue and a close working relationship
- Help customers plan for drought and minimise the effect of implementing TUBs on their lifestyles,
- Clearly communicate our changing resources position, the requirements for TUBs and the eventual lifting of restrictions,
- Reduce customer demand for water through encouraging and promoting water efficiency and providing advice,
- Communicate the positive steps we have taken to enable us to manage demand during drought conditions

In order to ensure we achieve this, we have updated our communication plan in light of our experiences from the 2012 drought (described further in Box 2) when TUBs were implemented, which allowed us to apply and test the effectiveness of our communication plan. The key learning points and actions taken were as follows:

- The cooperation between water companies on drought and TUB lifting communications was vital and made a significant contribution to drought communications nationwide. This was coordinated by Water UK.
- Despite an extensive advertising campaign, predominantly using local radio and newspapers, not all our customers were aware of the severity of the drought and the implementation of the TUB. Direct communications to customers will therefore be favoured for a future drought.
- Key stakeholders and customers could have benefited from more communication about the worsening water resources position before the TUB was introduced.
- It was identified that there is a need to introduce a way of regularly communicating our water resources position, particularly to key stakeholders, following a dry winter or a drop in water resource levels below the long-term average will be required. A more

proactive focus on Local Authority CEOs and one to one meetings or monthly bulletins on the water resources situation should also be adopted.

- Printed communications that were produced assumed that there would be no improvement in groundwater positions during early 2012 which quickly became obsolete when the water resource position improved. Communications should therefore promote our website and social media pages as information points for changing environmental conditions and TUB status.
- Many customers, across the south east of England, saw the TUBs as a failure by the water companies. We therefore need to work harder to communicate that TUBs are a planned part of drought management, as well as providing additional information about the water cycle and water sources.

Box 2: Our central region's experience of the 2011 – 2012 drought sequence

The 2011-2012 drought affected most of south east England for a period of approximately 12 months. Our Drought Management Group (DMG) was set up and its first meeting was held on 4th January 2012 along with the sub-groups that reported to it regularly. Our response followed the established procedures set out in its Drought Management Plan (DMP).

In order to preserve supplies and reduce demand, a Temporary Use Ban imposing various restrictions on water use was put in place on 5th April 2012, as was implemented across the majority of the water companies in south east England. These restrictions remained in place until 9th July 2012, when sufficient rainfall had fallen to replenish our sources and lift the drought conditions. Environmental monitoring was in place in accordance with the Plan; however, it was not required to support the application of Drought Permits or Orders.

Through effective monitoring and transfer of supplies between regions, we were able to supply all of our customers with an uninterrupted supply of water at all times during the drought.

Communication was a key component of our response to the drought. Effective channels of communication were set up between ourselves, the Environment Agency (EA) and other water companies. Maintaining consistent external messaging to all customers was very important, and various channels were used for this purpose.

8.4.2 Customer communications

Our communications with customers are designed to include different groups within our communities, as advised in the CCW Report (2013)[25]. Communication with our customers has two major strands:

1. On-going communication of activities focused on encouraging water conservation and awareness of limitations of water resources in the south east of England.
2. Targeted communications activities to manage communications around specific drought scenarios.

Our PR14 Business Plan for 2015-2020 has put water efficiency at the heart of our activities. With the launch of our Water Saving Programme (WSP) in 2014, there will be a continuous programme of communications going forward promoting water efficiency to all our customers – with the combined aims of saving water, energy and money.

As part of our WSP within our central region, as at the end of 2016 we have:

[25] Consumer Council for Water, 2013, *Understanding Drought and Resilience*

- Installed 72,034 meters
- Carried out 31,506 Home Water Efficiency Checks at customer properties
- Attended over 50 water efficiency events in our company supply area

8.4.2.1 On-going water efficiency communications

Our Water Saving Programme has been developed to promote water efficiency as a key message to customers. Under normal operating conditions, on-going communication activities include the active promotion of water efficiency and water conservation. Table 22 below details these communications.

Table 22: On-going water efficiency and water conservation communications

Communication Channel	Target Audience	Timing	Responsibility
Regular dialogue with EA	Regulator	Ongoing	Asset Strategy
Regular dialogue with local environmental groups	Stakeholders	Ongoing	Asset Strategy/ Corporate Affairs
Media - provide regular information on water saving programme, water efficiency and leakage reduction	Customers and stakeholders via the media	Ongoing	External Communications
Develop relationships with journalists in key media to provide background briefings on water supply/ demand	Customers via the media	Ongoing	External Communications
Printed communications - billing booklets and other company literature to carry water efficiency messages Specific leaflets and information online on water efficiency – at home, in the garden	Water users	Ongoing	External Communications/ Education Services
Affinity Water website and social media – water efficiency advice	Water users	Ongoing	External Communications and Digital Team
Participation at community events, promoting water efficiency through displays and promotional materials	Water users	Mainly spring/ summer	Corporate Affairs/ Water Efficiency Team
Speaker platforms to community groups e.g. Rotary Clubs, Chambers of Commerce, special interest	Water users	Ongoing	Managed by Corporate Affairs
Education Services - programmes focused on encouraging water efficiency, including water audits to help schools be more water efficient	Water users	Ongoing	Affinity Water Education Service
Publicise all activities above to underline key message of water efficiency	Water users and stakeholders	Ongoing	External Communications
Political - provide regular information on water saving programme, water efficiency and leakage reduction	Water users and stakeholders via politicians	Ongoing	Corporate Affairs

8.4.2.2 Additional communications in the lead up and in the event of a drought

In the event of a drought, a targeted communications campaign will be implemented in accordance with the severity of the drought. Sections 8.4.2.2.1 to 8.4.2.2.5 detail the key actions and messages that will be communicated in response to entering the corresponding Drought Trigger Zones.

8.4.2.2.1 Drought Trigger Zone 1 - Preparation

Key actions associated with entering this zone:
- Alert EMT that the drought trigger zone has been breached
- Assess implications of the timing of the breach and the potential need to implement the DMP

In response to Drought Trigger Zone 1 being breached, we would continue with our baseline water efficiency messaging, leakage activities and Water Savings Programme. Internally the Asset Strategy Team would alert the Executive Management Team and appropriate members of staff of the potential situation arising and increase our monitoring of groundwater levels.

8.4.2.2.2 Drought Trigger Zone 2 – Raise awareness

Key actions associated with entering this zone:
- Convene the Drought Management Group
- Raise awareness of water resource situation
- Call for voluntary reductions in demand
- Enhance leakage programme
- Increase contact with Defra, the EA, Water UK and neighbouring water companies, and report on operational readiness

Following the breach of Drought Trigger Zone 2 the following measures will be taken:

- Where other water companies are affected, coordinated communication plan with Water UK and other water companies will be initiated.
- Weekly reporting of the water resources situation for each water company's supply area and agreement on media strategy.
- General communications will be targeted to all potentially affected customer properties containing information about the water resource situation, potential need for restrictions if the situation worsens, water efficiency and advice.
- Communication will be issued to key stakeholders via letter or email, including a request to create a link from their websites to the Affinity Water drought web pages (Section 8.4.2.3)
- Updates on the water resource situation will be added to our website.
- Our website and social media (Facebook and Twitter) will be used to inform customers of the changing water resource situation.
- Question and answer documentation will be updated and reissued for the customer contact teams and public facing teams, including the Wholesale Service Desk.

8.4.2.2.3 Drought Trigger Zone 3 – Implement restrictions

Key actions associated with entering this zone:
- Review and refine leakage strategy
- Review the performance of our sources and transfers to ensure they are been utilised as efficiently as possible
- Use of Temporary Use Ban Restrictions to minimise peak demands and maintain water resource position as long as possible
- Review potential investment requirements to meet the specific needs of the drought observed

In the event that the water resource position enters Drought Trigger Zone 3, all activities already initiated will continue and will be supplemented with:

- If the drought affects neighbouring companies as well as us, Water UK will appoint a Drought Liaison Coordinator to act as industry spokesperson – their role is presented in Figure 49.
- Email communications to stakeholders highlighting the worsening situation.
- When the temporary use ban is launched, news releases will be sent to local media and local politicians will be briefed.
- Publication of TUB in national media as per regulatory requirement.
- A supplementary, one page drought leaflet will be issued with other customer communications.
- The drought will be a national media story, the External Communications Team will provide reactive and proactive media management to maximise awareness, education and minimise reputational damage.
- Vulnerable customers would be given a period of grace – specific communications will be developed for these customers.
- More focused messaging towards non-household water users will take place.

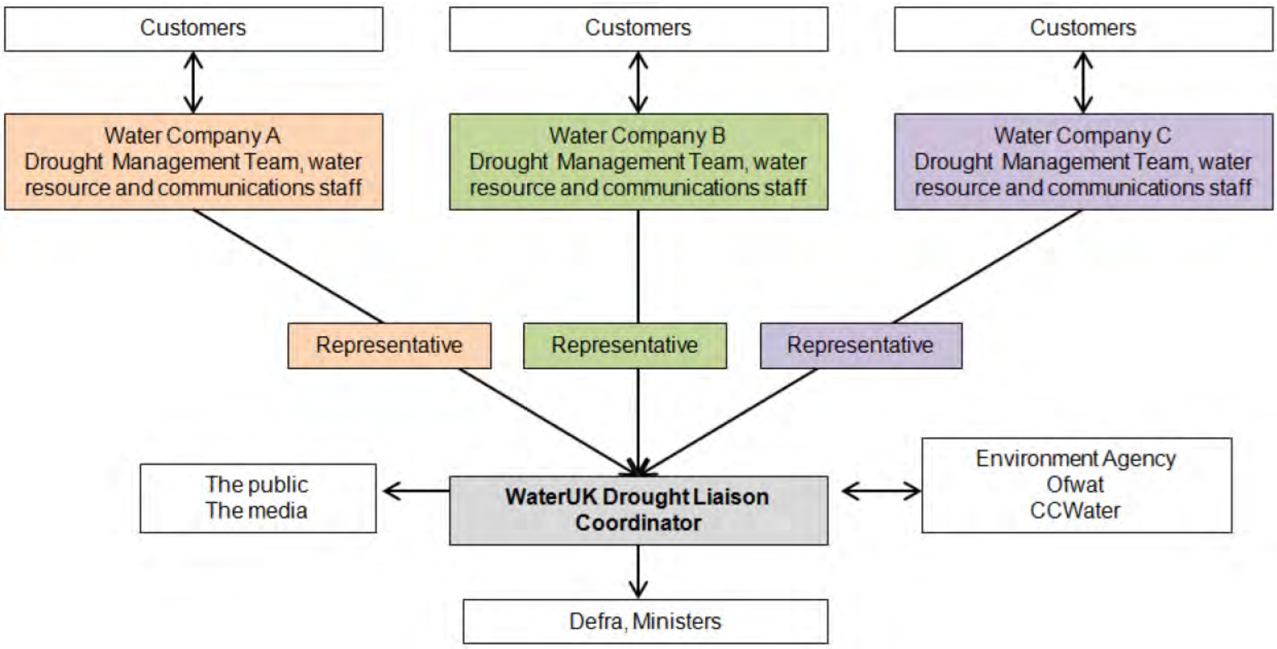

Figure 49: The role of a Drought Liaison Coordinator in droughts which span more than one water company area, as presented in the UKWIR Code of Practice [26]

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[26] UKWIR, 2014, Managing through drought: Code of practice and guidance for water companies on water use restrictions – 2013 (incorporating lessons from the 2011-12 drought). 14/WR/33/6

8.4.2.2.4 Drought Trigger Zone 4 – Restrictions and Supply Side Actions

Key actions associated with entering this zone:

- Continue to review and implement investment opportunities to manage the extreme water resource position observed
- Apply for and implement drought permits and orders to increase abstraction
- Implement ordinary drought orders
- Continue to communicate the deteriorating situation
- Prepare applications for Emergency Drought Orders

Following a breach of Drought Trigger Zone 4, all Drought Trigger Zone 2 and 3 activities will continue and will be supplemented with:

- Notices to be sent to the appropriate bodies to advise that we are applying for drought permits.
- Stakeholder contact, particularly with interest groups, will be increased and planned to assist with a worsening drought situation. Communications will explain the need for more severe actions and drought permits to try and avoid objections to applications.
- Upon the applications being granted, notices will be published in local and national media as per regulatory requirements. The process for drought permit applications is set out in Figure 50. In the event that our applications are refused we will continue to work with stakeholders as we proceed with drought order applications.

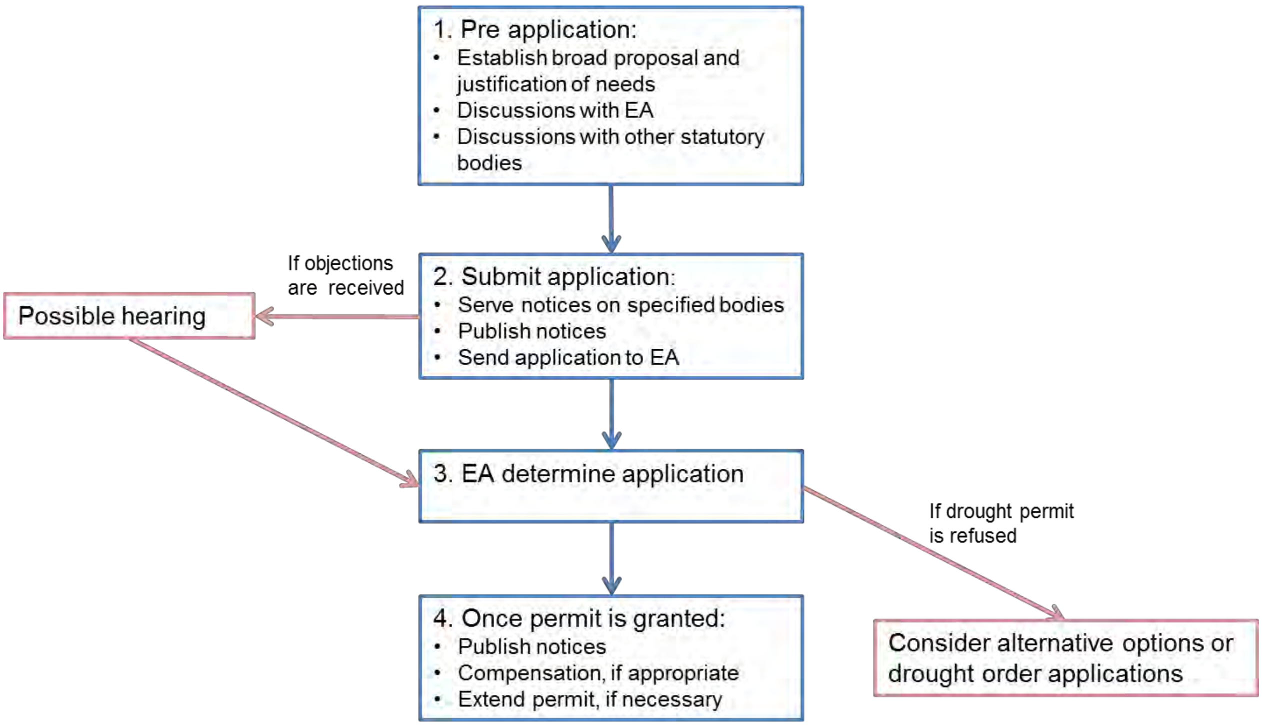

Figure 50: Drought permit application process

8.4.2.2.5 Drought Trigger Zone 5 – Emergency actions

Key actions associated with entering this zone:

- Apply for and implement emergency drought orders for abstraction potentially causing temporary environmental damage
- Potential enactment of our Emergency Plan

This would be an unprecedented drought situation exceeding a 1 in 120 year return rate which is the defined level of service for our 2014 WRMP, as discussed in Section 1.3. All Drought Trigger Zone 2, 3 and 4 activities will continue and will be supplemented with:

- The External Communications team will continue to provide reactive and proactive media management to maximise awareness, education and minimise reputational damage.
- Stakeholder contact will be further increased and planned to assist with a worsening drought situation.
- Prepare to enact Emergency Plan in localised areas.

8.4.2.3 Key stakeholders

We have developed good relations with many stakeholders. The following organisations would be key contacts to work with and keep informed throughout a drought situation.

Table 23: List of Key Stakeholders for drought communications

Environment Agency	Water UK
Secretary of State for the Environment	Ofwat
Greater London Assembly	Local Authorities (Officials and Elected)
Consumer Council for Water	Water Wise
Neighbouring Water Companies	Natural England
Drinking Water Inspectorate	Defra Officials
Water Minister, Defra	Constituency MPs

At Drought Trigger Zones 1 and 2, information would be communicated through active engagement, which will be coordinated as far as possible with the EA and other water companies.

If water resource levels dip to Drought Trigger Zones 3 and 4 we would communicate monthly updates to all of these organisations.

8.4.2.4 Vulnerable Customers

In the event of a drought we will proactively contact customers who are registered on our priority services register. In addition we will work with local stakeholders to ensure that we reach as many of our customers in vulnerable situations as possible.

8.4.2.5 Non-household Customers

In the event of a drought we will follow the processes set out in the market codes for dealing with and communicating with non-household customers. In addition we will liaise with retailers to develop communications which work for end users.

8.4.3 **Communication channels**

8.4.3.1 Target audiences

We recognise that our different stakeholders have different needs from us, both in terms of the information we provide and the frequency of our updates. We have therefore reviewed the key messages we are trying to alert our different target audiences to and selected the most efficient communication channel to meet these needs. The results of this review are outlined in Table 24.

Table 24: Objectives of our drought communications and the channels that would be employed to meet the needs of different target audiences

Group	Objective	Channels
Domestic customers	Help customers plan for drought Minimise adverse TUB effect Reduce demand for water Increase understanding and acceptance of TUB Enhance reputation through pro-active communication	Billing booklet, bill communications Dedicated direct mail Automated telephone messages Contact Centre Affinity Water website Facebook Twitter Employees in the community Public area roadshows Water Saving Squad Email
Non-domestic customers	Help customers plan for drought. Minimise adverse TUB effect. Reduce demand for water. Increase understanding and acceptance of TUB.	Wholesale Operations Service Desk
Stakeholders - Including elected representatives - MPs, local councillors. External Communications' stakeholder database	Increase understanding and acceptance of TUB. Gain support from stakeholders.	Email and direct mail Face to face contact Affinity Water e-newsletters Affinity Water website Facebook Twitter Business as usual engagement activities with local groups
Influencers - Media, advice groups and schools, colleges and universities. Trade associations	Increase understanding and acceptance of TUBs. Reduce demand for water.	Third party communications and support: Education Team Affinity Water website Facebook Twitter Student campaigns
Affinity Water employees	Increase understanding and acceptance of TUBs. Minimise customer contact. Low cost reinforcement of messages among friends and family.	Provide up to date information for customer facing team players.
Local interest groups	Communicate monitoring programme and mitigation actions, receive valuable local environmental information	Third party communications and support: Council meetings Interest group meetings Written communications Affinity Water website Facebook

Group	Objective	Channels
		Twitter
Industry stakeholders including – Environment agency Water UK WRSE Other Water companies CC Water Ofwat Retailers	Work with industry stakeholders to develop uniform messages, media management and joint communications strategies.	Retailer promotion with other south east water companies. Continue dialogue with EA & other water companies. Joint appeals for restraint with EA and other water companies
Customer Challenge Group	Inform group on customer and stakeholder communications	Email and face to face contact

8.5 Lessons Learnt from Previous Droughts

Following the 2011-12 drought, a full review of the lessons learnt was conducted and the results provided in *DMP Technical Report: Drought 2012 Response and Lessons Identified*. The following summarises the outcomes of this review in regard to both the positive aspects and lessons learnt. Table 25 also identifies the recommendations that came out of this work and how they have informed this plan.

8.5.1 Positive outcomes

- External communications were generally very effective and were well received by the press and stakeholders. They felt that we had kept them well informed of the developments around the drought as and when they occurred.
- Setting up an OASIS register for South East and Central company areas was an effective way to review issues at a company level.
- Modelling of predicted operational risk to the business was effective as it gave the business the information it needed to focus operational work and continue to be able to supply all of our customers with water without interruption.
- Traffic light risk to sources in Central area was a good tool to view the overall risk to the business.
- All the monitoring that was required was fulfilled.

8.5.2 Lessons learnt for future droughts

- Updates on our external website need to be more frequent.
- Breadth of the communication channels needs to be wider. We need to include social media, direct e-mail and text to customers and local authority magazines.
- A traffic light risk to sources tool for drought planning needs to be completed for each of our areas.

Table 25: Recommended actions before the next drought and actions that have been taken

ID	Recommendation	Response / Actions
1	Regular monthly updating of external website with water resources position, not just in drought conditions.	Water resource position is reported on a monthly basis to our EMT. We have developed graphics which summarise our Water Situation Report, and these are shared on our website.
2	Increase the number of customers for whom we have e-mail addresses, in order to improve direct email communications during future droughts.	Email addresses are now regularly collected by our customer relations teams and our digital engagement team.
3	Clarify the legal position with regard to ANGL Reservoir with Anglian Water.	Meetings were held with representatives from Anglian Water during the development of our WRMP, in which we confirmed the position over water from ANGL Reservoir in the event of a drought. Details of these are contained within WRMP Technical Report 3.5: Water Company & Third Party Bulk Transfers. Improved liaison with Anglian Water to ensure our drought plans are consistent.
4	Clearer definition as to who needs to attend the different sub-groups and the DMG.	Reviewed and clarified as part of the update to the roles and responsibilities section of this Drought Management Plan.
5	Improve the ability of transferring water around the company area through network improvements. These improvements will need to be agreed by Asset Strategy and within the business planning framework.	Modelling capability has been improved allowing us to establish up to date information on zone surplus and opportunities to transfer between WRZs in the most efficient manner. In a drought this would allow us to prepare preliminary design options and obtain funding through the capital assurance process for any schemes necessary.
6	Find out from the EA what they require us to do with regard to drought mitigation measures.	We have been working with the Environment Agency as part of the pre-consultation work for our full update of our DMP in order to identify the mitigation measures required. The initial outcomes from this work have been incorporated in to section 7.5 but further work will continue.
7	Write an impact assessment for our communications plan.	We have reviewed the success of our communications plan and amended accordingly.
8	Establish budget allocations for the various activities.	This would be dependent upon the scale and severity of the drought, but we have learnt the lessons for the requirement of this and it would be the responsibility of the DMG to evaluate this once it has convened.
9	Start environmental monitoring of drought permit sources once Lilley Bottom groundwater levels enter Drought Trigger Zone 3 and amend the DMP accordingly	We have been working with the Environment Agency as part of the pre-consultation work for DMP to agree an effective monitoring plan in the event of an impending drought. This has been incorporated into section 7 of this DMP and we will continue to work with the Environment Agency to ensure our monitoring plan is adequate and effective.

9 Post-drought Actions

9.1 Identifying End of Drought

The end of a drought can be defined as the point at which the risk of impact from drought is no greater than during a normal year, and where normal conditions have continued for a period of time. The hydrological conditions as a drought recedes can be complex and identifying the end of a drought can be difficult to determine. We will confirm first and foremost with the Environment Agency that the water resource situation has returned to normal before taking any action. The following stakeholders would also be notified before any actions are taken: Defra, Ofwat, Water UK, Consumer Council for Water, DWI, and Environmental Groups.

The end of a drought will be determined using the company's established triggers, with all restrictions to be removed when groundwater levels have moved sustainably out of Zone 3. The lifting of restrictions will first require notice to be published on our website and in two newspapers circulating in the affected areas. Unlike the imposition of restrictions, there is no lead in time necessary; restrictions will be revoked instantly when the notice is given.

It can take up to 2 years of consecutive above LTA rainfall in order to recover from a long-term drought scenario. It may require restrictions to be in place throughout this period until groundwater levels have fully recovered. A media campaign would be regularly reinforced outlining clear messages and educating customers that restrictions would remain in place despite heavy rainfall.

9.2 Post-drought Actions

Directly after a drought event, it will be the responsibility of the Director of Asset Strategy to produce a "lessons identified" report that will enable future processes to be improved. This report will be produced within 3-6 months of a drought ending and will be followed up within a year with evidence that recommendations were acted upon. The report will include:

- A review of the environmental impacts of our drought actions by analysing baseline, in-drought and post-drought data.
- A review of the effectiveness of any mitigation measures implemented.
- A review of the success of any drought permit and drought order applications.
- An assessment of how well individual sources delivered additional water and determine where any re-assessments of yields may be needed or invested to maintain yields of sources.
- An assessment of the effectiveness of demand reduction from the implementation of demand side drought management actions.
- An investigation into whether or not the company would need to make any changes to its demand forecast or longer term demand forecast.
- Whether any investments made as a result of the drought will affect other plans or programmes.

The post-drought review process will involve close communications with the EA and any other key organisations. This will principally consist of meetings with follow-up actions agreed mutually. Additionally a drought workshop would be held to assess the efficacy of the management process and review whether any improvements or changes to the Drought Plan were required.

Appendices

10 List of Appendices

The Appendices can be found in a supporting document. Below is a list of the titles: