Climate Change Adaptation Report

January 2011

Contents

Executive Summary

1. Information on Organisation	
Name of organisation	Cambridge Water Company
Organisation's functions, mission, aims, and objectives affected by the impacts of climate change A summary of your organisational purpose and key strategic priorities which are or will be affected by climate change is important when identifying risks to your organisation.	Cambridge Water (CW) is a water undertaker appointed under the Water Industry Act 1991 (2003) The Company's primary function is to maintain an efficient and economical system of water supply within its area and provide a wholesome supply of water to its customers. The aims and objectives of CW that are affected by climate change: • Continue to provide a consistent supply of clean, safe drinking water. • Meet the growth in demand from new customers, and satisfy customer expectations. • Keep bills as low as possible. • Manage the effects from climate change on supply and demand.

2. Business Preparedness before Direction to report was issued	
Has your organisation previously assessed the risks from climate change? Have you a baseline assessment of the risks of climate change to your business currently? The requirements of the Direction can build upon any existing risk assessment you have in place. Please include a summary of findings from your previous risk assessment(s) in your report.	Yes, through risk assessment and preparedness assessment. Climate change is an identified risk in the company risk register, and specific flood risk assessments also exist for operational sites and key infrastructure. Baseline risk assessment with respect to climate change was generally assessed as low, with satisfactory control measures in place. Likelihood of flood risk impacts to operations was assessed as possible to remote, with specific control measures identified and in place.
If so, how were these risks and any mitigating action incorporated into the operation of your organisation? It is useful to understand whether, and to what extent climate change	Control measures for identified risks are: • Continuous, regular review of climate change risks. • Operational response built into Company resilience procedures, emergency plan and policy. • Sustainability of the business and climate change are a key component of the Company vision

risks are already incorporated into your business risk management processes at the strategic level.	

3. Identifying Risks due to the impacts of climate change	
What evidence, methods, expertise and level of investment have been used when investigating the potential impacts of climate change? What evidence have you assimilated to inform your risk assessment? What has been your approach (quantitative, qualitative, scenario based)? What resource (£ / person / days) have been assigned to this assessment? Briefly summarise your approach – in house staff, professional advisors, research expertise?	The method applied to assess the potential impacts of climate change has used evidence from robust scientific sources, the UK Climate Projections (UKCP09) and Water Industry research (UKWIR) projects. The approach has used an appropriate level of detail and analysis including both quantitative and qualitative assessment of the key risk areas posed by climate change to the Company objectives. This initial adaptation assessment has been carried out at the strategic level and performed in-house by reference to available internal and external data sources.

4. Assessing risks	
How does your organisation quantify the impact and likelihood of risk occurring? Provide here a brief summary of the methodological approach to quantification where this has been possible and your categorisation of likelihood and impact. State what criteria you have used to characterise the significance of the risks (high, medium, low, negligible) and how these have been derived. What level of confidence do you have in the analysis?	To quantify the impact and likelihood of climate change risks occurring, a standard criticality and probability matrix have been used to score risks against climate variables and associated impacts on business functions. The significance of risks has been scored by the following criteria; Severity of risk has been categorised by climate change impacts to operations and customers, and an approximate magnitude of costs. Likelihood of risk has been categorised by probable frequency within a time period appropriate to climatic change. The level of confidence in the analysis used to quantify risk is good, within the uncertainties of climate change probabilities, and other uncertainties due to the timescales involved.

5. Uncertainties and assumptions	
What uncertainties have been identified in evaluating the risks due to climate change? Where are the key uncertainties in the analysis of the impacts of climate change and what impact do these have on the prioritisation of adaptation responses and risks for your organisation. How have these uncertainties been quantified and, in brief, what are the implications for the action plan?	The uncertainties identified are: • Magnitude of climate change effects due to various future emissions scenarios, beyond the 2020s • The range of probabilities for the change of climate variables in UKCP09 for the possible future climate. • climate model uncertainty in the estimation of frequency and magnitude of future extreme weather events • The natural variability of localised weather change and unpredictability of modelling at the regional scale A range of results has been used in the analysis as seen fit and appropriate for the risk evaluation, however it has not been possible to clearly quantify all the thresholds for which future climate change impacts upon the Company.
What assumptions have been made? The key strategic business assumptions and methodological assumptions that underpin your analysis of impacts, action plan and analysis of risks. Well-evidenced and justified assumptions are important to the credibility of and confidence in the risk assessment.	The Company has assumed that the methodologies and data within the guidance used to produce the statutory plans provided as evidence for adaptation measures, such as the WRMP, have incorporated climate change impact to an appropriate degree, and that guidance in the planning assumptions remains current. This includes elements such as population growth forecasts, demand forecasting and efficiency measures.

6. Addressing current and future risks due to climate change – summary							
Business function	Climate variable (e.g. increase in temperature)	Primary impact of climate variable (e.g. health)	Threshold(s) above which this will affect your organisation	Likelihood of threshold(s) being exceeded in the future and confidence in the assessment	Potential impacts on organisation and stakeholders	Proposed action to mitigate impact	Timescale over which risks are expected to materialise and action is planned
Water Resources	Increase in rainfall	Aquifer pollution	uncertain	Unlikely	LoS failure, loss of supply	WRMP updates	2035-2080
	Increase in temperature	Supply demand balance, security of supply	Demand exceeding 98Ml/d*	Likely	Restrictions on use, loss of supply, LoS failure	WRMP updates, AMP investment, water efficiency measures	2035-
	Drier summers	High demands, security of supply; drought	Demand exceeding 102Ml/d**	Likely	Restrictions on use, loss of supply, LoS failure	WRMP updates, AMP investment, water efficiency measures	2020's
	Extreme weather events	Aquifer pollution	uncertain	Uncertain	LoS failure, loss of supply	AMP investment, resilience plans	2020's
Water treatment & distribution	Increase in rainfall	Flooding	Uncertain	Unlikely	Loss of supply, LoS failure	AMP investment, resilience plans	2020's
	Increase in	High demands,	Demand	Likely	Restrictions on	WRMP updates,	2035-

	temperature Drier summers Extreme weather events	Pressure on infrastructure Pressure on infrastructure Loss of supply; Health & safety	exceeding 98Ml/d* Demand exceeding 102Ml/d** uncertain	 Likely Unlikely	use, loss of supply, LoS failure Restrictions on use, loss of supply, LoS failure Loss of supply, LoS failure	AMP investment, water efficiency measures WRMP updates, AMP investment, water efficiency measures AMP investment, resilience plans, H&S plans	 2020's 2020's
Facilities, transport & human resources	Increase in rainfall Increase in temperature Extreme weather events	Flooding Employee Health and safety Employee Health and safety	Uncertain Uncertain Uncertain	Unlikely Unlikely Unlikely	Loss of supply, LoS failure Resource implications H&S	AMP investment, resilience plans, H&S plans Resilience plans, H&S plans Resilience plans, H&S plans	2020's 2080's 2020's
Impact on customers	Increase in temperature Drier summers	Increased demand; loss of service Increased demand; loss of service	Demand exceeding 98Ml/d* Demand exceeding 102Ml/d** Uncertain	Unlikely Possible Possible	Restrictions on use, loss of supply, LoS failure Restrictions on use, loss of supply, LoS failure Los of supply, LoS	WRMP updates, AMP investment, water efficiency measures WRMP updates, AMP investment, water efficiency measures	2035- 2035- 2020's

	Extreme weather events	Potential loss of supply			failure	AMP investment, resilience plans	

**normal year WAFU 2035*
***normal year WAFU 2035 +dry year multiplier*

7. Barriers to implementing adaptation programme	
What are the main barriers to implementing adaptive action? What do you see as the key challenges to implementation of your action plan? How will these be resourced and addressed? Briefly, what additional work is required?	Key challenges to implementing adaptation measures: • Financial costs of future capital and carbon intensive measures; • Constraints of the regulatory planning and investment regime and cycles to making suitable business cases for long term adaptation options. • Inadequate climate risk information and inaccuracy of climate risk information
Has the process of doing this assessment helped you identify any barriers to adaptation that do not lie under your control? Interdependencies may arise where others' actions are likely to impact on your ability to manage your own climate change risks. Briefly comment on where this is the case.	See above

8. Report and Review	
How will the outcome of the adaptation programme be monitored and evaluated and what is the timetable for this? Adaptation programmes are expected to reduce the residual risk to organisations from climate change. What measures will you put in place to monitor this?	There were few specific adaptation measures identified by the reporting process for inclusion within a structured programme of specific adaptation measures. Therefore our adaptation programme will focus on: • Continuing with generic measures to address climate related risks, and the appraisal of climate change risks within statutory planning and reporting cycles, which are reviewed on a regular basis. • Incorporating climate variability in future decision making processes • Reporting on progress in climate change mitigation and adaptation.
How do you propose to monitor the thresholds above which impacts will pose a threat to your organisation (including the likelihood of these	Those thresholds that have been quantified are monitored within normal operational performance measurement; these include drought indicators, distribution input and seasonal weather variations. As the Company's exposure and sensitivity to climate change risk changes, these will be developed further, if

thresholds being exceeded and the scale of the potential impact)? It is possible that the current risk appetite within your organisation will change on account of the climate change risks identified. How will this be monitored?	required. The Company recognises that further research is required for some thresholds and impacts, and is encouraged that this is planned collaboratively within the industry over the coming years. This will enable greater use of climate projections in future decision making.

9. Recognising Opportunities	
What opportunities due to the effects of climate change and which the organisation can exploit have been identified? The risk assessment is also expected to generate opportunities for organisations, have these been captured? What are the key ones and the expected net benefits?	No tangible opportunities have been identified in the reporting process

10. Further Comments & Information	
Do you have any further information or comments which would inform Defra (e.g. feedback on the process, the statutory guidance, evidence availability, issues when implementing adaptation programmes, challenges, etc)?	No further comment

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1. Introduction

The global climate is changing, and the effect of this will be experienced everywhere to some degree, including in the UK. Rising global temperatures from greenhouse gas emissions (GHGs) will continue to change the climate for the next 30-40 years[1] regardless of reductions in emissions that we make now. Responding to the impacts of inevitable climate change requires adaptation, through flexible planning and behavioural changes, to make the best decisions at the correct times.

The UK government has recognised the need for business to ensure that the impact of climate change is assessed and that where required adaptation measures are put into place, opportunities are recognised and barriers to adaptation are removed. The benefits of flexible, timely adaptation programmes will be seen both in the private and public sectors.

In order to respond to climate change the Climate Change Act (CCA) was passed in November 2008, which introduces legislation and a framework to ensure that the appropriate adaptation measures are taken to minimise the impact of climate change in the UK. The Adaptation Subcommittee (ASC), an independent advisory panel established from this duty on government to produce an adaptation policy programme, has identified national infrastructure as a priority area for early action[2]

Government duties under the CCA[3] include a five yearly UK climate change risk assessment (CCRA) and an adaptation programme, the first of these to be in place for 2011-12 and 2012 respectively. The contents of this report will feed into the national programme for adapting to climate change.

1.1 Scope of this Report

This report has been prepared according to published guidance to the level of detail deemed appropriate for the size and risk exposure of our organisation. It includes an evaluation of the climate risks to key business functions and identifies any vulnerability. A comprehensive risk assessment of these key functions to climate change is included, together with the risk methodology, and the approach used to identify adaptation measures.

The aim of these assessments is to identify those business functions that are at greater risk from climate change, and provide, where appropriate, adaptation options that are able to feed into adaptation programmes to respond to climate changes.

The report includes:

- A summary of business functions, and assessment of risks and threats posed by climate change impacts.

[1] UKCP09 http://ukclimateprojections.defra.gov.uk
[2] http://downloads.theccc.org.uk.s3.amazonaws.com/ASC/CCC_ASC_Report_ES_web_1.pdf
[3] http://www.legislation.gov.uk/ukpga/2008/27/part/4

- Details of the evaluation process undertaken
- Adaptation measures to address prioritised risks

1.2 Climate Change in the UK

The climate in the UK is already changing. Average temperatures are higher than they were in the 1970s, and climate science undertaken by the UK Climate Impacts Programme (UKCP)[4], estimates that maximum summer temperatures could rise by up to 5°C by the 2080s.

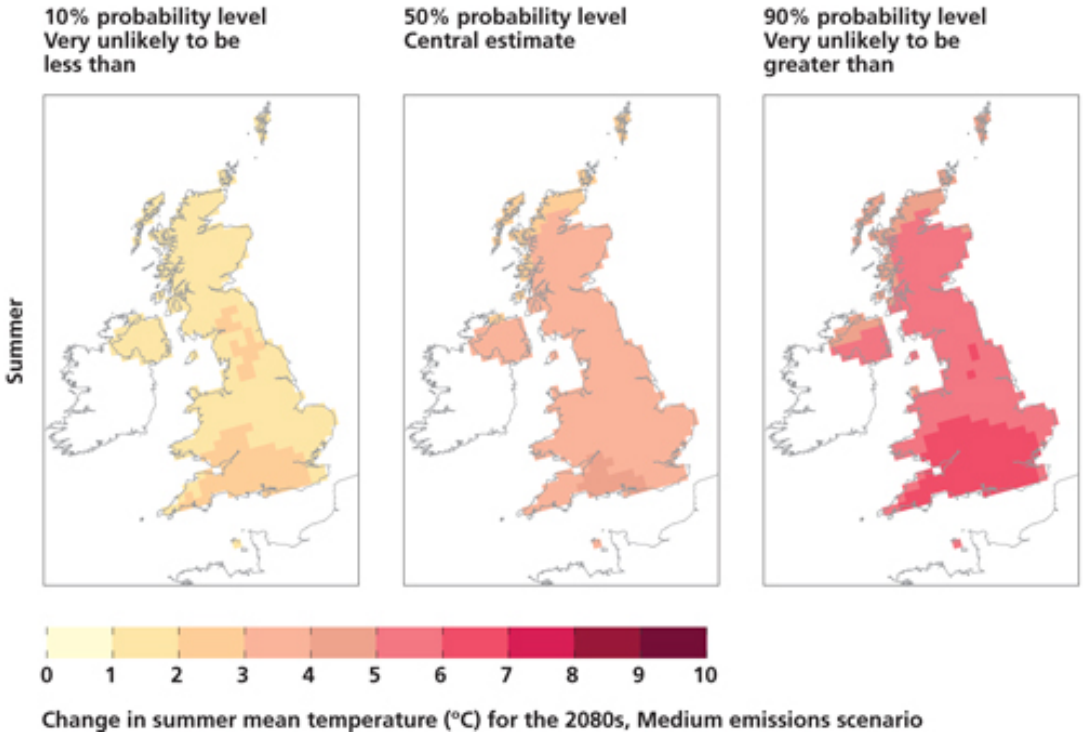

Fig. 1 Future summer temperature under medium emissions scenario[5]

Although average annual rainfall shows little change, projected trends are towards seasonal changes, with drier hotter summers and wetter, milder winters.

In summary, it is expected that in the UK we will see[6]

- Warmer, drier summers
- Milder, wetter winters
- Rising sea levels
- More very hot days
- More intense rainfall
- Fewer days of frost

[4, 5] UKCP09 © UK climate Projections 2009
[6] A changing climate for Buisness,3rd edition June 2010,UKCP

Increases in extreme weather events are also more likely, such as heavier storms, intensive rainfall, floods and prolonged heatwaves. Although these are more difficult to predict, the impacts of such events are already being experienced, in the summer floods of 2007, and the heatwave in 2003.

The water sector is likely to be affected specifically through:

- Water supply shortages
- Increased water demand
- Summer water shortages[7]

2. Background to the Reporting Power

The Climate Change Act 2008 conferred to government an Adaptation Reporting Power to direct statutory undertakers to produce reports[8] on:

- the current and future predicted impacts of climate change on their organisation;
- proposals for adapting to climate change;

the contents of which will feed into the UK climate change risk assessment, to be produced by January 2012, within the adaptation framework as indicated in Fig. 2 below.

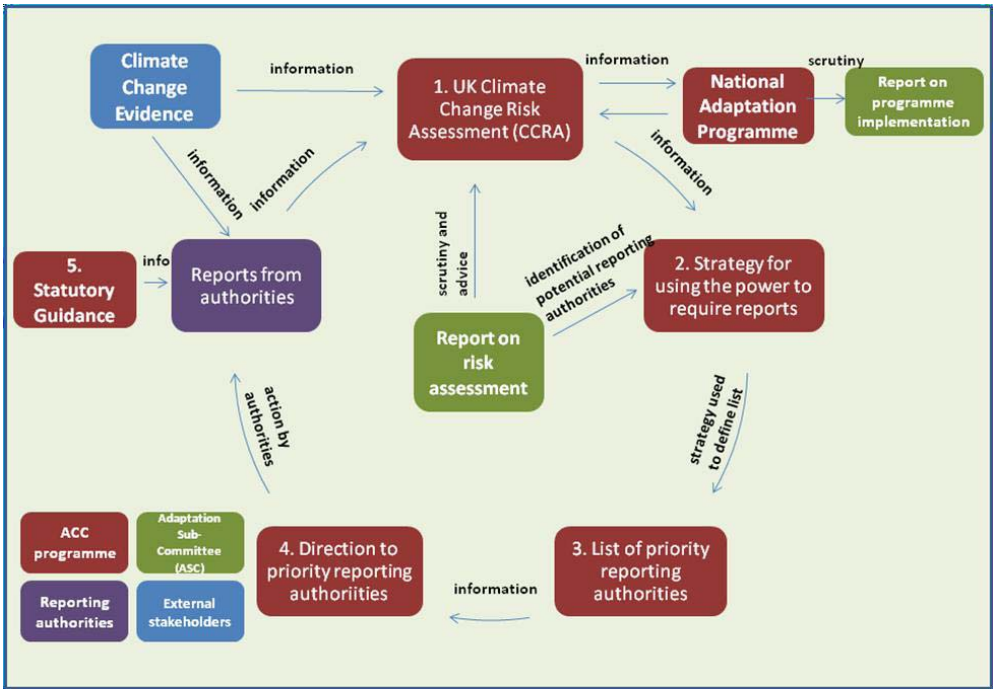

Fig.2 Statutory framework for adapation[9]

[7] http://www.defra.gov.uk/environment/climate/legislation/reporting.htm
[8] http://www.defra.gov.uk/environment/climate/documents/ensuring-progress.pdf
[9] http://www.defra.gov.uk/environment/climate/documents/ensuring-progress.pdf

2.1. Reporting Direction

The Secretary of State (SoS), under the powers conferred by the Climate Change Act 2008 section 62(1), has directed Cambridge Water as a reporting authority to produce an adaptation report to inform the production of a Climate Change Risk Assessment (CCRA) for the UK, by the 31st January 2011.

This report has been prepared in accordance with the statutory direction to reporting authorities from the Secretary of State under sections 62 and 63 of the Climate Change Act 2008, with respect to climate change adaptation.

The assessment has been prepared in line with directions from the Secretary of State, statutory guidance and additional Environment Agency Supplementary Guidance.

2.2. Approach

The approach that has been used in this report and assessment is consistent with the UKCP framework for strategic climate risk and decision making, and also draws upon commonly utilised risk management standards[10]. Broadly the process follows the framework in Fig. 3 below, however this report specifically addresses parts 1-4 of the framework.

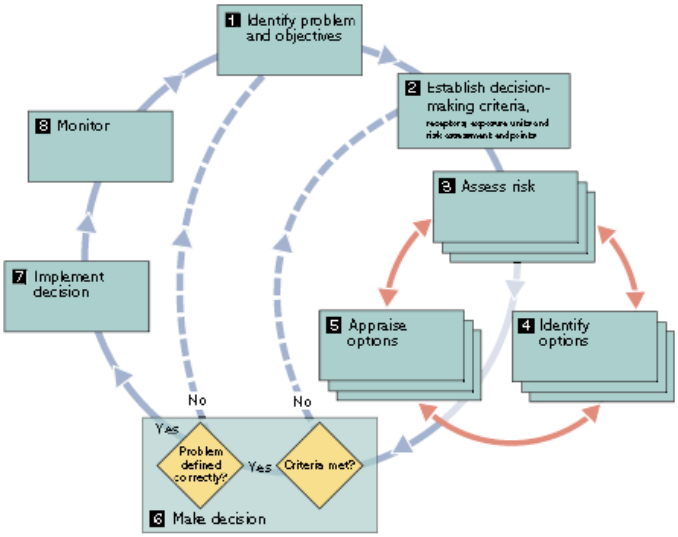

Fig. 3 framework for climate risk assessment and decsion making, UKCP[11]

The steps within the adaptation process and risk assessment for climate change, and their relationship are indicated in Fig. 4

[10] A Risk management Standard, AIRMIC, ALARM, IRM 2002
[11] http://www.defra.gov.uk/environment/climate/documents/ensuring-progress.pdf

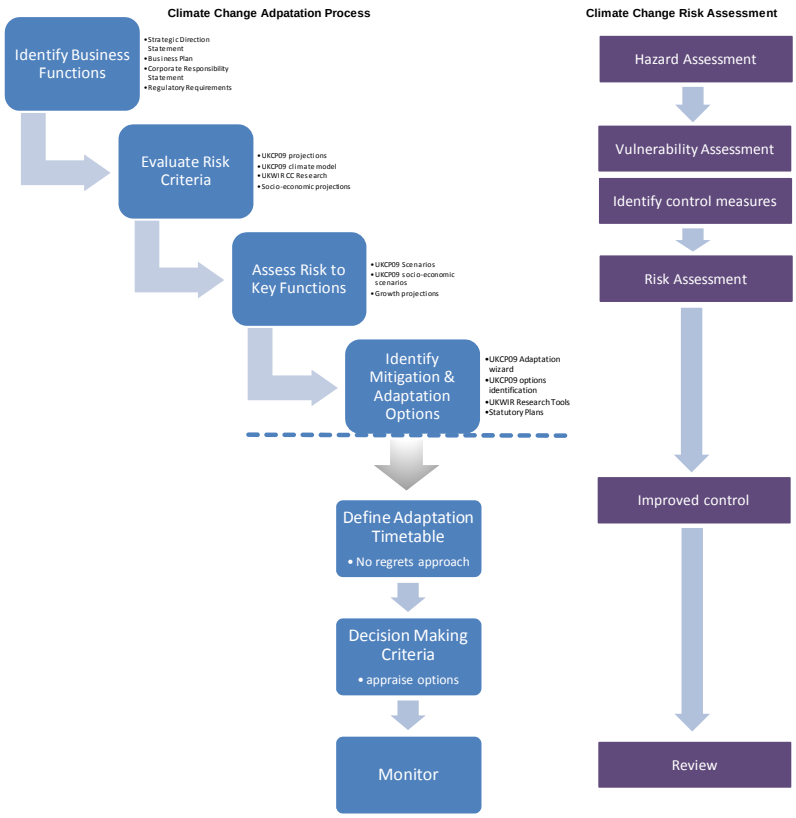

Fig. 4 Climate change adaptation and climate change risk assessment process

The adopted approach identifies the critical business objectives, and evalutes these for vulnerability to various climate change impacts. Those areas where impacts are identified are then assessed in more detail, against more detailed climate change variables as appropriate, and existing mitigatiion measures are highlighted. Following this a detailed risk assessmet is made against the key climate variables as an analysis for the adaptation requirements.

3. Business Functions

Cambridge Water is a water undertaker appointed under the Water Industry Act 1991 (2003), supplying high quality water to a population of 300,000 over a supply area of 453 square miles. As such, its main business function is to ensure a consistent supply of clean, safe drinking water to its customers, as set out in the provisions of the Act:

“It shall be the duty of every water undertaker to develop and maintain an efficient and economical system of water supply within its area and to ensure that all such arrangements have been made:

> For providing supplies of water to premises in that area and for making such supplies available to persons who demand them; and;

> For maintaining, improving and extending the water undertaker's water mains and other pipes,
>
> as are necessary for securing that the undertaker is and continues to be able to meet his obligations……"

In order to meet its obligations as an undertaker the Company abstracts treats and pumps water over a supply area of 453 sq. miles to a population of 300,000, which includes the operation and maintenance of the assets and infrastructure required to do so whilst meeting regulatory service levels and compliance standards.

The Company area of supply is situated in the central area of the East of England region, and covers the civil parishes indicated in section 3.1.

The Company has published a strategic direction statement[12] that outlines its objectives for the next 25 years:

- Satisfying the growth in demand from new customers
- Continuing the provision of safe, clean drinking water
- Dealing with the effect on supply and demand from climate change
- Reducing the Company's carbon emissions
- Maintaining the serviceability of the assets
- Satisfying customer expectations for a consistent supply of water at an appropriate pressure
- Satisfying the expectations of the providers of finance
- Balancing the price charged for water and its value to customers and the environment
- Competition in and for the market
- Providing a water-supply system resilient to emergencies and incidents
- Keeping bills as low as possible against a background of upward cost pressures

Achieving our statutory duties and organisational objectives will inevitably require adapting to the changing climate, and the water sector will be at the forefront of adaptation. Climate change will impact the water sector through the quality and availability of water resources, infrastructure, and demand for water.

[12] http://www.cambridge-water.co.uk/home/strategic-direction-statement

3.1. Area of Supply

Fig. 5 Company Area of Supply

3.2. Preparedness

The water sector has for many years been at the forefront of planning for climate change and has been working to incorporate climate change effects into long term planning, using the best available evidence and research.

In early 2010, the Company took part in a DEFRA supported self-assessment analysis of adaptive capacity, carried out by Alexander Ballard, using a Performance Acceleration Tool (PACT)[13] evidence based methodology to assess current position and organisational change needed for effective climate change adaptation programmes and management.

There are six response levels in the PACT framework to indicate what stage of preparedness an organisation is at in understanding and adapting to climate change issues. Fig. 6 shows the results for Cambridge Water.

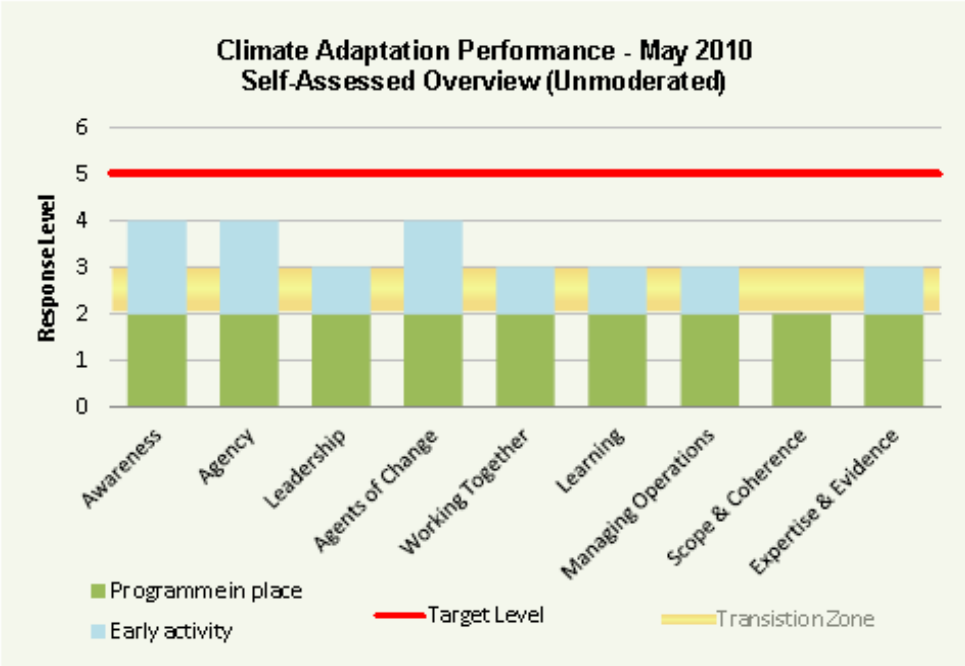

Fig. 6 [14]

From the results it was concluded that we are currently engaged in moving from RL2 to RL3, where the adaptation agenda is incorporated fully into operational systems, leading to RL5, 'Strategic Resilience', the ideal target for an organisation with a commitment to remain a sustainable business indefinitely into the future. The production of this adaptation report is an important stage in moving to the desired level of preparedness.

The Company has already incorporated climate change in its risk assessment, and has identified both climate change mitigation and adaptation as strategic issues for

[13] Cambridge Water PACT Pathways Analysis, Appendix 3, Alexander Ballard, 2010
[14] Cambridge Water PACT Summary Report, Alexander Ballard, 2010

the future in its strategic direction statement,[15] and sustainability principles within a corporate responsibility[16] statement.

[15] http://www.cambridge-water.co.uk/home/strategic-direction-statement
[16] http://www.cambridge-water.co.uk/home/community

4. Climate Impact on business functions

The Company business functions and objectives need to be considered within a preliminary assessment to identify those receptors at risk from climate change impacts, and the climate thresholds. We have utilised the industry sector focused Acclimatise report[17] to further inform our specific assessment of key business functions, and identified the following key areas of pressure:

- Growth in demand for water, from new development, socio-economic changes such as population growth and changes in household occupancy.
- Variation to the availability of water in the region, and effects of seasonal recharge
- Change to weather patterns, such as heat waves, intensity of rainfall, and occurrence of flooding events.
- Water quality pressures from pollution, changes to abstraction and aquifers, low river flows.
- Other effects of global climate change, on supply chains, society and workforce, land use changes.

The vulnerability of the water industry has also been assessed by URS Corporation [18] as mainly from changes in precipitation and temperature, and this aligns with the key areas of pressure identified for the Company. These pressures can be summarised into four strategic business areas for the Company objectives, and these are:

1. Water resources
2. Water treatment & distribution
3. Facilities, transport & human resources
4. Impact on customers

The vulnerability of these receptors to the climate change impacts in section 1.2 is assessed at the strategic level in table 1 below, to inform the decision making process for more detailed adaptation risk assessment. The business objectives and climate change variables that do not require detailed risk assessment are screened out at this stage.

The criteria for deciding whether a climate variable will impact upon a business function is based upon the vulnerability assessment and an evaluation of the climate variables and climate thresholds at the relevant spatial scale, and using best available scientific evidence.

Climate change variables that will impact upon Cambridge Water's key business objectives are focused around changes to temperature, rainfall, and weather extremes. The UK Climate Projections have been used to evaluate these variables

[17] Acclimatise managing your climate risks
[18] RMP 5456 Adapting Energy, transport and Water Infrastructure to the long term impacts of climate change, URS corporations Ltd, January 2010

for the key objectives, under future climate scenarios, in more detail to inform the decision making process for the risk assessment, and apply appropriate importance at the relevant temporal scale.

Risk Receptor	Climate Change variable	Impact on receptor
Water resources	Wetter winters	Less drought
	Dry summers	Increased demand
	Warmer winters	Increased SMD, drought
	Hotter summers	Increased drought, demand
	Extreme events	Pollution
Water treatment and distribution	Wetter winters	None
	Dry summers	Pressure on network infrastructure
	Warmer winters	None
	Hotter summers	Pressure on network infrastructure
	Extreme events	Asset Flooding risk, supply loss
Facilities, transport & human resources	Wetter winters	Flooding
	Dry summers	None
	Warmer winters	None
	Hotter summers	Health & safety implications
	Extreme events	Health & safety implications
Impact on customers	Wetter winters	None
	Dry summers	Increased demands
	Warmer winters	None
	Hotter summers	Increased demands
	Extreme events	Potential loss of supplies

Table 1. Vulnerability Assessment

4.1. Climate Change Scenarios

The climate in the East of England faces certain challenges relating to climate change, in particular vulnerability to water scarcity[19] as the area is already designated as an area of serious water stress by the Environment Agency, and summer rainfall is predicted to decrease against increases in demand.

The UKCP09 key findings for the East of England are presented in table 2 for the medium and high emissions scenarios. The high emissions scenario is representative of the worst case for future climate change, and at the central estimate, the most probable to occur within the range of uncertainty for that scenario. Projections for the 2020's are similar as these reflect climate change that is already committed to due to historic emissions.

[19] How well is the UK prepared for Climate Change, Adaptation sub committee, 2010

Climate variable	Projected Change Medium emissions			Projected Change High emissions		
	2020's	2050's	2080's	2020's	2050's	2080's
Summer mean temperature	+1.4°C	+2.5°C	+3.6°C	+1.4°C	+2.9°C	+4.5°C
Summer daily mean minimum temperature	+1.5°C	+2.7°C	+3.9°C	+1.6°C	+3.1°C	+5°C
Summer daily mean max temperature	+1.9°C	+3.4°C	+4.8°C	+1.9°C	+3.9°C	+6.2°C
Winter mean temperature	+1.3°C	+2.2°C	+3°C	+1.3°C	+2.5°C	+3.7°C
Annual mean rainfall	0%	0%	0%	0%	0%	+1%
Summer mean rainfall	-7%	-17%	-21%	-4%	-18%	-27%
Winter mean rainfall	+6%	+14%	+20%	+7%	+16%	+26%

Table 2. East of England Key findings, UKCP09[20]

Note: Projected values are at the 50% probability level or central estimate, the most likely to occur for a particular emissions scenario

An increased likelihood of extreme events will also potentially have an impact on our business functions, although these events are acknowledged as harder to predict, and less reliable than projections of monthly mean values for precipitation and temperature. To provide some idea of possible extremes, UKCP provides a Weather Generator tool that runs probabilistic projections for climate variables for future 30 year periods, to provide a representation of a future daily time series. This is a useful tool for determining the frequency of very hot or very wet days.

Whilst the weather generator has limitations, which are discussed in the UKCP report[21], the tool does provide "statistically credible representations" of possible daily values in a given future climate. Results from the tool can be further used for determining weather variable thresholds, using the threshold detector tool for defined variables, for example, the length of a dry period with temperatures above a defined value. Examples of the expected change for the East of England are presented in Table 3 below.

[20] http://ukclimateprojections.defra.gov.uk/content/view/2147/499/
[21] The UK Climate Projections science report: Projections of future daily climate for the UK

	Observed	2080's Medium Scenario		
	50%	10%	50%	90%
Heatwaves (2 days with Temp 15-29°C)				
Heathrow	0	1	7	22
Coltishall	0	0	1	9
Hot Days (>28°C)				
Heathrow	2	9	27	60
Coltishall	0	5	21	52
Hot Days (>25°C)				
Heathrow	15	44	76	109
Coltishall	7	18	42	77
Annual max Temp(°C)				
Heathrow	29.9	32.0	35.7	40.2
Coltishall	28	29.2	32.3	36.2
Dry Spells (10 days +)				
Heathrow	9	8	11	15
Coltishall	8	8	11	15
Dry Spells (20 days +)				
Heathrow	1	1	2	4
Coltishall	1	1	2	5

Table 3. Weather Generator future and control predictions for 2 East of England sites, number of days[22]

Results from the Weather Generator indicate that in the south east of the UK increases in the number of days with high temperatures will occur, and that numbers of frost days will reduce. An increase in the number of 10-day dry spells in southern England will also be expected.[23] Numbers of hot days and dry spells annually estimated by the Weather Generator are presented in Figs 7 and 8 below; the full range of probabilities is shown due to the additional uncertainty in weather generator outputs.

[22]The UK Climate Projections science report: Projections of future daily climate for the UK from the Weather Generator, UKCP

[23]UK Climate Projections Briefing report

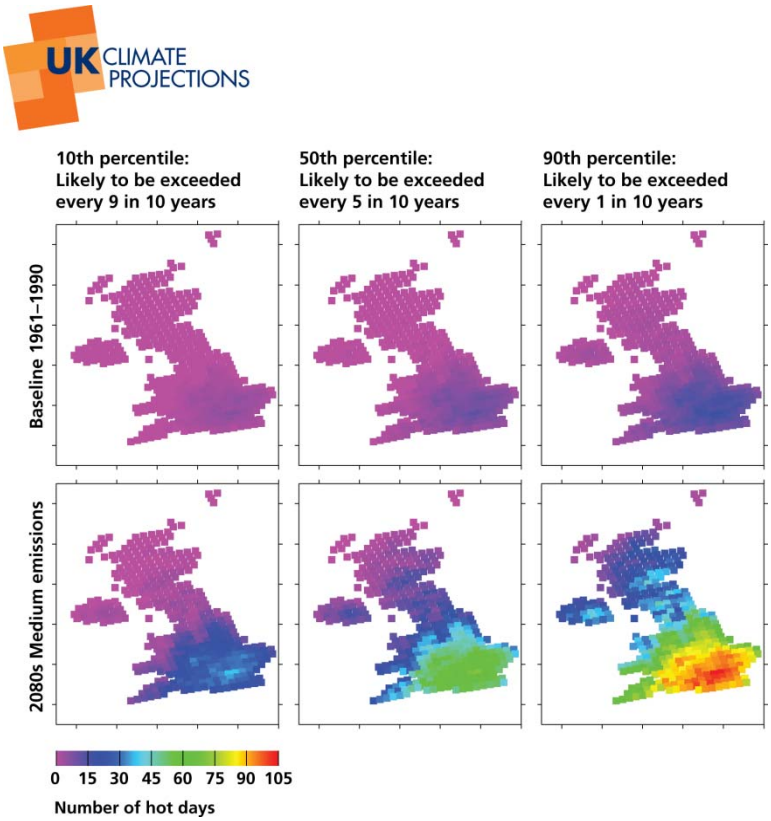

Fig. 7[24] Number of hot days (above 25°C) annually.

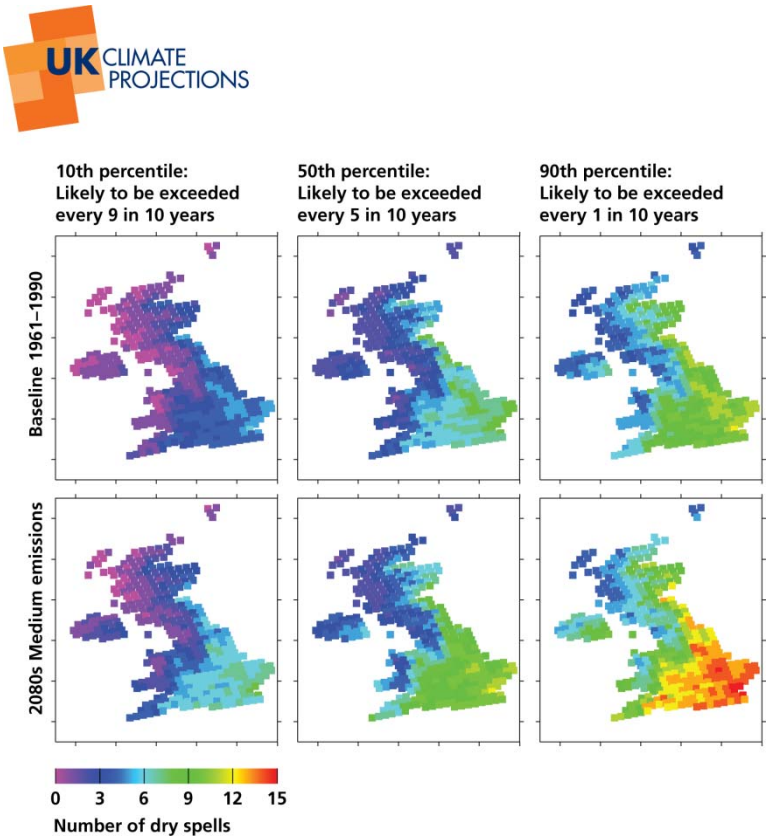

Fig. 8[23] Number of dry spells longer than 10 days annually

[24]UKCP09 © UK climate Projections 2009

4.2. Evaluation of impacts and thresholds

The key business objectives susceptible to vulnerability from climate change as identified in section 4.0 are quantitatively evaluated in this section, and related to those key climate thresholds discussed in 4.1. This will provide further understanding of exposure to climate change risk for these core business elements, prior to detailed risk assessment, and is also required to inform appropriate adaptation measures.

4.2.1. Water Resources

The Company is responsible for planning the level of water supply to meet predicted demand, and as such has to take account of the likely water availability and the predicted changes in people's water use. In order to do this, the Company produces a Water Resources Management Plan (WRMP)[25] every 5 years which considers a 25 year planning horizon; however it is worth noting that climate change does not emerge from natural variability until after the 2050s.[26]

Due to the long term aspect of water resources planning there are likely to be impacts from climate change over the longer term, both in supply and demand, and this has been incorporated as target headroom uncertainty in the current WRMP. The possible decline in groundwater levels, and impact on deployable output (DO) – source yield for abstraction – has been assessed for each PWS source using climate change models, and the results are shown Table 4. The overall reduction of less than 1% of total DO is not used in the plan as there is no impact on supply demand balance in the planning timeframe.

Risk Group	Likelihood that climate change could reduce DO	PWS affected	No of sources
1	Very unlikely	Abington Park, Babraham, Brettenham, Fowlmere, Hinxton Grange, Horseheath, Kingston, Linton, Rivey Hill, Sawston	10
2	Unlikely	Croydon, Duxford Airfield, Euston, Gt Wilbraham, Heydon, Lowerfield	6
2	Possibly not	Dullingham, St Ives	2
4	Possible	Fleam Dyke 12, Fulbourn, Morden Grange	3
5	Probable	Duxford Grange, Fleam Dyke 36, Gt Chishill, Westley, Weston Colville	6

Table 4. Assessment of PWS sources[27]

The Company has utilised Environment Agency planning guidance[28] in the assessment of climate change impact on demand, and has incorporated this into the

[25] http://www.cambridge-water.co.uk/customers/water-resources-management-plan
[26] EA Addressing Climate variability and change up to the 2030s, Data & Scenarios
[27] Final Water Resources Management Plan, Appendix 5

WRMP distribution input forecast. This uplift of 1.8%, a weighted average for commercial and domestic customer demand has a small impact on the supply demand balance over the planning timeframe.

Whilst there are uncertainties in these approaches for assessing climate change, the five year cycle and risk based approach of the WRMP ensures that the approach for adapting to climate change is reviewed on a regular basis, and updated climate scenarios can be incorporated as appropriate. The critical thresholds for which climate change becomes an issue for water resources are currently beyond this planning period.

4.2.1.1. Drought

The Company sources water from underground boreholes in the chalk, which are reliant upon winter rainfall for the majority of annual recharge. The UKCP projections indicate that winter rainfall is likely to increase, therefore the direct risk to supply is assessed as relatively low, and accordingly the risk of drought might be expected to reduce under these conditions dependent on storage capability.

The Company has assessed that a drought situation would arise from a succession of dry winters. Although the UKCP projections under most scenarios indicate an increase in winter rainfall, it is recognised that increased occurrence and severity of drought may be an impact of climate change. In addition, the frequency of drought episodes in England and Wales shows no clear trend over the period 1776-2006, Company data indicates no significant long term trend in annual average rainfall, and shows that the last 30 years has seen both the wettest, and driest 10 year cycles[29], and 2 drought sequences occurred in this period.

With UKCP predicting no significant change in annual average rainfall, it can be assumed that droughts will continue to occur at similar frequency; however the impact of these may be increased through extended dry periods, higher temperatures and increased occurrence of heat waves in the summer impacting the demand side of the water balance. Lower summer rainfall and higher temperatures will extend periods of high Soil Moisture Deficit (SMD) and increased Potential Evapotranspiration (PE), which may reduce the period of effective winter recharge, making dry years more severe and shortening drought recovery.

As part of operational management the Company monitors drought indicators at specific locations, and produces a drought plan[30] which is regularly updated in order to ensure that a drought situation is adequately managed through a staged approach of measures to increase available resources, and constrain demands as appropriate.

[28] Environment Agency (2008), *Water Resources Planning Guideline*
[29] http://www.cambridge-water.co.uk/customers/drought-plan
[30] http://www.cambridge-water.co.uk/customers/drought-plan

4.2.2. Water treatment and distribution

4.2.2.1. Treatment

Future problems arising from raw water deterioration are difficult to quantify, and are likely to be experienced on a gradual basis, due to reduced dilution of river baseflow and increased pollutant levels in rivers and groundwater from lower summer rainfall. Whilst the impacts at the catchment level have been assessed by UKWIR research[31], and suggest that no significant effects on water quality will result from climate change, there is limited information on additional impacts to groundwater and the chalk aquifer, although additional groundwater modelling and research is being undertaken.

The Company has existing challenges from diffuse nitrate pollution at a number of its sources, and a programme of measures to ensure continued compliance with water quality standards is underway, including treatment solutions and catchment management initiatives to control pollution at source. Catchment management is considered an adaptation measure for changes in water quality, and higher environmental standards that may occur in the future.

4.2.2.2. Distribution

Peak demand under 'dry year' hydrological conditions is considered the most critical period in water resources planning and this is likely to be the most sensitive to climate change impacts. Whilst the supply demand situation planned for each year over the next 25 includes allowances for uncertainties, and plans to allow for surplus resource or headroom, peak summer demand may introduce some constraints on the distribution infrastructure. Transfer ability within a resource zone may be impacted by such demands, and meeting peak demands when resources are already at stress, particularly in droughts may stretch the supply infrastructure. The relationship between distribution input and temperature is indicated in Fig. 9.

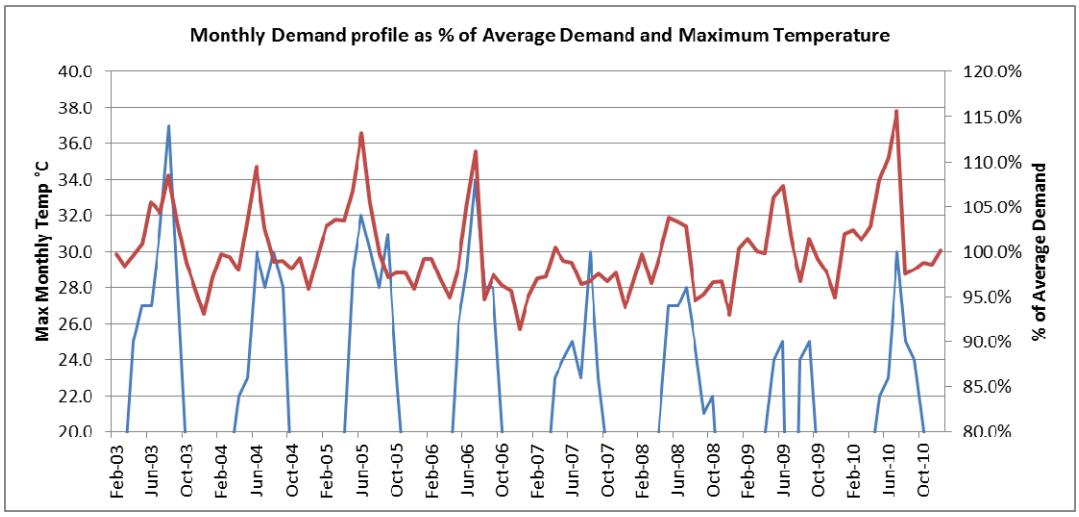

Fig. 9 Relationship between temperature and demand

[31] Modelling the Effects of Climate Change on Water Quality in Rivers and Reservoirs (01/CL/06/2)

The 'Peak Week' (the 7-day period in any year during which the highest sustained level of distribution input is observed) is when these constraints are experienced. The UKCP Threshold detector indicates that there is a possibility in the 2030s of such periods of hot, dry weather increasing by up to 5 fold, see Fig. 10 below.

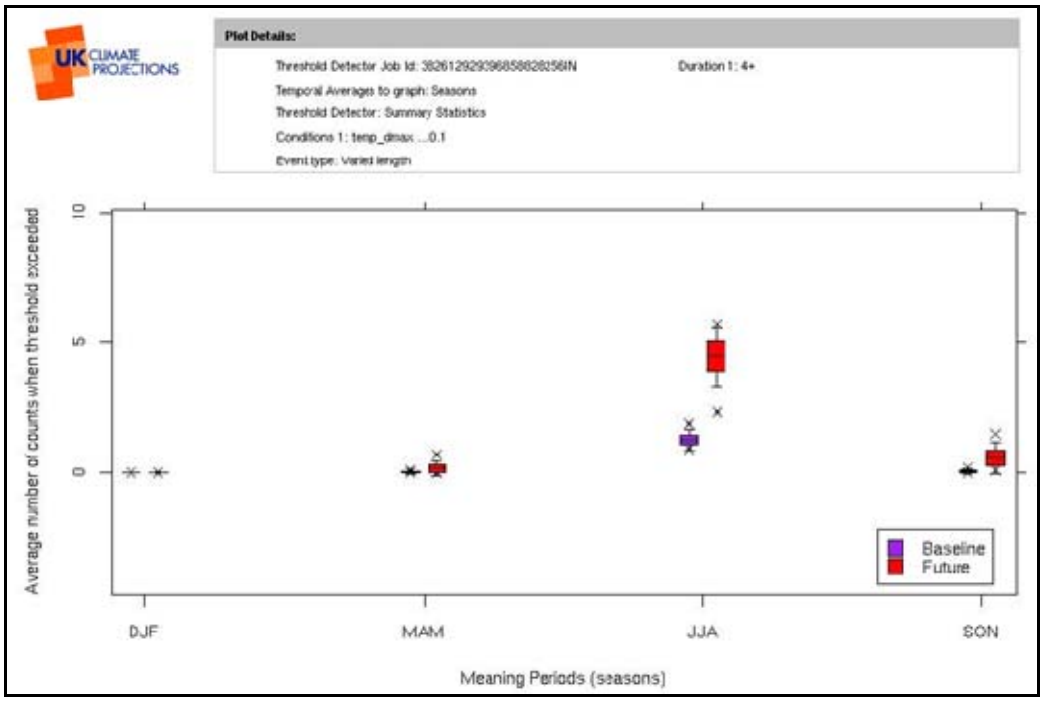

Fig. 10 Threshold Detector output for occurrences longer than 4 days with Temperature over 23°C and <0mm rainfall, high emissions scenario for 2030's

Such pressures are currently controlled by effective management of the transfer and distribution systems and, in 2009, an additional source was re-commissioned in order to provide additional resource to an area where transfer capacity at peak times had been identified as a potential issue. Additional engineering solutions are proposed in the current AMP to improve ability to transfer water at peak periods.

4.2.3. Facilities, transport and human resources

As a company providing a continuous service to our customers, our operations are exposed to risks relating to; logistics and the supply chain, utility supplies, transport, and operational facilities, and climate change impacts may affect our ability to respond with, and mobilise, appropriate resources. Our ability to respond to these impacts in extreme situations is accounted for as part of corporate risk management, and resilience plans. This has been done through generic risk assessment for all operations, and for emergency situations by our obligations as a Category 2 responder under the Civil Contingency Act, through an established and regularly exercised Emergency Response Plan.

In respect of climate change, it is important that upgrades, maintenance and new engineering projects take account of the future climate, and not just the current or

historic climate. To ensure long-term resilience, there is a need to ensure that all infrastructure projects consider the climate over their intended lifetime. Overall it is important to ensure flexibility in existing systems to maintain consistency of services, and this is reviewed regularly as part of the Company business continuity strategy, and in its risk assessments.

4.2.4. Impact on Customers

Customers may, through cascaded climate impacts, experience an impact through failure or reduction of their water service, although we employ extensive processes to ensure that this type of incident is very rare, and this would remain so in a changing climate, as policy and procedures are updated to take account of additional risks.

In recent years however water supply companies have experienced a number of disruptions and service level restrictions, including disruptions in water supplies, restrictions and hosepipe bans periodically in the south east, plus peak demands outstripping available resource. These impacts on the resilience of infrastructure may become more pronounced for future periods of drought, as both the likelihood and magnitude of these will be most at times of high demand for water in hotter periods.

These effects are managed by existing policy and procedures, including statutory plans such as the WRMP and drought plan.

4.2.5. Flooding Issues

Instances of extreme flooding are difficult to predict for the future climate; however increases in seasonal rainfall, and occurrences of extreme weather events are likely to increase flood risk. In light of the Pitt Review of the summer floods in 2007, and in recognition that all aspects of water supply infrastructure may be vulnerable to flood, and in particular operational sites, all water companies have assessed risk from flooding. The Company has therefore performed flood risk assessments for each of its operational sites, using Environment Agency flood risk data, and to its water supply and distribution operation: this is summarised in Annex 5 and 6. This indicates that there is acceptable risk to operational sites; however this assessment will require updating on a regular basis as new data is available, to account fully for climate change impact.

4.3. Summary of business risks

The key risks and potential impacts have been summarised in table 5 below

Business function	Climate variable	Primary impact
Water Resources	Increase in rainfall	Aquifer pollution
	Increase in temperature	Supply demand balance, security of supply
	Drier summers	High demands, security of supply; drought
	Extreme weather events	Aquifer pollution
Water treatment & distribution	Increase in rainfall	Flooding
	Increase in temperature	High demands, Pressure on infrastructure
	Drier summers	Pressure on infrastructure
	Extreme weather events	Loss of supply; Health & safety
Facilities, transport & human resources	Increase in rainfall	Flooding
	Increase in temperature	Employee Health and safety
	Extreme weather events	Employee Health and safety
Impact on customers	Increase in temperature	Increased demand; loss of service
	Drier summers	Increased demand; loss of service
	Extreme weather events	Potential loss of supply

Table 5. Key climate change risks and impacts

5. Risk assessment

5.1. Methodology

The approach used to assess climate change risk follows a standard risk assessment methodology, as used by the Company for usual business practice, utilising a criticality and probability matrix to provide an assessment of the current and predicted climate change risk to Cambridge Water's business functions. This is in line with recommended practice from the UKCP risk framework[32] and involves the following for the climate risks identified:

- Assessment of the probability or likelihood of an impact occurring
- Assessment of the magnitude or consequence of the impact occurring.

Risk is represented by these two factors;

Risk = probability of occurrence x the consequence of occurrence

The criteria that have been adopted for scoring climate risk are shown in Fig. 11, and these are used to provide a qualitative risk score from the risk matrix in Annex 1, for key elements of the business objectives previously identified, categorised by the climate variable risk.

5.2. Assessment of Risk

To assess the threats of identified impacts to the organisation, risk tables for each climate variable are presented in Annex 2, indicating the determined level of risk assessed for each sub category of business objective by each potential climate impact.

The Company has chosen to explore adaptation options for those risks with a score of 15 or above, as these have at least a high consequence and some likelihood of occurring. This detailed assessment has identified direct or acute impacts as well as incremental changes that will impact over the longer term. The adaptation options considered are discussed in the next section.

[32] http://www.ukcip.org.uk/images/stories/Pub_pdfs/Risk.pdf

5.3. Risk Criteria

Probable Severity		Description		Urgency/Likelihood		Description		Risk Rating
1	Insignificant	Very minimal/no disruption to operations, no impact on customers, no or low cost consequence (<£5k)	X	1	Very unlikely	Remote Likelihood. May occur in exceptional circumstances (beyond 2080)	=	1 to 8 = LOW
2	Minor	Small manageable operational impact, minor impact for small number of customers, slight cost consequence (>£15k No environmental impacts		2	Unlikely	Rare events (long term >2080)		
3	Moderate/marginal	Minor impact with significant impact on operations, manageable over. Customer impact and some cost consequence >£40k Some minimal, reversible environmental impacts		3	Possible	Will occur a number of times (medium-long term >2050)		9 to 24 = MEDIUM
4	Major	major impact to small number of customers, operations considerably compromised, high cost consequence >£125k. Some environmental impacts.		4	Likely	Will occur frequently (medium term >2035)		
5	Dangerous	Large number of customers impacted, operations significantly compromised, high cost consequence >£200k. Regulations broken exceeded.		5	Very likely	will probably occur frequently in most circumstances (short term 2015-25)		25 to 36 = HIGH
6	Catastrophic	Major impact to large number or all customers, serious social economic impacts, operations experiencing complete failure or compromise. Irreversible environmental impacts. Major cost consequence. (£1M>)		6	Extremely likely	almost certain to occur very frequently in next 5-10years (2015)		

Fig 11. Risk Score Criteria

6. Adaptation Options

This section considers the options for adaptation measures. There are two categories of adaptation as considered by UKCP Climate Impacts Programme (UKCIP);

- Building adaptive capacity
- Delivering adaptation actions

Adaptive capacity requires provision of the knowledge and resources to identify appropriate adaptation actions, and will include strategic decisions. To ensure adequate adaptation to climate change, adaptive capacity needs to be built into an organisation. Adaptive capacity within the climate change risk assessment is defined as:

> "The ability of a system to design or implement effective adaptation strategies to adjust to information about potential climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences."[33]

Delivering adaptation actions develops on this information, to manage and reduce climate risks by utilising temporary operational measures, technical solutions, changes to operational practices and appropriate documented response procedures. Actions within any programme should be flexible and proportionate to the risks involved.

Within the regulated water industry adaptation to climate change will be realised to some degree through compliance with legislation, as has been reflected within this report. The targets and objectives of legislation such as those within the Water Act, the Water Framework Directive (WFD), River Basin Management Plans (RBMP), Water Quality Directives, and the Flood and Water Management Act, all have regard to climate change. Within the regulatory regime, any intervention options will be evaluated by the existing price review, and planning mechanisms, and will therefore require appropriate justification and cost benefit analysis to ensure any actions are timely and appropriate.

6.1. Programme

The adaptation programme for identified risks from climate change is summarised in Annex 3, and includes measures to ensure adaptation capability, in addition to adaptation actions or plans for each risk. It is worth noting that many of the existing and proposed measures are relatively short term, in respect to climate timescales, reflecting the magnitude of uncertainties that arise over the longer term. The options considered are therefore, win-win, no regrets or low regrets, as they are low cost, high benefit, flexible adaptation measures.

[33] Adapting to climate change, statutory guidance to reporting authorities, Defra

6.2. Risk based adapatation measures

For those risks scoring 15 and above in the assessment, table 6 presents a detailed programme of specific adaptation measures for implementation. These are the subject of policy and planning during 2011-12 and beyond.

Some of the more generic risk based adaptation measures, assigned to each risk category in Annex 3, and recognised as being of high importance to our business (and therefore considered within our normal business priorities) are summarised as:

- Source control, rather than end-of-pipe treatment, to reduce pressure on treatment impacts through a catchment management programme.
- Demand management, through metering, water efficiency, use of water-saving devices, customer awareness.
- Development and maintenance of adaptive asset management and replacement plans.
- Continuing to work in close relationship with our regulators and within the statutory framework.
- Collaborating in research on addressing uncertainties in planning for climate change within the industry.

Ref	Risk description	Adaptation Measures	Timeline	Owner	Risk Score
DR4	Increased demand at daily & annual peak demand periods impacts security of supply	1. Increase meter penetration from 62% to 100% 2. Promote water efficiency measures through customer campaigns & communications 3. Meet water efficiency targets of 0.125Ml/d year on year 4. Update WRMP for planned growth of 40,000 properties by 2021, using population forecasts 5. Support and advise on water re-use technologies, and variable tariff structures 6. Improve transfer capacity, i.e. North West ring main scheme	2035 On-going on-going Every 5 years 2012 on 2015	Water Supply	16
RI22	Direct asset flooding causes service failure and asset loss	1. Backup power generation at all strategic operational sites 2. Annual Review and exercise of Emergency Response Plan(s) 3. Business Contingency measures 4. Develop and review risk based asset management plans, and proactive maintenance strategy	2015 on On-going 2015 2015	Production/ Water Supply	15
TR2	Daily and peak domestic and commercial demand increases, causing a reduction in security of supply	1. Increase meter penetration from 62% to 100% 2. Promote water efficiency measures through customer campaigns & communications 3. Meet water efficiency targets of 0.125Ml/d year on year 4. Update WRMP for planned growth of 40,000 properties by 2021, using population forecasts 5. Support and advise on water re-use technologies, and variable tariff structures 6. Improve transfer capacity, i.e. North West ring main scheme	2035 On-going on-going Every 5 years 2012 on 2015	Water Supply	25
TR8	Increased probability and duration of droughts, by delayed winter recharge from high SMD in summer poses risk of reduced security of supply	1. Resource sharing with neighbouring water companies 2. Future new resource development 3. winter reservoir/storage schemes	On-going 2035 2035	Water Supply	15
TR14	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to	1. Develop and review risk based asset management plans, and proactive maintenance strategy 2. Increase asset replacement, mains renewals programmes	2015 2015 on	Water Supply	16

	move increasing burst frequency	3. Improve leakage detection	On-going		
TR26	Increased seasonal demand cause LoS failure, pressure and supply, supply demand balance impacts	1. Increase meter penetration from 62% to 100% 2. Promote water efficiency measures through customer campaigns & communications 3. Meet water efficiency targets of 0.125Ml/d year on year 4. Update WRMP for planned growth of 40,000 properties by 2021, using population forecasts 5. Support and advise on water re-use technologies, and variable tariff structures 6. Pressure management schemes 7. Improve transfer capacity, i.e. North West ring main scheme	2035 On-going on-going Every 5 yrs 2012 on 2035 2015	Water Supply	20

Table 6 Adaptation options for risks scoring >15

7. Uncertainties

There are a number of areas of uncertainty that need to be considered in the assessment of climate change, risk and adaptation. These relate to both the magnitude of effect on climate from future emissions scenarios, the probability of the change in any future modelled climate and scale of impacts. These are discussed below and summarised in table 7.

The UKCP projections used to determine future climate variables are regarded as the most scientifically robust available, however there are uncertainties in the emissions scenarios and how the global climate will respond to these, particularly beyond the 2030s model period for committed change from past emissions. These uncertainties will be reflected in differences between the various global and regional climate models used, which are then downscaled for localised area modelling, thus adding to uncertainties in some aspects of climate, and particularly, extreme weather projections.

Uncertainty	Description
Emissions scenarios	Uncertainty due to future socio-economic changes, and emissions reduction and mitigation
Sensitivity of climate and climate models	Models do not represent perfectly the complex climatic processes involved, and other uncertainties such as feedback mechanisms.
Probability ranges	Future climate scenarios have a range of probabilities applied to particular climate changes
Local downscaling	Climate models are most accurate at the global scale, and have greater uncertainty as they are downscaled to the regional/local level
Impact	Assessing impacts from climate change on other systems introduces further uncertainty.

Table 7 Summary of Uncertainties

The projections provide a range of probabilities for climatic changes and it is uncertain, within these probabilities, what the future climate might be; thus it is important to use a range of results for analysis. A balanced approach using the most probable and worst case impacts has been used in preparing this report, as appropriate for assessing the risks involved.

There is, however, evidence from the past few years demonstrating how utility infrastructure can be vulnerable to climatic events such as heat waves, drought, and flooding, which can impact on critical infrastructure. Climate change is projected to change significantly the frequency and severity of such events, such that they will become more commonplace over the next few decades. Whilst it is difficult to predict when and where these events might occur, understanding long term climate implications, varied probabilities and uncertainties through the use of UKCP09 is essential in constructing an effective adaptation programme.

It should also be noted that within a regulated industry there are uncertainties in statutory requirements that could impact on the water sector that need to be considered, which could affect the adaptation options available, or the thresholds at which impacts will occur. These include outputs from the Water Framework Directive (WFD) and river basin management plans (RBMPs) that could require higher environmental water quality standards to be met. These may result in additional or higher quality standards, abstraction restrictions from future sustainability reductions and variations to time limited licences, all of which may on adaptation options.

7.1. Interdependencies

There are many aspects of the water sector that are dependent upon other sectors to ensure a reliable and robust continued provision of water supply business functions.

Although Cambridge Water has assessed, to a degree, some level of the risk from cascaded impacts as part of its risk register, shown in annex 4, such as failure of electricity supplies as part of business risk and contingency planning, there is currently minimal cross sector engagement as part of climate change risk. There may be a requirement in the longer term to ensure that these interdependencies are more fully understood, and effectively aligned across various sectors for climate change planning.

In particular energy, transport and water sectors rely on each other to deliver business functions, through a highly connected infrastructure. There is a recognised requirement to ensure this is considered in business planning, as consideration of long-term climate change impacts and the need for adaptation is not typically part of day to day business planning and operation.[34] This is of particular importance for cascade failures from linked impacts or compounded regional effects and impacts.

Cambridge Water has recently collaborated in a study[35] on the possibilities for resource sharing within the region to investigate how flexible the regional network is for interconnection and transfer possibilities. This has highlighted additional potential and also the physical and cost constraints for sharing water resources in the region over the current WRMP horizon, and is an example of how interdependencies can work, whilst highlighting some of the barriers which exist.

The close regulatory relationships that exist in the water sector, through the relationships with Ofwat, Natural England, Defra, and the Environment Agency (EA) result in linked dependencies between these agencies when assessing climate change impacts and adaptation requirements. These create potential barriers which may directly constrain adaptation actions, or otherwise indirectly affect effective adaptation.

[34] RMP 5456 Adapting Energy, Transport and Water Infrastructure to the Long-term Impacts of Climate Change URS Corporation Ltd, January 2010
[35] Trading theory for practice, Anglian water, Essex and Suffolk water, Cambridge water

7.2. Barriers

The primary challenges, or barriers to implementation of adaptation measures relate to the longer term adaptation options, and these barriers are summarised as:

- Financial costs of implementing large capital schemes, and their carbon intensive nature.
- Constraints of the industry regulatory framework, capital planning and price setting period, uncertainties and constraints in the planning processes
- Lack of information on some future climate risk impacts, the uncertainties and inaccuracy of climate change risk.
- Environmental regulation and water resources and ensuring security of supply against sustainability reductions, abstraction licence variations, and WFD obligations yet to be passed on.

Whilst the adaption options considered in this report do not include major capital projects, capital investment schemes are likely to be necessary beyond the current planning horizons, for example resource development beyond the current water resources planning period. The financial and carbon cost of such schemes may hinder an adaptation programme. It is recognised that, even with many changes, current levels of supply and infrastructure functionality may not be possible at a reasonable cost[36] in a future climate.

Within the existing regulated planning and investment regime, the price determination cycle could be a barrier to making a suitable business case for adaptation options over the longer term, as it focuses on a 5 year horizon unsuitable for some planning requirements with long lead times.

[36] URS Corporation Ltd, January 2010

8. Management process

The Company believes it is important that consideration of climate change adaptation issues is integrated into everyday business planning across all business functions and not necessarily left to a single environmental team, with specific responsibilities and ownership defined where appropriate. Climate change is part of the Company normal risk management process, both within its risk register, and also integrated into statutory plans such as the WRMP, and investment decision making, and includes generic 'soft touch' adaptation measures already in place. Future strategies and long term capital projects incorporate climate risk appraisal over the intended asset life as part of option assessment.

As further data becomes available and the Company's exposure and sensitivity to climate change risk develops, these management processes will be further developed. An over-arching sustainability strategy will ensure that thresholds are monitored at the appropriate departmental and management level by incorporating climate risk within operational procedures and performance measures. This policy will assist in the effective delivery of the appropriate adaptation options

8.1. Reporting and review

As part of the adaptation programme, and within the regulatory framework and statutory reporting, the Company will continue to review its approach to climate change. We will continue to collaborate within the industry and with other key stakeholders, including our regulators, to address and adapt to climate change, and would welcome the adoption of a common approach to ensuring adaptation is fully integrated into the decision making process at the next price review for the industry. We also undertake to report on our efforts to mitigate and adapt to climate change as far as is appropriate and practicable, through environment and sustainability reports, which will be made available on the Company website.

Within the industry a large amount of work has been carried out by UK Water Industry Research (UKWIR) to understand the impacts of climate change to many of the key planning requirements, and these studies have been used to prepare the industry for changing weather patterns. The findings and analysis from this research, referenced in Annex 7 have been used to assist in preparing this report. Further projects relating to climate change continue to build upon the latest science and data, and this is reflected in on-going research programmes at UKWIR and the EA, in preparation for the next submission of statutory reports over the coming years.

9. Conclusions

It is clear there will be a number of future challenges for the water industry in adapting to climate change. The main impacts will arise from temperature rise and changes to seasonal rainfall, and the associated strain that this will put on available resources together with increases in demands. There are, however, uncertainties in the impacts from climate change and the scale of the effects which will require further research and monitoring over the next few years, alongside the adaptation measures that are already in place. Fortunately, the sector is well advanced in this, and has already engaged in research projects to ensure climate change is included in planning requirements, and this is reflected in the progress made to date, and the research that has been drawn upon in this report. During 2011-13, in the lead to the next asset management plan in 2015, further detailed work building on the UKCP09 projections is planned to ensure the best evidence is used in decision making for future investment.

In summary, some of the challenges highlighted in this report are:

- Implications for water resources, the supply demand balance and ensuring security of supply with the possibility of increased drought risks to ensure water resources will be more resilient to climate change.
- Promoting and delivering increasing water efficiency measures through customer charges, metering and the introduction of innovative tariffs.
- Increases in the demand for water, particularly at times of reduced availability, exacerbating supply issues.
- Reducing the uncertainties around adapting to climate change
- Ensuring adaptation measures are appropriate, and timely, to minimise cost to our customers.

Annexes

Annex 1
Risk Matrix

	Insignificant	Minor	Moderate/marginal	Major	Dangerous	Catastrophic
Extremely likely	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Med-High	Unacceptable Risk High	Unacceptable Risk Extreme	Unacceptable Risk Extreme
Very likely	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Med-High	Unacceptable Risk High	Unacceptable Risk Extreme
Likely	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Med-High	Unacceptable Risk High
Possible	Acceptable Risk Low	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Med-High
Unlikely	Acceptable Risk Low	Acceptable Risk Low	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium
Very unlikely	Acceptable Risk Low	Acceptable Risk Low	Acceptable Risk Low	Acceptable Risk Medium	Acceptable Risk Medium	Acceptable Risk Medium

Likelihood/Probability

Impact/Consequence

Annex 2
Risk Assessment tables

Risk assessment Matrix						risk score		1 36
Ref	**Climate Hazard**	**Asset/Business area affected**	**Strategic Risks**	**Current Control Measures**	**Responsibility**	**consequence/severity**	**likelihood**	**Risk Score**
DR1	Drought (decrease in rainfall, reduced groundwater levels, dry summers, increased SMD)	Water Resources (general)	Increased probability and duration of droughts, by delayed winter recharge from high SMD in summer poses risk of reduced security of supply	WRMP produced every 5yrs, updated annually. Drought plan produced every 3 years. Research on effect of reduced flows (UKWIR 05/CL/04/6, 03/CL/04/2)	Water Supply	5	2	10
DR2			Low river flows and reduced aquifer recharge leads to lower BH yields and licence reductions, impacting security of supply	WRMP produced every 5yrs, updated annually. Drought plan produced every 3 years. Research on effect of reduced flows (UKWIR 05/CL/04/6, 03/CL/04/2) SRO maintained for sources	Water Supply	5	2	10
DR3			Lower yields leads to loss of sources or reduced output, and licence restrictions leading to reduction in headroom, reducing security of supply	SRO maintained for sources. WRMP produced every 5yrs, updated annually	Water Supply	5	2	10
DR4			Increased demand at daily & annual peak demand periods impacts security of supply	WRMP produced every 5yrs, updated annually	Water Supply	4	4	16
DR5			increase in demand for water, population/migration impacts (from economic, tourism) on growth predictions impacting future supply demand balance	Latest population growth figures used in WRMP updates	Water Supply	5	1	5
DR6			increase in demand for water & water intensive product a and activities	Drought plan management actions, WRMP, metering programme	Water Supply	5	2	10
DR7			Increase in evapotranspiration and SMD triggers drought actions	Drought plan produced every 3 years with management measures	Water Supply	6	2	12
DR8		Water Quality	Low aquifer and river flow leads to reduced raw water quality	raw water sampling regime, DWSP	Compliance	2	2	4
DR9			Less infiltration and dilution leading to reduced water quality requires additional treatment	raw water and treated water sampling regime	Compliance	3	2	6
DR10			Deeper water table pumping deteriorates raw water quality	raw water sampling regime, DWSP	Compliance	5	2	10
DR11			Supply losses leading to mains failures increase contamination risks in supply network	mains failure procedures, DWSP	Compliance	4	1	4
DR12		Network infrastructure	Increase in SMD - Dry ground and shrinkage leads to greater incidence of pipe failure	DMA monitoring, & leakage detection teams	Water Supply	3	3	9
DR13			Increased pipe failure leads to serviceability failures	DMA monitoring, & leakage detection teams	Water Supply	2	3	6
DR14			Poor serviceability performance leads to KPI failure	DMA monitoring, & leakage detection teams	Water Supply	1	3	3
DR15			Peak demands require increased pumping in network, leading to increased risk of pressure surge failures	DMA monitoring and telemetry controls. Peak demand management and NW ring main transfer project.	Water Supply	3	3	9
DR16		Treatment Works	Increased treatment increase chemical and carbon use/costs	Treatment optimisation	Production	2	4	8
DR18		Source pumping stations	Pumps working harder to meet high demands, increased risk of failure and high power consumption	Power and pumping optimisation. Proactive maintenance programme	Production	4	2	8
DR19			Abstraction pumps working harder to abstract from deeper water level, increased risk of failure and high power consumption	Power and pumping optimisation. Proactive maintenance programme	Production	4	2	8
DR20		Operations	Increased resource required in monitoring hosepipe bans	Drought plan management actions	Water Supply	2	3	6
DR21		Customer Impact	Restrictions imposed on water use	Drought plan management actions	Water Supply	2	2	4
DR22			Increased demand for recreational based leisure activities impacts on supply demand balance	Drought plan management actions, WRMP, metering programme	Water Supply	2	2	4

RI1	Increase in summer & winter rainfall, Floods high groundwater levels & greater storm intensity)	Water Resources	sewer flooding poses risk of contamination to groundwater and SoS	DWSP and raw water sampling programme	Compliance	4	2	8
RI2			flooding to pumping stations causes power loss and inability to use sources, impacting supply demand balance	Grid power generator backup at key stations	Production	5	2	10
RI3			More intense rainfall events compact upper soil layers, increasing run-off, reducing recharge of aquifers and reducing SoS	SROs reviewed and DO revised in WRMP updates	Water Supply	3	2	6
RI4			flood water infiltration around source protection zones deteriorates raw water quality reducing Supply demand balance	DWSP and raw water sampling programme, DO &WRMP updates	Water Supply/Compliance	4	2	8
RI5			flood water infiltration causes severe pollution of aquifer and source cannot be used, impacting supply demand balance, SoS	DWSP and raw water sampling programme, DO &WRMP updates	Water Supply/Compliance	6	2	12
RI6			increased rainfall causes erosion of soil, increased leaching of agrochemicals into aquifer	DWSP and raw water sampling programme	Water Supply/Compliance	4	3	12
RI7			Flood run-off introduces additional pollutants into source, leading to risk to SoS	DWSP and raw water sampling programme, DO &WRMP updates	Water Supply/Compliance	5	2	10
RI8		Water Quality	heightened risk of flood water infiltration into pipelines increases water quality risks	DWSP & water quality sampling	Compliance	3	3	9
RI9			Direct flooding causes contaminants to enter pipelines, increasing drinking water quality risk	DWSP & water quality sampling	Compliance	3	3	9
RI10			sewer flooding poses risk of contamination to groundwater raw water quality	DWSP and raw water sampling programme	Compliance	3	3	9
RI11			Increased Flood water run-off introduces additional pollutants into source, requiring additional, increased treatment	DWSP & water quality sampling	Compliance	4	3	12
RI12			high winter soil moisture increases leaching reducing raw water quality	DWSP & water quality sampling	Compliance	4	3	12
RI13			flood water infiltration around source protection zones deteriorates raw water quality risk requiring additional treatment	DWSP & water quality sampling	Compliance	4	3	12
RI14			Increased storm frequency increases frequency of power loss, causing treatment service failure	Telemetry alarms for treatment failure, raw and treated quality sampling	Production	3	3	9
RI15		Network infrastructure	Direct asset flooding cuts access to assets, increased H&S risk to staff	Risk Assessment	Compliance	3	3	9
RI16			Land slippage from flooding damages underground infrastructure, causing asset failures	Asset repair and maintenance teams	Water Supply	3	3	9
RI17		Source pumping stations	Increased storm frequency increases frequency of power loss, potential of total asset loss	Grid power generator backup at key stations, supply demand balance headroom	Production	3	3	9
RI18			Direct asset flooding causes service failure from temporary asset loss	Grid power generator backup at key stations, supply demand balance headroom	Production	4	3	12
RI19			Increased storm frequency and power supply flooding increases frequency of power loss, causing service failure	Grid power generator backup at key stations, supply demand balance headroom	Production	3	3	9
RI20			Direct flooding leads to submersion of electrical assets, increasing risk to operatives of electrocution endangering H&S of site staff	Risk Assessment	Compliance	6	2	12
RI21		Operations	Increased storm frequency increases frequency of power loss, total asset loss	Grid power generator backup at key stations	Production	3	3	9
RI22			Direct asset flooding causes service failure and asset loss	Grid power generator backup at key stations, supply demand balance headroom	Production/Water Supply	5	3	15
RI23			Direct asset flooding cuts access to assets, endangering H&S of site staff	Risk Assessment	Compliance	3	3	9
RI24			Direct flooding leads to submersion of electrical assets, increasing risk to operatives of electrocution endangering H&S of site staff	Risk Assessment	Compliance	6	2	12
RI25			Flooding causes loss of SCADA and /or telemetry causing a service loss	Operational response procedures	Compliance	2	2	4
RI26		Customer Impact	Possible loss of supply due to asset failures, cascaded impacts	Operational response procedures, Incident Response plan	Water Supply	2	2	4

TR1	Temperature Rise (increases in average and seasonal peak temperatures, increased evaporation/evapotranspiration)	Water Resources	Population redistribution from tourism increases seasonal demand and causes a reduction in security of supply	WRMP, supply demand balance headroom	Water Supply	5	1	5
TR2			Daily and peak domestic and commercial demand increases, causing a reduction in security of supply	supply demand balance headroom, operational response actions	Water Supply	5	5	25
TR3			Higher temperatures and longer growing season causes increase in agricultural demand and impacts on supply demand balance	WRMP updates, supply demand balance headroom, operational response actions	Water Supply	2	3	6
TR4			Redistribution of permanent population in response to temperature rise affects demand and impacts on supply demand balance	WRMP updates, supply demand balance headroom	Water Supply	4	1	4
TR5			Increased evaporation and evapotranspiration reduce yields, causing a reduction in SoS	SRO, DO and WRMP review and update	Water Supply	4	2	8
TR6			Increased evaporation and evapotranspiration reduces groundwater recharge and aquifer yield, causing a reduction in SoS	SRO, DO and WRMP review and update	Water Supply	4	2	8
TR7			Increased evaporation and evapotranspiration reduce infiltration, and so borehole yields, causing a reduction in SoS	SRO, DO and WRMP review and update	Water Supply	5	2	10
TR8			Increased probability and duration of droughts, by delayed winter recharge from high SMD in summer poses risk of reduced security of supply	SRO, DO and WRMP review and update	Water Supply	5	3	15
TR9			Increased peaks of demand lead to greater groundwater storage requirements reducing SoS	SRO, DO and WRMP review and update	Water Supply	5	2	10
TR10		Water Quality	Increased algal growth and risk of microscopic organisms within the water supply system increases drinking water quality risk	raw water sampling & DWSP measures	Production	4	2	8
TR11			Higher temperatures reduce raw water quality and increase drinking water quality risk	water quality sampling & DWSP measures	Production	4	2	8
TR12			Increased rate of micro-biological growth increases risk of residual chlorine depletion and contamination of supplies, increasing drinking water quality risk	water quality sampling & DWSP measures	Production	4	2	8
TR13			Higher average and peak temperatures cause an increase in incidence of water & wetland associated disease, thus risk of contamination of raw water	raw water quality sampling & DWSP measures	Production	4	2	8
TR14		Network infrastructure	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to move increasing burst frequency	Operational repair & maintenance response	Water Supply	4	4	16
TR15			Dry ground increases number of identified leaks requiring repair/investigation	Operational repair & maintenance response	Water Supply	3	4	12
TR16		Source pumping stations	Increased peaks of demand lead to greater storage requirements reducing security of supply, increasing pumping required.	SRO and DO updates, production pumping strategy	Water Supply/Production	3	3	9
TR17			Higher average and peak temperatures affect buildings, control systems, pumps and equipment working life, causing increase in failures	asset planning strategy	Water Supply	3	3	9
TR18			Higher average and peak temperatures affect buildings, control systems, pumps and equipment working life, causing accelerated asset deterioration	asset planning strategy	Water Supply	3	4	12
TR19		Operations	Higher average and peak temperatures affect buildings, HVAC plant, control systems working life, causing increase in failures affecting operations	pro active maintenance strategy	Water Supply	3	3	9
TR20			Higher average and peak temperatures affect buildings, HVAC plant, & control systems working life, causing accelerated asset deterioration	pro active maintenance strategy	Water Supply	3	4	12
TR21			Higher levels of UV increase the risk of sun-related injury, endangering H&S of site staff	Risk assessment	Compliance	2	4	8
TR22			Higher average and peak temperatures cause an increase in incidence of water & wetland associated disease, possibly affecting access to sites	Risk assessment	Compliance	2	3	6
TR23			Higher temperatures cause increased vegetation growth at sites requiring management	Risk assessment	Compliance	1	4	4
TR24		Customer Impact	Restrictions imposed on water use	Drought plan management actions, water efficiency measures	Water Supply	2	2	4
TR25			Increased demand for recreational based leisure activities impacts on supply demand balance	Drought plan management actions, WRMP	Water Supply	2	2	4
TR26			Increased seasonal demand cause LoS failure, pressure and supply, supply demand balance impacts	Drought plan management actions, WRMP, operational response, metering programme	Water Supply	4	5	20

Reference Terms

WRMP	Water Resources Management Plan
SRO	Source Reliable Output
DP	Drought Plan
BP	Business Plan
SoS	Security of Supply
KPI	Key performance indicator
UKWIR	UK Water Industry Research
WFD	Water Framework Directive
CAMS	Catchment Abstraction Management Strategy
CM	Catchment Management
UKCP	UK Climate Projections
SMD	Soil Moisture Deficit
DMA	District Meter Area
DWSP	Drinking Water Safety Plan
DO	Deployable Output

Annex 3
Adaptation Measures

Adaptation Options						
Ref	**Climate Hazard**	**Asset/Business area affected**	**Strategic Risks**	**Adaptation Capacity**	**Adaptation plan/actions**	**Responsibility**
DR1	Drought (decrease in rainfall, reduced groundwater levels, dry summers, increased SMD)	Water Resources (general)	Increased probability and duration of droughts, by delayed winter recharge from high SMD in summer poses risk of reduced security of supply	WRMP review, Drought plan, drought indicators/monitors, water efficiency measures, metering programme, Flood and water management Act	increase meter penetration, reduce leakage	Water Supply
DR2			Low river flows and reduced aquifer recharge leads to lower BH yields and licence reductions, impacting security of supply	WRMP & supply demand balance review/update. SRO, DO review and update, WFD objectives feed into AMP, regional groundwater models, flood and water management act.	Resource sharing, new resource development, winter reservoir schemes	Water Supply
DR3			Lower yields leads to loss of sources or reduced output, and licence restrictions leading to reduction in headroom, reducing security of supply	SRO updates. WRMP review, regional groundwater models, WFD objectives feed into AMP	Industry R&D into impacts, increase meter penetration, reduce leakage	Water Supply
DR4			Increased demand at daily & annual peak demand periods impacts security of supply	WRMP & supply demand balance review/update, water efficiency measures, metering programme	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, WRMP - plan for growth using population forecasts, winter reservoir schemes	Water Supply
DR5			increase in demand for water, population/migration impacts (from economic, tourism) on growth predictions impacting future supply demand balance	Latest population growth figures used in WRMP updates, water efficiency measures, metering programme	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, WRMP - plan for growth using population forecasts, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
DR6			increase in demand for water & water intensive product a and activities	Water efficiency measures and targets, metering programme and increased meter penetration, variable tariffs, WRMP review, Flood and water management Act 2010 - guidance on restriction on use of water in water shortages	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
DR7			Increase in evapotranspiration and SMD triggers drought actions	Drought plan, drought indicators/monitors, water efficiency measures, metering programme, Flood and water management Act -guidance on restriction on use of water in water shortages	Industry R&D into impacts, increase meter penetration, Customer communication, promoting behaviour change, variable tariffs, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
DR8		Water Quality	Low aquifer and river flow leads to reduced raw water quality	DWSP, Water Framework Directive (WFD) has regard for climate change feeds into AMP. Monitor trends and use groundwater models	R&D on impacts, Catchment management initiatives and solutions, blending schemes, adaptive treatment	Compliance
DR9			Less infiltration and dilution leading to reduced water quality requires additional treatment	raw water and treated water sampling regime, R&D WFD..	Catchment management initiatives and solutions, blending schemes, adaptive treatment	Compliance
DR10			Deeper water table pumping deteriorates raw water quality	SRO updates, WRMP, DWSP	R&D programmes, adaptive operations.	Compliance
DR11			Supply losses leading to mains failures increase contamination risks in supply network	mains failure procedures, DWSP	risk based asset management plan, renewals, adaptive response procedures	Compliance
DR12		Network infrastructure	Increase in SMD - Dry ground and shrinkage leads to greater incidence of pipe failure	mains failure procedures, operational response, DMA & network monitoring	asset life and performance models, risk based asset management plan, renewals, adaptive response procedures, increase asset replacement rates.	Water Supply
DR13			Increased pipe failure leads to serviceability failures	mains failure procedures, operational response, DMA & network monitoring	asset life and performance models, risk based asset management plan, renewals, adaptive response procedures, increase asset replacement rates.	Water Supply
DR14			Poor serviceability performance leads to KPI failure	mains failure procedures, operational response, DMA & network monitoring	asset life and performance models, risk based asset management plan, renewals, adaptive response procedures, increase asset replacement rates. Review KPIs	Water Supply
DR15			Peak demands require increased pumping in network, leading to increased risk of pressure surge failures	mains failure procedures, operational response, DMA & network monitoring,	asset life and performance models, risk based asset management plan, asset upgrades	Water Supply
DR16		Treatment Works	Increased treatment increase chemical and carbon use/costs	Treatment optimisation	R&D, New treatment technologies & solutions, Alternative power sources, adaptive plan for treatment measures	Production
DR17		Source pumping stations	Pumps working harder to meet high demands, increased risk of failure and high power consumption	Power and pumping optimisation, operational response, proactive maintenance	Alternative power sources, emergency response plans, adaptive response procedures, asset life and performance models	Production
DR18			Abstraction pumps working harder to abstract from deeper water level, increased risk of failure and high power consumption	Power and pumping optimisation, operational response, proactive maintenance	Alternative power sources, emergency response plans, adaptive response procedures, asset life and performance models, contingency measures	Production
DR19		Operations	Increased resource required in monitoring hosepipe bans	Drought plan, Flood and water management Act -guidance on restriction on use of water in water shortages	Adaptive response & resource plans	Water Supply
DR20		Customer Impact	Restrictions imposed on water use	Drought plan, Flood and water management Act -guidance on restriction on use of water in water shortages, Demand Management	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
DR21			Increased demand for recreational based leisure activities impacts on supply demand balance	Drought plan, Flood and water management Act -guidance on restriction on use of water in water shortages, Demand Management	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply

RI1	Increase in summer & winter rainfall, Floods high groundwater levels & greater storm intensity)	Water Resources	sewer flooding poses risk of contamination to groundwater and SoS	DWSP, WFD, operational response	Asset protection, Emergency Response plans, contingency measures, catchment management	Compliance
RI2			flooding to pumping stations causes power loss and inability to use sources, impacting supply demand balance	Flood and water management Act, analyse risk using flood databases, operational response, proactive maintenance	Asset protection, Emergency Response plans, contingency measures,	Production
RI3			More intense rainfall events compact upper soil layers, increasing run-off, reducing recharge of aquifers and reducing SoS	SRO updates, Groundwater modelling	Asset protection, Emergency Response plans, contingency measures,	Water Supply
RI4			flood water infiltration around source protection zones deteriorates raw water quality reducing Supply demand balance	DWSP, Flood and water management Act, analyse risk using flood databases, operational response, proactive maintenance	Asset protection, Emergency Response plans, contingency measures,	Water Supply/Compliance
RI5			flood water infiltration causes severe pollution of aquifer and source cannot be used, impacting supply demand balance, SoS	DWSP, Flood and water management Act, analyse risk using flood databases, operational response, proactive maintenance	Asset protection, Emergency Response plans, contingency measures,	Water Supply/Compliance
RI6			increased rainfall causes erosion of soil, increased leaching of agrochemicals into aquifer	DWSP groundwater modelling	Asset protection, Emergency Response plans, contingency measures, catchment management, R&D	Water Supply/Compliance
RI7			Flood run-off introduces additional pollutants into source, leading to risk to SoS	Flood and water management Act, DWSP, groundwater modelling	Asset protection, Emergency Response plans, contingency measures,	Water Supply/Compliance
RI8		Water Quality	heightened risk of flood water infiltration into pipelines increases water quality risks	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Compliance
RI9			Direct flooding causes contaminants to enter pipelines, increasing drinking water quality risk	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Compliance
RI10			sewer flooding poses risk of contamination to groundwater raw water quality	DWSP, operational response	Emergency Response plans, contingency measures, adaptive plan for treatment measures	Compliance
RI11			Increased Flood water run-off introduces additional pollutants into source, requiring additional, increased treatment	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Compliance
RI12			high winter soil moisture increases leaching reducing raw water quality	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Compliance
RI13			flood water infiltration around source protection zones deteriorates raw water quality risk requiring additional treatment	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Compliance
RI14			Increased storm frequency increases frequency of power loss, causing treatment service failure	Operational response	Asset protection, Emergency Response plans, contingency measures, asset life and performance models, risk based asset management plan, asset upgrades	Production
RI15		Network infrastructure	Direct asset flooding cuts access to assets, increased H&S risk to staff	analyse risk using flood databases	protect assets, risk based asset management plans, contingency measures, response and recovery plans	Compliance
RI16			Land slippage from flooding damages underground infrastructure, causing asset failures	analyse risk using flood databases	protect assets, risk based asset management plans, contingency measures, response and recovery plans	Water Supply
RI17		Source pumping stations	Increased storm frequency increases frequency of power loss, potential of total asset loss	analyse risk using flood databases, Operational response	Asset protection, Emergency Response plans, contingency measures, response and recovery plans	Production
RI18			Direct asset flooding causes service failure from temporary asset loss	analyse risk using flood databases, Operational response	Asset protection, Emergency Response plans, contingency measures, response and recovery plans	Production
RI19			Increased storm frequency and power supply flooding increases frequency of power loss, causing service failure	analyse risk using flood databases, Operational response	Asset protection, Emergency Response plans, contingency measures, response and recovery plans	Production
RI20			Direct flooding leads to submersion of electrical assets, increasing risk to operatives of electrocution endangering H&S of site staff	analyse risk using flood databases, Operational response	Asset protection, Emergency Response plans, contingency measures, response and recovery plans	Compliance
RI21		Operations	Increased storm frequency increases frequency of power loss, total asset loss	analyse risk using flood databases, Operational response	protect assets, risk based asset management plans, contingency measures, response and recovery plans	Production
RI22			Direct asset flooding causes service failure and asset loss	analyse risk using flood databases, Operational response	protect assets, risk based asset management plans, contingency measures, response and recovery plans	Production/Water Supply
RI23			Direct asset flooding cuts access to assets, endangering H&S of site staff	analyse risk using flood databases, Operational response	Asset protection, Emergency Response plans, contingency measures, response and recovery plans	Compliance
RI24			Direct flooding leads to submersion of electrical assets, increasing risk to operatives of electrocution endangering H&S of site staff	analyse risk using flood databases, Operational response	Asset protection, Emergency Response plans, contingency measures, response and recovery plans	Compliance
RI25			Flooding causes loss of SCADA and /or telemetry causing a service loss	analyse risk using flood databases, Operational response	protect assets, risk based asset management plans, contingency measures, response and recovery plans	Compliance
RI26		Customer Impact	Possible loss of supply due to asset failures, cascaded impacts	Operational response procedures	appropriate response plans, awareness	Compliance

TR1	Temperature Rise (increases in average and seasonal peak temperatures, increased evaporation/evapotranspiration)	Water Resources	Population redistribution from tourism increases seasonal demand and causes a reduction in security of supply	Latest population growth figures used in WRMP updates, water efficiency measures, metering programme	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, WRMP - plan for growth using population forecasts, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
TR2			Daily and peak domestic and commercial demand increases, causing a reduction in security of supply	WRMP & supply demand balance review/update, water efficiency measures, metering programme	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, WRMP - plan for growth using population forecasts, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
TR3			Higher temperatures and longer growing season causes increase in agricultural demand and impacts on supply demand balance	WRMP & supply demand balance review/update, water efficiency measures, metering programme	water-re-use technologies and initiatives water efficiency measures & targets, Customer communication, winter storage	Water Supply
TR4			Redistribution of permanent population in response to temperature rise affects demand and impacts on supply demand balance	Latest population growth figures used in WRMP updates, water efficiency measures, metering programme	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, WRMP - plan for growth using population forecasts, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Water Supply
TR5			Increased evaporation and evapotranspiration reduce yields, causing a reduction in SoS	WRMP & supply demand balance review/update. SRO, DO review and update, WFD objectives feed into AMP, regional groundwater models, flood and water management act.	Resource sharing, new resource development, winter reservoir schemes	Water Supply
TR6			Increased evaporation and evapotranspiration reduces groundwater recharge and aquifer yield, causing a reduction in SoS	WRMP & supply demand balance review/update. SRO, DO review and update, WFD objectives feed into AMP, regional groundwater models, flood and water management act.	Resource sharing, new resource development, winter reservoir schemes	Water Supply
TR7			Increased evaporation and evapotranspiration reduce infiltration, and so borehole yields, causing a reduction in SoS	WRMP & supply demand balance review/update. SRO, DO review and update, WFD objectives feed into AMP, regional groundwater models, flood and water management act.	Resource sharing, new resource development, winter reservoir schemes	Water Supply
TR8			Increased probability and duration of droughts, by delayed winter recharge from high SMD in summer poses risk of reduced security of supply	WRMP & supply demand balance review/update. SRO, DO review and update, WFD objectives feed into AMP, regional groundwater models, flood and water management act.	Resource sharing, new resource development, winter reservoir schemes	Water Supply
TR9			Increased peaks of demand lead to greater groundwater storage requirements reducing SoS	WRMP & supply demand balance review/update. SRO, DO review and update, WFD objectives feed into AMP, regional groundwater models, flood and water management act.	Resource sharing, new resource development, winter reservoir schemes	Water Supply
TR10		Water Quality	Increased algal growth and risk of microscopic organisms within the water supply system increases drinking water quality risk	DWSP, operational response	Emergency Response plans, contingency measures	Production
TR11			Higher temperatures reduce raw water quality and increase drinking water quality risk	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Production
TR12			Increased rate of micro-biological growth increases risk of residual chlorine depletion and contamination of supplies, increasing drinking water quality risk	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Production
TR13			Higher average and peak temperatures cause an increase in incidence of water & wetland associated disease, thus risk of contamination of raw water	DWSP, Flood and water management Act, analyse risk using flood databases, operational response	Asset protection, Emergency Response plans, contingency measures, adaptive plan for treatment measures	Production
TR14		Network infrastructure	Greater extremities in wetting and drying cycles lead to greater soil movement, causing pipe systems to move increasing burst frequency	analyse risk using flood databases, include climate extremes in network models	protect assets, risk based asset management plans, contingency measures, response and recovery plans, increase asset replacement, improve leakage detection	Water Supply
TR15			Dry ground increases number of identified leaks requiring repair/investigation	analyse risk using flood databases, include climate extremes in network models	protect assets, risk based asset management plans, contingency measures, response and recovery plans, increase asset replacement, improve leakage detection	Water Supply
TR16		Source pumping stations	Increased peaks of demand lead to greater storage requirements reducing security of supply, increasing pumping required.	Operational response, monitor trends, impacts and failures with pro active maintenance strategy	Asset protection, Emergency Response plans, risk based asset management plans, contingency measures, response and recovery plans, adaptive asset replacement	Water Supply/Production
TR17			Higher average and peak temperatures affect buildings, control systems, pumps and equipment working life, causing increase in failures	Operational response, monitor trends, impacts and failures with pro active maintenance strategy	Asset protection, Emergency Response plans, risk based asset management plans, contingency measures, response and recovery plans, adaptive asset replacement	Water Supply
TR18			Higher average and peak temperatures affect buildings, control systems, pumps and equipment working life, causing accelerated asset deterioration	Operational response, monitor trends, impacts and failures with pro active maintenance strategy	Asset protection, Emergency Response plans, risk based asset management plans, contingency measures, response and recovery plans, adaptive asset replacement	Water Supply
TR19		Operations	Higher average and peak temperatures affect buildings, HVAC plant, control systems working life, causing increase in failures affecting operations	monitor trends, impacts and failures with pro active maintenance strategy	Asset protection, Emergency Response plans, risk based asset management plans, contingency measures, response and recovery plans, adaptive asset replacement	Water Supply
TR20			Higher average and peak temperatures affect buildings, HVAC plant, & control systems working life, causing accelerated asset deterioration	monitor trends, impacts and failures with pro active maintenance strategy	Asset protection, Emergency Response plans, risk based asset management plans, contingency measures, response and recovery plans, adaptive asset replacement	Water Supply
TR21			Higher levels of UV increase the risk of sun-related injury, endangering H&S of site staff	Risk assessment	adaptive working practices	Compliance
TR22			Higher average and peak temperatures cause an increase in incidence of water & wetland associated disease, possibly affecting access to sites	defra controls	Emergency Response plans, contingency measures, response and recovery plans,	Compliance
TR23			Higher temperatures cause increased vegetation growth at sites requiring management	Risk assessment	adaptive working practices	Compliance
TR24		Customer Impact	Restrictions imposed on water use	Model and monitor network flow and pressure	manage customer expectations	Compliance
TR25			Increased demand for recreational based leisure activities impacts on supply demand balance	Water efficiency measures and targets, metering programme and increased meter penetration, variable tariffs, WRMP review, Flood and water management Act 2010 - guidance on restriction on use of water in water shortages	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives	Compliance
TR26			Increased seasonal demand cause Loss failure, pressure and supply, supply demand balance impacts	Model and monitor network flow and pressure, Demand Management	Increase meter penetration, water efficiency measures & targets, Customer communication, promoting behaviour change, variable tariffs, incentivise demand reductions, compulsory metering, variable tariffs, water-re-use technologies and initiatives, pressure management, increased storage, winter storage	Water Supply/Production

All Impacts	All Areas	All Risks	adapt decision making to cope with climate change uncertainty	Industry R&D programmes into climate change impact on resources.	All Depts.
			Follow government, regulators and EU policy for climate change adaption	Sector Resilience plans for critical national infrastructure	All Depts.
			scenario neutral option analysis for major investment decisions	Ofwat leakage targets	All Depts.
			Consider customer willingness to pay in climate change decisions		All Depts.
			social and political pressures towards climate risk		All Depts.
			have regard to future water strategy documents and guidance		All Depts.

Denotes Risk Score > 15

Reference Terms

WRMP	Water Resources Management Plan
SRO	Source Reliable Output
DP	Drought Plan
BP	Business Plan
SoS	Security of Supply
KPI	Key performance indicator
UKWIR	UK Water Industry Research
WFD	Water Framework Directive
CAMS	Catchment Abstraction Management Strategy
CM	Catchment Management
UKCP	UK Climate Projections
SMD	Soil Moisture Deficit
DMA	District Meter Area
DWSP	Drinking Water Safety Plan
DO	Deployable Output

Annex 4
Company Risk Register as at June 2010

	Risk Description	Process Level	Likelihood	Impact	Risk Rating	Existing Internal Controls to Mitigate Risk	Control Rating	Comments / Actions for Inadequate Controls	Valid internal audit area?	Actions already undertaken	Internal audit proposed
1	Failure to meet Nitrate quality standard	OPS	4	4	H	Rising nitrate levels in groundwater affecting significant number of production sites. Blending of higher nitrate sources.	Satisfactory	5 sites identified and supported by DWI. Undertakings in place from January 2010 for AMP5	No		
2	Loss of the Alarm Monitoring Centre	OPS	3	5	H	Building security system. Fire policy. Fire/smoke sensors. Preventative maintenance. Safety inspections.	Satisfactory	Off site alternate Alarm Monitoring Centre located at Fleam Dyke planned in AMP5, Telemetry replacement planned	No		
3	Occupational health & safety	ALL	3	5	H	Risk assessments. Health & safety training. Safety inspections. Issue PPE. Monitor entries in Accident and Near Miss Books. Accident investigations and reports. Review contractors Accident Book	Effective	Health & Safety Policy and Management Plan updated regularly	Yes	Various actions in place to cover H&S. Inc. HSG65 Audit, Workplace Inspections, Reviw of RA's, etc. with Competent Advisor - PSN	Review Departmental RA's with relevant stakeholders
4	Fire at HQ building	ET	3	5	H	Fire alarm. 24/7 security. Weekly alarm test and evacuation procedure formalised	Satisfactory	BC planning under review	Yes	Fire Risk Assessment in place and reviewed annually by the Fire Officer	Fulbourn Road HQ Workplace Audit took place June 2010
5	Contamination at a source works	OPS	3	4	H/M	Physical security measures in line with DEFRA Security & Emergency Measures Direction (SEMD). Intruder detection systems. Isolation procedures. Reactive standby staff. Failsafe chlorination. Catchment monitoring from Water Safety Plan activity. .	Effective	External SEMD audit, all AMP4 obligations under SEMD met	Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011. External Assessment planned for Q2 2011 (every 3 years)
6	Contamination of water storage	OPS	3	4	H/M	Physical security measures in line with DEFRA Security & Emergency Measures Direction (SEMD).Intruder detection systems. Local response plan. On call contractor for alternate water supplies. Bowsers/tanks. On call printing service. Media protocols. Emergency call centre. Training	Effective	External SEMD audit, all AMP4 obligations under SEMD met	Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011. External Assessment planned for Q2 2011 (every 3 years)
7	Failure to meet water quality standards	OPS	3	4	H/M	Water quality samples taken daily, failsafe chlorination of supply. Drinking Water Safety Plans (DWSP), DOMS & Competent Operator	Effective	Introduced separate Compliance function to further ensure quality control.	Yes	Competent Operator planned completion end of 2010. Review of DWSP's and DOMS ongoing	DOMS Q4 2010, DWSP's Q1 2011, Competent Op Q2 2011
8	Adverse financial and economic conditions	FIN	4	3	H/M	Monthly review of key financial indicators. Measurement of actual performance against budget. Regularly reviewed with budget holders. Quarterly forecasting	Effective	Constant monitoring of recession impact on customer ability to pay	No		
9	Strategic mains failure	OPS	3	4	H/M	Local response plan. On call contractor for alternate water supplies. Bowsers/tanks. On call printing service. Media protocols. Emergency call centre. Training. Distribution metering enhanced to improve large burst detection.	Satisfactory	Outsource arrangement and emergency pipe stock allow rapid respond & fix	Yes	Emergency Planning Exercise carried out August 2010.	Multi Agency Planning Exercise Q2 2011. Annual SEMD audit Q1 2011
10	Failure of the Telemetry System	OPS	3	3	H/M	Hot standby Telemetry System with operational back up.	Satisfactory	Hardware/Software support not sustainable Funding for replacement of telemetry system in AMP5.	Yes	SCADA Telemetry Questionnaire completed Q4 2009. Review of questionnaire with DEFRA Q2 2010	SCADA Telemetry Questionnaire q4 2010
11	Loss of VPN links to remote security camera	IT	4	3	H/M	Procedures in event of link loss	Satisfactory	Reliability of ADSL links improving. Continually reviewing alternative communications network solutions to improve resilience. AMP5 Telemetry replacement includes dual path comms..	No		
12	Loss of treatment chemicals	OPS	2	5	H/M	3 month storage at central secure company site. Individual sites have standby reserves.	Satisfactory	AMP5 scheme to replace treatment with non chlorine gas alternative having lower supply chain risk.	Yes	H&S Audit of CDG 2009 Regs took place in August 2010. Documentation covers stock levels	Audit of Maintenance & Calbration systems planned for 2011
13	Development of Competition in the Industry	ET	4	3	H/M	Company is actively participation in the consultations, keeping up to speed with developments, and position the Company as appropriate	Effective	Ofwat are currently consulting on the introduction of competition in the industry. Specifically it is expected that retail competition for non-households will be in place by 2012	No		
14	Failure to secure adequate funding	FIN	2	4	M	Regular discussions with financial institutions to assess current funding climate and access to markets. Current arrangements expire December 2010	Effective	Current market sentiment is that our funding requirement and class of asset is still considered attractive despite current market illiquidity. This is being monitored monthly and updated to Board.	No		
15	Interest rate fluctuation	FIN	3	3	M	Borrowings hedged by fixed rate Swap	Effective		No		
16	Loss of water storage	OPS	3	3	M	Intruder detection systems with multi agency local response plan. Emergency Plan. On call contractor for alternate water supplies. Bowsers/tanks. On call printing service. Media protocols. Emergency call centre. Training	Effective	External SEMD audit, all AMP4 obligations under SEMD met	Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011 inc. Major Incident Plan. External Assessment planned for Q2 2011 (every 3 years)
17	Unlawful site intrusion	OPS	3	3	M	Security signage to deter. Electronic intruder detection systems/alarm sensors in all buildings. Water storage access covers and CCTV at key sites under SEMD. Physical security measures-doors, windows, palisade and electric fencing. Police Response plans.	Effective	All strategic sites equipped with physical protection. CCTV installation at strategic sites completed.	Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011 inc. Major Incident Plan. External Assessment planned for Q2 2011 (every 3 years)
18	Loss of Computer Room and contents	IT	2	4	M	Fire alarm, 24/7 monitor, secondary off site computer room	Effective	No fire suppression in IT room, alternate site implementation underway as part of Business Continuity	No		
19	Loss of Data Links to other sites and internet	IT	3	3	M	Secondary link to internet	Effective	Planned upgrade to support Telemetry system	Yes	SCADA Internal Audit Q4 2009. DEFRA Audit Q3 2010	DEFRA Audit Q3 2011
20	Terrorist attack at HQ building	OPS	1	5	M	CCTV. 24/7 security. Bomb threat procedure. Personnel security procedures in line with CPNI guidance in HR recruitment process.	Effective		Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011 inc. Major Incident Plan. External Assessment planned for Q2 2011 (every 3 years)
21	Major incident interrupts business continuity	ALL	2	4	M	Back-up information and IT mirror site. High security control room. Standby off-site call centre function	Satisfactory	BC planning under review	No		
22	Drought	OPS	3	3	M	Drought Plan with demand and supply side options.	Effective	Drought monitoring with trigger for demand & supply side options in place	No	Company has "approved" drought plan	
23	Loss of sensitive data	ALL	3	3	M	Individual procedures in place under IT security, water supply security and statutory data protection. Company Data Protection Policy introduced. No current audit arrangement	Effective	Company policy introduced to cover all aspects of data protection and security and a suitable audit arrangement including staff training and awareness. IT Security Policy introduced using ISO 17799,	No		
24	Health Pandemic	H&S	2	4	M	DEFRA Pandemic advice/guidance. Pandemic policy for key personnel/ops activity. Resource plan in place	Satisfactory	Monitor impact and advice as available	No	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011 inc. Major Incident Plan. External Assessment planned for Q2 2011 (every 3 years)
25	Abstraction Licences - Time Limits	OPS	3	3	M	Optimum utilisation of licensed sources to demonstrate need.	Effective	We have some existing time limited licences, control effectiveness may deteriorate over time	No	The Company has an approved Water Resources Strategy	
26	Staff Competency shortfall	ALL	3	3	M	Training planning and regular reviews through one to ones and appraisal process. Working with industry bodies.	Effective	Recruitment challenges being monitored	No		
27	Loss of Key Individuals	ET	2	4	M	Benefits package, pension scheme, VP scheme, benchmarking, appraisal and one to one process.	Effective	Improved appraisal process introduced	No		
28	Corporate Liability	ALL	3	3	M	Public Liability Insurance, advisors	Effective		?		
29	Loss of Waterbeach Site	OPS	3	3	M	Contractors can operate from own locations, alternative supplies, remote systems	Effective		No		
30	Loss of Key IT Systems	IT	2	4	M	High reliability Hardware, Computer Room Design, Virtualisation, Business Continuity Plan.	Effective	Billing System is duplicated at remote site. Other key systems will be duplicated in AMP5	No		
31	Failure of a source works	OPS	3	2	L	Sufficient free board storage. Mechanical back up. Standby engineering staff.	Effective	Failure of an individual source works is mitigated by availability of multiple others in an integrated network.	Yes	Emergency Planning Exercise carried out August 2010.	
32	Loss of data from major IT systems	IT	1	4	L	Tape back ups, fire safes off site, updated AV, regular procedures & tests. HW Group Security Review. Supported key systems.	Effective		No		
33	Failure of key software suppliers	IT	2	3	L	Major suppliers e.g. Microsoft, in house access to source code. Basis 2 - in house expertise	Effective		No		
34	Loss of Key IT Staff	IT	3	2	L	Documentation, standardised tools and strategy.	Effective		No		
35	Unlawful entry to HQ building	OPS	2	3	L	Alarm system. Card entry. 24/7 security by monitored CCTV	Effective		Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011 inc. Major Incident Plan. External Assessment planned for Q2 2011 (every 3 years)
36	Flood at HQ building	ET	3	2	L	All plant equipment waterproofed with exception of mains distribution board	Satisfactory	BC planning under review	Yes	Flood RA Updated Q4 2009	Flood RA to be reviewed Q2 2011
37	Plant failure at HQ building	OPS	3	2	L	Preventative maintenance programme. Safety checks. Duplicate systems. Alarm system	Effective		Yes	Workplace Audit carried out Q3 2010	Audit planned for Q3 2011
38	Localised or regional flooding	OPS	3	1	L	Risk assessment updated, isolation procedures, no single site reliance, sufficient water resources	Effective		Yes	Flood RA Updated Q4 2009	Flood RA to be reviewed Q2 2011
39	Loss of supply to key customers	ET	2	2	L	Most key customers have storage for 24 hours which is sufficient time to repair major risk of burst. Quality of supply to Iceni protected by site security also twin pipeline	Effective		Yes	Emergency Planning Exercise carried out August 2010.	
40	Loss of key network maintenance contractor	ET	2	3	L	Risk mitigated by control of depot. Good relationships maintained with multiple contractors through unbundled contracting arrangement.	Effective		?		
41	Strike Action	ET	1	3	L	Aspects of the business are unionised, no company recognition, maintain strong working relationships and keep reps well informed through CWCF	Effective		No		
42	Climate Change	ALL	2	2	L	Sustainability is a key component of company vision and values.	Satisfactory	Monitor potential impacts every 6 months as part of this review	No		
43	Protection of the network	REG	2	3	L	The Company has a risk based approach to "protecting" its network.	Effective	As new forms of competition develop we need to ensure that our policies and procedures adjust accordingly. The first development is that developers are now allowed to lay their own on-site mains	Yes	Water regulation work is ongoing and there is a programme to review all categories 4 and 5. If this issue materialised it would be addressed	
44	Loss of Electricity & Fuel Supplies	OPS	2	3	L	Self generation of electricity at strategic sites. Additional generator scheme in AMP5 to maintain security of supply index. Classified by DEFRA as highest category priority fuel user and fuel provision in the event of national shortage	Effective	MOU with electricity supplier to provide backup generation to ensure water service is maintained	Yes	Annual external audit carried out Q1 2010. Self assessment completed and sent to DEFRA Q2 2010	Annual audit planned for Q1 2011 inc. Major Incident Plan. External Assessment planned for Q2 2011 (every 3 years)

Annex 5
EA flood Risk assessment for CW sites (2008)

Sites	EA Flood Assessment
	Likelihood of Flooding per Year
Sawston Mill PS	0.1% (1 in 1000) or less.
Duxford Airfield PS	0.1% (1 in 1000) or less.
Euston PS	0.1% (1 in 1000) or less.
Lowerfield PS	0.1% (1 in 1000) or less.
Dullingham PS	0.1% (1 in 1000) or less.
Duxford Grange PS	0.1% (1 in 1000) or less.
Hinxton Grange PS	0.1% (1 in 1000) or less.
Weston Colville PS	0.1% (1 in 1000) or less.
Abington Park PS	0.1% (1 in 1000) or less.
Brettenham PS	0.1% (1 in 1000) or less.
Fleam Dyke 12 PS	0.1% (1 in 1000) or less.
Fulbourn PS	0.1% (1 in 1000) or less.
Fleam Dyke 36 PS	0.1% (1 in 1000) or less.
Great Wilbraham PS	0.1% (1 in 1000) or less.
Babraham PS	0.1% (1 in 1000) or less.
Melbourn PS	0.1% (1 in 1000) or less.
Sawston PS	0.1% (1 in 1000) or less.
Westley PS	0.1% (1 in 1000) or less.
Fowlmere PS	0.1% (1 in 1000) or less.
Morden Grange PS	0.1% (1 in 1000) or less.
Great Chishill PS	0.1% (1 in 1000) or less.
Heydon PS	0.1% (1 in 1000) or less.
Rivey PS	0.1% (1 in 1000) or less.
Croydon PS	0.1% (1 in 1000) or less.
Horseheath PS	0.1% (1 in 1000) or less.
Kingston PS	0.1% (1 in 1000) or less.
Linton PS	0.1% (1 in 1000) or less.
Lordsbridge PS	0.1% (1 in 1000) or less.
Rushford PS	0.1% (1 in 1000) or less.
Fenstanton PS	Low- 0.5% (1 in 200 o less.
St Ives PS	Significant- 1.3% (1 in 75) or less.
Bluntisham Res	0.1% (1 in 1000) or less.
Coton Booster Station	0.1% (1 in 1000) or less.
Bourn Booster Station	0.1% (1 in 1000) or less.
Balsham Booster Station	0.1% (1 in 1000) or less.
Genome Bosster Station	0.1% (1 in 1000) or less.
Castle Hill Booster	0.1% (1 in 1000) or less.
St Ives Booster Station	0.1% (1 in 1000) or less.
Wandlebury Booster	0.1% (1 in 1000) or less.
Woodhurst Booster	0.1% (1 in 1000) or less.
Bury Booster Station	0.1% (1 in 1000) or less.
Croydon Booster Station	0.1% (1 in 1000) or less.
Cambourn Booster Station	0.1% (1 in 1000) or less.

The location you have selected is in an area which fell outside the extent of the extreme flood, at the time of our assessment of the likelihood of flooding. Generally this means that the chance of flooding each year from rivers or the sea is 0.1% (1 in 1000) or less. The Flood Map shows our current best information on the extent of the extreme flood from rivers or the sea that would occur without the presence of flood defences.

Annex 6
Cambridge Water Flooding Risk Assessment (2008)

HAZARD		RISK	CONTROL MEASURE
1.	Borehole flooding	Contamination of source, possibly into supply Severity Extremely high Likelihood Remote	Sites most at risk near rivers are out of commission long term for other reasons Programme to fit riser pipes on boreholes below ground to cater for failure of drain pumps Critical boreholes- works above ground because of localised flooding No affects from previous severe river flooding
2.	Loss of electrical supply	Loss of affected stations Loss of control and telemetry Severity Extremely high Dependent on number of stations Likelihood Possible	Installation of standby generators at supply critical sites Integrated supply network with redundancy Ability to manually cross feed between zones Manual control of equipment
3.	Loss of BT services	Partial loss of telemetry control Severity medium Likelihood possible Loss of ability to call standby personnel Severity high Likelihood possible	Reducing reliance on BT leased circuits- costs reduction Replacement of landline links by back to back radio systems Radios are low powered with battery back up Use mobile phones Issue CR with mobile phone Use those contactable to alert others

HAZARD		RISK	CONTROL MEASURE
4.	Road flooding	Driving conditions Difficulty in getting to sites Severity low Likelihood remote	Use of 4x4 Availability of diversionary routes
5.	Loss of third party supplies- chemicals, diesel	Suppliers unable to maintain production Severity extremely high Likelihood possible	Own holdings in chemicals sufficient to maintain operations for 3-4 weeks Holdings of diesel sufficient for 6 months
6.	Loss of radio system	Loss of contact with mobile workers Severity low Likelihood possible	Use of mobile phones

Annex 7

Table of reference documents

Title	Description	Reference source
Effect of Climate Change on River Flows and Groundwater Recharge, A Practical Methodology: A Strategy for Evaluating Uncertainty in Assessing the Impacts of Climate Change on Water Resources	Develops a strategy for evaluating uncertainties related to assessing the impacts of climate change on river flows and groundwater recharge using different climate and hydrological models for translating changes in river flow and recharge from the global scale to catchment scale	Ref: 05/CL/04/6, ISBN 1 4057
UK Climate change projections Science Report: UKCP09 Climate Change projections	UKCP09 methodology for producing probablistic projections of climate change, including example s of projections.	http://ukclimateprojections.defra.gov.uk/images/stories/projections_pdfs/UKCP09_Projections_V2.pdf
UK Climate change projections: Briefing Report	UKCP09 climate change key projections summary results, pre prepared maps and graphs and key findings. Projections are given of changes to climate, and of changes in the marine and coastal environment; recent trends in observed climate are also discussed.	http://ukclimateprojections.defra.gov.uk/images/stories/briefing_pdfs/UKCP09_Briefing.pdf
The climate of the UK and recent trends	UKCP09 Recent trends in observed climate	http://ukclimateprojections.defra.gov.uk/images/stories/trends_pdfs/Trends.pdf
UK Climate change projections Science Report: Projections of future daily climate for the UK from the Weather Generator	Introduction to the UKCP09 weather generator and how it can be used to assess changes in weather extremes and different temporal and spatial scales	http://ukclimateprojections.defra.gov.uk/images/stories/UKCP09_WGenerator.pdf
The UKCP09 Threshold Detector Manual	Explains the use of the UKCP09 Threshold detector to investigate future weather event extremes for multiple weather variables	http://ukclimateprojections-ui.defra.gov.uk/ui/docs/td/td_manual.pdf
How well prepared is the UK for climate change? Adaptation subcommittee	Summary of the adaptation subcommittees findings on climate change adaptation progress to date and discussion on future options for sectors in the UK	http://downloads.theccc.org.uk.s3.amazonaws.com/ASC/CCC_ASC_Report_web_1.pdf
Climate adaptation: Risk, uncertainty and decision-making	Presents a risk based approach to adapting to climate change taking account of uncertainty in the UKCP projections for future climate change	http://www.ukcip.org.uk/images/stories/Pub_pdfs/Risk.pdf
Preparing for climate change through the UK	Presents findings from UKCP studies to provide a national picture for climate change impacts and adaptation options available to assist	http://www.ukcip.org.uk/image

Climate Impacts Programmed	desicion makers prepare for climate change	s/stories/Pub_pdfs/Measuring Progress.pdf
Identifying adaptation options	UKCP guidance on adaption to climate change, sing a risk based approach to identifying adaptation options	http://www.ukcip.org.uk/images/stories/Tools_pdfs/ID_Adapt_options.pdf
Climate Change Uncertainty in Water Resource Planning	Investigates uncertainty in the impact of climate change on river flows and water resource. • Uncertainty in climate change projections, due to Global Climate Models (GCM), emission scenarios and downscaling techniques for the UK.	Ref: 05/CL/04/4, ISBN 1 4057 389 9, Ref: 03/CL/09/2, ISBN 1 84057 285
Effects of Climate Change on River Flows and Effect of Climate Change on River Flows and Groundwater Recharge, A Practical Methodology: Use of Climate Change Scenario Data at a Catchment Level	Provides background information on using the (UKCIP02) climate scenarios and catchment scale climate scenario and provides monthly temperature, rainfall and potential evapotranspiration (PET) factors for river catchment boundaries. Provides a consistent data set that can be used by all stakeholders.	Ref: 05/CL/04/3, ISBN 1 84057 373 2,
Effect of Climate Change on River Flows on River Flows and Groundwater Recharge:	Presents a procedure for the rapid determination of the effects of climate change by the 2020s on mean monthly runoff and average annual groundwater recharge for strategic scale assessments. Using UKCIP02 Scenarios.	Ref: 03/CL/04/2, ISBN 1 84057 286 8,
Scoping Study to Identify Research Requirements to assist the UK Water Industry in Dealing with Changing patterns of Drought	Determines the requirements for future research into the effects of changes in the occurrence of droughts across the whole range of water industry operations.	Ref: 00/CL/07/1, ISBN 1 84057 187 X,
Uncertainty & Risk in Supply/Demand Forecasting	Presents guidelines on how uncertainties in the individual elements of supply and demand can be brought together in an integrated way. Provides guidance on how to interpret uncertainties By which investment decisions are made.	Ref: 03/CL/09/1, ISBN 1 84057 284 1 Ref: 03/CL/09/2, ISBN 1 84057 285
Climate Change - A Programme of Research for the UK Water Industry: Volume 1 - Summary Report (08/CL/01/7)	This report provides a first climate-related snapshot looking across the UK water industry and out to 2100. It identifies where significant uncertainties in the climate science remain, the nature and extent of impact and business risks, adaptation options, and where there are critical knowledge gaps and capacity within the industry.	ISBN: 1 84057 513 1
Climate change and river flows in the 2050s	This study was based on the UK's previous climate projections published in 2002 (UKCIP02), and are appropriate when used as part of a high-level assessment of future water challenges	http://publications.environmentagency.gov.uk/pdf/SCHO1008BOSS-e-e.pdf

WaterUK asset management Planning Tool	Water UK planning tool to support a common approach for the water industry to assess adaptation risks and their incorporation into asset management planning.	http://www.water.org.uk/home/policy/climate-change
UKWIR Effect of Climate Change on River Flows and Groundwater Recharge UKCIP 02 Scenarios (03/CL/04/2)	This report presents a procedure for the rapid determination of the effects of climate change by the 2020s on mean monthly runoff and average annual groundwater recharge	(03/CL/04/2)
Defra Climate Change and Demand for Water Revisited (2006)	Defra future water strategy document	http://www.defra.gov.uk/science/Project_Data/DocumentLibrary/WT01001/WT01001_2050_FRP.pdf
UKWIR Effects of Climate Change on River Flows and Groundwater Recharge: Guidelines for Resource Assessment and UKWIR06 Scenarios	Provides technical guidelines for the assessment of the impacts of climate change on average monthly river flows and recharge in UK catchments for the 2020s	(06/CL/04/8) ISBN: 1 84057 431 3
UKWIR, Defra, EA and Ofwat (2007), A Framework for Valuing the Options for Managing Water Demand	Develops a best practice framework for assessing the contribution of demand management to long-term supply/demand balance planning.	(07/WR/25/3)
UKWIR (2007), Effect of Climate Change on River Flows and Groundwater Recharge: A practical methodology for draft recharge and groundwater level impact assessment	Provides tools and guidance on estimating changes in recharge and regional groundwater levels based on changes in precipitation and potential evaporation. The approach considers uncertainty.	(07/CL/04/9)
Effect of Climate Change on River Flows and Groundwater Recharge, A Practical Methodology: A Strategy for Evaluating Uncertainty in Assessing the Impacts of Climate Change on Water Resources	Develops a strategy for evaluating uncertainties related to climate change impacts on river flows and groundwater recharge.	ISBN: 1 84057 396 1 (05/CL/04/6)
Effects of Climate Change on River Water Quality (05/CL/06/4)	Investigates the impact of predicted climate change on water quality in UK rivers, and its implications to the UK water industry using a distributed catchment-scale hydrological and water quality model, for the UKCIP 1998 medium-high emissions scenario in the 2080s.	(05/CL/06/4) ISBN: 1 84057 402 X
UKWIR/Environment Agency (2001), Critical Period Groundwater Yield UKWIR (1995), A Methodology for the Determination of Outputs of Groundwater Sources	Details existing methods and data availability. Provides an easy to use unambiguous, regulatory, auditable methodology for assessing reliable outputs from single sources to complex audits systems. Operational or, where data is lacking, analytical approaches provide deployable outputs and potential yields for the range of water levels and demand conditions.	(95/WR/01/2) ISBN: 1 84057 121 7 (95/WR/01/2) ISBN: 1 84057 121 7