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**Water UK**

**A Climate Change Adaptation Approach  
for Asset Management Planning**

41414874  
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November 2007



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**A Climate Change Adaptation Approach for Asset Management Planning**

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**CONTENTS**

|            |  |           |
|------------|--|-----------|
| <b>1.</b>  | <b>INTRODUCTION</b>  | <b>2</b>  |
| <b>2.</b>  | <b>PROJECT DESCRIPTION</b>   | <b>2</b>  |
| <b>2.1</b> | <b>Project context</b>   | <b>2</b>  |
| <b>2.2</b> | <b>Project aim, objectives and outputs</b>                               | <b>3</b>  |
| <b>3.</b>  | <b>THE ASSET MANAGEMENT PLANNING PROCESS</b>                             | <b>3</b>  |
| <b>3.1</b> | <b>Incorporating climate change adaptation</b>                           | <b>3</b>  |
| <b>4.</b>  | <b>ASSET LISTS</b>   | <b>5</b>  |
| <b>5.</b>  | <b>CLIMATE CHANGE ADAPTATION INFORMATION TABLES</b>                      | <b>6</b>  |
| <b>6.</b>  | <b>TABLE 1: CLIMATE CHANGE IMPACTS ON WATER INDUSTRY ASSETS</b>          | <b>6</b>  |
| <b>6.1</b> | <b>Aim</b>   | <b>6</b>  |
| <b>6.2</b> | <b>Table Description</b>   | <b>6</b>  |
| <b>7.</b>  | <b>TABLE 2: ADAPTATION OPTIONS IN RESPONSE TO CLIMATE CHANGE IMPACTS</b> | <b>10</b> |
| <b>7.1</b> | <b>Aim</b>   | <b>10</b> |
| <b>7.2</b> | <b>Table Description</b>   | <b>10</b> |
| 7.2.1      | Consequence Grouping   | 10        |
| 7.2.2      | Adaptation Response Options  | 10        |
| 7.2.3      | Information Sources  | 11        |
| <b>7.3</b> | <b>Table 2 Column Descriptions</b>                                       | <b>11</b> |
| 7.3.1      | Impact Description   | 11        |
| 7.3.2      | Response Description & Impacts Addressed                                 | 11        |
| 7.3.3      | Identifying adaptive characteristics                                     | 11        |
| 7.3.4      | Information Source Reference   | 12        |
| <b>8.</b>  | <b>TABLE 3 – INFORMATION SOURCE ANALYSIS</b>                             | <b>12</b> |
| <b>8.1</b> | <b>Table Description</b>   | <b>13</b> |

## 1. INTRODUCTION

The water industry is at the forefront of climate change, as its raw material is directly dependent on the natural environment. Climate change will impact all areas of the water industry.

To provide an appropriate strategic and regulatory response to climate change, at PR09, SR10 and NIAMP3 and beyond, the water industry through Water UK is producing three parallel responses to this challenge. These are coordinated through the Water UK Climate Change Focus Group (CCFG), and are:

- Strategies for mitigation of CO<sub>2</sub> equivalent emissions
- Development of consistent metrics for carbon and CO<sub>2</sub> equivalent calculations and reporting
- A common approach for assessing adaptation risks, and their incorporation into asset management planning

This project addresses the third of these elements, delivering a checklist and short piece of guidance to enable the consistent incorporation of climate change impacts and adaptation responses into asset management plans for PR09, SR10 and NIAMP03. The CCFG have provided the Steering Group members, together with members from Defra, OFWAT, the Environment Agency and the Consumer Council for Water.

MWH was commissioned to carry out the work, following the CCFG meeting on 6<sup>th</sup> July 2007.

## 2. PROJECT DESCRIPTION

### 2.1 Project context

Water UK was aware of a separate but related UKWIR longer-term study: "UKWIR CL/01: Towards a UK Water Industry Strategic Framework for Adapting to a Changing Climate". This Water UK project differs from the UKWIR project in that it has a specific asset management perspective with a short-term focus on PR09, SR10 and NIAMP, while UKWIR's CL/01 project is taking a broader and longer-term view of the adaptation issue. Water UK and UKWIR agreed to discuss and collaborate in detail, to ensure that they produce complimentary work.

The two projects have worked very closely to clarify work boundaries, reduce overlap and share information, specifically:

- This Water UK project - through identifying, summarising and assessing climate change impacts, adaptation responses and relevant information sources - will feed into the UKWIR CL/01 project via the draft and final reports to be issued November 2007.
- This Water UK project will not duplicate the aims of the UKWIR CL/01 project which include: identify and summarise what relevant adaptation *research* is or will become available; identify what this research covers; clarify the gaps in the research; and recommend how/when should they be addressed. This is expected as an early UKWIR CL/01 output, in November 2007.

As a result of the collaboration between the two studies, draft data has been exchanged between projects, and a UKWIR CL/01 team member attended both October 2007 Water UK CCFG meetings. The two projects will run a joint workshop on 7<sup>th</sup> November 2007 to present the output of this Water UK project, and initiate the main part of the UKWIR CL/01 project.

## 2.2 Project aim, objectives and outputs

The aim of this study is to provide water companies with a consistent set of climate change adaptation information for asset management planning and the forthcoming price reviews. It provides information on climate change impacts and adaptation options that can be fed into company 25-year WR plans and SDS, and PR09, SR10 and NIAMP3 business plans where appropriate.

The objectives of this project were to address a number of strategic questions, which were conditioned by the CCFG discussion on 6th July 2007, and revised by the outcomes of discussion of the interface with the UKWIR CL/01 project, at the 16<sup>th</sup> August 2007 meeting:

- Examine what strategic, design, planning, operational or other adaptation *options* are available, and what *timescales* are appropriate; assess these, and propose a consistent approach.
- Consider which climate change *scenarios*, *assumptions* and *data* should be used; including the range of *uncertainty*.
- Suggest a decision-making framework with which to *evaluate alternatives* and determine a preferred adaptation strategy
- Engage with regulators and other key stakeholders to explain this Climate Change Adaptation Approach for PR09, SR10 and NIAMP3, and to inform an appropriate understanding from economic regulators for the next set of price reviews. In addition take appropriate inputs from others stakeholder groups.

The project deliverables identify the impact of climate change on water company assets and procedures, and propose a set of consistent adaptation response options that can feed into existing PR09, SR10 and NIAMP3/SR10 asset management planning procedures. Project deliverables are:

- Project report
- An Excel workbook containing the following worksheets:
  - An introduction to the workbook and an explanation of the tables contained
  - Table 1: Climate change impacts on water industry assets
  - Table 2: Adaptation options in response to climate change impacts
  - Table 3: Information Sources

This study does NOT suggest a new way of doing AMP, nor does it seek to repeat or modify the approach of individual water companies. It instead aims to assist asset planners to incorporate the latest information on climate change impacts, possible adaptation response options, and investment selection criteria that can take account of climate change.

## 3. THE ASSET MANAGEMENT PLANNING PROCESS

The generic Asset Management Plan (AMP) process is shown in Fig. 1. The typical stages of AMP are shown in grey boxes from left to right. Iteration is used at the Option Definition and Investment Selection stages to analyse and develop alternative strategic scenarios for investment.

### 3.1 Incorporating climate change adaptation

The activities where consideration should be given to climate change impacts or adaptation solutions are shown in blue boxes in Fig 1. All climate change impacts and adaptation response options must

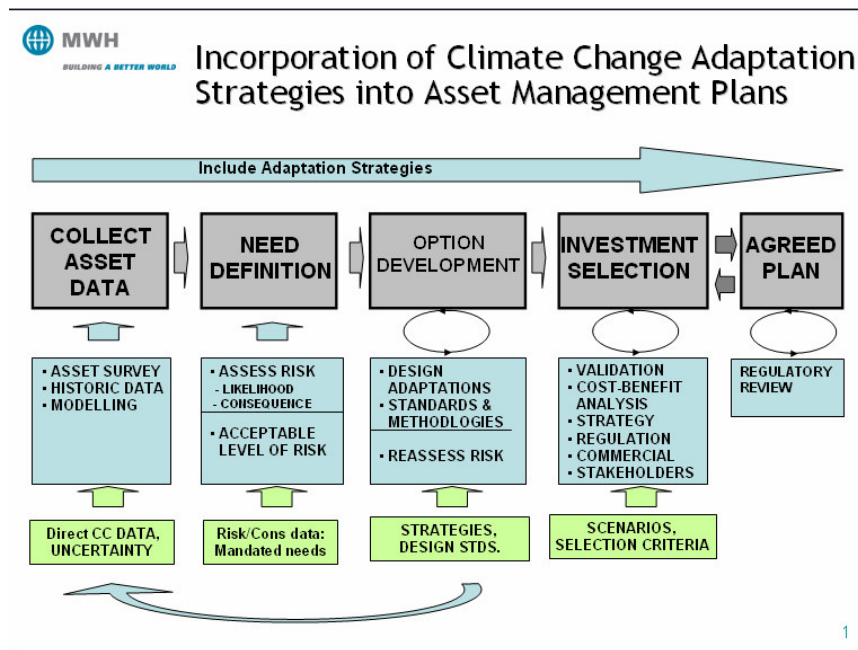
be identified against the AMP asset groups that they may affect. There are two key points of entry into the process:

- **Climate Change Impacts:** input at the Collect Asset Data + Needs Definition stages.
- **Adaptation Response Options:** input at the Option Development and Investment Selection stages.

The extra types of information required to incorporate climate change adaptation into the AMP process include:

- Climate change impacts:
  - Direct impacts e.g. temperature increase
  - Indirect impacts e.g. population movements
  - Impacts of other stakeholders' adaptation strategies
- Global, regional & corporate strategies for climate change mitigation (including success assumptions)
- Future scenarios e.g. possible societal responses
- Potential and preferred adaptation response options e.g. change sewer design standards
- Extra climate change-driven Selection Criteria, e.g. adaptability; resilience; CO<sub>2</sub> equivalent price

UKCIP provide valuable guidance for dealing with risk assessment, response options, and investment selection in the context of the timescales and uncertainties of climate change. Elements of their guidance are shown in this report in a simplified and summary form, but asset planners are urged to read the UKCIP information sources 219, 220, 221 detailed in Table 3.



**Fig 1: Incorporation of Climate Change Adaptation Strategies into Asset Management Plans**

#### 4. ASSET LISTS

Asset Planning in the water industry typically divides assets into groups for investment, and the listing in the table below gives a typical generic structure. Asset Hierarchy Level 1 is not shown but differentiates between water, wastewater and IT and Management & General (M&G) asset groups.

This project will identify how climate change impacts water company assets at Asset Hierarchy Levels 2 and 3.

| Asset Hierarchy Level 2 | Asset Hierarchy Level 3                           |
|-------------------------|---|
| Water Resources         | Storage Reservoirs and Aqueducts                  |
|                         | Boreholes / source pumping stations               |
|                         | Raw water pipelines                               |
|                         | Intake Pumping stations                           |
| Water treatment         | Treatment works                                   |
|                         | Service Reservoirs and Water Towers               |
|                         | Treated water pipelines                           |
|                         | Treated water pumping stations                    |
| Water networks          | Distribution networks including ancillaries       |
|                         | Distribution pumping stations                     |
|                         | Distribution storage                              |
| Wastewater networks     | Sewer networks, incl./trunk sewers                |
|                         | Pumping stations                                  |
|                         | Rising mains                                      |
|                         | CSOs and overflows                                |
| Wastewater treatment    | Pumping stations                                  |
|                         | Treatment works                                   |
|                         | Outfalls  |
| Sludge                  | Sludge treatment (including CHP and incineration) |
|                         | Sludge disposal or re-cycling                     |
| Site Wide Services      | SCADA & Telemetry                                 |
|                         | Electrical Supply                                 |
|                         | Buildings   |
|                         | Security  |
|                         | Mobile Plant                                      |

As the AMP process progresses, the investment plans for each asset group will be divided between OFWAT-agreed 'funding streams'. These are, typically:

- **Water:**
  - W Customer Lead; W Major Projects
  - W AGL maintenance; W BGL maintenance
  - W Quality; W Leakage; W Leakage
  - W Resources; W Growth
- **Wastewater:**
  - WW Customer Lead; WW Major Projects
  - WW AGL maintenance; WW BGL maintenance
  - WW Quality; WW Sludge
  - WW Flooding; WW Growth
- **IT, Management & General**

Ultimately all these streams are optimised into a single plan. Investment solutions aimed at a given funding stream may give secondary benefits to another. The iteration of solutions developed at the

Option Development and Investment Selection stages, and the final optimisation may need to acknowledge and deal with such overlaps

**5. CLIMATE CHANGE ADAPTATION INFORMATION TABLES**

The following chapters describe the information presented in the Excel file *A Climate Change Adaptation Approach for Asset Management Planning.xls* accompanying this report.

The function of these tables is to:

- Map a range of climate change impacts against the water company asset groups affected
- Give an ‘indicative score’ of impacts in terms of urgency and severity
- Associate climate change impacts with potential adaptation response options
- Identify some potential adaptive characteristics for each adaptation response option: whether it is a ‘no regrets’, ‘low regrets’, ‘win-win’ or ‘flexible/adaptive’ option
- Identify information sources of use in understanding impacts & adaptation response options

**Most of the following information is repeated in the accompanying Excel Tables to provide guidance to users. Information not repeated in the Excel Tables is shown in numbered boxes.**

**6. TABLE 1: CLIMATE CHANGE IMPACTS ON WATER INDUSTRY ASSETS**

**6.1 Aim**

- 1) To categorise climate change impacts into four parent impact groups
- 2) To map climate change impacts against the water company asset groups affected
- 3) To give an ‘indicative score’ of impacts in terms of urgency and severity
- 4) To reference information sources which build an understanding of climate change impacts

**6.2 Table Description**

- 1) Climate change impacts affecting water company assets have been identified, and each is shown in a separate cell in Table 1
- 2) The description of each impact is a combination of environmental impact (e.g. lower river flows) and the water company *Consequence*, which is shown in bold (see example in Fig 2 – **reduction in security of supply**).

**Box 1: Impact Description**

This text is as short as it can be to convey the necessary distinct information to a water company asset manager or planner. It may not be described in sufficient detail for a wider less expert audience.

- 3) Each impact has a unique impact reference number; a letter and number e.g. D1. This code stays with the impact throughout this workbook (and in future asset management planning)

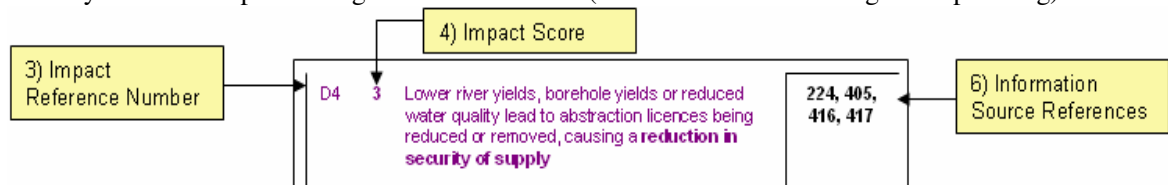


Fig 2 – Explanation of Climate Change Impact format



- 4) Each impact has an indicative impact scoring to indicate relative urgency and severity
- 5) The method used to indicate relative urgency and severity – a simple matrix – is shown below in Fig 2

| Impact Score = (Severity x Urgency) of the Consequence |                 | Urgency – <i>when the Impact affects</i> |                               |
|--|-----------------|--|-------------------------------|
|  |                 | Urgent (before 2015)                     | Medium/long-term (after 2015) |
| Severity – <i>what the Impact affects</i>              | Life and Health | 4  | 2                             |
|  | Property/other  | 3  | 1                             |

Fig 3 – Determining Impact Score

In addition to showing the impact score number after the impact reference, impacts are colour coded to illustrate score as follows:

- Score 4 = Red (Urgent, Severe),
- Score 3 = Purple (Urgent, Not Life-threatening)
- Score 2 = Blue (Not urgent, Life-threatening)
- Score 1 = Black (Not urgent, Not Life threatening)

### Box 2: Determining Indicative Impact Score

The allocation of an impact score was at the request of the Water UK Climate Change Focus Group. The method used is taken from recent MWH work on Climate Change adaptation for the City of Chicago.

Impact Scoring requires a judgement to be made on **what** an impact will affect and **when** it is likely to require an adaptive response.

The method used determines severity by identifying whether 'Life and Health' are affected. The impact scoring shown in the attached Tables have been made with the following assumptions on **severity**:

- 'Life and Health' impacts are those causing:
  - Service loss of clean water treatment and network assets
  - A reduction in drinking water quality
  - Direct asset flooding cutting access to manned assets
  - Significant H&S risks to site staff
- 'Property/other' impacts include all other impacts

Determining the urgency of an impact is subjective, and there is as yet no objective agreement about which climate change impacts require an adaptation response in AMP5. The EA document *Addressing Climate Variability and Change up to the 2030s* (Information source 404 in Table 3) suggests that:

*"Climate change within the next few decades will be dominated by natural variations...climate change does not emerge from natural variability until after the 2050s."*

However we *are* already seeing changes in general trends in our climate. (Information source 412 in Table 3).

**Therefore, it is suggested that individual water companies use their own risk assessment tools and criteria (including cost) to repeat the exercise of determining Impact Score themselves, as the urgency and severity of climate change impacts will vary geographically throughout the UK, and will be different for individual catchments/supply zones and assets within water company areas.**

The following assumptions have been made to determine **urgency**:

- 'Urgent' impacts are those within the 'Drought' and 'Floods' groups. The rationale for this is that extreme climatic events of this type have already been already observed, notably the 2007 Summer Floods and the 2005-6 Drought in the southeast of England; *and have exceeded current design provision*. The impacts described within the 'Drought' and 'Floods' groups are therefore to be expected to emerge or become enhanced before 2015.
- 'Medium/Long Term' Impacts' are 'Temperature Rise' and 'Sea Level rise/Storm Surge'. (Although there have also been recent extreme temperature and storm surge events, *they have not generally exceeded current design provision*.)

- 6) Impacts have been categorised into one of four 'Parent' Impacts: Drought, Temperature Rise, Flood, Sea Level Rise Storm Surge. This determines the **column** an impact is displayed in.

### Box 3: Explanation of Parent Impacts

The following is covered within these Parent Impacts:

- Drought Includes the effects of: lower levels of rainfall, reduced levels of groundwater and soil moisture, lower levels of infiltration
- Temperature Rise Includes the effects of: higher peak and average temperatures, increased evaporation and evapotranspiration
- Flooding Includes the effects of: increased summer and winter rainfall, greater storm intensities, higher groundwater levels, increased soil moisture
- Sea Level Rise/Storm Surge Includes the effects of global sea level rise, gocal storm surges

- 7) Impacts have been mapped against seven water company asset groups: Water Resources, Water Treatment, Water Network, Waste Water Network, Waste Water Treatment, Sludge, Site Wide Services. They are shown in rows under the appropriate heading.
- 8) Within each group, impacts affecting ALL assets within an asset group (eg all Water Resources assets) are shown against the 'All' row. This impact is not repeated at sub- group level
- 9) Impacts affecting only specific assets within an asset group (e.g. raw water pipelines) are shown against the row of the affected sub-category

### Box 4: General Notes on Climate Change Impacts

It is crucial to clearly separate 'climate change impacts' from 'adaptation response options'; in this project, an 'impact' has been identified as the action that climate change has on water company assets. This does not include any subsequent response from the asset or asset operators. Thus '*increases in OPEX/CAPEX and asset maintenance requirements*' are not impacts but responses, as these involve a water company decision; in this case, to respond to the impact of accelerated asset deterioration through increasing OPEX/CAPEX spend.

In general, Drought, Flood and Temperature Rise impacts may involve three different kinds of risk – higher or lower averages, more extremes, and a wider range of variability. Sea level rise has a single component, which may be compounded by a range of more extreme 'surge' components.

Temperature Rise is another general impact risk affecting most assets. Several different Temperature Rise impacts may affect a given asset group; for example, in water treatment works, buildings, MEICA plant working life and process performance are affected.

Within Water Resources, the impacts numbered D2, T2, T3, T5, F3, S2 can all cause changes in demand (location and size) due to climate change effects, impacting the supply–demand balance. The adaptation response options chosen to deal with these will then determine what 'growth' (location and size) changes are needed in subsequent asset groups. In subsequent groups this affect has been combined into a single 'G1, G2, G3, G4, G5, G6' impact, shown in the Drought column.

## 7. TABLE 2: ADAPTATION OPTIONS IN RESPONSE TO CLIMATE CHANGE IMPACTS

### 7.1 Aim

The aim of Table 2 is to:

- 1) Associate climate change impacts with potential adaptation response options
- 2) Identify whether each adaptation response option has potential adaptive characteristics of 'no regrets', 'low regrets', 'win-win', or 'flexible/adaptive'
- 3) Identify information sources of use in understanding each adaptation response option

### 7.2 Table Description

- 1) This table matches the impacts shown in Table 1 with potential adaptation response options
- 2) As in Table 1, impacts have been grouped into seven separate tables to show the water company asset affected, using asset groups at Asset Level Hierarchy 3.

#### 7.2.1 Consequence Grouping

- 3) Within each asset group table, each impact has been classified with impacts of a similar *Consequence*. *Consequence* is the final part of the impact description text, shown in bold (e.g. **affects security of supply**).
- 4) These *Consequence* groupings are shown by the *Consequence* sub-headings within each asset group table (e.g. Consequence: Supply-Demand Balance affected)

#### Box 5: Impact *Consequence* Groups

Each impact has been classified with impacts of a similar *Consequence*. The *Consequence* Groups shown in Table 2 are:

- **Supply–Demand Balance**
- **Service Performance affected.** These impacts *directly* affect the main service performance function of the group. These involve conveying flows (Quantity), and providing the correct hydraulics (including pressure) and processes (Quality). Examples for waste water networks are: 'urban and sewer flooding' and 'sewage or receiving water quality'.
- **Asset damage/failure.** These impacts affect service indirectly, through asset condition, to cause asset damage or failure of structure or MEICA plant.
- **Staff H & S issue.** Because many of these impacts/responses in each group are the same, all general Staff H & S impacts are shown in the '*Site Wide Services*' sub-table.

- 5) Within each *Consequence* group table, the potential adaptation response options for the impacts contained are shown to the right.

#### 7.2.2 Adaptation Response Options

- 6) The *Impacts Addressed* column provides information on the adaptation response options which address **all** impacts in a *Consequence* group and the options addressing only specific impacts
- 7) If 'All' is present in the *Impacts Addressed* column, then all impacts in a *Consequence* group are addressed
- 8) Each adaptation response option is assessed to identify some potential adaptive characteristics: whether it is no-regrets, low-regrets, win-win, and/or flexible/adaptive.

### 7.2.3 Information Sources

- 9) The final column in Table 2 provides reference numbers for information sources of use in understanding an adaptation option. These numbers refer to sources described and assessed in Table 3

## 7.3 Table 2 Column Descriptions

### 7.3.1 Impact Description

- This column lists the impacts shown in Table 1. They retain the same unique number, and the same coloured scoring
- They are listed under the same Asset Hierarchy 2 groups as in Table 1
- The Asset Hierarchy Level 3 column shows the Asset Hierarchy 3 sub-group an impact affects, or show 'All'.

#### Box 6: Adaptation Response Options for 'All Assets'

There is an 'All Assets' section at the end of Table 2. This identifies response options and information sources relevant to all impacts on all asset groups. This includes 'Investment Solution appraisal' options. These are additional climate change issues to be considered during option appraisal as part of Investment Selection. These are generally common to all impacts and responses.

### 7.3.2 Response Description & Impacts Addressed

- This column shows potential adaptation responses to all climate change impacts within a given *Consequence group* for each Asset Hierarchy level 2 asset group (e.g Water Resources)

#### Box 7: Classifying Adaptation Response Options

Because of the extended timescales and uncertainties involved in climate change adaptation response, it is suggested that preparedness, monitoring and planning are useful adaptive responses. So, adaptation response options are classed as Capability, Plan or Action

- **Capability:** involves building models and monitoring trends to understand changes, make predictions and test scenarios
- **Plans:** using models and data to try out alternative options, and finalise an adaptive plan. Where new options are to be considered, part of this plan is likely to need pilot-scale trials.
- **Action:** implementing the plans. This may include 'hard' engineering and 'soft' measures too, such as demand management and stakeholder dialogue.

- Adaptation Responses are not row-specific, they are *Consequence group*-specific
- The *Impacts Addressed* column details the impacts addressed by a given adaptation response option. If 'All' is present, then all impacts in a Functional Consequence group are addressed.

### 7.3.3 Identifying adaptive characteristics

- This column identifies some potential adaptive characteristics for each adaptation response option: whether it is no-regrets, low-regrets, win-win, and/or flexible/adaptive (see Fig 4). It does not attempt to consider any other criteria for adaptation option choices.

| Response Description  | Impacts Addressed       | Adaptive Characteristics |                |            |                              | Info Source Refs |
|---|-------------------------|--------------------------|----------------|------------|------------------------------|------------------|
|   |                         | NR No Regrets            | LR Low Regrets | WW Win-Win | FA Flexible/ Adaptive Mngmnt |                  |
| <b>Capability:</b> 1. Monitor and analyse temperature, UV, flood and sea level rise trends rise re: risks to staff. | <b>M &amp; G</b><br>All | Y                        |                |            | Y                            |                  |
| <b>Plan:</b> 2. Re-assess H&S plans in the light of all types of CC impacts   | All.                    |                          | Y              |            |                              |                  |
| <b>Action:</b> 3. Protect Health and Safety of indoor and outdoor workers through training and provision on PPE     | All.                    | Y                        |                |            | Y                            |                  |

Fig 4 – The identification of adaptive characteristics

- This identification of adaptive characteristics adds to, and does not replace, existing risk assessment or investment selection decision-making processes. At this generic level, it is inevitably subjective.

#### Box 8: Assessing Adaptation Response Options – UKCIP Criteria

The processes of Risk Assessment and Investment Selection will be applied when any adaptation response has been included within an investment solution.

The *assessment of adaptive characteristics* shown in Table 2 makes a preliminary assessment of each possible response on the basis of the particular climate challenges (timescale, uncertainty, the need for mitigation as well as adaptation) that make decision-making harder. It uses the UKCIP ‘Identifying Adaptation Options’ criteria (pp16-18) [Table 3, Ref 221] to identify potential adaptive characteristics, using the following terms:

- No-regrets (NR): response option is worthwhile whatever the extent of future climate change
- Low-regrets (LR): although benefits may be uncertain, relative costs are low, and relative benefits are large
- Win- win (WW): response option has other social, environmental, or economic benefits, possibly including climate change mitigation, as well as adaptation. [Y = likely win-win; blank = no impact, or depends upon detail; N = potentially negative impact, within this definition]
- Flexible or Adaptive Management (FA): this option reduces the risk of over-adaptation, and allows new information to inform responses as it becomes available

#### 7.3.4 Information Source Reference

- This column provides reference numbers for information sources of use in understanding an adaptation option
- These numbers refer to sources described and assessed in Table 3

### 8. TABLE 3 – INFORMATION SOURCE ANALYSIS

The aim of Table 3 is to identify and summarise information sources of use in understanding climate change impacts and potential adaptation response options.

## 8.1 Table Description

- 1) This table describes and assesses the information source references provided in Tables 1 and 2
- 2) The information source reference is shown in the 'Ref' column, and where possible a hyperlink to the information source has been provided.
- 3) A description of the source function and approach is provided
- 4) The source has been assessed by industry experts, and has been classified as either Essential, Useful or Background in understanding the relevant impacts or adaptation response options
- 5) Where relevant, additional comments have been provided

### **Box 9: Information Sources**

For some impacts and adaptation response options, no specifically climate change- related information sources have been identified. This may not constitute a 'gap'; it may be that assessing climate change impact risk, and appropriate responses, does not require specifically climate change-related approaches or information. These may be covered by other standard Water Sector methods, for instance, The Common Framework.

However, in some cases, there may be a real data, tool or regulatory gap. Then it is necessary to track the expected outputs of ongoing R & D, to decide and declare 'holding' assumptions, and be ready to amend AMPs when the new information becomes available. It may also be that there is no current or planned, R & D programme to fill the gap. This suggests the need for more R & D work.

The assessment of current R & D, and identification of such gaps, with recommendations on filling them, is part of the on-going UKWIR CL/01 study, which follows on from this project.