South East Climate Change Partnership
A partnership of the public, private and voluntary sectors
President: Sir Crispin Tickell GCMG KCVO
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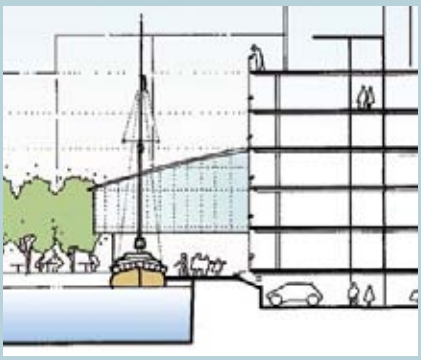
Sustainable Development Round Table
for the East of England

LONDON climate change PARTNERSHIP

# Adapting to climate change impacts - A good practice guide for sustainable communities



October 2006

This guidance is an output of a research study commissioned by Defra and the Three Regions Climate Change Group (South East Climate Change Partnership, Sustainable Development Round Table for the East of England, and the London Climate Change Partnership). The study was undertaken by Land Use Consultants, Oxford Brookes University, CAG Consultants and Gardiner & Theobald.

The study team comprised:
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Oxford Brookes University – Elizabeth Wilson and Rajat Gupta
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The guidance should be referenced as:
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October 2006

Front cover images:

Left Bloomsbury Square, London. Land Use Consultants.
Centre Queenborough & Rushenden Masterplan. Rummey Design Associates.
Right River Trent floodplain, 2000/01. Rob Wiley, Environment Agency.
Bottom Derwent Reservoir, 1995. Rob Wiley, Environment Agency.

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# Foreword

Climate change represents one of the greatest challenges facing humanity over this century. To meet this challenge we have to reduce our emissions of greenhouse gases. We must also recognise that some climate change is now unavoidable so we need to start adapting now to the predicted impacts we are likely to see in the future.

Over the next twenty years a significant amount of new housing will be required in the UK, and particularly in the south east, London and the east of England. The government's response, as set out in the Sustainable Communities Plan, is to develop integrated communities at appropriate sites across the three regions. These new developments will stand for many decades. It is therefore vital we think from the outset how buildings and infrastructure can be adapted to cope with the climate they are likely to experience over their lifetime.

This guidance sets out the climate change adaptation issues that planners and developers should consider at each stage of the development process, and ways to respond to them. It will help planners and developers implement current planning guidance, including Planning Policy Statement 1: Delivering Sustainable Communities. It links up with the government's wider approach to climate change adaptation as an output of Defra's cross-regional research programme as well as with our own Adapting to Climate Change: A Checklist for Development.

Through use of this document we can help ensure that the new communities we construct are truly sustainable - that they remain comfortable, safe and attractive places for many decades to come.

Gerry Acher CBE LVO

Chair of London Climate Change Partnership

John Rumble

Chair of Climate Change Steering Group, East of England Sustainable Development Roundtable

Graham Tubb MBE

Chair of South East Climate Change Partnership

**Adapting to climate change impacts – a good practice guide for sustainable communities**

Action is needed now to ensure new homes and businesses can cope with predicted changes in climate. Planners and developers are at the centre of this process.

The UK Climate Impacts Programme (UKCIP) predicts significant changes in climate for the 2020s, 2050s and 2080s, all within the design life of the average home. There is a clear argument for the need to take account of climate change in planning and development decisions. It is a requirement of national planning policy, and must be taken forward at the local level.

This guide provides advice on how to take account of the predicted impacts of future climate change when planning new developments. This document is not a statement of government policy but is designed to inform policy making. While it identifies climate change issues associated with different types of location, the guidance focuses on site level decision making for climate change adaptation in site layouts and building design.

The guide is designed for use by all those involved in area and site level policy making, decision making, funding and development. It has been produced with particular reference to three case study sites in the Growth Areas in England, in Bedford, London and Kent, but it is equally relevant to development in other parts of the UK.

The guide is designed to sit alongside 'Adapting to climate change: a checklist for development' published in 2005 by the Three Regions Climate Change Group.

**Part 1** of the guidance summarises the impacts climate change will have on development in the Growth Areas and beyond. In considering climate change and development budgets, the business case for adapting to climate change and the risks and opportunities of adaptation are set out.

**Part 2** applies the UKCIP 'Risk, uncertainty and decision making framework' to planning policy and development decisions. It provides guidance on how to select appropriate ways of adapting to climate change in response to development objectives, the risks associated with climate change impacts which will vary according to the location, and other local criteria. A key message is to choose ways to adapt which will have benefits for other sustainability objectives. This means ensuring adaptation measures do not contribute to additional carbon emissions, but do contribute to enhanced biodiversity, enhancement of the public realm, and regeneration, for example.

**Part 3** provides generic guidance for developers and planners on planning and development responses to climate change impacts. It focuses on how to integrate the need to adapt to climate change into planning policy, the location of development, site layout and building design, issues to address and examples of possible adaptation responses. Some of the cost and benefit considerations relating to adaptation at the location, layout and building scale are explored.

Finally, **Part 4** provides examples of how mixed use developments in town and city centres and as urban extensions can adapt to climate change impacts. It illustrates how the three case study schemes are seeking to adapt to climate change, as well as other adaptation measures which could be considered.

Part 1

# Introduction to the guidance and the need to adapt to climate change

# 1.1 Purpose of the guidance

### Background

This guidance is the product of a research project commissioned by **Defra** and the **Three Regions Climate Change Group** to consider what practical climate change adaptation measures can be taken by those involved in delivering the Sustainable Communities Plan[1] Growth Area agenda, at the development project scale.

### Climate change adaptation

Climate change adaptation means responding to actual or expected climate changes or their effects, to reduce harm or exploit beneficial opportunities[2].

### Purpose of the guidance

This document provides guidance on how to take account of the predicted impacts of climate change, including increased temperatures, flood risk and water resource shortages, when planning developments.

While it identifies climate change issues associated with different types of locations, the guidance focuses on site level decision-making for climate change adaptation during masterplanning (layout), and building design. It provides a framework for assessing climate change risks and for appraising adaptation options. Examples are provided to show how development can be adapted to climate change impacts in ways which will not increase greenhouse gas emissions.

### Why should developments be adapted for climate change?

- Taking climate change impacts into account in the location and design of development is a requirement of national planning policy, including Planning Policy Statement 1: Delivering Sustainable Development.
- Action is needed now because the climate is already changing – past greenhouse gas emissions have already determined many of the changes predicted for the next 30-40 years[3]. Action is also needed to plan for the future to anticipate longer term changes.
- Developments will need to be able to cope with the changing climate during the whole of their design life. Consideration of adaptation from the outset, and as part of regular upgrades and reviews helps to reduce risk, minimise costs and make the most of opportunities arising from climate change.

### Who is the guidance for?

The guidance is for all those involved in area and site level policy making, decision-making, funding and development e.g. developers, architects, their design teams and planning advisers, planning officers and councillors, delivery and funding bodies.

The guidance has been produced with particular reference to the Growth Areas in England but it is equally relevant to development in the rest of the UK.

### How should the guidance be used?

The guidance is designed for use in policy making e.g. for local development documents and in the preparation of development briefs, and masterplans. It is also for use by developers in putting forward their own masterplans and detailed development proposals, and to inform pre-application discussions. The guidance should be used from the earliest stages from deciding development location and layout design through to implementation and monitoring.

### How this document relates to other guidance

This guidance sits alongside **Adapting to climate change: a checklist for development** published by the Three Regions Climate Change Group[4] and illustrates ways of applying the checklist. It is referred to as 'The Three Regions Checklist' in this guidance. The summary checklist can be found at **Appendix 3**.

The guidance is structured around the **Risk, uncertainty and decision-making framework** developed by the **UK Climate Impacts Programme (UKCIP)**[5] and shows how this tool may be used to identify appropriate adaptation measures.

A **case study report**[6] documents the choice of case studies, the application of the UKCIP framework, examples of adaptation mesures and how the study contributed to the policy and development process at each site.

## 1.2 Stucture of the guidance

**What does the guidance contain?**

- The guidance is structured around and provides illustrative examples of how to use existing tools and advice to consider adaptation options.
- It illustrates what adaptation measures could look like on the ground.
- It shows how climate change adaptation should be integrated with wider sustainability considerations, including climate change mitigation, protecting and enhancing biodiversity, regeneration and improving health.
- It addresses the cost and benefit implications for developments of adapting to climate change, together with considerations for funding bodies and for organisations seeking finance for developments.
- It provides advice on the process of considering climate change adaptation options.

**Structure of the guidance**

**Part 1: Introduction** - The remainder of the introduction provides background on climate change and its likely impacts on development in the Growth Areas and beyond. It also sets out the case study sites used as examples throughout the guidance to illustrate approaches to adaptation.

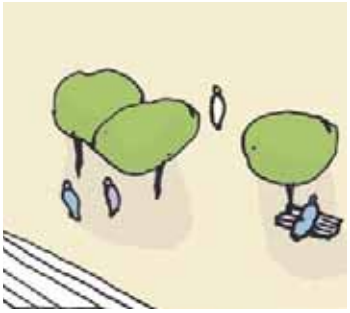
**Part 2: Deciding how to adapt to climate change - Part 2** is structured around the UK Climate Impacts Programme Risk, uncertainty and decision-making framework. It provides worked examples of how to consider climate change impacts on development proposals through risk assessment and how to identify appropriate adaptation options.

**Part 3: Planning and development responses to a changing climate** - focuses on how planners and development teams should integrate climate change adaptation into planning policy, locating development, site layout and building design.

**Part 4: Case studies** - illustrates the climate change issues associated with the three case study site locations, and provides examples of adaptation measures that could be used as part of the site layout and building design.

Examples of adaptation measures that are discussed in **Part 4** of the guidance.

Cafés along the waterfront promenade



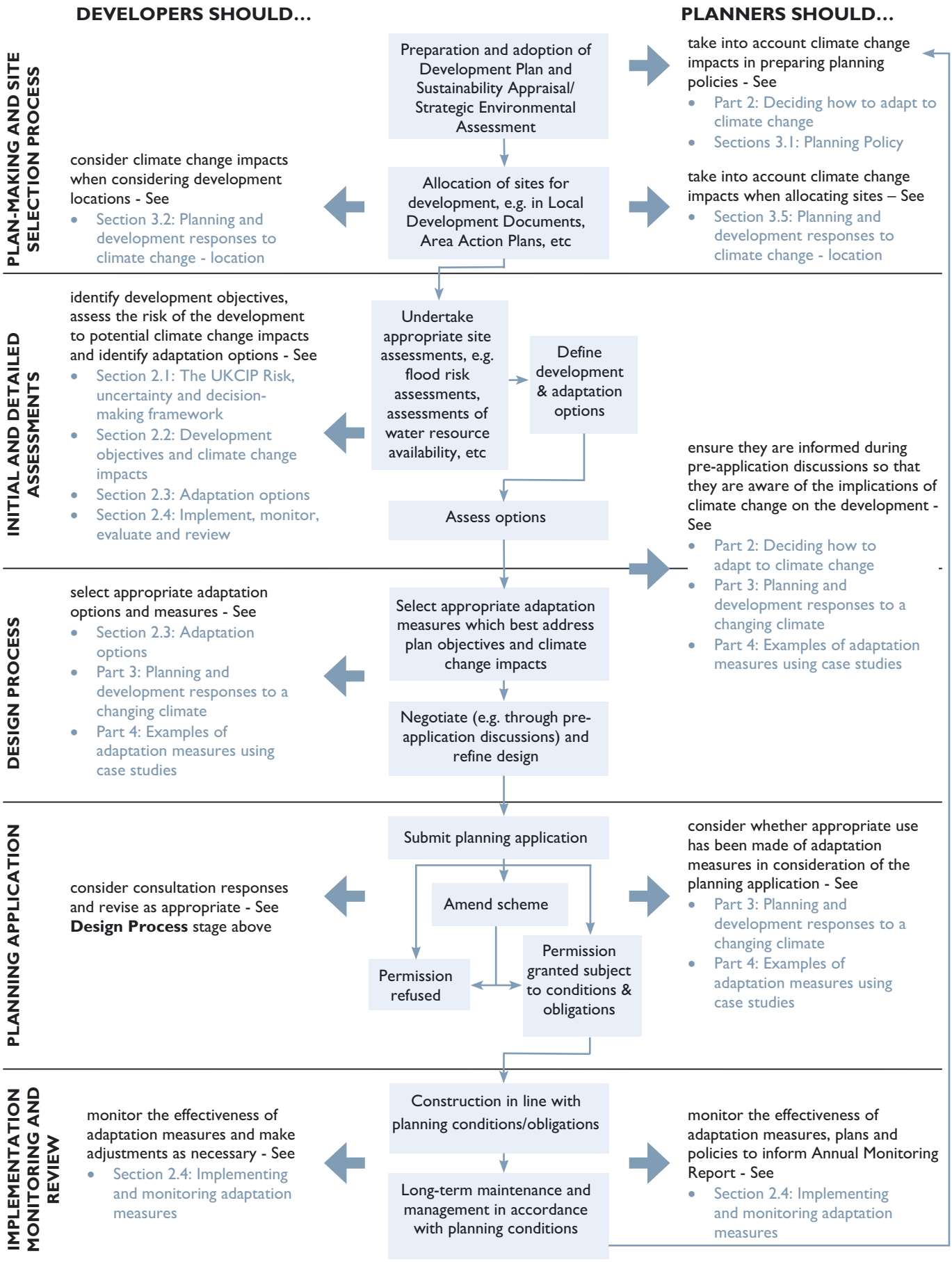
Use of trees to provide shading

**Finding your way around the guidance**

It is recommended that guidance users consult the full document through all stages of the planning and development process. However, some sections will be more relevant than others depending on the nature and stage of the development they are involved in. The diagram opposite breaks the planning process down into five key stages. It highlights the most relevant Parts and Sections of the guidance to each stage of the planning process depending on whether the user is involved in the development or planning side of the project.

A signpost image is used where cross references are made between different Parts or Sections of the guidance.

## THE PLANNING PROCESS



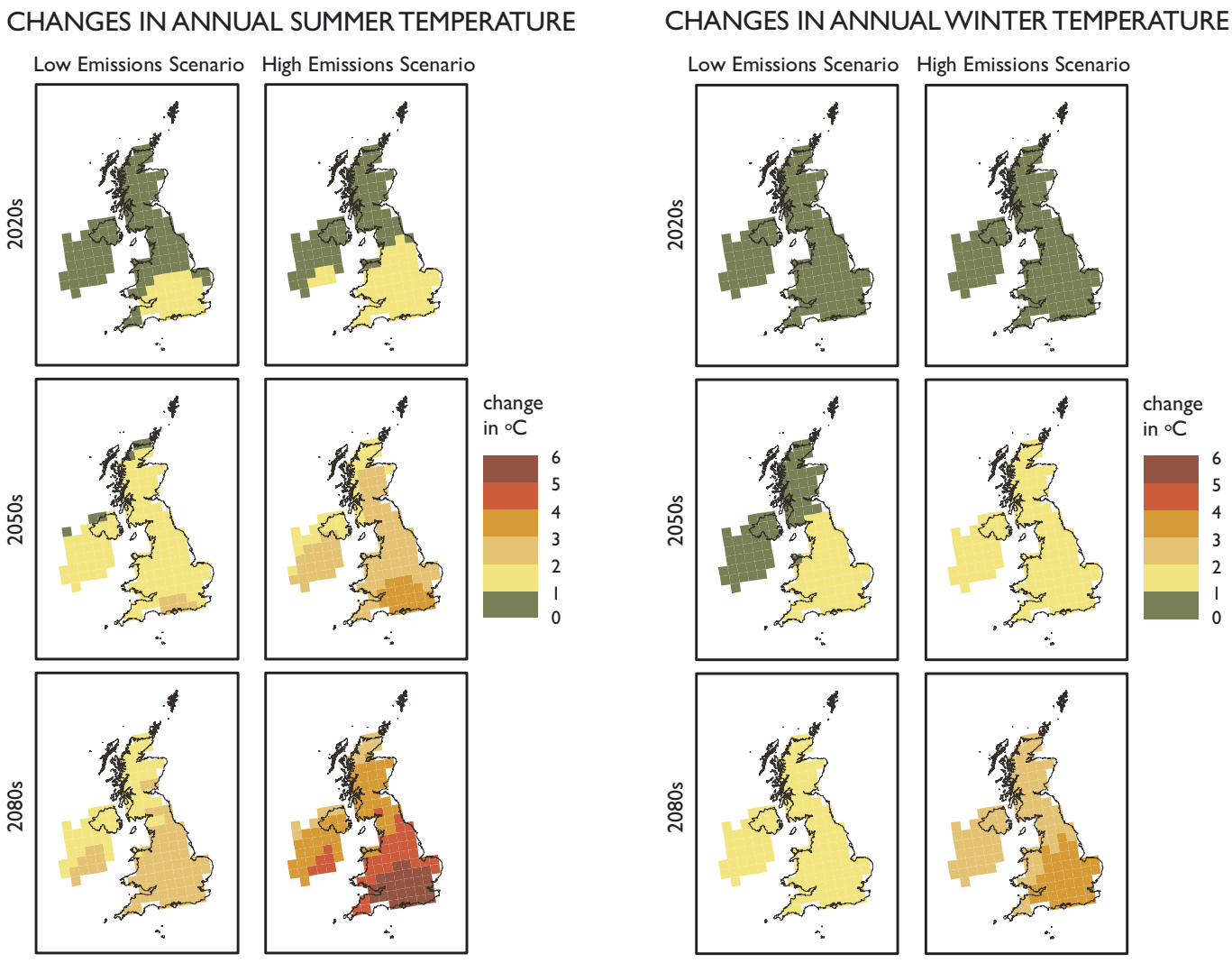
## 1.4 How will climate change?

All parts of the UK will experience significant changes in climate over this century. These changes can be summarised as:

- Hotter drier summers.
- Milder wetter winters.
- More frequent extreme high temperatures.
- More frequent extreme winter precipitation.
- Significant decreases in soil moisture content in the summer.
- Net sea level rise and increases in sea surge height.
- Possible higher wind speeds.[3]

The south and east of England will experience the most dramatic changes in climate. Those managing developments in the Growth Areas will therefore need to be particularly aware of the likely impacts climate change will have. The figures below show the predicted temperature rises for the UK. This shows that the nature of changes in the region's climate will depend upon the extent to which global greenhouse gas emissions increase or reduce in the future. The low emissions scenario assumes that global emissions of carbon dioxide will fall below today's levels by the 2080s. The high emissions scenario assumes that carbon dioxide emissions will increase at a faster rate than current trends until the 2080s, at which point emission rates will be approximately four times today's level. Some anticipated changes can be predicted with a high degree of confidence. Others are less certain but are best estimates based on current information and modelling techniques.

**Predicted summer and winter temperature increases for the UK**




Source: UKCIP02 Climate Change Scenarios (funded by DEFRA, produced by Tyndall and Hadley Centres for UKCIP [3])

The predicted climate changes for the South-East region are summarised in **Table 1.1** below. Summaries for the other Growth Area Regions (East of England and London) can be found at **Appendix 4**. Information for the rest of the UK can be found on the UKCIP website (www.ukcip.org.uk), and will be updated in 2008 as 'UKCIP Next'.

**Table 1.1: Anticipated climate changes in the South-East of England under the low and high emissions scenarios**

| Anticipated climate changes | Relative confidence level | Specific changes in the South-East of England | |
|---|---|---|---|
| | | Low emissions scenario | High emissions scenario |
| Increasing summer temperatures | High | 2020s: 1-1.5°C<br>2050s: 1.5-2.5°C<br>2080s: 2.5-3.5°C | 2020s: 1-1.5°C<br>2050s: 3-3.5°C<br>2080s: 4.5+°C |
| Increasing winter temperatures | High | 2020s: 0.5-1°C<br>2050s: 1-1.5°C<br>2080s: 1.5-2°C | 2020s: 0.5-1°C<br>2050s: 1.5-2°C<br>2080s: 3-3.5°C |
| More frequent extreme high temperatures | High | Increase of up to 14 'extremely'* warm days in summer by the 2080s** | Increase of up to 30 'extremely'* warm days in summer by the 2080s** |
| Less extreme low temperatures | High | Fewer frosts, long runs of snowless winters | |
| Increasing winter rainfall | High | 2020s: 0-10%<br>2050s: 0-15%<br>2080s: 10-20% | 2020s: 0-10%<br>2050s: 15-20%<br>2080s: 25-30+% |
| Reducing summer rainfall | Medium | 2020s: 10-20%<br>2050s: 20-30%<br>2080s: 20-40% | 2020s: 10-20%<br>2050s: 30-40%<br>2080s: 50+% |
| Increases in winter precipitation intensity | High | By the 2080s, 10-20% increase in the daily precipitation amount which can be expected, on average, once every 2 years** | By the 2080s, 20+% increase in the daily precipitation amount which can be expected, on average, once every 2 years** |
| Potentially an increase in frequency of winter storms | Low | Increase in the number of winter depressions resulting in a strengthening of winter winds | |
| Reduction in soil moisture content | High for summer changes | In summer, reduction of 10-30% by the 2080s** | In summer, reduction of 30-50% by the 2080s** |
| Sea level change | Medium | Net sea level rise of approximately 19cm by the 2080s** | Net sea level rise of approximately 79cm by the 2080s** |
| Extreme sea levels (storm surges) | Low | Coast around the South East will experience an increase in 50-year return surge height of up to 1m by the 2080s** | Coast around the South East will experience an increase in 50-year return surge height of up to 1.4m by the 2080s** |

* 'Extremely' warm days are defined using the 90th percentile daily average temperature modelled for the baseline period 1961-1990, i.e. the daily average temperature which is exceeded, on average, on 10% of days.

** Data only available for the 2080s in the UKCIP02 Climate Change Scenarios.

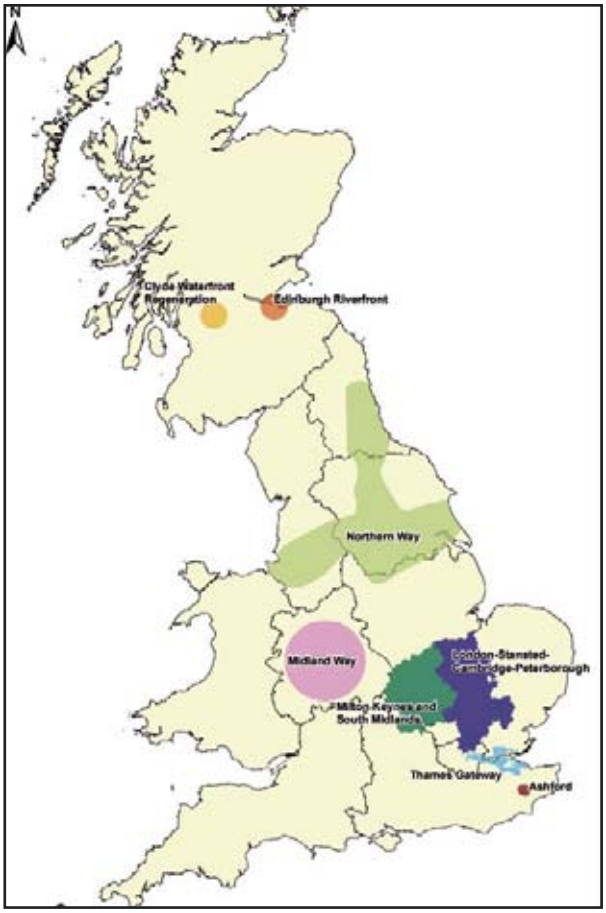
## 1.5 Potential impacts on development

This document provides guidance on how to take account of predicted climate changes when planning developments. The long term action plan to deliver strategic development in England is set out in the Sustainable Communities Plan[1]. It aims to tackle problems of housing supply in the South East through the identification of four Growth Areas, to address low demand for housing in parts of the North and Midlands through the Pathfinder Programme, and to improve the quality of housing and public spaces. Whilst this guidance has been prepared with particular reference to the Growth Areas, it is transferable to other development projects throughout the UK.

### Sustainable Communities in the Growth Areas

The Sustainable Communities Plan seeks to deliver development with associated infrastructure improvements in four Growth Areas in Southern England. The locations of the Growth Areas are shown on the map to the right and plans for their development are described below:

- **Thames Gateway:** 120,000 homes by 2016, of which 60,000 would be built in London and 180,000 jobs.
- **London-Stansted-Cambridge-Peterborough:** 129,000 homes by 2016. 26,000 jobs in North London by 2016, and 57,400 jobs in the remainder of the Growth Area by 2021.
- **Milton Keynes / South Midlands:** 170,000 homes and jobs by 2016 and up to 300,000 jobs by 2031.
- **Ashford:** 31,000 homes and up to 28,000 jobs by 2031.




Land Use Consultants, 2006 (Source: ODPM (2004 and website))

### Development beyond the Growth Areas

There is significant development planned in other parts of the UK to which this guidance will be relevant. This includes:

- **The Northern Way:** Led by Yorkshire Forward, One North East and the North West Regional Development Agency[7].
- **The Midlands Way:** Led by Advantage West Midlands and the East Midlands Development Agency[8].
- **Edinburgh Forthside:** Redevelopment of large areas of brownfield land by Forth Ports.
- **Clyde Waterfront Regeneration, Glasgow:** Enhancing a 30 kilometre stretch of the river.

### Effects of climate change on this development

Climate change will have a number of impacts on development, which should be taken into account when planning and designing development projects. These are summarised in **Table 1.2**.

**Table 1.2: Potential impacts on development**

| Climate change | Impact on development |
|---|---|
| • Hotter, drier summers<br>• More frequent extreme high temperatures<br>• Reduction in soil moisture content | • Reduces thermal comfort within buildings and outdoors leading to heat stress, health problems, reduced productivity and a shorter design life for buildings which are not adapted.<br>• Water resource shortages for both supplies and treatment may limit the capacity of some areas to accommodate development.<br>• Increased risk of subsidence in areas with clay soils and geology, and potential problems of insurance cover. |
| • Warmer, wetter winters<br>• More frequent extreme winter precipitation<br>• Net sea level rise and increase in sea surge height | • Increased flood risk, particularly in winter, increased flood damage to buildings and infrastructure, with associated costs and potential problems of insurance cover.<br>• Increased risk of damp and mould affecting buildings. |
| • Possible higher wind speeds | • Increased risk of damage to buildings, infrastructure and vegetation from high winds and driving rain. |

## 1.6 Climate change adaptation and development budgets

The cost implications of climate change will affect different developments to different degrees, based not just on the vulnerability of an area to changes in weather patterns but also on whether a developer or public sector agency intends to occupy, manage or own a development following construction. Such factors therefore need to be included in any evaluation of the overall economics of a development. The costs and benefits of adapting to climate change are considered at the strategic level in a recent Defra funded study by Risk Solutions Consulting Ltd (in partnership with AEA Technology and Metroeconomica)[9]. This guidance focuses on project level benefits and costs.

Incorporating climate change adaptation into the design of a development can, in some cases, incur a negligible or manageable cost to developers, managers or users of the development, and may result in a financial benefit (see **Box 1.1** below). However, in other cases, including adaptation measures will impact on the profitability of the scheme. On sites where economic viability of development is already marginal this is likely to have a significant impact on determining whether adaptation is carried out, and whether a scheme goes ahead. Factors such as local land values, the type of adaptation required, and whether any costs can be passed on to users of the development, will contribute to these decisions. The costs and benefits associated with many adaptation measures are project specific and are therefore considered in generic terms in this guidance.

### Opportunities and risks associated with adapting to climate change

Deciding **not** to adapt to climate change also has potentially significant cost implications, for example:

- The impact of future weather events on buildings and infrastructure and on the management and maintenance of the development.
- The possible threat of litigation against those developers that did not take on board climate change issues leaving building occupiers and managers exposed to climate change impacts and additional risk.[10]
- The implications of a changing climate for the insurability of properties.[11]
- The cost of the energy required to make buildings comfortable in a low carbon future with high electricity costs.
- Disruption to supply chains and productivity.
- Aggravation of the urban heat island effect through increased heat dumping from air conditioning.
- Additional cost of retro-fitting adaptation measures at a later date.

### Retro-fitting adaptation measures

Based on commercially recognised principles, it is likely that the relative costs incurred in retro-fitting adaptation measures at a future date will be some 10-20% higher than if these works were incorporated into the base scheme, due to:

- Remobilisation of contracting organisations – site set up and management.
- Insurance for working in and around existing buildings.
- Inefficiencies of working around established businesses and the public.
- Building cost inflation.
- Removal of abortive installation works.

**Adapting to climate change: a checklist for development** sets out the key opportunities and risks associated with adapting to climate change. These are summarised in **Box 1.1**.

**Box 1.1: Opportunities and risks associated with climate change adaptation**

**Opportunities**

- Financial – higher future asset values.
- Access to funding – e.g. through Socially Responsible Investor Funds who may require good environmental performance.
- Marketing – adapted buildings will be easier to sell or let; develop market leader position; competitive edge.
- Better risk management by reducing potential liabilities .
- Staff retention – premises will be more comfortable in hot weather, and staff more productive.
- Assist innovation and creativity in the building industry.

**Risks**

- Financial and operational – problems selling or letting and higher management costs.
- Failure to meet consumer expectations.
- Failure to anticipate requirements of legislation resulting in need for remedial action in the future.
- Damage to reputation.
- Increased insurance premiums and claims.
- Loss of productivity due to working conditions.
- Possible litigation for failing to take into account future known risks.

For more information on benefits and costs associated with location, site layout and building design, see **Part 3.**

## 1.7 The case study sites

The guidance uses three case study sites within the Growth Areas to illustrate ways of adapting to climate change. The locaion of these case studies are shown on the map below. Each site is an example of a generic development type and can be used to translate lessons across the UK.

The three case studies are grouped into three generic development types:

- **Town Centres – Bedford Area Action Plan**
- **City Centre Sites – Wood Wharf, London**
- **Urban Extensions – Queenborough & Rushenden Regeneration, Isle of Sheppy**

Each case study provides information on **Location**, **Site layout**, and **Building Design**.

Under **Location**, the issues relevant to climate change adaptation are identified for each site, including cost considerations. Examples of generic adaptation measures are provided.

Under the **Site Layout** and **Building Design** themes, adaptation options and measures are explored in more detail. These adaptation options and measures will also be applicable across the country to other examples of the three generic development types.

**Locations of the three case study sites**


Land Use Consultants, 2006 (source ODMP)

**Town centre regeneration: Bedford Town Centre Area Action Plan**

Bedford Borough Council (October 2005)

The Bedford Town Centre **Area Action Plan Preferred Option** (2005)[12] sets out key areas of change, transport and highway improvements and general policies for development.

The Town Centre West site is a key area of change. The existing site comprises high rise housing, a bus station, car park and shops. The redevelopment plans will create an extension to the primary shopping area, with a major foodstore, department store, shops, cinema and hotel, replacement and additional homes, open space and a new bus station.

The Council's preferred development partner is St Modwen Properties Plc. An outline application is expected in 2006.

| Climate change impacts: | Climate change opportunities: |
|---|---|
| • Fluvial flooding | • Outdoor living |
| • Water shortages | • Planting and landscape |
| • Higher temperatures | • Attractive retail environment |

### A city centre site: Wood Wharf, Isle of Dogs, Tower Hamlets, London

British Waterways London (December 2003)[7]

**Wood Wharf** is an 8 hectare brownfield industrial site between the Canary Wharf commercial centre and an area of existing housing. It is one of the few significant development sites remaining on the Isle of Dogs. A masterplan[13] was adopted as Supplementary Planning Guidance (SPG) in 2003 for a high quality high density mixed use development of 330,000sqm of commercial office space, 1,500 homes, retail and community facilities, in buildings ranging from 7-35 storeys, along with open space and a new canal.

The development will be carried out by the Wood Wharf Limited Partnership, a joint venture company whose partners are British Waterways (50%), Ballymore Properties (25%) and Canary Wharf Group (25%). The masterplanning architects are the Richard Rogers Partnership. An outline planning application is expected late 2006.

| Climate change impacts: | Climate change opportunities: |
|---|---|
| • Flood risk | • Landmark site |
| • Water shortages | • Proximity to water |
| • Heat island effect | • Dockside leisure opportunities |

### An urban extension: Queenborough and Rushenden Regeneration, Isle of Sheppey, Swale, Kent

Rummey Design Associates (2006)

This 165 hectare site lies between the settlements of **Queenborough and Rushenden** and is currently a mix of brownfield industrial land and greenfield farmland. The local area has been in economic decline since the 1960s. However the construction of the new River Swale crossing presents a major opportunity for economic, social and environmental regeneration. The mixed use development will comprise approximatly 2,000 homes, employment land and tourism opportunities with a focus on skills and enterprise.

The masterplanning process is being led by SEEDA. A development framework was adopted in 2004 by Swale Borough Council and a draft masterplan has been prepared by Rummey Design Associates (2005/6)[14].

| Climate change impacts: | Climate change opportunities: |
|---|---|
| • Flood risk | • Waterside location |
| • Transport and accessibility | • Integration of heritage, biodiversity and landscape |
| • Water resources | • Extensive new build of mixed uses |
| • Biodiversity | |
| • Higher temperatures | |

Part 2

# Deciding how to adapt to climate change

## 2.1 The UKCIP Risk, uncertainty and decision-making framework

### Taking climate change impacts into account

The UKCIP risk, uncertainty and decision-making framework[5] aims to support good decision-making in the face of the risks and uncertainties associated with climate change. Using the framework will help to identify where climate change impacts are a material consideration, and the decision is **climate sensitive**. Where decisions are climate sensitive, the framework will help to identify and appraise measures to reduce climate change impacts or exploit opportunities, i.e. adaptation measures. It provides a structured way to consider climate change and non climate change risks and uncertainties alongside each other, integrating the consideration of climate change impacts into a standard decision-making framework. The framework is particularly relevant to decisions on the long term use of land. It has been designed for flexible application to public and commerical decisions relating to policy, programmes and projects e.g. Regional Spatial Strategies, Local Development Frameworks and individual development projects.

### Examples of climate sensitive decisions

Where policies or developments may be directly or indirectly affected by climate change impacts they are **climate-influenced**. In other cases climate change may be the main reason for a policy or development (e.g. flood defence works) – these are **climate adaptation** policies and developments. Decisions to undertake developments which prevent or constrain future adaptation options should be avoided – these are known as **adaptation constraining** decisions, or **maladaptation**.

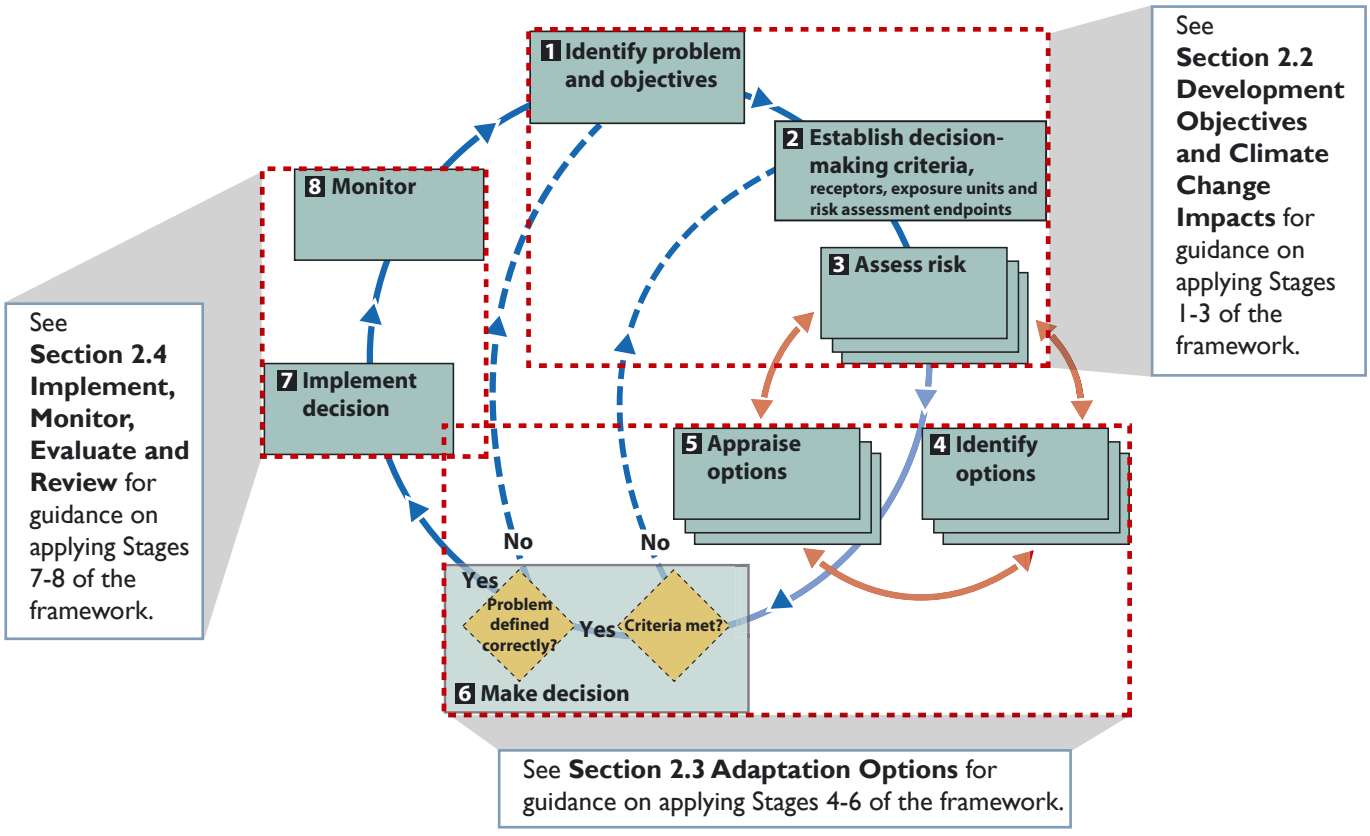
### Principles for good climate adaptation

The following principles have been developed by UKCIP and should be considered throughout the decision-making process[15].

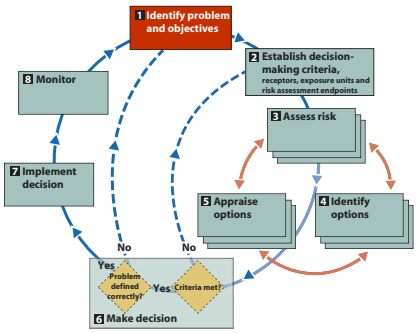
- Work in partnership.
- Keep a handle on uncertainty.
- Frame your objectives carefully before you start.
- Take a balanced approach to managing climate and non-climate risks.
- Focus on actions to manage priority climate risks.
- Use adaptive management to cope with uncertainty.
- Try to find no-regret adaptation options.
- Try to find win-win options.
- Avoid actions that will make it more difficult to cope with climate risks.
- Review your adaptation strategy regularly.

### The UKCIP Framework[5]

**Part 2** is structured around the UKCIP's Risk, uncertainty and decision making framework. It is organised into three main sections which group together the eight stages of the UKCIP framework. This is shown below:



## 2.2 Development objectives and climate change impacts



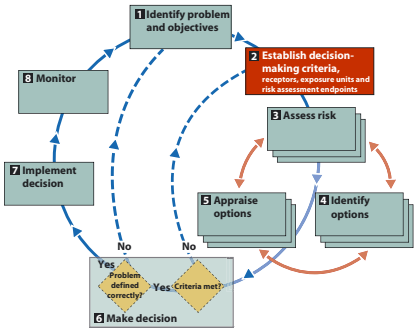

### Stage 1: Identifying plan / development objectives

| Developers should: | Planners should: |
|---|---|
| • Identify development objectives:<br>  • Identify the main drivers of the development (climate change itself or other drivers).<br>  • If climate change could impact on the development, identify how important climate change is relative to the overall development objectives.<br>  • Identify the design life and key stakeholders. | • Identify plan / policy objectives:<br>  • Identify the main drivers of the plan / policy (climate change itself or other drivers).<br>  • If climate change could impact on the plan / policy identify how important climate change is relative to the overall plan / policy objectives.<br>  • Identify the timescale for delivering the plan / policy and key stakeholders. |

Before evaluating the potential to integrate climate change adaptation measures into a new plan or development it is necessary to establish what the plan or development aims to achieve. The overall objective of the Growth Areas initiative is to provide new housing, jobs and infrastructure, creating sustainable communities. For area action plans and masterplans objectives may be more site specific e.g. to create a new retail quarter, regenerate a former industrial site, or to provide a new public square in a town centre. For most developments a core objective will be to ensure commercial viability.

At **Wood Wharf** in London, the overarching objective is to deliver a mixed use development of a scale and quality to complement Canary Wharf and contribute to the regeneration of the wider area. Underpinning this are more specific objectives including:

- To secure significant residential development.
- To develop a community focus and facilities that are appropriate to local needs.
- To create more varied employment opportunities than those displaced by the redevelopment of Wood Wharf.




### Stage 2: Identifying decision making criteria

| Developers should: | Planners should: |
|---|---|
| • Identify criteria to appraise adaptation options, informed by:<br>  • Development objectives.<br>  • Legislative / policy requirements (e.g. requirement for EIA, cost-benefit analysis, plan policies, sustainable building code, building regulations).<br>  • Organisation / decision maker attitude (e.g. to risk / uncertainty, business priorities, corporate social responsibility, resource availability).<br>  • Other factors e.g. timescale for development, design life, monitoring requirements, funding criteria (e.g. sustainability criteria).<br>• Identify risk assessment parameters (see below).<br>• Identify whether climate change impacts have been adequately considered at a more strategic level (e.g. masterplan). | • Identify criteria to appraise adaptation options, informed by:<br>  • Plan / policy objectives.<br>  • Legislative / policy requirements (e.g. requirement for sustainability appraisal / SEA, national / regional planning policy, statutory functions).<br>  • Organisation / decision maker attitude (e.g. to risk / uncertainty, community / stakeholder priorities, resource availability).<br>  • Other factors e.g. plan / policy timescale, monitoring requirements.<br>• Identify risk assessment parameters (see below).<br>• Identify whether climate change impacts have been adequately considered at a more strategic level (e.g. Regional Spatial Strategy). |

Once the objectives of the plan or development have been identified the next step is to consider how the objectives can be achieved in a way which ensures that what is planned is resilient to future climate impacts.

Planners and developers should define criteria to be used to appraise adaptation options for the plan, policy or development.

Factors having an impact on the choice of criteria may include:

- **Timescale of development –** if the masterplan for the development envisages the whole project taking 15 years to complete then it could be expected that the climate conditions during construction and on opening may already have begun to change, as is predicted in the UKCIP 2020 scenarios.
- **Anticipated lifetime of development –** if a development has an estimated lifespan of 100 years the need to include significant adaptation measures may be greater than if the development is only expected to be in operation for 50 years.
- **Attitude to risk –** a more risk averse attitude to development would be expected to lead to a greater emphasis being placed on considering climate change impacts.

An objective or outcome-led approach to selecting criteria will ensure the most appropriate adaptation options are chosen to achieve the desired objectives. This approach is illustrated by a worked example of selecting decision making criteria to compare adaptation options for development at Queenborough and Rushenden on the Isle of Sheppey (see panel below). The decision making criteria are grouped under two main development objectives which reflect the need to ensure both delivery of development, and the desired outputs of regeneration.

**Worked example of decision making criteria - Regeneration of Queenborough and Rushenden**

**Regeneration delivery criteria**

***Objective 1 - Facilitating regeneration:***

- Will the adaptation measures:
  a. Recognise and respond to development opportunities?
  b. Respond to development constraints, such as topography, flood risk, ecology, archaeology and history, contamination, highway infrastructure/capacity, and railway access?

***Objective 2 - Balancing costs of regeneration:***

- Will adaptation measures:
  c. Be financially viable, taking into consideration costs and benefits over the lifecycle of regeneration?

***Objective 3 - Integrating flexibility in light of future development uncertainties:***

- Will the adaptation measures:
  d. Ensure the 'saleability' of development once completed (due for completion in 2012) in a largely unknown housing market?
  e. Meet possible future policy developments?
  f. Allow the use of technology improvements as they become available?

**Regeneration output criteria**

***Objective 4 - Promoting a positive image:***

- Will the adaptation measures:
  g. Promote Queenborough and Rushenden as somewhere people want to live, work, invest in and visit?
  h. Promote the tourist industry in the area, particularly uses relating to yachting and sailing?
  i. Contribute to meeting development standards, such as BREEAM and CEEQUAL?

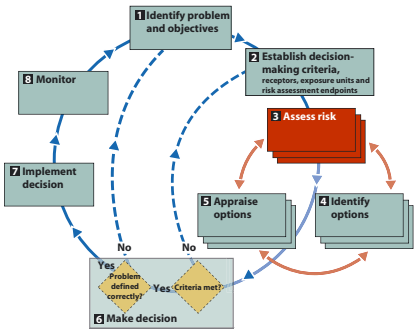
***Objective 5 - Maximising sustainable development:***

- Will the adaptation measures:
  j. Enable the use of renewable energy, the conservation of energy and the efficient use water resources?
  k. Protect and enhance biodiversity?
  l. Support economic and social sustainability?

***Objective 6 - Integrating new development into the local community:***

- Will the adaptation measures:
  m. Bring benefits to the existing residential and business communities?
  n. Retain employment uses whilst providing a catalyst for inward investment?
  o. Support the integration of regeneration in existing communities?

## 2.2 Development objectives and climate change impacts




### Stage 3: Considering climate change impacts through risk assessment

**Developers and Planners should:**

- Identify the lifetime of the plan or development to inform the choice of climate change scenario (2020s, 2050s, 2080s), using the latest scenarios from UKCIP.
- Identify which climate variables are likely to have impacts on identified receptors, development objectives and decision making criteria.
- Identify the significance and certainty of climate impacts (if possible).
- Identify if any climate impacts can be screened out (e.g. subsidence).
- Identify any non climate related risks that will affect the development.

A preliminary risk assessment helps ensure that all significant climate change impacts likely to affect an area or development site are identified early, and inform the choice of adaptation measures. To evaluate the risks, developers and planners will need to consider:

- The predicted changes to climate for the plan / development area – their magnitude, frequency and the level of certainty associated with the changes (See **Section 1.4** of this guidance – How will climate change?).
- The areas, habitats, people and infrastructure (or other receptors) likely to be affected by climate change impacts, whether these include vulnerable groups, and the significance of the risk to each.
- Evidence of existing vulnerability to climate change impacts.
- The risks associated with deciding not to adapt to climate change impacts.
- Any non-climate risks that are relevant to the decision of whether to adapt e.g. those associated with predicted socio-economic change (see **Box 2.1** below).

**Box 2.1: How future socio-economic scenarios may interact with climate change adaptation**

The consequences of changing climates will be influenced by economic, social and technological conditions, which may be very different from those of today. These conditions will have an effect on our vulnerability to climate change impacts, by influencing our 'adaptive capacity' – our ability to adapt to climate change impacts. UKCIP (2001)[16] describes four possible socio-economic scenarios, or story-lines: national enterprise, local stewardship, world markets and global sustainability. This work to consider how these scenarios may interact with climate change adaptation is being extended by the BESEECH study led by the Policy Studies Institute[17].

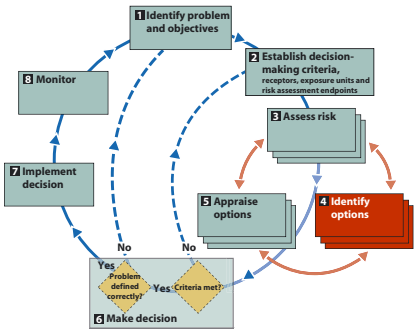
### Considering risk at the local level

Predicted changes in climate vary across the UK, and impacts will be influenced by local circumstances. For example; extremely hot summer temperatures were experienced close to Queenborough and Rushenden in summer 2003, and these are likely to become more frequent with climate change. There is also an existing risk from storm surges in the Thames Estuary which is likely to increase.

A worked example of how the risks associated with increasing summer temperatures could be considered is provided in **Table 2.1** (below), for development at Queenborough and Rushenden. This should be repeated for other identified receptors, and for other climate change elements which have been identified as being important locally, such as the increased frequency of storm surges.

**Table 2.1: Worked example to consider risks associated with increasing temperatures**

| Climate change element | Predicted change | | | Receptors that could be affected? | Nature of the risk | | Risk of not adapting (Significance) |
|---|---|---|---|---|---|---|---|
| | Magnitude | Frequency | Certainty | | Exposure | Vulnerability | |
| Increasing summer temperaures<br><br>(*continue for other climate change elements*) | High emissions scenario: over 4.5°C increase in temperature by the 2080s. | High emissions scenario: increase of 24-30 'extremely' warm days in summer by the 2080s. | High confidence associated with all anticipated changes in temperature. | People who live and work in the area.<br><br>(*continue for other receptors*) | High: Residents and employees are highly exposed but may be able to take shelter e.g. by staying indoors. | Medium-high: Vulnerability expected to be high for elderly and very young, and medium for others. | High: (potential for) heat stress in the elderly and very young, and reduced workforce productivity. |




**Stage 4: Identifying adaptation options**

**Developers and planners should:**

- Identify options for adaptation, taking into account:
  - Relevant climate change impacts identified in Stage 3 and their significance.
  - The degree of risk and uncertainty associated with selecting the preferred option.
  - Likely consequences of not adapting, or delaying a decision.
  - Whether 'quick wins', 'low / no regrets' and 'flexible' options can be identified.
  - Whether 'high resilience' options may be required.

When deciding whether and how to adapt a plan or development to climate change impacts it is important to consider alternatives to avoid the premature rejection of viable options.

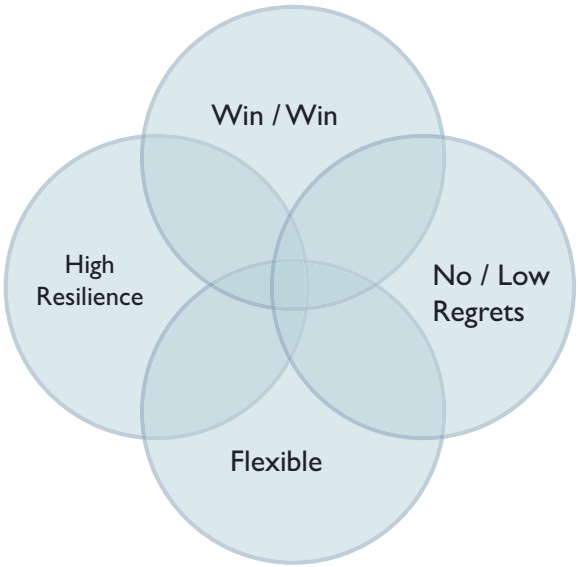
Appropriate adaptation **measures** (specific adaptation actions) should fall into one or more of the types of **options** in the **Table 2.2** below. The symbols against each type of option are used to categorise examples of adaptation measures in the case study examples in **Part 4** of this guidance.

**Table 2.2: Adaptation options**

| Adaptation Option category | Symbol | Description |
|---|---|---|
| Win / win | ✓ | Win / win measures deliver multiple benefits e.g. for economic development or wider sustainability as well as adapting to climate change. |
| No / low regrets | ☺ | No / low regrets measures deliver benefits now and in the future, whatever the extent of climate change. They may be low cost but have the potential of delivering high benefits. No / low regrets measures do not rule out options for further adaptation in the future. |
| Flexible | ⇝ | Flexible measures are part of an adaptive management approach – a sequential process of making the best decision at each stage, without constraining options for future adaptation. They may involve a staged response to adaptation to take account of current uncertainty. They may also include deciding to delay action, or deciding no action is necessary, but continuing to monitor the situation and review earlier decisions. |
| High resilience | ☂ | High resilience measures provide the ability to prevent or recover quickly from climate change impacts (e.g. buildings which are designed to cope with flooding of basements). |

**Adaptation measures can fall into more than one option category**

The Venn diagram below illustrates how adaptation measures may fall into one or more of the options, while **Box 2.2** provides examples of different types of adaptation strategies.



## 2.3 Adaptation options

UKCIP have identified a series of generic adaptation strategies which are useful in considering the most appropriate response. These are summarised in **Box 2.2**.

**Box 2.2: Adaptation strategies** (modified from Burton, 1996)[5]

Adaptation strategies may include:

- Share the cost of an impact (e.g. through insurance).
- Bare the cost (e.g. loss of coastal habitat).
- Prevention of effects through structural / technological measures (e.g. increase water storage capacity, construct resilient buildings, create wildlife corridors).
- Prevention of effects through legislative / regulatory / policy measures (e.g. planning policy takes account of climate change; amending design standards).
- Avoiding or exploiting changes in risk (e.g. locate housing away from high risk areas, emergency planning).
- Research (e.g. develop more risk-based climate change impact assessments).
- Education or behavioural change (e.g. increase public awareness of health issues).

### Integrating climate change adaptation with other sustainability objectives

**Table 2.3** below provides examples of where measures taken to adapt to one climate change impact can have additional benefits – these are shown as Win / Win measures because:

- They also adapt to another climate change impact (e.g. they address both higher temperatures and increased flood risk).
- They also reduce the contribution of a development to climate change (i.e. they reduce carbon emissions and therefore have a mitigation benefit).
- They contribute towards meeting other sustainability objectives (e.g. improved public realm, amenity / open space, enhancing biodiversity, improved health).

The table also identifies where adaptation choices can work *against* other objectives - these are shown as Win / Loss measures. It is not intended to be an exhaustive list of adaptation measures or benefits and conflicts.

**Table 2.3: Identifying benefits and conflicts between adaptation measures (examples)**

| Climate change issue / impact | Adaptation measure | Win / Win because… | Win / Loss because… |
|---|---|---|---|
| **Higher temperatures / poor thermal comfort, heat stress, lower productivity.** | Correct location and use of energy efficient appliances and lighting. | Reduce internal heat gains and require less energy (reducing carbon emissions). | |
| | Thermal mass with high levels of insulation and air tightness, with controllable natural ventilation (e.g. for night time ventilation during summer). | Less energy required to cool buildings (and heat in winter). Natural ventilation reduces indoor temperatures in summer. Avoids heat loss in winter. | Could increase security risk (e.g. open windows at night) so requires careful design. |
| | Ground / water source heat exchange for cooling / heating. | Less energy required to cool buildings (and heat in winter). | Potential increase in carbon emissions if pump powered by fossil fuel energy source. |
| | Green / Brown roofs. | Absorb solar radiation, reduce thermal transference and extend roof life. Biodiversity gains. Can reduce flood risk. | |

cont'd overleaf

**Table 2.3: Identifying benefits and conflicts between adaptation measures (examples)** (cont'd)

| Climate change issue / impact | Adaptation measure | Win / Win because… | Win / Loss because…. |
|---|---|---|---|
| **Higher temperatures / poor thermal comfort, heat stress, lower productivity.** | External shading – louvres, shutters etc. | Less energy required to cool buildings in summer. | Potential need for additional lighting in winter so requires careful design. |
| | Planting to provide summer shade and reduce building temperatures. | Dissipates heat before it reaches the walls. Deciduous species provide a cooling effect in summer and a warming effect in winter. Biodiversity and amenity gains. | Water thirsty species could increase subsidence risk. |
| | Traditional air conditioning. | | Energy intensive (and increase carbon emissions if sourced from fossil fuels), dump heat and exacerbate urban heat island effect. |
| **Water resources / shortages.** | Water efficient fixtures, fittings and appliances. | Less energy required to pump / heat a smaller volume of water. | |
| | Rainwater harvesting. | Less energy required for treatment. | |
| | Sustainable Drainage Systems (SuDS). | Reduce run-off rates and reduce flood risk. Biodiversity and amenity gains. On site reed beds avoid need to pump and treat water downstream, saving energy. | |
| **Wetter winters, sea level rise / increased flood risk.** | Sustainable Drainage Systems (SuDS). | Reduce run-off rates and reduce flood risk. Biodiversity and amenity gains. On site reed beds avoid need to pump and treat water downstream, saving energy. | |
| | Managed retreat – using mud flats and wetlands as flood storage areas to dissipate energy of flooding. | Reduced problems of coastal squeeze. Biodiversity gains. Economic benefits from reduced cost. | Potential loss of agricultural land. |
| | Sustainable Drainage Systems. | Reduce runoff rates and volumes by mimicking natural systems. Potential biodiversity, amenity and economic gains, plus water conservation and energy savings, and improved water quality. | Need to plan for whole life management and for potential failure during flood events. Must be planned in at early masterplanning stage. |
| | Installation of wider gutters to cope with increased risk of storms / driving rain. | Build into ongoing maintenance programmes. | |
| **Warmer wetter winters / increased risk of damp and mould.** | Installation of mechanical systems to prevent damp and mould. | | Increased energy use and potential increased carbon emissions. |

## 2.3 Adaptation options

### Three Regions Checklist

Provides examples of adaptation measures in the following categories:

- Location
- Site Layout
- Buildings (Structure, Physical Envelope and Materials)
- Ventilation and Cooling
- Drainage
- Water
- Outdoor Space
- Connectivity (infrastructure resilience, impact on neighbours)

Once a need for adaptation is identified specific measures should be considered with reference to the risk of not adapting, the plan/development objectives and decision making criteria.

Examples of adaptation measures are provided in **Part 4** of this guidance, the Three Regions Checklist (see left and **Appendix 3** of this guidance) and in the Case Study Report[6]. In **Part 4** of this guidance adaptation measures are divided into three broad categories of Location, Site Layout and Building Design with reference to the three case study sites.

**Table 2.4** below provides an extract of a worked example of how each relevant climate change element can be considered with reference to the identified risk of not adapting to climate change impacts, to help determine what adaptation measures may be appropriate:

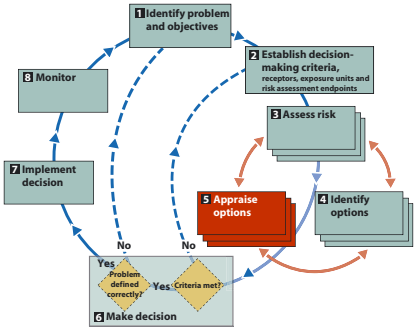
**Table 2.4: Worked example of identifying adaptation measures to address impacts associated with increasing summer temperatures.**

| Climate change element | Risk of not adapting | Example adaptation measures |
|---|---|---|
| Increasing summer temperatures<br><br>(*Continue for other climate change elements*) | Potential risk of heat stress in people who live and work in the area, especially the elderly and very young.<br><br>Reduced workforce productivity. | • Include green / brown roofs, to regulate temperatures within buildings (Win / Win).<br>• Use exterior louvres or shutters for shade (No / Low Regrets).<br>• Use planting to provide summer shade for buildings (Win / Win and No / Low Regrets) (see below).<br>• Incorporate secure natural night-time ventilation (No / Low Regrets) (see below).<br>• Incorporate flexibility in building design to allow for future building trends and innovations (Flexible).<br>• Incorporate appropriate thermal mass in buildings, combined with night ventilation to enable heat to be absorbed into and then released from the building fabric (High Resilience).<br>• Use cooling and ventilation systems which are as energy efficient as practicable in place of air conditioning e.g. heat exchange / groundwater cooling, evaporative cooling technologies, solar powered absorption chilling powered by solar thermal collectors (Win / Win).<br>• Demonstrate that the building has or is capable of having installed a ventilation system which will deliver comfortable temperatures (i.e. exceeding 28°C for less than 1% of the time and exceeding 25°C for less than 5% of the time) throughout the design life of the development (High Resilience). |

Example adaptation measures to address the impacts associated with increasing summer temperatures.


Using planting to provide summer shade


Providing secure night-time ventilation




### Stage 5: Appraising adaptation options and measures

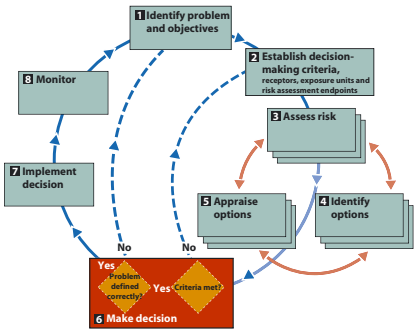
| Developers should: | Planners should: |
|---|---|
| • Appraise adaptation options / measures informed by:<br>  • Development objectives identified at Stage 1.<br>  • Decision making framework developed at Stage 2.<br>  • Consideration of risk at Stage 3.<br>  • Whether options / measures can be screened out.<br>  • Whether options / measures would constrain action by others.<br>  • Consideration of appropriate appraisal method e.g. qualitative, quantitative etc.<br>  • Stage of design / development process – e.g. incorporate into EIA or cost-benefit analysis, outline / layout / detailed design stage as appropriate. | • Appraise adaptation options / measures informed by:<br>  • Plan / policy objectives identified at Stage 1.<br>  • Decision making framework developed at Stage 2.<br>  • Consideration of risk at Stage 3.<br>  • Whether options / measures can be screened out.<br>  • Whether options / measures would constrain action by others.<br>  • Consideration of appropriate appraisal method e.g. qualitative, quantitative.<br>  • Stage of plan / policy making – e.g. incorporate into sustainability appraisal. |

In order to choose the most appropriate adaptation measures, they should be appraised against the decision making criteria (UKCIP Stage 2) and against the objectives of the development (UKCIP Stage 1), with reference to the risk assessment (UKCIP Stage 3). A worked example of how this could be done is set out in **Table 2.5** below. This uses a simple qualitative appraisal method to compare options for adapting to higher summer temperatures.

**Table 2.5: Worked example of an appraisal framework to compare adaptation measures**

| **Climate change element – increasing summer temperatures** | | | | | | |
|---|---|---|---|---|---|---|
| **Development objective: Improving the ambience of the town centre** | | | | | | |
| **Decision making criteria** | **Adaptation measure** | **Win/ Win** | **No/ Low Regrets** | **Flexible** | **High resilience** | **Comment** |
| Will the option meet the following criteria:<br>• Make the town centre safe night and day?<br>• Provide a mix of soft (natural) and hard (built) uses?<br>• Connect clearly and safely with adjoining development?<br>• Provide an environment where people want to live?<br>• Provide an environment where people want to shop? | Design buildings to provide shade in publicly accessible areas at times of peak sunshine. | | ✓ | ✗ | ✓ | Measure would stand the test of time, but being permanent could rule out future changes. |
| | Incorporate planting of mature trees into main square and into public thoroughfares. | ✓ | ✓ | ✓ | | Would also provide biodiversity benefits and soften built environment. Could be removed in future if needed. |
| | Ensure all air conditioning units are designed to expel hot air into areas not frequented by the public. | ✗ | ✓ | | ✓ | Could be carried out as a matter of course, but air conditioning high energy use. |
| | Remove traffic from town centre and improve walking and cycling facilities in order to avoid pollution build-up. | ✓ | ✓ | | ✓ | Would help to encourage the use of more sustainable transport, and improve health. |
| | Provide rest areas (seating etc.) under shaded canopies/trees. | ✓ | ✓ | ✓ | | Would benefit elderly in particular, and very flexible measure, plus low cost. |

## 2.3 Adaptation options



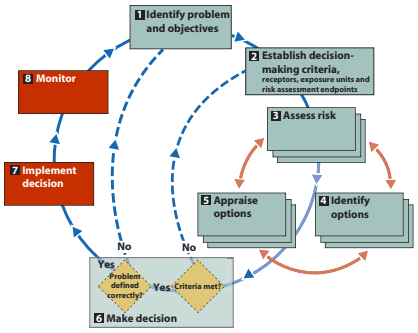

**Stage 6: Making the decision – Selecting adaptation options and measures**

| Developers should: | Planners should: |
|---|---|
| • Select adaptation measures for implementation, informed by:<br>  • A clearly communicated appraisal process.<br>  • An understanding of the costs / benefits of each option, trade-offs between options, and the distribution of impacts on different criteria, stakeholders etc.<br>  • An understanding of key areas of risk, uncertainty and sensitivity in the appraisal process.<br>  • Considering whether the appraisal will produce a robust decision - was the overall development objective correctly defined, and appropriate decision making criteria used? | • Select adaptation measures for implementation, informed by:<br>  • A clearly communicated appraisal process.<br>  • An understanding of the costs / benefits of each option, trade-offs between options, and the distribution of impacts on different criteria, areas / stakeholders etc.<br>  • An understanding of key areas of risk, uncertainty and sensitivity in the appraisal process.<br>  • Considering whether the appraisal will produce a robust decision: was the overall plan / policy objective correctly defined, and appropriate decision making criteria used? |

The selection of adaptation options / measures to implement depends on the objectives of the plan, policy or development, the decision making criteria selected, and the particular climate change impacts and risks involved for the site or area under consideration. Combinations of measures and options may be chosen to achieve the desired objectives. For example, on a site at high risk of flooding, a combination of no / low regret and high resilience measures may be chosen to adapt to flood risk, but due to the cool local microclimate a flexible staged approach may be chosen to adapt to higher summer temperatures.

The selection of adaptation options should reflect the objectives of the development. For example, provision of a park with appropriate shade ensures that open spaces are useable in summer months and also supports biodiversity and promotes a positive image of the area.

Demand for shade in public open spaces




**Stage 7 and 8: Implement, monitor, evaluate and review**

| Developers should: | Planners should: |
|---|---|
| • Build into project planning the expectation that developer contributions may be required to cover on-going maintenance and management of climate change adaptation measures.<br>• Implement developments in accordance with the latest best practice and bench mark developments against sustainability standards.<br>• Review development performance to inform future schemes (e.g. as part of a company quality management system or corporate responsibility policy).<br>• Review performance against UKCIP principles for good adaptation. | • Ensure policies are drafted to enable effective implementation and monitoring.<br>• Communicate decisions on policy content and planning applications transparently and clearly.<br>• Use all appropriate mechanisms to ensure adaptation measures are implemented at the site level, and are maintained and managed for the life of the development (see below).<br>• Monitor the implementation of conditions through the enforcement system.<br>• Ensure the Annual Monitoring Report for the LDF informs the review of DPD policies, SPDs and other guidance.<br>• Ensure monitoring of Climate Change Action Plan policies (and other corporate level plans), and other corporate audits (e.g. CPA) to inform planning policy review (see below). |

This section provides guidance on implementing and monitoring decisions relating to climate change adaptation. These decisions may relate to policy choices on the location of new development, the design of a layout and adoption of a masterplan or the detailed design of buildings.

### Stage 7: Implement decision

***Local Planning Authorities:***

Local planning authorities should ensure all necessary policy backing for climate change adaptation is put in place at the DPD and SPD level, and that policies are drafted to enable implementation and long term management and maintenance of climate change adaptation measures (see **Part 3** of this guidance). Where DPDs and SPDs are a long way from adoption, reference should be made to the regional spatial strategy and national planning policy statements. Other policy tools should also be used in the shorter term, such as the provision of design guidance, the adoption of standards for new development (e.g. BREEAM) and draft policies for development control purposes.

In seeking to secure and guide the implementation of new developments incorporating climate change adaptation measures, development control planners should:

- Proactively use planning conditions, planning agreements and the planning gain supplement to require longer-term management and maintenance of adaptation measures.
- Engage developers in early negotiations on draft conditions and agreements.
- Secure land restructuring agreements where appropriate, so that land with development rights in areas at risk can be exchanged for development rights at alternative sites.

***Developers:***

Adaptation measures which have been chosen as part of a development, whether at the site layout or building design stage, must be properly constructed to ensure they maximise their potential to achieve adaptation objectives, e.g. to provide buildings which are resilient to flood damage, and can cope with high temperatures. Specialist contractors may be required and should be budgeted for.

## 2.4 Implement, monitor, evaluate and review

In building their schemes, developers should adopt best practice and anticipate revisions in regulations and standards. For example, for housing schemes developers should:

- Adopt the Ecohomes 2006 Excellent standard (the homes version of BREEAM) which includes a new credit for minimising flood-risk.
- Adopt SAP 2005 (energy rating for dwellings) which provides a method for estimating in a dwelling the tendency to achieve high internal temperatures in summer.
- Prepare for adoption of the strengthened Code for Sustainable Housing as a minimum standard.
- Anticipate revisions to Part L of Building Regulations.

**Stage 8: Monitor, evaluate and review**

The monitoring stage tests the results of decisions on whether to incorporate climate change adaptation into planning policy making or development design. Monitoring is essential to identify whether plans and developments are achieving their objectives, whether they are having unintended consequences, whether the assumptions behind the plan - for instance, about current and future climate-risks - have changed, and whether targets - such as natural resource efficiency - are being met.

***Local Planning Authorities:***

Exising monitoring regimes offer opportunities to build in climate-adaptation and adaptive capacity. S 35 of the Planning and Compulsory Purchase Act 2004 requires LPAs to produce an Annual Monitoring Report (AMR). Monitoring the effects of a plan or programme is also a requirement under the SEA Directive. Authorities also need to link their LDFs to Public Service Agreements for delivering sustainable communities[19]. Authorities and developers with Climate Change Action Plans will need to monitor adaptation take up. Under Best Value district, unitary and county councils also have a statutory duty to put in place arrangements to secure continuous improvement in their functions having regard to a combination of economy, efficiency and effectiveness. The Audit Commission carries out Comprehensive Performance Assessment (CPA) of all services on a rolling basis, to monitor how authorities are satisfying this duty (see www.audit-commission.gov.uk for more details).

Local Planning Authorities should also ensure policies are worded to enable effective monitoring of objectives, and review plan outcomes as knowledge of the science of climate change and of its impacts develops (see www.ukcip.org.uk).

***Developers, LPAs and Local Delivery Vehicles:***

Developments should be bench-marked against sustainability standards that include climate change adaptation. For instance, CIRIA has recently published guides[20] to provide building owners, facility managers and designers with information for benchmarking on water-efficiency.

The review process should provide an opportunity to revisit UKCIP's principles for good climate change adaptation which are set out in **Section 2.1** of this guidance.

Monitoring should lead to corrective action where the effects do not turn out as anticipated. Where possible, in plans, programmes and projects, flexibility should be 'built-in' so that such corrective actions are possible. This is one of the key messages for climate change adaptation - do not do things now that will prevent action in the future, and keep a watching brief.

**Keeping a watching brief:** Boscastle, Cornwall.

National Trust properties in Boscastle, Cornwall, have been renovated following the floods of August 2004 to incorporate adaptation measures which will increase resilience to future events.

The National Trust (2006)

National Trust shop, holiday flats and District Council Visitors Centre: Removal of impermeable wall finishes, and their replacement with limewash, will allow walls to dry out after inundation. Internally, a suspended floor was converted to a solid floor to reduce the impact of any future flood inundation, and electrical points were raised off the ground.

Youth Hostel: Floor levels raised by 400mm to improve flood protection (both from fluvial and tidal inundation), and electrical points raised off the ground.

The National Trust (2006)

The National Trust (2006)

National Trust shop: Use of water tolerant wall finishes e.g. Newtonite Lath in refurbishment works.

Part 3

# Planning and development responses to climate change impacts

# 3.1 Integrating climate change adaptation into planning policy

**Introduction**

**Part 3** of the guidance focuses on how planners and developers should integrate climate change adaptation into development plan documents and other planning policy tools and decisions on where to locate development, site layout and building design. The section on location explores the particular climate change issues associated with different locations, while the site layout and building design sections consider appropriate responses to climate change impacts. The section on building design is also relevant to redevelopment / refurbishment proposals. Generic guidance is provided for planners and developers, illustrated with reference to the three case study sites. Examples of costs and benefits associated with climate change impacts are highlighted for the location, site layout and building design stages of the development process. Costs information is liable to change; references include dates where available.

While decisions to adopt policies or strategies will lie with Local Planning Authorities or funding bodies, developers and their design teams should seek to get involved in early discussions on development proposals to ensure climate change impacts and risks are considered as part of the development design process.

At all stages, developers should:

- Expressly consider the design life of the development and the climatic conditions both the development and its occupants will experience throughout that time.
- Assess the costs of retro-fitting adaptation measures against the costs of integrating adaptation in the initial design.

**Integrating climate change adaptation into planning policy**

| **Planners should:** | |
|---|---|
| *As part of plan and policy making:*<br>• Explicitly consider the need to adapt to climate change when preparing DPDs (and sustainability appraisals), SPDs and guidance, using the UKCIP Risk, uncertainty and decision making framework (see **Part 2** of this guidance).<br>• With development control colleagues, consider the implications for long term management and maintenance of adaptation measures.<br>• Engage with partners on key climate change issues relevant to policy making (e.g. flood risk, water resources, higher temperatures etc.). | *At the corporate level:*<br>• Encourage the local authority to sign up to the Nottingham Declaration on Climate Change (see **Box 3.1**).<br>• Adopt a Climate Change Strategy and Action Plan.<br>• Review regional implementation plans and ensure actions are incorporated into corporate strategies (e.g. see the Climate Change Mitigation and Adaptation Implementation Plan for the Draft South East Plan).<br>• Join the Regional Climate Change Partnership. |

Taking climate change into account in locating and design of development is a requirement of national planning policy, including Planning Policy Statement 1: Delivering Sustainable Development. Development Plan Document (DPD) policies which require that climate change adaptation is considered and incorporated into new developments are essential to ensure implementation is carried out on the ground and can be enforced. The emphasis should be on no / low regrets and win / win adaptation measures which bring wider sustainability benefits. This requires the following actions:

- Review how climate change adaptation is addressed in the Regional Spatial Strategy.
- Explicit consideration of climate change adaptation in preparation of LDDs including DPDs, AAPs and SPDs. This may mean incorporating climate change adaptation into wider sustainability policies and guidance (e.g. design guidance on sustainable construction).
- Consider climate change adaptation as part of the sustainability appraisal process (see **Box 3.2**).
- Use of Green Charters and Climate Change or Sustainability Checklists setting out climate change adaptation requirements (e.g. including the adoption of standards where appropriate) to guide the design process (e.g. the SEEDA Sustainability Checklist and Green Charter for Queenborough and Rushenden, see Panel, right).

**Box 3.1: The Nottingham Declaration on Climate Change**

To date over 140 Local Authorities across the UK have signed up to the Nottingham Declaration, committing their Council to action on Climate Change. To support this process the Nottingham Declaration Action Pack (NDAP) has been launched. This online resource guides Local Authority staff through the process required to develop and implement a Climate Change Strategy or Action Plan for their Council or Community. It offers guidance on adaptation and mitigation and is supported by agencies including the Carbon Trust, UKCIP, IDeA, Local Government Association, Environment Agency and the Energy Saving Trust. To register and access the pack a .gov email address is required. See: www.est.org.uk/housingbuildings/localauthorities/NottinghamDeclaration/

## 3.1 Integrating climate change adaptation into planning policy

**Box 3.2: Incorporating climate change adaptation in Strategic Environmental Assessment / Sustainability Appraisal**

Undertaking a Strategic Environmental Assessment (SEA) on a wide variety of plans, programmes and strategies including Local Development Documents (LDDs) is now a legal requirement. SEA (and the associated process of Sustainability Appraisal) requires that the impact of a plan on a range of environmental factors is considered fully and, where possible, any adverse impacts eliminated or ameliorated.

At the start of the SEA/Sustainability Appraisal process it is necessary to identify the objectives against which to appraise a plan or strategy. The European SEA Directive, now transposed into UK law, requires that climatic factors are included in the assessment. This is also supported by the government's generic guidance on SEA[21], published by ODPM, and by specific guidance on SEA and Climate Change[22]. The inclusion of climate change adaptation as an objective within the SEA should ensure that the main climate change issues and impacts that need to be considered in developing the plan or strategy are assessed and that a suitable adaptation response to these challenges is made.

### Policy making for effective implementation

In discussion with development control colleagues (and developer panels or key developer partners), policy planners should:

- Prepare a Developer Contributions Strategy to identify the type, amount and cost of climate adaptation measures (e.g. for the AAP area or a particular major development site).
- Ensure DPD policies provide for the creative use of planning conditions, planning agreements and planning gain supplement to secure longer term maintenance and management over the life of the development (e.g. to provide for phased land uses over the longer term, permanent exclusion of domestic uses from ground floors in flood risk areas and secure the long term maintenance of those features of that would, if lost, risk undermining the design principles and resilience of the development as a whole).
- Consider the use of land restructuring agreements so that land with development rights in areas at risk can be exchanged for development rights at alternative sites.

Reference should also be made to the following sections to inform decisions on choosing development locations for Site Allocation DPDs, and drafting development control policies relating to site layout and design.

### Case study examples

The regeneration proposals at Queenborough and Rushenden and Bedford Town Centre AAP provide examples of how climate change adaptation could be integrated within planning policy (see panel below and overleaf):


SEEDA (2006)[23]

### Regeneration at Queenborough and Rushenden

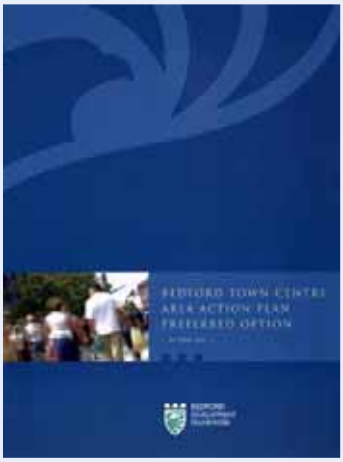
The South East England Development Agency (SEEDA) is preparing a Green Charter for Queenborough and Rushenden[23]. This sets an ethos for development that demonstrates the needs and desires of the local community and will act as SPD for all developments within the regeneration area.

The Charter provides a stringent set of guidelines for developers under a number of Sustainability Themes. One of these Themes is Climate Change Adaptation, the content of which has been informed by this research project. As well as recognising the potential impacts of climate change within Queenborough and Rushenden and the wider South East, the Charter advises that:

- Impacts including water shortages, flooding, storm damage and adverse effects on biodiversity, energy, transport and telecommunications infrastructure must be taken into account in the design of buildings, in line with the Masterplan.
- Developers and architects must fully consult and adhere to The Three Regions Checklist to help future proof any development against the negative impacts of climate change.

**Bedford Town Centre Area Action Plan**

Bedford Borough Council is considering preparing a Supplementary Planning Document (SPD) on climate change which would help to ensure that new development within Bedford does not contribute to or suffer from the effects of climate change. Whilst the focus or content of the SPD has not been determined, it could include a series of principles that would be used by planners and developers to ensure that development takes into account the need to adapt to climate change. A worked example of the type of Climate Change Principles which could be integrated in planning policy is provided below.



Bedford Borough Council (October 2005)[12]

Any guidance provided in the SPD needs to be clearly cross-referenced in Development Plan Documents. Whilst the Bedford Town Centre AAP does not refer to climate change adaptation, there are a number of 'policy hooks' which could be used, for example:

- The AAP sets out submission requirements for individual planning applications. One of these requirements is to provide a sustainability and energy statement to demonstrate how sustainability principles have been applied to the development. The remit of these audits could be defined to ensure that individual planning applications consider climate change principles as outlined in the proposed SPD.
- Policy TC39 of the AAP outlines principles of urban design that will be used in the determination of planning applications in the town centre. These principles could build in specific requirements in relation to climate change adaptation, for example, in relation to water efficiency and flood proofing.

**Climate change principles: A worked example for Bedford Town Centre**

When considering options for development (UKCIP Stage 4), developers should address:

1. What risks to the development may be posed by climate change.
2. The significance of the risk in relation to the development proposed.
3. Adaptation measures available, appropriate to the development and commensurate with the risk identified.
4. The need to plan for impacts of extreme events (e.g. failure of flood defences, SuDS etc).
5. The costs and benefits of not taking action.
6. Whether development proposals allow for flexibility to incorporate adaptation measures in the future.
7. Other non-climate related benefits of including adaptation measures in new development.

Considering options

Factors to take into account

In addressing these principles the following factors should be kept in mind (UKCIP Stage 5):

- Location of the development.
- Layout and design of the development.
- Lifetime of the development.

In selecting appropriate solutions (UKCIP Stage 6), developers should also be mindful of the following:

- It is important that climate change is considered alongside wider sustainability issues (e.g. enhancing biodiversity through Sustainable Drainage Systems (SuDS). These principles could be incorporated into wider sustainable design and construction policy or guidance.
- Scope for low cost/no-cost measures (e.g. layout and orientation of buildings to maximise resilience to climate change).
- Scope for no/low regrets options i.e. measures which will increase resilience but also pay dividends now (e.g. measures to improve water and energy efficiency).

Selecting appropriate solutions

## 3.2 Location

**Key issues and adaptation responses - location**

| **Developers should:** | **Planners should:** |
|---|---|
| • Follow the UKCIP risk assessment methodology (as illustrated in **Part 2** this guidance).<br>• Include climate change adaptation in the scoping stage of SA/SEA or EIA of projects to inform the preferred location for development.<br>• Use these assessments to engage in informed pre-application discussions.<br><br>The Three Regions Checklist also advises that developers should:<br>• Establish the Environment Agency flood risk designation for the location and ensure proposals accord with it.<br>• Review any strategic flood risk assessments and implications of coastal erosion.<br>• Assess viability of the development for insurance purposes. | • Include climate change adaptation in the scoping stage of SA/SEA of DPDs to inform the preferred locations for development.<br>• Liaise with service providers to identify climate change impacts relating to particular locations (e.g. Environment Agency, water companies etc. - see below).<br>• Liaise with local strategic partnership and other organisations (e.g. health and education authorities, business community etc.) to identify receptors (sectors of the community, sensitive habitats, allocated land uses) which may be vulnerable to climate change impacts in particular locations.<br>• Engage with developers in pre-application discussions. |

The actions in this section will overlap in some cases with those in **Section 3.1** on planning policy so planners and developers should refer to both sections.

Strategic decisions on locating development are made at the national, regional and local levels:

- Sustainable Communities Plan e.g. Growth Areas
- Regional Spatial Strategies and Sub-Regional Strategies
- Local Development Documents including Area Action Plans

National Planning Policy Statements provide guidance on locating development through regional spatial strategies and local development documents. PPS1 Delivering Sustainable Development, PPS11 Regional Spatial Strategies, PPS12 Local Development Frameworks, and PPG25 / draft PPS25 Development and Flood Risk all **require that development is located to take account of climate change impacts**. The Planning Response to Climate Change (ODPM, 2004) provides guidance on developing infrastructure, and PPG14 Development on Unstable Land provides guidance on subsidence.

Locating development to mitigate and adapt to climate change impacts is a win/win response. PPG13 Transport, PPG3 / draft PPS3 Housing and PPS6 Planning for Town Centres all require development to be located to reduce the need to travel, so reducing carbon emissions. The government is also producing a planning policy statement on reducing carbon emissions through sustainable development.

Engaging with key stakeholders and partners is important to ensure planning policies take into account the impact of climate change on service and infrastructure providers. For example, for water resources, flood risk and coastal erosion, planners should:

- Engage in River Basin Management Plans to deliver sustainable water use and ecological objectives (under the Water Framework Directive the RBMPs will look ahead to 2027).
- Engage with the review of Shoreline Management Pans in coastal areas.
- Establish a local flood-risk liaison group to include insurance representation, and review estimates of insurance costs of flood-risks.

Planners and developers should:

- Liaise with the Environment Agency and water utilities on flood risk and water resources.

A similar approach will be required for other key climate change issues and the impacts associated with them e.g. higher temperatures, subsidence, coastal erosion and biodiversity.

**Table 3.1** below provides examples of generic measures to adapt to climate change impacts relating to location. The cost and benefit considerations for two examples of climate change issues associated with location are explored in **Box 3.3**.

**Table 3.1: Climate change issues and adaptation measures relating to location**

| Climate Change Issue | Strategic issues and tools | Location level adaptation measures |
|---|---|---|
| Flood risk and coastal erosion | Catchment Flood Management Plan<br>Shoreline Management Plan<br>Strategic Flood Risk Assessment | Follow sequential approach to locating development in PPG25 / PPS25. Maximise development densities in non-floodplain or low risk areas. Ensure vulnerable uses are located away from areas of high risk. Manage residual risk (i.e. from failure of defences) through resilience, resistance, flood warning and evacuation planning. |
| Water resources | River Basin Management Plan<br>Consider carefully the location of water intensive development | Locate away from areas of water resource shortages (including for water treatment capacity). Where development is necessary in areas of shortage ensure supply and treatment is viable in discussion with water companies, and taking into account efficiency measures. |
| Higher temperatures - Urban Heat Island effect | Locating services for key vulnerable groups | Locate vulnerable uses away from hottest areas.<br>Where development is necessary build in resilience. |
| Subsidence / unstable land | Strategic infrastructure location | Where development is necessary build in resilience. |
| Biodiversity climate space | Landscape scale changes in habitat and species distribution | Enhance and create ecological networks. |

**Part 4** provides examples of ways to adapt to the urban heat island effect and to increased flood risk. The cost and benefit considerations relating to these issues are explored in **Box 3.3.**

British Waterways London (December 2003)

Dense urban areas such as Central London experience a significant heat island effect.

Rob Wiley, Environment Agency

Avoid developing in locations at high risk of flooding.

**Box 3.3: Examples of cost and benefit considerations – location**

**1. The urban heat island effect**

***Loss of productivity and revenues where buildings are not adapted to higher temperatures***

UK employers lost an estimated £168m a day in productivity during one week of the July 2006 heatwave, allowing for travel disruptions and staff arriving late, according to a report by the Centre for Economics and Business Research (CEBR). It is estimated that work levels dropped by almost a third when temperatures soared to more than 30 degrees Celsius. Occupational health provider Active Health Partners (AHP) estimated that UK businesses lost £119m through absenteeism when temperatures topped 35 degrees on 19 July 2006. AHP has calculated that for every 10% increase in temperature, there is a similar increase in absence.

Office temperature is a particular concern, with a third of UK offices lacking air conditioning according to recruitment agency Office Angels. While Health and Safety Executive guidelines state that employers have a duty to ensure reasonable workplace temperature there is no legal maximum workplace temperature. Many businesses are neglecting to take into account heat as a workplace risk, which could seriously impact on the health of workforces and businesses.

The heatwave also affected retailers as people stayed away from town centres. According to research group Footfall's latest figures, the number of people in town centres on 19 July 2006 - the hottest July day since records began - was down 7.3% compared with a year earlier. This illustrates the need to ensure the public realm and retail quarters are also adapted to higher temperatures.

When adapting to higher temperatures alternatives to traditional air conditioning should be chosen to avoid increasing carbon emissions and problems of dumping heat, which itself contributes to higher temperatures in urban areas.

***Adapting through choice of location***

Proximity to a river or other water bodies helps to reduce the extreme summer temperatures associated with the urban heat island effect experienced in most cities, and selecting such a location is a way of adapting to higher temperatures in urban locations. Choosing a riverside location, such as Wood Wharf in the docklands of London, has a number of benefits which may add to the value of the development and offset the costs of providing necessary adaptation measures.

Potential cost/benefit issues include:

- Maximisation of site development potential.
- Attractive water-side location with riverside views and access to water based recreation opportunities.
- Reduction in cooling plant; installation, maintenance and carbon emissions.
- Costs of waterproofing works to lower ground floor construction of buildings.
- Costs of pedestrian safety balustrading.
- Costs of bridging over integrated water ways.

**2. Increased flood risk**

Flooding can be amongst the most costly weather events, as explored by the 2004 Foresight Report[24]. Under the most extreme climate change scenario considered in the report, the annual cost of flood damage could increase by 20 times the current level. However, such costs could be reduced by an integrated portfolio of adaptation measures - losses incurred through flooding could be managed by methods including insurance and local floodplain charging schemes.

The Association of British Insurers has considered the implications of the Growth Area development plans for the cost of flooding (ABI, 2005[25]). New development in the Growth Areas could increase the annual costs of flooding by more than £50 million if adaptation measures are not put in place to manage losses (most of this increase would occur in the Thames Gateway), equating to a 74% increase in annual costs within the Growth Areas, and a 5% increase nationally. This annual costs figure could increase by ten times with predicted effects of climate change.

The ABI advises that locating development in areas outside or in lower risk parts of the floodplain is the most cost-effective approach and will minimise the increases in flood risk. Coupled with increasing development densities, this strategy could save approx. 15-17% of flood damage costs (if limited to non floodplain areas), and 49-59% if low and moderate flood probability areas are included. However, these cost savings would be lower for the Thames Gateway Growth Area (1% and 40% under the two scenarios), as 89% of development sites are located within the floodplain, and existing development is already built to high densities (e.g. East London). The need to increase investment in flood defences and build in flood-resilience will add to the cost of developments in higher risk areas.

PPG25 Development and flood risk (2001) requires a sequential approach to spatial planning decision making at all levels. Flood risk assessments are required to accompany planning applications and must include consideration of extreme events, including an allowance for climate change.

**Key issues and adaptation responses - site layout**

| **Developers should:** | **Planners should:** |
|---|---|
| • Use the UKCIP decision making framework to help select appropriate adaptation measures and incorporate these into the site layout.<br>• Plan for long term management and maintenance of adaptation measures (e.g. SuDS, evacuation routes etc).<br>Ensure the layout and massing of development:<br>• Responds to findings of the EIA with revisions to the layout as required.<br>• Does not increase flood risk and where possible reduces risk, taking account of climate change and the sequential approach in PPG25.<br>• Incorporates SuDS from the outset where the site is suitable (determine suitability by site survey).<br>• Incorporates a drainage design (including SuDS as appropriate) which allows for excess flows to be managed safely e.g. during an exceptional storm.<br>• Takes account of the increased risk of subsidence.<br>• Minimises solar gain in summer.<br>• Maximises natural ventilation.<br>• Provides public and private outdoor spaces.<br>• Maximises natural vegetation.<br>• Allows for appropriate storage of compost, recycling and waste in hot weather.<br>(adapted from The Three Regions Checklist) | • Ensure development plan policies and design guidance require climate change adaptation to be incorporated into site layouts as part of an integrated masterplanning approach (see the Three Regions Checklist, and the summary developers' checklist to the left).<br>• Use this guidance (and the Three Regions Checklist) to inform pre-application discussions.<br>• Draw developers' attention to the LPA's Developer Contributions Strategy (where available) to identify the type, amount and cost of climate adaptation measures required.<br>• Ensure long term maintenance and management of adaptation measures relating to site layout (e.g. SuDS) is addressed as part of the scheme.<br>• Ensure long term phasing of land uses is secured through appropriate conditions or planning agreements. |

Decisions on the layout of development need to consider the role of the site in terms of natural processes, especially its functions as a green or brownfield site, the links to adjacent land and water, and the implications of climate change impacts for the overall distribution, orientation and massing of development and provision of blue and green infrastructure within the site.

Decisions on layout are taken at the local level, guided by national planing policy statements, LDDs including AAPs and Supplementary Planning Documents / Masterplans and by sustainability check-lists, Local Biodiversity Action Plans, Catchment Flood Management Plans (CFMPs) and Shoreline Management Plans (SMPs).

Some examples of generic adaptation measures are provided below, followed by examples of cost/benefit considerations for adaptation of site layouts, focusing on adapting to flood risk.

**Table 3.2: Examples of climate change issues and adaptation measures relating to site layout**

| Climate change Issue | Site level issues and tools | Site level adaptation |
|---|---|---|
| Urban drainage/flash flooding | Consider feasibility of Sustainable Drainage Systems (SuDS). | Design in Sustainable Drainage Systems (SuDS) as part of green infrastructure and use planning gain supplement or planning conditions to secure commitment to maintenance. |
| Fluvial flooding | Flood Risk Assessment (FRA). | Use outcomes of FRA in landscape design to allow streams to retain or regain natural water-course.<br>Follow sequential test in PPG25 / draft PPS25.<br>Maximise densities in areas of lower flood-risk. |
| Sea-level rise & storm surge | Historic information and site investigation.<br>Emergency access plans. | Ensure safe evacuation routes.<br>Consult and engage in Shoreline Management Plan (SMP).<br>Planned use of soft defences as buffer and as part of green/blue infrastructure. |

cont'd overleaf

**Table 3.2: Examples of climate change issues and adaptation measures relating to site layout** (cont'd)

| Climate change Issue | Site level issues and tools | Site level adaptation |
|---|---|---|
| Increased risk of high wind speed and driving rain | Modelling | Consider prevailing wind and driving rain when planning layouts.<br>Design layout of public spaces to be safe to use during high winds. |
| Water resources | Local resources / treatment capacity.<br>SuDS feasibility.<br>Water conservation and efficiency measures. | Design in SuDS as above.<br>Design landscape scheme and distribution of permeable/ impermeable surfaces to maximise water retention and water harvesting on site.<br>Design of residential, community and commercial layout to maximise possibility of communal grey-water recycling (by including space for on-site treatment eg reed-beds). |
| Higher temperatures | Consider how high temperatures will affect the development and vulnerable users (e.g. elderly). | Retain or enhance urban cooling effect of undeveloped or previously developed site and soils through provision of green infrastructure.<br>Use landform, topography and layout to maximise cooling and avoid solar gain in summer.<br>Locate public and private open space to offer accessible choice of shade and shelter.<br>Design planting and landscaping schemes to provide summer shade for buildings. |
| Subsidence/unstable land | Historic information and site survey/investigation. | Consult SMP in coastal areas.<br>Ensure geo-physical site survey takes account of climate change and that findings are reflected in distribution of land uses and infrastructure/services.<br>If areas of the site are found to be at current or future risk of subsidence, erosion or land-slip, design for soft land uses such as open space.<br>Allow for appropriate foundation design and siting of vegetation. |
| Biodiversity | Biodiversity Action Plans.<br>Habitat Management Plans.<br>Open Space Strategy. | Retention or new provision of green infrastructure to strengthen the function and integrity of ecosystems, avoid fragmentation and provide for the possible shift of species and habitats.<br>Phased land uses e.g. public recreational open space used for occasional flood-storage and eventual marshland or wetland. |
| Infrastructure and services | Site investigation. | Use land-form or allow extra land-take to ensure essential services can be maintained in flood or extreme events.<br>Plan for decentralised services to allow continuity in event of disruption to remotely-sourced supplies. |
| Connectivity | Local Transport Plan.<br>Emergency access plans. | Plan for pedestrian and cycle routes to be protected from exposure to higher temperatures or wind-speeds.<br>Plan routes for emergency vehicles to have secure access in event of flood. |

**Box 3.4: Examples of cost/benefit considerations for site layout adaptation to increased flood risk:**

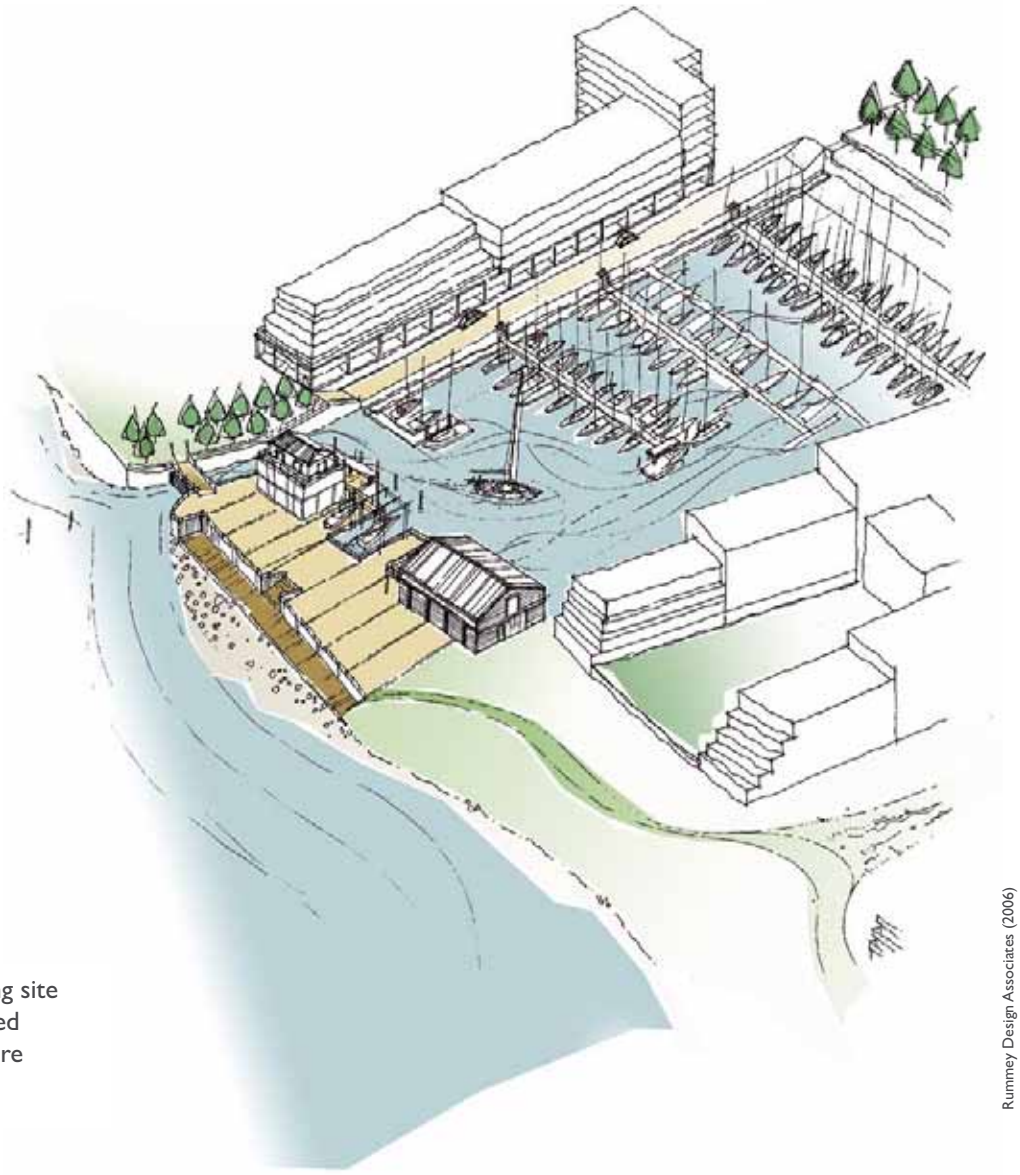
*Savings/benefits:*

- Maximisation of site development potential through increased densities in parts of the site at lower risk of flooding.
- Reduction of buildings insurance premium.
- Cost savings from integration of low maintenance landscaping schemes into outdoor spaces.
- Reduction in localised flood damage to property (residential, commercial and community).
- Minimised stress and health costs associated with flooding events.
- Increased land/property values adjacent to adaptation features (e.g. ponds) planned for amenity value.

*Costs:*

- Value constraints due to restricted re-development sites.
- Restriction on development potential of site.
- Cash flow pressure with phasing of development/land uses.
- Written-off costs of temporary recreational facilities.
- Capital costs of future works to sea defences (hard or soft), increased build programme and maintenance.
- Cost of local demountable flood barriers and dual lines of defence.
- On-site attenuation and storage: typical geo-cellular storage medium system costs[26] c. £125-150/m$^2$.

Further guidance on adapting site layout can be found in **Part 4** and **Appendix 3.**



In areas at risk of flooding site layouts should be designed to reduce the risk to more vulnerable land uses.

Rummey Design Associates (2006)

## 3.4 Building Design

**Key issues and adaptation responses - building design**

| **Developers should:** | **Planners should:** |
|---|---|
| • Use the UKCIP decision making framework to help select appropriate adaptation measures and incorporate into building design.<br>• Plan for long term maintenance and management of adaptation measures relating to building design (e.g. water conservation measures).<br>• Ensure building design adapts to climate change at all levels: foundations and structure, physical envelope, materials, ventilation and cooling and water conservation. The Three Regions Checklist provides examples for each level. | • Ensure development plan policies and design guidance require climate change adaptation to be incorporated into building design.<br>• Use this guidance (and the Three Regions Checklist) to inform pre-application discussions.<br>• Draw developers' attention to the LPA's Developer Contributions Strategy (where available) to identify the type, amount and cost of climate adaptation measures required.<br>• Ensure long term maintenance and management of adaptation measures relating to building design (e.g. water conservation measures) is addressed. |

Strategic decisions on location and layout of development may significantly reduce the risks associated with climate change impacts for individual developments. However, in many cases there will remain a need to ensure that buildings are resilient to climate change impacts, responding to the particular characteristics of the site, but also in response to those impacts which are likely to be more uniform across the Growth Areas, such as higher temperatures and water resource shortages.

This section identifies the climate change issues that are important to consider when designing buildings. Some examples of generic adaptation measures are provided below, followed by examples of cost/benefit considerations at the building scale, and issues relating to the use of modern methods of construction.

**Table 3.3: Examples of climate change issues and adaptation measures at the building scale.**

| Climate change issue | Building level issues and tools | Building level adaptation |
|---|---|---|
| Urban drainage / flash flooding<br>Fluvial flooding<br>Sea-level rise and storm surge<br>Storms, driving rain and light winds | Flood Risk Assessment.<br>SuDS feasibility study.<br>Shoreline Management Plan.<br>Damp and mould. | Building level SuDS measures.<br>Prevent back-up of drains into buildings.<br>De-mountable flood barriers.<br>Flood-resilient materials.<br>Locate electrical services above flood levels.<br>Increase capacity of drainage systems (e.g. guttering).<br>Install damp course.<br>Zoning of wet and dry activities.<br>Good ventilation. |
| Water resources | SuDS feasibility study.<br>Water conservation. | Reduce use - efficient fittings and foxtures.<br>Install systems for water conservation and reuse e.g. communal rainwater harvesting.<br>Drought resistant landscaping. |
| Higher temperatures | Urban heat island effect and other local micro-climate effects.<br>Limit effects of peak summertime temperatures, particularly at night. | Passive cooling.<br>Increase thermal mass.<br>Limit solar gains.<br>Adequate ventilation.<br>Use natural sinks for cooling.<br>Mechanical assisted cooling systems e.g. heat pumps.<br>Planting for shade adjacent to buildings. |
| Subsidence/unstable land | More diffucult to retro-fit.<br>Site Investigation | Enhanced or piled foundations.<br>Underpinning (existing buildings only).<br>Careful planning of vegetation. |
| Biodiversity | Identify which local habitats should be retained / enhanced as part of the development.<br>Local Biodiversity Action Plan and site survey. | Ensure buildings do not obstruct flight paths, corridors or networks.<br>Green / Brown roofs. |
| Infrastructure and services | Ensuring services are resilient to impacts. | Resilient ducting, overhead cable, drainage and other services. |

**Box 3.5: Examples of cost and benefit considerations - building design**

**1. Building level SuDS/water conservation measures**

Water efficient appliances: Additional costs add up to approx. £120 per dwelling – WC with 4.5/2.2-litre dual flush: £80 per dwelling, aerating taps: £50 per dwelling, washing machine: £30 per dwelling (where a washing machine is being provided), Low flow showers: no extra cost[27].

Rainwater harvesting: The cost of installing a pumped system (30% from 50m$^2$ roof) is estimated at around £500 per dwelling based on a dense urban setting where collection storage can be shared between dwellings. The cost doubles in suburban areas with lower density housing where it is more difficult to share storage between dwellings[27].

Greywater recycling: For a system to reuse 30% of bath, shower and tap water, the cost is estimated at £1,000 per dwelling in a dense urban setting and double in lower density housing areas[27].

**2. Adaptation measures for higher temperatures**

Natural stack ventilation in low rise housing / offices: Controlled/passive stack ventilation with heat recovery carries a premium construction cost of £30-35 /m$^2$ gross floor area for wind and air density driven ventilation with heat recovery in place of a simple extraction system[26]. Passive stack ventilation with humidity control is estimated to cost around £250 per dwelling based on 50 properties on a single development[27]. Airtight building envelope: Additional cost - £80 per dwelling based on 50 dwellings in a single development[27].

Ground source heat pumps and boreholes: Electricity demand can be reduced by 30% compared with traditional heating and cooling systems. Factors affecting the relative costs and benefits include the number of kW hours of cooling / heating required on a monthly basis, local geology / hydrogeology and the ratio between plot and building size[26]. The main additional cost is the installation of pipes in the ground. The additional cost is estimated at £2,000-£3,000 per house depending on ground conditions and the length / depth of pipe required[28].

Green/brown roofs: Payback in 2-3 years through savings in heating and cooling costs. Use of recycled aggregate from the site in place of paving slabs would result in a saving of £10,000 for a 1000m$^2$ green roof. Life expectancy increased from 30 to 60 years by protecting waterproofing membrane from climatic extremes, UV light and mechanical damage. Maintenance costs add £1/m$^2$ per year[29]. For a typical factory unit the cost of an extensive green roof is estimated at £84,000 (based on 5,000m$^2$ production plus 1,000m$^2$ office) and for a typical warehouse £250,000 (13,000m$^2$ production plus 3,340m$^2$ office)[28].

**3. Adapting to increased risk of subsidence**

Enhanced or piled foundations in new buildings: More expensive than traditional foundations in low rise buildings, but less of a premium on high rise buildings. Customer expectation could lead to problems selling non-adapted buildings in the future in affected areas[28].

**Box 3.6: Modern methods of construction**

The term 'Modern Methods of Construction' (MMC) embraces a range of technologies involving prefabrication and/or off-site assembly. MMC is increasingly regarded as a realistic means of improving quality, reducing time spent on-site, improving on-site safety and addressing skills shortages in the construction of UK housing (CABE, 2005[30]; BRE, 2005[31]). MMC is also seen as a way of reducing construction costs, and increasing the supply of affordable housing, as illustrated in the recent competition to design £60K homes promoted by government.

However the use of MMC for residential properties is largely untested in the UK, and the insurance industry therefore has limited information about their long-term resilience to impacts including flooding, driving rain, subsidence and windstorm (ABI, 2005[32]), which are predicted to increase with climate change. There are also concerns about the resilience of lightweight construction, often used in MMC, to higher summer temperatures (e.g. Arup, 2004[33] and Hacker, JN et al, 2005[34]). These issues should be fully explored when considering how to use MMC as part of a building designed to adapt to climate change impacts.

Further guidance on building design for climate change adaptation can be found in **Part 4, Appendix 1** and **Appendix 3**.

Part 4

# Case studies

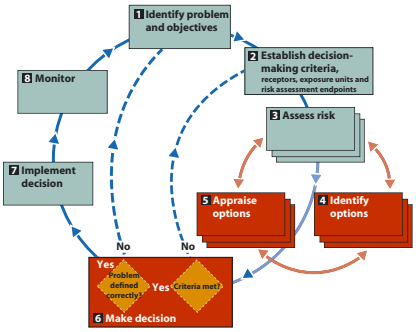
## 4.1 Using the case studies

**Part 4** of the guidance illustrates ways of adapting to climate change using three case study sites within the Growth Areas. Each site is an example of a generic development type and can be used to translate lessons across the UK. The generic development types are:

- **Town centres**, as illustrated by Bedford Town Centre Area Action Plan.
- **City centre sites**, as illustrated by Wood Wharf, London.
- **Urban extensions**, as illustrated by Queenborough and Rushenden, Isle of Sheppey, Swale, Kent.

See **Section 1.7** for more information on the case studies.

Each case study provides information on Location, Site Layout and Building Design. Under **Location**, the issues relevant to climate change adaptation are identified for each site. Examples of adaptation measures are then explored under the **Site Layout** and **Building Design** themes. These adaptation options reflect the case study locations but also include some generic measures which will be applicable across the country to other examples of the three generic development types. Many adaptation measures are transferable between development types – signposts have been used to illustrate some of these crossovers.




**Part 4** of the guidance relates to Stages 4, 5 and 6 of the UKCIP Risk, uncertainty and decision-making framework.

For more information on how to identify, appraise and select climate change adaptation measures, see **Section 2.3**.

The adaptation measures illustrated throughout **Part 4** include measures which are already being incorporated as part of the case study proposals, as well as further measures which could help to improve the climate resilience of the proposed developments. As the case study examples involve developments at the early stages of masterplanning, it is not known what combination of adaptation measures will feature in the final developments, and therefore, the developments cannot yet be described as best practice. While the adaptation measures featured are all considered to be examples of good practice, their suitability will depend on the individual site characteristics and the consideration of local climate change impacts and risks.

The adaptation measures are categorised according to the following type of options:

| Adaptation Option category | Symbol |
|---|---|
| Win / win | ✓ |
| No / low regrets | ☺ |
| Flexible | ⇝ |
| High resilience | ☂ |

For more information on adaptation options, see **Section 2.3**, and technical sources listed in **Appendix 1.**

## 4.2 Climate change issues in Bedford

Bedford/Kempston and the northern Marston Vale forms one of six growth locations in the Milton Keynes and South Midlands Strategy[35]. This Strategy provides for urban renaissance coupled with increased delivery of new housing, economic development and new jobs. Growth within Bedford/Kempston and the northern Marston Vale includes 19,500 new dwellings to be constructed between 2001 and 2021. In delivering this growth, consideration should be given to issues which could be exacerbated by climate change. These include **fluvial flooding**, **water shortages**, **thermal comfort** and **subsidence**.

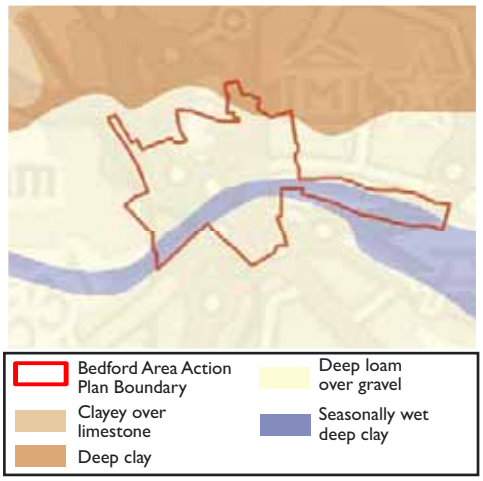
### Fluvial flooding

There is a risk from fluvial flooding in Bedford from the River Great Ouse. Whilst part of Bedford benefits from flood defences (red hatched area), some areas lie within the Environment Agency's Zone 3 flood risk (blue hatched area), having a 1 in 100 or greater chance of flooding each year. A larger proportion of the town centre, including part of the AAP, is within the Environment Agency's Zone 2 flood risk (light blue shading), being at risk from an extreme flood from the river (having a 1 in 1000 chance of happening each year). This risk of flooding is likely to increase in the future due to climate change.

### Subsidence

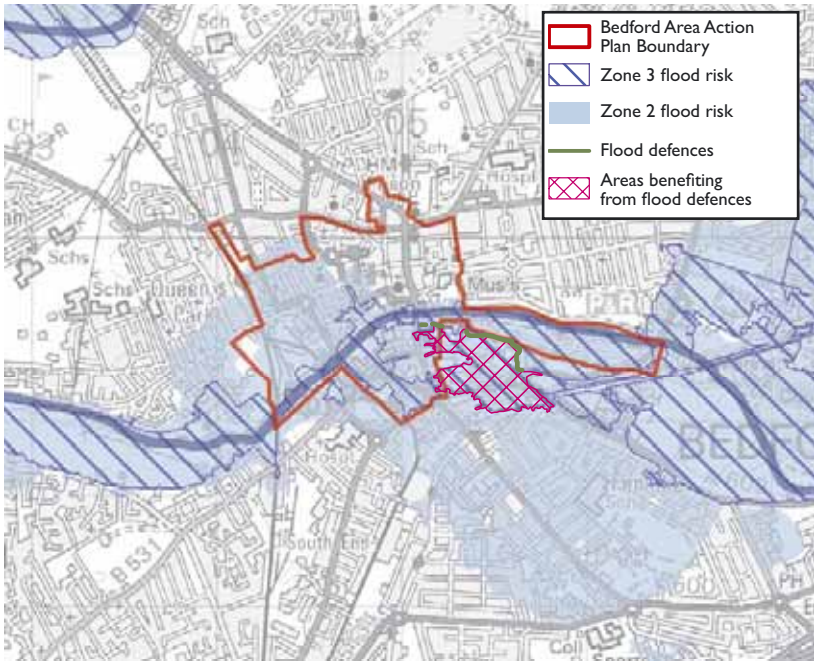
Most subsidence is caused by the movement of clay soils around the foundations of buildings as the clay dries out in summer (shrinks) or becomes wet in winter (heaves)[36]. The deep clays (orange shading on the map below) correspond with significant shrink-swell potential, which could be worsened with climate change. Whilst this is an issue for Bedford as a whole, it only affects the northern most tip of the Area Action Plan.

### Soils in Bedford




Land Use Consultants, 2006 (Source: Cranfield University)

### Risk of flooding in Bedford



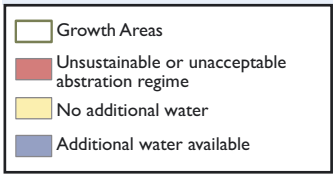

Land Use Consultants, 2006 (Source: Environment Agency)

### Summer water resource availability


Land Use Consultants, 2006 (Source: Environment Agency)

### Water shortages

Bedfordshire is already facing water resource pressures. As shown on the map (left) there are no significant surface water resources available to meet additional demand in summer months – these are already fully committed.




### Thermal comfort

Issues of thermal comfort in Bedford could become more pronounced during hotter summers, both within buildings and in outdoor areas. For example, in the East of England, summer temperatures are expected to increase by between 0.5 and 1.5°C by the 2020s and this increase could exceed 4.5°C by the 2080s.

## 4.3 Key issues for Bedford Town Centre Area Action Plan

Bedford Town Centre AAP sets out the spatial strategy for the regeneration of the town centre. It identifies a number of key areas of change, potential areas of change, and transportation and highway improvements. In planning for this change, consideration should be given to the potential implications of climate change impacts. Particular attention should be paid to those issues local to the town centre which could worsen or ameliorate due to climate change. These issues are **localised flooding**, **the shopping environment** and **treescape**.

**Table 3.1** highlights the need for flood risk assessments and management of residual risks.

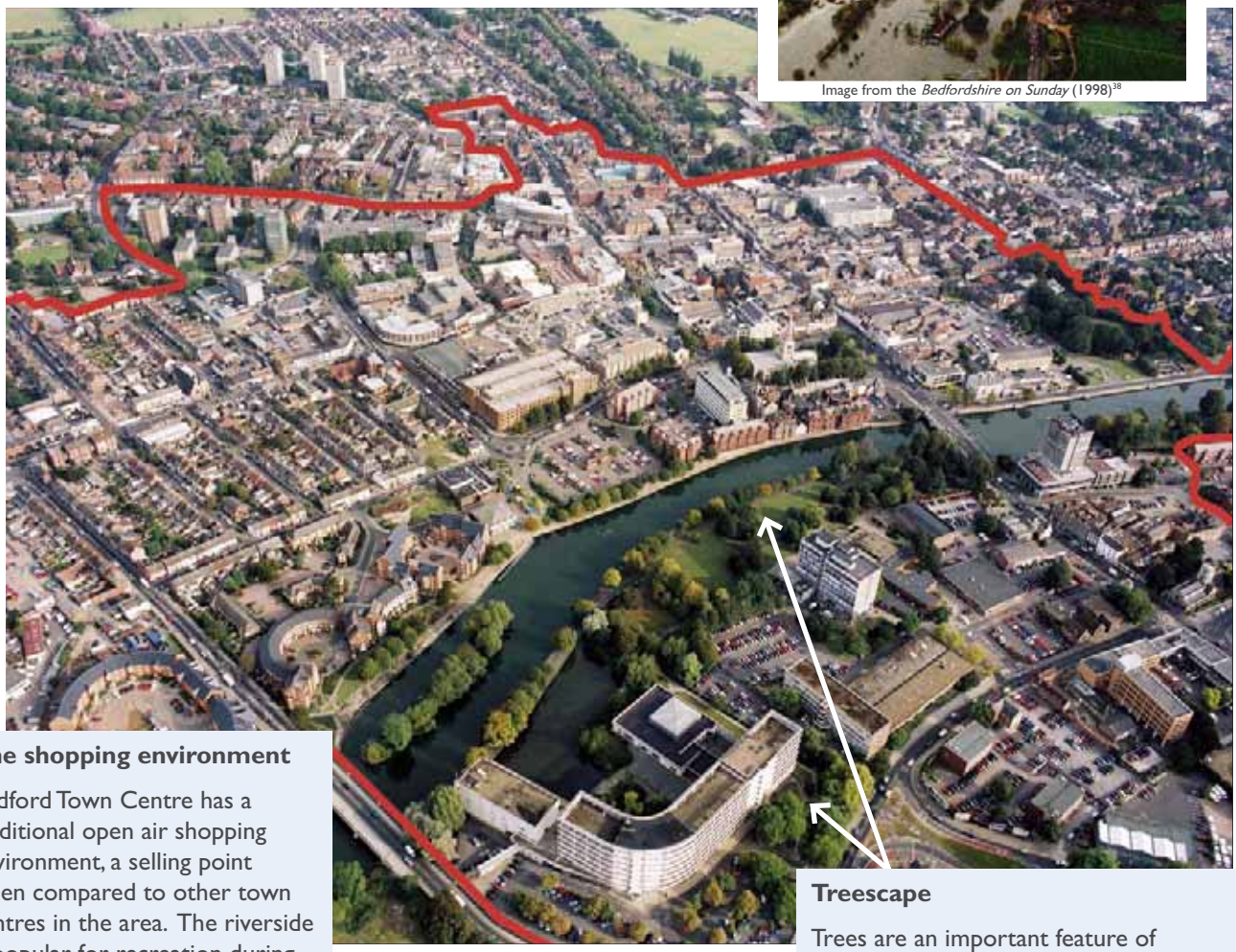
### Localised flooding

The River Great Ouse has historically flooded parts of central Bedford to the south of the river and more limited parts of Bedford Town Centre to the north of the river on a few occasions e.g. in 1998 (right). There is potential for these events to become more frequent from climate change. The overall risk to the retail sector is considered to be low, although basements in some streets are likely to be affected.

### Flooding of the River Great Ouse

Image from the *Bedfordshire on Sunday* (1998)[38]

### Bedford Town Centre



Bedford Borough Council (October 2005)

### The shopping environment

Bedford Town Centre has a traditional open air shopping environment, a selling point when compared to other town centres in the area. The riverside is popular for recreation during warmer weather.

Promoting outdoor living and café culture in the town centre, through the creation of new public squares and pedestrianised streets, as part of the AAP, will help to maximise opportunities associated with climate change.

Bedford Borough Council (October 2005)

### Treescape

Trees are an important feature of the Bedford townscape. They also provide shade and shelter from warmer temperatures. In light of potential climate changes, careful consideration should be given to the choice of species in new developments to take account of warmer temperatures, less summer rainfall, etc.

## 4.4 Adapting the public realm

Bedford Town Centre West is a key area of change as identified in the Area Action Plan Preferred Option[12]. Existing uses comprise high rise housing, a bus station, car park and shops (see photograph to the right). Draft proposals for the site comprise 20,000 sqm of retail, a multiplex cinema, a 4,500 sqm department store, a foodstore, hotel, bus station and up to 590 residential units.

Developers at Bedford Town Centre West are incorporating a number of measures to adapt the **public realm** to potential climate changes and to maximise opportunities for outdoor living:

**Bedford Town Centre West**

Bedford Borough Council (October 2005)[12]

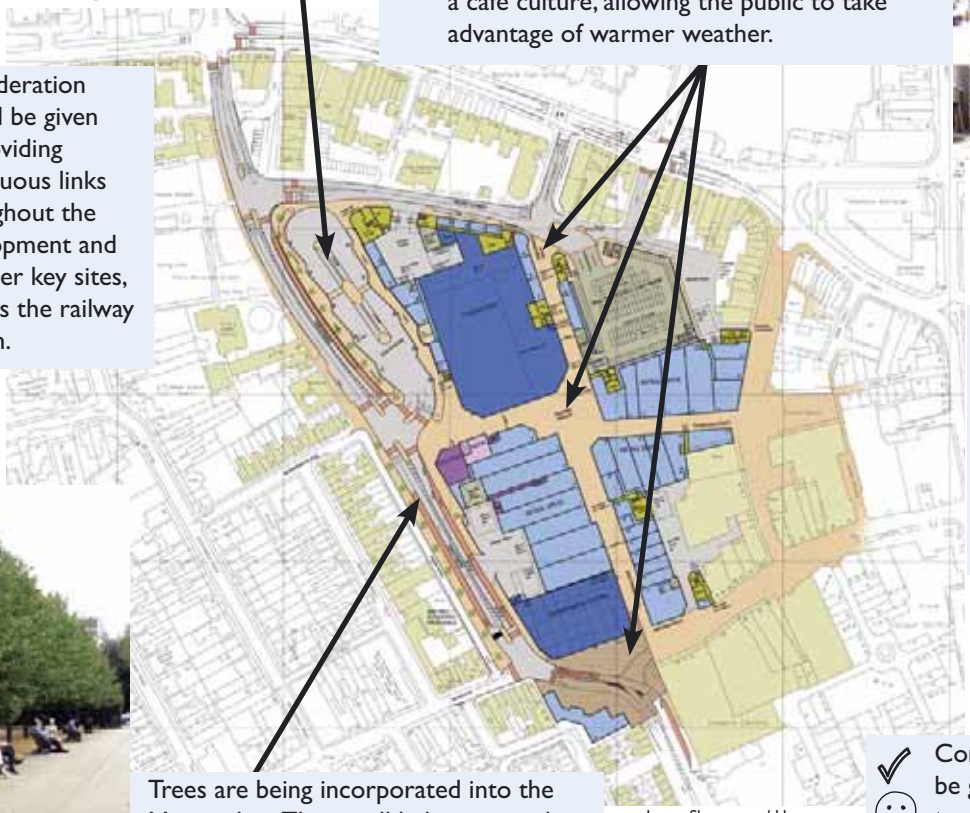
✓ ☺ ≈ A sheltered open air bus station has been incorporated into the Masterplan, providing protected links for bus passengers to the shops. This will help to protect the passengers from both increased summer temperatures and more intense rainfall events during the winter.

✓ ☺ ≈ ☂ The Masterplan builds on the town centre's traditional open air environment. For example, the Plan includes:

- Public squares, including Pilgrim Square which forms the hub of the development.
- New pedestrianised streets.

These open spaces help to increase opportunities for outdoor living and promote a café culture, allowing the public to take advantage of warmer weather.

**Masterplan for the site**



Lyons, Sleeman and Hoare Architects (2006)

✓ ≈ ☂ Consideration should be given to providing continuous links throughout the development and to other key sites, such as the railway station.

✓ ☺ ≈ ☂ Landscaped areas are being designed to require minimal irrigation. This will help to conserve water resources.

✓ ☺ Trees are being incorporated into the Masterplan. These will help to provide shade in summer and solar gain in winter, ensuring that public open spaces can be used in warmer temperatures.

✓ ☺ Consideration needs to be given to the choice of tree species, ensuring this takes into account climate change and reduced availability of water.

## 4.5 Maximising opportunities for outdoor living

Developers at Bedford Town Centre West are incorporating a number of measures to provide opportunities for outdoor activity. Some of these, and additional measures that could be included in the scheme, are illustrated below:

There is provision of a range of private and public outdoor spaces, including roof gardens, balconies and public open spaces.

Public open spaces should be designed to withstand high use, especially in summer months.


**Proposed streetscene at Castle Lane, Bedford**

Rainwater collection systems/grey-water recycling systems could be used to provide water for roof gardens.

Drainage systems from the roof gardens and balconies should be able to cope with increased frequency and intensity of rainfall in winter.

Private and public outdoor spaces should have appropriate shade and vegetation. The cooling benefits of water features could be considered for new public spaces. Water features should be designed to minimise water consumption.

**Conflicts and constraints**

- While trees help to provide shade and shelter from warmer temperatures, they can restrict CCTV coverage. Thought should be given to appropriate species and locations to ensure that they do not compromise security.
- Sheltered walkways may not always be appropriate in some locations, such as those with a historic context.

**Win/wins**

- As well as providing shade, trees are an important feature of Bedford's townscape, reduce rainwater run-off (through interception) and flooding, improve air quality and contribute to climate change mitigation.
- Ensuring that public transport nodes are well-adapted to extreme climate events could encourage the uptake of sustainable modes of transport. This will also contribute to climate change mitigation.

## 4.6 Adapting to changes in temperature and rainfall

Building design principles used at Bedford Town Centre West highlight a number of features that help to climate proof a range of building types against the impacts of climate change. There are a number of additional measures that could be integrated into the building design to further minimise the site's vulnerability to climate change. Existing and additional adaptation measures for this town centre location are presented below.

### Maintaining the thermal comfort of buildings

✓ Secure window openings are being provided at Bedford Town Centre West to allow natural ventilation in residential, office and retail buildings.

✓ Where appropriate, a suitable outdoor micro-climate should be provided through landscaping, planting and use of green roofs. E.g. trees can regulate building temperature by providing shade and cooling the air by transpiration.

**Image of a typical town centre redevelopment**

HalcrowYolles

✓ Blinds, shutters or movable awnings should be integrated in building design to allow for manual thermal control.

✓ Permanent shading should be provided, such as louvres (horizontal louvres should be positioned on south-facing walls and vertical louvres should be positioned on east/west facing walls), overhanging eaves, etc.

✓ Large south facing glazed areas should be avoided to reduce solar gain in summer.

✓ Balconies are being considered at Bedford Town Centre West. As well as providing private outdoor space, balconies also shade lower stories.

✓ Natural ventilation systems should be used in all buildings to ensure they stay cool during warmer summers.

### Climate proofing outdoor spaces

The outdoor bus station proposed at Bedford Town Centre West will protect passengers from both increased summer temperatures and more intense rainfall events during winter. Overhangs will provide shelter and shade during waiting and boarding time.

The design of the station is similar to Birkenhead bus station and includes natural 'stack effect' ventilation and passive solar energy, minimising energy requirements for lighting, heating and cooling.

Materials used in the construction of the bus station should be able to perform adequately in the climate throughout the lifetime of the development.

The drainage and guttering systems of the bus station should be designed to cope with more intense rainfall.

**Adaptation measures incorporated into an oudoor bus station**

## 4.7 Conserving water in buildings

The key principles for water conservation in buildings are:

- Reduce the level of usage through the introduction of more efficient fittings and fixtures.
- Harvest water through rainwater collection, and recycle and reuse water using grey water systems and reedbeds.

### Reducing level of usage: more efficient fittings and fixtures

Developers at Bedford Town Centre West are planning to incorporate water conservation measures within residential buildings, finding them to be a no/low cost solution to meeting Ecohomes standards. Examples of measures they are incorporating[20] are:

**Water taps**

Low flow taps can save up to half the volume of conventional faucets. It is possible to further reduce tap water consumption (by up to 20%) with the use of automatic closure taps. Electronic taps are able to promote 40% tap water savings compared to conventional faucets.

**Showerheads**

Showers tend to consume a third of the water of baths, but time spent in the shower has a great influence over this. Low-flow rate showerheads can make use of both flow restrictors and aerators to provide efficient cleaning with less water use.

**Low flush toilets**

The use of 6 litres low-flush toilets, as required since 2001[38], provides an overall saving of 40-50% compared to the standard 13.5 litres per flush. Dual flush valves (4.5/2.2 litres) further reduce water consumption in toilets.

**Aerators**

Aerators mix air into the water stream. This reduces the overall flow of mains water, providing efficient cleaning with less water use.

### Harvesting water: rainwater collection

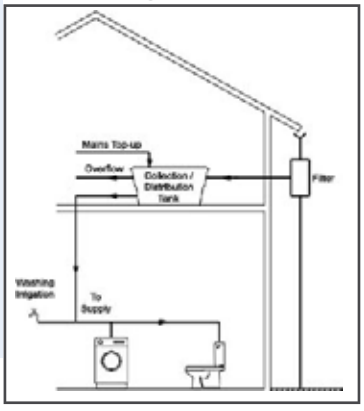
Harvesting rainwater is another measure that could be used to promote water conservation at Bedford Town Centre West. Rainwater harvesting is discussed in the panel below:

Rainwater collection or rainwater harvesting (RWH) promotes water conservation and minimises flooding caused by run-off[39].

RWH systems collect rain, filter the runoff and store it for later use. Untreated rainwater can only be used where there is no risk of consumption, such as garden irrigation, flushing toilets and vehicle washing. If water is to be used internally, such as in food preparation, cooking and drinking, treatment is usually necessary – it must undergo a process of micro-filtration and disinfection.

The design of a RWH system depends on the intended use of the water, the site's potential yield and resource and external factors which may affect harvesting. The gravity fed system illustrated above has a collection tank in a building's loft. Gravity then supplies appliances.

**Gravity fed rainwater harvesting system**




Legget et al. (2001)[39]

- For general information on ventilation and cooling of buildings, see **Section 4.11**.
- For general information on including brown/green roofs in building design, see **Section 4.11**.
- For general information on adapting buildings at risk of flooding, see **Section 4.16**.

**Conflicts and constraints**

- Retail units tend to be constructed as shells and fitted out by tenants, who may not incorporate water conservation measures.
- Fixtures and fittings can be replaced by occupants.

**Win/wins**

- Balconies provide outdoor space and shading for lower stories.
- Water efficient fixtures and fittings help to save both water and energy.

# 4.8 Climate change issues on the Isle of Dogs

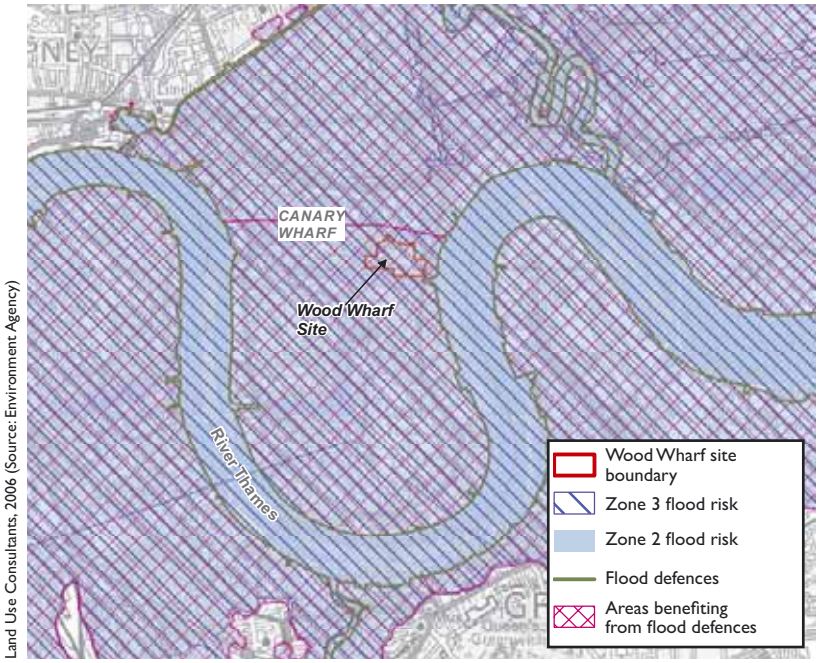
Development at Wood Wharf is expected to contribute to significant social, economic and environmental benefits for the Isle of Dogs, create a new community and provide employment opportunities for new and existing residents. In delivering these benefits, consideration should be given to issues which could be exacerbated by climate change. These issues include **fluvial flooding**, thermal comfort from the **heat island effect** and **water shortages**.

## Fluvial flooding

As illustrated on the flood risk map (right) the Isle of Dogs is currently protected from flooding (the red hatched area). The Thames Barrier protects the area from all but a 1 in 1000 fluvial flood event. This level is expected to be maintained until 2030. However, the Isle of Dogs could be vulnerable to flooding from:

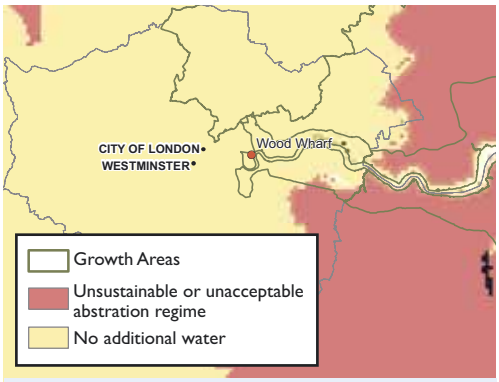
- Any failures of current flood defences around the Isle of Dogs.
- Localised flooding from excessive rainfall (although this is unlikely as run-off is expected to empty directly into the dock basin).

### Risk of flooding on the Isle of Dogs




Land Use Consultants, 2006 (Source: Environment Agency)

### Summer water resource availability




## Water shortages

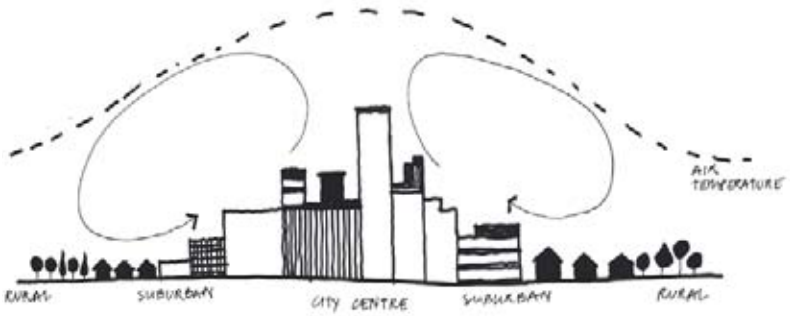
There is pressure on water resources across the South East. As shown on the map above, the majority of Greater London has no additional water available, meaning that summer surface water is already fully committed. The supply-demand balance of water in London currently stands in deficit. The Environment Agency has estimated that without any further action to manage water demand, new strategic water resources may be required, under some scenarios, by 2020[40].

## Heat island effect

Greater London will experience more pronounced temperature increases owing to the higher temperatures associated with the urban heat island effect (as shown on the diagram below). In central London, the urban heat island effect adds up to 5-6°C to summer night time temperatures[41].

This has implications for the thermal comfort of all those who live and work at Wood Wharf. To ensure that buildings are effective at moderating temperatures for occupants, appropriate thermal mass needs to be combined with night ventilation to remove heat absorbed during the day. For example, night ventilation applied to a high thermal capacity structure can reduce the maximum daytime temperature by 2-3°C[42].

### Urban heat island profile



## 4.9 Climate change issues at Wood Wharf

Proposals at Wood Wharf are for a high quality high density mixed use development with provision for office space, homes, retail and community facilities. In planning for this development, particular attention should be paid to those attributes local to Wood Wharf which could worsen or ameliorate the effects of climate change. These attributes are **proximity to water**, **dockside leisure**, **flood risk** and provision of **high buildings**.

### Aerial photograph of the Wood Wharf site


British Waterways London (December 2003)[13]

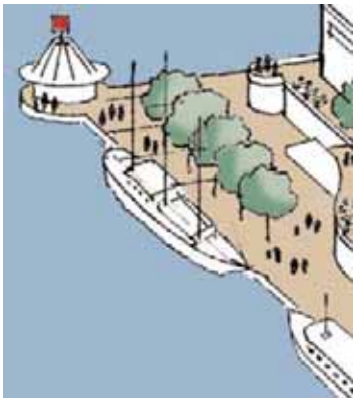
### High buildings

The high buildings planned at Wood Wharf, some almost as high as those at Canary Wharf, will promote high density development while maintaining areas of open space for leisure.

However, they could be vulnerable to any increases in wind speed or storminess. The design and arrangement of these buildings could also increase ground wind speed, affecting those who live or work in the area.

### Proximity to water

Water bodies have a cooling effect on surrounding land. Careful consideration should be given to the location and arrangement of buildings at Wood Wharf, to ensure that the potential cooling effect from the surrounding dock basins, canals and water spaces is maximised.



British Waterways London (December 2003)[13]

### Dockside leisure

Waterspaces are a unique feature of the Isle of Dogs. They are also a focus for development at Wood Wharf as the site is surrounded by water and is to be bisected by a new canal.

Promoting dock and canal side living and providing facilities for outdoor leisure will help to maximise opportunities associated with warmer temperatures.

### Flood risk

Wood Wharf is upstream from the Thames Barrier (left) and other river defences so is currently protected from potential flooding from tidal surges. Development will be elevated 8 m above the current dock level, further reducing the potential risk of flooding. However, even if flood defences are adequately designed and maintained for the life of the development, there will remain a residual risk from the defences failing.

**Section 3.2** and **Table 3.1** highlight the need for flood risk assessments and management of residual risks.

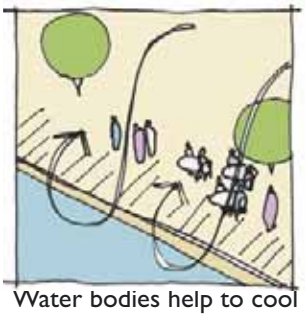
## 4.10 Offsetting the urban heat island effect

A key potential impact of climate change in any large town or city is more pronounced summer temperatures associated with the urban heat island effect. There are a number of measures that can be incorporated to the layout of a development which can help to reduce the negative effects and take advantage of opportunities associated with the heat island effect.

### Water bodies

✓ ☺ Buildings and open spaces adjoining the dock and proposed canal at Wood Wharf take advantage of the cooling effect of water.

✓ ☺ Consideration could be given to the use of water from the dock basin for cooling buildings. Care should be taken to ensure that any resultant increase in the temperature of the water bodies does not negatively affect the local biodiversity of the nearby Sites of Borough Importance at Blackwater Basin.



Water bodies help to cool surrounding land

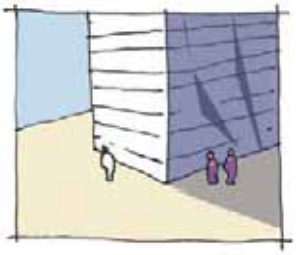
**The illustrative site plan for Wood Wharf**

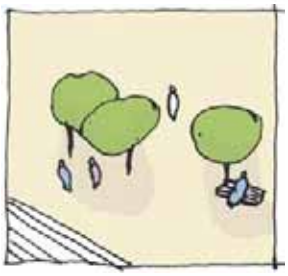
Development includes:

1. Cartier Circle
2. Marina
3. Blackwall Basin
4. Moorings
5. Central Plaza
6. Possible station entrance
7. Bridge link
8. New canal
9. South Dock
10. Public garden
11. LUL Vent shaft
12. Preston's Road
13. River Lock


British Waterways London (December 2003)

Use of buildings and trees to provide shading





### Shading

☺ The proposed layout, height and orientation of buildings ensure that shade is provided to many of the open spaces at Wood Wharf, enhancing their attractiveness during warm weather.

✓ ☺ Appropriate planting regimes should be used in public and private open spaces at Wood Wharf to ensure that shading is provided in summer months when it is most required.

### Open space

✓ ☺ Account should be taken of future climate changes when choosing tree and shrub species within the network of landscaped open spaces at Wood Wharf.

✓ ☺ If included within open spaces, water features should be designed to minimise water consumption.

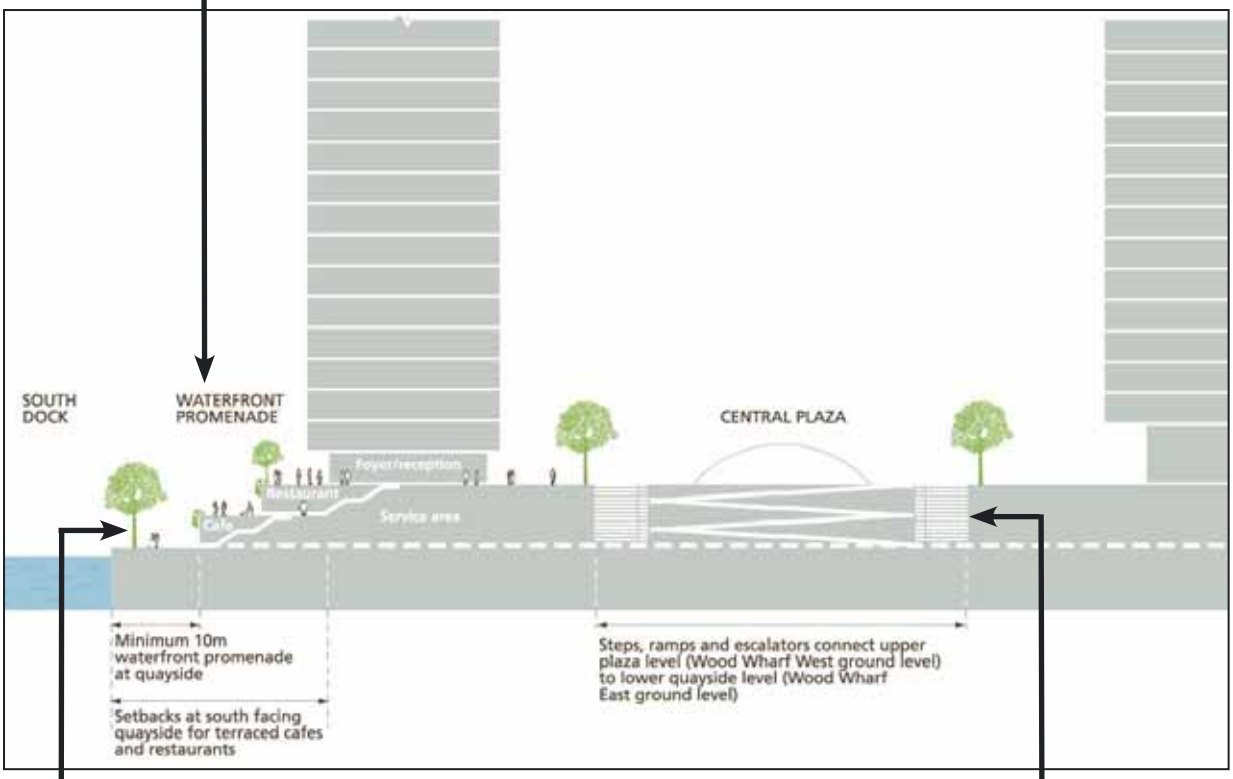
✓ ☺ Landscaped areas should be designed to require minimal irrigation.

### Café culture

Proposals at Wood Wharf include cafés and restaurants along the waterfront promenade. These will help to create opportunities for outdoor living, allowing those who live and work in the area to take advantage of warmer weather.

Cafés along the waterfront promenade

**Section through Wood Wharf**




British Waterways London (December 2003)[13]

### Outdoor environment

The dockside will be publicly accessible and connect to other publicly accessible areas and routes next to Wood Wharf.

Additional leisure facilities could be created along the docksides to meet the increased demand for outdoor water-based recreation facilities during warmer weather.

British Waterways London (December 2003)[7]

### Providing a comfortable temperature for shopping and leisure

Wood Wharf will provide shopping and leisure facilities, many of which are expected to be within a covered centre. These facilities will provide a regulated temperature for users in all weather conditions.

### Conflicts and constraints

- The use of heat exchange to cool buildings could have negative effects on biodiversity (by increasing the temperature of water bodies).
- The use of indoor shopping centres could deter people who would prefer to shop in an outdoor environment during warmer summers.

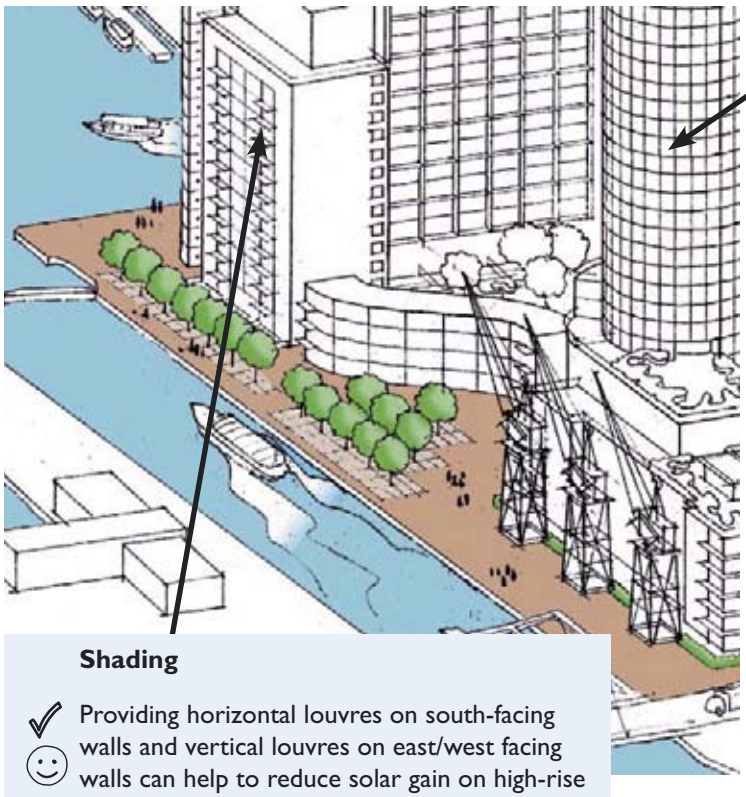
### Win/wins

- The use of docksides to help cool surrounding buildings or areas of open space and provide opportunities to take advantage of warmer weather (provision of cafés, leisure facilities, etc).

# 4.11 Adapting high-rise, high density buildings

The challenge in large high-rise buildings such as those proposed at Wood Wharf is to reduce the amount of heat generated by staff and office equipment. Reducing heat gain will become increasingly important in a warmer world.

**High-rise buildings proposed at Wood Wharf**



British Waterways London (December 2003)

### Shading

- Providing horizontal louvres on south-facing walls and vertical louvres on east/west facing walls can help to reduce solar gain on high-rise buildings[18].
- Balconies on high-rise buildings provide shading for lower stories, limiting solar gain to glazed areas.
- Provide integral blinds to allow for manual thermal control in high-rise buildings.

### Materials and glazing

- Ensure building materials are thermally efficient and minimise heat absorption from the outside.
- Triple glazing with interpane shading reduces the proportion of solar heat transmission into the building to 12% (unshaded double pane glazing only reduces solar heat transmission to 70%)[43].

### Limit internal heat gains

- Heat released inside a building by lighting and equipment should be minimised, by:
  - Having maximum energy-efficient appliances correctly positioned, installed and turned off when not in use.
  - Using low energy lighting.
  - Insulating cylinders and primary pipe work.
  - Locating the boiler close to the hot water cylinder.

### Ventilation and cooling

High-rise deep-plan buildings present particular challenges in terms of cooling and ventilation.

The feasibility of heat exchange/groundwater cooling could be explored at Wood Wharf as an alternative to air conditioning. However, heat exchange pumps should be powered by renewable energy sources where possible.

Where air conditioning is necessary, the use of renewable energy sources should also be considered, e.g. using solar energy.

For guidance on how to naturally ventilate buildings, see www.zedstandards.com, www.arup.com and www.bre.co.uk and **Appendix 1**.

### Examples of well adapted buildings for ventilation and cooling

- MOD Building, Abbey Wood (see below) uses the evaporative power of water to assist in cooling the building.
- Boots Headquarters, Nottingham employs horizontal louvres on south facing aspects and vertical louvres on east and west facing elevations to enable good temperature control.
- BRE Environmental Office Building cuts solar gain and glare using external mechanical louvres on south facing elevation. It also employs cross and stack ventilation to assist in natural cooling and ventilation.

MOD Building, Abbey Wood

Source: Dr Terry Wyatt, Hoare Lee and Partners, London

### Brown / green roofs

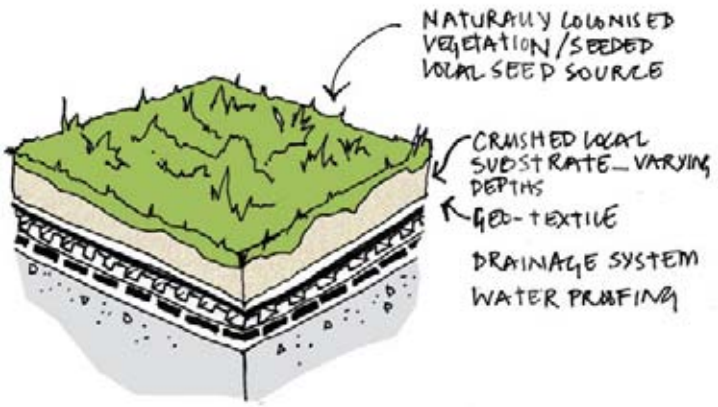
Developers at Wood Wharf are considering brown / green roofs on some of the high-rise buildings. These help to regulate temperature within buildings by absorbing solar radiation and reducing thermal transference[44].

The recent construction of a green roof on the 160m high Barclays Headquarters in Canary Wharf demonstrates the feasibility of installing brown / green roofs on high rise buildings[29]. It was retro-fitted onto paving and has been designed for biodiversity with a mosaic of habitats to encourage invertebrates and black redstarts – shingle areas with bare ground, a calcareous grassland mix, and a small area of sedum mat (see right).

**Use of brown / green roofs at Barclays Headquarters, Canary Wharf**


www.livingroofs.org

**Cross-section through a brown / green roof**




www.livingroofs.org

- For general information on conserving water in buildings, see **Section 4.7**.
- For general information on flooding proofing the lower storeys of high rise buildings, see **Section 4.16**.

### Conflicts and constraints

- Roof space is often required for telecommunication masts, infrastructure and plant, reducing the potential for brown/green roofs.
- Mixed mode ventilation includes the use of mechanical ventilation which increases demand for energy and contributes to internal heat gains. Where possible mechanical components should be powered by renewable energy sources.

### Win/wins

- Brown roofs have multiple benefits, including providing habitats, helping to regulate building temperature through thermal insulation, attenuation of rainfall, reducing storm-water run-off and extending roof life.
- Balconies on high-rise buildings provide private outdoor space and shading for lower stories.
- Limiting internal heat gains by using energy efficient applicances, using low energy lighting, insulating pipework and locating the boiler close to the hot water cylinder reduces energy bills, contributions to greenhouse gas emissions and heat gain in buildings.

# 4.12 Climate change issues on the Isle of Sheppey

The South East England Development Agency (SEEDA) and Swale Borough Council's principal aim for Queenborough and Rushenden on the Isle of Sheppey is regeneration, to address the area's employment decline, social exclusion and physical isolation. In delivering regeneration, consideration should be given to **flood risk**, **water resources**, **thermal comfort** and the potential effect of climate change on **infrastructure** links and **biodiversity** on the island.

## Flood risk

The Isle of Sheppey has a history of flooding. More than 50% of the island lies below high tide level and much of the land area is within the Environment Agency's Zone 2 flood risk (dark blue shading on map to the right), having a 1 in 100 or greater chance of flooding each year from the river. This risk of flooding is likely to increase in the future due to climate change. Additional housing and employment development in the area may also exacerbate intra-urban flood risks.

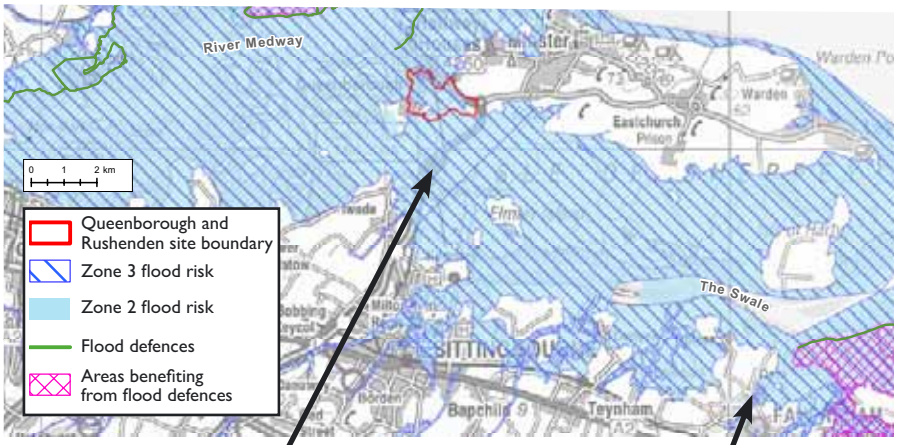
## Biodiversity

The Isle of Sheppey lies adjacent to three Special Protection Areas (SPAs), as illustrated on the map below. These inter-tidal areas and coastal grazing marshes support internationally important populations of waterfowl and wading birds, as well as plants, fish, invertebrates and some mammals. Inter-tidal habitats may be vulnerable to 'coastal squeeze', a process whereby habitats cannot migrate inland due to hard sea defences or other barriers, and grazing marshes may be vulnerable to flood damage. Both habitats could be vulnerable to flood-risk management works.

### SPAs near to site


Land Use Consultants, 2006 (Source: English Nature)

### Risk of flooding on the Isle of Sheppey




Land Use Consultants, 2006 (Source: Environment Agency)

## Infrastructure

Development at Queenborough and Rushenden is intended to benefit from the Swale Crossing Bridge and the new Rushenden Relief Road. Infrastructure links may be vulnerable to flood, subsidence or storm damage.

Rummey Design Associates (2006)

## Thermal comfort

The highest recorded UK temperature (38.5°C in August 2003) occurred at nearby Brogsdale-Faversham. The South East region is expected to experience the highest increase in average and extreme summer temperatures as a result of climate change. There may be negative impacts on vulnerable groups, but also opportunities for making the most of natural sea breezes offered by the coastal location and maximising tourism opportunities on the Isle of Sheppey.

## Water resources

Kent is already facing water shortages. Much of the Isle of Sheppey is considered to have an unsustainable abstraction regime. The Green Charter for the Queenborough and Rushenden masterplan indicates that residential development must achieve a minimum of 30% reduction in water consumption.

# 4.13 Climate change issues at Queenborough and Rushenden

The urban extension planned for Queenborough and Rushenden will comprise a mixed use development with housing, employment and tourism opportunities. Particular attention should be paid to those local features which could be particularly affected by climate change.

## Historic environment and archaeology

Working with the historic setting and heritage of the area is an important element of the regeneration scheme. Historic features include visible remains of former land reclamation and sea defences, Queenborough Conservation Area, Queenborough Castle (a Scheduled Ancient Monument), and archaeological potential from cleared factory sites e.g. previous alignments of the present-day creek. These may be vulnerable to flooding, storm surges, erosion, higher temperatures or driving rain, all of which could be exacerbated by climate change.

**Historic features at Queenborough and Rushenden**


www.photographicservices.co.uk

**Existing flood defences**

Rummey Design Associates (2006)

## Flood risk

Masterplanners at Queenborough and Rushenden have adopted a sequential approach to planning the development in line with PPG25. The masterplan proposes new housing for the ex-industrial area between Queenborough and Rushenden, which is protected by the western sea-defences. The Environment Agency has undertaken a Condition Survey of the western and southern sea defences, and a two-dimensional hydrodynamic modelling study to assess the extent of flood risk under a range of scenarios[14]. This suggested that a 1 in 100 or 1 in 200 event could overtop the new A249 from the south, but would not lead to flooding of residential property.

The South East Coastal Group is currently reviewing the estuarine Shoreline Management Plan, which will take account of climate change, and shift the focus from coastal defence to coastal risk management.

**Section 3.2** and **Table 3.1** highlight the need for flood risk assessments and management of residual risks.

## Nature conservation

Given the international importance of biodiversity on and around the Isle of Sheppey, development should take into account the effects of climate change on wildlife. A key consideration is to promote movement and permeability for wildlife throughout the area and to maintain the 'robustness' of populations. This will allow populations and species to spread out and move in response to changes in climate.

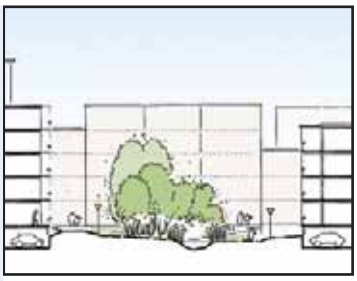
Rummey Design Associates (2006)

## 4.14 Adapting to flood risk

The Queenborough and Rushenden masterplan already incorporates a number of measures to address urban flooding and drainage.

**Existing measures in the masterplan to address flood risk include:**

- SuDS are being developed as part of the layout of the development, alongside existing evaporation and evapotranspiration on marsh land.
- The development is making use of the micro-topography of the site, allocating land uses that use depressions to retain water (e.g. at the marina and to replace mini-storage depressions lost to the new link road).
- Water courses are being opened through the site for amenity and flood absorption.
- Water features can be used for site cooling in residential and employment areas.
- New development is being set well back from existing flood defences, using the space for a linear park and walk-cycle route along the Swale.



Rummey Design Associates (2006)

**SuDS as part of the site layout**

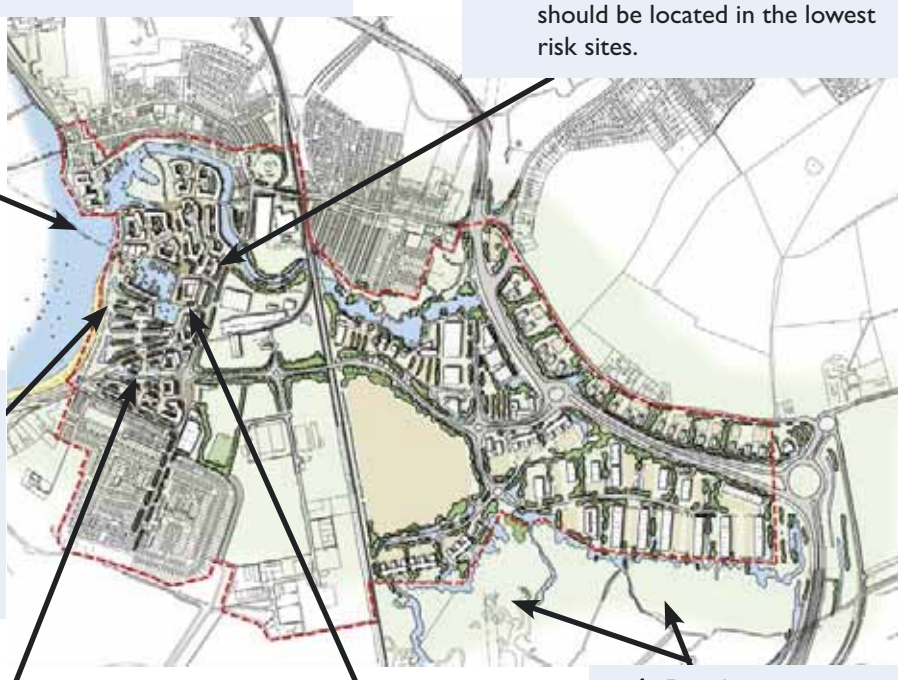
**Further adaptation measures to address future flood risk are illustrated below:**

PPS25/ABI flood risk sequential test for whole development (new and existing) should be adopted.

The potential insurance implications associated with the flooding of residential uses on current brownfield land and employment uses on greenfield land should be kept under review.

Strategic community facilities (e.g. emergency facilities, sewage treatment works and pumping stations, community centres, etc) and vulnerable land uses (e.g. schools, medical facilities, sheltered housing, etc) should be located in the lowest risk sites.

Dual lines of flood defences from hard to soft defences could be considered to allow for a staged coastal retreat.



Rummey Design Associates (2006)[6]

Different levels of flood defences should be provided for different land uses according to their vulnerability. Land uses that are flood-compatible (e.g. informal open spaces) should be located close to the most vulnerable areas.

Drainage and sewerage systems should be designed to have sufficient capacity to cope with more intense winter rainfall.

Existing development aggregations should be sub-divided into smaller flood cells.

High housing densities are being considered in areas at lower risk of flooding, with SuDS to accommodate extra urban storm drainage.

Developer contributions could be used to provide large flood-storage areas e.g. on land to the south east of employment sites or the new link road.

Given the importance of biodiversity on the Isle of Sheppey, masterplanners at Queenborough and Rushenden have included a number of biodiversity enhancement measures. Many of these will also act as climate change adaptation options. These measures and additional measures that could be considered are presented below.

**Biodiversity and climate change at Queenborough and Rushenden**

✓ ☺ ☂ Ecologial networks (including patches, gardens and green corridors), are being incorporated and will support local biodiversity and improve the resilience of habitats e.g. restoration of creeks.

✓ ☺ The design layout maximises connectivity between green spaces in Queenborough and Rushenden and adjacent habitats on the Isle of Sheppey (e.g. water courses, creeks and estuarine inter-tidal habitats).


✓ ☺ ⇝ ☂ Land uses could be phased in flood risk areas e.g. short-term use for playing fields, medium term use as a biodiverse meadow and long-term use for flood-storage.

✓ ☺ ⇝ ☂ Ecosensitive edges to the employment park are being incorporated to facilitate movement of species between habitats.

Rummey Design Associates (2006)

Rummey Design Associates (2006)

✓ ☺ The biodiversity network of the green infrastructure (e.g. linear park, waterside green spaces) should be aligned with the blue infrastructure to provide multiple functionality and benefits.

✓ ☺ ☂ The masterplan anticipates the need for replacement of inter-tidal habitats. The locations of these replacement habitats should take into account their long-term viability in the context of climate change.

**Conflicts and constraints**

- Promoting connectivity and networks for nature could conflict with securing separate flood cells.
- Maximising housing densities in low flood risk areas could exceed the capacity of SuDS.

**Win/wins**

- The use of SuDS could help to reduce the risk of flooding, create habitats and provide amenity functions.
- Aligning the green (open spaces and parks) and blue (creeks, rivers and docks) infrastructure provides multiple benefits for nature and recreation.

## 4.16 Adapting buildings to flooding

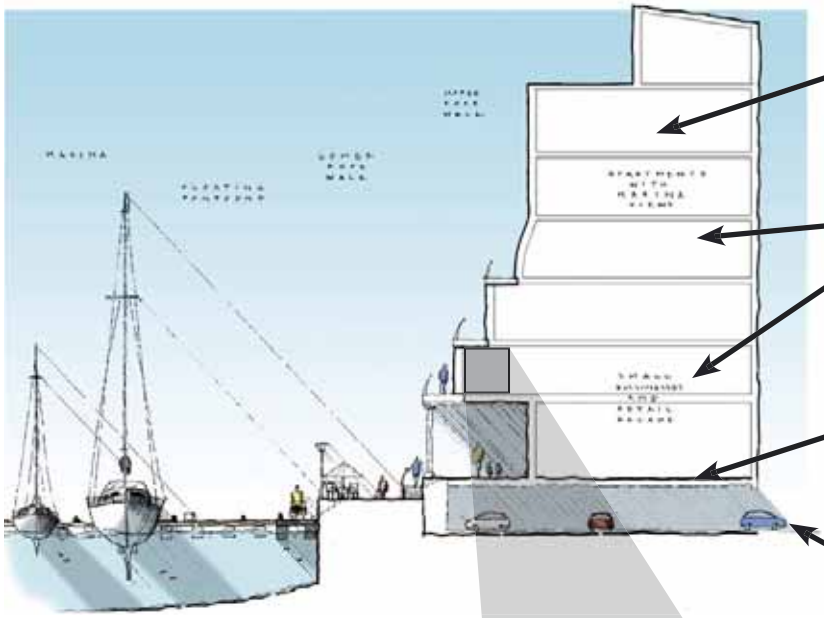
The best ways to increase resilience in property at risk of flooding are to:

- Move functional living-space above the likely level of flood risk.
- Reduce the amount of water entering a property.
- Limit the damage caused by flood water once it enters a property (wet proofing).

### Existing measures to address flooding at Queensborough and Rushenden

Masterplanners at Queenborough and Rushenden are incorporating a number of measures to increase the resilience of buildings at risk of flooding. These are shown below:

**Cross section through a proposed building at Queenborough and Rushenden**



Rummey Design Associates (2006)

✓ The masterplan includes high density apartment blocks in areas of lower flood risk.

✓ The functional and less-easily evacuated parts of properties are kept above the likely flood level where possible.

✓ Ground-floor levels are being raised to reduce the risk of flooding.

✓ Flood-compatible uses (e.g. car parking) are being provided at ground-floor level, the level most at risk of flooding.

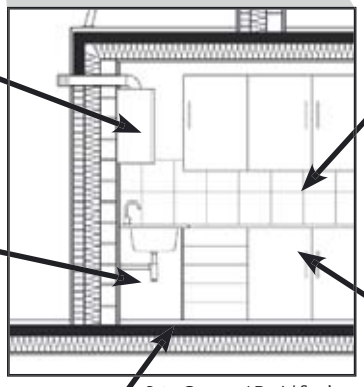
### Additional measures to address flooding in building design

A number of additional building specific measures that could be incorporated or considered to increase the resilience of individual apartments to flood risk are illustrated below:

✓ Service meters, boilers and electrical points should be placed above the likely flood level.

✓ One-way valves should be used in drainage pipes to prevent sewage backing up into property.

✓ Access and exit strategies should be considered for all buildings during flood events.



Rajat Gupta and Daniel Sant'ana

Lime-based or waterproof render could be used to cover walls rather than gypsum plaster.

Chipboard/mdf kitchen and bathroom units could be replaced with a plastic equivalent. However, consideration should also be given to wider sustainability considerations of using plastic alternatives to wood.

Timber floors could be replaced with concrete and tiles.

## 4.17 Adapting historic buildings to potential climate changes

The masterplan for Queenborough and Rushenden seeks to create a sense of place for the proposed development, inspired by its surroundings including its heritage and historic environment. However, SEEDA and Swale Borough Council need to ensure that the historic environment is adequately protected from current and future climate risks. Measures that could be incorporated or considered to adapt the historic environment are described below.

Review vulnerability of wooden structures and contents to fire risk under higher and more extreme temperatures.

Review the thermal comfort needs of those who live in, work in, or visit historic buildings, both within and outside of those buildings.

Rummey Design Associates (2006)

**The historic dock at Queenborough and Rushenden**

Rummey Design Associates (2006)

Review requirements for shading and ventilation of historic buildings.

Appraise impact of any raised sea defences on historic landscape setting.

Evaluate the vulnerability to flooding of wharves and other historic buildings in the Flood Risk Assessment.

Rummey Design Associates (2006)

Consider damp-proofing and up-grading rainwater disposal systems. For example, at Blickling Hall, Norfolk wider guttering has been installed to cope with heavy rainfall (see image below).

The National Trust (2006)

Review problems of damp and overcome using energy efficient solutions.

Consider resilience of building materials used in any restoration work.

Allow time in the regeneration process to carry out investigations of subterranean and submerged archaeological artefacts/ deposits, including borehole and deposit surveying and modelling.

- For general information on ventilation and cooling of buildings, see **Section 4.11**.
- For general information on conserving water in buildings, see **Section 4.7**.
- For general information on including brown/green roofs in the building design, see **Section 4.11**.

Appendix 1

# References and other sources of guidance

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# Appendix 1

## References


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28. DTI funded Energy Saving Trust website. The low carbon buildings programme (2006) includes cost benefit information on adaptation measures which also reduce carbon emissions. www.est.org.uk/ > housing buildings > funding > low carbon buildings programme.
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UK Climate Impacts Programme (UKCIP) www.ukcip.org.uk

UKCIP e-news and cuttings pack – use as a monitoring tool to keep informed about latest developments in UK climate impacts and adaptation work including new guidance, tools and climate change scenarios. www.ukcip.org.uk > Cuttings pack

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**Toolkits and guidance**

Wolverhampton City Council Climate Change toolkit for development/regeneration (currently offline, but available on CD from Adrian Hilton at adrian.hilton@wolverhampton.gov.uk)

South East Climate Change Partnership Signposting for planners and developers www.climatesoutheast.org.uk/ > downloads

UKCIP (2003) Climate Change and Local Communities Climate change and local communities - how prepared are you? UK Climate Impacts Programme. www.ukcip.org.uk > resources > publications

UKCIP Adaptation Wizard: www.ukcip.org.uk > resources > tools

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Nottingham Declaration Action Pack – guidance on developing a Climate Change Strategy or Action Plan. For more details see: www.est.org.uk/housingbuildings/localauthorities/NottinghamDeclaration/

**Insurance issues**

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# Appendix 1

## Other sources of guidance

DTI funded Energy Saving Trust website. The low carbon buildings programme (2006) includes cost benefit information on adaptation measures which also reduce carbon emissions. www.est.org.uk/ > housing buildings > funding > low carbon buildings programme.

www.livingroofs.org.uk Advice, research and promotion of roof systems for environmental urban regeneration - an independent resource for the UK. Includes cost / benefit information (undated)

**Adaptation case studies**

London Climate Change Partnership. (2006) Adapting to climate change: Lessons for London. Greater London Authority, London. www.london.gov.uk/climatechangepartnership/

UKCIP Database of adaptation case studies www.ukcip/tools/ (forthcoming)

www.zedfactory.com > projects

**Adaptation Measures**

General

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Adaptation as part of wider sustainable construction: www.sustainable-construction.org.uk/

Adaptation which does not contribute to increased carbon emissions: Energy Saving Trust www.est.org.uk/

Landscaping / Urban Design

Adaptation using green/brown roofs: www.livingroofs.org.uk

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Flood Risk

Flood resilient homes:

www.abi.org.uk/Display/File/Child/228/Flood_Resilient_Homes.pdf

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Appendix 2

# Acronyms

# Appendix 2

## Acronyms

| | |
|---|---|
| AAP | Area Action Plan |
| ABI | Association of British Insurers |
| AMR | Annual Monitoring Report |
| BESEECH | Building Economic and Social Information for Examining the Effects of Climate Change |
| BKCC | Building Knowledge for a Changing Climate |
| BRE | Building Research Establishment |
| BREEAM | Building Research Establishment Environmental Assessment Method |
| CCTV | Closed Circuit Television |
| CEEQUAL | Civil Engineering Environmental Quality Assessment and Award Scheme |
| CFMP | Catchment Flood Management Plan |
| CIBSE | Chartered Institute of Building Services Engineers |
| CIRIA | Construction Industry Research and Information Association |
| Defra | Department for Environment, Food and Rural Affairs |
| DPD | Development Plan Document |
| EIA | Environmental Impact Assessment |
| FRA | Flood Risk Assessment |
| LDD | Local Development Documents |
| LPA | Local Planning Authority |
| ODPM | Office of the Deputy Prime Minister |
| PPG | Planning Policy Guidance |
| PPS | Planning Policy Statement |
| RBMP | River Basin Management Plan |
| RWH | Rainwater Harvesting |
| SA | Sustainability Appraisal |
| SAP | Standard Assessment Procedure (for Energy Rating of Dwellings) |
| SEA | Strategic Environmental Assessment |
| SEEDA | South East England Development Agency |
| SMP | Shoreline Management Plan |
| SPA | Special Protection Area |
| SPD | Supplementary Planning Document |
| SPG | Supplementary Planning Guidance |
| SuDS | Sustainable Drainage Systems |
| UKCIP | UK Climate Impacts Programme |

Appendix 3

# Summary - checklist for adapting to climate change

from - Adapting to climate change: a checklist for development (2005)
The Three Regions Climate Change Group.

South East Climate Change Partnership
A partnership of the public, private and voluntary sectors

Sustainable Development Round Table for the East of England

LONDON climate change PARTNERSHIP

# checklist for adapting to climate change

This checklist summarises the key issues that need to be considered when climate proofing your development against the impacts of climate change, and is followed by more detailed guidance on each aspect.

## Location

✔

- [ ] Establish the Environment Agency flood risk designation(s) for the site and ensure that the design of the development accords with it. Check the Environment Agency's Flood Map resource at **www.environment-agency.gov.uk/subjects/flood/826674/829803**
- [ ] Check with the Local Planning Authority to review any strategic flood risk assessments.
- [ ] Undertake an appropriate flood risk assessment and evaluate the flood risk over the design life of the development. Demonstrate that this is acceptable for the proposed use(s) and, at a minimum, that there will be no overall increase in flood risk (likelihood and negative impact).
- [ ] Consult the insurance industry guidance *Strategic Planning for Flood Risk in the Growth Areas – Insurance Considerations*[i] about the viability of the development for insurance purposes.
- [ ] Help reduce the urban heat island[ii] effect e.g. by planning green space and using appropriate shade when locating your development.
- [ ] Consider the implications of coastal erosion when planning a development.

## Site layout

Ensure the overall layout and massing of the development:

- [ ] does not increase the flood risk and where possible reduces risk;
- [ ] minimises solar gain in summer;
- [ ] maximises natural ventilation;
- [ ] maximises natural vegetation;
- [ ] takes account of the increased risk of subsidence;
- [ ] provides homes and other appropriate uses with a private outdoor space wherever possible.

## Buildings

*A: Structure*

| Demonstrate the structure is: | ✔ |
|---|---|
| • strong enough or able to be strengthened if wind speeds increase in the future due to climate change; | ☐ |
| • strong enough to avoid movement due to expected future levels of subsidence and heave; | ☐ |
| • able to incorporate appropriate ventilation and cooling techniques/ mechanisms; | ☐ |
| • of an appropriate thermal mass for the intended use and occupancy. | ☐ |

*B: Physical envelope of structures*

| Demonstrate the envelope of the building is designed so that: | |
|---|---|
| • drainage systems and entrance thresholds can cope with more intense rainfall; | ☐ |
| • there are opportunities for incorporating green roofs or walls; | ☐ |
| • the exterior of buildings reduces heat gain in summer; | ☐ |
| • the overall envelope avoids infiltration from increased wind and temperatures; | ☐ |
| • cladding materials are able to cope with higher wind speeds. | ☐ |

*C: Materials*

| | |
|---|---|
| Ensure the materials specified will perform adequately in the climate throughout the lifetime of the development. | ☐ |
| Ensure the construction methods to be used are suitable for the weather conditions at the time of construction. | ☐ |

## Ventilation and cooling

| | |
|---|---|
| Ensure that ventilation brings clean pollution-free air into the building and does not compromise noise levels or security. | ☐ |
| Demonstrate the building has or is capable of having installed a ventilation system which will deliver comfortable temperatures (i.e. exceeding 28°C for less than 1% of the time and exceeding 25°C for less than 5% of the time) for the expected climate throughout the design life of the development. | ☐ |
| Cooling and ventilation systems, where necessary, should be designed to use as little carbon-based energy as possible by utilising renewable energies and being as energy efficient as practicable. | ☐ |

## Drainage

| | ✔ |
|---|---|
| Carry out a site survey to determine which SUDS techniques will be appropriate for use on the site. For example, ground conditions will determine the suitability of infiltration systems. Consider rainwater harvesting, green roof systems and opportunities for permeable paving if soil permeability is low. | ☐ |
| Ensure, in consultation with the Environment Agency, that the requirements of the Groundwater Regulations are complied with (you should though note that shallow, extensive infiltration systems will minimise risks to groundwater). | ☐ |
| Demonstrate consideration is given to future maintenance requirements of SUDS including the need, where necessary, for the removal of silt which will be treated as a controlled waste, and that space requirements for this purpose are allowed for in the design. | ☐ |
| Ensure that responsibility for maintaining SUDS is clear at the planning application stage[iii]. | ☐ |
| Consider using permeable paving anywhere that loadings will not cause structural failure. In practice, all pavements, driveways, footpaths, car parking areas and access roads could have permeable surfaces. | ☐ |
| In developing the drainage plan for the site, ensure that the design standard takes account of climate change and that carriageways, paths and other features of the site are designed to convey this excess flow safely. | ☐ |

## Water

| | |
|---|---|
| Estimate the net water consumption of the development under normal use and under water conservation conditions (i.e. during a drought), both initially and during the lifetime of the development in consultation with the relevant water company. | ☐ |
| Discuss existing sewerage infrastructure and sewage treatment capacity with the local sewerage provider. | ☐ |
| Regarding water use, for housing, achieve a target of 30 cubic metres per person per year under typical use and for offices, 1.05 cubic metres per person per year. | ☐ |
| Minimise water use in buildings, consider the use of rainwater collection/re-use systems and consider the environmental impact (in terms of water consumption) of products, materials and building methods. | ☐ |

## Outdoor spaces

| | ✔ |
|---|---|
| Incorporate an appropriate range of public and private outdoor spaces in developments, with appropriate shade, vegetation and water features. | ☐ |
| Ensure the design of surfaces take account of more intense use, permeability, potential for causing dust and for soil erosion. | ☐ |
| Ensure the selection of vegetation with longer life (over 10 years) takes account of future climate change. | ☐ |
| Ensure water features have minimal net water use. | ☐ |
| Provide a rainwater collection system/grey-water recycling for watering gardens and landscaped areas. | ☐ |
| Ensure there are arrangements for storing waste which allow for separation and prevent excessive smell in hotter conditions. | ☐ |

## Connectivity

### *A: Infrastructure Resilience*

| | |
|---|---|
| Ensure there are safe access routes above the likely flood levels and the routes are clearly marked (e.g. by a series of poles) during the design life of the development. | ☐ |
| Negotiate with utilities and others over the resilience of services and infrastructure to the development. | ☐ |

### *B: Impact on Neighbours*

| | |
|---|---|
| Identify immediate neighbour impacts as well as the cumulative impacts and the increased demands on services. | ☐ |

*i Strategic Planning for Flood Risk in the Growth Areas – Insurance Considerations, Association of British Insurers July 2004, www.abi.org.uk/display/File/Child/554/Strategic_Planning_for_Flood_Risk_thamesgateway.pdf*

*ii Microclimates, The Met Office, www.metoffice.com/education/secondary/students/microclimates.html*

*iii Interim Code of Practice for SUDS, National SUDS Working Group 2004, www.environment-agency.gov.uk/business/444304/502508/464710/465036/466851/?land=_e*

Appendix 4

# Climate change summaries for the East of England & London

# Climate change summaries for the East of England & London

Anticipated climate changes in the East of England under the low and high emissions scenarios[3].

| Anticipated climate changes | Relative confidence level | Specific changes in the East of England | |
|---|---|---|---|
| | | Low emissions scenario | High emissions scenario |
| Increasing summer temperatures | High | 2020s: 0.5-1.5°C<br>2050s:1.5-2.5 °C<br>2080s: 2-3 °C | 2020s: 1-1.5°C<br>2050s: 2.5-3.5°C<br>2080s: 4.5+°C |
| Increasing winter temperatures | High | 2020s: 0.5-1°C<br>2050s: 1-1.5°C<br>2080s: 1.5-2°C | 2020s: 0.5-1°C<br>2050s: 1.5-2°C<br>2080s: 3-3.5°C |
| More frequent extreme high temperatures | High | Increase of up to 14 'extremely'* warm days in summer by the 2080s** | Increase of up to 30 'extremely'* warm days in summer by the 2080s** |
| Less extreme low temperatures | High | Fewer frosts, long runs of snowless winters | |
| Increasing winter rainfall | High | 2020s: 0-10%<br>2050s: 10-15%<br>2080s: 15-20% | 2020s: 0-10%<br>2050s: 15-25%<br>2080s: 25-30+% |
| Reducing summer rainfall | Medium | 2020s: 10-20%<br>2050s: 10-20%<br>2080s: 20-30% | 2020s: 10-20%<br>2050s: 20-40%<br>2080s: 40-50+% |
| Increases in winter precipitation intensity | High | By the 2080s, 10-20% increase in the daily precipitation amount which can be expected, on average, once every 2 years** | By the 2080s, 20+% increase in the daily precipitation amount which can be expected, on average, once every 2 years** |
| Potentially an increase in frequency of winter storms | Low | Increase in the number of winter depressions resulting in a strengthening of winter winds | |
| Reduction in soil moisture content | High for summer changes | In summer, reduction of 10-30% by the 2080s** | In summer, reduction of 30-50% by the 2080s** |
| Sea level change | Medium | Net sea level rise of approximately 22cm by the 2080s** | Net sea level rise of approximately 82cm by the 2080s** |
| Extreme sea levels (storm surges) | Low | Coast around the South East will experience an increase in 50-year return surge height of up to 1m by the 2080s** | Coast around the South East will experience an increase in 50-year return surge height of up to 1.5m by the 2080s** |

* 'Extremely' warm days are defined using the 90th percentile daily average temperature modelled for the baseline period 1961-1990, i.e. the daily average temperature which is exceeded, on average, on 10% of days.

** Data only available for the 2080s in the UKCIP02 Climate Change Scenarios.

# Appendix 4

## Climate change summaries for the East of England & London

Anticipated climate changes in London under the low and high emissions scenarios[3].

| Anticipated climate changes | Relative confidence level | Specific changes in London | |
|---|---|---|---|
| | | Low emissions scenario | High emissions scenario |
| Increasing summer temperatures | High | 2020s: 1-1.5°C<br>2050s: 2-2.5 °C<br>2080s: 2.5-3 °C | 2020s: 1-1.5°C<br>2050s: 3-3.5°C<br>2080s: 4.5+°C |
| Increasing winter temperatures | High | 2020s: 0.5-1°C<br>2050s: 1-1.5°C<br>2080s: 1.5-2°CC | 2020s: 0.5-1°C<br>2050s: 1.5-2°C<br>2080s: 3-3.5°C |
| More frequent extreme high temperatures | High | Increase of up to 14 'extremely'* warm days in summer by the 2080s** | Increase of up to 30 'extremely'* warm days in summer by the 2080s** |
| Less extreme low temperatures | High | Fewer frosts, long runs of snowless winters | |
| Increasing winter rainfall | High | 2020s: 0-10%<br>2050s: 0-15%<br>2080s: 10-20% | 2020s: 0-10%<br>2050s: 15-25%<br>2080s: 25-30% |
| Reducing summer rainfall | Medium | 2020s: 10-20%<br>2050s: 10-30%<br>2080s: 20-30% | 2020s: 10-20%<br>2050s: 30-40%<br>2080s: 50+% |
| Increases in winter precipitation intensity | High | By the 2080s, 10-20% increase in the daily precipitation amount which can be expected, on average, once every 2 years** | By the 2080s, 20+% increase in the daily precipitation amount which can be expected, on average, once every 2 years** |
| Potentially an increase in frequency of winter storms | Low | Increase in the number of winter depressions resulting in a strengthening of winter winds | |
| Reduction in soil moisture content | High for summer changes | In summer, reduction of 20-30% by the 2080s** | In summer, reduction of 40-50% by the 2080s** |
| Sea level change | Medium | Net sea level rise of approximately 26cm by the 2080s** | Net sea level rise of approximately 86cm by the 2080s** |
| Extreme sea levels (storm surges) | Low | Coast around the South East will experience an increase in 50-year return surge height of up to 0.9m by the 2080s** | Coast around the South East will experience an increase in 50-year return surge height of up to 1.5m by the 2080s** |

* 'Extremely' warm days are defined using the 90th percentile daily average temperature modelled for the baseline period 1961-1990, i.e. the daily average temperature which is exceeded, on average, on 10% of days.

** Data only available for the 2080s in the UKCIP02 Climate Change Scenarios.

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www.london.gov.uk/climatechangepartnership


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www.gos.gov.uk/gol


**Department for Environment Food and Rural Affairs**
www.defra.gov.uk


**Environment Agency**
www.environment-agency.gov.uk


**South East Climate Change Partnership**
www.climatesoutheast.org.uk


**East of England Development Agency**
www.eeda.org.uk


**Surrey County Council**
www.surreycc.gov.uk


**Association of British Insurers**
www.abi.org.uk


**Greater London Authority**
www.london.gov.uk