Adapting Waste and Recycling Collection Systems to the Changing Climate

A guide for local authorities on preparing waste and recycling collection services for the impacts of climate change.

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Executive summary

Our climate is changing and further change is inevitable. It is important that all local authority service areas consider the threats and opportunities from the changing climate in order to avoid disruption to services and ensure that they can continue to deliver their service objectives effectively and efficiently.

Planning for the impacts of climate change in order to minimise potential threats and to take advantage of any opportunities is known as adaptation.

Domestic waste collection is a universal service which is considered by the public to be one of the key services provided by local authorities and any disruption can have severe consequences for the reputation of councils. Effective management of waste and recycling makes a vital contribution to sustainability through the efficient use of resources and by minimising greenhouse gas emissions.

This guide outlines the expected changes to the UK climate over the century; suggests approaches to assessing potential impacts and developing responses; and considers some of the short and longer term implications for the delivery of waste collection and recycling services.

At the present time, heavy snowfall and flooding represent the greatest risk of disruption to waste collection and recycling services from extreme weather, as events of the past decade have demonstrated.

In future, climate change is expected to lead to warmer, wetter winters and hotter, drier summers with more intense rainfall leading to an increased risk of flooding and periods of high temperatures giving rise to heat wave conditions. Although winters in the UK are expected to warm on average, there are likely to continue to be risks of disruption from heavy snowfalls from time to time, therefore it will continue to be necessary to prepare to deal with such events in future.

During the course of producing this guide, a sample of local authority risk assessments were reviewed, a number of telephone interviews with waste officers were conducted and a workshop was held with service operators.

This research identified the main issues for waste collection and recycling services as:

- Increased risks of flooding leading to localised disruption of collection rounds, and potential difficulties reaching waste treatment and disposal sites
- Capacity to cope with large volumes of waste generated by flood events
- Potential loss of value and degradation of recycled paper and card due to increased moisture content
- Health and safety issues for staff due to higher summer temperatures and increased likelihood of heat waves
- Increased rates of decay of putrescent waste potentially necessitating in some areas more frequent collections of food waste to avoid nuisance impacts such as odour
- Lengthened thermal growing seasons leading to increases in the quantities of garden waste
- Potential changes in the composition of the waste stream due to changes in lifestyles and consumption patterns
- Possible increase in nuisance due to waste dispersed by high winds

Climate changes are unlikely to represent critical risks for waste collection and recycling services, but it is important to consider the implications of these changes in order to maintain the quality of service that residents expect and meet recycling targets. This guide proposes a 5-step approach for authorities to follow in adapting to climate change and provides advice on each stage. Key points emerging from this approach are:

- A key requirement for successful adaptation is that it should be embedded in the normal business processes of an organisation
Identify your objectives at the outset and set out a process for achieving them.

Begin the process of thinking through the impacts of future climate change by reviewing how severe weather has affected your services in the recent past.

Identify potential impacts of the changing climate and assess their consequences for your objectives.

Consider indirect impacts caused by climate change, for instance, changes to the volumes and composition of the waste streams or potential implications for access to treatment/disposal facilities.

Once you’ve identified the most significant climate risks faced by waste collection and recycling services, the next step is to decide how best to address these. Adaptation options are practical actions to either reduce vulnerability to climate risks, or to exploit positive opportunities.

The consensus view of participants at the workshop was that the hazards identified could be coped with through appropriate use of existing processes such as business continuity, procurement and reasonable changes to operational practices and that coping was easier where plans were in place before hand.
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1.0 Introduction

Our climate is already changing and further change is inevitable. There are two main responses to human-induced climate change:

- **Mitigation** that aims to limit the causes of climate change by reducing the emissions of greenhouse gasses, such as carbon dioxide and methane. The waste sector has been active in responding to the need to mitigate greenhouse gas emissions, for example, by reducing waste disposed to landfill and promoting greater reuse, recycling and composting.

- **Adaptation** that aims to prepare for the impacts of climate change in order to minimise potential threats and to take advantage of any opportunities. To date the waste sector has been less active in the field of adaptation.

It is important that all local authority service areas, including waste collection and recycling, consider the threats and opportunities from the changing climate in order to avoid disruption and ensure that they can continue to deliver their service objectives effectively and efficiently into the future.

This guide outlines the expected changes to the UK climate over the century; suggests approaches to assessing potential impacts and developing responses; and considers some of the short and longer term implications of climate change for the delivery of waste collection and recycling services.

2.0 Method

UKCIP (UK Climate Impacts Programme) has been working on adaptation issues since 1997 and has developed a number of tools to help organisations understand the threats and opportunities arising from climate change and to adapt accordingly. The approach outlined in this guide is based on extensive experience of working with local authorities and utilises the framework of the UKCIP adaptation wizard.

The starting point for developing this guide was to use the 2009/10 returns from the former performance framework indicator NI188 Planning to adapt to climate change to identify local authorities that have considered risks to their services from climate change.

- Waste officers from a small sample of these authorities were interviewed by telephone in January and February 2011. An online survey was also produced but the responses to this were too small to yield any useful results.

- A number of local authority officers and representatives of waste management companies were invited to a workshop held in Birmingham in March 2011.

The results of these interviews and workshop discussions, together with materials gathered by searches of council websites, have been used to identify some of the adaptation issues for waste collection and recycling services and to provide examples of actions.

3.0 Why adapt?

Recent flooding, for instance in Cockermouth, and the severe winters of 2009 and 2010 across much of England illustrate the capacity of severe weather to disrupt waste collection services. Although extreme cold and snow events are expected to become less frequent as the climate changes, they are likely to occur from time to time so there will still be the need to be prepared for them. In addition, lessons learnt from these events may help to prepare for the impacts of other severe weather. Intense rainfall, leading to increased risks of flooding, and summer heat waves are likely to increase in frequency and intensity in future. It is important to consider how these may impact on waste collection and recycling services and to identify the measures that can be taken to minimise the negative impacts, and to use any opportunities, so as to maintain the capacity to deliver services effectively and efficiently.

Waste collection is perceived by the public as one of the key services provided by local authorities and any disruption can have severe consequences for the reputation of councils.
As well as changes to the frequency and intensity of weather extremes, climate change is expected to lead to a generally warmer climate in the UK which may raise issues for the management of putrescible materials, such as food waste, and lengthen the thermal growing season leading to increased volumes of garden waste. Lifestyle changes brought about by the changing climate may lead to variations in the mix of components in waste streams e.g. food scarcity and therefore increased food costs may lead to less food waste, or hotter summers may lead to higher packaging content from soft drinks containers.

4.0 The changing climate

The Earth's climate has changed many times in the past in response to natural causes – the term climate change usually refers to changes that have occurred since the early 1900s particularly those attributed to human causes.

Natural and human factors both affect global climate. Natural causes include interactions between the ocean and the atmosphere, changes in the Earth's orbit and volcanic eruptions. Humans influence global climate by releasing greenhouse gases – such as carbon dioxide and methane – into the atmosphere. These gases absorb energy that is radiated from the Earth's surface, warming the atmosphere and increasing temperatures globally.

In 2007, the Intergovernmental Panel on Climate Change (IPCC), the world's most authoritative body on climate change, concluded that most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic (man-made) greenhouse gas concentrations.

Figure 1 below shows the atmospheric concentrations of the main greenhouse gases carbon dioxide, methane and nitrous oxide over the past 2000 years. The rapid increases in concentration over the past 250 years are primarily due to human activities. For instance, carbon dioxide concentrations have increased from a pre-industrial average of around 280 parts per million (ppm) to 380 ppm in 2005 representing an increase of 36%. A similar pattern is seen for methane and nitrous oxide.

**Figure 1** Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. (Source: IPCC Fourth Assessment Report, 2007)

Global average temperatures have risen by nearly 0.8°C since the late 19th century, and rose at almost 0.2°C/decade over the past 25 years. This is illustrated in Figure 2 that shows the global temperature series since 1850.
Figure 2: Annual-average global-mean near-surface temperature from 1850-2006, as a difference from the average over the 1961-1990 baseline period. (Source: Met Office Hadley Centre/Climate Research Unit, UEA)

Global temperatures during the first decade of the 21st century have been the highest on record. However, there can be significant regional and local variations. Although for the UK 2010 was the coldest year since 1986 with the coldest December on record, globally 2010 has been ranked provisionally as the second hottest on record according to the Met Office and University of East Anglia. NASA ranked 2010 as the hottest year on record and NOAA’s National Climatic Data Centre ranked it as the joint hottest.

More information on global climate trends is available from the Met Office climate change web pages.

5.0 Climate change in the UK

Global warming is already apparent in the UK. The Central England Temperature (CET) monthly series is the longest continuous temperature record in existence. It has risen by about a degree Celsius since 1980, with 2006 being the warmest year since records began in 1659.

The Met Office Hadley Centre has been producing estimates of climate change in the UK since 1991. The most recent set of climate change projections (UKCP09) were released in 2009. The broad trends are summarised in Table 1 below:

Table 1: Summary of trends in UK climate and weather due to global climate change (Source: UKCP09)

<table>
<thead>
<tr>
<th>Annual / seasonal averages</th>
<th>Extremes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warmer, drier summers (spring, autumn too)</td>
<td>More very hot days</td>
</tr>
<tr>
<td>Milder, wetter winters</td>
<td>More intense downpours of rain</td>
</tr>
<tr>
<td>Rising sea levels</td>
<td>Shorter return periods for high water levels at coast</td>
</tr>
<tr>
<td>Seasonal shifts</td>
<td>Uncertain changes in storms – possible increases in frequency and intensity of strong winds in winter</td>
</tr>
</tbody>
</table>
These broad trends should be sufficient to identify the main types of impacts on the delivery of waste collection and recycling services.

For any major issues identified as part of your risk assessment, see section 6.3.4, it may be necessary to look at more detailed information available from UKCP09 to understand how and when to act.

5.1 UK Climate Projections (UKCP09)

The latest UK Climate Projections (UKCP09) provide a vast array of information based on the modelling work of the Met Office Hadley Centre. This can be found at the UKCP09 website. UKCP09 includes information on temperatures, precipitation (rain, hail and snow), cloud, humidity, sea level rise and storm surges.

There are inevitable uncertainties associated with modelling future climate. UKCIP considers two sources of uncertainty. First, it presents natural variability and modelling uncertainty as a range of likelihood rather than a single number. This provides more information on which to base assessments of future risks. Second, because we cannot be certain about future emissions, UKCP09 uses three emissions scenarios – high, medium and low – based on the IPCC's Special Report on Emissions Scenarios. As a result of the lag in how the climate responds to emissions, the alternative scenarios do not result in significant variations in the projections up to 2040, but after 2040 the projections start to diverge noticeably. Because of the typical planning horizons for waste collection and recycling services, these longer timescales are unlikely to be relevant, so it may not be necessary to consider variations between alternative emission scenarios in any detail. Figure 3 illustrates an example of UKCP09 information displayed as a series of maps of the UK showing the projected changes to mean summer temperature in the 2050s at the 10, 50 and 90 probability levels for all three emission scenarios. Note that there is relatively little variation between the changes for the different emission scenarios by this period.

Figure 3 Changes to mean summer temperature 2050 for all emission scenarios

The IPPC uses standard terms to describe various probability levels. Applying this terminology to the UKCP09, we can say that a change is very unlikely to be less than the 10% probability level and very unlikely to be more than the 90% probability level. The 50% probability level is described as the central estimate. Notice that this does
not represent the most likely level of change, it simply means that there is an equal probably that the change will be above or below this value.

One of the simplest points to start using UKCP09 information is via the Key findings which summarises the expected changes in temperature and precipitation for the whole of the UK and for 16 administrative regions. The term wider range is used to describe the range of likelihood from 10% probability of the low emission scenario to the 90% of the high emission scenario. Table 2 below shows an example of the information available in the UKCP09 Key findings for the East of England in the 2050s. Again notice that this only extends the range slightly compared with the medium emission scenario for the 2050s because the effects of different emission paths only become significant later in the century.

### Table 2 Detail from key findings of UKCP09

<table>
<thead>
<tr>
<th>Key findings for East of England, 2050s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Medium emissions scenario</strong></td>
</tr>
<tr>
<td>The wider range is from the lowest to highest value for all emissions scenarios and three (10, 50, and 90%) probability levels for each 30-year time period.</td>
</tr>
<tr>
<td>Under medium emissions, the central estimate of increase in winter mean temperature is 2.2°C; it is very unlikely to be less than 1.1°C and is very unlikely to be more than 3.4°C. A wider range of uncertainty is from 0.9°C to 3.8°C.</td>
</tr>
<tr>
<td>Under medium emissions, the central estimate of increase in summer mean temperature is 2.5°C; it is very unlikely to be less than 1.2°C and is very unlikely to be more than 4.3°C. A wider range of uncertainty is from 1°C to 4.8°C.</td>
</tr>
</tbody>
</table>

An introduction to the use of UKCP09 can be found on the UKCIP website which includes some online learning resources to help in understanding and using UKCP09.

Key findings for your region are likely to provide sufficient information to undertake a qualitative risk assessment of waste collection and recycling services. If you require more detailed information, this can be found on the UKCP09 website.

### 6.0 Adapting to climate change

The term adaptation applies to measures taken to prepare for expected changes in climate in order to moderate the harm from negative impacts and exploit beneficial opportunities.

This section outlines a general approach to adapting to climate change based on the UKCIP adaptation wizard. This divides the process into 5 steps:

1. Getting started
2. Assessing vulnerability to the current climate
3. Assessing vulnerability to future climate change
4. Identifying, assessing and implementing adaptation options
5. Monitoring and reviewing progress
This approach is shown in Figure 4 below and highlights that good adaptation should be seen as a continuing process rather than a one-off set of actions.

**Figure 4** Key steps in adapting to climate change (Source: UKCIP [adaptation wizard](#))

These steps provide a useful framework for understanding the impacts of climate change and for developing practical responses, but one of the key requirements for successful adaptation is that it should be embedded in the normal business processes of an organisation. You may wish to modify some, or all, of this framework so that it fits in better with your existing processes for, for instance, risk management or business continuity.

6.1 Step 1: Getting started

It is important to identify your objectives at the outset and to plan a process for achieving them. In the case of waste collection, your primary objective is likely to be to deliver a reasonable level of service in the face of the changing climate, particularly extreme weather events. Since it is unlikely to be practical to adapt to all potential impacts, one of the issues that will need to be considered is what constitutes a reasonable level of service i.e. how much disruption is acceptable? There are likely to be other factors, such as impacts on policies to increase recycling rates, to consider when setting objectives.

For any responses to climate change to be successful they will need the support of people across the organisation. It is important to decide who to involve in the process and how to engage with them. Experience suggests that, where resources permit, workshops with a mix of people including both managers and operatives provide a useful range of perspectives on the issues raised by climate change. Engaging relevant people at appropriate stages should not only improve the outcomes but also achieve greater buy-in to any changes required.

6.2 Step 2: Assessing vulnerability to the current climate

Reviewing how severe weather has affected your services in the recent past is a good way to begin the process of thinking through the impacts of future climate change. It helps to identify the specific vulnerabilities of your service, the potential cost of severe weather events and possible responses. It can provide a basis for considering the consequences of more frequent and severe weather events in future. This will be valuable when assessing future vulnerabilities and adaptation options in steps 3 and 4. This step may also provide grounds for adapting better to current risks, regardless of projected climate change.

**Box 1** provides an outline of the sort of information that is useful in considering the impacts of severe weather. In practice it may not be possible to collect all this information for every event that you identify. You may want to consider setting up a system for recording relevant information about the impacts of weather on your operations and objectives as part of developing the adaptive capacity of your organisation. This will help in
monitoring the effectiveness of your strategies for dealing with them at step 5. Your authority may have already recorded some of this information as part of undertaking an LCLIP (see next section below).

<table>
<thead>
<tr>
<th><strong>Box 1 Information to record for each severe weather event</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Event: Year &amp; weather</td>
</tr>
<tr>
<td>2. Impact: How and why did this affect waste collection and recycling services?</td>
</tr>
<tr>
<td>3. Critical thresholds: Were there any critical thresholds, e.g. temperature, drought timespan or flood levels, which precipitated disruption? If so what were they?</td>
</tr>
<tr>
<td>4. Immediate response &amp; cost: What remediation measures were taken during the severe weather? What was the full cost?</td>
</tr>
<tr>
<td>5. Longer-term response &amp; cost: What longer terms repairs or other measures were necessary and what was the cost?</td>
</tr>
<tr>
<td>6. Effectiveness of response: How effective was the immediate and longer-term response? Are there any lessons?</td>
</tr>
</tbody>
</table>

### 6.2.1 Local Climate Impacts Profiles

Over half of English local authorities have undertaken a Local Climate Impact Profile (LCLIP). An LCLIP is a process to highlight a locality’s vulnerability to severe weather events and how these affect local communities, local authority assets, infrastructure and capacity to deliver services. If your authority has undertaken an LCLIP, this may already include some information on the impacts of weather on your waste collection and recycling services. It will also identify some of the extreme events that have affected your area in the recent past. You may find it useful to check whether any of these have affected your waste collection and recycling services.

**Box 2** extract from The South Oxfordshire District Council LCLIP

The following issues for waste collection were identified as a result of studying the impacts of weather and climate in the area for the 5 years up to 2008:

- Waste collection problems caused by gales and wind – increased litter and complaints of missing bins
- Increased garden waste due to warmer weather and early spring growth
- Waste material spilling out of collection boxes during high winds has the potential to adversely affect the reputation of the street cleansing service


**Box 3** extract from Doncaster Council’s LCLIP

includes a headline from 4/12/1999

**Gales Bring Refuse Collection to a Halt**

Refuse collection in Doncaster halted as the landfill sites are closed due to strong winds.

The snow and ice events of January 2010 were a particular issue for the waste management and street cleansing teams in Operational Services.

On a daily basis the waste service had to assess whether it was possible for the collection vehicles to leave the depot, and also if they could complete their collection rounds. Each day waste collections could not take place led to problems with future scheduling. A major problem was being unable to plan ahead, with the risk assessment having to take place at 6.30am and therefore there being no opportunity to communicate with the customers regarding whether their service would take place or not.

As a result of the service disruption there was a lot of negative media coverage as residents didn’t understand why collections couldn’t go ahead especially if their own roads were clear of snow. Figure 6.3 shows the road network in the district with responsibilities for gritting, minor roads are not shown as these are low priority for gritting, but it was often accessing these roads that caused the most disruption to waste collections.

The service recognises that there is a need to further update business continuity planning building on the lessons learned during 2010 and also learning from the experiences at other councils in the locality who experienced worse weather disruption. The street cleansing team was diverted to other work such as gritting to make full use of the available manpower.

To limit the bad reputation a press releases website was set up to keep the public updated regularly. The cost of catching up on collections was met within the existing budget and was not deemed to be significant due to the relatively short nature of the event.

Warm weather brings different issues to the waste department. Very hot weather has implications for the health of the operatives. Current legislation states that the minimum temperature under which people in an office environment should work is 16 degrees Celsius and 13 degrees Celsius where the work is more physical in nature. There currently is no threshold for maximum working temperature.

Personal Protective Equipment (PPE) is provided to all those employees who require it. This includes sun cream, hats and shorts in warm weather. Drinking water is also provided for employees on hot days. Warm weather changes the type of waste to be collected. There is a higher garden yield in the summer months and so collections may need to be adjusted each year depending on the length of the growing season. At this time the council has not considered the effect of rising temperature on the frequency and methods of residual collections.

High winds have so far had a low significance on the services however the street cleansing and ground maintenance teams are sometimes diverted to clear debris. Fallen trees may hinder the waste collections.

6.3  Step 3: Assessing vulnerability to future climate change

This step is also known as a Climate Change Risk Assessment. Many local authorities have undertaken Climate Change Risk Assessments as part of their work on the former national indicator NI 188 Planning to adapt to climate change and it may be possible to draw on this work to help plan your responses to climate change. Box 5 lists questions to ask at this step in the process. Each question is addressed in more detail in sections 6.3.1. to 6.3.4.

<table>
<thead>
<tr>
<th>Box 5: Four questions on vulnerability to future climate change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How might the climate change in your area?</td>
</tr>
<tr>
<td>2. What are likely to be the key vulnerabilities for your services?</td>
</tr>
<tr>
<td>3. What are the indirect impacts that need to be considered?</td>
</tr>
<tr>
<td>4. What risks do these impacts present?</td>
</tr>
</tbody>
</table>

6.3.1  How might the climate change in your area?

Section 5.0 on Changing Climate in the UK, gave a brief summary of projected trends based on the UKCP09 climate projections. These are listed again below and should be sufficient to identify any serious threats or opportunities. For these, you can consider the more detailed information available from UKCP09 for your specific locality when assessing risks at Step 6.3.4.

**Annual / seasonal averages**
- Warmer, drier summers (spring, autumn too)
- Milder, wetter winters
- Rising sea levels
- Seasonal shifts

**Extremes**
- More very hot days
- More intense downpours of rain
- Shorter return periods for high water levels at coast
- Uncertain changes in storms – possible increases in the frequency and intensity of strong winds in winter

6.3.2  What are likely to be the key vulnerabilities for your services?

You can start the process of identifying the vulnerabilities in your services by considering the potential impacts of climate change on your waste collection and recycling services based on these broad trends. Note that the UK climate projections only provide information on changes to the weather and climate. You will need to make an assessment of the affects of these changes on your services. Figure 3 shows a schematic representation of the chain from climate/weather event to consequence.

**Figure 3** Pathway from climate/weather event to consequences
Adapting Waste and Recycling Collection Systems to the Changing Climate

Here we are using the term ‘impact’ to mean the physical result of extreme weather, or a change in climate, and ‘consequence’ to mean the result of the physical impact on some issue of concern. So, for instance the impact of intense rainfall might be flooding leading to a consequence for waste collection services such as the disruption of a collection round. There are many factors, physical, economic and social, that can affect the chain from weather event to consequences. These can represent points of intervention for adaptation responses.

The aim of this initial step is to identify potential impacts of the changing climate and to assess their consequences for your objectives. This will enable you to identify any potentially severe threats that require further consideration. You may also be able to identify some opportunities in the process. Potential impacts on waste collection and recycling may include:

- Increased risks of flooding leading to localised disruption of collection rounds, and potential difficulties reaching waste treatment and disposal sites. (A significant number of existing waste management facilities are located in flood risk zones and are likely to be subjected to increased flood risks in future.)
- Capacity to cope with large volumes of waste generated by flood events, much of which will need to be treated as hazardous waste.
- Potential loss of value and degradation of recycled paper and card due to increased moisture content
- Health and safety issues for staff due to higher summer temperatures and increased likelihood of heat waves
- Increased rates of decay of putrescent waste necessitating more frequent collections of food waste to avoid nuisance from odour and potential health risks
- Possible increase in nuisance due to waste dispersed by high winds

At this stage you should make an initial assessment of the severity of any impact you identify on your services. For any severe threats you identify, you need to consider the likelihood of their occurrence and when to respond using a risk assessment process (see Assessing risks below, 6.3.4).

### 6.3.3 Are there any indirect impacts that need to be considered?

So far we have considered direct impacts that changes to the climate may have on waste collection and recycling services. You should also consider indirect impacts caused by climate change, for instance, changes to the volumes and composition of the waste streams, such as:

- Lengthened thermal growing seasons leading to increases in garden waste
- Potential changes in the composition of the waste stream due to changes in lifestyles and consumption patterns
- Access to waste treatment facilities not controlled by your local authority or contractor e.g. MRFs, composting or AD facilities and landfill sites which may be affected by severe weather events or indeed climate change

Cherwell District Council noticed an increase in garden waste during the wet summers of 2007 and 2008 together with an extended growing season as shown in Box 6.

**Box 6** Extract from Environmental Services section of Cherwell DC LCLIP

Volumes: Across Cherwell District, the garden waste stream begins to increase in Easter with a peak in May. Garden waste volumes generally drop off in late summer. However, in 2007 and 2008 this was no longer the case, with considerable waste collected in August, due to the wet summer speeding plant growth.

Data shows that the increased tonnage collected in the wet summers of 2007 and 2008 was approx. 800 additional tonnes over the volumes typically collected in earlier years, with increased uptake of this service likely to be a contributing factor. The date when collections slowed down changed as well, with high volumes being collected into mid-October. These volumes are now routinely planned for.


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1 The term ‘impact’ is often used more loosely to encompass both physical impacts and their consequences. Generally, we have used the term in this latter sense in this guide.

22 Climate change impacts and adaptation: developing the waste management response, EA workshop, Bristol October 2007
6.3.4 Assessing risks

Once you have identified the likely positive and negative impacts on your organisation, and the threats and opportunities they represent, you need to determine the risk each of those potential impacts presents.

Figure 4 Schematic representation of some of the main types of risks from climate change (Source: UKCIP adaptation wizard)

A risk assessment involves assessing: (i) the probability, or likelihood, of the impact occurring and (ii) the magnitude of the consequence, should the impact occur. The product of these factors represents risk:

\[ \text{the probability of occurrence} \times \text{the consequence of occurrence} = \text{risk}. \]

Note that in order to keep the process as simple and efficient as possible, we suggest that you only consider risks for those threats or opportunities identified as most significant in the previous stage.

There are several approaches to risk assessment. Your organisation will probably have its own in-house risk assessment methods, in which case you should use these.

For the types of risks you are likely to be considering for waste collection and recycling a simple qualitative approach is sufficient. Typically, this uses an equal number of categories for likelihood and consequences – in the simplest case low, medium and high – but 5 categories are also commonly used.

Some possible descriptions of risk categories are shown in Table 2 and
Table 2 Example of possible criteria for a simple 3 x 3 risk matrix.

<table>
<thead>
<tr>
<th>Likelihood of consequence</th>
<th>Score</th>
<th>Severity of consequence</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>3</td>
<td>High</td>
<td>Major disruption of service requiring special response</td>
<td>3</td>
</tr>
<tr>
<td>Medium</td>
<td>2</td>
<td>Medium</td>
<td>Some disruption of service managed through normal processes</td>
<td>2</td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>Low</td>
<td>Partial disruption of service</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 3 below. These are only intended as illustrative examples. You will need to choose criteria appropriate to your requirements and objectives.
### Table 3 Example of possible criteria for a simple 5 x 5 risk matrix.

<table>
<thead>
<tr>
<th>Likelihood of consequence</th>
<th>Percentage likelihood</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost certain</td>
<td>81 – 100%</td>
<td>5</td>
</tr>
<tr>
<td>Highly likely</td>
<td>61 – 80%</td>
<td>4</td>
</tr>
<tr>
<td>Even chance</td>
<td>41 – 60%</td>
<td>3</td>
</tr>
<tr>
<td>Likely</td>
<td>21 – 40%</td>
<td>2</td>
</tr>
<tr>
<td>Rare</td>
<td>0 – 20%</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity of consequence</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme</td>
<td>Loss of service for more than 14 days or major impact on objectives</td>
<td>5</td>
</tr>
<tr>
<td>Major</td>
<td>Loss of service for more than 7 days or significant impact on objectives</td>
<td>4</td>
</tr>
<tr>
<td>Moderate</td>
<td>Loss of service for up to 7 days or moderate impact on objectives</td>
<td>3</td>
</tr>
<tr>
<td>Minor</td>
<td>Minor disruption to service with no effect on objectives</td>
<td>2</td>
</tr>
<tr>
<td>Insignificant</td>
<td>No disruption to service or effect on objectives</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 5 below shows typical examples of scoring 3 x 3 and 5 x 5 risks matrices. In this case, areas shown in red or orange represent severe risks that may need active management and/or contingency planning. Areas shown in yellow represent moderate risks that may need to be monitored or managed if there are any simple, low cost responses. Areas shown in green represent low risks of no immediate concern.
Table 4 below shows an extract from Derby City Council's risk assessment of waste services which used information from UKCP09 key findings to assess changing risks to their services over the course of the century.

**Figure 5** Examples of two common types of qualitative risk matrices
### Table 4 Extract from Derby City Council’s risk assessment of waste services

#### Increasing winter precipitation

The central estimates for increases in **winter mean precipitation** are: 16% by 2020s / 33% by 2050s / 53% by 2080s

<table>
<thead>
<tr>
<th>Identified Risk and/or Opportunity</th>
<th>Consequence</th>
<th>Who or What is Impacted</th>
<th>2020</th>
<th>2050</th>
<th>2080</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pluvial flooding (flash floods from rainfall)</td>
<td>Increased risk of disruption of collections and supporting infrastructure from intense rainfall or flooding.</td>
<td>Staff</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Customer/Citizen</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reputation</td>
<td>6</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Service Delivery</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Disruption to transport</td>
<td>Unable to dispose of waste collected due to closed landfill sites.</td>
<td>Service Delivery</td>
<td>15</td>
<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Dispersal of waste</td>
<td>Heavy rain or flooding could disperse waste awaiting collection so may be a need for appropriate containers. Also bins may topple over if the water level is high enough.</td>
<td>Customer/Citizen</td>
<td>6</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reputation</td>
<td>6</td>
<td>9</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environment</td>
<td>6</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>Reduced staff numbers</td>
<td>Staff unable to get to work due to flooding.</td>
<td>Service Delivery</td>
<td>6</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>

You may wish to modify these scoring schemes based on the importance you assign to your various risk criteria. For instance, you may wish to consider any high, or extreme, risks as severe even if they only have low likelihood of occurrence.

#### 6.3.5 Timescales

As the climate is expected to change over time, it is important to consider what timescales are relevant to your consideration of risks. For instance, waste collection contracts typically are for around 7 years, in which case you will only need to consider information for the immediate future when assessing risks to these. If your services are dependent on longer term investments such as for a new waste transfer station, or materials recovery facility, you may need to consider risks over a longer timescale.
6.4 Step 4: Identify, assess and implement adaptation options

Having identified the most significant climate risks faced by waste collection and recycling services, the next step is to decide how best to address them. Box 7 Developing adaptation options lists the main actions needed at this stage.

<table>
<thead>
<tr>
<th>Box 7 Developing adaptation options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. identify adaptation options</td>
</tr>
<tr>
<td>2. choose preferred options</td>
</tr>
<tr>
<td>3. plan your actions</td>
</tr>
</tbody>
</table>

More information is given on each of these below.

6.4.1 Identifying adaptation options

Adaptation options are practical actions to either reduce vulnerability to climate risks, or to exploit positive opportunities. These may range from simple low-tech solutions to larger infrastructure projects and could include:

- **Accepting the impacts and bearing the losses**, e.g. accepting the inevitability of occasional interruptions to collection rounds, preparing recovery plans to minimise disruption and accepting any financial consequences
- **Avoiding or reducing vulnerability to climate risks**, e.g. replacing collection vehicles to better cope with higher temperatures
- **Exploiting new opportunities**, e.g. promoting use of increased volumes of composted garden waste (from increased growing season) as a mulch to improve soil water retention

While at first sight it might appear that there is only one way to deal with a priority risk, in most cases there will be several alternatives. For instance, to deal with the impacts of higher summer temperatures on collection staff, changing the timing of rounds to avoid the hottest part of the day might be an alternative to having collection vehicles with air-conditioned cabs.

Once again it would be useful to hold a workshop where participants are asked to identify possible options for dealing with the priority risks to waste collection and recycling services.

6.4.2 Choosing preferred options

Once you have identified some potential measures to deal with your priority risks, the next task is to choose the preferred option for each. Box 8 gives a comprehensive list of criteria that can be used to help select your preferred adaptation options. In practice you will probably want to consider only a selection of these criteria that best suit your purposes.

<table>
<thead>
<tr>
<th>Box 8 Criteria for evaluating alternative options suggested by UKCIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>- <strong>Effectiveness</strong> – will the actions meet your objectives?</td>
</tr>
<tr>
<td>- <strong>Efficiency</strong> – do the benefits exceed the costs?</td>
</tr>
<tr>
<td>- <strong>Equity</strong> – does the action adversely affect other areas or vulnerable groups?</td>
</tr>
<tr>
<td>- <strong>Flexibility</strong> – is it flexible and will it allow for adjustments and incremental implementation?</td>
</tr>
<tr>
<td>- <strong>Sustainability</strong> – does it contribute to sustainability objectives?</td>
</tr>
<tr>
<td>- <strong>Practicality</strong> – can the action be implemented on relevant timescales?</td>
</tr>
<tr>
<td>- <strong>Legitimacy</strong> – is it politically and socially acceptable?</td>
</tr>
<tr>
<td>- <strong>Urgency</strong> – how soon could it be implemented?</td>
</tr>
<tr>
<td>- <strong>Costs</strong> – what are the costs (economic, social and environmental)?</td>
</tr>
</tbody>
</table>
Clearly, effectiveness and efficiency are always going to be important criteria. The issue of equity also needs to be considered. For instance, the winter snowfall of 2010 made many local roads impassable, or dangerous, for collection vehicles. Some authorities arranged collections from points on more major routes. This was a reasonable short-term measure, but had the disruption persisted for longer would have seriously disadvantaged vulnerable people unable to get their waste to collection points.

Flexibility in working arrangements can affect the resilience of waste collection services to the impacts of extreme weather. Again this was apparent in the winter of 2010 which required flexibility by the workforce and contractors to cope with and recover from the impacts of the heavy snow. Industrial relations agreements and the terms of contracts need to be flexible enough to meet the challenges of climate change.

Given that waste collection has such a high public profile, the legitimacy criteria may also be particularly important in your decision making. For instance, one of the options discussed at the workshop in response to higher summer temperatures and heat waves, was to start collections much earlier in the day. However, it was felt that this would lack public acceptability in England currently, even though it is common practice on the continent. If this was considered a preferred option, then it would require effective communications to explain reason for the change to residents and seek their views. It could be more acceptable to residents if implemented for the hotter months of the year.

When evaluating alternative adaptation options it is also useful to consider how they meet the following criteria:

- **No-regrets** options deliver benefits that exceed their costs, whatever the extent of climate change
- **Low-regrets** options yield large benefits for relatively low costs and seek to maximise the return on investment when uncertainties associated with risks are high
- **Win-win** options enhance adaptive capacity whilst also contributing to the achievement of other social, environmental or economic outcomes
- **Flexible or adaptive management** options enable incremental adaptation options to be put in place as required

In addition to measures specifically designed for adaptation, it is important to consider how other actions and decisions may affect your resilience to climate change. You should ensure that you:

- **Avoid actions that will make it more difficult to cope with climate risks**
- **Avoid making decisions that will make it more difficult to manage climate risks in the future**

When considering any adaptation options, it can be worthwhile to ask the workforce for their suggestions both to benefit from their practical experience and to gain their help in facilitating the implementation of any proposed changes.

**6.4.3 Planning actions**

Having decided on your preferred adaptation responses, the next stage is to plan how to implement them. The types of options that you are likely to be considering can probably be integrated into your organisation’s existing procedures. However, you may find it useful to think about the questions in

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robust</td>
<td>Is the option robust under a range of future climate projections?</td>
</tr>
<tr>
<td>Synergies / coherence with other strategic objectives</td>
<td>Does it help to achieve other objectives?</td>
</tr>
<tr>
<td>Other factors</td>
<td>Which your local authority considers important</td>
</tr>
</tbody>
</table>
Box 9 Simple checklist for adaptation planning

to help plan your actions.
Box 9 Simple checklist for adaptation planning

- How are the preferred adaptations going to be implemented (eg. through new or existing management systems)?
- Have the necessary resources (staff, facilities, capital) required to implement the adaptations and monitor their effectiveness been allocated?
- Have roles and responsibility for the individuals involved been clearly identified?
- What institutional and community support will be required to implement the adaptations?
- Is there an effective communication strategy?
- Have opportunities for synergies between climate adaptation with other planning and development activities been explored?
- Have potential barriers to action been considered together with mechanisms to overcome them?
- What are the mechanisms for evaluating the performance of the planned adaptation actions?
- Is there a detailed timetable for action?

6.5 Step 5: Monitoring and review

It is important to monitor the performance of adaptation options against the objectives you set at step 1. You can probably achieve this through your existing performance management framework. You will need to ensure that any weather-related disruptions to services are recorded and reviewed periodically to see whether you are meeting the standard for an acceptable service. If not, you should re-consider your adaptation options.

7.0 Taking a strategic view

There was a general view amongst interviewees and participants at the workshop that waste collection authorities and their contractors currently have the capacity to deal with the challenges of climate change. There was also the view that the impacts of climate change should not have a significant negative effect on recycling and resource efficiency objectives. However, interviewees and participants advised that planning for change and early consideration of climate change adaptation allows local authorities to reduce their exposure to risk overall.

A key concern identified from the research for this guide is around pressure to increase economic efficiency through specialisation and concentration of resources which can reduce the flexibility and resilience necessary to cope with extreme events. This is a general issue not confined to the waste sector. This does not seem to be a major problem at the moment as demonstrated, at least in the best cases, by the flexibility shown in response to impacts of the winter snows of 2009 and 2010. This may become more of an issue if there is a significant increase in the number of disruptive events, particularly if they have greater costs associated with them. For instance, it may become more important to consider which party bears which (climate-related) risks when procuring waste services.

However, local authorities need also to be aware that indirect impacts could leave collection services vulnerable to disruption even when the collection services function normally. The loss of a major facility, such as a paper mill, due to a major flood, or other event, could have a major impact not just on local reprocessing capacity but also on international market prices. Again, consideration of the issues in advance will allow a local authority to adapt more readily. As mentioned in 6.3.2, many existing waste management facilities are located in high flood risk zones. It is worth checking whether this is the case for any facilities used to dispose of your collected waste and to ensure that adequate provision is made in the event of disruption to your usual disposal facilities.
8.0 Sources of information

1. Adaptation Wizard, UKCIP http://www.ukcip.org.uk/wizard/

2. Local Climate Impacts Profiles (LCLIP) UKCIP http://www.ukcip.org.uk/lclip/


5. Climate UK is the national network of climate change partnerships from the English regions, Northern Ireland, Scotland and Wales http://www.climateuk.net/


9. UK Climate Change Risk Assessment register your interest at http://ccra.defra.gov.uk/
Appendix 1 Summary of issues for waste collection and recycling arising from interviews and workshop discussions

This appendix summarises the key issues arising from the telephone interviews and workshop discussions undertaken as background to developing this guide. Neither this process, nor the review of a sample of local authority climate risk assessments, identified any critical risks currently for waste collection and recycling services arising from expected climate changes. They did identify a number of issues that will need to be considered in order to maintain the quality of service and meet recycling targets as the climate changes.

The consensus view amongst workshop participants was that all the identified hazards could be coped with through appropriate use of existing processes such as business continuity, procurement and reasonable changes to operational practices.

The telephone interviews and the initial phase of the workshop tended to be dominated by discussions of the impacts of the then recent heavy snowfall in December 2010. This raised a number of points that have implications for other weather impacts.

The importance of communication with residents was stressed. It was suggested that variable residents’ responses to similar levels of service disruption in different areas were strongly affected by the prior reputation of the authority and the effectiveness of communication during the disruption. Effective communication with residents is likely to be an important component in gaining acceptance of any changes in collection and recycling service in response to climate changes.

Although the disruption came at a particularly inconvenient time in the lead up to Christmas, its relatively short duration meant that normal collection services were resumed quickly in the New Year with little adverse effect on recycling rates. It was suggested that periods of disruption longer than 2 weeks would constitute a more serious problem in terms of storage of waste, negative effects on recycling rates and recovery time. Periods of disruption during hotter weather may also cause increased nuisance from odour and pest, and in the extreme, health risks.

The workshop participants stressed the importance of maintaining as normal a service for residents as possible during a period of disruption, waiting until the end of the event, or utilising any surplus capacity or overtime, to catch up rather than modifying the normal collection regime.

A degree of flexibility is important in managing responses to disruption. For example, West Oxfordshire was able to use in-house street scene staff to assist in the collection of waste using their own adaptable rather than specialist vehicles. It is important to consider whether the drive to efficiency might lessen the kinds of flexibility needed to cope with disruption due to extreme events with the potential to increase vulnerability to the impacts of future climate.

Considering some of the potential increased risks from climate change:

Small scale surface water flooding events pose risks of localised disruption of collection services, with the additional burden of the disposal of flood damaged property. Flood damaged material generally is considered hazardous because of likely contamination by sewage and cannot be recycled. One of the issues raised in discussions was the need for insurance assessors to inspect damage causing delays for collection. It was reported that in some cases insurance companies have been willing to accept photographic evidence which allows clearance and collection to be undertaken more rapidly. Whilst generally beyond the scope of individual authorities, this is an issue that could be taken up with the insurance industry.

Larger scale fluvial or surface water flooding events have the potential to cause greater disruption, but typically the scale of the event requires special services to take care of the disposal of flood damaged property. Waste
collection authorities may offer to collect flood damaged goods free of charge but arrangements do vary, residents may expect their local authority to provide additional services following a flood.

There was some discussion on the potential for increased rainfall, particularly in winter, to increase the moisture content of paper and cardboard. It was generally considered that this should not be a significant problem with appropriate containers and good management.

Increased average summer temperatures and heat waves could raise health and safety issues for collection staff. These may also impact working capacity. It was noted that many continental countries use night-time and early morning collections, but it was thought that this would be unacceptable in Britain at the moment. There are possible conflicts in the requirements for protective clothing and need to keep cool in higher temperatures.

Higher summer temperatures may lead to increased rates of decay of putrescent waste causing increased nuisance from odour. Coupled with warmer winter temperature this may lead to increased prevalence of flies and other pest and vermin. This may require more frequent collection of food waste, again as is common in warmer continental countries.

Longer thermal growing seasons may lead to increased volumes of garden waste, although drier summers may limit this increase. This may provide further incentive for creating additional outlets for waste-derived composts, for instance via promoting compost as a mulch.

Warmer weather may lead to some changes in lifestyles and consumption patterns with impacts on the composition of waste streams, although are likely to be fairly minor in relation to other factors influencing consumption patterns and waste.

Wind can cause problems for waste collection blowing around poorly stored waste and overturning poorly designed containers. There is considerable uncertainty over whether climate change will increase the frequency and intensity of high winds in the UK, but some suggestion that it might.