Water: Planning ahead for an uncertain future

Water in the 2050s

1. Background: Update to water demand briefing note

In 2009 we published the briefing note ‘Demand for water in the 2050s’. The note outlined the processes and outcomes of our work on the water demand scenarios for the 2050s. This briefing note is an update and replacement.

2. Introduction

What will life be like in the 2050s? How will we use water? Will we have access to water of a better quality or quality worse than it is today? How will we value water in the environment? And does it matter?

The Environment Agency thinks it does matter. Water is essential to people and the plants, animals and fish that live in our natural environment. Water is also a vital part of our heritage and of our leisure time.

Access to clean, reliable water supplies is something we are able to take for granted within England and Wales – despite having less water per capita than some Mediterranean countries. As pressures on our water supply increase, this may not always be the case. If pollution pressures rise the quality of water in our environment may be impacted.

To be in the best position possible to manage these pressures in the future, we need to understand what impact they might have. This document summarises the work we have done to develop a picture of what water resources and water quality could look like in the 2050s.

The original water resources demand scenarios fed into ‘Water for people and the environment’, our Water resources strategy for England and Wales, published in March 2009.

3. Thinking about the future

When thinking about future water quality or demand for water we have to make assumptions about how people will live and work, systems of government, the technology that will be available, how people will use their leisure time and how they’ll value the environment. Over a short time period of five to 10 years or so we can make assessments based largely on the changes we know are coming. We can also consider these changes alongside investment we know will occur. For example,
following a periodic review of the water industry price limits. However, as we go beyond this, it becomes more difficult to know what changes will happen and how they will affect the demand for water and environmental water quality.

One way to allow for this is to use scenarios which describe a set of possible futures. This is particularly useful as it allows us to explore and rehearse future possibilities and identify those that require further investigation or analysis.

In 2006, the Environment Agency and Defra commissioned Henley Centre Headlight Vision to develop a set of scenarios that explore the possible changes in the pressures on the UK environment between now and 2030\(^1\). These scenarios were used as the starting point for the water demand scenarios, published in our Water resources strategy in March 2009.

Please note that climate change has been considered as integral to each of these scenarios. They all assume that climate change will occur and it is implicit in the assumptions made. We have not however quantified the impact of this change or made this change explicit.

4. Extending the 2030 scenarios to the 2050s

The first step in developing the water demand scenarios, was to extend the core social scenarios from the 2030s to the 2050s. We commissioned Henley Centre Headlight Vision, who created the original 2030 scenarios in 2006, to carry out this part of the process.

As the time horizon over which the scenarios were being extended was so long, Henley Centre Headlight Vision felt that simple projection would not be appropriate. For this reason they used two tools to help them extend the scenarios. The first tool was the ‘Three Horizons’ method, first used in the Foresight Intelligent Infrastructure Systems project\(^2\). The second tool was based on Stewart Brand’s proposed model of the different layers of speeds of change, itself adapted from ecological models\(^3\). These tools helped to act as lenses through which to interpret and develop the existing scenarios.

At the end of this part of the process we still had four possible scenarios built around two axes of uncertainty (Figure 1) but extended out to the 2050s. In late 2009 we used The Futures Company\(^4\) to confirm that these scenarios were still valid considering the global economic decline that had occurred since the water demand scenarios were developed.

\(^4\) The Futures Company – the coming together of Yankelovich Inc and Henley Centre HeadlightVision.
Each scenario is supported by a narrative and a description of important areas such as technology and the prevailing economic model. A brief summary of the story behind each scenario is given in Annex one.

5. Tailoring the scenarios to water demand and water quality

We developed each of the four scenarios into a more detailed picture of water in the 2050s. Our aims in doing this were to:

i. produce a qualitative picture that we could then quantify to provide an estimate of possible future demand.

ii. produce a qualitative picture of the drivers of water quality that we could use to indicate the direction and magnitude of future changes in water quality.

It is important to note that the qualitative description and quantification process was never intended to be highly accurate and precise. We felt that this would be inappropriate given the numbers relate to 40 years in the future and to four possible scenarios of that time.

The process of tailoring the scenarios was split into 11 main stages.

5.1 Stage one – identify the qualitative drivers of demand and the social values that affect these

During the development of the water demand scenarios we began by extending the information we had for each scenario to provide more detail on how people will use water. To help us do this we held a workshop with invited experts in water demand,

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5 During the development of the water demand scenarios, the names Alchemy, Restoration, Survivor and Jeopardy were used. These names were since changed to Innovation, Sustainable Behaviour, Local Resilience and Uncontrolled Demand.
water supply, agriculture, demographics, nature conservation and environmental policy development.

We introduced the scenarios to participants and then asked them to think about what people’s attitudes might be at home, at work, to food production, to goods and services, to leisure, to efficiency and to the environment. Using this information we then asked them to think about the broad areas of water demand (household use, agricultural use etc) and suggest whether demand for water was likely to increase or decrease and by a little or a lot.

The output of this stage was a qualitative picture of water demand for each scenario.

5.2 Stage two – develop population estimates for the 2050s

Estimates of future population are a critical part of forecasting water demand. The total population numbers are needed to multiply the household demand by to give a total demand. They also need to be taken into account in assessing industrial and commercial demand and agricultural demand.

Rather than try to develop specific scenario population forecasts from scratch we decided to use existing information where possible. ONS released population forecasts in 2007 which covered the 2030s, 2050s and 2080s. This release included a principal projection forecast for England, Wales, Scotland and Northern Ireland. It also included a range of variant forecasts based on differing rates of fertility, life expectancy and migration.

Using the qualitative information about population from stage one, we made assumptions about fertility, life expectancy and migration for each scenario. We then chose the appropriate variant ONS forecast and used this population figure for the scenario. In order to make sure that the range of forecasts we used was realistic, we checked that both the upper and lower estimates were within one standard deviation of the ONS principal projection.

5.3 Stage three – quantify water demand

For each water demand sector we first identified the key components that we would need to quantify when generating an overall demand. For example, under the household sector we would need to quantify the water used for toilet flushing, for personal washing, by white goods, in outdoor use and for miscellaneous uses. We used the output from the workshop (stage one) to summarise the qualitative values that would affect these components. So, for example, under Innovation, people would have more time to spend on personal washing and would value the experience of a powerful shower. However, strong regulation combined with technological innovation would mean that high flow power showers would be replaced with low flow, low energy alternatives that still provided the desired experience.

To translate this qualitative information into a quantified water demand we used expert opinion. For the household, industrial and commercial and leakage sectors we used a group of Environment Agency experts in water demand forecasting.

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agricultural sector we worked with experts in agricultural water demand from Cranfield University.

Before we could begin quantifying future water demand we needed a consistent base year for a starting point. For household demand and non-household demand supplied by water companies, we used the 2005/06 dry year annual average base data from the latest (2008) water company draft water resources management plans. For non-household demand supplied by direct abstraction, we used 2006 data from the abstraction licensing returns that companies make to the Environment Agency. For agricultural demand we used 2005 survey return data adjusted for a dry year. In all cases this is the most up-to-date data available.

For each demand sector, we then defined a percentage change to each of the key components (for each scenario) based on the assumptions identified from the workshop. We applied these changes to the base data to give us a future demand for each scenario. The output of this stage was a draft England and Wales figure for demand from each sector by the 2050s.

5.4 Stage four – review and refine quantified demand against qualitative drivers

We then needed to make sure that the quantified demand scenarios reflected the qualitative picture developed at the workshop in stage one. To help us do this, we took the output of stage three back to the same group of external experts at a second workshop.

The output of this stage was a list of issues raised by the workshop participants on individual demand sectors and components within them. The list was relatively short as few changes were identified.

5.5 Stage five – finalise England and Wales level quantified demand

The same two groups of experts who helped to develop the quantified demand (stage three) reviewed the output from stage four and identified the changes necessary. These changes were primarily to the agriculture sector. There were also some minor changes to the household and industrial demand sector under the Uncontrolled Demand scenario.

The output of this stage was a final England and Wales figure for demand under each sector by the 2050s.

5.6 Stage six – identify the qualitative long-term drivers of water quality

To expand our 2050 water demand scenarios to include water quality we further tailored the information we had for each of the core social scenarios (see section 3) and the water demand scenarios to give more information on the long-term influences on water quality.

We considered influences on future quality that would be the same regardless of future social changes. For example, nitrogen pollution from historical pollution of groundwater. Such influences were to be implicit in the scenarios, and it was the social influences of change that were focused upon.
Once we had identified the main themes that influence long-term change in water quality we held a two day workshop with experts in water quality. We asked them to contribute to the development of a historical timeline for water quality to further understand the factors that to date have caused the main changes in water quality over the past one hundred (or so) years.

We then introduced the scenarios to the participants and asked them to think about what each of the main themes that influence long-term water quality might be like in 2050 for each scenario. We checked the outcomes of the workshop against assumptions in the core social scenarios, and the water demand scenarios to build up a qualitative outline of the pressures on future water quality.

5.7 Stage seven – development of qualitative water quality scenarios

We used a group of Environment Agency experts to turn the outputs from the two day workshop into more detailed qualitative scenarios. The group included experts in water quality, agriculture, the Water Framework Directive and those involved in the development of the water demand scenarios. The detailed qualitative scenarios were used to provide indicative arrows showing the direction and magnitude of change for key long term drivers for water quality and for four families of water quality indicators (sanitary determinands, nutrients, chemicals and metals and microbes).

For our qualitative descriptions of the agricultural pollution of water we asked a Cranfield University expert, previously involved with the water demand work, to check that the assumptions were inline with the assumptions made for the water demand scenarios.

5.8 Stage eight – partial quantification of water quality scenarios

We used the population estimates for the 2050s with unit loading figures from literature to estimate loads entering sewage treatment works. We did this for the domestic population for each scenario. We generated estimates of Dry Weather Flow (DWF) using the population estimates, per capita consumption figures (from the water demand scenarios) and assumptions around infrastructure quality.

5.9 Stage nine - review and refine magnitude and direction of water quality change

We needed to make sure that the detailed qualitative future pictures of water quality that we had developed and the arrows showing direction and magnitude of change were aligned to the views that the external water quality experts had developed during the workshop (in stage seven). To help us do this we took the outputs from stages eight and nine back to the same external experts at a second workshop.

We undertook calibration exercises to ensure that the magnitude and direction of change for each scenario was correct. The workshop output was a short list of suggested amendments to magnitude of change, with a qualitative description to support this change.
5.10 Stage Ten – finalise England and Wales water quality scenarios

We used the same Environment Agency experts (from stage eight) to review the output of stage ten and the changes necessary. The output of this stage was four full water quality scenarios. These water quality scenarios included arrows indicating the direction and magnitude of change for main drivers of long term water quality, families of determinands, and overall water quality. In total we have estimated the direction and magnitude of change for a total of 19 different water quality aspects. A full list of the 19 aspects is given in Annex two.

5.11 Stage eleven – finalisation of England and Wales water scenarios

We have combined the water demand information and the water quality information to generate a set of four water scenarios for the 2050s.

6. Scenario tailoring results

The output of the 2050s water scenarios project was four possible futures of water for the 2050s. The results describe, in broad terms, two scenarios where water demand decreases and overall environmental water quality improves, and two scenarios where water demand increases and overall environmental water quality deteriorates7. This is shown in Table 1.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Total demand</th>
<th>Overall water quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation</td>
<td>- 4 per cent</td>
<td></td>
</tr>
<tr>
<td>Uncontrolled Demand</td>
<td>+ 35 per cent</td>
<td>↓ ↓ ↓</td>
</tr>
<tr>
<td>Local Resilience</td>
<td>+ 8 per cent</td>
<td>↓ ↓ ↓</td>
</tr>
<tr>
<td>Sustainable Behaviour</td>
<td>- 15 per cent</td>
<td>↑</td>
</tr>
</tbody>
</table>

Note: Three arrows is the greatest number of arrows we have applied for changes to 2050. The three arrow system does not represent a change to near ‘pristine’ waters, or a disastrous change to water quality. To describe such situations we would award a much greater number of arrows. These three arrows are used to indicate a scale of change within realistic boundaries of 40 years. Red arrows indicate a deterioration in water quality, whilst green arrows indicate an improvement in water quality.

Table 1 – 2050 total scenario demand and overall water quality.

To put some context on the water demand figures (also shown in Figure 2), the increase in demand under the Uncontrolled Demand scenario (the yellow bar) is equivalent to 14 times volume of water we can take from Kielder reservoir or more than 30 times the volume of water we can take from Rutland reservoir.

7 This is coincidental and not something we set out to achieve.
6.1 Innovation

6.1.1 Overview

This is a world where society expects government and scientists to solve the problems of climate change and resource shortfalls so they can carry on living their lives as they wish. Although sustainable development is at the core of the scenario, this is delivered through means other than a shift in societal values. Regulation is strong and compliance high. The speed with which innovation is moving means the risk of new chemicals being released into the environment is greater; however this world has the technology to cope with these risks.

Total demand under the Innovation scenario falls by just under five per cent. This is largely driven by the level of regulation and resulting technological innovation. Table two shows how this is broken down.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Quantification</th>
<th>Change from now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita consumption</td>
<td>125 litres per head per day</td>
<td>- 20 per cent</td>
</tr>
<tr>
<td>Population</td>
<td>73,600,000 people</td>
<td>+ 35 per cent</td>
</tr>
<tr>
<td>Household</td>
<td>9,250 million litres per day</td>
<td>+ 10 per cent</td>
</tr>
<tr>
<td>Industrial and commercial</td>
<td>6,250 million litres per day</td>
<td>- 15 per cent</td>
</tr>
<tr>
<td>Leakage</td>
<td>2,250 million litres per day</td>
<td>- 30 per cent</td>
</tr>
<tr>
<td>Agriculture</td>
<td>950 million litres per day</td>
<td>+ 145 per cent</td>
</tr>
<tr>
<td>Total demand</td>
<td>19,250 million litres per day</td>
<td>- 4 per cent</td>
</tr>
</tbody>
</table>

Table 2 – 2050 demand under the Innovation scenario

Nationally, water quality has improved over the last half century. The use of the latest technologies means sewage effluent contains less pollutant load. Standards for water quality are more specific, and ambition to meet these is high. Regulation is tighter, and compliance with environmental water quality standards is high.
Sewerage systems are increasingly separate systems and improved surface water management has reduced the impact of diffuse urban pollution. Diffuse pollution from agriculture has also declined and historic pollution has a minimal impact. There are reduced discharges to coastal water because of re-use inland. Technology for disinfection of storm overflows has reduced the load entering coastal waters.

People value good environmental water quality, but expect government to provide it rather than to contribute their own disposable income. Innovation has increased the risk of water related public health scares, but society is fairly resilient to these risks.

Since 2010 overall environmental water quality has improved: 📡💧

6.2 Uncontrolled Demand

6.2.1 Overview

This is a largely selfish world driven by a desire for economic growth about both a national and individual scale. This however results in a significant divide between the very rich and the very poor with the remainder of society in the fragile middle ground. The environment is low on the agenda expect for the very rich who can afford to pay for access to ‘nice’ areas. As a result regulation is minimal and regulatory standards low.

Total demand under the Uncontrolled Demand scenario rises by about 35 per cent. This is largely due to the massive population increase but also a result of the focus on cutting costs meaning water and energy efficiency measures are often forgotten or are at least given a lower priority. Table three shows how this is broken down.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Quantification</th>
<th>Change from now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita consumption</td>
<td>165 litres per head per day</td>
<td>+ 5 per cent</td>
</tr>
<tr>
<td>Population</td>
<td>78,500,000 people</td>
<td>+ 45 per cent</td>
</tr>
<tr>
<td>Household</td>
<td>13,000 million litres per day</td>
<td>+ 55 per cent</td>
</tr>
<tr>
<td>Industrial and commercial</td>
<td>8,250 million litres per day</td>
<td>+ 10 per cent</td>
</tr>
<tr>
<td>Leakage</td>
<td>3,500 million litres per day</td>
<td>+ 10 per cent</td>
</tr>
<tr>
<td>Agriculture</td>
<td>1,000 million litres per day</td>
<td>+ 180 per cent</td>
</tr>
<tr>
<td>Total demand</td>
<td>26,000 million litres per day</td>
<td>+ 35 per cent</td>
</tr>
</tbody>
</table>

Table 3 – 2050 demand under the Uncontrolled Demand scenario

Environmental water quality has declined. Standards for environmental water quality are less stringent than those earlier in the century. Monitoring of water quality indicators is poor, but it is believed that if monitoring systems were sufficient that compliance with water quality standards would be good.

Sewerage systems are primarily combined systems (receiving both sewage and rainfall runoff from roads and other surfaces), and are under increasing pressure from the increased population and increase in consumption of water. Diffuse pollution from agriculture has increased with greater pollution of the water environment by both nutrients and chemicals. Historic pollution still causes problems.
Society values a good quality water environment. However, it is largely only the richest that are able to pay for access to good quality environments, and to protect themselves from water-related public health scares.

Since 2010 overall environmental water quality has declined: 

6.3 Local Resilience

6.3.1 Overview

This is a world recovering from a massive economic shock earlier in the 21st century. The result is that growth, whilst important, is no longer about money. There is a massive rise in subsistence type living and a 'make-do and mend' culture. As a result society and its governance has a much greater regional focus and this extends to both regulation of the environment and operation of water systems.

Total demand under the Local Resilience scenario rises just under 10 per cent. This is largely driven by the need to implement efficiency measures in order to get by. However it is limited by the relative lack of innovation to improve that efficiency. Table 4 shows how this is broken down.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Quantification</th>
<th>Change from now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita consumption</td>
<td>140 litres per head per day</td>
<td>- 10 per cent</td>
</tr>
<tr>
<td>Population</td>
<td>64,000,000 people</td>
<td>+ 20 per cent</td>
</tr>
<tr>
<td>Household</td>
<td>9,000 million litres per day</td>
<td>+ 5 per cent</td>
</tr>
<tr>
<td>Industrial and commercial</td>
<td>7,500 million litres per day</td>
<td>No real change</td>
</tr>
<tr>
<td>Leakage</td>
<td>3,750 million litres per day</td>
<td>+ 20 per cent</td>
</tr>
<tr>
<td>Agriculture</td>
<td>475 million litres per day</td>
<td>+ 25 per cent</td>
</tr>
<tr>
<td>Total demand</td>
<td>20,750 million litres per day</td>
<td>+ 8 per cent</td>
</tr>
</tbody>
</table>

Table 4 – 2050 demand under the Local Resilience Scenario

It is believed that water quality has declined since the 2010s but monitoring to confirm this is inadequate. There are significant local differences depending on the management of sewage treatment works, the surrounding agriculture and any success of local pressure groups.

Some national and European legislation is in place, but the effluent standards vary. Sewage effluent contains a greater load than earlier in the century.

Sewerage systems are primarily combined. Reliability has decreased resulting in an increase in sewer flooding and hence pollution. Pollution from rural agriculture and urban agriculture has increased. Individuals are willing to pay (with time, rather than financially) for improvements to environmental water quality if they believe it will protect them from public health risks.

Since 2010 overall environmental water quality has declined:
6.4 Sustainable Behaviour

6.4.1 Overview

The focus of this world is on achieving sustainable development and living within our environmental means. However it is important to recognise that this does not mean the environment wins every time – economy and society are important too. The focus of the early part of the century was on reducing carbon and now both low carbon technologies and green energy are common place.

Total demand under the Sustainable Behaviour scenario falls by about 15 per cent. This is driven primarily by individuals behaviour as they pride themselves in being as efficient as possible and being seen as ‘green’ is a positive attribute. Table 5 shows how this is broken down.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Quantification</th>
<th>Change from now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per capita consumption</td>
<td>110 litres per head per day</td>
<td>- 30 per cent</td>
</tr>
<tr>
<td>Population</td>
<td>66,000,000 people</td>
<td>+ 25 per cent</td>
</tr>
<tr>
<td>Household</td>
<td>7,250 million litres per day</td>
<td>- 15 per cent</td>
</tr>
<tr>
<td>Industrial and commercial</td>
<td>6,250 million litres per day</td>
<td>- 15 per cent</td>
</tr>
<tr>
<td>Leakage</td>
<td>3,000 million litres per day</td>
<td>- 15 per cent</td>
</tr>
<tr>
<td>Agriculture</td>
<td>700 million litres per day</td>
<td>+ 85 per cent</td>
</tr>
<tr>
<td>Total demand</td>
<td>17,250 million litres per day</td>
<td>- 15 per cent</td>
</tr>
</tbody>
</table>

Table 5 – 2050 demand under the Sustainable Behaviour Scenario

Nationally there are marked differences in environmental water quality. Legislation is prescriptive but water quality standards are less stringent than in 2010. Sewage effluent, therefore, contains more pollution load. Locally led regulation has increased, and compliance with environmental water quality standards is high.

Sewerage systems are primarily combined systems, except in areas of new development. There is less pressure in terms of foul water per individual but this has been offset by the increase in population. There has been a decline in nutrient and chemical pollution from agriculture. Investment has been made in stabilising the most polluted contaminated land.

People value good environmental water quality but due to low disposable incomes the ability for improvements is low. The reduction in wastewater treatment has resulted in an increased risk of public health scares.

Since 2010 overall environmental water quality has improved:

6. Taking the scenarios forward

The aim of this work was to produce a picture of what water quality and water resources could be like in the 2050s. We used scenarios to help us deal with the uncertainty associated with looking forty years into the future and so produced an envelope of demand and quality. Actual demand and quality in the 2050s is most
likely to fall within this envelope, rather than match a specific scenario. This makes it a useful tool for assessing plans to manage the future.

The picture we have developed for water demand has been used, along with work looking at the effect of climate change on river flows by the 2050s, to help test our 2009 Water resources strategy. This means we can be sure our actions to manage water resources will be valid across a range of futures.

Using these 2050 water scenarios as a starting point and applying futures methods we have developed a set of 2100 worldviews.

A full report containing the detail behind each of the 2050 water scenarios is available together with the social scenarios for water which provide the detail behind why people behave the way that they do. These documents are available by emailing kate.riley@environment-agency.gov.uk

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Annex 1: Brief scenario narratives

**Innovation**
This scenario sees a highly technological driven and knowledge led UK. Consumers continue to consume in a relatively resource intensive manner. Environmental concerns are perceived to be the problem of manufacturers and service providers, who have responded by becoming increasingly resourceful at engineering new (and less carbon intensive) solutions to the problems of meeting consumption demands. Closed loop systems have become widespread in an attempt to ensure that nothing gets wasted. Supply side regulation has now become an accepted and integral part of the economy – and in the UK the influence of EU legislation is particularly strong. This is a world in which there have been a wide range of scientific breakthroughs, including in nanotechnology, genetics, transport pharmaceuticals and health diagnostic technologies. However these are in the context of heavy government intervention around innovation patterns, ensure that efficient resource use is prioritised by business. Huge numbers of people now work in regulation and compliance; a new army of what the public call ‘men in green coats’. However, the loss of jobs from manufacturing has caused societal inequality amongst the unskilled workforce.

**Uncontrolled Demand**
In this world, there is broad awareness of environmental issues – but for many consumers these issues are not heavily pressing. Economically, Britain is doing well by 2050, and a historic commitment to free trade and open markets has helped to keep overall GDP levels among the worlds highest.

However, there is also considerable inequality and polarisation in this world. The wealthiest 20 per cent of society enjoy a high standard of living – but increasingly cut themselves off from the rest of society. At the other end of the scale, there is also a growing underclass, which by 2050 represents around 20 per cent of the population, unable to sufficiently adapt to the changing demands of the globalised labour market. This significant minority includes the British-born poor, many climate change refugees and second generation immigrants. Meanwhile, the middle class has also found economic life increasingly challenging, experiencing stagnant wage growth and feeling economically and materially worse off than previous generations. The picture of national prosperity therefore masks significant disparities.

Service provision (including provision of water) in this world is dominated in many cases by private companies, leading to heavy disparities in the quality and reliability of provision, depending on income levels.

**Local Resilience**
In Local resilience, ‘Peak Oil’ turned out to happen much sooner than the consensus suggested, resulting in a series of economic shocks triggering recession and inflation. Protectionism followed, and the market model which dominated the global economy in the late 20th century was not designed for a world in which underlying resources – especially energy – was scarce.

One result was that governments spent less on infrastructure as social payments absorbed more of their shrinking revenues. Transport schemes were cut, telecoms infrastructure deteriorated, investment in sewage and water schemes was cancelled,
and the electricity grid became less reliable. Systems which had been national have frequently been localised. As a result, 'local resilience' (and technologies to facilitate this) have a high degree of importance. Moreover, the cost of resources means that people have adapted their houses to reduce energy consumption and water use. Food is more seasonal and more local and there is also more ‘urban agriculture’.

People have also become used to reusing goods. Online networks help people find things cheaply that they need – second-hand, and ‘Decluttering’ is a widespread social phenomenon. GDP has declined in importance as a measure of social success, as other measures of social wellbeing and welfare have become more prominent. There is less concern for the environment, and some habitats have suffered. But eco-system services have a far greater importance, and bio-diversity has increased.

Sustainable Behaviour
Those living in Sustainable Behaviour have a strong sense of their role and responsibilities within the wider world, and recognise the need for action against climate change. Governments around the world have responded to these concerns, and over the past decades we have witnessed a virtuous circle of growing public awareness and policy developments. Sustainable behaviour in the home and business has consequently increased.

This focus on sustainability resulted in increased prices across the board, and reduced purchasing power. However, levels of social cohesion are high, reinforced by local or regional delivery of a number of services and shared ownership schemes for now expensive goods (e.g. cars). Moreover, local governance is increasingly important in this world. There has also been a shift towards public ownership of key utilities, and mutualisation is common in a number of industries, including water, energy supply and waste.

The greater focus on regional governance has resulted in variable levels of service quality. Whilst some areas have prospered under engaged and enthusiastic representatives keen to meet the needs of their community, others have suffered from less effective leadership. With moving out of the area unaffordable for the majority, the idea of a ‘postcode lottery’ determining the quality of service provision is becoming a key concern.
Annex 2: Arrows indicating direction and magnitude of change for water quality in the 2050s

i. Overall degree of environmental regulation
ii. Ambition of water quality standards
iii. Load of sanitary determinands entering waters from wastewater treatment works
iv. Load of nutrients entering waters from wastewater treatment works
v. Load of chemicals and metals entering waters from wastewater treatment works
vi. Load of microbes entering waters from wastewater treatment works
vii. Load from rural diffuse pollution entering waters
viii. Load from urban diffuse pollution entering waters
ix. Historic pollution from contaminated land
x. Pollution from mine waters
xi. Extent to which public value environmental water quality
xii. Likelihood of water related health scares (real or imagined)
xiii. Mitigation of water related health scares
xiv. Technological innovation in the waste water industry
xv. Change in load of sanitary determinands entering waters
xvi. Change in load of nutrients entering waters
xvii. Change in load of chemicals and metals entering waters
xviii. Change in load of microbes entering coastal waters
xix. Overall environmental water quality