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Costs of Environmental Infrastructure Needs to Meet the North West Regional Spatial Strategy

Resource Efficiency science programme

Science report: SC060067

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Steve Killeen

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Head of Science

Executive summary

Introduction

Our towns and cities would be uninhabitable without the network of services that protect us from flooding, deal with our rubbish and sewage and provide us with clean water. The services provided by *environmental infrastructure* are essential to our quality of life and the environment that we inhabit. Their failure can cause harm to health and wellbeing, damage the environment and cost money.

The Environment Agency is the leading public body for protecting and improving the environment. We are at the forefront of work looking at the capacity of environmental infrastructure to cope with development. As communities grow it is vital that plans are in place to manage the increased demand from new households and related development. Our 2007 Report *Hidden Infrastructure* identified principles to ensure that environmental infrastructure is in place to support growing communities and to protect the environment. These include getting the location of new housing right; planning for environmental infrastructure for the longer term; reducing demand on environmental services; as well as securing funding at an early stage.

This study looks at the cost of environmental infrastructure to support growing communities in the North West, a region with a number of new Growth Point areas backed by Government for additional housing. It was informed by previous work the Environment Agency has undertaken including a detailed study in the South East - *A strategy for provision of environmental infrastructure to meet the needs of the South East Plan (2007).*

Key Findings

- It will cost just over £29 billion to continue to operate and maintain existing environmental infrastructure in the North West up to 2029.
- It will cost a further £8 billion to provide, operate and maintain environmental infrastructure to support the rate of housing growth projected in the North West Regional Spatial Strategy (RSS, 23,000 homes/annum) over the same period. This equates to £16,528 for each new house.
- Current water company plans suggest that water resource and waste water infrastructure to support RSS levels of growth will be planned and provided for up to 2015. Beyond this there are significant uncertainties, especially if the North West chooses to adopt higher growth figures, including the recent round of Growth Points.
- Urgent action will be needed to improve the delivery and planning of environmental infrastructure if the growth aspirations of the region are to be realised. This will include:
  - A multi-organisational approach to managing water demand and water quality and prioritised new investment in water supply and waste water treatment infrastructure.
  - Limiting inappropriate development in flood risk areas and improved coordination between planners and utility companies to identify sewer, surface water and groundwater flood risk.
  - Greater coordination of waste transfer capabilities, the identification of suitable processing sites and the promotion of waste avoidance for all sectors.

Overview

With the methodology used in the South East study as a starting point, we asked Arup and SURF to model the costs of environmental infrastructure in the North West, a region which has seen a step change in housing growth projections. In the recent round of Growth Points some local authorities committed to increase the number of new homes up to 20 per cent beyond targets set in the Regional Spatial Strategy (RSS). The study costed the environmental infrastructure requirements of four comparable growth scenarios over the period 2008-2029:

1. Zero Growth – no new homes built and the population does not increase
2. Adopted RSS growth rates – 23,000 new homes/annum
3. RSS + 20% (referred to as RSS+ scenario) – 28,000 new homes/annum
4. RSS + 40% (referred to as RSS++ scenario) – 32,000 new homes/annum

Four main issues were considered:

- Waste: infrastructure used in the collection, treatment and disposal of residential waste (collection, recycling and landfill).
- Water resources and supply: all infrastructure involved in the supply of water to households (treatment, storage and distribution).
- Water quality: all infrastructure used for maintenance and improvement of the quality standards of surface water and groundwater (sewer systems, wastewater treatment).
- Flood risk management: the damage costs from the consequences of flooding to properties.

The flooding costs were calculated differently from the infrastructure assessments for waste, water resources and water quality. The flooding costs refer to the number of properties potentially affected by flooding and the costs of the damage from flooding. These results are not comparable to the 2007 South East study which estimated future costs according to existing Environment Agency projected spend on flood protection measures. Biodiversity and green infrastructure were issues outside the scope of this North West study.

Results

The estimated costs of environmental infrastructure in the North West over the four growth scenarios are as follows:

	Zero growth Cost 2008-29	**RSS** Additional cost 23,000 houses/year	**RSS+** Additional cost 28,000 houses/year	**RSS++** Additional cost 32,000 houses/year
Water resources and supply	£8,378m	£3,868m	£5,410m	£6,108m
Water quality	£9,733m	£3,094m	£3,875m	£4,229m
Flood risk	£3,540m	£907m	£1,088m	£1,270m
Waste	£7,362m	£114m	£244m	£265m
Total	£29,013m	£7,983m	£10,617m	£11,872m
Cost per additional house	-	£16,528	£18,056	£17,666

It will cost just over £29 billion to continue to operate and maintain existing environmental infrastructure in the North West up to 2029.

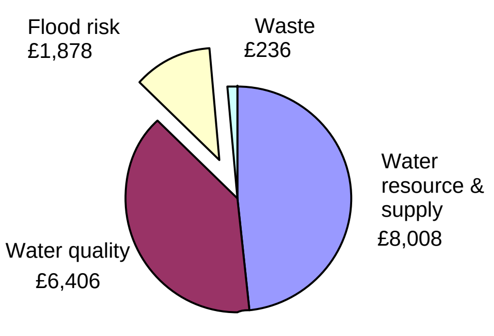
It will cost a further £8 billion to provide, operate and maintain environmental infrastructure to support the rate of housing growth projected in the North West Regional Spatial Strategy (23,000 homes/annum) over the same period. This equates to £16,528 for each new house.

Under a higher housing growth scenario of 28,000 new homes per year up to 2029 – the RSS+ scenario – the additional environmental infrastructure costs rise to just over £10 billion. This equates to £18,056 per new house.

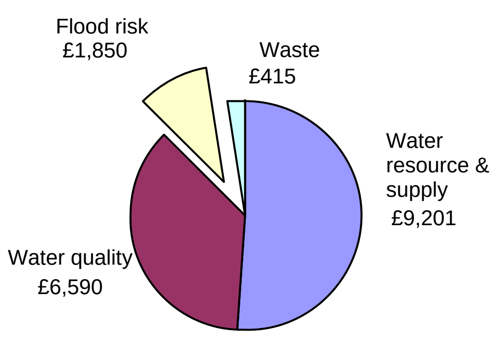
Water resources and water quality make up the greater part of additional infrastructure requirements. Waste costs appear low as the bulk of spending is associated with existing capacity constraints. Furthermore as flood risk was measured by the consequential cost of flooding and not the cost of flood defences these costs should be viewed as a conservative estimate and considered separately.

The following charts show the cost per house of the additional environmental infrastructure needed to support projected levels of growth in the RSS (23,000 additional houses/annum) and RSS+ scenarios (28,000 additional houses/annum) up to 2029:

North West RSS Growth Scenario
Cost per additional house:



RSS + scenario
Cost per additional house:



Total: £16,528 per house **Total: £18,056 per house**

Water Resource and Supply

The latest water resource plan for the region is broadly in line with RSS levels of housing growth up to 2029. However, meeting the region's future needs will be dependent on successfully managing a number of difficult issues including leakage, water meter penetration, and the behavioural change necessary to achieve ambitious water consumption targets (from 139 l/person/day in 2006/07 to 124 by 2034/05). Whilst the region is likely to satisfy its water needs in the short term, there is little 'headroom' to cope with extreme events, such as drought, or differing water usage trends.

Existing funding is adequate to 2015. Beyond this improved co-ordination between planners and utilities will be required to identify local constraints to allow for further growth. A multi-organisational approach to demand management will also be needed to assess risk to development plans and to prioritise new resource investment. Lessons should be learned from partnerships in the Thames Gateway which bring together representatives from regional and local government, utilities and regulatory bodies.

For the level of growth projected in the RSS the cost of water resource and supply infrastructure is around £8,008 per new house - the largest component of the total environmental infrastructure cost. This level of spend is associated with demand management costs, upgrading local distribution capacity and a past emphasis on waste water rather than water supply investment in the region. In calculating costs, the model uses United Utilities' current spend commitments for 2010-15 (AMP5). The Water Services Regulation Authority (Ofwat) figures for average annual spend were used to estimate additional costs up to 2029. Key assumptions were as follows:

- Water usage and occupancy rates in the draft Water Resources Management Plan are the same between and within sub-regions.
- The targeted reductions in water demand are achieved, including a 96% water meter penetration rate by 2035.
- The requirement to maintain a positive water supply/demand balance until the end of the next planned asset management period (2010 to 2015) has already been included in the submission to Ofwat, so the additional cost (for new homes built up to 2015) is zero.

Water Quality

Without additional investment, the combination of higher loads due to population growth and an anticipated reduction in water consumption will reduce water quality in the region. Source control of runoff and measures to control water quality and flooding from sewers will be a major challenge. As with water resource infrastructure, water quality will be a major factor in the cost of environmental infrastructure to support growing communities.

Waste water process enhancement to support additional population load should be straightforward to 2015. Beyond this, older and smaller waste water treatment works will require additional investment and new approaches to provide additional capacity. Multi-organisational catchment management plans will also be required to coordinate water quality issues and to plan and implement catchment wide approaches to improve water quality.

For the level of growth projected in the RSS the cost of water quality infrastructure is around £6400 per new house. This makes up the second largest component of the total environmental infrastructure costs per house. The level of spend is associated with investment in additional process units, additional storage of surface water and increased costs for maintaining the extended system (including Sustainable Drainage Systems - SUDS). In calculating these costs, the model does not consider the separate constituents of water quality. Instead, it assumes that the impact on river water quality is related to the volume of flow received by the water course. Key assumptions are as follows:

- The model does not consider whether development has combined or separate sewer systems e.g. whether runoff reaches receiving water via overflow or via direct discharge.
- The model assumes that storage capacity through attenuation and sustainable urban drainage systems is provided local to the development site.
- Modelling based on average dry weather flows only, no seasonal or daily peak estimates.

Flood Risk

With Planning Policy Statement 25 (PPS25) limiting inappropriate development in the floodplain, the future costs of flood risk in the region are associated with funding planned flood risk management strategies and dealing with legacy sites already at risk of flooding. To support housing growth improved coordination between planners and utility companies will also be required to identify local sewer, surface water and groundwater flooding risks.

The model uses average annual damages calculations developed as part of our Catchment Flood Management Plan programme. This estimates the number of proposed properties potentially affected by flooding and the costs of damage resulting from flood events. This includes development in or partially inside areas identified as high or medium flood risk. The costs generated represent the worst case scenario if no additional protection of flood risk management processes are implemented. Under the RSS growth scenario the estimated cost of flood damage per additional house is around £1878.

These results are not comparable to the 2007 South East study which estimated future costs according to existing Environment Agency projected spend on flood defence measures. As a measure of the consequential costs of flooding the costs estimated for the North West are also likely to represent only a conservative estimate of potential flood risk demands on the public purse. Key assumptions are as follows:

- Developers have provided suitable mitigation measures at their cost.
- Despite the principles of PPS25 being followed, there is always a higher risk of property flooding in a flood zone.
- Multi-storey, single storey or buildings with basements are all the same.
- Fluvial and coastal flooding are the only types of flooding considered.

Waste

Landfill is a critical constraint on housing growth with regional landfill capacity likely to be exceeded within a decade. Whilst the findings do not take into account reductions in residual waste that should be achieved over the 2008-29 period, they suggest that increases in recycling and composting will not, on their own, be adequate to reduce dependence on landfill.

Current waste strategies will alleviate some of the pressures with most waste disposal authorities having initiated procurement for additional treatment of residual waste. However there remains a risk that sufficient capacity may not be in place in time to meet the region's needs. Addressing this risk will require greater co-ordination in the management of waste transfer capabilities and the identification of suitable waste processing sites to fill the shortfall in capacity. The promotion of waste avoidance for all sectors will also be crucial to achieving higher landfill diversion targets. This along with the implementation of best available techniques in waste treatment and recycling will require early consultation and planning

Unsurprisingly, given the immediate pressures on landfill, the bulk of costs associated with new infrastructure provision are applicable to the zero growth scenario (£7,362m). The additional pressure posed by new development has only a relatively small impact on future costs. For the RSS growth scenario this amounts to around £237 per additional house – less than 2% of the total environmental infrastructure cost. To overcome the difficulties surrounding the mapping of existing waste management practices in the North West, this study used a generic scenario to model the costs of municipal waste services. This included the costs associated with the collection, transport and processing of recycling and residual waste. Key assumptions in the generic scenario were as follows:

- Current landfill practices continue into the future.
- All municipal waste produced is disposed of within the region.
- Current disposal contracts held by each authority are unknown and therefore each authority is currently associated with all waste disposal sites in the region, proximity was used to determine which landfill site each authority transfers waste to.
- Costs are for the collection and disposal of municipal waste and do not include commercial and industrial waste nor construction and demolition waste.

Conclusion

The provision of environmental infrastructure will be key to the achievement of regional growth ambitions. Our study shows that the North West, like the South East, faces substantial costs in order to accommodate levels of development projected in the RSS or greater. This challenge will increase in urgency as the North West, like many regions, approaches the issue of infrastructure alongside the delivery of the RSS and the Regional Strategy that follows. In meeting this challenge, the North West's key regional and sub-regional organisations will have to actively build the capacity and capability to understand and shape infrastructure networks.

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1.1 Rationale

The towns and cities we live in would be uninhabitable without the services of flood protection, waste and sewerage management, and clean water provision. There is a high demand for new housing across England and Wales, accelerated by the Government Housing Agenda to increase the rate of house building from 150,000 in 2005 to 240,000 homes a year until 2016 (Great Britain 2007d). Growing communities are putting pressure on these environmental services and associated infrastructure. As outlined in the Environment Agency's Hidden Infrastructure report (Environment Agency 2007b), a combination of strategies and fiscal interventions are needed to ensure that environmental infrastructure will cope with the projected development. These involve building in the right place, reducing demand on infrastructure services, increasing capacity and changing our approach to infrastructure planning within a changing climate.

City regions of the North West (NW) have been prioritised as growth poles within regional economic and spatial strategy and the Government housing agenda. Adding to this pressure is a new round of growth points, where certain authorities have pledged to increase the number of new homes in their local areas by 20 per cent beyond the Regional Spatial Strategy (RSS) targets up to 2017 (Great Britain 2007a).

In the NW of England, current understanding of the level of growth in the RSS would equate to adding an average of around 23,000 extra properties per annum to the region up to 2021 (GONW 2008) . The challenge will be to meet these ambitious growth projections within the capacity of the environment and the regions' environmental infrastructure. There will be cost implications as with any infrastructure decision but we need to plan and manage growth and infrastructure delivery via new long-term solutions (Section 1.5).

This is particularly important when considering the current conditions of environmental infrastructure in the NW. For example, the region's generation of municipal household waste currently stands at 524 kg/person, above the UK average of 495 kg/person (Defra 2008a). Also, NW river water quality has generally been improving since 1990 but still lags behind the national average (ranked seventh for biological and fourth for chemical water quality out of nine regions) (Environment Agency 2006). Finally, it is predicted that coastal erosion and climate change will increase the risk and severity of flooding and that the population at risk of flooding will increase as new development is more likely to take place on previously developed land.

The draft RSS received a significant number of objections and representations during its consultation period, which led to an Examination in Public (EiP) process in 2006-2007 (North West Examination in Public Panel 2007). The EiP Panel recommended that a partial review of the RSS be carried out in six key areas. Two of these had direct impacts on Environmental Infrastructure (EI): one was waste policy, in terms of identifying broad areas for the location of new facilities in the region; the second was a re-examination of overall housing numbers (North West Examination in Public Panel 2007). The housing, waste and energy elements of the partial review have now been halted. These areas are likely to be addressed in the Single Integrated Regional Strategy which the NW is developing in advance of other regions (NWRA 2008).

The Environment Agency, with its remit to protect and improve the environment, has an interest in promoting sustainable household and economic growth through proper planning and regulation.

To date, understanding the links between household growth and infrastructure has taken place in the South East (SE), namely the Thames Gateway area. A study commissioned by the Environment Agency and carried out by Jacobs considered the costs of providing, maintaining and operating the EI to satisfy current needs and the growth described in the SE Plan (RSS). This work is referred to as the *Strategy for Meeting Environmental Infrastructure needs in the South East* or SMEISE study. The Environment Agency felt that an examination of this work in the context of the North and NW of England could identify possible ways forward for the region, which also face pressures associated with growth.

The Environment Agency needs to anticipate and prepare for the imminent planning and development decisions to be taken in the NW. Therefore, it asked Arup and SURF to test out the methodology used in the SMEISE study (Jacobs 2007a) in the context of the North and NW of England and the applicability of lessons from the SE to the NW region and city regions in the Mersey Belt.

1.2 Aims and objectives

The Environment Agency commissioned Arup and SURF to (1) identify the costs of environmental infrastructure for meeting the requirements of the NW Regional Spatial Strategy and (2) assess which lessons from the Thames Gateway (TG) and new infrastructural solutions are relevant and transferable to the NW of England.

Phase 1 of the project was to conduct a case study of the TG to understand the transferable lessons of TG to the NW context (see Section 1.5.4). Phase 1 reviewed the current state of development through a comparative analysis of the key documents, strategies and research on the TG focusing on the development of infrastructure solutions. There were three objectives:

i. To set out the status of infrastructure solutions being developed in the TG.

ii. To identify, through comparative analysis of secondary sources, key lessons learnt about the construction of new infrastructure.

iii. To assess relevant and transferable lessons to the NW of England.

Phase 2 of the project built on the SMEISE study to estimate the economics costs of providing waste management, water resources and supply, water quality, flood risk management and biodiversity infrastructure for alternative growth scenarios (23,000; 28,000 and 32,000 properties per year).

The primary aim was to develop an understanding of the complex relationship between behaviour, growth and the use of environmental infrastructure and translate this into a simple but sensible economic model. Model users should be aware of the assumptions and decisions made in developing the model, to understand the limitations of its outputs (Sections 3.3.1, 4.3.1, 5.3.1 and 6.3.1). Despite its limitations, the model represents a start in the process of assessing the implications of different housing development sites for environmental infrastructure.

The current situation in the NW region is that housing growth has kept below the growth scenarios proposed in the RSS. However, in order to make decisions on the location, timing and sustainability of new developments, authorities need information with a high level of spatial resolution. Together, Phases 1 and 2 aimed to consider the following issues:

- Does the information published on resource requirements and potential costs associated with projected levels of growth only examine constraints at a scale which is too large to be useful in decision making?
- Can constraint “hot spots” be identified at the sub regional or lower level?
- At higher growth scenarios, what is the scale of constraints on growth? Are the constraints local problems that can be overcome by reinforcing existing systems or are they systemic, requiring fundamental changes?
- Can solutions developed for other regions be applied to the NW?

1.3 Definitions of environmental infrastructure

The project considers five types of environmental infrastructure: municipal waste, flood risk management, water quality, water resources and supply, and biodiversity. Each is defined below in the context of this project:

- Waste: infrastructure used in the collection, treatment and disposal of residential waste (collection, recycling and landfill).
- Water resources and supply: all infrastructure involved in the supply of water to households (treatment, storage and distribution).
- Water quality: all infrastructure used for maintenance and improvement of the quality of surface water and groundwater (sewer systems, wastewater treatment).
- Flood risk management: the infrastructure involved in the protection and reduction of flood risk to households is only a part of the strategy currently used in catchment flood risk management. The report and model therefore look at the possible consequences of flooding and use the concept of average annual damages (see Section 6.3) as a proxy for the financial implications of building in flood risk areas.
- Biodiversity: ideally the report and model would cover habitats, land, air and water, with the main purpose of supporting native species and maintaining natural ecological processes. However, it became clear during the project that the topic area was too broad to be adequately covered in the limited time available (see section 1.4).

Other infrastructure types that were not part of the SMEISE study (such as transport) are not considered.

1.4 Biodiversity

1.4.1 What was done in the SMEISE study

In the SMEISE study, the costing of biodiversity-related infrastructure is based on the targets identified in Biodiversity Action Plans (BAPs) and the SE England Biodiversity Forum.

BAPs provide targets for habitat improvement for various categories of environment, such as 950 hectares of improved coastal and floodplain grazing marsh by 2010 or improvements to 800 km of rivers by 2026. Jacobs assume that, in the short term, the restoration of existing habitats predominates over the establishment of new habitats or habitat expansion.

The study references English Nature's (1993) policy stressing the need to provide Local Nature Reserves (LNRs) in every urban area at a minimum rate of one hectare per thousand population. However, there is no mention of existing levels of LNR provision or of projected shortfalls if new homes are built. A discussion of differential impacts is also missing; for example, areas near national parks or existing reserves presumably need less additional reserve area. Cost calculations are simply based on a rate of one hectare of LNR required for mitigation against development for a thousand increase in population or part thereof. Using a rate of 0.1 ha per 100 population increase would be more accurate.

The study assumes that 80 per cent of the biodiversity targets from BAPs and the SE England Biodiversity Forum until 2010 will be met by restoration of existing habitats. After this point, 50 per cent of the targets between 2010 and 2026 will be met by 50 per cent restoration and 50 per cent establishment/expansion.

Costings for habitat restoration, establishment and expansion are extracted from the report *Preparing Costings for Species and Habitat Action Plans* submitted to the UK Biodiversity Group in 2006. The average cost per hectare of habitat is £5,554 and the ongoing management costs are £160 per hectare. Land prices are considered to be £26,190 per hectare so that together, the cost of land and cost of enhancement average £31,744 per hectare.

However, Jacobs is not clear on the amount of land required and its relationship to new housing. It does not specify how many households do not or would not have access to LNRs. As explained above, the study suggests one hectare per 1,000 additional population but does not state what the current provision is. Indeed, it is fairly easy to apply this methodology to assess the current level of nature reserves across the NW. For instance, there are 72 ha of LNR in Bolton; the mid-year population estimate for 2006 is 262,400, suggesting Bolton already has 190 ha in nature reserve deficit. Obviously, additional population will increase this deficit.

Jacobs does not differentiate between delivering habitat expansion in urban areas and delivering the same extension in rural areas, where presumably the cost is cheaper (although probably less of a necessity).

Salford, Manchester and other areas are probably already in deficit on this measure, like Bolton, and therefore the costs of provision are presumably not only higher because of their setting, but because more area is needed to make up for the deficit.

Finally, there are close links between biodiversity and flood risk management and water resources infrastructure. For example, ground nesting birds will have to find somewhere else to nest if a field is flooded. This should add to the mitigation costs but it is not clear whether they are included in the calculations.

Separate projects have looked at estimating the impact of development on biodiversity. It was therefore decided to limit this project to the same scope as the SMEISE study

1.4.2 Arup's work

Arup took the same approach as in the SMEISE study. However, because of the gaps and uncertainties in the methodology (outlined in the previous section), the results did not add to the understanding of the costs of biodiversity infrastructure associated with projected housing growth in the NW. Instead, the results were largely a reflection of the costs of access to open space, but the provision of open space is not a guarantee of safeguarding or enhancing biodiversity around new housing developments.

Over the course of the project, Arup and the Environment Agency had several discussions to develop a methodology that would better capture the complex links between household growth and biodiversity. However, the progress made within the timeframe of the project was insufficient to agree on a more appropriate methodology. Given the complexity of the issue, further investigation was required and it was decided that the biodiversity component of the model would be omitted from this report. The Environment Agency intends to build on the work done by Arup and progress the biodiversity component of the model in partnership with other organisations.

1.5 Pressures, policy drivers and responses for integrated infrastructure

Planning and infrastructure is becoming more challenging for cities and regions both within the UK and internationally. There are new pressures that need to be anticipated and addressed; policy drivers to develop new mechanisms for coordinating and overcoming resource constraints; and emerging responses related to different levels of urban and regional capacity and capability.

1.5.1 New pressures

Cities and regions have to consider new and intensified pressures when deciding how to coordinate and manage their infrastructure. Three new issues are significant:

i. The need to understand the implications of climate change and resource constraint on the long-term security of infrastructure supply. Critical to this is developing knowledge and expertise to understand how cities' and regions' growth ambitions can be managed against a background of carbon constraint, the security of energy and water resources and the impacts of climate change.

ii. The need to mesh national and sectoral solutions for systemic change in the social and technical organisation of key infrastructures – transport, energy, water and waste which are network-based with their own spatial and economic objectives. Critically, how do cities and regions link new pressures to ensure, for example, low carbon transitions in infrastructure systems with their own territorial ambitions?

iii. The need to develop anticipatory infrastructure solutions to deal with these pressures. In particular, how are new concepts such as carbon, water and waste neutrality integrated within new developments and applied across existing infrastructure networks? Critically, what knowledge and relationships have to be developed to apply such solutions and at what scales do these need to be developed and coordinated?

1.5.2 Policy drivers

The need to address these new issues is being accelerated through policy drivers cascaded on to regions, sub-regions and cities. These are of three types:

i. New requirements for more integrated coordination of planning and infrastructure. For example, the Housing Green Paper (2007) calls for "improved infrastructure planning" that requires earlier communication between utilities and planners. Such drivers are being cascaded through the planning process.

ii. New standards for development projects include water neutrality, decentralised energy and carbon reduction targets. These are all placing requirements on authorities to think systemically about new infrastructure solutions and ensure these are incorporated into new developments.

iii. Piloting of exemplary and emblematic infrastructure solutions. Key to these are the new responses being piloted in the Thames Gateway eco-region such as carbon, water and waste neutrality. Such solutions may become significant in the management of demand in new and existing development in areas where infrastructure is currently stretched or at capacity.

1.5.3 Emerging responses

In response to these pressure and policy drivers the cities, sub-regions and regions have different capacity and capabilities to develop systemic responses. A brief overview of current responses reveals that:

i. Many regions are approaching the issue of infrastructure retrospectively after spatial strategies have been prepared. Responses are focused on assessments of more detailed capacity constraints and opportunities in relation to existing growth ambitions (NW, YHA). Where growth locations are better understood, the focus is on how to prioritise schemes and understand financing options (SW, SE).

ii. At a city-regional level practices also vary. The Greater London Authority (GLA) has the most integrated and ambitious proposals for a whole suite of infrastructures but there are critical issues on the capability to meet these proposals and integrate them with the planning system. In other contexts, city regions and sub-regions are working to more effectively understand constraints and develop strategic responses.

iii. Because infrastructure solutions cut across administrative boundaries, new scales of solutions are emerging. These are sometimes at a smaller scale such as eco-towns where integration can be designed into the masterplan or at a much larger scale such as the Thames Gateway where coordination needs to cut across local authority, regional and utility boundaries.

1.5.4 The exemplar eco-region

The Thames Gateway is emerging as the exemplar national (and even international) testing ground for ambitious integrated "infrastructural solutions". New concepts such as water, carbon and waste neutrality may be able to pre-emptively overcome conventional environmental constraints. In aspiration at least, this logic is about a new style of urbanism that combines design, architecture, planning, economic development, engineering and new technologies to produce development that can systemically transcend limits to further growth.

Transcending constraints?

Cumulatively, these solutions seek to transcend infrastructure and environmental constraints. The new style of urbanism seeks to accommodate substantial new development within a defined growth area without increasing overall resource use or production for certain types of infrastructure – in particular water and carbon but also waste. This represents an attempt to develop a style of urbanism that ensures continued and accelerated growth through new approaches to infrastructure provision. In doing so, it is claimed that these solutions not only overcome constraints but may exceed national targets. This requires the development of new social relations, the management of new technologies and social practices, and upscaling from experiments to whole system changes.

Implications for the North West

Critically, these infrastructure solutions have important implications for the growth agenda in the North West for the following reasons.

First, the emergence of infrastructure solutions is directly associated with the designation of the Thames Gateway as an "eco-region". This implies that certain regions are "producers" of infrastructure solutions.

Second, infrastructure solutions push beyond conventional notions of infrastructure constraints to develop more systemic and long-term solutions around neutrality and to overcome limits. This implies that capacity to overcome resource limits and carbon constraints becomes a key aspect of competitive positioning in which those places which have innovative capability could ensure their future growth.

Third, there is evidence that new solutions developed in the eco-region may be translated into action in other contexts. For example, draft government advice proposes that eco-towns should be zero-carbon, set targets for recycling and landfill diversion that are "more ambitious" than existing national targets for 2020 and in areas of water stress, should "aspire" to water neutrality (DCLG 2008).

1.6 The SMEISE study

It is not surprising to see many initiatives emerging in the SE, since much of the growth planned for England will take place in that region. In fact, the South East Plan predicts that an additional 28,900 houses per annum will be built in the region between 2006 and 2026. In 2006, the Environment Agency commissioned Jacobs to develop cost estimates for providing the environmental infrastructure to meet the housing growth identified within the South East Plan. The Environment Agency also asked Jacobs to define the measures required to deliver this infrastructure. This work is referred to as the *Strategy for Meeting Environmental Infrastructure needs in the South East* or SMEISE study.

The study's key findings in terms of cost estimates are presented in Section 2.1 and Table 2.1 of this report. Section 2.1 also reviews the SMEISE methodology in detail for each type of environmental infrastructure considered and discusses the main issues affecting the results.

Of equal importance, SMEISE outlines a strategy for delivering this infrastructure while achieving the aims of the South East Plan: to stabilise and reduce the region's ecological footprint. The strategy recommends a focus on:

- demand management in all fields of environmental infrastructure, considering the optimum use of existing infrastructure before seeking provision of new one;
- the integration of objectives within and across all fields of environmental infrastructure;
- a partnership approach to development and planning;
- integrated planning taking into account economic development and quality of life;
- a regional approach to infrastructure planning as well as inter-regional solutions.

In sum, substantial changes in the way environmental infrastructure is provided are needed to achieve sustainable growth. As discussed in the previous sections, this situation is not unique to the South East. Other regions, sub-regions and cities of the UK are facing new pressures, accelerated by policy drivers relating to environmental infrastructures. Already, some responses are emerging which offer useful pointers on a way forward for the North West.

1.7 Report outline

Following the rationale for this study (Section 1), Section 2 outlines this project's methodology and structure. The section begins by reviewing the SMEISE methodology and discussing the pressures on NW infrastructure before explaining the case study work, describing the basis of development of the economic model and providing a summary of the findings. Sections 3 to 6 provide details of the work on each of the four types of infrastructures: waste (Section 3), water resources and supply (Section 4), water quality (Section 5) and flood risk management (Section 6). Each section reviews the baseline needs and pressures in the NW and the current funding mechanisms, then describes the development of the cost model, results and analysis, compares the results to that of the SMEISE study and finally identifies strategies appropriate to the NW. Section 7 examines transferable lessons and new responses, by looking at lessons and responses from the Thames Gateway and SMEISE study. It considers what the NW responses could be and outlines possible strategies to achieve them. Finally, Section 8 offers recommendations for further studies.

2 Project methodology and structure

2.1 Review of SMEISE study

2.1.1 Key facts and figures

The SMEISE study models the cost of providing, maintaining and operating the environmental infrastructure (EI) to satisfy current needs and growth described in the SE Plan, projected to be 28,900 houses per annum for a 20-year period (Section 1.6).

Jacobs also modelled the impact of higher growth rates, with two additional scenarios looking at a 30 per cent increase in growth (37,570 houses/year) and a 60 per cent increase in growth (46,240 houses/year).

The EI is classified into five fields:

- water resources and supply;
- water quality;
- flood risk management;
- waste;
- biodiversity.

SMEISE found that the cost of satisfying current needs and predicted growth in the SE over the 2006-2026 period is approximately £42 billion, which includes £11 billion for water resources and supply, £16 billion for water quality, £6 billion for flood risk management, £6 billion for waste and £2.6 billion for biodiversity. If the actual increase in housing were 30 per cent or 60 per cent higher than anticipated, the overall costs would rise to approximately £45.6 billion and £49 billion respectively. Key areas of expenditure are water resources and supply and water quality accounting for 61 per cent of required expenditure to meet existing needs, and 64 per cent of required expenditure to meet growth in SE Plan. See Table 2.1 below.

The study also found that while funding for water resources and supply, water quality and waste infrastructure is adequate, its continuity is uncertain. On the other hand, funding for flood risk management and biodiversity is inadequate and needs to be increased if the services are to keep pace with current population growth.

Table 2.1 Estimated costs of provision of EI[1]

Fields of EI	Existing needs – zero growth £million	Existing needs + SE Plan growth (28,900 houses per year) £million	Existing needs + SE Plan growth + 30 per cent (37,570 houses per year) £million	Existing needs + SE Plan growth + 60per cent (46,240 houses per year) £million
Water resources and supply	£10,200	£11,167	£11,396	£11,603
Water quality	£8,477	£15,995	£18,251	£20,506
Flood risk management	£3,148	£6,256	£7,188	£8,120
Waste	£6,020	£6,077	£6,086	£6,096
Biodiversity	£2,444	£2,657	£2,723	£2,788
Total	£30,289	£42,152	£45,644	£49,113
Approximate average cost per new house		£20,524		

Notes: [1]From Table 4.1 in Jacobs (2007)

2.1.2 Water resources and supply

Jacobs combined multiple sources of data to estimate the costs of providing water resources and supply infrastructure to developments in the SE. Data came from the Environment Agency, water companies and Ofwat.

The Environment Agency provided data compiled from 2004 water company resource plans on new resource development schemes for the SE. Water resource plans contain the best estimates of future water demand from household, commercial and industrial consumers over the coming 25-year period. The Environment Agency also provided its own supply/demand forecasts for the area of interest over the 2006-2026 period.

The operational costs of water supply works were based on Environment Agency spreadsheets which list the costs of individual schemes. These costs were uprated to account for foreseen inflation. Similarly, the capital costs for constructing new water infrastructure were uprated to 2006/7 using the Construction Outputs Price Index (COPI).

Annual expenditure on existing schemes was taken from the water companies' annual return to Ofwat in 2005. As the area of the study, the SE of England Regional Assembly (SEERA), represents a portion of the total area covered by the water companies, the annual return was apportioned using an estimate of household property numbers for the SEERA area.

Based on this cost data, Jacobs calculated the costs of water resource and supply development for each five-year period making up the 20 years duration of the SE Plan.

2.1.3 Water quality

In the SMEISE study, the costs for water quality infrastructure to new developments have been assessed to address water quality for all waters. This includes surface water, estuarine and marine waters, and groundwater.

The costs are based primarily on the provision of new and upgraded sewage treatment works and new or upgraded sewerage to meet growth requirements.

Jacobs adopted the cost band figures of the *Creating a Better Place – Planning for Water Quality and Growth in the South East* (CaBP) report for sewage treatment works and sewerage: ‘High’ above £10,000; ‘Medium’ of £5,000-10,000; ‘Low’ below £5,000.

Where the CaBP report identified limits on growth imposed by insufficient sewerage infrastructure, Jacobs assumed that a solution could be achieved through relocation of discharge points, new technology or redistributing growth.

In its calculations, Jacobs made a 20 per cent allowance for risk and a 10 per cent allowance for the costs to other environmental infrastructure. It also assumed that the cost estimates for sewerage infrastructure would also address the potential problems linked with sewer flooding. Thus, costs arising from risks of sewer flooding would not need to be accounted for when calculating cost estimates of flood risk infrastructure.

Based on these data and assumptions, Jacobs calculated the estimated expenditure for each year of the SE Plan in accordance with growth targets.

Issues

The CaBP report identified nine locations considered to be at high risk and therefore requiring further study. In its study, Jacobs made an allowance of £0.46 billion to cover these locations; however it is not clear where this figure comes from.

Jacobs also followed the CaBP band figures for the connection of all new houses built in locations currently outside of a sewage treatment work drainage area. They assigned the costs to the low cost banding or £5,000 per household for a connection.

Where the CaBP report identified locations where growth could be accommodated without capital costs, Jacobs assumed the same. This implies that the drainage areas and sewage systems have spare capacity for additional flows from new households.

Importantly, the Jacobs study used the demand projections from water companies to calculate cost of water quality infrastructure for new households. It did not specifically model any of the RSS or growth plans.

2.1.4 Flood risk management

Jacobs produced cost estimates for providing flood risk management infrastructure for new developments in the SE by dividing the number of new homes into homes inside and outside flood zones. The extent of Flood Zones 2 and 3 was superimposed to housing location to separate housing numbers and yield an estimate of the number of properties in Zone 3, Zone 2 or outside the floodplain.

For houses in the flood zones, the cost of protection per house was derived from the Environment Agency Medium-Term Plan for Southern and Thames regions. These costs exclude expenditure by the Maritime Authorities and Internal Drainage Boards on flood protection.

Costs were calculated on a household basis for protection against fluvial and coastal risk of flooding. In the model, flood protection was achieved by upgrading existing defences or building new ones. The cost of raising new defences was estimated at £20,000 per property and the cost of upgrading and repairing of existing defences, at £10,000 per property.

Costs were then adjusted for properties in areas currently defended against flood. In areas where existing defences are not adequate, the cost of protection was entirely passed on to new homes. This means that if new homes increase the total number of homes by 25%, the cost applied only to new homes (to protect new and existing homes) is 5 times more than if the costs were shared equally.

The study assumed that all new development outside the flood zones includes run-off control measures. Therefore, the cost of flood management infrastructure outside the floodplain would be the cost, per property, of incorporating sustainable urban drainage (SUD) schemes to the design of new housing developments. The cost of SUDs was estimated at £2,000 per property. This figure includes an allowance for land costs and the future maintenance of the scheme.

Issues

The assumption that new homes located in areas with inadequate flood defences will bear the full cost of upgrading or repairs is very difficult to defend. If existing defences are not adequate, these defences will need repairing regardless of whether new homes are added to the area. It would be more sensible for costs related to protecting new homes against flood risks to be proportionate to the number of existing homes.

Also, is it disputable whether the costs of SUD schemes in a new development would be borne by the public purse. Presumably, these would normally be borne by the developer. However, costs associated with the maintenance of schemes need to be met and it is unlikely, or at least not clear, that this would be the developer’s role.

2.1.5 Waste

Jacobs based its assumptions for the cost of waste infrastructure on the report *Update of the Model for Future Waste Capacity Needs of the South East Final Report*” by SEERA (2005) and a survey of existing infrastructure by SERTAB (2001/2002). These documents contain information on the additional waste management facilities required in the SE of England.

The amount of waste arising was calculated from Annex B Table Data_01 in the 2005 report. It includes municipal solid waste (MSW), excluding London MSW, commercial and industrial (C&I) waste and construction and demolition (C&D) waste. Proportions of waste going to thermal, composting, recycling and landfill in 2025 were extracted from projections in Annex B Table Data_05.

The additional capacity required for 2025, compared to today’s capacity, was converted to the number of facilities required based on average facility capabilities from the SERTAB report (such as 250,000 tonnes per annum for a thermal facility). The amount of waste generated per household was calculated using figures in the SERTAB report and figures from the SEERA 2005 report.

The capital expenditure (CAPEX) and operational expenditure (OPEX) were estimated form a Department for Environment, Food and Rural Affairs (Defra) database containing each type and size of waste management facility. The costing of facilities was based on 20-year contract/operating period and included thermal treatment, composting plants and various material recycling facilities (MRFs).

CAPEX and OPEX for landfills were based on the methodology published in the Waste Management Paper 26B using updated estimates of expenditures. The landfill size was estimated at 3,000,000 m^3 and the disposal rate was assumed to be 250,000 tonnes per annum.

Issues

The OPEX and CAPEX from Defra database exclude the cost for land, the cost of financing and the cost due to changes in legislation.

Also, the model handles all of the waste arisings through one single disposal route, identical for all authorities. The projection of different models would more accurately reflect the reality of existing disposal routes. For instance, more incinerators might have different implications than more landfill or vice versa.

It is not clear whether the unit for additional waste arisings are tonnes per household or tonnes per person.

Jacobs calculated that the overall rise in all waste arisings would be from 23 million tonnes in 2006 to 43 million tonnes in 2021. There is also a massive rise of more than 10 million tonnes in construction, demolition and excavation waste. This appears surprisingly high. For comparison, Jacobs' report *Identification of Nationally, Regionally and Sub-Regionally Significant Waste Management Facilities in the North West* (October 2007) suggests an increase in MSW for the NW region from 4.2 million tonnes in 2006 to 5.2 million tonnes in 2021.

In addition, Jacobs provided estimates for the number of new waste facilities required: three non-hazardous landfills, ten organic stabilisation facilities, two metal-reprocessing facilities, five aggregate-reprocessing sites, four hazardous waste treatment works and five thermal treatment plants. However, there are no costs attached to these facilities.

The calculations do not make any explicit link with household growth projections in the RSS, which is expected to link to both MSW and the growth in waste from construction, demolition and excavation.

2.2 Case study work

The case study work involved a review of the relevant and transferable lessons learnt in the Thames Gateway around innovative infrastructure responses - such as water, waste neutrality, developer guidelines - and a critical assessment of the key implications for governance and capability in developing context sensitive solutions in the North West of England.

2.3 Development of cost model

2.3.1 Model structure and build

In Phase 2, the model was constructed with strict separation of data from the manipulation of data and presentation of results. Data was stored in database tables and results generated using standard relational database procedures for presentation using standard web-enabled viewers and scripting. This had several advantages over a spreadsheet type approach.

Performance and security: the base data was separated into component tables with individual security settings. These tables are remote from the end users so there is limited opportunity for intentional or accidental corruption. The added advantage of separating the base data into component tables is that performance is improved for large volumes of calculations.

Transparent and logical: the structure mirrors the simple logic used to link development with the impact on the environment (see Sections 3.3, 4.3, 5.3 and 6.3). Any changes necessary to improve/amend the model functionality can clearly be planned and the consequences predicted.

Simple and transferable: the technologies and software used are freely available and the formats are easily convertible into alternative implementations.

The aim of the model was to give broad brush indications to help decision makers identify possible constraints to development on a regional and sub-regional scale. The model could also be used as a tool to look at the alternative growth scenarios to help evaluate possible future strategies. More detailed models are already available and in use (such as those used by United Utilities to plan water supply and demand). However, these have the disadvantage of requiring detailed and accurate data, take considerable time and effort to build and maintain and are better suited to experts looking at managing systems on a micro-scale (such as changes to individual pipe sizes). In addition, these models tend to look at shorter time horizons than the ones of interest in this study - the RSS timescales.

The model used for the project was thus a highly simplified attempt to capture the key proxy indicators of the links between development and the four areas of waste, water resources, water quality, and flooding. For example, in simplistic terms with everything else being equal, increased flooding due to development would be a function of the development impermeable area.

Additional information on the model structure and build is available in the following sections and all of the detailed information is in a separate model build report made available to the Environment Agency.

2.3.2 Using the economic model

This first iteration of the economic model successfully captured a shared understanding of the relationship between household growth and infrastructure costs for waste, water resources and supply, water quality and flood risk management. For each of the infrastructure types, the links were described through a series of logical equations and variables relevant to the geographical situation of the NW region. These links formed the base of the decision support tool. With key variables and equations established, the value of individual variables could easily be altered to improve the accuracy of results.

It was understood that the model would continue to evolve beyond this first phase. Consequently, the database was designed to allow great flexibility for future development. Its entity-relationship structure makes it straightforward to add, remove or modify connections between datasets, as well as update datasets. As several of the datasets it uses are published by external organizations on a regular basis (annually or otherwise), Arup made an effort to keep datasets in their publication format to minimize data manipulation and facilitate the updates.

The current iteration of the model calculates indicative costs attached to housing growth for each infrastructure type, on a geographical basis. In keeping with the objective, more effort was spent on capturing accurate links between growth and infrastructure than on acquiring detailed datasets for each variable. When detailed datasets were not readily available, sensible default values were extracted from several sources including published literature and reports, personal communications, and expert knowledge. Arup ensured that the model was completely transparent so that users could easily identify sources of data (and derivation of values where applicable) for each of the variables.

Model performance and its usefulness as a decision tool is expected to increase as the model is developed along several dimensions. It is recommended that development be focused on:

i. refining variables by gathering more detailed datasets and information, for instance the exact location of future developments in each NW council;

ii. as much as possible, specifying the values of variables for individual geographic entities (water basin, council, wards and so on) and individual service providers (incinerator, wastewater treatment facility);

iii. fine-tuning links; the assumptions and limitations outlined in this report suggest ways of achieving this for each infrastructure type;

iv. introducing more complexity to reflect the reality of the relationship between growth and infrastructure and between infrastructure types. For example, the model assumes for simplicity that all the waste generated in the NW is treated and disposed of within the region. However, it is known that waste flows extend beyond the boundaries of the NW.

Importantly, the cost figures produced by the model should only be used in comparing development scenarios and are not intended as part of a budget-planning process. They are indicative figures aimed at illustrating the relative cost differences between geographical areas (wards, councils, city regions or sub-regions). The outputs depict a gradient of locations where infrastructure is least/most stressed at present, and where a proposed housing development would be least/most costly in terms of environmental infrastructure, to inform decisions on where to locate housing growth in the NW.

Finally, although this economic model is a useful decision tool, it would not be sensible to use it in isolation or as the only input to a decision-making process. For one thing, it considers only four types of environmental infrastructure. For example, it ignores the links between housing growth and transport. It is recommended that the model outputs be considered alongside other sources of information including: current planning frameworks and policies, upcoming policy changes, recent climate change projections and anticipated impacts. The relative weighting of all of these inputs will vary from one process to another and should be agreed by the users involved.

2.4 Summary of findings

Findings in Sections 3 to 6 were organised to look at how the various growth scenarios will impact on the waste management, water resources and supply, water quality and flood risk of the NW of England.

The data collection and modelling described above can be interrogated to generate a number of datasets. The analysis below sets out some findings that can be extracted from the model.

For each of the infrastructure types and in the following sections, for each growth scenario, and where the available data permits, results have been extracted to provide data on:

- when the capacity of existing infrastructure will be exceeded;
- the amount by which the capacity of the existing infrastructure will be exceeded at the end of the period (2029);
- a spatial indication of where pressures on the existing infrastructure will be greatest.

These findings should be considered in light of the assumptions in the modelling as set out in the sections above. For many of the datasets, these assumptions mean that there is an increased risk of inaccurate results when the model is interrogated for areas at the ward- or development-scale. Results are more reliable at the local authority -scale.

In Sections 3 to 6, comments are made on particular issues where assumptions in the model may have produced a finding that requires further clarification.

The model permits other datasets to be collected, if required by the Environment Agency.

2.4.1 Growth scenarios considered

Three scenarios have been considered:

- Baseline – 23,000 properties per annum. This equates to the current property build rate that has been used in resources and investment plans by organisations like United Utilities. The baseline was run to validate the model against published understanding of the subject area (to check that the model behaved as expected) and to identify any "pinch points" at a local level not currently highlighted at the regional level. These pinch points would be considered high risks on development in the region.
- RSS Plus – 28,000 properties per annum. This is a 20 per cent increase on the baseline scenario. This scenario was run to identify any areas above those identified in the baseline results at risk of constraining growth.
- RSS Plus Plus – 32,000 properties per annum. This is a 40 per cent increase on the baseline scenario. This scenario was run to identify any areas currently considered low risk to development, but that could become a constraint if growth levels reached the upper end of possible predictions.

2.4.2 Costs

As with the SMEISE study, the current estimated cost for each of the four topic areas was first calculated as a baseline cost to compare each of the subsequent years of development growth for the three scenarios. Table 2.2 shows a summary of the cost output from the model for 2029. Compared to the SMEISE study, water quality is the largest cost element. Waste and flooding elements are of similar proportions but water resources and supply is lower. Each cost element is discussed in more detail below.

Costs do not include any allowance for risk or inflation.

Biodiversity costs are included in Table 2.2 for completeness and for comparison to the original SMEISE study. However, as explained in Section 1.4.2, the level of detail in the model and research for this type of infrastructure was lower than for other sections of the model. Zero growth costs are built up using the BAP-estimated amount of habitat requiring maintenance. Future costs build on this by applying the habitat creation targets and adding the green space accessible figure (as per the SMEISE approach).

2.4.3 Summary of costs

Table 2.2 gives a summary of the estimated costs for the NW between 2008 and 2029 in the same format as the SMEISE report Table 4.1 (see Table 2.1).

Table 2.2 Summary of estimated costs of provision of EI in 2029

Fields of EI	Predicted needs – zero growth £million	Predicted needs + NW Plan growth (23,000 houses per year) £million	Predicted needs + NW Plan growth + (28,000 houses per year) £million	Predicted needs + NW Plan growth ++ (32,000 houses per year) £million
Water resource and supply	£8,378	£12,246	£13,788	£14,486
Water quality	£9,733	£12,827	£13,608	£13,962
Flood risk management	£3,540	£4,447	£4,628	£4,810
Waste	£7,362	£7,476	£7,606	£7,627
Biodiversity	£1,799	£1,903	£1,909	£1,912
Total	£30,812	£38,899	£41,539	£42,797
Approximate average cost per new house		£16,743	£20,063	£20,671

Zero growth assumes that there are no additional houses built and that the population does not increase (house numbers and population are frozen at 2008 levels). The estimated needs based on 2008 figures are then costed on the following:

- Waste: model estimates for 2008 multiplied by number of years (21).
- Water resources and supply: current spend commitments for the water companies asset management plans for the period 2010-2015 (AMP5) plus allowance for years up to 2029. The allowance uses Ofwat figures for average annual spend in AMP4 for operational expenditure (OPEX) costs and renewal of existing assets but excludes provision of new assets.
- Water quality: as per water resources.
- Flood risk: current numbers of properties in flood zone multiplied by the relevant Average Annual Damages (AAD figure multiplied by the number of years (21).

Future cost estimates (such as RSS, RSS+ and RSS++) are then calculated by adding the baseline costs to the model estimate of additional costs generated by the additional housing built over the same period. For example, the water resources element for RSS growth figures is £8,378 million for baseline costs plus £3,868 million for housing growth to give a total of £12,246 million.

3 Municipal waste

3.1 Baseline review of existing needs and pressures in the NW

The collection and disposal of waste (residual and recycling) generated by households in the NW is handled by five unitary authorities, 38 collection authorities and five disposal authorities. The unitary authorities (Warrington, Wigan, Blackpool, Blackburn with Darwen and Halton Councils) are responsible for collection and disposal, whereas the remaining 38 local councils collect waste but are paired up to one of the regional disposal authorities (Cheshire, Cumbria, Lancashire County Councils, and Greater Manchester and Merseyside) for waste disposal.

In 2007/08, the NW generated more household waste per capita than the UK average (524 kg/person in the NW compared to 495 kg/person in the UK, Defra 2008a). The trend in sustainable waste management in the region is, however, encouraging. The NW achieved an overall recycling and composting rate of 33.4 per cent in 2007/08 which was just below the national average for England of 34.5 per cent (Defra 2008a). This achievement is also mirrored in less residual waste being sent to landfill which has dropped from 2,222 TT (thousand tonnes) in 2004/05 to 1,828 TT in 2007/08. It is important that the effort continues. Where regional waste production rates and management strategies have remained the same, calculations indicate there could be eight years of landfill capacity left in the NW from the end of 2006 (Jacobs 2007b).

Across the region, the Waste Disposal Authorities (WDA) achieved different recycling and landfill diversion rates. For example, in 2006/07, the amounts landfilled by the 10 disposal authorities ranged from 36,554 tonnes (Halton Borough Council) to 613,434 tonnes (Greater Manchester WDA), see Figure 3.1. This reflects the wide differences in population served. Greater Manchester WDA is the largest WDA in England. It is also the only one with a surplus of more than 20 per cent in its current Landfill Allowances, which are at the core of the Landfill Allowance Trading Scheme (LATS) introduced by the British government as an incentive to divert waste from landfill. In contrast, Merseyside WDA has a surplus of 3.6 per cent of their original 2006/07 allocation.

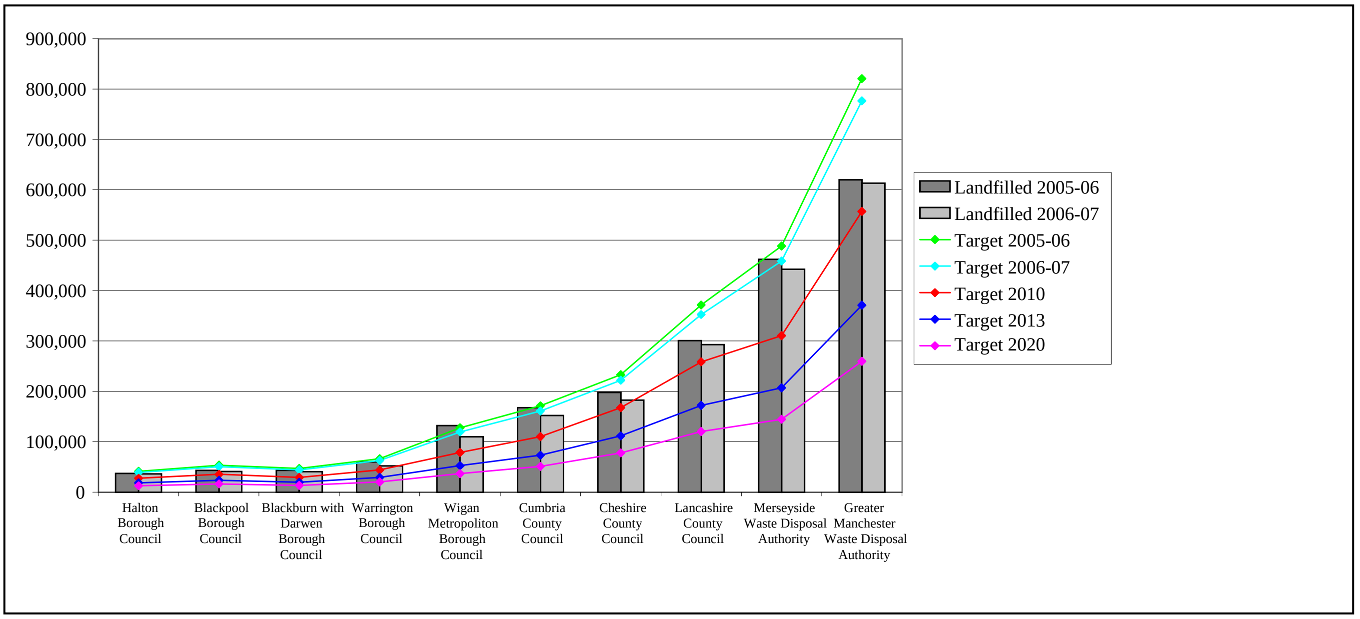

Figure 3.1 Biodegradable municipal waste landfilled compared to Landfill Directive targets. Source: Environment Agency modification of Defra LATS data, unpublished

Looking ahead, the authorities in the NW who are closest to achieving their 2009/10 LATS allocations are Halton, Blackpool and Warrington Borough Councils. In contrast, Wigan, Cumbria, Lancashire, Merseyside and Greater Manchester must all make significant increases in diversion over the next two years or trade in the run-up to 2009/10 (Figure 2.1). Overall, the NW currently has the largest deficit of all regions against its 2009/10 LATS allocations, of approximately 344,000 tonnes. However, projected landfill requirements to 2020 are less than one million tonnes, with only 650,000 tonnes deposited within the NW Region. Both Lancashire and Cheshire expect to landfill at levels below those in the LATS scheme.

In order to meet LATS targets, targets from the EU Landfill Directive and the ones set out in the NW Regional Waste Strategy (RWS), NW local authorities are developing Municipal Waste Management Strategies and Waste Local Development Documents (GONW Climate Change and Sustainability Team, no date). These policies identify the amount of waste generated, how it will be managed and the facilities needed to manage the process.

The 'waste hierarchy' is adopted as the guiding principle to selecting the best option for dealing with waste; this includes the waste management practice of reduction, re-use, recycling and recovery (Great Britain 2007c).

Following this hierarchy, the Waste Strategy for England (Great Britain 2007c) sets out a number of targets to be met under these key objectives:

- prevention and reuse - decouple waste growth from economic growth;
- landfill directive diversion targets;
- increase non-municipal waste diversion;
- investment in infrastructure;
- recycling of resources and recovery of energy.

To achieve these objectives, incentives and legislation have been set:

- the landfill tax escalator: increasing the cost of waste per tonne disposed of at landfill by approximately £8 per year from 2008;
- enhanced capital allowances for investments using secondary recovered fuel for combined heat and power facilities;
- packaging regulations which place a duty on the producer to become responsible for the amount of waste which enters the waste stream;
- WEEE (Waste Electrical and Electronic Equipment).

To meet European, national and regional waste reduction targets and to reduce waste production through the adoption of waste hierarchy principles, a combination of waste management solutions should be sought. This will help to promote sustainable waste management practice and encourage waste to be viewed as a resource.

A number of factors may hinder the achievement of reduction targets; however, through careful planning and the uptake of waste strategies, many of these can be managed to limit their impact:

- Behaviour – people's habits and lifestyles are difficult to change. Reducing the waste production growth rate or increasing recycling and composting rates will require dedicated public campaigns and well-designed incentive programmes.
- Affluence – the trend is for families to have more disposable income, which tends to be linked to higher consumption rates. If these two factors are not decoupled, it will be difficult to keep waste production growth rates under control and meet statutory targets.
- Economic growth – some commercial and industrial wastes count towards municipal solid waste. As part of its regeneration process, the NW is attracting new businesses and industries, which will add to the load of waste produced in the region. If economic growth and waste generation rates are not decoupled, it will be challenging to keep waste production growth rates under control and meet statutory targets.
- Environment – all waste management solutions, even recycling and composting, have an impact on the environment. Choosing the best option or combinations of solutions will require a better knowledge base on the nature and significance of these impacts. Decisions will have to be made with incomplete information because of pressures imposed by the target timelines and dwindling landfill space.

Despite recent progress, the view expressed by RTAB in its Third Waste Management Monitoring Report (August 2007) on the implementation of the NW Regional Waste Strategy (2007) is that increased recycling and composting will not be adequate to reduce dependence on landfill in accordance with the LATS requirements. There is no doubt that additional treatment of residual waste will be required. Although most of the WDAs have initiated procurement for such treatment options, there remains a medium-term risk that infrastructure may not be in place in time to meet the regions' needs (RTAB 2007).

3.2 Current funding mechanisms

The heading 'domestic waste' refers to solid waste generated by households that is recycled or landfilled and excludes commercial, industrial, demolition and construction waste. Toxic and dangerous waste categories are also excluded from this discussion.

3.2.1 Structure of the industry

The diagram below shows that in terms of the delivery of domestic waste services, there are two key functions of waste collection and waste disposal. In two-tier areas the district, borough or city council has responsibility as the Waste Collection Authority (WCA) and the county council acts as the Waste Disposal Authority (WDA), although in both cases the service is generally contracted out to the private sector. The role of the county council as WDA ties in with their statutory role in producing a Minerals and Waste Development Framework. Unitary authorities, on the other hand, are responsible for waste collection and disposal, as well as production of the Minerals and Waste Development Framework for their area.

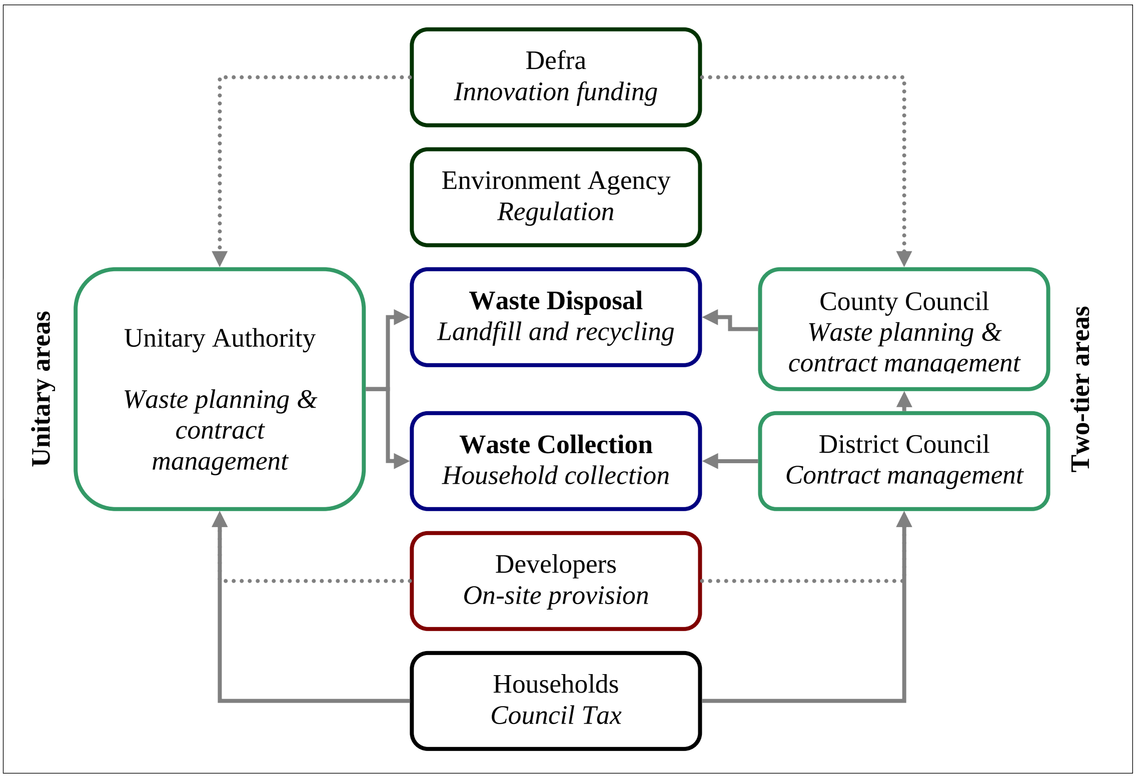

Figure 3.2 Principal funding routes - waste

3.2.2 Current funding mechanisms

Waste collection and disposal is funded primarily through council tax. Supplementary sources of funding can be either through direct financial contributions from developers at the planning stage or by them providing on-site neighbourhood recycling areas during the construction stage.

In certain circumstances, applications for additional funding can also be made to Defra which administers initiatives such as the Technology Research and Innovation Fund

(TRIF) and Demonstrator Programme. The Technology Research and Innovation Fund allocated around £2 million in 2004 to address the lack of funding for R&D projects into innovative new technologies to reduce the amount of biodegradable municipal waste (BMW) going to landfill, in line with national obligations. Defra also launched the £30 million Demonstrator Programme to test waste treatment technologies as possible alternatives to landfill. The programme aims to prove the economic, social and environmental viability (or not) of each selected technology.

3.2.3 Forward planning procedures

There is a sound framework in place for the long-term strategic planning of waste management; however, it is important that waste collection and disposal contracts with the private sector are carefully aligned with these plans to ensure that innovation is not stifled. Waste plans include: a concise strategy within the Regional Spatial Strategy, which should look forward for a 15- to 20-year period; the Minerals and Waste Development Framework normally prepared by county councils or groupings of unitary authorities (this should plan for a minimum of 10 years) (Great Britain 2005a); and the Municipal Waste Management Strategies (MWMS) prepared by local authorities that must 'set out a long-term strategic vision in line with local, regional and national expectations' (Defra 2005).

Waste management plans and strategies will be influenced by the solutions proposed by private and third sector partners and it is therefore important to ensure that contract preparation is aligned with local government structures and programmes for plan preparation. Recent research funded by the Economic and Social Research Council (ESRC) warns that large-scale centralised facilities with long contract timeframes, such as those developed under the Private Finance Initiative (PFI), can 'lock authorities into particular technologies and processes and in doing so stifle innovation' (ESRC – Society Today, online).

3.2.4 Future funding mechanisms

The costs of waste management are rising, which puts pressure on council tax and threatens cuts to other services. A position statement by the Local Government Association (LGA 2007) proposes two reforms in relation to the funding of the sector:

- Provide powers for councils to charge householders directly for the amount of waste they produce. Indirect charging via taxation does not incentivise householders to recycle and reduce waste.
- Strengthen 'producer responsibility', by ensuring local authorities are fully recompensed for recovering packaging, waste electric and electronic equipment and batteries. In many European countries, producer responsibility measures place the burden on producers and retailers.

The LGA also recommends strong action by the government on disposable, single-use items.

3.3 Development of waste cost model

In England, the cost of managing municipal waste is paid for by the public through taxation. The cost of C&D (construction) waste and C&I (industrial) waste is borne by the private sector and good quality data on those waste streams is very difficult to obtain. As this model is primarily concerned with spending from the public purse, it only considers municipal waste.

Capturing the links between household growth and waste infrastructure is particularly difficult because of the variety of ways in which waste is handled and treated across the NW of England. Municipal waste (residual and recyclables) is managed at the local authority (LA) level by two-tier local authorities, that is, waste collection and disposal authorities or alternatively by unitary authorities, who take on both collection and disposal duties. Each authority manages (internal or external contract) its waste collection, segregation, treatment and disposal in different ways; for example, the types of recycling offered to residents in Manchester City may be different to those offered in Halton.

Although each LA tries to meet its own targets, there are no set criteria or rules for how this should be achieved. For instance, some LAs may offer a fortnightly collection between residual and recycling, while others may provide a weekly residual collection with a green and recycling collection on an alternate week.

These variances present a number of possible waste scenarios for municipal waste management which are outlined below:

- local authority collection strategies, with waste collected as separate fractions or co-mingled (meaning a material mix combining more than two different recycling streams contained in a residential storage box or bin);
- differences in the items which are collected for recycling;
- how and where the sorting of co-mingled recyclables take place;
- the various locations and types of reprocessing plants for recyclables;
- whether or not residual waste is sent directly to landfill or further sorted;
- the use of various landfill sites depending on the local authority agreement with its contactor;
- the collection, treatment and disposal of hazardous materials.

The mapping of individual waste management scenarios currently used in the NW would prove difficult, due to the shear volume of data required. Following discussions between the project team and various waste specialists, it was decided that the model would adopt a generic ‘waste scenario’ for Phase 1.

This scenario describes the key steps that take place from collection at the residential door through treatment to disposal. The simplified logic behind the scenario is illustrated in Figure 3.3.

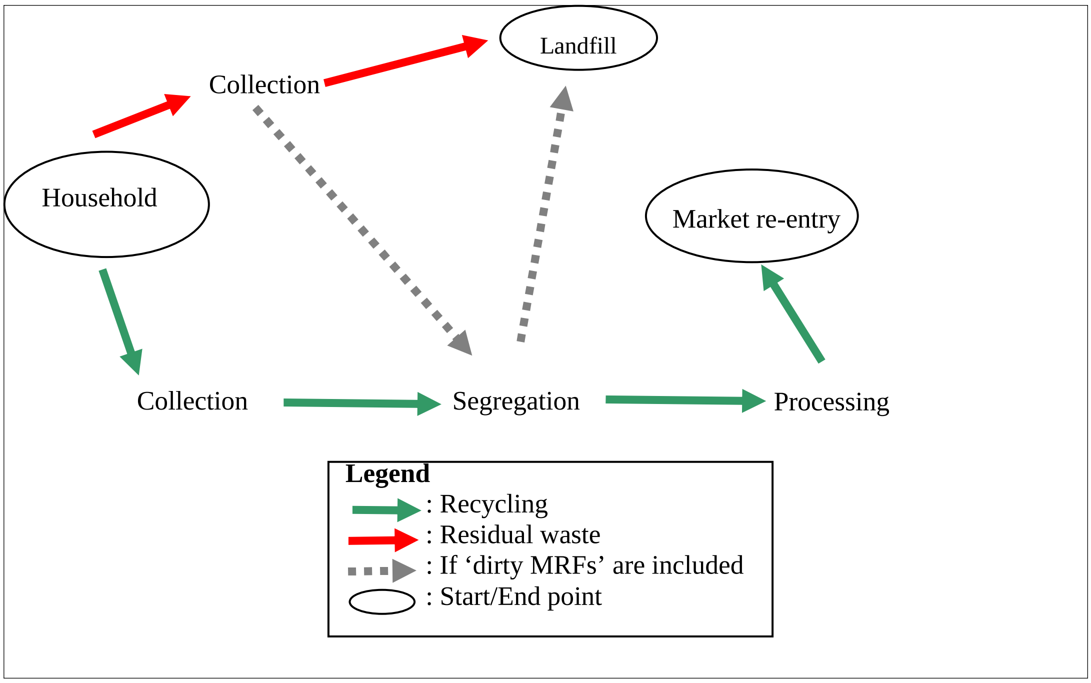

Figure 3.3 Overall logic of waste model

From the descriptions of scenarios, logical steps were developed to include cost inputs at critical points. The cost of additional households to residual waste infrastructure and recycling waste infrastructure were a function of the variables listed in Table 3.1.

Table 3.1 Variables used in the determination of waste and recycling infrastructure costs

Residual waste	Recycling
Number of additional people	Number of additional people
Per capita waste generation rate	Per capita waste generation rate
LA recycling rates	LA recycling rate
Distance to landfill	Distance to the processing plant
Cost of transport	Cost of transport
Cost of collection	Cost of collection
Cost of landfill	Cost of segregation
	Cost of processing

The total cost of household growth related to waste infrastructure is a simple addition of the residual waste and recycling functions.

3.3.1 Assumption and risks

A number of assumptions and choices were made in designing the logic and equations for the waste infrastructure. Most were made to simplify the design and match the data that is readily available or that can be acquired with minimal resources. The main assumptions and decisions used are:

i. The collection of residual waste and of recyclables happens separately.

ii. It makes no difference whether the LA manages its waste as a unitary or two-tiered (paired WCA and WDA) authority. It is the waste strategy or scenario that determines costs.

iii. C&I and C&D waste costs are not incurred by the public purse. Therefore, the costs associated with their collection and disposal do not affect the economic model attributed to the municipal waste stream.

iv. The capacity of landfill/processing plants available to municipal waste will be the difference between the total capacity and capacity taken up by C&I and/or C&D waste.

v. Current disposal contracts held with each LA are unknown and therefore each LA is currently associated with all waste disposal sites. The model uses proximity to determine the default landfill site that a LA residual waste is transferred to. When this site has reached capacity, residual waste is diverted to the next nearest site. This process is repeated until there are no landfill sites with capacity available. This means that, in the model, a landfill can reach capacity at an earlier date than it would in reality for authorities who divide residual waste among multiple sites.

vi. More than one authority can use the same landfill. However, the model does not account for the tonnage coming into this landfill from other authorities at the same time as that from the new development. This means that, in the model, a landfill site can reach capacity at a later date than in reality, where a site is simultaneously used by multiple authorities.

vii. Assumption vi could counterbalance assumption v. However, the degree to which it does is not known and will vary on a case-by-case basis.

viii. The same logic (in previous two bullet points) is applied to recycling plants.

ix. All of the municipal waste produced in the NW of England is disposed of within the region. The model does not consider waste travelling across the NW boundary.

x. The management of dangerous (toxic) waste is omitted.

xi. The contract terms for collection, segregation, landfill and processing do not impact on (do not limit or increase costs of) the management of waste generated by the new households.

xii. LATS transactions (trade, sell, purchase) are not taken into account.

xiii. All recyclables enter the market after processing. None are sent to landfill. If there is no market demand at the time, they will be held and stored until demand rises while the cost of storage is absorbed by the plant operator.

3.4 Model results

The waste infrastructure has the following principal points of constriction:

- For waste that is landfilled, the annual receiving capacity of landfill sites, and the total capacity of landfill sites.
- For waste that is recycled, the transfer station capacity and the waste processing capacity.

The model currently applies the average regional recycling rate for the NW throughout all local authorities. It is possible to obtain the varying percentages of recycled waste for individual authorities; however, provided that the model makes broad assumptions on waste strategies, at this stage, adding in this amount of detail would create a false sense of confidence in the results. Data on recycling rates at the local authority and ward level, if available, can be added into the model at a later phase.

These findings have looked at how many facilities will have their capacity exceeded under each growth scenario, the extent to which they are exceeded, and a spatial assessment of where capacity is being exceeded.

These analyses look at the following elements of the waste network, by waste authority:

- landfill receiving capacity;
- total landfill capacity (including composting);
- waste transfer capacity;
- waste processing centre capacity.

3.4.1 Amount & number of elements exceeding capacity by year

Figures 3.4 to Figure 3.6 show for the four elements and the three scenarios, the total number of elements predicted to exceed their current capacity in each year.

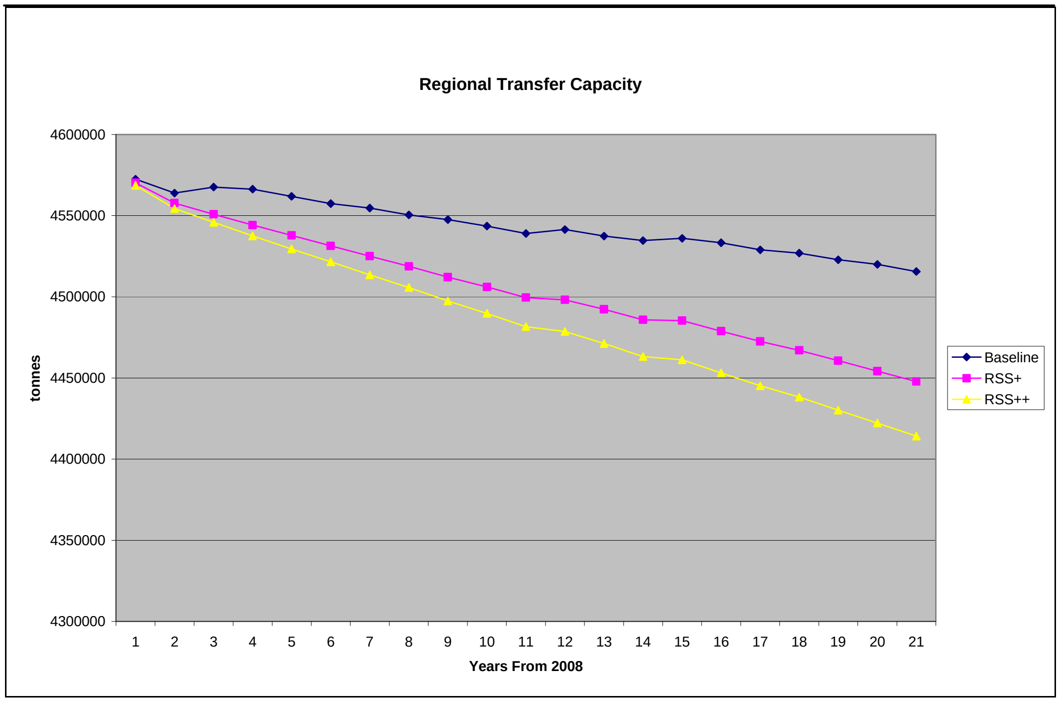

Figure 3.4 North West transfer capacity

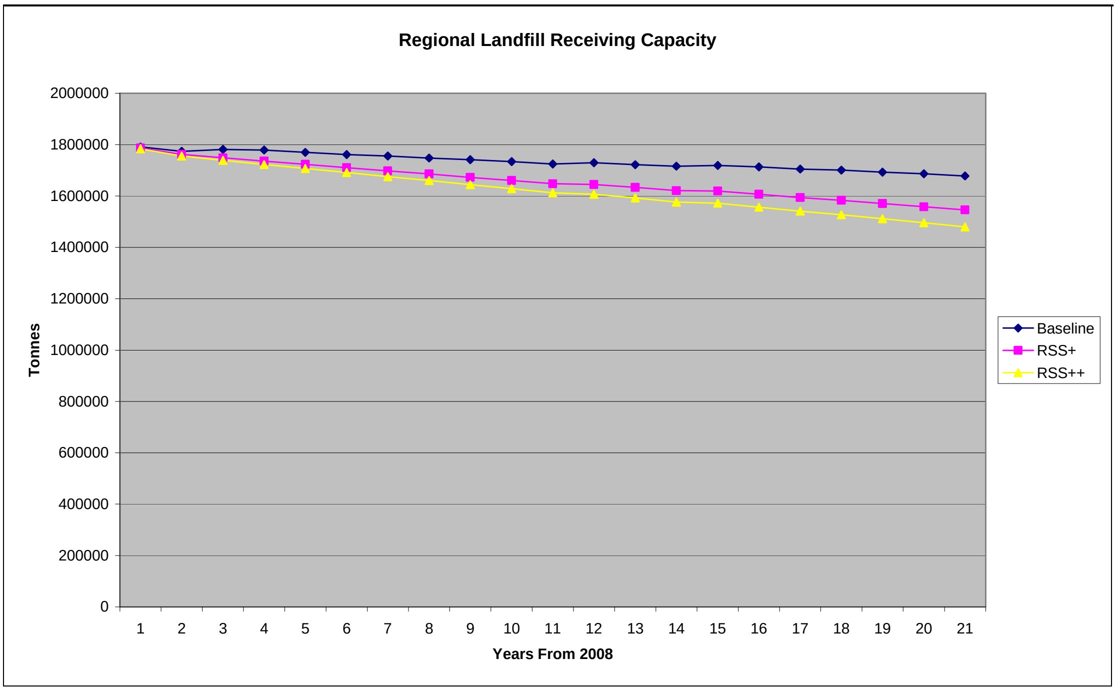

Figure 3.5 North West landfill receiving capacity

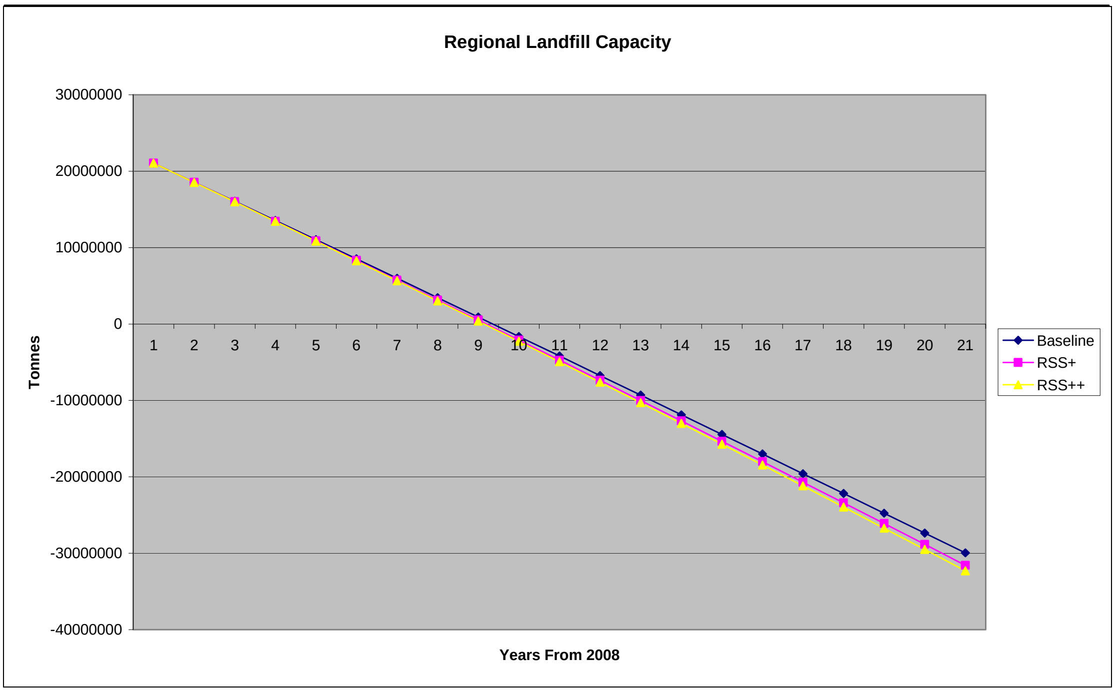

Figure 3.6 North West landfill capacity

3.4.2 Analysis by waste authority

Tables 3.2 to 3.4 show, for each waste authority, the extent to which each of the elements of its waste infrastructure will be exceeded in 2029.

Table 3.2 Waste capacity by authority in 2029 – Baseline scenario

Baseline **Waste capacity by authority in year 21 (2029)** [1]	**Landfill capacity** **(tonnes)**	**Transfer capacity** **(tonnes)**	**Process capacity** **(tonnes)**	**Annual landfill receiving capacity** **(tonnes)**
Warrington	4,553,990	12,958	-35,034	1,030,378
Wigan	-1,827,070	194,894	-39,704	-10,974
Blackpool	-1,129,873	37,624	-26,874	-54,653
Blackburn & Darwen	-1,065,148	110,077	35,878	-47,134
Halton	-965,517	214,611	2,653	-47,650
Cheshire	-3,513,203	391,117	-84,914	77,945
Cumbria	-2,781,924	140,320	-77,138	7,917
Lancashire	-3,481,997	678,849	79,028	553,390
Greater Manchester	-11,427,121	1,311,603	100,011	261,575
Greater Merseyside	-8,321,480	1,423,579	293,606	-92,375
Regional total	-29,959,342	4,515,633	247,512	1,678,419

Notes: [1]Assumes no transfer of waste between authorities.

Table 3.3 Waste capacity by authority in 2029 – Scenario 2

Scenario 2 **Waste capacity by authority in year 21 (2029)** [1]	**Landfill capacity** **(tonnes)**	**Transfer capacity** **(tonnes)**	**Process capacity** **(tonnes)**	**Annual landfill receiving capacity** **(tonnes)**
Warrington	4,527,285	11,826	-36,167	1,028,179
Wigan	-1,902,532	192,203	-42,395	-17,153
Blackpool	-1,161,151	36,294	-28,204	-57,234
Blackburn & Darwen	-1,099,551	108,624	34,424	-49,956
Halton	-1,000,700	213,127	1,168	-50,531
Cheshire	-3,686,772	383,780	-92,252	63,701
Cumbria	-2,904,167	135,152	-82,305	-2,114
Lancashire	-3,726,008	668,520	68,699	533,339
Greater Manchester	-12,036,727	1,285,814	74,222	211,512
Greater Merseyside	-8,583,176	1,412,512	282,539	-113,857
Regional total	-31,573,499	4,447,851	179,730	1,545,887

Notes: [1]Assumes no transfer of waste between authorities.

Table 3.4 Waste capacity by authority in 2029 – Scenario 3

Scenario 3 **Waste capacity by authority in year 21 (2029)** [1]	**Landfill capacity** **(tonnes)**	**Transfer capacity** **(tonnes)**	**Process capacity** **(tonnes)**	**Annual landfill receiving capacity** **(tonnes)**
Warrington	4,515,140	11,263	-36,730	1,027,086
Wigan	-1,936,756	190,862	-43,736	-20,256
Blackpool	-1,175,292	35,637	-28,861	-58,508
Blackburn & Darwen	-1,115,150	107,899	33,699	-51,364
Halton	-1,016,610	212,387	428	-51,968
Cheshire	-3,765,409	380,125	-95,907	56,606
Cumbria	-2,959,363	132,572	-84,885	-7,123
Lancashire	-3,836,351	663,395	63,575	523,392
Greater Manchester	-12,312,854	1,273,013	61,422	186,665
Greater Merseyside	-8,701,662	1,407,008	277,035	-124,542
Regional total	-32,304,308	4,414,162	146,041	1,479,989

Notes: [1]Assumes no transfer of waste between authorities.

The model results suggest there is approximately 10 years waste disposal capacity within the NW region. The main constraint is landfill capacity, with some areas also predicting processing constraints by the end of the period.

Table 3.5 Residual waste transport distances (total km transferred)

Council Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase on 2008
Allerdale	3	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	3,140	111,647
Barrow-in-Furness	18,327	18,327	18,327	18,327	18,327	18,327	18,327	18,327	18,327	18,327	18,327	0
Blackburn + Darwen	342	342	342	342	342	342	342	342	342	342	342	0
Blackpool	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	1,338	0
Bolton	1,053	1,053	1,053	1,053	1,053	6,186	6,186	6,186	6,186	6,186	6,186	487
Burnley	2,146	2,146	2,146	2,146	2,146	2,146	2,146	2,146	2,146	2,146	2,146	0
Bury	737	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	1,258	70
Carlisle	613	613	613	613	613	613	80,793	80,793	80,793	80,793	80,793	13,084
Chester	2,465	2,465	15,447	15,447	15,447	15,447	15,447	15,447	15,447	15,447	15,447	526
Chorley	92	92	92	92	92	92	92	92	6,710	6,710	6,710	7,170
Congleton	876	876	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	5,475	524
Copeland	600	600	3,0317	30,317	30,317	30,317	30,317	30,317	30,317	30,317	30,317	4,948
Crewe + Nantwich	510	9,122	9,122	9,122	9,122	9,122	9,122	9,122	9,122	9,122	9,122	1,688
Eden	5,206	5,206	5,206	5,206	5,206	5,206	5,206	5,206	5,206	5,206	5,206	0
Ellesmere Port + Neston	1,574	1,574	3,215	3,215	3,215	3,215	3,215	3,215	3,215	3,215	3,215	104
Fylde	2,177	5,399	5,399	5,399	5,399	5,399	5,399	5,399	5,399	5,399	5,399	148
Halton	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	1,597	0
Hyndburn	4,284	4,444	4,444	4,444	4,444	4,444	7,618	7,618	7,618	7,618	7,618	77
Knowsley	29	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	1,075	3,669
Lancaster	8,375	8,375	8,375	8,375	8,375	8,375	8,375	8,375	8,375	8,375	8,375	0
Liverpool	981	4,689	5,666	5,666	5,666	5,666	5,666	5,666	5,666	5,666	5,666	477
Macclesfield	2,165	2,165	2,165	2,165	2,165	3,643	3,643	3,643	3,643	3,643	3,643	68
Manchester	3,382	3,583	3,583	3,583	3,583	3,884	3,884	3,884	3,884	3,884	3,884	14
Oldham	888	6,611	6,611	6,611	6,611	6,611	6,611	6,611	6,611	6,611	6,611	644
Pendle	4,708	4,708	4,708	4,708	4,708	4,708	5,857	5,857	5,857	5,857	5,857	24
Preston	479	479	479	479	479	479	479	479	479	479	479	0
Ribble Valley	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	2,560	0
Rochdale	230	230	230	230	230	230	230	230	230	230	230	0
Rossendale	1,231	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	3,462	181
Salford	1,958	1,958	1,958	1,958	1,958	1,958	1,958	1,958	1,958	1,958	1,958	0
Sefton	3,275	5,668	5,668	5,668	5,668	5,668	5,668	5,668	5,668	5,668	5,668	73

Council Name	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	% Increase on 2008
South Lakeland	2,093	5,315	5,315	5,315	5,315	5,315	5,315	5,315	5,315	5,315	5,315	153
South Ribble	247	247	247	247	247	247	247	247	247	247	247	0
St. Helens	342	342	342	342	342	342	342	342	342	342	342	0
Stockport	1,950	6,382	6,382	6,382	6,382	6,382	6,382	6,382	6,382	6,382	6,382	227
Tameside	896	2,976	2,976	2,976	2,976	2,976	2,976	2,976	2,976	11,705	11,705	1,206
Trafford	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	2,145	0
Vale Royal	1,542	1,542	1,542	3,379	3,379	3,379	3,379	3,379	3,379	3,379	3,379	119
Warrington	1,097	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	1,620	47
West Lancashire	416	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	1,124	170
Wigan	58	58	58	58	58	58	841	841	841	841	841	1,347
Wirral	8,095	9,610	9,779	9,779	9,779	9,779	9,779	9,779	9,779	9,779	9,779	20
Wyre	1,954	1,954	1,954	1,954	1,954	1,954	1,954	1,954	1,954	1,954	1,954	0
Total for Region	95,037	138,471	188,555	190,392	190,392	197,303	282,589	282,589	289,206	297,936	297,936	

Table 3.5 shows the model's assumed change in transport distances per tonne of waste going to landfill for each council within the NW. To achieve the predicted life expectancy for landfill capacity shown in Figure 3.6, these are the distances residual waste will have to be transported within the region. As can be seen, several councils will have a significantly increased requirement to transfer waste if no additional capacity is provided in the short term. These councils are the Cumbria councils of Allerdale, Carlisle and Copeland. In the medium term several central councils (Chorley, Crewe, Knowsley and Tameside) will also need to look at alternatives. Long term (greater than 10 years), all councils will have to look at transport issues especially with the added constraints of meeting carbon footprint and air quality targets.

3.5 Analysis and comments on results

These results represent the worse case scenario where current landfill practices continue into the future. However, current trends in waste strategy (as explained in Section 3.1) should lead to a reduced reliance on landfill. While the model only includes current operational waste sites in the analysis, a variety of waste disposal options are being considered/constructed under international and national policies coming into force. Data on these sites, if included in the model, should provide a clearer picture of future waste disposal capacity for the NW.

The results of the model in its current form, using a simplified level of detail, show that annual receiving capacity at some sites is the limiting criteria. For sites in Allerdale, Crewe and Nantwich, Salford, Stockport, Vale Royal and Wigan, the annual receiving capacity is exceeded two to five years before landfill capacity is exceeded.

It is assumed that receiving capacity is a function of on-site facilities, local transport and environmental constraints. It is therefore concluded that any significant increase in annual receiving capacity would be costly for short-term gains. Thus, landfill capacity in the region is a critical constraint on development.

In the model, assumptions are made on the flexibility of movement of waste and the ease of making cross border transfers (with the NW region only). The model currently assumes that waste from wards is transferred to the nearest waste site. When this site has reached its capacity, waste is diverted to the next nearest site. It is also assumed that the sub-region boundaries are administrative only and that waste can easily be transferred between sub-regions to maximise landfill availability (such as Halton exports waste to Warrington, Blackburn exports waste to Hyndburn).

This transfer of waste has implications for transport costs and environmental impacts that could further reduce the effective capacity of residual waste disposal sites in some areas on political and environmental grounds (such as in Cumbria).

Limits on the distance waste can be acceptably transferred is a possible refinement of the model to consider.

Little information was available on the capacity of processing plants for individual waste streams. Therefore, though the model is sufficiently flexible to analyse individual waste streams if the data is available, the analysis here was done using total recycling capacity.

In general, for the NW region as a whole, processing capacity would be exceeded by 2024. Again, as with landfill, this would require substantial effort and cooperation in transferring recyclables around the region to achieve this life expectancy. The actual capacity in some areas (such as Cumbria) would therefore be less than this.

Transfer of waste outside the region is not currently included in the model. This would improve the predicted waste constraints, but cost and other environmental constraints would have to be considered. Additional investigation and collaboration with the waste authorities would be required to determine if this element of waste management could be included in the model.

Waste generated by new development only has a small impact on the life expectancy of landfill capacity. Indeed, the graphs for all three growth scenarios show landfill exceedence roughly around the same time. The real pressure is from waste generated by existing properties, where the additional impact of new properties is marginal by comparison.

In summary, residual municipal waste production and processing in the region is a potential constraint to growth. A number of recent studies have looked at possible strategies to compensate for this. Our model analysis shows that transfer of waste from existing and new developments is probably a bigger issue than new development size. The spatial relationship of new development and existing or planned waste processing facilities is therefore critical planning information when assessing new scenarios.

3.6 Costs

Estimated total costs of providing waste infrastructure for the NW in 2029 will be £7,476 million under the RSS growth scenario and could increase to £7,627 million under the RSS++ scenario.

The current model only has a single municipal waste management strategy (MWMS) applied to all LAs. The MWMS assumes that residual waste is disposed of at the nearest landfill site to waste production. When this site reaches its capacity, the waste is sent to the next nearest site and so on until all available landfill capacity is exhausted. In subsequent model development, with consultation with others, actual MWMS could be applied to individual LA and WDA and costs recalculated.

The estimated landfill life expectancy for the region is 10 years; however, the model does not take into account the impact of diversion targets set out by the European, UK and regional governments. In this sense, the predicted landfill life expectancy represents the worse case scenario of ‘business as usual’.

Costs have been divided into collection, transport and processing (Table 3.1). These have further been subdivided into residual waste and recyclable waste streams. The rates used for the collection, transport and disposal of waste are ‘all in’ rates that include OPEX; the total costs for waste are therefore not broken down into CAPEX and OPEX except for the CAPEX provision of new waste disposal facilities.

Table 3.1 Summary of municipal waste RSS costs

Total collection £million	Total transport £million	Total processing £million	Additional capacity £million	Total £million
£3,283	£347	£3,730	£115	£7,476

New waste disposal facilities are assumed to be provided in unit sizes of 250,000 tonnes per annum capacity as per the SMEISE study. As the exact mix of new capacity is unknown at this time, a general cost rate was applied (five million GBP for 100,000 tonnes per year capacity based on recent Waste to Energy WtE schemes in the UK). After further involvement of outside partners in the enhancement of the model, it was assumed that more detailed information would be available to allow more accurate rates to be used for each WDA.

While the generation of waste from construction and commercial activities was included in the model for calculating landfill and processing capacities, costs are associated with the collection or disposal of municipal waste only.

3.7 Comparison with SMEISE study

3.7.1 Pressures and needs

The SE and NW have similar population sizes (SE has slightly greater of the two) but the NW region has a larger and more elongated land area. The current model of the NW includes distance calculations for waste movements; this level of calculation was not explicitly done for the SMEISE report. This means that for the same amount of waste production, the NW model applies higher costs because of the additional transport.

The NW makes relatively low use of incineration for municipal waste compared with the rest of the UK and particularly the SE (including London). This and the higher estimated remaining landfill capacity (especially for non-hazardous waste) gives the SE a slight advantage in waste disposal. However, this is offset against a faster decline in capacity in the SE (probably driven by higher construction waste generation).

3.7.2 Costs

Waste costs at ‘zero growth’ in the NW are estimated to be higher (£7,362 million versus £6,020 million). This is a reflection of the transport costs included in the NW model.

The relative gap in waste cost further widens in the RSS growth scenarios. Again, this reflects the transport element of the NW model.

3.8 Uncertainties and strategies for the future

There has been a great deal of activity in the NW to deal with known waste disposal issues. In the short term, these plans are likely to improve the situation substantially. However, national and international understanding of waste reduction, recycling and processing are rapidly developing. Longer term, the region will have to look at how new technologies and management methods can best be applied on a local and regional basis.

Short term, the waste strategies being developed and implemented will alleviate some of the pressures. However, declining landfill capacity will remain the principal issue to address, especially in relation to local waste transfer. New facilities at the planning/feasibility stage need to be included in the model to better assess the longer term needs of the regions.

Medium term, the targets for diverting residual waste from landfill will require greater coordination in the network of waste transfer capabilities and identification of suitable waste processing sites to meet the shortfall in current and planned capacity. There will be significant difficulties in planning and influencing the behaviour of the construction, commercial and industrial sectors.

Long term, promotion of waste avoidance/minimisation for all sectors will be crucial to achieving any inspirational targets for waste management. This, along with the use of best available techniques in waste treatment and recycling, applied at the appropriate scale (some locally and some regionally), will require early consultation to influence decision makers and identify sources of funding.

4 Water resources and supply

4.1 Baseline review of existing needs and pressures in the NW

The majority of the NW region is supplied by United Utilities (supported with some minor bulk imports from other water companies). The main exception to this is the area around Chester that has supplies from Dee Valley Water. Water supplies come primarily from upland reservoirs and lowland rivers, but are supported by supplies from groundwater and upland streams.

The majority of abstractions in the region are by the public water system (51 per cent), approximately 20 per cent is abstracted by the power generators and the remainder is abstracted directly for private supplies (industry, farming and so on) (Defra no date b). The long-term trends have been for power generation abstractions to increase over time while other abstractions have reduced.

United Utilities (UU) carried out an assessment of predicted water availability over the next 25 years. Total yield from the sources from which the company draws its water are projected to reduce from current levels, as summarised below in Table 4.1. These reductions are attributed to foreseen climate change impacts and changes to the abstraction licence conditions for reasons of sustainability.

Table 4.1 Predicted water resource yields (million litres per day)

Resource zone	Water resources yield [1] at 2006/07 [2]	Water resources yield [1] at 2007/08 [3]	Impact of sustain-ability reductions from 2014/15	Impact of climate change at 2034/35	Water resources yield [1] at 2034/35
Integrated	1,931.7*	1,916.1	-33.5	-30.0	1,852.6
Carlisle	37.7	37.1	-3.6	-0.4	33.1
North Eden	9.2	9.8	0	0	9.8
West Cumbria	58.9	61.5	-8.6	-0.8	52.0
Region	2,037.5	2,024.4	-45.7	-31.2	1,947.5

Notes:
[1] The water source yield figures are officially known as "Water available for use" (WAFU).
[2] 2006/07 values are officially reported figures based on United Utilities 2004 yield review.
[3] 2007/08 values are derived from United Utilities 2007 yield review which incorporates some changes to water sources and improved modelling methods.
Source: UU Water PLC (2008)

There is a predicted increase in demand within the region over the same period (from population increase, increased economic output and possible increase per capita consumption). The development growth used in UU current water resource plan (WRP) is a rise from around 16,000 properties per year in 2007/08 to 22,000 properties per year in 2014/15 and each year thereafter.

The proposed strategy to mitigate the predicted demand in line with predicted water yields is:

- leakage reduction;
- water efficiencies (domestic and non-domestic);
- water meter penetration (increase to 96 per cent by 2035);
- enhance existing water resources (raising reservoir levels and so on);
- possible future technology advances (such as smart meters, new water tariffs and new leakage reduction techniques).

In addition to the pressures on water yields, other factors could lead to increases in demand. The main identified factors are:

i. Behavioural – Human behaviour is difficult to predict but simple changes such as taking more holidays in the UK instead of overseas could put significant strains on local capacity (such as Blackpool, Lake District).

ii. Affluence – The trend has been for lower occupancy rates in new build properties and the per capita consumption (pcc) of two-person households tends to be higher than for three- and four-person households.

iii. Climate change – Water consumption increases in warmer weather. The average pcc could rise as people use more water for gardening, washing and air conditioning.

iv. Economic growth – The trend in the NW has been for high water use industries (such as breweries) to be replaced with lower water use industries. There remains, however, a large food and chemical industry in the region. The aspiration to increase the economic output of the region could have a significant impact on water usage.

The current WRP does not highlight any problems below water resource zone level. However, other studies have identified possible at-risk assets that would require additional investigation depending on the spatial distribution of future development.

4.2 Current funding mechanisms

4.2.1 Structure of the industry

The diagram below shows the structure of the water industry in England and Wales. The Water Act 1989 led to the privatisation of public water authorities and there are now 22 water and sewerage companies in England and Wales, which operate across local and regional 'natural monopolies.' Economic regulation of the system is controlled by Ofwat who review the five-year Asset Management Plans (AMPs) of the water companies to make sure customers do not lose out and that growth strategies/improvements are acceptable. Environmental regulation of water supply is undertaken by the Environment Agency (abstraction consents) and the Drinking Water Inspectorate.

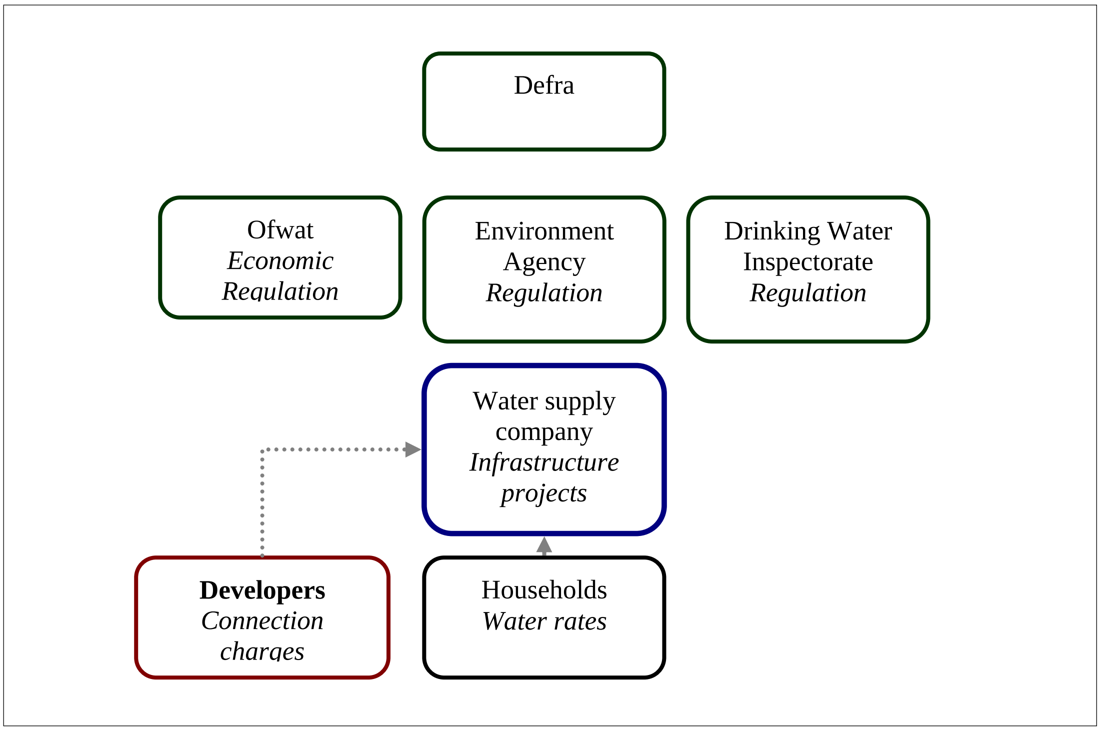

Figure 4.1 Principal funding route – water resources and supply

4.2.2 Current funding mechanisms

Water system improvements are primarily funded from the rates paid by customers through their water rates. The setting of rates is controlled by Ofwat and directly related to the proposed improvements to the network outlined by each water company in their five-year AMP. Small amounts of additional funding come from developer contributions through connection charges (adding new sites to the network), requisitioning charges and infrastructure charges. It is possible for water companies to borrow money to raise funds but this source is heavily regulated by Ofwat and therefore would have to be justified as being in the consumer's interest.

4.2.3 Forward planning procedures

Water companies are required by the Water Industry Act (updated 2003) to produce Water Resource Management Plans which focus on the "balance between supply and demand for water over the next 25 years" (Environment Agency 2007a) and therefore align well with the 20-year planning horizons of Regional Spatial Strategies. Baseline projections are made based on current demand and supply levels with the aim of avoiding deficits in any of the 25 years. Should deficits be encountered, water companies are required to switch options to correct this imbalance. Water companies are required to use a twin-track approach to water resource management that promotes water use efficiency as well as additional supply.

4.2.4 Future funding mechanisms

If water becomes a scarce commodity, costs will rise for water companies which will be passed on to consumers through higher water rates. Through careful management of the 25-year plans, there should not be any shocks to the system, but rather a smooth incremental change.

4.3 Development of water resources and supply cost model

Water resources have a relatively simple correlation to housing development in a straightforward supply-demand calculation. Demand is proportional to the population and supply is fixed by the assets available. Work to date on the model has provided sufficient detail to be comparable to current knowledge (the results can be validated) without replicating the detailed models already in existence (United Utilities water resource models). The quality of the data available has been a limit on the detail included in the model.

The methodology follows industry practice of linking demand to population growth. From these descriptions, logical steps were developed to include cost inputs at critical points. The link to water resources cost is therefore modelled as a function of:

- the number of additional people;
- how existing population demand changes due to:
    i. introduction of metering;
    ii. behaviour (global warming concerns, lifestyle trends and so on);
    iii. water sustainability retrofitting (such as low flush, grey water systems);
- other demands on the public water system (such as agriculture, industry);
- the availability of raw water supplies;
- the capacity to treat raw water;
- the effectiveness of the distribution system to deliver water to households.

4.3.1 Assumptions and risks

The modelling approach of supply and demand calculations is limited by the accuracy and granularity of the data available. The calculations can only be approximate because:

i. treatment and distribution zones do not coincide with population boundaries (wards);

ii. distribution of water can change depending on operational requirements of water companies and so on;

iii. water usage and occupancy rates can vary considerably between and within sub-regions;

iv. no allowance was made for seasonal variations during the year (such as summer holiday populations) - this is not possible with the current version of the model;

v. only the impact on the public water system was included; no allowance was made for private abstractions direct from rivers and boreholes by power companies, private suppliers and so on.

4.4 Model results

The water resource modelling considered two areas of infrastructure capacity:

- Water resources – How much water can be put into the four water supply zones? Given the degree of interconnectivity within the network, this was considered on the basis of the four supply zones identified by UU in the NW.
- Water distribution – How much capacity is there in the local water supply zones? This looked at each of the 250 distribution zones in the NW, and compared their capacity against the predicted demand.

4.4.1 Impact on supply zones

Figure 4.2 to Figure 4.5 show for each of the four supply zones, the predicted water balance for each of the scenarios against United Utilities' predicted supply capacity from Water Resource Plans.

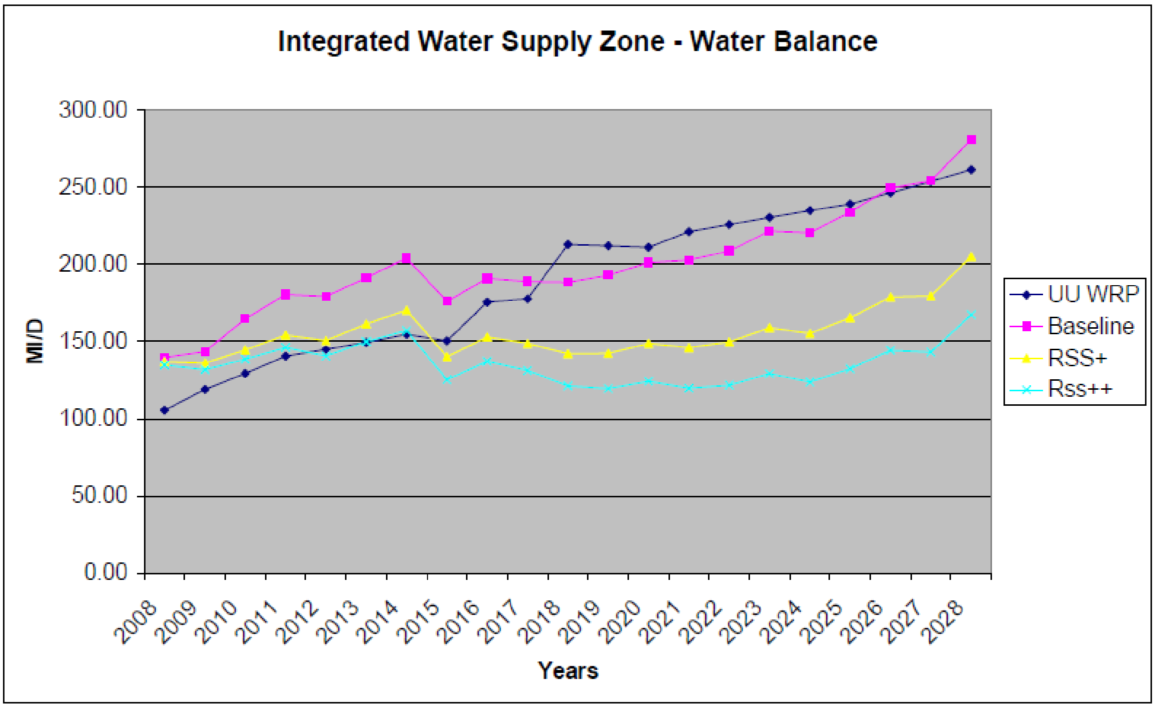

Figure 4.2 Water balance in the Integrated Water Supply Zone

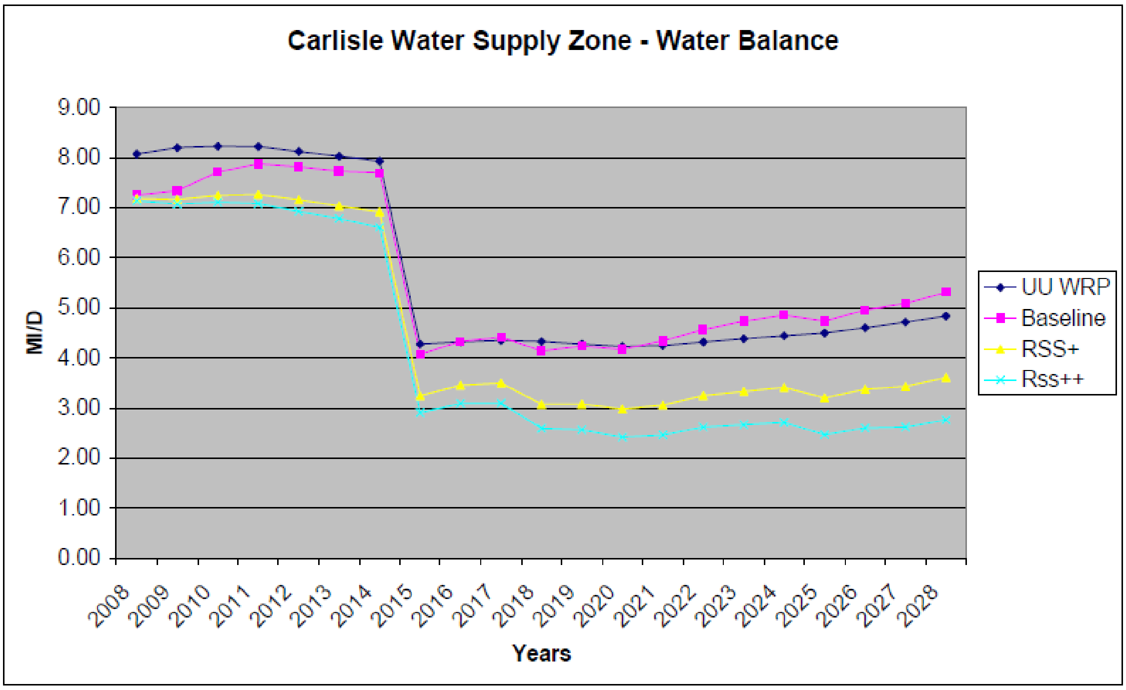

Figure 4.3 Water balance in the Carlisle Water Supply Zone

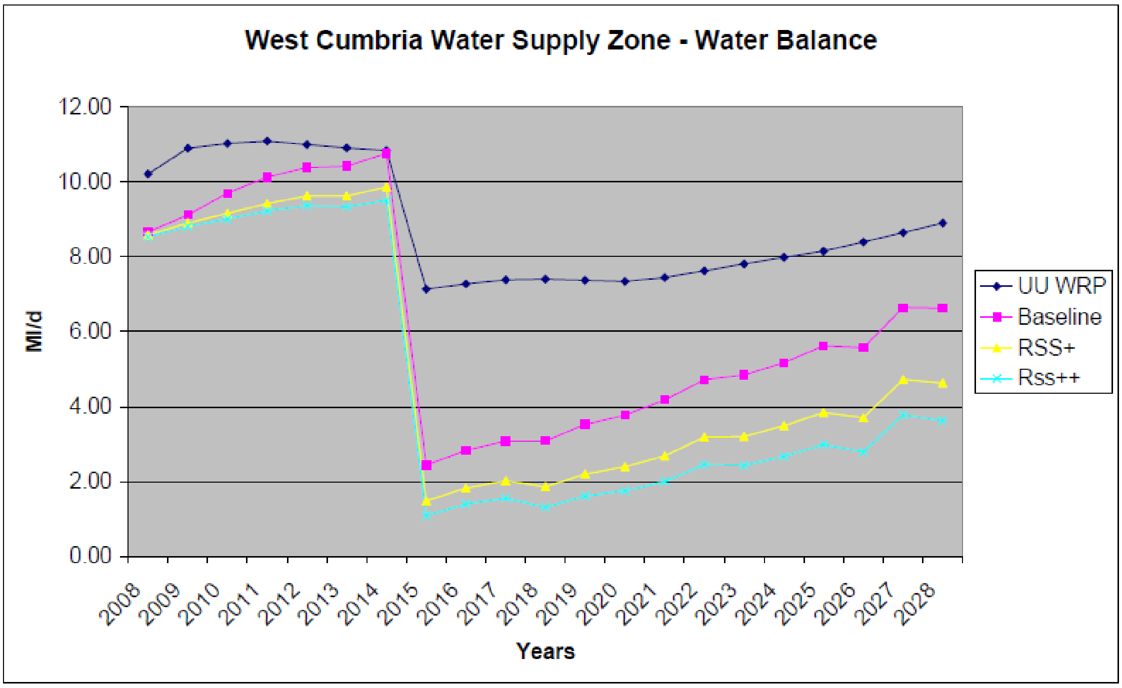

Figure 4.4 Water balance in the West Cumbria Water Supply Zone

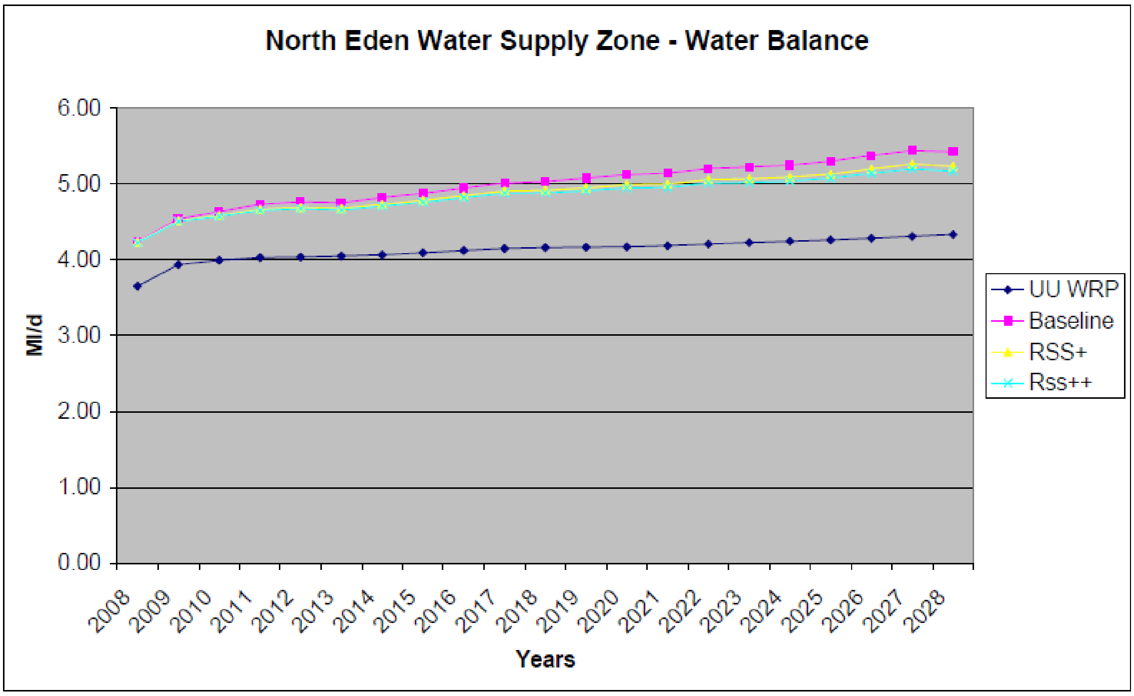

Figure 4.5 Water balance in the North Eden Water Supply Zone

Each of these assumptions shows the demand and supply capacity both falling. The fall in supply capacity is due to various factors including environmental constraints on water sources. The fall in demand for all scenarios is based on an assumed reduction in per capita demand, driven principally by a radical increase in the adoption of metering.

The results show, for the integrated supply zones which include over 95 per cent of predicted supply capacity, the RSS++ scenario would take up more than half of the "spare" capacity in the system, placing increasing pressure on the need to reduce demand.

Although the graphs above show a positive balance in general, these figures do not include the concept of required headroom for uncertainties. Figure 4.6 below shows a synthesis of water balance and UU calculated headroom for the integrated zone.

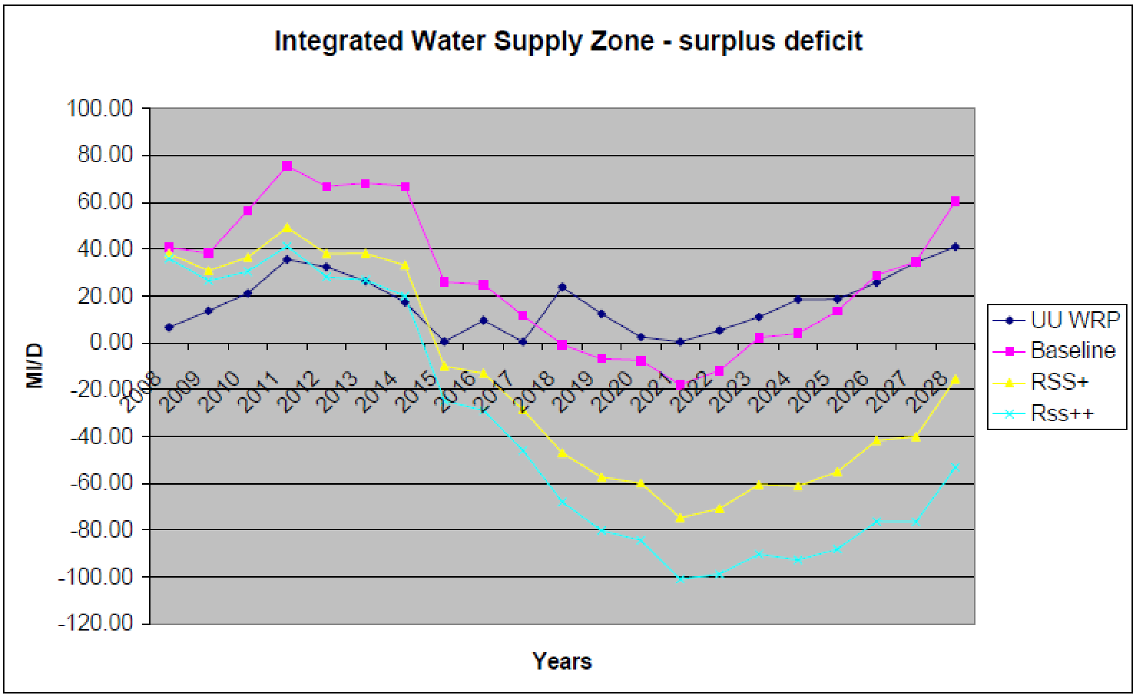

Figure 4.6 Surplus deficit in the Integrated Water Supply Zone

This shows that for all years from 2008, the model predicts little or no additional buffer in water resources to cope with unforeseen events (such as exceptionally dry years) or different water usage trends to those predicted (such as public response to metering and water efficiency). The situation does start to improve after year 14, but this is reliant on increased water efficiency and reduced per capita consumption of water.

4.4.2 Spatial extent of capacity exceedance in distribution zones

The following issues should be noted:

Mersey Belt:

- The biggest pressures are in the seven Salford districts of Langworthy, Broughton, Irwell Riverside, Kersal, Weaste and Seedley, Claremont and Ordsall.
- Next area with problems is Wigan (four wards of Wigan West, Ince, Wigan Central and Douglas).
- Tameside (four wards of Ashton Hurst, St Peters, Ashton Waterloo and Ashton St Michael's).
- Most of Manchester has a problem (all 32 wards shown to have an issue of some degree).
- Only two Liverpool wards have a definite issue (Allerton and Hunts Cross), with one more ward with possible problems but not enough detail to be sure (Central Ward).

Outside the Mersey Belt the following have resource issues (in order of magnitude):

- Ribble Valley Wilpshire ward. This could be an anomaly as the figure looks high. It is the current highest ranking ward in Lancashire with average earnings 37 per cent above national average but may have been given too high a weighting in the model as it comes out as the highest rank area and well above any Mersey Belt ward.
- Carlisle
- Northwich
- Penrith
- Ulverston
- Lancaster - Carnforth, Bare and Duke's ward
- Crewe and Nantwich
- Congleton
- Macclesfield.

Rural areas

The model also predicts several rural areas facing constraints on development due to water resources. This may be because of issues with the model - namely:

- Allowance for industrial and commercial use is made by applying a factor to domestic use. Currently the model only has water resource zone (WRZ) level information; therefore, all wards in a WRZ have the same factor applied, whether urban or rural. The model is thus distorted to underestimate water use in urban areas and overestimate it in rural areas.
- Similar as above but with leakage allowance - leakage tends to be a bigger problem in urban areas (higher pressures and greater number of pipes) - but factors are applied per population. Probably less of an issue than industrial and commercial (rural areas will have leakage but may not have I&C).

Rural areas identified with issues are:

- Alston Moor in Eden district east of Penrith.
- Appleby in Eden district south east of Penrith.

Chester, Chorley, Preston and Blackburn face significantly increased demand but are currently shown in the model as just within capacity. This would need to be checked with UU and Dee Valley Water, if the factor of safety was comfortable or tight.

Figure 4.7 below shows that 79 distribution zones are predicted to have capacity problems in 2008, rising to 81 in 2010 before falling back to 70 in 2029 as total water demand reduces.

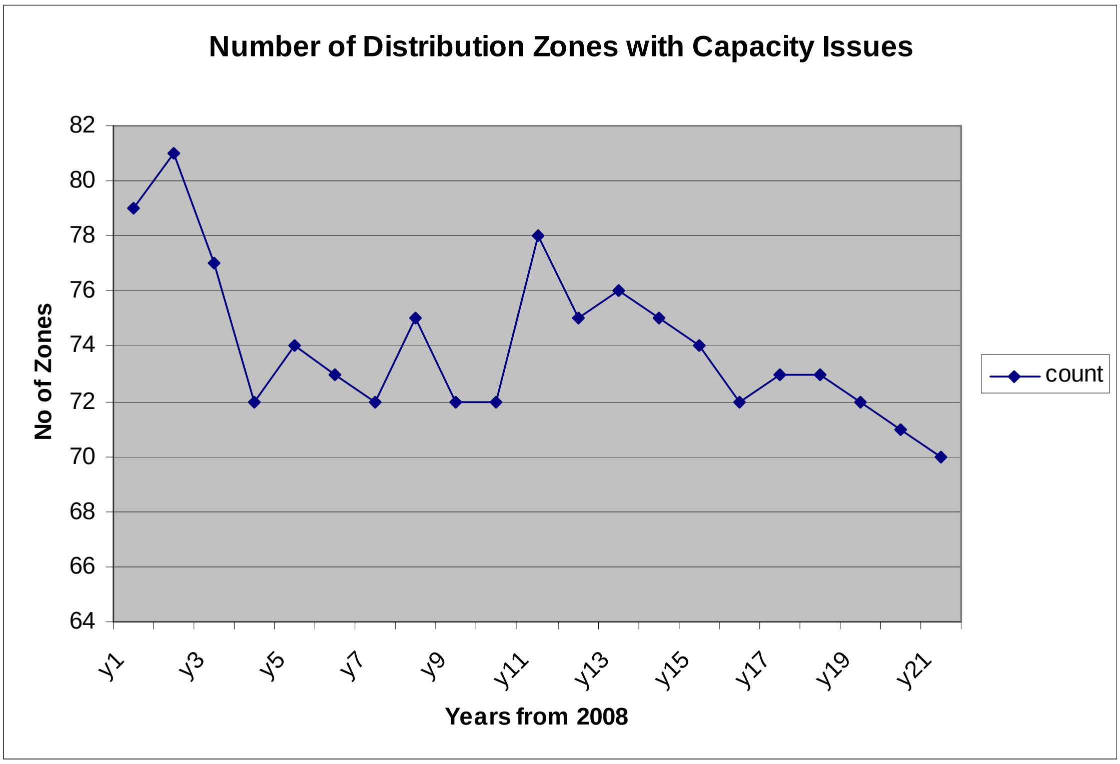

Figure 4.7 Number of distribution zones with capacity issues

4.5 Analysis and comments on results

The baseline model broadly agrees with current published plans. The water resource element was compared to water company published water resource plans (WRP). The United Utilities WRP allows for a greater than baseline rate of expansion between the years 2008 and 2015, with baseline expansion rate for all subsequent years. The model baseline estimates are therefore a good match and give a comparable reference when looking at alternative scenarios. For some areas (notably the Eden Water Resource Zone of UU) the model shows lower growth rates than that predicted by the utility company. This is a result of uncertainty in the apportionment of development between wards and water distribution zones. Water distribution zone boundaries were not available at the time of the model build. Therefore, apportionment of development was based on estimated percentages rather than measured overlap.

In summary, although the region is likely to satisfy its water needs in the short term, the concept of headroom (such as allowance for future uncertainty) suggests that the region's ability to cope with extreme events (such as droughts) could be severely reduced in the medium to long term. The main uncertainties are around climate change, resource availability and per capita consumption figures.

Water resource and water quality infrastructure information within the model was provided by the Environment Agency or taken from publicly available documents. The capacity information is therefore unlikely to be up to date. In addition the spatial relationship between the infrastructure and development is at a coarse level and would benefit from additional input from the utility companies.

4.6 Costs

The estimated total costs of providing water resources and supply infrastructure for the NW in 2029 will be £12,246 million under the RSS growth scenario and could increase to £14,486 million under the RSS++ scenario.

As per the SMEISE study, it was assumed that the predicted requirement for water resources until the end of the next planned AMP period (AMP5, 2010 to 2015) was already included in the water company submission to OFWAT and was therefore reflected in the predicted needs "zero growth" element of Table 2.2. There would be very little scope at this time to alter the planned spend for AMP5 but there could be scope to influence its implementation.

Table 4.2 Summary of water resources RSS costs

Existing commitment £million	Total OPEX £million	Total CAPEX £million	Total meters £million	Total £million
£8,378	£440	£3,194	£234	£12,246

As can be seen from Figure 4.6, the current UU WRP shows that supply will equal demand in 2015. In effect, UU predictions show that the headroom for water resources will be at its lowest during the AMP5 period. As the budget for AMP5 is already set, it is assumed that expansion of the system for water sources and treatment is already included in AMP5 costs. The model therefore assumes that no further expenditure is required for expansion of water treatment or sources after 2015. After 2015, however, there will be costs associated with the following, which the model takes into account:

- Connection to supply – developer/household cost via infrastructure and/or requisition charge/house price.
- Extension of distribution network to include new properties – developer/household cost via requisition charge/house price.
- Increased OPEX for maintaining the extended system – household cost via billing.
- Demand management costs for:
    i. Meter fitting – fitting cost per household.
    ii. Education mailshots, water hippos and so on - cost per household.

The breakdown of the total cost in terms of existing commitments, OPEX, CAPEX and meter-fitting costs is shown in Table 4.1. Possible additional costs not included in the model but requiring discussion with the water companies to confirm their exclusion are:

- OPEX costs associated with increased transfer of water around the WSZs – insufficient data to determine the extent of this.
- Additional transfer capacity within the UU integrated zone has been supplied recently (or planned for AMP5) with rehabilitation work on the Dee and Vrynwr aqueducts and the new East West Link. There is, however, insufficient data to determine if additional capacity is required, especially in rural areas.
- Local treatment capacity – it was assumed that the current water company long-term asset management plans have identified current deficiencies at

local WTW for implementing works within AMP5. The current model does not have sufficient data to identify any local deficiencies due to current growth plans. This should be reviewed when additional data becomes available.

- Local distribution capacity - it was assumed that the current water company long-term asset management plans have identified current deficiencies in local distribution zones for implementing works within AMP5. The current model has sufficient data to pinpoint possible local constraints; including actual distribution zone boundaries would improve their accuracy.
- Local water resources (such as boreholes in rural areas) - it was assumed that the current water company long-term asset management plans have identified deficiencies at local water sources (such as boreholes and river abstraction points) for implementing works within AMP5. The current model does not have sufficient data to identify any local deficiencies due to current growth plans. This should be reviewed when additional data becomes available.

4.7 Comparison with SMEISE study

4.7.1 Pressures and needs

The SE was considered water sensitive before the SMEISE study. The region is therefore more advanced in legislation and planning for new water resources development and demand management (such as compulsory metering). The SE region is, however, hampered by the split in water resource responsibility into 11 water supply companies, whereas there are predominantly two in the NW. Regional relationships within the SE have been created to overcome this problem (such as Water Resources in the SE Group).

The SE water resource plan currently places greater emphasis on new resource development than the NW. This is a reflection of the greater reliance on abstraction and lower surface storage capacity in the SE and therefore lower capacity to cope with dry year demands.

4.7.2 Costs

Total spend estimates on water resources and water quality for the ‘zero growth’ costs are very similar between the regions (£18,677 million in the SE versus £18,111 million in the NW) but the proportions are different. The SE has a predominant water resources spend (55 per cent) compared to predominant water quality spend in the NW (54 per cent). This reflects the focus in the NW over the past few years on increasing water quality, whereas the SE has been more focused on drought issues.

Going forward in the RSS growth options, NW water resources make a bigger jump in estimated cost from ‘zero growth’ to RSS growth values than the SE. However, the relative gap between the SE and NW narrows from 18 per cent to 10 per cent. The jump in costs in the NW is mainly associated with demand management and local distribution costs. The increase also reflects the relative importance of water resources between the two regions in the past.

4.8 Uncertainties and strategies for the future

In the short term, the AMP5 of United Utilities aims to increase water meter penetration from around 21 per cent to 39 per cent by 2015. This is an average of 50,000 meters fitted to existing properties per year. This rate of providing meters would be insufficient to meet the target of 96 per cent meter penetration by 2034. Without compulsory meter fitting, other methods will be needed to encourage per capita consumption reduction targets assumed in current WRPs. A collaborative approach within the region between all partners would need to be developed along the lines of the WRSE group mentioned in Section 4.7.1.

The traditional methods of delivering new infrastructure will be adequate for the baseline scenario requirement, assuming that predicted per capita consumption figures can be achieved. Short-term funding requirements are therefore adequate.

In the medium term, improved coordination between planners and utility companies will be required to identify local constraints within a sufficient time frame to allow funding and planning to be developed.

The long-term strategy must be a multi-organisational approach to demand management. The water companies have identified additional sources that could be used at a cost. These include new boreholes and raising existing reservoir levels/yields. Depending on the success of the demand management strategy and the spatial development of housing growth, none, some or all of the identified sources could be required. Closer coordination between planners and water companies is needed to assess the risk to development plans and to prioritise new investment.

5 Water quality

5.1 Baseline review of existing needs and pressures in the NW

There have been significant improvements in river and canal water quality over the past 20 years. The majority of rivers in the region are generally of average to good quality.

The EU Freshwater Fisheries Directive (FFD) was introduced in 1978 to improve the quality of rivers, and to set water quality standards to ensure that from source to sea, rivers are capable of supporting fish. Improvements made to the watercourses as a result of the Directive have increased the water quality of the region through greater investment in wastewater treatment and overflow operation.

The EU Water Framework Directive (WFD) is the most significant piece of water legislation of the past 30 years. The core environmental objectives of the WFD are to prevent deterioration of aquatic ecosystems and to restore polluted surface waters and groundwater to “good” ecological and chemical status by 2015. The Environment Agency is the authority charged with implementing the Directive in England and Wales.

River water quality in the region is now regarded as the best since the Industrial Revolution, and creatures of all kinds are making reappearances in the region’s watercourses, including salmon to the Mersey.

Coastal waters are also improving and more are meeting the tough European quality standards.

These achievements have been helped by investment to improve wastewater treatment levels over the last 15 years. During the period 2005-2010, United Utilities plans on spending over £1.5 billion on wastewater improvements in the NW region.

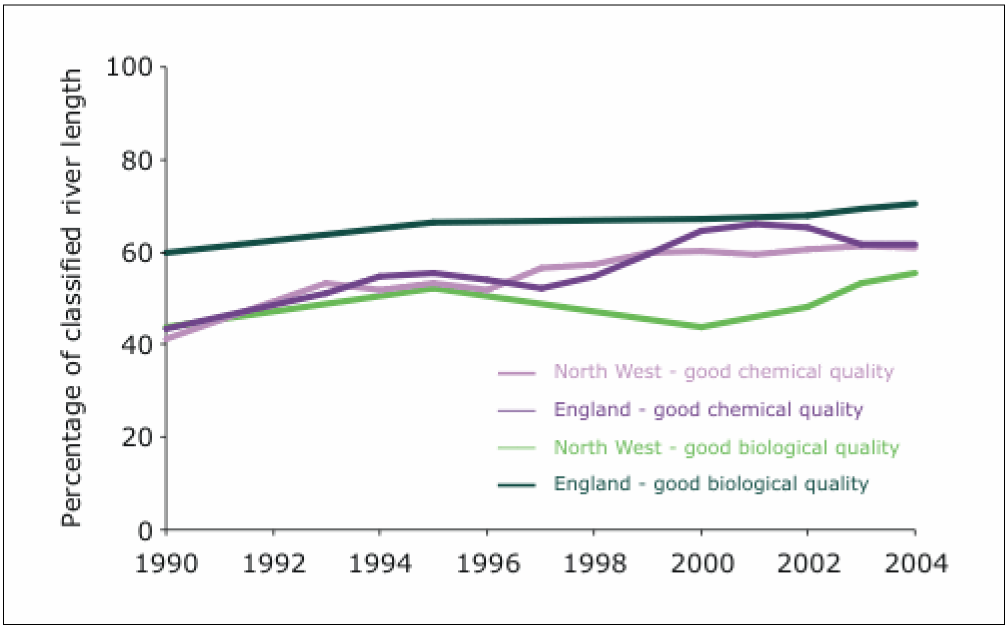

Figure 5.1 NW river water quality. Source: Defra Sustainable Development (2005)

Some key statistics are:

- Fifty-five per cent of the total river lengths in the NW were of good biological quality (England average 70 per cent) in 2004 and 61 per cent were of good chemical quality (England average 62 per cent).
- The NW was ranked seventh of the Environment Agency regions in terms of biological water quality, and fourth for chemical water quality.
- The total river lengths classed as having good biological quality in the NW increased by 12 percentage points between 1990 and 2004, and lengths with good chemical water quality increased by 19 percentage points.
- Some of the region's water bodies have very high nitrate levels, mainly in the more rural areas of North Cumbria, Cheshire and West Lancashire. Most of these areas are now designated as Nitrate Vulnerable Zones.
- High phosphate levels are found in some water bodies throughout the region, especially in Lancashire and Cheshire.
- Two pesticides linked to agriculture or rural land use had an impact on the water environment in the NW. These are diuron and diazinon. Diuron is mainly used in the amenity sector for weed control; diazinon is mostly used as a sheep dip.

The majority of properties in the NW Region are drained by United Utilities-owned sewerage systems. The main exception to this is the area around Chester that is served by Dwr Cymru Welsh Water (DCWW).

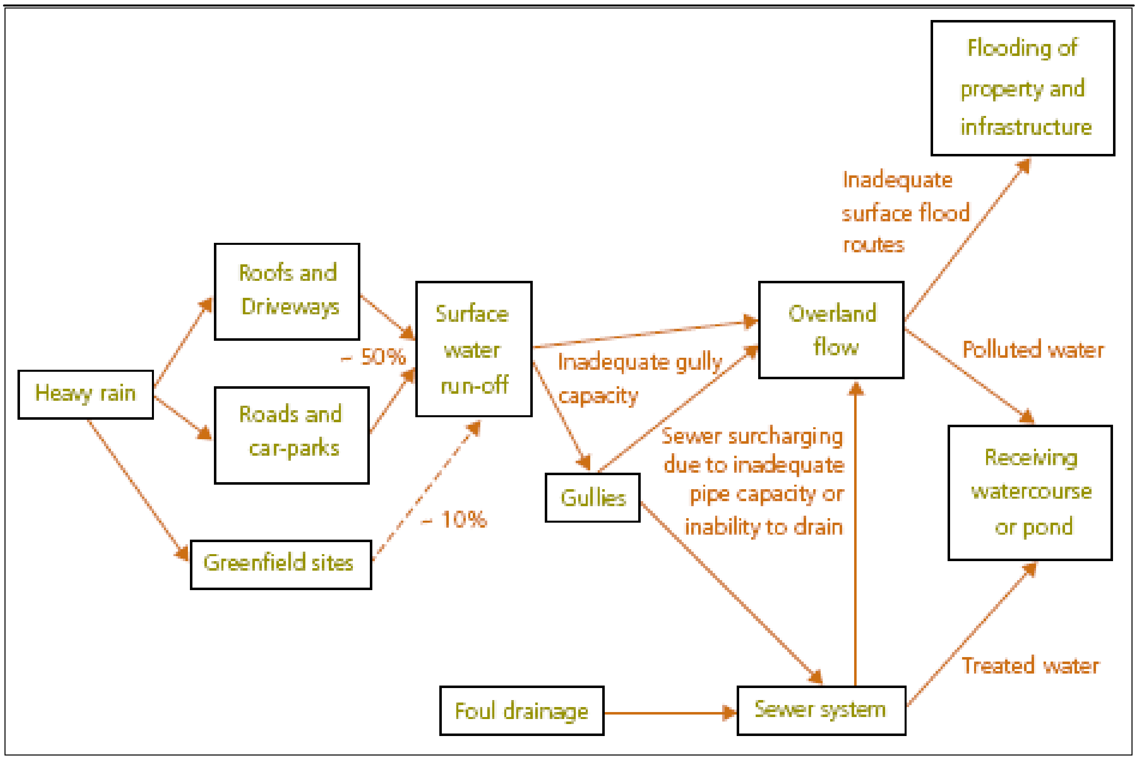

Figure 5.2 Main routes for discharge to receiving waters. Source: Great Britain (2008)

The main contributors to water quality (other than accidental or malicious discharges) are:

i. Wastewater treatment works – treatment works, either private or water company, are considered to be the main sources of ammonia and phosphorous (Coastal Management for Sustainability 2007). Their discharges also contribute other pollutants and in some instances volume of flow can also be an issue.

ii. Intermittent discharges (such as Combined Sewers Overflow (CSO)) – in the NW region, the majority of the sewage system is combined in nature with over 1,000 known overflows (UU Water PLC 2004). During wet weather these contribute significant amounts of pollution.

iii. Diffuse urban pollution – discharges from urban impermeable surfaces directly to receiving waters contribute significant amounts of sediment, phosphorous (from detergents used in vehicle washing and so on) and toxic trace elements.

iv. Diffuse rural pollution – approximately 80 per cent of the NW region is classed as rural (GONW 2003). Of this, a large proportion is designated as National Park, SSSI or Area of Outstanding Natural Beauty (AONB) (around 28 per cent). Farming in the region is predominantly livestock-based. This contributes significantly to sediment, nutrient (around 60 per cent of nitrates are estimated to come from agricultural sources) and chemical (such as sheep dip) pollution to the region's rivers.

The introduction of the Water Framework Directive has major implications for managing pollution from all of the above sources. These impacts will range from additional treatment requirements to meet discharge limits at many of the existing treatment works, further changes in agricultural practices, increasing specification of permeable surfaces and SUDs at planning stages and more regulation of substance use (such as phosphorous in detergents). The UK Technical Advisory Group (UKTAG no date) is developing environmental standards and conditions for the implementation of the Water Framework Directive on behalf of the UK.

The increase in new properties predicted for the region would place additional pressures on water quality for the following reasons:

- A high proportion of new properties are likely to be built on brownfield sites based on past performance. Between 20001/02 and 2006/07, an average of 75 per cent of all new homes in the NW were built on previously developed land (Environment Agency no date a). Some of this land may not be best suited to infiltration-type SUDs schemes due to the broad spectrum of contamination which may affect previously developed land. Infiltration and surface SUD solutions would increase pollution from leachates and provide pathways for heavier pollutants into the ecosystem.

- The national trend in urban developments is towards greater density of property build. Historically the figure has been below 30 dwellings per hectare (dph) but this has risen sharply in the last six years to 43 dph (Defra Sustainable Development no date a). This will affect the volume and intensity of runoff. In addition to increasing the percentage of impermeable area from roofs and hard standing, and hence the potential peak discharge rate from the development, higher density often restricts the space available for below ground alternative SUD solutions.

The dual effect of the above trends (high density brownfield development) is to make urban sites more difficult to drain using on-site SUDs. Often, additional off-site attenuation is more cost-effective and sustainable.

- Climate change is likely to increase the intensity of storms but reduce the overall flows in rivers (UK WIR 2004). This has the two-fold effect of increasing the potential for pollution discharges and reducing the river capacity to cope with discharges. More intense storms will overload existing systems not designed for such events (the majority of strategic sewage infrastructure is post-war in design standards). The lower overall flow in rivers will reduce the dilution capacity available, so any pollution will have a proportionally greater impact.
- Increased population increases foul flows to existing treatment works.

5.2 Current funding mechanisms

5.2.1 Structure of the industry

The determinants of water quality in terms of potential sources of pollution can be described as point source or diffuse source. Point source refers to those major outfalls to rivers, such as from water treatment plants and factories, that are easy to identify and therefore relatively straightforward to regulate. The term diffuse source, on the other hand, relates to potential sources of pollution that are less easy to quantify and control, such as surface water runoff from urban areas and agricultural land.

Water quality is also affected by abstraction rates from rivers and aquifers.

The Environment Agency assumes overall responsibility for maintaining water quality, using regulatory tools including abstraction and discharge consents and pollution fines.

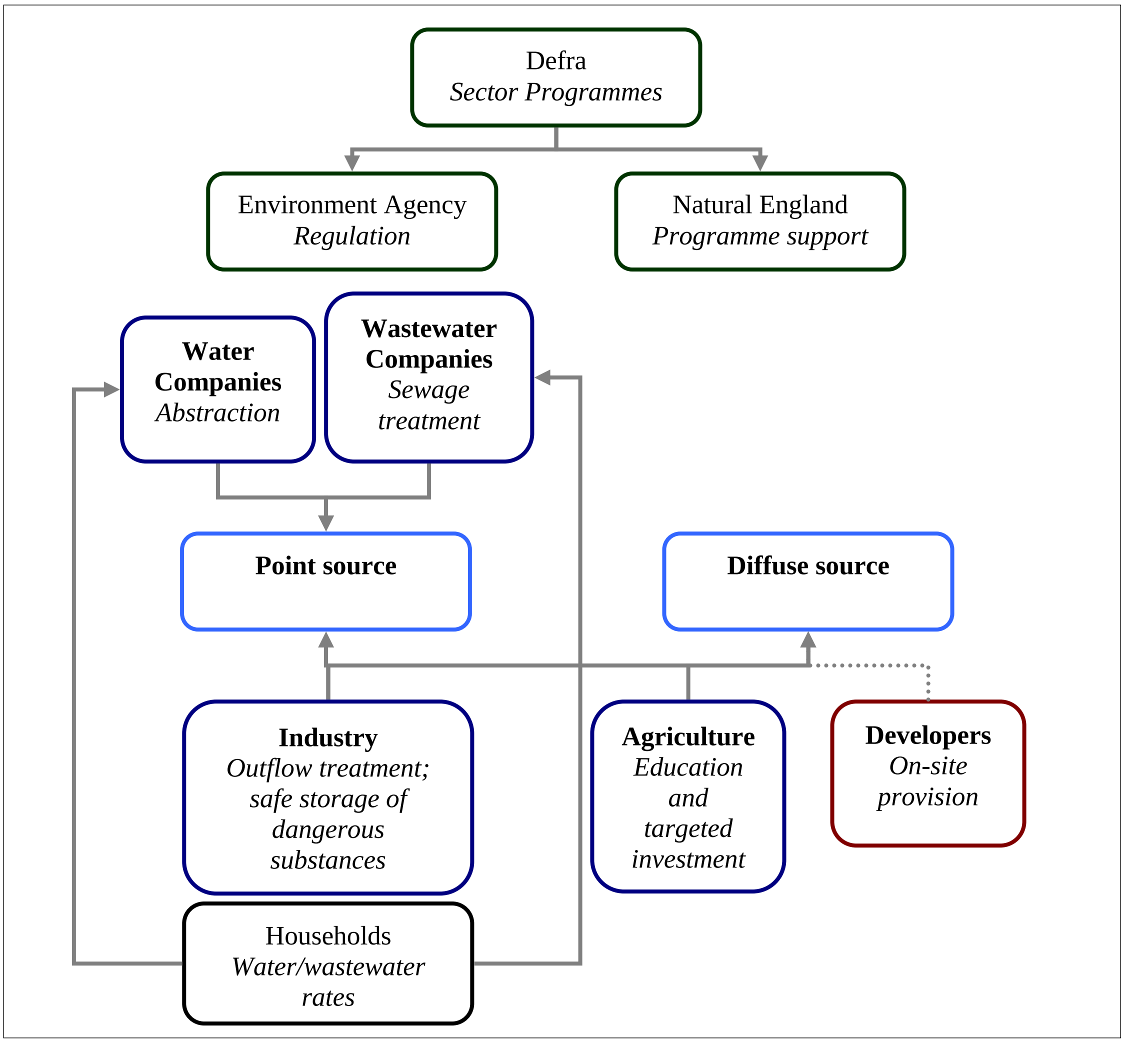

Figure 5.3 Principal funding route – water quality

5.2.2 Current funding mechanisms

The financing of treatment plants required to keep water quality within set standards falls to industry and the utility companies, allowing the government to control point source water quality by regulation. In the case of sewage treatment, the wastewater companies fund capital projects and revenue through customer charges, subject to control by Ofwat. An area of concern here is that the five-year AMP process does not adequately provide for the long-term planning of wastewater discharges taking account of proposed household growth. In areas where river catchments are close to capacity for accepting effluents, planning processes must be put in place to ensure that this is taken into account through integrated land use and infrastructure planning.

Diffuse sources of pollution by their nature necessitate use of a range of policy tools including regulation, education and targeted investment. Defra issues directives and provides funding for programmes to improve the quality of the water in rivers, lakes, estuaries, coastal waters and groundwater. Programmes include the England Catchment Sensitive Farming Delivery Initiative (ECSFDI) that commenced in April 2006. Over 80 per cent of farmers receiving advice from the ECSFDI confirmed that water pollution had increased and that they had taken, or were intending to take, action to tackle water pollution.

Other forms of diffuse pollution, such as oil in runoff from car parks, can be addressed through planning condition requirements for interceptors. However, this approach relies on relatively ad hoc upgrading as individual sites are redeveloped.

5.2.3 Forward planning procedures

A significant development in planning for water quality is the requirement under the European Water Framework Directive for the production of River Basin Management Plans. The WFD introduces a six-yearly cycle of river basin planning. The river basin planning process involves setting environmental objectives for all groundwaters and surface waters (including estuaries and coastal waters) within the river basin district, and devising programmes of measures to meet those objectives (Defra 2006).

5.3 Development of water quality cost model

Water quality in the simplest terms can be split into consented discharges (such as treatment works and CSOs) and runoff (such as diffuse pollution). The impacts of consented discharges are proportional to population and the impacts of diffuse discharges are proportional to the area of the development. Logical steps were developed here to include cost inputs at critical points. It was agreed that the cost of additional households to water quality infrastructure was a function of:

- the number of additional people;
- water usage;
- development area.

5.3.1 Assumptions and risks

The model approach is limited due to the following:

i. The model is not a water quality model. It assumes the impact is related to the volumes of flow.

ii. Drainage areas associated with treatment works and other drainage areas do not coincide with population boundaries (wards).

iii. Runoff volumes and rates, although proportional to development area, are spatially variable in themselves (for example, more rainfall in the Lake District compared to the Cheshire Plain). The topic of runoff generation is more complex than can be accommodated by a simple model.

iv. Defining whether a development is served by a combined or separate drainage system is only approximate and depends on the spatial relationship of the development and CSOs.

v. No seasonal or daily peak estimates are made; modelling is based on average dry weather flow (DWF) only.

5.4 Model results

The water quality analysis considers each of the waste water treatment works (WwTW) in the region. A cumulative analysis was also done of all the WwTW connected to each main river.

Water quality results are based on the same growth and water usage figures as for water resources (waste water generated is a factor of water consumed); however, development is apportioned over drainage areas rather than water distribution zones. Drainage areas are associated with WwTW and as with the water resource element, drainage boundaries were not available at the time of the model build. Therefore, apportionment of development was based on estimated percentages rather than measured overlap.

5.4.1 Impact of scenarios on main rivers

Table 5.1 aggregates the results of each of the WwTWs discharging to each main river. It compares the current population load from WwTWs to each river, and shows the amount by which this would increase under each of the scenarios.

Table 5.1 Receiving river impact

Receiving water	Percentage increase Baseline	Percentage increase RSS +	Percentage increase RSS ++
ACTON BROOK	-7.54	-7.03	-6.75
ASBY BECK	2.38	4.23	5.06
ASHTON BROOK	-5.48	-4.10	-3.37
BAMPTON BECK	-6.81	-6.19	-5.70
BARROW CLOUGH	-4.40	-2.59	-1.76
BARTON BROOK	5.26	10.70	13.33
BASHALL BROOK	-6.50	-5.49	-4.99
BEN BROOK	7.23	13.42	16.40
BIRKIN BROOK	-1.92	0.71	2.00
BLACK BECK	0.89	4.73	6.49
BLEA BECK	-0.39	2.84	4.45
BOATHOUSE SLUICE	-3.97	-2.06	-1.15
BORSDANE BROOK	13.45	22.04	26.19
BRIDES BECK	-6.56	-5.86	-5.31
BRUNSOW BECK	-7.72	-7.38	-7.11
BURGH MOOR BECK	5.54	9.67	11.66
CAIRN BECK	5.25	9.26	11.20
CARFOOT BECK/TROUT BECK	-7.01	-6.45	-6.01
CASTLE BROOK	9.09	16.01	19.38
CHATBURN (HEYS) BROOK	-6.89	-6.06	-5.64
CHIPPING BROOK	5.22	10.70	13.33
CLOUGH	19.67	30.63	35.90
COCKSHOT BECK	-6.90	-6.31	-5.84
COLMIRE SOUGH	5.63	11.19	13.94
COLNE WATER	-0.78	2.33	3.84
CROSSENS POOL	6.86	12.90	15.85
CUDDINGTON (CLIFF) BROOK	-1.29	1.62	3.07

Receiving water	Percentage increase Baseline	Percentage increase RSS +	Percentage increase RSS ++
DAY GREEN STREAM	-5.52	-4.21	-3.58
DEAN BROOK	-7.17	-6.46	-6.10
DEEP MEADOWS BECK	-6.13	-5.05	-4.56
DIMPERLEY CLOUGH	17.69	27.90	32.76
DOG CLOG BROOK	1.10	4.92	6.79
DOUGLAS ESTUARY	-6.69	-5.89	-5.46
DUB BECK	2.72	7.13	9.33
DUBBS GUTTER	-7.93	-7.66	-7.44
DUDDON ESTUARY	-1.46	1.34	2.75
DYAN BECK	11.56	19.49	23.28
EAGLEY BROOK	-2.13	0.45	1.72
EDEN	-4.89	-3.30	-2.58
FINE JANES BROOK	-0.35	2.93	4.52
FIR BROOK	-4.56	-2.80	-1.87
GLODWICK BROOK CULVERT	2.38	6.71	8.81
GROUND WATER	-0.82	2.27	3.78
GROUNDWATER VIA A SOAKAWAY	-0.14	0.68	1.06
GUY LANE BROOK	10.97	18.57	22.29
HALEWOOD BROOK	13.30	21.83	25.96
HALL LEE BROOK	-2.25	0.29	1.53
HAWESWATER BECK	-4.64	-2.96	-2.19
HEY COP DRAIN	-7.25	-6.65	-6.36
HOLE BROOK & RIVER DARWEN	8.93	15.76	19.08
HORNSMILL BROOK	-0.37	2.90	4.52
IRISH SEA	1.20	5.10	7.00
KEER ESTUARY	-5.10	-3.71	-3.01
KENT CHANNEL	9.47	16.47	19.91
KIDSGROVE STREAM	-5.85	-4.68	-4.12
KIRK BECK	1.90	5.99	8.04
KIRKHOUSE GILL	-4.93	-3.37	-2.66
LADES POOL	5.48	11.00	13.68
LADY BECK	23.80	36.39	42.32
LAVERSDALE BECK	5.75	9.95	11.98
LINLEY BROOK	-5.52	-4.21	-3.58
LITTLE CALDER	-4.77	-3.19	-2.45
LITTLE CALDER RIVER	-4.77	-3.19	-2.45
LIVERPOOL BAY & RIVER BIRKET	-6.70	-5.90	-5.50
LORDS BROOK	-1.13	1.86	3.31
LUNE ESTUARY	4.81	10.06	12.61
LYDGATE CLOUGH	-3.23	-1.08	-0.01
M/C SHIP CANAL (TIDAL)	4.04	9.00	11.41
MANCHESTER SHIP CANAL	19.72	30.69	35.96
MARSH MOSS	1.24	5.14	7.06
MATTY BECK	-0.94	0.64	1.41
MERE GUTTER	-7.06	-6.36	-6.02
MERSEY ESTUARY	-1.53	1.30	2.66
MILL BROOK	1.83	5.94	7.96
MILTON BROOK	-3.24	-1.08	0.00
MOBBERLEY BROOK	0.38	3.94	5.67

Receiving water	Percentage increase Baseline	Percentage increase RSS +	Percentage increase RSS ++
MORECAMBE BAY	-4.52	-2.85	-2.06
MOSS BROOK	4.42	9.51	11.99
MURTON BECK	10.16	14.93	17.23
NETHER BECK	44.45	64.72	74.35
NETHERLEY BROOK	4.23	9.28	11.73
OSTLOW BROOK	-1.55	1.25	2.61
PEARL BROOK	2.68	7.14	9.30
PEASEY BECK	17.51	27.58	32.51
PENDLETON BROOK	-3.80	-1.77	-0.86
PENNINGTON BECK	46.93	68.20	78.29
PENNINGTON BROOK	0.12	3.57	5.25
PEOVER EYE (VIA TRIB)	17.05	27.03	31.83
PIEL CHANNEL	-6.26	-5.23	-4.77
PIG HOLE CLOUGH	-2.07	0.56	1.83
POTTERS BROOK	0.50	4.09	5.84
PRESTWICH CLOUGH BROOK	19.67	30.63	35.90
R LEVEN ESTUARY & CARTER POOL	-6.91	-6.32	-5.86
RED BROOK	1.73	5.80	7.78
RIVER ALT	4.17	9.20	11.64
RIVER BOLLIN	0.53	4.14	5.88
RIVER BRATHAY	-7.86	-7.57	-7.34
RIVER CALDER (EHEN)	-3.91	-1.97	-1.07
RIVER CALDER (RIBBLE)	-2.56	-0.12	1.07
RIVER CRAKE	-7.02	-6.47	-6.03
RIVER CROCO	1.04	4.86	6.74
RIVER DANE	14.82	23.89	28.33
RIVER DARWEN	4.83	10.10	12.66
RIVER DEAN	-6.24	-5.24	-4.76
RIVER DERWENT	7.82	14.18	17.34
RIVER DOUGLAS	-1.91	0.76	2.08
RIVER DUNSOP	-6.01	-4.79	-4.17
RIVER EAMONT	21.30	32.95	38.43
RIVER EDEN	4.84	9.45	11.69
RIVER ELLEN	2.37	6.63	8.81
RIVER ESK	-4.07	-2.19	-1.33
RIVER ETHEROW	-4.16	-2.36	-1.48
RIVER GLAZE	1.64	5.69	7.65
RIVER GLENDERAMACKIN	-8.17	-7.98	-7.83
RIVER GOWY	-2.64	-0.12	1.08
RIVER GOYT	-4.46	-2.78	-1.96
RIVER HYNDBURN	0.65	4.33	6.09
RIVER IRK (VIA LUZLEY BK)	-2.83	-0.51	0.61
RIVER IRTHING	37.34	53.46	61.20
RIVER IRWELL	10.39	17.80	21.39
RIVER KEEKLE	5.78	11.45	14.18
RIVER KENT	4.27	9.30	11.80
RIVER LOSTOCK	5.96	11.66	14.44
RIVER LOWTHER	36.81	54.32	62.49
RIVER LUNE	1.98	6.14	8.17

Receiving water	Percentage increase Baseline	Percentage increase RSS +	Percentage increase RSS ++
RIVER MARRON	4.49	9.76	12.16
RIVER MERSEY	11.75	19.69	23.52
RIVER MERSEY ESTUARY	1.86	5.98	7.99
RIVER MERSEY ESTUARY/R.BIRKET	-0.03	3.37	5.03
RIVER PETTERIL	16.19	24.85	29.00
RIVER RIBBLE	-4.14	-2.27	-1.38
RIVER RIBBLE ESTUARY	8.43	15.06	18.30
RIVER ROCH	3.02	7.59	9.81
RIVER TAME	4.71	9.94	12.48
RIVER WAMPOOL(CHALK BECK)	-6.84	-6.23	-5.74
RIVER WAVER	-7.04	-6.50	-6.06
RIVER WEAVER	5.75	11.42	14.15
RIVER WEAVER NAVIGATION	47.45	68.84	78.98
RIVER WENNING	-5.19	-3.84	-3.16
RIVER WHEELOCK	10.51	17.99	21.58
RIVER WYRE	-1.87	0.83	2.13
RIVER YARROW	-6.28	-5.34	-4.84
RIVER YARROW & CHOR	9.55	16.66	20.11
SALTEYE BROOK	2.62	7.04	9.18
SANKEY BROOK	5.43	10.93	13.61
SDANDAL BECK	-4.59	-2.89	-2.11
SHAP BECK (RIVER LEITH)	-4.12	-2.22	-1.37
SHOWLEY BROOK	9.19	16.15	19.52
SIMONSWOOD BROOK	0.44	4.03	5.78
SINDERLAND BROOK	0.07	3.50	5.17
SOLWAY FIRTH	2.92	7.41	9.69
SOUTERGATE BECK	-6.57	-5.67	-5.26
STOCK BECK	-0.29	2.99	4.60
SWINDALE BECK	2.37	6.61	8.72
TARLETON RUNNER	4.83	10.10	12.68
TARRA CARR GUTTER	-0.49	2.72	4.34
THE BANKSIDE	-3.41	-1.21	-0.16
THE RIVER CALDER	21.96	33.83	39.44
THE RIVER MEDLOCK	17.99	28.32	33.28
THISTLETON BROOK	5.76	11.36	14.14
THORNTON BROOK	9.00	15.87	19.20
TIDAL STRETCH OF RIVER BELA	-7.59	-7.21	-6.91
TIDAL TRIB OF THE SOLWAY FIRTH	41.35	58.97	67.41
TO GROUND WATER VIA A SOAKAWAY	7.95	14.39	17.52
TRIB ASTLEY BROOK	0.72	4.41	6.20
TRIB BELMAN BECK	-7.15	-6.63	-6.23
TRIB BENTLEY BROOK	-5.56	-4.29	-3.66
TRIB BIRKIN BROOK	12.35	20.53	24.46
TRIB BLACK BROOK	1.16	5.01	6.90
TRIB CHESTERLANE BROOK	-0.94	2.10	3.62
TRIB CROW BROOK	-7.34	-6.78	-6.53
TRIB CROWTON BROOK	-5.12	-3.60	-2.79

Receiving water	Percentage increase Baseline	Percentage increase RSS +	Percentage increase RSS ++
TRIB FURNACE GILL	-2.33	0.13	1.40
TRIB KINGSLEY BROOK	-5.12	-3.60	-2.79
TRIB MAIN DYKE	3.72	8.58	10.93
TRIB MIDDLE BROOK	-4.84	-3.31	-2.55
TRIB MILTON BROOK	-3.24	-1.08	0.00
TRIB OF RIVER WEAVER	-5.26	-3.80	-3.02
TRIB OF THE RIVER WEAVER	-3.24	-1.08	0.00
TRIB OLD MOSS BROOK	-3.63	-1.66	-0.57
TRIB POAKA BECK	-6.98	-6.41	-5.96
TRIB POPPING BECK	2.49	4.39	5.24
TRIB RAVEN BECK	19.91	28.42	32.54
TRIB RIVER ALT	-0.81	2.29	3.80
TRIB RIVER DANE	9.36	16.34	19.76
TRIB RIVER ETHEROW	-5.68	-4.48	-3.89
TRIB RIVER MARRON	-5.39	-4.04	-3.42
TRIB RIVER WEAVER	-4.47	-2.76	-1.92
TRIB SARAH BECK	3.68	8.52	10.90
TRIB TODD BROOK	-7.13	-6.48	-6.20
TROUT BECK	12.27	17.86	20.55
TRUB BROOK	-4.81	-3.26	-2.50
UNITY BROOK	2.43	6.79	8.90
UNKNOWN[1]	41.35	58.97	67.41
WALNEY CHANNEL	-0.10	3.29	4.96
WAMPOOL ESTUARY	-6.99	-6.42	-5.98
WESTNEWTON BECK	-6.80	-6.17	-5.68
WETTENHALL BROOK	-6.95	-6.18	-5.77
WHITEHALL BROOK	1.84	5.96	7.92
WHITTLE BROOK	-3.65	-1.64	-0.67
WICKENHALL CLOUGH	-3.47	-1.41	-0.39
WILLY BECK	5.52	9.63	11.62
WINCE BROOK	5.88	11.57	14.33
WINDERMERE	-7.04	-6.50	-6.06
WYRE ESTUARY	-0.40	2.88	4.49

Notes: [1]Unknown indicates several WwTW discharges to receiving waters that have no descriptive information in the model.

From the analysis, the four worst affected rivers are the Weaver Navigation, Pennington Beck, Nether Beck and the Solway Firth. Although the total increase in population load discharging to these rivers is not the greatest (greatest increase seen by Mersey, Irwell, Tame and Alt), these see the greatest percentage increase of over 40 per cent under the baseline scenario.

Further analysis shows that some rivers that have little or negative increase along the river as a whole have significant increases along some sections. For example, the River Eden has eight reaches included in the model and an overall increase of 4.84 per cent. However, of the eight reaches three have a slightly negative increase, four have a slightly positive increase but one reach has a significant positive increase. This section is associated with the discharge from Carlisle WwTW.

WwTWs discharging to the worst affected rivers are therefore likely to require investment to improve the treatment capacity (biological if not volume) for all scenarios. These sites would require additional investment to deal with the increased surface water runoff. Table 5.2 shows that even for receiving waters where the DWF discharge volume from the associated WwTW is likely to decrease, there will be an increase in storm runoff that will affect water quality.

Table 5.2 Increase in impermeable area (baseline)

Receiving water	Development Area (ha)
ACTON BROOK	1
ASBY BECK	1
ASHTON BROOK	2
BAMPTON BECK	0
BARROW CLOUGH	2
BARTON BROOK	40
BASHALL BROOK	0
BEN BROOK	67
BIRKIN BROOK	12
BLACK BECK	3
BLEA BECK	6
BOATHOUSE SLUICE	3
BORSDANE BROOK	363
BRIDES BECK	0
BRUNSOW BECK	0
BURGH MOOR BECK	2
CAIRN BECK	2
CARFOOT BECK/TROUT BECK	1
CASTLE BROOK	81
CHATBURN (HEYS) BROOK	1
CHIPPING BROOK	9
CLOUGH	328
COCKSHOT BECK	0
COLMIRE SOUGH	9
COLNE WATER	32
CROSSENS POOL	78
CUDDINGTON (CLIFF) BROOK	6
DAY GREEN STREAM	7
DEAN BROOK	0
DEEP MEADOWS BECK	2
DIMPERLEY CLOUGH	5
DOG CLOG BROOK	94
DOUGLAS ESTUARY	2
DUB BECK	6
DUBBS GUTTER	0
DUDDON ESTUARY	5
DYAN BECK	26
EAGLEY BROOK	116
EDEN	1
FINE JANES BROOK	50
FIR BROOK	1
GLODWICK BROOK CULVERT	104
GROUND WATER	10
GROUNDWATER VIA A SOAKAWAY	1
GUY LANE BROOK	118
HALEWOOD BROOK	116
HALL LEE BROOK	109
HAWESWATER BECK	1
HEY COP DRAIN	2

Receiving water	Development Area (ha)
HOLE BROOK & RIVER DARWEN	40
HORNSMILL BROOK	16
IRISH SEA	96
KEER ESTUARY	3
KENT CHANNEL	17
KIDSGROVE STREAM	5
KIRK BECK	4
KIRKHOUSE GILL	1
LADES POOL	48
LADY BECK	14
LAVERSDALE BECK	2
LINLEY BROOK	7
LITTLE CALDER	2
LITTLE CALDER RIVER	2
LIVERPOOL BAY & RIVER BIRKET	20
LORDS BROOK	10
LUNE ESTUARY	41
LYDGATE CLOUGH	12
M/C SHIP CANAL (TIDAL)	119
MANCHESTER SHIP CANAL	441
MARSH MOSS	10
MATTY BECK	2
MERE GUTTER	1
MERSEY ESTUARY	73
MILL BROOK	25
MILTON BROOK	9
MOBBERLEY BROOK	11
MORECAMBE BAY	1
MOSS BROOK	23
MURTON BECK	2
NETHER BECK	27
NETHERLEY BROOK	248
OSTLOW BROOK	16
PEARL BROOK	81
PEASEY BECK	19
PENDLETON BROOK	3
PENNINGTON BECK	13
PENNINGTON BROOK	81
PEOVER EYE (VIA TRIB)	33
PIEL CHANNEL	2
PIG HOLE CLOUGH	21
POTTERS BROOK	6
PRESTWICH CLOUGH BROOK	328
R LEVEN ESTUARY & CARTER POOL	0
RED BROOK	11
RIVER ALT	314
RIVER BOLLIN	57
RIVER BRATHAY	0
RIVER CALDER (EHEN)	2
RIVER CALDER (RIBBLE)	74
RIVER CRAKE	0
RIVER CROCO	23
RIVER DANE	79
RIVER DARWEN	156

Receiving water	Development Area (ha)
RIVER DEAN	14
RIVER DERWENT	71
RIVER DOUGLAS	20
RIVER DUNSOP	0
RIVER EAMONT	29
RIVER EDEN	190
RIVER ELLEN	17
RIVER ESK	4
RIVER ETHEROW	15
RIVER GLAZE	36
RIVER GLENDERAMACKIN	0
RIVER GOWY	1
RIVER GOYT	44
RIVER HYNDBURN	76
RIVER IRK (VIA LUZLEY BK)	54
RIVER IRTHING	20
RIVER IRWELL	922
RIVER KEEKLE	87
RIVER KENT	48
RIVER LOSTOCK	142
RIVER LOWTHER	14
RIVER LUNE	79
RIVER MARRON	4
RIVER MERSEY	876
RIVER MERSEY ESTUARY	443
RIVER MERSEY ESTUARY/R.BIRKET	158
RIVER PETTERIL	80
RIVER RIBBLE	11
RIVER RIBBLE ESTUARY	316
RIVER ROCH	150
RIVER TAME	397
RIVER WAMPOOL(CHALK BECK)	0
RIVER WAVER	0
RIVER WEAVER	233
RIVER WEAVER NAVIGATION	146
RIVER WENNING	3
RIVER WHEELOCK	73
RIVER WYRE	7
RIVER YARROW	1
RIVER YARROW & CHOR	171
SALTEYE BROOK	72
SANKEY BROOK	284
SDANDAL BECK	1
SHAP BECK (RIVER LEITH)	1
SHOWLEY BROOK	96
SIMONSWOOD BROOK	19
SINDERLAND BROOK	32
SOLWAY FIRTH	5
SOUTERGATE BECK	3
STOCK BECK	11
SWINDALE BECK	3
TARLETON RUNNER	24
TARRA CARR GUTTER	11
THE BANKSIDE	1

Receiving water	Development Area (ha)
THE RIVER CALDER	8
THE RIVER MEDLOCK	417
THISTLETON BROOK	12
THORNTON BROOK	281
TIDAL STRETCH OF RIVER BELA	1
TIDAL TRIB OF THE SOLWAY FIRTH	20
TO GROUND WATER VIA A SOAKAWAY	46
TRIB ASTLEY BROOK	141
TRIB BELMAN BECK	0
TRIB BENTLEY BROOK	3
TRIB BIRKIN BROOK	109
TRIB BLACK BROOK	177
TRIB CHESTERLANE BROOK	13
TRIB CROW BROOK	1
TRIB CROWTON BROOK	2
TRIB FURNACE GILL	6
TRIB KINGSLEY BROOK	2
TRIB MAIN DYKE	259
TRIB MIDDLE BROOK	76
TRIB MILTON BROOK	2
TRIB OF RIVER WEAVER	1
TRIB OF THE RIVER WEAVER	7
TRIB OLD MOSS BROOK	1
TRIB POAKA BECK	0
TRIB POPPING BECK	1
TRIB RAVEN BECK	5
TRIB RIVER ALT	82
TRIB RIVER DANE	21
TRIB RIVER ETHEROW	4
TRIB RIVER MARRON	2
TRIB RIVER WEAVER	4
TRIB SARAH BECK	25
TRIB TODD BROOK	1
TROUT BECK	2
TRUB BROOK	19
UNITY BROOK	68
UNKNOWN[1]	20
WALNEY CHANNEL	37
WAMPOOL ESTUARY	0
WESTNEWTON BECK	0
WETTENHALL BROOK	1
WHITEHALL BROOK	12
WHITTLE BROOK	14
WICKENHALL CLOUGH	14
WILLY BECK	2
WINCE BROOK	142
WINDERMERE	2
WYRE ESTUARY	19

5.5 Analysis and comments on results

In the model, population load has been used as a proxy for water quality analysis; although several WwTW have predicted decreases in DWF reaching them (see Section 4 on water use per capita), this flow will be more concentrated. Biological load on the WwTW is a better indication of possible receiving water quality (all other factors being equal) than DWF. The current model does not include any explicit water quality calculation; further investigation would be required to determine whether water quality parameters could be included to increase the accuracy of the above analysis. Nor does the model look at cumulative impacts on downstream sections of discharges. Information on the connectivity of rivers would need to be included in the model for such an analysis.

The model does not hold any data on the type of drainage area a development would sit in (such as combined or separate), therefore it is not known whether additional runoff generated by new development would reach the receiving water via overflow (from WwTW or CSO) or via direct discharge. It was assumed in the model that additional runoff could be managed by providing extra storage at the WwTW, CSO or within the development itself. As more detailed information becomes available (for example, drainage area boundaries and types) the model can be improved.

However, if the predicted water consumption is reached, this will reduce the DWF volume load on most WwTW systems. The biological load on WwTW, and therefore receiving waters, will increase significantly in all scenarios modelled here, which will reduce water quality in the region without additional investment.

Several catchments will also receive significantly more surface water discharge. While there are systems in place to mitigate this through the planning process, additional coordination and cooperation will be required to avoid water quality problems (such as the promotion of permeable and porous SUDs over attenuation-only systems).

Recent European directives regulating water quality in water courses (such as the WFD) imply that it might not be possible to increase the volume of effluent discharged from treatment works. The ‘capacity’ of the environment to receive additional effluent, particularly under the objectives of these directives, is not considered in the model.

Water resource and water quality infrastructure information within the model was provided by the Environment Agency or taken from publicly available documents. The capacity information is therefore unlikely to be up to date. In addition, the spatial relationship between infrastructure and development is at a coarse level and would benefit from additional input from the utility companies.

5.6 Costs

The estimated total costs of providing water quality infrastructure for the NW in 2029 will be £12,827 million under the RSS growth scenario and could increase to £13,962 million under the RSS++ scenario. Population load was used as a proxy for water quality analysis because the total suspended solid load is related to the number of people connected to the sewer system. The combination of anticipated reduction in water consumption and higher biological load due to growth is likely to reduce water quality in the region without additional investment.

A similar approach to water resources was used in building up costs. Water quality costs here include allowances for the following:

- Increased biological load – in WwTW drainage areas with an increased load, it was assumed that additional process units or modifications to existing units would be required. In WwTW drainage areas with no predicted increase in load, it was assumed that no additional work would be required. Cost was based on a population increase base paid for through water company AMP spend via household bills.

- Increased surface runoff – urban runoff produces diffuse pollution and contributes to flood risk. The use of SUD systems on new developments improves water quality while reducing flood risk. Increased sewer network capacity at overflows and treatment works will also protect/improve water quality. The model here assumed that additional storage would be provided at source by estimating a volume required based on new development areas. In reality, providing storage at the source (on the development site) would be more effective than providing storage at treatment works. The model would require refining to analyse the relative impact of storage location. Control of runoff also has benefits for flood risk. It was assumed that SUDs would be adopted by water utilities and maintenance costs would be included in the general OPEX costs for water quality.
- Increased OPEX for maintaining the extended system – household cost via billing by the water companies.

Table 5.3 shows the breakdown of the total cost in terms of these allowances.

Table 5.3 Summary of water quality RSS costs

Existing commitment £million	Total OPEX £million	Total CAPEX biological load £million	Total CAPEX runoff £million	Total £million
£9,733	£455	£1,841	£799	£12,827

5.7 Comparison with SMEISE study

5.7.1 Pressures and needs

As a percentage of the total area, the SE is more urbanised that the NW and runoff will therefore have a greater impact on water quality. The NW, however, has a greater proportion of urban areas in upper reaches of rivers where dilution factors are extremely low (in some cases less than one – effluent discharge is greater than the receiving water flow). The NW will therefore have a greater issue with baseline water quality (impact of existing population). This is reflected in the anticipated wastewater spend of United Utilities in AMP5 being 47 per cent higher than their water services spend[1].

5.7.2 Costs

The total estimated spend on water resources and water quality for the ‘zero growth’ costs is very similar between the two regions (£18,677 million in the SE versus £18,111 million in the NW) but the proportions are different. The SE has a predominant water

[1] Planning for the Future – United Utilities draft business plan for 2010 to 2015.

resources spend (55 per cent) compared to predominant water quality spend in the NW (54 per cent). This reflects the focus in the NW over the past few years on increasing water quality, whereas the SE has been more focused on drought issues.

Water quality cost estimates for the NW show less of an increase for RSS growth than the SE. The relative gap in spend also widens from a 13 per cent to a 20 per cent difference. The reasons are similar to water resources but in the reverse order. That is, water quality in the NW has see historically higher per capita spend than in the SE. Many of the larger WwTW and failing works have already had major work on them or have major work planned for AMP5.

5.8 Uncertainties and strategies for the future

Source control of runoff and the effective location of attenuation to control both water quality and flooding from sewers will be a major challenge. Water companies are developing a better understanding of where capacity constraints are located in their sewer systems. This information is, however, lacking in the model at the moment. The relative impact of various spatial options for development growth on sewer systems is also poorly understood, water companies have detailed network models but these are not typically used by planners when development growth is being considered. Cooperation has improved between the various bodies but further effort will be required over the short and medium term to achieve reasonable cost benefit strategies that balance growth demands with achievable infrastructure capabilities.

For the larger WwTW that have recently been improved and expanded in the last AMP periods (such as Wigan), process enhancements using existing technology should be relatively straightforward to cope with additional biological loads in the short term. The existing funding mechanism is adequate for this element.

In the medium term, the older and smaller WwTW, especially those that are space-constrained, will require additional investigation and new approaches to provide extra biological capacity. The limiting constraint at many of these sites will be sludge handling, treatment and disposal.

In the longer term, multi-organisational catchment management plans will be required to co-ordinate water quality issues and plan and implement catchment-wide approaches to improve water quality (such as vegetation buffers between rivers and farmland, infiltration and porous-type SUD systems)

6 Flood risk management

6.1 Baseline review of existing needs and pressures in the NW

The NW covers the main river catchments of the Wyre, Weaver, Gowy, Irwell, Mersey, Alt, Crossens, Douglas, Eden, Ribble, Lune, Kent, Leven and Derwent in addition to many smaller rivers and tributaries. The existing fluvial and coastal flooding situation for the region is summarised in the following figure:

Table 6.1 Flood facts for the North West

Regional flood facts 2007	
Area covered by the Regional Flood Defence Committee	1,442,000 ha
Area at risk of flooding Flood Zone 3[1]	1,500 km^2
Area at risk of flooding Flood Zone 2[2]	1,751 km^2
Population of region	6,655,000
Estimated population at risk of flooding	474,500
Number of addresses in Flood Zone 3	140,000
Number of addresses in Flood Zone 2	72,500
Length of motorway in areas at risk of flooding	25.5 km
Length of A class roads in areas at risk of flooding	112.6 km
Length of railways in areas at risk of flooding	156.9 km
Number of flood warning areas in operation	130
Number of properties covered by flood warning areas	94,000
Population of area covered by flood warning areas	170,000
Length of main river managed	6,341 km

[1]Flood Zone 3 has annual probability of flooding of one per cent or greater (one in 100 years) for rivers and 0.5 per cent or greater (one in 200 years) for tidal and coastal.
[2]Flood Zone 2 has annual probability of flooding in the range of 0.1 to one per cent (between one in 100 years and one in 1,000 years) for rivers and 0.1 to 0.5 per cent (between one in 200 years and one in 1,000 years) for tidal and coastal.
Source: modified from Environment Agency 2008

Around 215,000 properties in the NW are at risk of flooding (Environment Agency no date b). Currently, the Environment Agency spends over £40 million a year protecting people and property from flooding in the NW. A typical flood claim is between £15,000 and £30,000 (Association of British Insurers 2002).

An Environment Agency survey in 2000 revealed that 84 per cent of flood defences in the NW of England were good or very good. However, current maintenance of assets is fragmentary and the responsibility of different landowners. Much recent flooding is attributed to the shortfall of standards (such as cleaning of grills, cutting back vegetation, cleaning rubbish from streams) in the servicing of assets rather than failure due to condition. There remains a need for greater integration of asset management for effective flood risk management. A reduction in floodplain development is also essential, especially with increased flood risk from climate change.

Floods are now more frequent, more widespread and more costly due to a number of factors. These include variations in weather patterns and heavier rainfall, more building on floodplains, more affluent lifestyles and changing construction techniques, poor maintenance of flood defences and drainage systems and changes in agricultural practices. Climate change is expected to increase flood risk further in future.

The Government's own research in 2001 showed that the budgeted spending on flood defences was significantly below the levels necessary to meet Defra's own standards of flood defence (the Indicative Standards of Service for flood defence).

The Foresight project in flood and coastal defence was commissioned by Sir David King, former Chief Scientific Advisor to the Government, to answer two questions:

- How might the risks of flooding and coastal erosion change in the UK over the next 100 years?
- What are the best options for Government and the private sector for responding to future challenges?

The project looked at flood and coastal defence in the UK between 2030 and 2100. It considered all of the UK, and looked at flooding from rivers and the sea, as well as internal flooding in towns and cities. It also considered the risks of coastal erosion.

Currently, flooding and flood management cost the UK around £2.2 billion each year: we spend around £800 million per annum on flood and coastal defences, but even with existing defences we experience an average of £1,400 million of damage.

The Foresight project started by assessing the size and nature of future risks under the baseline assumption that policies and expenditure on flood management would remain unchanged. Some of the key findings were:

- Under every scenario considered, flooding would increase substantially by 2080. However, the cost of the increase varies from less than £1 billion to around £27 billion, depending on the scenario.
- The increase in flood risk varies across the UK, with some areas consistently likely to suffer higher risks - for example, the Lancashire-Humber corridor, the east and south coasts, and major estuaries.
- Coastal erosion will increase substantially in all scenarios. Average annual damage is set to increase by three to nine times by the 2080s, although the worst case (£126 million per year) is much less than current flood losses.
- An integrated portfolio of responses could reduce the risks of river and coastal flooding from the worst scenario of £20 billion damage per year, down to around £2 billion in the 2080s. However, this would still be double present-day damage.
- Reducing global greenhouse gas emissions would substantially help to manage future risks. For the so-called 'world markets' high-growth scenario in two cases coupled with high and low global emissions, in the absence of other responses, the risks of catchment and coastal flooding would fall from around £21 billion per year to around £15 billion per year in the 2080s (these figures do not include risk reductions for intra-urban flooding).
- In towns and cities, reducing global greenhouse-gas emissions could make the difference between our drains and sewers coping with increased future rainfall, or becoming increasingly overwhelmed.
- To implement the portfolios of responses would require between £22 billion and £75 billion of new engineering by the 2080s, depending on the scenario.

Coastal erosion and climate change are predicted to increase the risk and severity of flooding in the NW (Evans *et al.* 2004). This, coupled with the likelihood of new development on previously developed land (see water quality section), would suggest that the population at risk of flooding will increase if no extra investment is provided.

6.2 Current funding mechanisms

6.2.1 Structure of the industry

Flood risk can be attributed to several sources, including flooding from the sea, rivers, groundwater and sewers, which means that a wide range of organisations are involved in planning and managing complex interrelationships. The Environment Agency assumes the overarching role in the planning, regulation and distribution of funds to manage flood risk, while flood alleviation and defence projects on the ground are undertaken by Harbour Authorities, Local Authorities, Internal Drainage Boards, wastewater companies and developers/companies where individual sites are threatened. The Environment Agency is also responsible for some elements of flood management infrastructure.

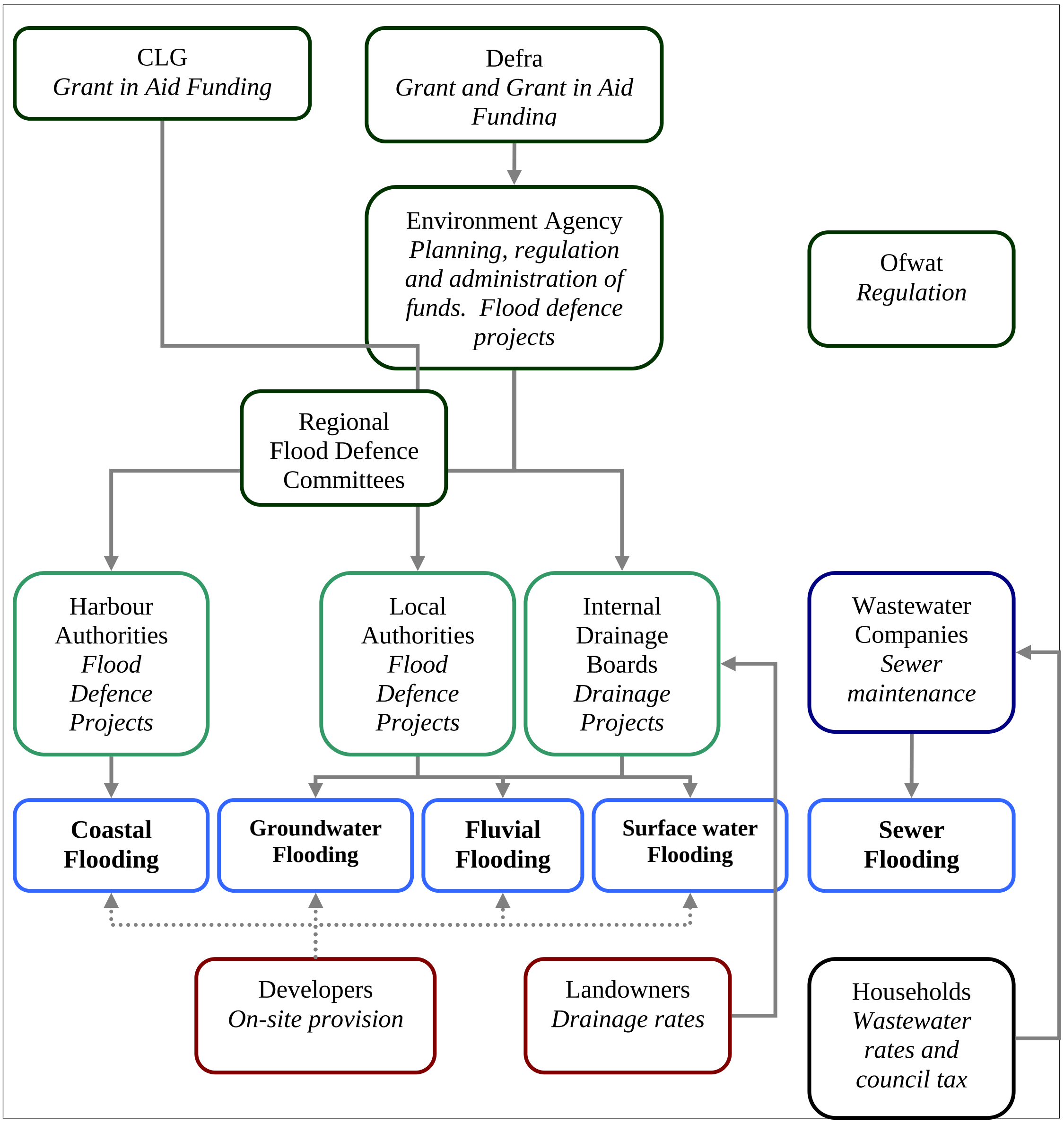

Figure 6.1 Principal funding route – flood risks

6.2.2 Current funding mechanisms

The funding of flood risk management is complex and it is difficult to capture all the relationships between organisations in a single diagram. Funding contributions by different bodies can be summarised as follows (Defra 2008b):

- Defra contributes grant and grant in aid to the Environment Agency to cover capital and revenue activities.
- From April 2006, the Environment Agency took over responsibility for the grant aiding of local authority and internal drainage board (IDB) flood risk management capital projects.
- Local authority expenditure on flood risk management is funded from a number of sources including central government grants channelled through the Environment Agency, council tax and reserves. The primary source is Revenue Support Grants from DCLG.

- Regional flood defence committees provide a forum whereby local authority levies to the Environment Agency can be agreed for instances where Defra grant funding will be insufficient to fund a flood defence project.
- The activities of Internal Drainage Boards are funded by landowners within their administrative area and through local authority levies.
- Site-specific flood defence projects will be undertaken by landowners, companies and developers. PPS25 now strictly regulates the level of surface water runoff from new developments; hence, flood alleviation measures are now regularly designed into developments.
- Wastewater companies are required to maintain sewer networks to prevent sewer flooding. Funding for the maintenance of sewers by wastewater companies comes from householder charges.

6.2.3 Forward planning procedures

Given the range of organisations involved in flood risk management, a number of plans are produced at different spatial scales. Key documents are:

- Catchment Flood Management Plans – the aims of CFMPs, produced by the Environment Agency, are to carry out a strategic assessment of current and future flood risk from all sources (rivers, sewers, groundwater and so on) within a catchment; and to identify opportunities and constraints for reducing flood risk through strategic changes or responses, such as changes in land use, land management practices and/or the flood defence infrastructure (Environment Agency 2004).
- Shoreline Management Plans - these are the coastal equivalent of CFMPs and may, for example, include a number of communities and a series of sea defences. The plans look at how the maritime local authorities and local populations can work together to reduce the risks to people, property and land from sea flooding and coastal erosion.
- Strategic Flood Risk Assessments (SFRA) – local authorities are required to produce SFRAs to identify areas at risk of flooding in the preparation of Development Plan Documents within the Local Development Framework. SFRAs are required to identify factors relevant to current and future flood risk and to outline policies to minimise and manage the risk.
- Utility Asset Management Plans (AMPs) - English water utility investment programmes run in five-year cycles for which each wastewater company produces an AMP.

A gap in the current planning framework is that there is no wastewater equivalent to the long-term Water Resource Plan (WRP), whereby companies would be required to produce 25-year sewerage plans that consider strategic options.

6.2.4 Future funding mechanisms

A report by the National Audit Office (NAO) found that only 57 per cent of all flood risk asset systems, and 46 per cent of high risk systems such as those protecting urban areas, had achieved their target condition by March 2007. At that time the Environment Agency estimated that a further £150 million a year would be needed to bring all flood defence systems up to their target condition (Great Britain 2007b).

Furthermore, a national strategy is required to ensure the maintenance of those assets by local authorities and private owners.

The general principle underlying water management for new developments has been that it would be technically possible for water supply, sewerage and sewage treatment to be made available anywhere. For instance, sewage companies have a duty to provide drainage and have limited powers to stop additional flows into the network, even though these may overload it and cause flooding. Under current legislation, there is no requirement for developers to contribute to the cost of upgrading sewage networks and it can be difficult to secure increased capacity in advance of development, as capital works must be funded through general customer tariffs.

6.3 Development of flood risk cost model

It was assumed here that to obtain planning permission to build in a flood zone, the developer provided suitable mitigation measures at their cost. The extra cost calculated in the model is thus only related to the consequential cost of flooding after the property has been built and not the cost of flood defences.

The Environment Agency, under the CFMP programme, has conducted broad-scale modelling of the main river catchments in the NW region. Economic damages from the one per cent (one in 100) annual exceedance probability (AEP) fluvial flood event and the average annual damages (AAD) due to fluvial flooding were calculated as part of the study. AAD is determined by considering the damage values associated with a range of different flood events and averaging these to give an indication of the flood damages that may be experienced in any one year. The Environment Agency used these figures to assess whether flood management responses made economic sense.

Our model estimated the number of proposed properties potentially affected by flooding. These were developments in or partially in Flood Zone 2 or 3. Developments partially within a flood zone were assumed to have all properties within affected by flooding. This would be the worst case result. The model could be amended to proportion affects by percentage area overlap or by dividing the development into sub-plots, but this was considered too time-consuming for this stage of the project.

The number of properties per catchment area then had the appropriate AAD applied (Workington AAD applied to Workington region and so on) to estimate the potential cost of flooding for the region.

This cost was the potential worst case cost if no additional protection of flood risk management processes was implemented. The next stage of the project would be to look at how mitigation measures (new defences, increased maintenance and so on) could be included to reduce the overall cost.

The network element of the water quality model methodology covers sewer flooding.

From these descriptions, logical steps were developed to include cost inputs at critical points. It was agreed that the cost of additional households to flooding infrastructure was a function of:

- the number of additional properties;
- development area;
- the relationship between development and the known flood risk zones.

6.3.1 Key assumptions and risks

The model did not attempt to calculate the increased risk of flooding. The model only assumed the consequences of having development (new or existing) in at-risk flood areas. The risk of flooding (probability of occurrence) could be reduced using various flood management techniques or by building in lower risk areas but the consequences of a flood would be the same. Consequences could be reduced by moving properties out of the risk area or by providing building resilience. In the model used here, all properties (existing and new) were assumed to have zero flood resilience and to be at risk or not (no distinction was made between Flood Zone 2 and 3 in terms of consequences). All developments were treated equally.

The model approach was limited due to the following:

i. The model was not a flood risk model. It assumes the impact of additional housing was related to the existing level of risk in a given location.

ii. The model treated all developments equally; no distinction was made between multi-storey, single storey and buildings with basements.

iii. SUD principles were applied to all developments in flood zones as part of the planning process and therefore the cost of such would be calculated under the water quality section.

iv. Properties built in Zone 1 were still considered to have an impact on flood risk. It was assumed that large developments (above one hectare) would as part of the planning process, adopt SUD principles. Smaller developments were assumed to need additional network capacity downstream.

v. No distinction was made between the cost of building in defended areas and the cost of building in undefended areas.

6.4 Model results

Planning policy directs development away from sites at flood risk. Thus, the aspiration is that new development sites should not be in areas at risk of flooding.

For sites planned for the next five years, it was possible to plot the location of each known development site against the Environment Agency's fluvial and coastal flood mapping to identify any part of the development in an area of flood risk. This was available for about half of the local authorities.

This did not mean that the development would happen in the area of flood risk. This area might be planned to be open space, for example. However, our analysis indicated the number of sites where flooding will have to be considered.

For the remaining sites the spatial extent was not known, and for those more than five years away, they could only be located to the centre of the relevant local authority. To provide a proxy for the degree of flood risk that might result from future development, we looked at the proportion of residents in each borough believed to be at flood risk.

This analysis only considered fluvial and coastal flood risk. Other types of flood risk such as sewer flooding and groundwater flooding would need to be considered on a site-by-site basis.

On the basis that past development in each authority would be a guide to the flood risk of future development, it was possible to estimate the number of future dwellings that might be located in area of fluvial and coastal flood risk.

Table 6.2 Potential total number of properties in Flood Zones 2 and 3

Local Authority	5YR Plan	Baseline	RSS +	RSS ++
Allerdale	n/a	538	646	753
Barrow-in-Furness	n/a	204	245	286
Blackburn with Darwen	n/a	587	704	822
Blackpool	n/a	2,286	2,743	3,200
Bolton	1,159	1,159	1,391	1,622
Burnley	n/a	468	562	655
Bury	985	1,525	1,830	2,135
Carlisle	n/a	1,932	2,318	2,705
Chester	n/a	516	619	722
Chorley	1,412	2,387	2,864	3,341
Congleton	39	39	47	55
Copeland	41	179	215	251
Crewe and Nantwich	n/a	1,790	2,148	2,506
Eden	n/a	146	175	204
Ellesmere Port & Neston	n/a	1,548	1,858	2,167
Fylde	n/a	1,305	1,566	1,827
Halton	n/a	810	972	1,134
Hyndburn	n/a	1,360	1,632	1,904
Knowsley	374	914	1,097	1,280
Lancaster	n/a	2,040	2,448	2,856
Liverpool	n/a	1,170	1,404	1,638
Macclesfield	n/a	39	47	55
Manchester	n/a	9,845	11,814	13,783
Oldham	128	128	154	179
Pendle	n/a	109	131	153
Preston	n/a	1,284	1,541	1,798
Ribble Valley	n/a	68	82	95
Rochdale	n/a	270	324	378
Rossendale	786	1,386	1,663	1,940
Salford	n/a	2,700	3,248	3,790
Sefton	n/a	1,890	2,268	2,646
South Lakeland	n/a	1,008	1,210	1,411
South Ribble	n/a	451	541	631
St. Helens	5,621	5,621	6,745	7,869
Stockport	n/a	909	1,091	1,273
Tameside	603	603	723	844
Trafford	n/a	860	1,032	1,204
Vale Royal	3,273	3,273	3,928	4,582
Warrington	n/a	1,284	1,541	1,798
West Lancashire	n/a	45	54	63
Wigan	5,353	5,724	6,869	8,014
Wirral	n/a	336	403	470
Wyre	n/a	1,498	1,798	2,097
	TOTAL	**62,234**	**74,691**	**87,136**

These results should be treated with caution, and planning policy should ensure that no new dwellings are located in areas at flood risk.

6.5 Costs

The estimated total costs of flood risks for the NW in 2029 will be £4,447 million under the RSS growth scenario, increasing to £4,810 million under the RSS++ scenario.

Flood costs were derived from the number of properties within or affected by Flood Zones 2 & 3. Costs were applied using the average annual damages (AAD) taken from Environment Agency CFMP reports. These give the cost breakdown by river catchment and include allowances for items such as services, moveable equipment and general fixtures, fittings and contents (such as stored goods in shops/offices). This is considered a worse case where existing defences have been breached. Current flood risk management strategies in the NW are exploring new approaches to flooding. In the future, sub-regions will have a ‘do nothing’, ‘maintain’ or ‘improve’ approach to flood risk. The current model does not make this distinction between sub-regions. A future enhancement would be to look at ways of identifying the cost difference of building in a ‘do-nothing’ area as opposed to an ‘improve’ area.

It was not possible to break down flooding costs in the same detail as for the other sections and therefore only the total figure is given.

6.6 Analysis and comments on the results

The risk of flooding to new properties built on brownfield sites can be more easily allowed for in the model as location can be assessed in relation to known flood zones. New development sites outside flood zones will require additional input from the utility companies to improve understanding of where the likely risk areas will be, especially from sewage and surface water systems. Sewer flooding is not currently included in the flooding model. There are assumptions in the water quality section that sewer investment to reduce overflows and so on will reduce flooding risk, but there is limited data on current risks from sewers, sewer flooding locations or sewer flooding impacts. Current sewer flooding studies by regional utilities and LAs will need to be incorporated within the model to generate a more accurate assessment.

In addition, planned and predicted changes in flood management throughout the region are not included in the model. Therefore results are based on existing levels of risk. These risks will change over time.

6.7 Comparison with SMEISE study

6.7.1 Pressures and needs

A greater proportion of the existing population in the SE is at risk of coastal and/or tidal induced flooding but a slightly larger total population is at risk of flooding in the NW. The distribution of existing and proposed development in both regions would suggest that the SE is more sensitive to climate change and potentially has more properties at risk in future years than in the NW.

6.7.2 Costs

Flooding costs at ‘zero growth’ are estimated to be slightly higher in the NW (£3,540 million versus £3,148 million) to reflect the higher estimate of properties at risk.

Flood risk cost estimates do not increase at the same rate in the NW model as in the SMEISE report. This is thought to be down to the method of calculating costs. In the NW a spatial element is introduced by using AAD estimates for catchment areas, whereas the SMEISE report apportioned the cost of flood protection in an area to new housing based on average regional values (see Section 6.3).

6.8 Uncertainties and strategies for the future

The planning structures and regulations now in place (such as PPS 25) make it much more difficult to obtain planning permission to build on floodplains. Flood risk management strategies are also being developed or planned for catchments within the NW region. In the short term, the main issues will be funding of strategy outcomes and dealing with legacy sites (like those already at risk of flooding). Longer term, the lack of coordination between development planners and sewer network modellers, if maintained, will have the greatest effect along with climate change.

Flood management plans are being developed and implemented in the region. In the short term, planning regulations should limit the number of additional properties at risk of fluvial and coastal flooding.

In the medium term, better coordination between planners and utility companies will be required to identify local surface water flooding risks.

7 Transferable lessons and new responses

7.1 Introduction

7.1.1 Thames Gateway – producing new infrastructural solutions

The Thames Gateway is emerging as a national (and international) test bed for ambitious “infrastructural solutions”. New concepts such as water neutrality, zero carbon development, and waste neutrality may anticipate and overcome conventional environmental constraints. This emerging logic of infrastructural development is a style of urbanism that combines design, new technologies, planning and economic development to overcome limits to further growth.

7.1.2 Challenge – transcending limits, exceeding targets and national prioritisation

Cumulatively, these solutions seek to overcome limits to further economic growth. This new style of urbanism attempts to accommodate new development within a defined growth area without increasing overall resource use or waste production. In doing so, the solutions may not only overcome constraints but may even be exemplary by exceeding national targets to reduce resource flows. However, meeting these priorities is not likely to be easy at a practical level. Such solutions will require:

i. Complex coordination between existing and new development.

ii. New capacity and capability to develop relationships between disconnected bodies and local groups and different social interests.

iii. The incorporation of new technologies in development and resource-saving practices by households.

iv. The up-scaling of such solutions from demonstrations and pilot studies to wider replication.

Development of new solutions is a national priority – central government has given the Thames Gateway (TG) national eco-region status, steered new solutions with resources and capacity, and sought to ensure they are developed systemically.

7.1.3 Key issues and lessons

These infrastructure solutions have important implications for the growth agenda in the North West for two reasons.

First, the emergence of such solutions is directly associated with the designation of TG as a national “exemplary” eco-region. This implies that the TG is a “producer” of exemplary infrastructure solutions that need to be translated into action in other national and even international contexts. Do these concepts easily transfer to the very different region of the North West of England? Do they meet its growth and infrastructure challenges? Has there been sufficient evaluation to ensure that they can achieve the claims made for these fixes?

Second, these initiatives seek to develop more systemic and long-term solutions to overcome conventional limits. This suggests that the capacity to overcome resource limits could be strategically important as those places that have the capability to implement such solutions ensure continued growth against a background of constraint. Does this then imply that localities without such capability are disadvantaged in their ability to continue growing? How does the North West region create the capacity and capability to develop innovative solutions that support its own growth agenda?

7.2 Producing the "UK's first eco-region" – new ambitions and social expectations

7.2.1 Sustainable Communities Plan (SCP) – conventional infrastructure response

In 1995 the TG Planning Guidance Framework (Regional Planning Guidance 9a) identified the TG as a priority area for regeneration. The TG covers 100,000 hectares, with a population of 1.45 million and includes the financial centre at Canary Wharf, undeveloped docklands, the site of the 2012 Olympics and communities on the North and South Thames. In 2003 the SCP allocated a funded structure programme of £672 million (2003/8) to accelerate delivery of the programme. A total of 24,000 homes were built between 2001 and 2004.

The TG will play a critical role in the future development of London, and as a global city, by providing the locations for 160,000 new homes and 225,000 new jobs by 2016. The TG is a critical space for London and national economic growth priorities for three reasons: firstly, the potential for employment growth in financial services, business services and inward investment in East London; secondly, the need to provide affordable housing and communities for workers; thirdly, shrinking household size will generate greater demand for more housing. Overall, development of the TG is closely linked to the national priority of ensuring London's continued growth as a global financial centre.

In the period up to 2006, most of the evidence for infrastructural constraint focused on a regional, local authority or development project scale and not at the level of the TG. Consequently, concern focused on overcoming the problem of infrastructure shortage:

- Shortfalls in capacity of energy infrastructure could arise in some areas due to localised infrastructure issues.
- Water shortages could occur from a combination of increased consumption and reduced supply.
- No studies were undertaken on wastewater but evidence from London suggested the network was not in good condition and might not have the capacity for housing growth.
- Shortage of landfill in some parts of the TG.

At this stage, discussion focused on whether there was sufficient infrastructure capacity for new development based on conventional models of provision – mainly conceived of as a "supply-led" response – through an expansion of the networks. But there was also recognition of the ability of energy and water efficiency measures to lower demands in new development. However, since 2007 these issues have been dealt with in a much more systemic manner.

7.2.2 Re-designation as eco-region and new infrastructure solutions

Since 2007 the Government's policy responses and public statements have continually emphasised the importance of sustainability ambitions for the TG:

"*We see it as a showcase for environmental sustainability, it must be an exemplar of international significance in response to climate change. It will show regeneration and development can not just co-exist with but actively promote low carbon growth, increasingly sustainable use of water, increasing waste use not landfill disposal, and strengthened safeguards against flooding – almost entirely on brownfield land*" (Department for Communities and Local Government 2007, page 61).

Following this designation, infrastructure and resource issues appear to have been given much greater priority. After 2007, there was much more drive to anticipate and overcome constraint at the TG scale. Three reasons appear to have put 'eco-region' on the TG agenda:

- First, the 2007 National Audit Office review of TG focused on the severity of existing infrastructure constraints and the need for a more systemic response. Linked to this was concern that novel approaches to infrastructure provision would not be able to deal with constraints at the small scale of development sites or localities. Because of the complex interdependencies between new development and infrastructure network, new solutions should be developed at enlarged scales.
- Partly in response to these pressures, proposals for innovation in infrastructure planning and provision were put forward. For instance, a World Wildlife Fund report in 2003 suggested that homes constructed to different standards could substantially reduce resource use for similar infrastructure costs. This and other work started to shift the debate towards consideration of innovations and solutions.
- Finally, within the South East region and the GLA, a greater focus on water resources, energy and carbon and the need for more systemic responses to resource constraints to achieve ecological and carbon reduction targets accelerated proposals for new types of infrastructure provision within the TG.

Consequently, from 2007 there was wider recognition of the need to develop new knowledge, expertise and systemic solutions to infrastructure provision at the TG scale. A series of infrastructural solutions was designed to overcome limits.

7.2.3 New infrastructure solutions in the Thames Gateway

A set of infrastructure solutions were developed as policy priorities and for the Thames Gateway. Below we summarize the main features of each of these fixes focusing on the drivers and pressures, the development process, a definition of the concept, and its proposed application.

Water neutrality - The key driver for developing water neutrality was the need to meet water demand generated by the construction of 160,000 new homes using existing and planned water resources. Growth was expected to generate an increase in demand of eight per cent from 521 million litres per day (Ml/day) to 563 Ml/day by 2016. In response, a study was commissioned by the Environment Agency, DCLG and Defra in 2006 to assess the problems and potential responses, using modelling to explore future scenarios and assess the public acceptability of different water savings options. The study was competed in 2007, and concluded that new demand for water should be offset in the existing community by making users more water efficient. The target was to save 42 million litres per day. A mix of measures was envisaged including building new homes to higher water efficiency standards and retrofitting existing homes and businesses to reduce water consumption. This would be linked to metering and the possible introduction of variable tariffs. An investigation is now underway on the costs and means of carrying out these measures, particularly the issue of who will be responsible for implementing water savings in existing homes.

Low carbon/zero carbon development – The key driver for carbon neutrality was the need to meet London's ambitious carbon reduction targets and the rise in carbon emissions associated with development planned for the TG. In response, a feasibility study of making the TG a carbon-zero development area was commissioned by DCLG (with Environment Agency, English Partnerships and Defra) and the interim report was published in November 2006. This work carried out a baseline assessment of carbon emissions and defined 'business as usual' (BAU) emissions. The study then explored alternative scenarios based on different packages of interventions to reduce greenhouse gas emissions in the TG above those in the BAU scenario. The work demonstrated that without action, carbon emissions would rise in five sectors (energy, waste, water, transport and logistics) up to 2050. The final report was planned to be published in February 2007. Progress since then has been overshadowed by the ongoing debate about the definition of zero carbon development, that is, whether it is 'self-contained' or uses imported energy. The Code for Sustainable Homes (CSH) was drawn up by the DCLG and published in 2006. The code's highest rating, level six, is the Department's current definition of zero carbon and allows homes that import energy from renewable sources to be defined as zero carbon. In 2007, DCLG announced that, from 2016, all new homes in England would have to be zero carbon. In December 2008 the Government announced a consultation exercise to seek views on a proposed definition that is intended to apply to all new homes from 2016.

Zero construction waste zone - Nationally, the construction sector accounts for about one-third of all waste produced, including hazardous waste. The TG was expected to produce significant levels of construction waste against a background of constraint in landfill capacity. The Interim Plan committed the Government to investigate making the Gateway a 'zero construction waste zone'. Since then, Defra has led a government working group which has proposed more challenging targets for construction waste in the Gateway than those proposed nationally, given the scale of development expected. This included the proposal to reduce the amount of CDE waste to landfill to zero by 2015, five years earlier than the national target. Defra is continuing to work with private and public sector groups to establish the costs and practicalities of meeting this target.

Flooding – Flood risks in the TG are dealt with under PPS25 which requires each local planning authority to manage flood risk by ensuring that new development is designed to avoid the consequences of flooding. In addition, *Thames Estuary 2100* is an Environment Agency initiative to assess the level of flood protection needed for London and the Thames Estuary for the next 100 years. London's existing tidal defences were designed to provide protection up until 2030. Thames Estuary 2100 is a process to shape the way in which future flood defence schemes are designed and managed. Thames Estuary 2100 aims to: review tidal defences in the context of the wider Thames Estuary setting; assess the useful life of existing defences; inform and gain support of political and funding partners and groups; and prepare and manage a programme of studies, with public consultation, to produce a strategy for flood risk management in the Thames Estuary for the next 100 years. Following further consultation, final proposals on these measures will be submitted to Defra in 2009-10.

Producing the new solutions – comparative features

These solutions are all in the early stages of development, but five critical features emerge:

i. *New solutions at the TG scale* - All approaches represent an attempt to develop new solutions at the enlarged scale of the TG. The benefit of using this enlarged scale is that it creates solutions that transcend development site, local government, sub-regional, regional and utility boundaries. At the same time, the aim of each solution is to bring forward in time or exceed national targets via resource neutrality concepts.

ii. *New collaborations to develop systemic solutions* - Each approach has been developed through new collaboration characterised by five features. First, the multi-level character of these partnerships involving representatives from central, regional and local government together with utilities and regulators. Second, the critical role often assigned to the Environment Agency in coordinating these partnerships. Third, the commissioning of new research to develop a more in-depth and contextual knowledge of options and potentials. Fourth, building greater understanding of how resources and infrastructure are used and the potential social acceptability of different policy options. Finally, looking across the different infrastructures this represents the most systemic and long-term view of infrastructure requirements in any UK large scale development project.

iii. *A "relational" view of development* - Across these initiatives there is an attempt to consider the interrelationships between the resource consumption of existing development and the resource demands created by new development. Effectively what this means is that if demand for resources in an existing development can be reduced through efficiency or conservation measures this can then create spare infrastructure capacity to provide services for new development located on the same infrastructure network. This means then that the relations between new and existing demands need to be considered in a systematic manner. Significantly the creation of spare capacity for new development may then require the implementation of intensive demand management measures in existing homes and businesses. Implementing such a relational approach requires a degree of coordination, planning and public engagement not usually present in conventional development processes.

iv. *Piloting, experimenting and learning* – In many cases there are pilots and experiments underway to explore and test the feasibility of these solutions. The key participants in these processes consider these new solutions to be still at an early stage of development that have not significantly affected planning processes to date. There is still considerable uncertainty about the governance frameworks that will provide the capability for more wide spread implementation, particularly of relational styles of planning that require coordination between new and existing development.

v. *Proposed replication* – Finally despite the fact that these solutions are still at an early stage and subject to experimentation – there are already emerging signals that they may be incorporated into development processes outside the Thames Gateway. For example draft government guidance on Eco-Towns proposes that water neutrality should be incorporated into developments in water stressed areas. But there is evidently a need to subject the new techniques to closer scrutiny and evaluation – partly to assess whether they are able to achieve their objectives and second to more effectively understand what lessons can be learnt from such practices and be replicable in other contexts.

7.3 Translating new solutions into action?

The new infrastructure solutions are still at an early stage and have not yet significantly reshaped planning and development in the TG. Consequently, a set of proposals are in place to ensure that the solutions are incorporated into new development projects through initiatives at a number of local and sub-regional scales.

7.3.1 Reshaping development schemes as exemplars

Government statements want these solutions to be strongly framed around new development schemes which find novel responses. At least three types of development are proposed:

- First, to facilitate the incorporation of new design and environmental technologies in mixed-use developments, the Government will commit up to £2 million to fund eco-assessments of the top ten housing programmes. The aim is to provide additional funding to cover climate change mitigation, flood risk management, energy and water efficiency measures in the design of schemes. The first study will cover Kent Thameside and will focus on energy infrastructure, especially renewable energy and community heating and cooling systems.
- Second, even though the national competition for eco-towns is now closed, the Government will explore how to achieve such developments within the TG possibly by inviting further proposals for an eco-quarter. This would be on top of existing housing targets and would act as a context to demonstrate the new solutions.
- Finally, other innovative activities are also national and international exemplars. For example, a Dongtan-style development mirroring the approach taken in Shanghai for more self-reliant forms of development has been proposed for the TG. Also, new developments associated with the Olympic Games located in the TG also provide an opportunity to create eco-exemplary responses. These are designed to raise the profile and visibility of new fixes at an international scale.

7.3.2 TG – designated as the UK eco-region – supporting environment technologies and an innovation platform

The TG is designated as the first UK eco-region and its role in producing infrastructure fixes is linked to a wider set of economic priorities designed to use the TG to "*explore and test innovative solutions for improving the resource efficiency of the built environment, and to share knowledge in order to encourage cost-effective and widespread adoption*". In November 2007, a Strategic Economic Investment Fund of £275 million over three years was announced by DCLG and the three Regional Development Agencies (RDAs) to launch five new projects including the creation of an International Institute for Sustainability for "*driving forward global leadership in innovation and the environmental agenda across the TG*" and an Environmental

Infrastructure Fund to increase the uptake of low-carbon technologies. Together these are designed to help the TG to secure a "*global reputation for excellence in environmental technologies and infrastructure*". Consequently there is active positioning of the new infrastructure fixes as a source of economic growth and innovation supported by significant funds.

7.3.3 Translation into national policy

These infrastructure solutions are starting to be translated into policy guidance at national level to reshape other development proposals. For example, proposed eco-towns are expected to consider the option of water neutrality when located in areas of water stress. More widely some fixes are being incorporated into developer guidance issued by the Environment Agency. Innovations may well be taken up and passed on to other authorities through national policy. In this sense, the TG is seen as a national site for new eco-fixes that will be replicated in other parts of the UK and even internationally.

7.3.4 Reconfiguring the Environment Agency

The Environment Agency has played a central role in developing many of the new solutions within the TG. However, the established Environment Agency structure presented problems in coordinating work in the TG. Before April 2006, the Environment Agency managed consultations on planning applications using its standard regional and area structures. The Thames Gateway spans three Environment Agency regions and four operational areas. The Environment Agency found it difficult to feed into TG spatial planning, and local developers complained about the Environment Agency being too remote. In April 2006 the Environment Agency set up a Thames Gateway team to ensure it had direct input into master plans and other spatial strategies and to help coordinate and support staff in operational areas responding to detailed planning applications. The team has also been working closely with the Thames Estuary 2100 project on a strategic review of flood risk for the Thames Estuary. Although this approach is at an early stage, it should enable a more strategic view for the sub-region and support local involvement and partnerships to ensure environmental considerations are built into master plans and higher level policy.

In summary, implementation of the solutions is currently focused on reshaping the development processes at a number of scales and at an early point in the development process. What is less clear is which institutions will have the capacity to develop these new and more complex forms of infrastructure provision involving the coordination of new and existing development and interrelations with existing users and households.

7.4 Relevance and transferability of new infrastructure solutions?

7.4.1 Differential capacity to shape infrastructure solutions - the TG and NW compared

This section identifies the relevant and potentially transferable lessons from the TG experience to the North West (NW) of England. To do this, we must first establish how these two locations are positioned in terms of their capacity to develop, implement and learn from new infrastructure solutions. We can then explore the implications of the TG experience for the North West in terms of its own environmental infrastructure.

i. The TG is seen as a producer of infrastructure solutions through its status as a national eco-region by central government and investment in developing new solutions. *In contrast,* the NW has no explicit national status as a creator of fixes. On the contrary, the dominant assumption is that innovative solutions developed in the TG are translated into guidance and practice which is then passed on to other regions.

ii. Environmental solutions being developed in the TG are designed to exceed - either in level or time - national environmental standards for resource use or waste production. *In contrast,* NW targets are designed to meet existing standards rather than then exceed them.

iii. The TG's governance model is multi-level and flexible in its boundaries. For example, the TG has a central government team to coordinate development and implementation of the strategy, where environmental issues are given a much higher national priority. *In contrast,* there is no central government team with the same level of responsibility or capacity for steering major regeneration developments in the NW.

iv. The TG has established the capability to innovate on infrastructure solutions. Each of the new solutions is produced by teams usually coordinated by the Environmental Agency but involving multiple levels of governance and systemic research and development. *In contrast,* there is no comparable systemic attempt to develop solutions at this scale involving multiple partners and members of the public in the NW.

v. While there has been relatively slow progress in translating these solutions into practice, the scale and scope of ambition in the TG is significant. Larger housing schemes and symbolic projects – such as the Olympics and Dontang-style development – are intended, in some cases with financial support, to act as large-scale demonstrators of innovative solutions. *In contrast,* the NW has not identified its largest or most important development projects as potential exemplars for innovative infrastructure solutions.

vi. The TG aspires through the establishment of an Institute for Sustainability to develop the knowledge, expertise and capacity to use these solutions in other development projects, along with funding to develop low carbon and environmental technologies across the three regions. *In contrast,* in the NW growth of environmental and low carbon technology sectors is not linked with major development projects.

Recognising that the NW has restricted capacity, what are the practical lessons for the region?

7.4.2 Developing new infrastructure solutions for the North West

Whereas the TG is configured to develop systemic solutions, the NW response is likely to be more piecemeal and reactive. Consequently within the NW, regional and sub-regional organisations with local authorities will have to build the capacity to shape infrastructure networks. If the region aims to make a planned and purposive response, the TG experience is useful in two respects.

- First, the NW can learn from the efficiency of processes developed in the TG to find solutions: What are the key steps that led the TG to develop such solutions and what is relevant for the NW?
- Second, the NW should explore the effectiveness of solutions: What is the effectiveness of the proposed solutions in the TG and how might these translate to the NW?

Three critical steps are required to develop a systemic and purposive response.

1. NW regional infrastructure priorities – understanding the new evidence base

The TG reflects a conscious attempt to find eco-exemplary responses to infrastructure and environmental constraints. Critically this decision – primarily by central government – gave a significant impetus to shift from piecemeal and conventional responses to innovative solutions. Such national steerage enticed other partners to commission research and policy development to find infrastructural solutions.

While the NW is not positioned in the same way, there is an opportunity within the region to begin the process of formulating a response.

A key step in the development of innovative solutions in the TG was the 2006 review of research and policy documents which revealed mainly localised responses, as well as the critical NAO office report in 2007 which called for a more strategic and systemic response to infrastructure constraint.

Within the North West, a range of work has recently been undertaken on infrastructure constraints in the region. This includes North West Development Agency (NWDA)-commissioned work on infrastructure constraints to the growth agenda, 4 North West (formerly North West Regional Assembly) work on infrastructure capacities and this project on the costs of environmental infrastructure. There is also work on infrastructure constraints in the city regions in terms of flooding, energy and waste.

This work has not been subject to critical review. While in the short term there appears to be sufficient head room to mesh planning and infrastructure priorities, over the medium and longer term new responses will be needed to ensure growth ambitions can be met. This will require:

- More effective coordination between planners and utility companies to identify constraints within a time frame to allow solutions to be developed for water supply, waste disposal and flooding.
- More systemic application of waste avoidance and minimisation and water demand management measures to meet existing and new targets.

The region needs to determine how this greater degree of coordination and more systemic use of demand management measures will be developed.

As part of the process of developing the Integrated Regional Strategy (IRS), there would be considerable value in bringing existing work together and comparatively reviewing the critical constraints, where they were located, what conventional solutions would be and assess the potential for developing innovative solutions.

This would need to bring together regional agencies and public sector bodies as well as sub-regions, private utilities and infrastructure providers, developers and green groups. Non-government organisations (NGOs) and environmental groups appear to have played an important role in policy responses in the TG.

Recommendation 1 - Regional organisations should review the findings of the three pieces of work on infrastructure constraint to assess whether more systemic and anticipatory solutions are required to coordinate growth ambitions. This joint process should involve a wider set of partners, sub-regional and local planning authorities and green groups to assess where and when constraints occur, whether these can be addressed with existing approaches, whether new approaches are required and if so, at what scale and through what capability. The region must decide whether to meet national standards or aim to exceed them through eco-exemplary solutions.

2. Rescaling the solutions - assessing the feasibility of the Mersey Belt

The Thames Gateway was chosen as the right scale to develop infrastructure solutions spanning governmental and utility boundaries. This new scale was a sufficiently enlarged boundary through which the 'eco-region' could be demonstrated around new infrastructure solutions for large development sites, exemplary projects and emblematic buildings that could act as showcases for the new solutions.

The NW should consider whether it could construct such a narrative and at what scales, and how particular projects - growth points, city regions and new buildings - could act as exemplars of infrastructure solutions. For example, the Mersey Belt which covers the city regions of Greater Manchester, Merseyside and Warrington may provide a suitable scale for innovative infrastructure solutions that link across government, utility and regulatory boundaries.

Recommendation 2 – Regional organisations should assess whether the Mersey Belt constitutes the best scale at which to develop innovative solutions to infrastructure constraints. This process should involve public and private partners in the Mersey Belt and should consider whether the scale of development is of regional (and even national) significance in understanding whether infrastructure is a constraint on growth ambitions, new solutions that can be developed at the scale of the Mersey Belt, how new growth points and city regions can be developed as exemplary solutions and what capability is required to deliver these solutions.

3. Developing capacity and capability in the NW to deliver innovative solutions

The central issue for the NW is how to build the capability to develop innovative solutions. Whilst it may be possible to draw on the experience of the TG, it must meet the needs of its own region and Mersey Belt. The TG team in the Environment Agency can commission and/or be partners in research and policy initiatives; the absence of such a role in the NW means that responses are likely to be piecemeal rather than anticipatory.

Recommendation 3 – Regional organisations should assess the feasibility of developing a joint capacity involving regional agencies, regulators, utilities and sub-regions to collaborate on innovative solutions for the NW. The focus should be on measures to reduce demand in existing developments and improve resource use in new developments; piloting and testing solutions and learning from them to improve replication and roll out; and working with wider economic priorities on environmental technologies to test new technologies in development projects.

In summary, the NW should:

i. Review the effectiveness and efficacy of current infrastructure provision against problems anticipated in the growth agenda.

ii. Develop new types of infrastructure provision that more effectively mesh economic and ecological objectives, potentially at the scale of the Mersey Belt.

iii. Work with policy, utility, business, regulatory and local groups to develop a better understanding of infrastructural provision and how it might change.

iv. Build knowledge and expertise on the infrastructural requirements and options for the region.

v. Establish the capability to translate this model into action with different partners in a systematic rather than piecemeal manner.

7.5 Future policy development work

i. An analysis of the implications of the modelling project for infrastructure planning in the North West at different spatial scales over the short, medium and long term, to identify critical pinch points and constraints.

ii. An examination of the current organisation of infrastructure provision and its ability to deal with the new growth ambitions.

iii. An assessment of infrastructure experiments on energy, water, waste, transport and flooding currently taking place in the North West and their replicability through documentary analysis and interviews with policy makers, developers, utilities and regulatory officials.

iv. A workshop to bring together representatives of infrastructure provision and the public to explore the challenges of coordinating the expectations of these different groups.

v. Identification of potential solutions, drawn from the process developed in TG to build social networks, knowledge and expertise in the North West.

vi. Develop capacity and capability to translate these into practice through an active intermediary that can work at different scales and with different social interests.

8 Further actions required

For the model to go forward from here, it is critical that the Environment Agency consults interested and affected groups. Not only will it be difficult to develop the model further without their support, but more importantly, the outputs will not have much value unless they are adopted and acted upon.

The first step to improving the model would be to fill important data gaps by acquiring missing data from authoritative sources. Critical ones include the water services boundaries, location of planned developments (five-year plans), and details of the arrangements waste disposal authorities have with waste treatment facilities. Ward and council boundaries will need updating in April 2009 (such as new Cheshire East, Cheshire West and Chester boundaries) as well.

The model requires high resolution data for its calculation of impacts. For instance, it needs to know the boundaries of a development and ideally the location of houses within those boundaries in order to calculate the number of properties at risk of flooding. However, the scale at which the model outputs are most reliable and useful is thought to be a larger scale than development level. Outputs should have a minimum resolution of sub-regional level, and finer (city regions and local authority) if possible.

The second step would be to refine the model logic and assumptions for each of the environmental infrastructures (EI), to make them a closer representation of the complex reality. This should be done in consultation with experts in the appropriate fields.

In particular, the complex link between biodiversity and growth entails considerable effort to develop a logic for the model. Biodiversity should ideally be examined on its own, in separate work. Suggestions for a way forward include using the Natural England ANGST model and considering the results of recent UK studies on ecosystem services and recreational pressures created by development in protected areas.

Other valuable suggestions were made by participants in the two external workshops held as part of this project. They include:

- the development of scenarios other than growth scenarios, namely worse case business as usual, and climate change scenarios;
- conducting sensitivity analyses on which parameters have the largest impact on the future requirements and costs of EI for the NW;
- adding air quality as a sixth type of EI;
- adding the risk of flooding from sewers to the flood risk management model.

In parallel, the geospatial viewer and user interface of the model should be developed. The aim is for the interface to be more user friendly than a database. It should be GIS-based, with some access restricted to expert or professional user. The geospatial viewer should provide users and decision makers with a visual representation of where the infrastructure pinch points occur across the region, as well as the spatial variation in costs associated with environmental infrastructure.

Currently, the model requires an expert user to manipulate the various elements to produce a scenario. The full potential of the model will be achieved when non-expert users will be able to generate 'what if' scenarios. It would be useful to provide a user interface to allow the build up of new scenarios by selecting elements of existing scenarios or by creating new elements (such as aspirational waste recycling targets). The main steps in commissioning a user interface would be:

- User requirement workshop to capture the ideas of people who would be using the interface; this would avoid time wasted on unnecessary interface features while maximising the desirable ones.
- Interface specification: the outcomes of the workshop could be used to produce an interface specification. The specification could then be issued to a software designer to produce the interface.
- Prototype testing: at suitable points during the software design process, a prototype could be released for comment and feedback. Prototypes do not always have full functionality but would give users the opportunity to suggest improvements and comment on usability and clarity of layout.
- Launch and training workshop: the final interface would be launched at a workshop where installation and use could be explained.

Finally, it would be equally important to review the policies in place to address infrastructure constraints in the NW and identify barriers to improving infrastructure planning and decision-making. For example, there is continued concern that links between the RSS and AMP processes are weak, leading to disparities in projected needs for the region. By understanding the policy barriers, the Environment Agency can decide where to focus efforts to ensure that the required changes are made.

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List of abbreviations

AAD	Average Annual Damages
AEP	Annual Exceedance Probability
AMP	Asset Management Plan
AONB	Area of Outstanding Natural Beauty
BAP	Biodiversity Action Plan
BAU	Business as Usual
BMW	Biodegradable Municipal Waste
BTCV	British Trust Conservation Volunteers
CaBP	Creating a Better Place (Jacobs report)
CAPEX	Capital Expenditure
CBD	Convention on Biodiversity
C&D	Construction and Demolition
CFMP	Catchment Flood Management Plan
CHP	Combined Heat and Power
C&I	Commercial and Industrial
COPI	Construction Outputs Price Index
CSO	Combined Sewers Overflow
DCLG	Department of Communities and Local Government
DCWW	Dwr Cymru Welsh Water
Defra	Department for Environment, Food and Rural Affairs
DWF	Dry Weather Flow
EA	Environment Agency
ECSFDI	England Catchment Sensitive Farming Delivery Initiative
EiP	Examination in Public
EI	Environmental infrastructure
ESRC	Economic and Social Research Council
EU	European Union
GIS	Geographical Information System
GLA	Greater London Authority
GONW	Government Office for the North West
IDB	Internal Drainage Board
LA	Local Authority
LATS	Landfill Allowance Trading Scheme
LBAP	Local Biodiversity Action Plan
LDF	Local Development Framework
LGA	Local Government Association
MB	Mersey Belt
MRF	Materials Transfer Station
MSW	Municipal Solid Waste
MWMS	Municipal Waste Management Strategy
NAO	National Audit Office
NW	North West
NWRA	North West Regional Assembly
Ofwat	Water Services Regulation Authority
OPEX	Operational Expenditure
PFI	Private Finance Initiative
PCC	Per capita consumption
PPS	Planning Policy Statement
RSPB	Royal Society for the Protection of Birds
RTAB	Regional Technical Advisory Body
RWS	Regional Waste Strategy
R&D	Research and Development

RSS	Regional Spatial Strategy
SE	South East
SEERA	South East of England Regional Assembly
SERTAB	South East Regional Technical Advisory Body (on waste)
SFRA	Strategic Flood Risk Assessment
SMEISE	Strategy for Meeting Environmental Infrastructure needs in the South East
SSSI	Site of Special Scientific Interest
SUD	Sustainable Urban Drainage (schemes/systems)
SURF	Centre for Sustainable Urban and Regional Futures (Salford University)
SW	South West
TG	Thames Gateway
TT	Thousand tonnes
TRIF	Technology Research and Innovation Fund (Defra)
UK TAG	United Kingdom Technical Advisory Group
UU	United Utilities
WDA	Waste Disposal Authority
WEEE	Waste Electrical and Electronic Equipment
WFD	Water Framework Directive
WRP	Water Resources Plan
WTW	Water Treatment Works
WwTW	Wastewater Treatment Works
YHA	Yorkshire and Humberside Authority

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