

URS

Stratford-on-Avon DC

Water Cycle Study

Final Report

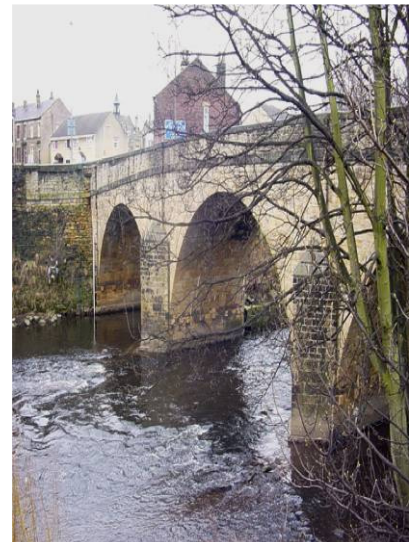
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NON-TECHNICAL SUMMARY

Stratford-on-Avon District Council is expected to experience a significant increase in housing provision over the period to 2031. This growth represents a challenge in ensuring that both the water environment and water services infrastructure has the capacity to sustain this level of growth and development proposed.

The Stratford-on-Avon District Council Water Cycle Study (WCS) was previously been reported in a Scoping and Outline Warwickshire Sub-Regional WCS which was completed in March 2010¹ and was based on previous drafts of the Stratford-on-Avon Core Strategy.

An initial Stage 2 Detailed WCS was commissioned in 2012 to update the Stage 1 baseline and identify the Water Services Infrastructure (WSI) solutions required to assist delivery of the planned growth to 2028. However, since the 2012 WCS was published, Stratford-on-Avon District Council are proposing a larger growth target within the district and over a longer planning horizon to 2031. Therefore an update to the Stage 2 report was required in 2014. The Stage 2 WCS Update is reported in this document and supersedes the initial Stage 2 WCS produced in 2012.

Stratford-on-Avon District Council's revised spatial approach of future expected development is detailed in their 2011-2031 Housing Requirement and Strategic Site Options², which was in consultation at the time of undertaking this WCS update, as part of the Council's Core Strategy. This WCS update is based on figures for homes already built since 2011, committed sites and allocations, and the five alternative strategic options the Council has proposed for development within the District:

- Option A: Further Dispersal throughout the District
- Option B: Gaydon/Lighthorne Heath
- Option C: Long Marston Airfield
- Option D: Southeast Stratford-upon-Avon
- Option E: North of Southam and Stoneythorpe

This WCS Update will help Stratford-on-Avon District Council determine the most appropriate option for development within the District (with respect to water infrastructure and the water environment) to be identified in the Council's Core Strategy.

Growth information has been used to determine how the water cycle constraints may relate to potential development sites within the settlements, if and how the constraints can be resolved and how they may impact on phasing of development over the plan period to 2031. Furthermore, it provides a detailed suggested approach to the management and use of water which demonstrates ways to ensure that the sustainability of the water environment in the study area is not compromised by growth.

A Water Cycle Strategy is presented for the District as a whole and for each of the Settlement Areas.

¹ Halcrow (2010) – Warwickshire Sub-Regional Water Cycle Study, Stratford-on-Avon Scoping and Outline Final Report

² Stratford-on-Avon District Council (2014), Focused Consultation: 2011-2031 Housing Requirement and Strategic Site Options.

The Wastewater Strategy

Wastewater Treatment

The table below provides an indication of the Wastewater Treatment Works (WwTWs) which are currently unable to accept any additional growth, and which have able capacity.

SUMMARY OF WWTW AVAILABLE CAPACITY	
WwTW Catchment	Phasing of Development
Alcester (All options)	Capacity for all additional growth
Alcester – Option A	Capacity for all additional growth
Bearley (All options)	Capacity for all additional growth
Bideford on Avon (Options B, C, D & E)	Capacity for all additional growth
Bidford on Avon – Option A	Capacity for all additional growth
Butlers Marston (All options)	Capacity for all additional growth
Cherington (All options)	WwTW at permit limit after an additional 55 dwellings
Claverdon (All options)	Capacity for all additional growth
Earlswood – Spring Brook (All options)	Capacity for all additional growth
Ettington Works (All options)	Capacity for all additional growth
Fenny Compton (All options)	Capacity for all additional growth
Gaydon (Option A, C, D & E)	Capacity for all additional growth
Gaydon – Option B	WwTW at permit limit after an additional 105 dwellings
Ilmington (All options)	Capacity for all additional growth
Itchen Bank (Option B, C& D)	Capacity for all additional growth
Itchen Bank – Option A	Capacity for all additional growth
Itchen Bank – Option E	WwTW at permit limit after an additional 1792 dwellings
Kineton (Option B, C & D)	Capacity for all additional growth
Kineton (Option A)	Capacity for all additional growth
Lighthorne (All options)	Capacity for all additional growth
Lighthorne Heath (All options)	Capacity for all additional growth
Long Compton (All options)	Capacity for all additional growth
Long Marston (Option B, D & E)	Capacity for all additional growth
Long Marston – Option A	Capacity for all additional growth
Long Marston – Option C	WwTW at permit limit after an additional 1610 dwellings

SUMMARY OF WWTW AVAILABLE CAPACITY	
WwTW Catchment	Phasing of Development
Moreton Morrell (All options)	Capacity for all additional growth
Napton (All options)	Capacity for all additional growth
Northend (All options)	Capacity for all additional growth
Oxhill (All options)	Capacity for all additional growth
Preston on Stour (All options)	Capacity for all additional growth
Redditch – Sernal (Option B, C, D & E)	Capacity for all additional growth
Redditch – Sernal – Option A	Capacity for all additional growth
Shipston – Fell Mill (Option B, C, D & E)	Capacity for all additional growth
Shipston - Fell Mill – Option A	Capacity for all additional growth
Snitterfield (All options)	Capacity for all additional growth
Stratford – Milcote (Option B, C & E)	Capacity for all additional growth
Stratford – Milcote – Option A	Capacity for all additional growth
Stratford – Milcote – Option D	Capacity for all additional growth
Tanworth-in-Arden (All options)	Capacity for all additional growth
Tysoe (All options)	WwTW at permit limit after an additional 53 dwellings
Wellesbourne (Option B, C, D & E)	WwTW at permit limit
Wellesbourne – Option A	WwTW at permit limit after an additional 338 dwellings
Wootton Wawen (Option B, C, D & E)	Capacity for all additional growth
Wootton Wawen – Option A	Capacity for all additional growth
Priors Marston (TW) (All options)	WwTW at permit limit

The WCS has shown that several WWTWs have capacity to accept wastewater flow from the proposed growth without the need for improvements to treatment infrastructure. This is the case for those works highlighted in green in the table above. Growth is not constrained by wastewater treatment in these locations.

WWTWs at Cherington, Gaydon, Itchen Bank, Long Marston, Tysoe and Wellesbourne, have some initial capacity within their permit limit, but do not have sufficient capacity to accept all growth within the plan period. Therefore solutions are required in order to accommodate the growth to ensure that the increased wastewater flow discharged does not impact on the current quality of the receiving watercourses, their associated ecological sites and also to ensure that the watercourses can still meet with legislative requirements. Priors Marston WwTW is shown to already be at the permit limit with current housing levels,

The detailed assessments have shown that improvements for all but two WwTW (Itchen Bank and Long Marston) are possible within the limits of conventionally applied technology.

For Itchen Bank WwTW (Strategic Option E only) and Long Marston WwTW (Strategic Option C only), the detailed assessments have shown that the improvements required would be beyond the capabilities of conventionally applied technology in order to protect water quality if the strategic options affecting these sites are pursued. Therefore a solution needs to be identified by the Environment Agency and Severn Trent Water if either of these options is taken forward, so that the WwTW have the capacity to accept the additional wastewater from the planned growth.

The WCS has concluded that the study partners, including Stratford-on-Avon District Council, the Environment Agency, Severn Trent Water and Thames Water should work together to determine if any of the potential solutions proposed in the study are acceptable and hence conclude when and how much development can be accommodated across the District in the early phases of the Local Plan delivery period.

In all cases, the assessments have shown that the ability of watercourses to meet future water quality targets (Good Status) under the WFD will not be compromised by growth alone and hence growth should not be seen as a barrier to watercourses in the District meeting 'Good Status' in the future.

Ecological Impacts

There are four statutory designated sites that have been identified as potentially being connected to WwTW discharges in Stratford-on-Avon District Council: River Blythe SSSI, Sherbourne Meadows SSSI adjacent to Bell Brook, Welford Field SSSI on a tributary of the Middle Avon River and the River Arrow Local Nature Reserve at Alcester. All other designated sites identified within the district are remote from watercourses into which WwTW's discharge treated effluent.

The Water Cycle Study identifies that all four of these WwTW's have existing permitted headroom, which is sufficient to accommodate all of the proposed growth sites. Hence no infrastructure upgrades are required to deliver the proposed growth levels in these locations. Growth in these catchments would not therefore deteriorate water quality, or increase flood risk and hence there is no barrier to delivering the proposed growth levels.

Seven WwTWs in Stratford-on-Avon District Council will require a change to their permits in order to comply with the WFD requirements for no deterioration downstream. For all seven sites, 'no deterioration' is achievable within the limits of conventional treatment. With such permit tightening in place there should be no deterioration in downstream water quality and therefore there will be no adverse effects on wildlife in the receiving watercourses.

All developments would have potential for the enhancement of ecological value through new SuDS opportunities linked to the new development. These could provide habitat for Warwickshire BAP species and habitats such as fen, marsh and swamp, great crested newt or water vole.

Sewer Capacity

In order to ensure wastewater from growth can be drained to the WwTWs, an assessment of sewer capacity constraints on potential growth sites was undertaken. This assessment has determined where upgrades to existing sewerage infrastructure (sewer mains or pumping stations) or new infrastructure is required; but concludes no significant barrier to development with respect to sewer capacity. Upgrades to existing sewerage infrastructure and sewage treatment will be funded by STW via the charging mechanism as agreed by Ofwat.

The Water Supply Strategy

Based in the growth assessed, the WCS has concluded that, allowing for the planned resource management of STW's Strategic Grid Water Resource Zone, Stratford-on-Avon would have adequate water supply to cater for growth over the plan period.

However, the WCS has identified that there are long term limitations on further abstraction from the raw water resources supplying the district and that there is a drive to ensure the delivery of sustainable development for Stratford-on-Avon as a whole. Hence there are key drivers requiring that water demand is managed in the study area for all new development in order to achieve long term sustainability in terms of water resources.

In order to reduce reliance on raw water supplies from rivers and aquifers, the WCS has set out ways in which demand for water as a result of development can be minimised without incurring excessive costs or resulting in unacceptable increases in energy use. In addition, the assessment has considered how far development in the District can be moved towards achieving a theoretical 'water neutral' position i.e. that there is no net increase in water demand between the current use and after development across the Plan period has taken place. A pathway for achieving neutrality as far as practicable has been set out, including advice on:

- what measures need to be taken technologically to deliver more water efficient development;
- what local policies need to be developed to set the framework for reduced water use through development control;
- how measures to achieve reduced water use in existing and new development can be funded; and
- where parties with a shared interest in reducing water demand need to work together to provide education and awareness initiatives to local communities to ensure that people and business in the District understand the importance of using water wisely.

Four water neutrality scenarios have been proposed and assessed to demonstrate what is required to achieve different levels of neutrality in the District. This has been undertaken for two different water neutrality options, as described below.

- Option 1 – all properties remaining unmetered in 2040 (at the end of STW's WRMP period) would be metered in addition, through a specific initiative in conjunction with Stratford-on-Avon District Council for the WCS for the medium, high and very high scenarios.
- Option 2 – only 10% of households that remain unmetered in 2040 (at the end of STW's WRMP period) would be metered additionally (equates to 1,600 dwellings).

The assessment concluded that measures should be taken to deliver the first step on the neutrality pathway by implementing the medium scenario, which is generally considered to require a significant level of funding and joint partnership working. The following initial measures are therefore suggested by the WCS:

- ensure all housing is water efficient, new housing development must go beyond Building Regulations and as a minimum reach Code for Sustainable Homes Level 3 or 4 for water. Where appropriate, specific developments should be identified for water re-use/greywater features to be included;
- ensure all non-residential development is water efficient and goes beyond Building Regulations and as a minimum reach Good BREEAM status;
- carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings. Aim to move towards delivery of 10% of the existing housing stock, additional to that in the WRMP, with easy fit water saving devices; and,

- Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

Surface Water Drainage Management

Conventional surface water drainage systems for new development were designed to convey rainwater and surface water run-off away as quickly as possible. This helps to prevent flooding of the drained area, but may cause flooding of downstream areas. In addition to the increased flood risk, conventional drainage systems can cause pollution of the receiving watercourses as impermeable surfaces accumulate pollutants such as hydrocarbons, tyre fragments and debris, detergents and grit and particulates.

Sustainable Drainage Systems (SuDS) can be used to both hold back and treat surface water run-off thereby reduce downstream flood risk and protect or improve water quality in the water environment.

The vision for sustainable surface water management in the proposed new growth in Stratford-on-Avon is based on the following key aims:

- linkage to water efficiency measures, including rainwater harvesting and SuDS; and,
- linkage to the Warwickshire wide Surface Water Management Plan (SWMP).

The aim is that all SuDS should include environmental enhancement and should provide amenity, social and recreational value.

Although SuDS are an important tool in managing surface water drainage across the District, at a site specific level, the requirements of any discharge of surface water from a site are dictated by the specifics of the water level management system operated by the Environment Agency. Developers or development control officers should seek the advice of the Environment Agency.

Water Cycle Strategy Recommendations and Policy

In order to support the further development of the Stratford-on-Avon's Local Plan with respect to water services infrastructure and the water environment; the WCS reports a site specific assessment of the potential constraints on each of the growth sites where the majority of development within the District is likely to take place.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS	
Abbreviation	Description
AMP	Asset Management Plan
BAP	Biodiversity Action Plan
BGS	British Geological Society
BOD	Biochemical Oxygen Demand
BREEAM	Building Research Establishment Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CBA	Cost Benefit Analysis
CFMP	Catchment Flood Management Plan
CIL	Community Infrastructure Levy
CIRIA	Construction Industry Research and Information Association
CLG	Communities and Local Government
CRC	Carbon Reduction Commitment
CSH	Code for Sustainable Homes
DEFRA	Department for Environment, Food and Rural Affairs
DO	Dissolved Oxygen
DPD	Development Plan Document
DWF	Dry Weather Flow
DWI	Drinking Water Inspectorate
EA	Environment Agency
EIB	European Investment Bank
FMfSW	Flood Maps for Surface Water
GI	Green Infrastructure
GWR	Greywater Recycling
HA	Highways Agency
HMWB	Heavily Modified Water Body (under the Water Framework Directive)
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LDDs	Local Development Documents
LDF	Local Development Framework

GLOSSARY OF ACRONYMS AND ABBREVIATIONS	
Abbreviation	Description
LFE	Low Flow Enterprise (low flow model)
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MI	Mega Litre (a million litres)
NE	Natural England
NH4	Ammonium
NPPF	National Planning Policy Framework
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
OR	Occupancy Rate
P	Phosphorous
PE	Population Equivalent
Q95	The river flow exceeded 95% of the time
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RoC	Review of Consents (under the Habitats Directive)
RQP	River Quality Planning (tool)
RWH	Rainwater Harvesting
SAB	SuDS Approval Body
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SS	Suspended Solids
SSSI	Site of Special Scientific Interest
SoA	Stratford-on-Avon District Council
STW	Severn Trent Water
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

GLOSSARY OF ACRONYMS AND ABBREVIATIONS	
Abbreviation	Description
TW	Thames Water
UKCIP02	United Kingdom Climate Impacts Programme 2002
UKCP09	United Kingdom Climate Projections 2009
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UKWIR	United Kingdom Water Industry Research group
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WN	Water Neutrality
WRMP	Water Resource Management Plan
WRMU	Water Resource Management Unit (in relation to CAMS)
WRZ	Water Resource Zone (in relation to a water company's WRMP)
WSI	Water Services Infrastructure
WTW	Water Treatment Works
WwTW	Waste Water Treatment Works

1 INTRODUCTION

1.1 Background

Stratford-on-Avon District Council is currently in the process of updating its evidence base to support the production of the Submission Version of the Core Strategy. This updated Water Cycle Study (WCS) will be an important part of the evidence base that will help to identify sites with potential for development over the period 2011 to 2031.

The WCS will help Stratford-on-Avon District Council determine the most appropriate locations for development (with respect to water infrastructure and the water environment) to be identified in the Local Development Framework, whether in the form of strategic sites allocated within the Core Strategy, or as other sites to be allocated in a future Site Allocations Development Plan Document.

The objective of the WCS update is to identify any constraints on planned housing growth that may be imposed by the water cycle. The WCS then identifies how these can be resolved i.e. by ensuring that appropriate Water Services Infrastructure (WSI) can be provided to support the proposed development. Furthermore, it should provide a strategic approach to the management and use of water which ensures that the sustainability of the water environment in the district is not compromised.

1.2 WCS History

Water Cycle issues relevant to Stratford-on-Avon District Council were previously reported in a Scoping and Outline Warwickshire Sub-Regional WCS which was completed in March 2010³.

The Scoping and Outline report, based on the West Midlands Regional Spatial Strategy (WMRSS) assessed the baseline conditions of various elements of the water cycle in Stratford-on-Avon, including the natural water environment and the capacity of the WSI that would be used to support growth. In addition, the Stage 1 study undertook a high level assessment of the likely growth in town locations and the proposed levels of growth within the district, and determined where growth would be achievable within the existing capacity of both the infrastructure and the water environment at a strategic level.

An initial Stage 2 Detailed WCS was commissioned in 2012 to update the Stage 1 baseline and identify the WSI solutions required to assist delivery of the planned growth relating just to the Stratford-on-Avon administrative area to 2028. However, since the 2012 Stage 2 Stratford-on-Avon WCS was published, Stratford-on-Avon District Council is proposing a larger growth target within the district and over a longer planning horizon to 2031. Therefore an update to the Stage 2 report was required. The Stage 2 WCS Update is reported in this document and supersedes the initial Stage 2 WCS produced in 2012.

In addition to the changes in the preferred spatial strategy for growth, a number of key water related documents (including, Severn Trent Water and Thames Water's draft Water Resource Management Plans) have been published, and as such, the evidence upon which the Outline WCS conclusions and recommendations were founded has changed.

1.3 Study Governance

This WCS update has been carried out with the guidance of the Steering Group and comprised the following organisations:

- Stratford-on-Avon District Council;

³ Halcrow (2010) – Warwickshire Sub-Regional Water Cycle Study, Stratford-on-Avon Scoping and Outline Final Report

- Severn Trent Water (STW) Ltd;
- Warwickshire County Council; and
- Environment Agency.

Thames Water was also consulted with respect to one element of specific wastewater treatment infrastructure falling within their area of operation.

The Steering Group met during the completion of the study to both guide and feedback on the assessments undertaken in support of the study.

1.4 **WCS Update Scope**

This WCS update provides information at a level suitable to ensure that there are solutions to deliver growth for the preferred development allocations, including the policy required to deliver it.

The outcome is the development of a water cycle strategy for the district which informs site specific and other DPDs of the water environment and WSI issues. This will need to be considered in bringing growth forward at various sites, including guidance for developers in conforming to the requirements of the strategy.

The following sets out the key objectives of the WCS update for Stratford-on-Avon District Council:

- determine if solutions to wastewater treatment for each growth location are required and how this might impact phasing of development within (and around) each growth location;
- determine whether any Habitats Directive designated ecological sites have the potential to be impacted by the wastewater treatment strategy via a screening process;
- determine whether additional water resources are required to support growth;
- determine upgrades required to water supply infrastructure relative to potential options for growth;
- consider whether growth can be delivered and achieve a 'neutral water use' condition. Provide a pathway to achievement of water neutrality;
- provide detail on SuDS constraints for each growth location;
- determine impact of infrastructure and mitigation provision on housing delivery phasing; and
- provide policy recommendations.

1.5 **Study Drivers**

A full list of the key legislative drivers shaping the study is detailed in the Stage 1 Outline WCS³, and a summary table is included in Appendix 1 of this study for reference. However, it is important to note that the key driver for this study is Water Framework Directive compliance.

It is important to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies in Stratford-on-Avon District Council (and more widely) from achieving the standards required of them as set out in the Water Framework Directive (WFD) River Basin Management Plans.

Other relevant studies that have a bearing on the provision of water services infrastructure for development include, but are not limited to, the following key documents:

- Stratford-on-Avon District Council Level 1 Strategic Flood Risk Assessment;
- The Warwickshire, Coventry and Solihull Biodiversity Action Plan;

- The Stratford-on-Avon District Council Green Infrastructure Strategy and,
- STW draft Water Resource Management Plan.

1.6 Water Use – Key Assumption

For all wastewater and water supply assessments, an assumption was made on the likely use per new household going forward in the plan period. It was agreed with STW that a starting assumption of 131l/h/d would be used to calculate wastewater generation and water use per person. This is different to the value of 150l/h/d used in the previous version of the WCS as a higher value was used to account for commercial use; however, as employment growth figures have been used in this update, the value of 150l/h/d has been adjusted.

The 150l/h/d figure makes an allowance for commercial use and use in schools and hospitals etc. considered to represent increases in non-domestic use across the study area

It is acknowledged that this figure exceeds the current Building Regulations requirement of 125l/h/d for all new homes. However, in their asset planning STW will continue to assume this higher water use for new homes as their analysis has shown that even when homes are built to a standard of 125l/h/d, the average household use increases over time due to various factors. STW and TW are required under their remit to the industry regulator Ofwat, to plan for the expected actual use. Therefore, it is important that conclusions made on infrastructure capacity within this study are consistent with STW's and TW's planning strategies.

This study has however considered the effect that achieving lower average per person consumption would have on infrastructure capacity and the water environment to assist in developing policy that supports and helps lead to a lower per capita consumption.

1.7 Report Structure

There are several water cycle elements that have been considered in this WCS. However, because some strategic level WSI can often serve a larger geographical area some water cycle elements are common to several of the growth sites in combination. These elements are assessed at a district level and hence are presented within a separate chapter in this report. These elements include:

- Wastewater treatment; and,
- Water availability (Water Resources).

The other water cycle elements of the study are specific to each site and hence these elements have been reported at the 'settlement area' level. These elements include:

- Wastewater network;
- Water supply network; and,
- Flood risk;

This report has therefore been set out in the following way to assist its presentation as a primarily planning based source of evidence:

- the planned growth in relation to the water cycle assessment (Chapter 2);
- the assessment of district wide water cycle elements (Chapters 3 and 4);
- a summary of how the site specific water cycle elements have been assessed and the WSI and water environment issues within the Settlement Areas (Chapter 5); and,
- Policy and other recommendations (Chapter 6).

2 PROPOSED GROWTH

2.1 Preferred Growth Strategy

The purpose of the Water Cycle Study update is to assess the potential impact of a revised wide dispersal of proposed development upon Stratford-on-Avon District's water environment and WSI, including flood risk, surface water drainage, water resources, wastewater infrastructure and water quality and ecological issues. Stratford-on-Avon District Council's revised spatial approach of future expected development is detailed in their 2011-2031 Housing Requirement and Strategic Site Options⁴, which at the time of undertaking this WCS, was in consultation stage as part of the development of the Council's Core Strategy. This WCS update is based on figures for homes already built since 2011, committed allocations, and the five alternative strategic options the Council has proposed for development within the District:

- Option A: Further Dispersal throughout the District
- Option B: Gaydon/Lighthorne Heath
- Option C: Long Maston Airfield
- Option D: Southeast Stratford-upon-Avon
- Option E: North of Southam and Stoneythorpe

The focus of this study is on wastewater treatment infrastructure and the impact of wastewater treatment on water quality and ecology within the District and more widely. This is because a more dispersed spatial pattern of growth affects more Wastewater Treatment Works (WwTW) and because many of the WwTWs serving the District discharge into smaller watercourses with less dilution capacity near the headstreams of the rivers.

2.2 Housing

The WCS update incorporates development in all settlement areas within the District, including Stratford-upon-Avon, Main Rural Centres, Local Service Villages and Rural areas. The Council is required to build 10,800 additional homes between 2011 and 2031, and has proposed five alternative strategic options to meet this target. The proposed options could provide a greater number of houses than the 10,800 requirement in the long term, therefore this WCS has assessed the greatest possible housing development for each option. Strategic Option C (Long Marston Airfield) provides the greatest housing increase, with a total of 12,620 new homes.

Table 2-1 provides a summary of the housing figures to be assessed. Due to the focus on wastewater treatment, the settlement areas have been grouped into the WwTW catchments within which they are located. Furthermore, the total proposed allocations for each WwTW catchment are shown for the implementation of either Option A, where development is dispersed throughout the District, or the alternative independent development sites in Options B, C, D and E. Some WwTW catchments are not impacted by the strategic options and therefore have a single proposed allocation value.

Locations of Settlement Areas for the proposed growth have been provided by Stratford-on-Avon District Council and these have been used to inform both strategic and village specific infrastructure capacity assessments and requirements (Figure 2-1).

⁴ Stratford-on-Avon District Council (2014), Focused Consultation: 2011-2031 Housing Requirement and Strategic Site Options.

TABLE 2-1: SUMMARY OF HOUSING FIGURES TO BE ASSESSED

WwTW Catchment	Settlement Area	Housing Numbers	Strategic Option A	Strategic Option B	Strategic Option C	Strategic Option D	Strategic Option E
Alcester	Alcester	738	175				
	Aston Cantow						
	Great Alne						
	Kinwarton						
Bearley	Bearley	35					
	Billesley						
Bidford-on-Avon	Bidford-on-Avon	450	125				
	Salford Priors						
Butlers Marston	Pillerton Priors	25					
Cherington	Brailes (Upper & Lower)	103					
Claverdon	Claverdon	79					
Earlswood - Spring Brook	Earlswood	84					
	Wood End						
Ettington Works	Ettington	98					
Fenny Compton	Fenny Compton	99					

TABLE 2-1: SUMMARY OF HOUSING FIGURES TO BE ASSESSED

WwTW Catchment	Settlement Area	Housing Numbers	Strategic Option A	Strategic Option B	Strategic Option C	Strategic Option D	Strategic Option E
Gaydon	Gaydon	85		3,000 (5,000 Employment)			
	Temple Herdewyke						
Ilmington	Ilmington	64					
Itchen Bank	Bishops Itchington	1,072	150				2,800 (500 Employment)
	Harbury						
	Ladbroke						
	Long Itchington						
	Southam						
	Stockton						
Kineton	Kineton	159	50				
Lighthorne	Lighthorne	35					
Lighthorne Heath	Lighthorne Heath	79					
Long Compton	Long Compton	67					
Long Marston	Long Marston	569	500 (2,500 Employment)		3,500 (3,250 Employment)		
	Quinton (Upper & Lower)						
Moreton Morrell	Moreton Morrell	38					

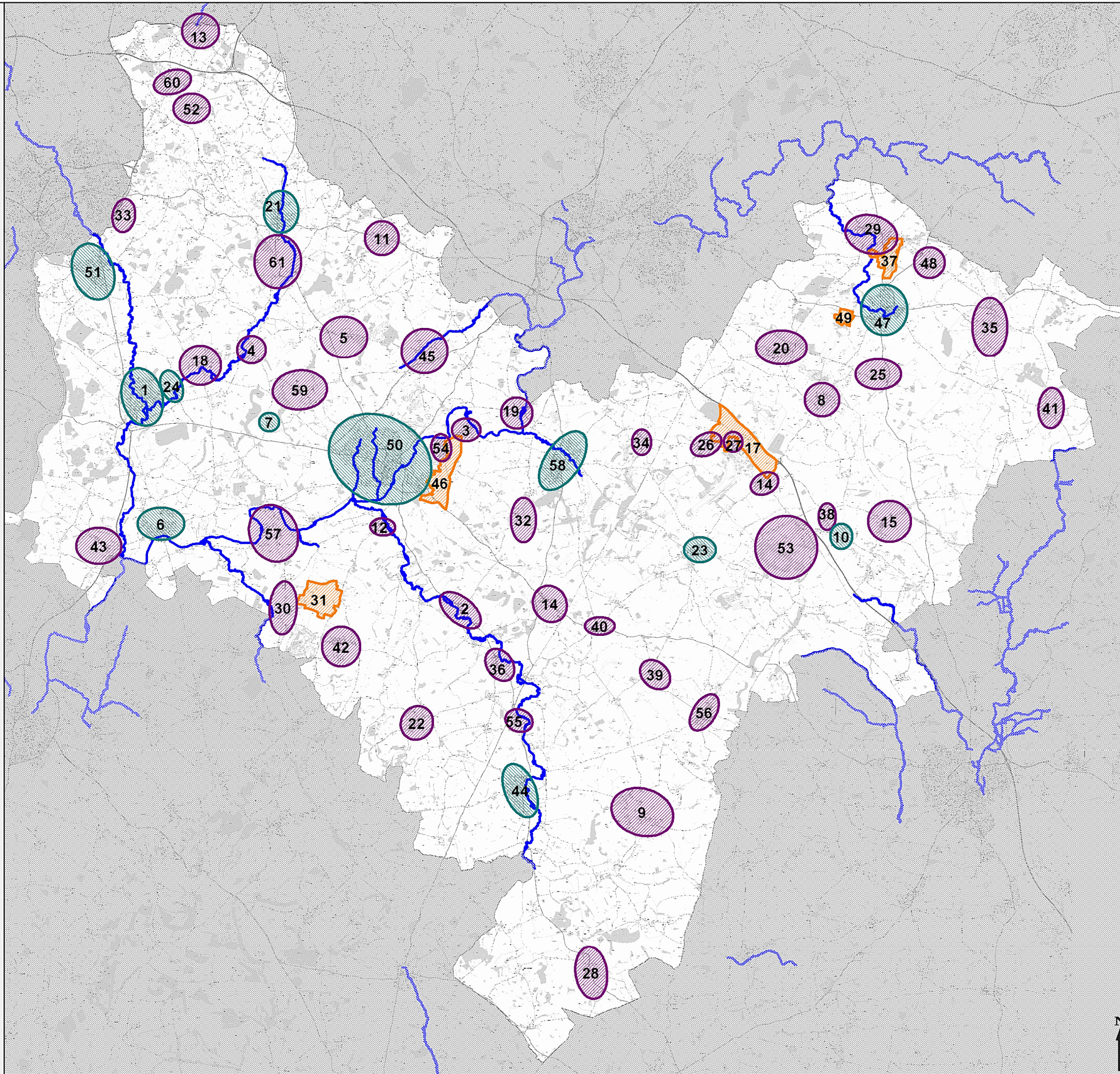
TABLE 2-1: SUMMARY OF HOUSING FIGURES TO BE ASSESSED

WwTW Catchment	Settlement Area	Housing Numbers	Strategic Option A	Strategic Option B	Strategic Option C	Strategic Option D	Strategic Option E
Napton	Napton-on-the-Hill	93					
Northend	Burton Dasset	38					
	Northend						
Oxhill	Oxhill	36					
Preston on Stour	Alderminster	36					
Redditch - Sernal	Mappleborough Green	157	150				
	Studley						
Shipston - Fell Mill	Newbold-on-Stour	518	125				
	Shipston-on-Stour						
	Tredington						
Snitterfield	Snitterfield	100					
Stratford - Milcote	Alveston	3,288	650			3,000 (2,000 Employment)	
	Clifford Chambers						
	Stratford-upon-Avon						
	Tiddington						
	Welford-on-Avon						

TABLE 2-1: SUMMARY OF HOUSING FIGURES TO BE ASSESSED

WwTW Catchment	Settlement Area	Housing Numbers	Strategic Option A	Strategic Option B	Strategic Option C	Strategic Option D	Strategic Option E
	Wilmcote						
Tanworth-in-Arden	Tanworth-in-Arden	70					
Tysoe	Tysoe (Upper & Middle)	104					
Wellesbourne	Hampton Lucy	596	150				
	Loxley						
	Wellesbourne						
Wootton Wawen	Henley-in-Arden	168	75				
	Wootton Wawen						
Priors Marston (TW)	Priors Marston	37					

1. Alcester
2. Alderminster
3. Alveston
4. Aston Cantlow
5. Bearley
6. Bidford on Avon
7. Billesley
8. Bishops Itchington
9. Brailes (Upper & Lower)
10. Burton Dassett
11. Claverdon
12. Clifford Chambers (& Milcote)
13. Earlswood
14. Ettington
15. Fenny Compton
16. Gaydon
17. Gaydon Lighthorne
18. Great Alne
19. Hampton Lucy
20. Harbury
21. Henley-in-Arden
22. Ilmington
23. Kineton
24. Kinwarton
25. Ladbroke
26. Lighthorne
27. Lighthorne Heath
28. Long Compton
29. Long Itchington
30. Long Marston
31. Long Marston Airfield
32. Loxley
33. Mappleborough Green
34. Moreton Morrell
35. Napton-on-the-Hill
36. Newbold-on-Stour
37. North of Southam
38. Northend
39. Oxhill
40. Pillerton Priors
41. Priors Marston
42. Quinton (Upper & Lower)
43. Salford Priors
44. Shipston-on-Stour
45. Snitterfield
46. South East Stratford-upon-Avon
47. Southam
48. Stockton
49. Stoneythorpe, Southam
50. Stratford-upon-Avon
51. Studley
52. Tanworth-in-Arden
53. Temple Terdewyke
54. Tiddington
55. Tredington
56. Tysoe (Upper & Middle)
57. Welford-on-Avon
58. Wellesbourne
59. Wilmcote
60. Wood End
61. Wootton Wawen



- LEGEND**
- Strategic Site Allocation
 - Local Service Village
 - Settlement Area
 - Main River

NOTES

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Drawing Status: **FINAL**

Drawing Title: **Settlement Areas**

Stratford-on-Avon District Council Water Cycle Study 2014

Scale at A3: 1:280,000

Drawn	GH	Check	CP	Approved	JR	Date	MARCH 2014
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Drawing Number: **FIGURE 2-1**

3 WASTEWATER TREATMENT ASSESSMENT

3.1 Wastewater Treatment Assessment Approach

Increases in residential and employment growth results in an increase in wastewater flows generated within a district and hence it is essential to consider:

- Whether there is sufficient capacity within existing treatment facilities (WwTWs) to treat the additional wastewater;
- what new infrastructure is required to provide for the additional wastewater treatment; and
- whether waterbodies receiving the treated flow can cope with the additional flow without affecting water quality.

There are therefore two elements to the assessment of existing capacity (and any solutions required) with respect to wastewater treatment:

- the capacity of the infrastructure itself to treat the wastewater (infrastructure capacity); and
- the capacity of the environment to sustain additional discharges of treated wastewater (environmental capacity).

3.1.1 *Wastewater Treatment in Stratford-on-Avon District Council*

Wastewater treatment in the district is provided via several WwTWs with the majority operated and maintained by STW, all of which discharge to surface watercourses. Each of these WwTWs is fed by a network of wastewater pipes (the sewerage system) which drains wastewater generated by property to the treatment works; this is defined as the WwTWs 'catchment'.

Due to the dispersed nature of development within the district (and the costs and energy required to pump wastewater over large distances), each settlement tends to have its own designated WwTW, hence numerous WwTWs are affected by growth in the district.

3.1.2 *Management of WwTW Discharges*

All WwTWs are issued with a permit to discharge by the Environment Agency, which sets out conditions on the maximum volume of treated flow that it can discharge and also limits on the quality of the treated flow. These limits are set in order to protect the water quality and ecology of the receiving waterbody. They also dictate how much flow can be received by each WwTW, as well as the type of treatment processes to be used at the WwTWs.

The volume element of the discharge permit determines the maximum number of properties that can be connected to a WwTW catchment. When discharge permits are issued for the first time, they are generally set with a volume 'freeboard', which acknowledges that allowance needs to be made for additional connections. This allowance is termed 'permitted headroom'. The quality conditions applied to the discharge permit are derived to ensure that the water quality of the receiving waterbody is not adversely affected, even when the maximum amount of flow is discharged. For the purposes of this WCS, a simplified assumption is applied that the permitted headroom is usable⁵ and would not affect downstream water quality. This headroom therefore determines how many properties can be connected to the WwTW before a new discharge permit would need to be issued (and hence how many properties can connect without significant changes to the treatment infrastructure).

⁵ In some cases, there is a hydraulic restriction on flow within a WwTWs which would limit full use of the maximum permitted headroom,
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March 2014

When a new discharge permit is required, an assessment needs to be undertaken to determine what new quality conditions would need to be applied to the discharge. If the quality conditions remained unchanged, the increase in flow would result in an increase in total load of some substances being discharged to the receiving waterbody. This may have the effect of deteriorating water quality and hence in most cases, an increase in permitted discharge flow results in more stringent (or tighter) conditions on the quality of the discharge. The requirement to treat to a higher level may result in an increase in the intensity of treatment processes at the WwTWs which may also require improvements or upgrades to be made to the WwTW to allow the new conditions to be met.

In some cases, it may be possible that the quality conditions required to protect water quality and ecology are beyond that which can be achieved with conventional treatment processes and as a result, this WCS assumes that a new solution would be required in this situation to allow growth to proceed.

The primary legislative driver which determines the quality conditions of any new permit to discharge are the Water Framework Directive (WFD) and the Habitats Directive (HD) as described in the following subsections.

3.1.3 *WFD Compliance*

The WFD is the most significant piece of water legislation since the creation of the EU. The overall requirement of the directive is that all waterbodies in the UK must achieve “Good Status”. The definition of a waterbody’s ‘status’ is a complex assessment that combines standards for water quality with standards for hydromorphology (i.e. habitat and flow quality) with ecological requirements.

The two key aspects of the WFD relevant to the wastewater assessment in this WCS are the policy requirements that:

- development must not cause a deterioration in status of a waterbody⁶; and
- development must not prevent future attainment of ‘good status’, hence it is not acceptable to allow an impact to occur just because other impacts are causing the status of a water body to already be less than good.

Where permitted headroom at a WwTW would be exceeded by proposed levels of growth, a water quality modelling assessment has been undertaken to determine the quality conditions that would need to be applied to the new permit to ensure the two policy requirements of the WFD are met. The modelling process (assumptions and modelling tools) is described in detail in Appendix 2.

3.1.4 *Habitats Directive*

The Habitats Directive and the Habitats Regulations has designated some sites as areas that require protection in order to maintain or enhance the rare ecological species or habitat associated with them. A retrospective review process has been on-going since the translation of the Habitats Directive into the UK Habitats Regulations called the Review of Consents (RoC). The RoC process requires the Environment Agency to consider the impact of the abstraction licences and discharge permit it has previously issued on sites which became protected (and hence designated) under the Habitats Regulations.

If the RoC process identifies that an existing licence or permit cannot be ruled out as having an impact on a designated site, then the Environment Agency are required to either revoke or alter the licence or permit. As a result of this process, restrictions on some discharge permits

⁶ i.e. a reduction High Status to Good Status as a result of a discharge would not be acceptable, even though the overall target of good status as required under the WFD is still maintained

have been introduced to ensure that any identified impact on downstream sites is mitigated. Although the Habitats Directive does not directly stipulate conditions on discharge, the Habitats Regulations can, by the requirement to ensure no detrimental impact on designated sites, require restrictions on discharges to (or abstractions) from water dependent habitats that could be impacted by anthropogenic manipulation of the water environment.

Where permitted headroom at a WwTW would be exceeded by proposed levels of growth, a Habitats Regulations assessment exercise has been undertaken in this WCS to ensure that Habitats Directive sites which are hydrologically linked to watercourses receiving wastewater flows from growth would not be adversely affected. The scope of this assessment also includes non-Habitats Directive sites designated at a national (SSSI) and local level (LNRs). This assessment is reported in Section 3.3 of this chapter (Ecological Appraisal).

3.1.5 *Assessment Methodology Summary*

A stepped assessment approach has been developed for the WCS to determine the impact of the proposed growth on wastewater treatment capacity and the environmental capacity of the receiving watercourse. The assessment steps are outlined below:

- determine the amount of growth draining to each WwTW and calculate the additional flow generated;
- calculate available headroom at each WwTW;
- determine whether the growth can be accommodated within existing headroom;
- for those WwTWs where headroom is exceeded, calculate what quality conditions need to be put in place to meet the two key objectives of the WFD to ensure:
 - no deterioration in receiving watercourse from its current WFD status;
 - future Good Status is not compromised by growth.
- determine whether any quality conditions required to meet WFD objectives would be beyond the limits of conventional treatment for WwTWs;
- where the conditions are achievable, indicate where infrastructure upgrades are required to be undertaken by the Water Company to meet the new permit conditions and phasing implications of these upgrades; and
- where the conditions are not achievable, indicate where there are alternative solutions for treatment in that catchment which would need to be perused by the Water Company.
- Undertake an ecological site screening assessment to determine if any Habitats Directive (or other nationally or locally) designated sites are likely to be affected,

In order to complete the above steps, the following assessment techniques were developed. Details of the procedures can be found in Appendix 2:

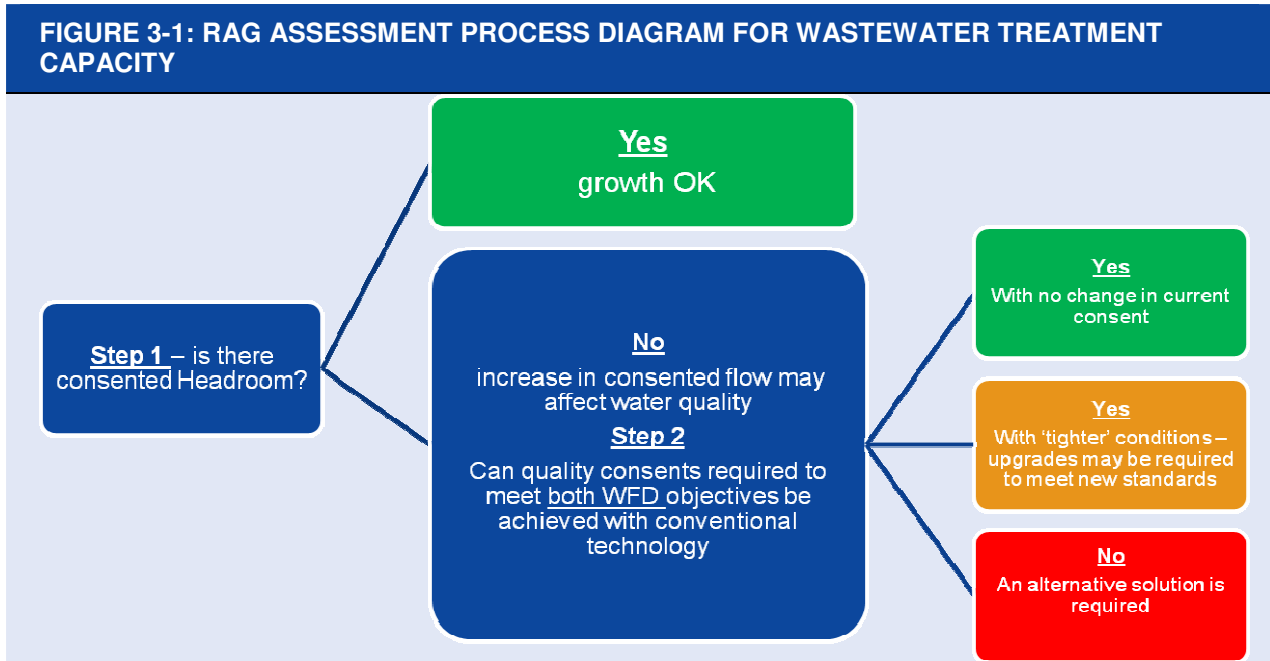
- a headroom calculation spreadsheet was developed; and,
- a water quality modelling procedure was agreed with the Environment Agency using Environment Agency software (RQP) designed for determining discharge permit conditions.

3.1.6 *Assessment Results Overview*

The results for each WwTW are presented in a Red/Amber/Green (RAG) Assessment for ease of planning reference. The RAG code refers broadly to the following categories and the process is set out in Figure 3-1.

- Green – WFD objectives will not be adversely affected. Growth can be accepted with no changes to the WwTW infrastructure or permit required.

- Amber – in order to meet WFD objectives, changes to the discharge permit are required, and upgrades may be required to WwTW infrastructure which may have phasing implications;
- Red - in order to meet WFD objectives changes to the discharge permit are required which are beyond the limits of what can be achieved with conventional treatment. An alternative solution needs to be sought.



3.2 Wastewater Treatment Assessment – Results

The assessment results are presented in this section and have been reported in the following order as follows:

- A RAG assessment summary table providing an overview of where there is capacity and where there are constraints for each WwTWs depending on the Strategic Growth Option being considered.
- Further detail on catchments where growth can be accepted within the current permitted headroom have been reported together in a single subsection;
- Further detail on those WwTWs requiring a new permit and hence a water quality assessment have been reported in individual subsections of this results section.

3.2.1 *RAG assessment summary*

TABLE 3-1: WWTW RAG ASSESSMENT SUMMARY						
WwTW	No Strategic Option	Option A	Option B	Option C	Option D	Option E
Alcester						
Bearley						
Bidford on Avon						
Butlers Marston						
Cherington						
Claverdon						
Earlswood – Spring Brook						
Ettington Works						
Fenny Compton						
Gaydon						
Ilmington						
Itchen Bank						
Kineton						
Lighthorne						
Lighthorne Heath						
Long Compton						
Long Marston						
Moreton Morrell						
Napton						
Northend						

TABLE 3-1: WWTW RAG ASSESSMENT SUMMARY

WwTW	No Strategic Option	Option A	Option B	Option C	Option D	Option E
Oxhill	Green	Green	Green	Green	Green	Green
Preston on Stour	Green	Green	Green	Green	Green	Green
Priors Marston (TW)	Orange	Orange	Orange	Orange	Orange	Orange
Redditch – Sernal	Green	Green	Green	Green	Green	Green
Shipston – Fell Mill	Green	Green	Green	Green	Green	Green
Snitterfield	Green	Green	Green	Green	Green	Green
Stratford – Milcote	Green	Green	Green	Green	Green	Green
Tanworth-in-Arden	Green	Green	Green	Green	Green	Green
Tysoe	Orange	Orange	Orange	Orange	Orange	Orange
Wellesbourne	Orange	Orange	Orange	Orange	Orange	Orange
Wootton Wawen	Green	Green	Green	Green	Green	Green

3.2.2 *WwTW with Permitted Headroom*

The volume of wastewater generated from growth in each WwTW catchment was calculated for the proposed growth locations and compared to the treatment capacity at each WwTW.

Table 3-2 details the WwTW where existing permitted headroom is sufficient to accommodate all of the proposed growth and hence no infrastructure upgrades are required to deliver the proposed growth levels in these locations. The strategic options scenarios for which this conclusion is relevant have been indicated.

Growth in these catchments and for the scenarios stipulated would not deteriorate water quality, or increase flood risk and hence there is no barrier to delivering the proposed growth levels. These catchments are Green in the RAG assessment and have not been assessed any further.

Table 3-2 also includes information on how many additional homes could be connected before the headroom would be exceeded to inform potential variations to the spatial strategy.

TABLE 3-2: WWTW WITH PERMITTED HEADROOM

Relevant WwTW	Current Permitted DWF (m ³ /d)	Future 2031 DWF after Growth (m ³ /d)	Headroom Assessment	
			2031 Headroom Capacity (m ³ /d)	Approximate Residual Housing Capacity after Growth (2031) ⁷
Alcester Option A	3,150	2,695	455	1,653
Alcester (Options B,C,D & E)	3,150	2,647	503	1,828
Bearley (All options)	172	92	80	292
Bidford on Avon Option A	1,870	1,697	173	628
Bidford on Avon (Options B, C, D & E)	1,870	1,663	207	753
Butlers Marston	120	104	16	59
Claverdon (All options)	250	230	20	74
Earlswood - Spring Brook (All options)	440	379	64	221
Ettington Works (All options)	460	177	283	1,029
Fenny Compton (All options)	251	135	116	421
Gaydon ⁸ (Options C, D & E)	110	104	6	20
Ilmington (All options)	210	181	29	107
Itchen Bank Option A ⁹	2881	2,724	157	570
Itchen Bank (Option B, C & D)	2881	2,683	198	720
Kineton Option A	750	658	106	384
Kineton (Option B, C & D)	750	644	92	334
Lighthorne ¹⁰ (All options)	70	73	-3	-10
Lighthorne Heath (All options)	193	142	51	186
Long Compton (All options)	165	161	4	13
Long Marston Option A	835	729	106	541
Long Marston (Option B, D & E) ¹¹	835	549	286	1,041
Moreton Morrell (All options)	148	119	29	104

⁷ Based on an Occupancy rate of 2.1 and consumption rate of 131 l/h/d

⁸ Gaydon Option B would not have permitted headroom and is presented in Table 3-2

⁹ Itchen Bank Option E would not have permitted headroom and is presented in Table 3-2

¹⁰ Headroom exceeded but growth is minimal and can be accepted within permit

¹¹ Long Marston Option C would not have permitted headroom and is present in Table 3-2

TABLE 3-2: WWTW WITH PERMITTED HEADROOM

Relevant WwTW	Current Permitted DWF (m ³ /d)	Future 2031 DWF after Growth (m ³ /d)	Headroom Assessment	
			2031 Headroom Capacity (m ³ /d)	Approximate Residual Housing Capacity after Growth (2031) ⁷
Napton (All options)	197	192	5	20
Northend (All options)	120	82	38	136
Oxhill (All options)	130	78	52	189
Preston on Stour (All options)	140	98	42	153
Redditch – Sernal Option A	27,500	18,273 ¹²	9,227	33,539
Redditch – Sernal (Options B, C, D & E)	27,500	18,232 ¹²	9,268	33,689
Shipston - Fell Mill Option A	1,697	1,463	234	851
Shipston - Fell Mill (Options B, C, D & E)	1,697	1,429	268	976
Snitterfield (All options)	343	250	93	340
Stratford – Milcote Option A	13,110	9,622	3,488	12,678
Stratford – Milcote Option D	13,110	10,303	2,807	10,328
Stratford – Milcote (Options B, C & E)	13,110	9,444	3,666	13,328
Tanworth-in-Arden (All options)	99	65	34	123
Wootton Wawen Option A	2,536	1,811	725	2,636
Wootton Wawen (Options B, C, D & E)	2,536	1,790	746	2,711

¹² Growth within Stratford-on-Avon DC has only been assessed at Redditch – Sernal WwTW, and does not include growth going to the WwTW from outside the district

3.2.3 *WwTW without Permitted Headroom*

The calculations of headroom demonstrated that several WwTW would not have sufficient headroom once all the growth in the catchment is included for some of the strategic options as detailed in Table 3-3.

TABLE 3-3: WWTW WITHOUT PERMITTED HEADROOM

Relevant WwTW	Current Permitted DWF (m ³ /d)	Future 2031 DWF after Growth (m ³ /d)	Headroom Assessment	
			2031 Headroom Capacity (m ³ /d)	Approximate Residual Housing Capacity after Growth (2031) ¹³
Cherington – All options	365	378	-13	-48
Gaydon Option B	110	1,015	-905	-2980
Itchen Bank Option E	2,881	3,462	-581	-2,980
Long Marston Option C	835	1,567	-732	-2,459
Priors Marston – All options	152	162	-10	-37
Tysoe – All options	181	196	-15	-53
Wellesbourne – (Options B,C, D and E)	1,559	1,630	-71	-258
Wellesbourne Option A	1,559	1,671	-112	-408

All of the WwTWs listed above required water quality modelling to determine whether the quality permits needed in order to meet WFD objectives would be achievable within the limits of conventionally applied treatment. Detailed results from the modelling are provided in Appendix 2.

A summary of the results and proposed infrastructure upgrades required are included in the following subsections for each of the WwTWs.

Cherington

Cherington WwTW has available headroom in its existing discharge permit and can accept an additional 55 dwellings after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment any growth beyond 55 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions. The growth in the catchment (covering Brailes (Upper and Lower), Stourton and Sutton-under-Brailes) would cause the WwTW to exceed its existing permit conditions by 13m³/d by the end of the plan period for all strategic growth options.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the River Stour, the quality conditions on the new discharge permit would need to be tighter than the current conditions for Ammonia and a new condition would be required for

¹³ Based on an Occupancy rate of 2.1 and consumption rate of 131 l/h/d

Phosphate¹⁴. Modelling has shown that the Phosphate permit would need to be 1mg/l (annual average) which is at the theoretical level of conventional treatment. The changes are therefore within the limits of conventional treatment and hence a solution is considered feasible at this WwTW.

The Stour is already at Good Status or higher for all parameters and hence the 'No Deterioration' assessment meets both objectives of the WFD.

Upgrade Requirements and Phasing

The requirement to limit Phosphate concentrations and the significant change of Ammonia conditions required for the new permit is likely to require process upgrades at Cherington WwTW. Although there is likely to be room for expansion¹⁵, funding for these upgrades may not be available until later in AMP6) and hence development beyond 55 additional homes up to 2019 may need to be restricted to a rate to be agreed with STW until sufficient process capacity is made available.

RAG Assessment

The growth in the Cherington catchment is given an Amber status on the basis that upgrades are required, but are within the limit of conventional treatment. Upon application of the revised discharge permit, STW should determine potential impact of the additional discharge on flood risk.

Gaydon

Gaydon WwTW has sufficient headroom for all Strategic growth Options except for Option B. The WwTW only has available headroom in its existing discharge permit to accept 105 of the dwellings proposed in Option B after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment any growth beyond 105 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions. The growth in the catchment with Strategic Option B (covering Gaydon, Temple Herdewyke, Chadshunt) would cause the WwTW to exceed its existing permit conditions by 905m³/d by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the River Dene (the WwTW discharges into a tributary of the River Dene), the quality conditions on the new discharge permit would need to be tighter than the current conditions for BOD, Ammonia and a new condition would be required for Phosphate. However, these changes are within the limits of conventional treatment and hence a solution is considered feasible at this WwTW.

The modelling has shown that growth would not prevent future Good Status being reached in the River Dene for Phosphate as it would not be possible without the growth.

Upgrade Requirements and Phasing

The requirement to limit Phosphate concentrations and the significant change of Ammonia conditions required for the new permit is likely to require process upgrades at Gaydon WwTW. Although there is likely to be room for expansion¹⁶, funding for these upgrades may not be available until later in AMP6) and hence development beyond 105 additional homes up to

¹⁴ BOD conditions would not need to change

¹⁵ Assuming adjacent land can be made available

¹⁶ Assuming adjacent land can be made available

2019 may need to be restricted to a rate to be agreed with STW until sufficient process capacity is made available.

RAG Assessment

The growth in the Gaydon catchment is given an Amber status on the basis that upgrades are required, but are within the limit of conventional treatment. Upon application of the revised discharge permit, STW should determine potential impact of the additional discharge on flood risk.

Itchen Bank

Itchen Bank WwTW has sufficient headroom for all Strategic growth Options except for Option E. The WwTW only has available headroom in its existing discharge permit to accept 1792 of the dwellings proposed in Option E after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment any growth beyond 1792 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions. The growth in the catchment with Strategic Option E (covering Bishops Itchington, Harbury, Long Itchington, Ufton, Stockton and Southam) would cause the WwTW to exceed its existing permit conditions by 581 m³/d by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the River Itchen, the quality conditions on the new discharge permit would need to be tighter than the current conditions for BOD, Ammonia and a new condition would be required for Phosphate. The change that is required for BOD and Phosphate is within the limits of conventional treatment; however, the change required for Ammonia is outside the limits of conventional treatment. Hence, discharge of all of the additional flow to the River Itchen, when considering growth in the catchment as part of Strategic Option E is not possible and a long-term solution would be required at this WwTW catchment if Strategic Option E was taken forward.

The modelling has shown that growth would not prevent future Good Status being reached in the River Itchen for Phosphate as it would not be possible without the growth.

Upgrade Requirements and Phasing

The Ammonia condition required for the new permit, when considering Strategic Option E is likely to require a new solution at Itchen Bank WwTW as the upgrades required would be outside the limits of conventional treatment and the costs to improve the WwTW may be excessive. It should be noted that the requirement for a new permit is only required once approximately 45% of the growth targets at locations including Stoneythorpe and North of Southam are delivered.

A solution would need to be developed between STW and the Environment Agency if Strategic Option E was taken forward. The onus is on STW to maintain standards set within their current environmental permit.

A number of options can be considered once the headroom at the WwTWs is fully utilised:

1. STW consider whether a permitted ammonia limit less than 1mg/l¹⁷ would be acceptable and achievable at the WwTW;

¹⁷ Based on a 95 percentile compliance

2. STW undertake measures to help create additional 'headroom' in the system (i.e. demand measures or infiltration reduction measures such that a new permit is not required);
3. Consider moving the discharge location further downstream where there is a greater capacity for dilution and the ammonia condition may not need to be as stringent.

RAG Assessment

The growth in the Itchen Bank WwTW catchment, based on growth from Strategic Option E is given a Red status on the basis that a potential new solution would be required, and would need to be identified by the Environment Agency and STW if Option E is taken forward. On this basis, it is recommended that an alternative to the strategic growth Option E is considered, either as:

- less dwellings proposed in this catchment; or
- another strategic option considered.

Long Marston

Long Marston WwTW has sufficient headroom for all Strategic growth Options except for Option C. The WwTW only has available headroom in its existing discharge permit to accept 1610 of the dwellings proposed in Option E after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment any growth beyond 1610 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions. The growth in the catchment with Strategic Option C (covering Long Marston and Quinton (Upper and Lower)) would cause the WwTW to exceed its existing permit conditions by 732m³/d by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the Marchfont Brook (the WwTW discharges into a tributary of the Marchfont Brook), the quality conditions on the new discharge permit would need to be tighter than the current conditions for BOD, Ammonia and a new condition would be required for Phosphate. The change that is required for BOD and Ammonia is within the limits of conventional treatment; however, the change required for Phosphate is outside the limits of conventional treatment. Hence, discharge of all of the additional flow to the Marchfont Brook, when considering growth in the catchment as part of Strategic Option C is not possible and a long-term solution would be required at this WwTW catchment if Strategic Option C was taken forward.

The modelling has shown that growth would not prevent future Good Status being reached in the Marchfont Brook for Phosphate as it would not be possible without the growth.

Upgrade Requirements and Phasing

The Phosphate condition required for the new permit, when considering Strategic Option C is likely to require a new solution at Long Marston WwTW as the upgrades required would be outside the limits of conventional treatment and the costs to improve the WwTW may be excessive. It should be noted that the requirement for a new permit is only required once approximately 40% of the growth targets at locations including Long Marston (including the Airfield development) and Quinton are delivered.

A solution would need to be developed between STW and the Environment Agency if Strategic Option C was taken forward. The onus is on STW to maintain standards set within their current environmental permit.

A number of options can be considered once the headroom at the WwTWs is fully utilised:

1. STW consider whether a permitted Phosphate limit less than 1mg/l¹⁸ would be acceptable and achievable at the WwTW;
2. STW undertake measures to help create additional 'headroom' in the system (i.e. demand measures or infiltration reduction measures such that a new permit is not required);
3. Consider moving the discharge location further downstream where there is a greater capacity for dilution and the ammonia condition may not need to be as stringent.

RAG Assessment

The growth in the Long Marston WwTW catchment, based on growth from Strategic Option C is given a Red status on the basis that a potential new solution would be required, and would need to be identified by the Environment Agency and STW if Option C is taken forward. On this basis, it is recommended that an alternative to the strategic growth Option C is considered, either as:

- less dwellings proposed in this catchment; or
- another strategic option considered.

Priors Marston

Priors Marston WwTW currently has no headroom in its existing discharge permit; hence the growth in the catchment would cause the WwTW to exceed its existing permit conditions by 10m³/d by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the Highfurlong Brook, the quality conditions on the new discharge permit would need to be tighter than the current conditions for Ammonia; these changes are within the limits of conventional treatment.

A new quality condition would be required for Phosphate¹⁹. Modelling for P has shown that both with and without any growth in the WwTW catchment, the P permit would need to be under 1mg/l (annual average) and hence theoretically below the level of conventional treatment. However, the watercourse is currently achieving Good Status for P which shows that the WwTW is likely to be outperforming on P quality and hence the small amount of additional growth should not alter this position. This would need to be confirmed as part of a detailed assessment when Thames Water applies for a new permit to discharge.

For this WCS, a solution is considered feasible at this WwTW.

Upgrade Requirements and Phasing

The requirement to limit Phosphate concentrations and the significant change of Ammonia conditions required for the new permit is likely to require process upgrades at Priors Marston WwTW. Although there is likely to be room for expansion²⁰, funding for these upgrades may not be available until later in AMP6) and hence development up to 2019 may need to be restricted to a rate to be agreed with STW until sufficient process capacity is made available.

¹⁸ Based on a mean annual compliance

¹⁹ BOD conditions would not need to change

²⁰ Assuming adjacent land can be made available

RAG Assessment

The growth in the Priors Marston catchment is given an Amber status on the basis that upgrades are required, but are likely to be within the limit of conventional treatment. Upon application of the revised discharge permit, TW should determine potential impact of the additional discharge on flood risk and maintaining Good Status for P.

Tysoe

Tysoe WwTW has available headroom in its existing discharge permit and can accept an additional 51 dwellings after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment any growth beyond 51 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions. The growth in the catchment (covering Tysoe Upper and Middle) would cause the WwTW to exceed its existing permit conditions by 15m³/d by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the Wagtail Brook (the WwTW discharges into a tributary of the Wagtail Brook) a new condition would be required for Ammonia and Phosphate²¹. Modelling has shown that the Phosphate permit would need to be slightly under 1mg/l (annual average) and hence theoretically below the level of conventional treatment. However, it is considered that a 1mg/l permit is likely to be acceptable on the basis that such modelling has some degree of uncertainty.

The changes are therefore within the limits of conventional treatment and hence a solution is considered feasible at this WwTW.

The modelling has shown that growth would not prevent future Good Status being maintained in the Wagtail Brook for Phosphate as it would not be possible without the growth.

Upgrade Requirements and Phasing

The requirement to limit Phosphate and Ammonia concentrations required for the new permit is likely to require process upgrades at Tysoe WwTW. Although there is likely to be room for expansion²², funding for these upgrades may not be available until later in AMP6) and hence development beyond 51 additional homes up to 2019 may need to be restricted to a rate to be agreed with STW until sufficient process capacity is made available.

RAG Assessment

The growth in the Tysoe catchment is given an Amber status on the basis that upgrades are required, but are within the limit of conventional treatment. Upon application of the revised discharge permit, STW should determine potential impact of the additional discharge on flood risk.

Wellesbourne

Wellesbourne WwTW has available headroom in its existing discharge permit and can accept an additional 338 dwellings after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment (covering Hampton Lucy, Loxley and Wellesbourne) any growth (with or without the Strategic Growth Option A) beyond 338 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric

²¹ BOD conditions would not need to change

²² Assuming adjacent land can be made available

permit conditions by either 71m³/d (without strategic option A) or 112m³/d (with Strategic Option A) by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain current WFD status downstream in the River Dene, the quality conditions on the new discharge permit would need to be tighter than the current conditions for Ammonia²³. However, this change is within the limits of conventional treatment and hence a solution is considered feasible at this WwTW.

The modelling has shown that growth would not prevent future Good Status being maintained in the River Dene for Phosphate as it would not be possible without the growth.

Upgrade Requirements and Phasing

The significant change of Ammonia condition required for the new permit is likely to require process upgrades at Wellesbourne WwTW. Although there is likely to be room for expansion²⁴, funding for these upgrades may not be available until later in AMP6) and hence development beyond 338 additional homes up to 2019 may need to be restricted to a rate to be agreed with STW until sufficient process capacity is made available.

RAG Assessment

The growth in the Wellesbourne catchment is given an Amber status on the basis that upgrades are required, but are within the limit of conventional treatment. Upon application of the revised discharge permit, STW should determine potential impact of the additional discharge on flood risk.

3.3 Ecological Appraisal

There are four statutory designated sites that have been identified as potentially being connected to WwTW discharges in Stratford-on-Avon District Council: River Blythe SSSI, Sherbourne Meadows SSSI adjacent to Bell Brook, Welford Field SSSI on a tributary of the Middle Avon River and the River Arrow Local Nature Reserve at Alcester. All other designated sites identified within the district are remote from watercourses into which WwTW's discharge treated effluent. The River Arrow, River Alne and River Middle Avon all drain into the River Avon which itself drains into the Severn Estuary SAC/SPA/Ramsar site. However, the Severn Estuary is over 50km downstream of Stratford-on-Avon District Council and as such there is no realistic link given the large dilution factors that would be involved.

The ecological background to the statutory designated sites included the details of the interest features and relevant condition assessments are provided in Appendix 4. Sherbourne Meadows SSSI and Welford Field SSSI are essentially designated for their flood meadow. Local Nature Reserves do not have citations as such but the River Arrow LNR is designated for its river, pond and wet grassland and the locally rare small teasel. The River Blythe SSSI is designated for its riverine habitats.

3.3.1 *Impact on designated sites*

Sherbourne Meadows SSSI is immediately downstream of Snitterfield WwTW, Welford Field SSSI is downstream of Stratford – Milcote WwTW, River Blythe SSSI is downstream of Earlswood – Spring Brook WwTW and River Arrow LNR is approximately 5km downstream of Redditch WwTW. Therefore, any need to increase the permitted discharge volumes from these WwTWs could have impacts on the downstream designated sites. However, the Water

²³ BOD and Phosphate conditions would not need to change

²⁴ Assuming adjacent land can be made available

Cycle Study identifies that all four of these WwTW's have existing permitted headroom, which is sufficient to accommodate all of the proposed growth sites. Hence no infrastructure upgrades are required to deliver the proposed growth levels in these locations. Growth in these catchments would not therefore deteriorate water quality, or increase flood risk and hence there is no barrier to delivering the proposed growth levels. No further consideration is therefore required.

3.3.2 *Impacts on ecology outside designated sites*

In addition to impacts on designated sites, a range of other UK or Warwickshire Coventry & Solihull BAP species or otherwise protected/notable species that are found in Warwickshire can be affected by wastewater discharge. These include:

- Water vole (protected through Wildlife & Countryside Act 1981 and a UK BAP species)
- Grass snake (partially protected through Wildlife & Countryside Act 1981)
- Common toad (UK BAP species)
- Great crested newt (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981 and a UK BAP species)
- Birds such as bittern, kingfisher (protected through Wildlife & Countryside Act 1981 and a UK BAP species), lapwing and snipe; and
- Otter (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981 and a UK BAP species).

Similarly important habitats (all listed in the Warwickshire BAP) include:

- Rivers & streams;
- Canals;
- Reedbeds;
- Fen, marsh and swamp;
- Ponds, lakes and reservoirs.

All of these habitats and species are present (or possibly present) in Stratford-on-Avon District Council.

It is not possible within the scope of this commission to undertake a detailed investigation and evaluation of the impacts of the changes in water quality/flow and infrastructure to be delivered under the water cycle study on wildlife generally. This is because since it would be necessary to undertake detailed species surveys of each watercourse and utilise detailed flow and quality data/modelling which has not been available for this commission for most watercourses.

Seven WwTWs in Stratford-on-Avon District Council will require a change to their permits in order to comply with the Water Framework Directive requirements for no deterioration downstream:

- Cherington WwTW;
- Gaydon WwTW;
- Itchen Bank WwTW;
- Long Marston WwTW;
- Tysoe WwTW;
- Wellesbourne WwTW; and,
- Priors Marston WwTW.

For all seven sites, 'no deterioration' is achievable within the limits of conventional treatment. With such permit tightening in place there should be no deterioration in downstream water quality and therefore there will be no adverse effects on wildlife in the receiving watercourses.

3.3.3 *Ecological opportunities associated with proposed development locations*

All development sites would have potential for the enhancement of ecological value through new SuDS opportunities linked to the new development. These could provide habitat for Warwickshire BAP species and habitats such as fen, marsh and swamp, great crested newt or water vole. In addition, many of the settlement areas are close to existing watercourses and may therefore present opportunities for more specific riverine habitat improvements associated with development, such as the creation of an improved river profile and improved backwaters/meanders.

It should be noted that the Local Service Village of Welford-on-Avon lies very close to Welford Field SSSI. Development here would therefore provide a potential specific opportunity to enhance this SSSI.

3.4 **Climate Change Sensitivity – Water Quality**

Though not directly influencing water quality and water environments, climate change has the potential to impact and alter the water environment through increasing river temperatures, reducing flows and increasing diffuse run-off from heavier rainfall and storm events, all of which can alter the quality of the receiving water bodies.

The Environment Agency's 'Potential Impacts of Climate Change on River Water Quality' study²⁵ reported that relatively little research has been undertaken in assessing the impacts of climate change on water quality. However, the following high-level findings were reported from the literature review undertaken as part of the study:

- water quality will be affected by changes in flow regime;
- lower minimum flows imply less volume for dilution and hence higher concentrations downstream of point discharges;
- enhanced growth of algal blooms in rivers and reservoirs could affect levels of dissolved oxygen and the costs of treating water for potable supply;
- increased storm events, especially in summer, could cause more frequent incidence of combined sewer overflows, discharging highly polluted waters into receiving water bodies. The potential impacts on urban water quality will be largely driven by these changes in short duration rainfall intensity overwhelming drainage systems, as well as rising sea levels affecting combined sewerage outfalls;
- the most immediate reaction to climate change is expected to be an increase in river and lake water temperatures with subsequent effects on Dissolved Oxygen levels;
- more intense rainfall and flooding could result in increased suspended solids, sediment yields and associated contaminant metal fluxes;
- nutrient loads are expected to increase;
- in shallow lakes, oxygen levels may decline and cyanobacteria blooms may become more extensive; and

²⁵ Potential Impacts of Climate Change on River Water Quality. Science Report SC070043/SR1, Environment Agency 2008

- in the UK, there has been relatively little research on toxins in streams, lakes and sediments, as the problems are thought to be limited. However, climate change may alter this perception.

Climate change studies, especially in relation to water quality and ecology, are at fairly early stages and the outcomes are subject to considerable uncertainty. However, understanding the processes and mechanisms controlling water quality and ecology, and how these combine and interact, is essential for sustaining potable water supplies and conserving river systems. As such, the findings of this study and planned adaptation and mitigation options should be updated when further research and guidance becomes available.

Climate Change, Water Quality and Adaptation

Table 3-4 provides a summary of the potential climate change adaptation and mitigation measures that could be considered in Stratford-on-Avon District Council with regards to water quality and wastewater services infrastructure. The organisations likely to be responsible for leading these measures have been identified alongside the suggested timescale for these actions to start being taken forward (Immediate, Medium (1 - 10 years) and Long (10+ years)).

TABLE 3-4: WATER QUALITY AND WASTEWATER POTENTIAL CLIMATE CHANGE ADAPTION AND MITIGATION

Potential Climate Change	Potential Impact	Adaption and Mitigation Measures	Lead Organisation (s)				Timescale for Action
			SoA	EA	STW	NE	
Temperature Rise	<ul style="list-style-type: none"> Decrease in Dissolved Oxygen in rivers – impact on river ecology and wildlife Faster wastewater asset deterioration Changes in wastewater process efficiency 	Ensure climate change mitigation strategies are in place for species and habitats at risk, e.g. BAPS		✓		✓	Medium
		Monitor long-term Dissolved Oxygen levels in rivers and impacts		✓			Medium
		Improve resilience of wastewater assets to temperature rise, where new assets are required or upgraded			✓		Medium
Winter rainfall increase	<ul style="list-style-type: none"> Increased diffuse pollution Insufficient infrastructure capacity – storm tanks, CSOs etc. Increased risk to rivers from combined sewer outflows 	Where possible, control diffuse pollution runoff through SuDS	✓	✓	✓	✓	Immediate
		Promoting the creation and preservation of space (e.g. verges, agricultural land, and green urban areas, including roofs) in support of water quality, biodiversity and flood risk goals	✓	✓		✓	Immediate
Summer rainfall decrease	<ul style="list-style-type: none"> Degraded wetlands More frequent low river flows Less dilution in rivers for wastewater discharge Reduced risk to rivers from combined sewer outflows Tightening of discharge permit Reduced flexibility – effluent required to maintain river flows 	Ensure climate change mitigation strategies are in place for species and habitats at risk, e.g. Biodiversity Action plans		✓		✓	Medium
		Consideration of future climate change impacts on wastewater discharges when renewing permits		✓	✓		Medium
Increase in weather extremes (heatwaves, intense rainfall, storms)	<ul style="list-style-type: none"> Increased flooding and risk of service loss Increased clean-up costs Inability of infrastructure to cope Increased subsidence – pipe failure 	Promoting the creation and preservation of space (e.g. verges, agricultural land, and green urban areas, including roofs) in support of water quality, biodiversity and flood risk goals	✓	✓		✓	Immediate
		Improve resilience of key wastewater assets such as CSOs, WwTW and outfalls, including new industry design standards for wastewater assets			✓		Medium

3.5 Wastewater Summary

Table 3-5 provides a summary of the RAG assessment of the WwTWs within the Stratford-on-Avon WCS study area.

TABLE 3-5: WASTEWATER TREATMENT SUMMARY				
WwTW	Watercourse	Is Headroom Available?	Is a quality permit update possible – within LCT?	Solution Available?
Alcester	River Arrow	Yes	N/A	
Alcester – Option A	River Arrow	Yes	N/A	
Bearley	Tributary of Edstone Brook	Yes	N/A	
Bidford on Avon	River Avon	Yes	N/A	
Bidford on Avon – Option A	River Avon	Yes	N/A	
Butlers Marston	River Dene	Yes	N/A	
Cherington	River Stour	No	Yes	Upgrade required
Claverdon	Tributary of Claverdon Brook	Yes	N/A	
Earlswood - Spring Brook	Spring Brook	Yes	N/A	
Ettington Works	Tributary of River Dene	Yes	N/A	
Fenny Compton	Tributary of River Itchen	Yes	N/A	
Gaydon	Tributary of River Dene	Yes	N/A	
Gaydon – Option B	Tributary of River Dene	No	Yes	Upgrade required
Ilmington	Fosse Way Brook	Yes	N/A	
Itchen Bank	River Itchen	Yes	N/A	
Itchen Bank – Option A	River Itchen	Yes	N/A	
Itchen Bank – Option E	River Itchen	No	Yes	New solution needs to be identified if this Strategic option is pursued
Kineton	River Dene	Yes	N/A	
Kineton – Option A	River Dene	Yes	N/A	
Lighthorne	Tributary of Thelsford Brook	Yes	N/A	
Lighthorne Heath	Tach Brook	Yes	N/A	

TABLE 3-5: WASTEWATER TREATMENT SUMMARY

WwTW	Watercourse	Is Headroom Available?	Is a quality permit update possible – within LCT?	Solution Available?
Long Compton	Nethercote Brook	Yes	N/A	
Long Marston	Gran Brook	Yes	N/A	
Long Marston – Option A	Gran Brook	Yes	N/A	
Long Marston – Option C	Gran Brook	No	Yes	New solution needs to be identified if this Strategic option is pursued
Moreton Morrell	Tributary of Charlecote Brook	Yes	N/A	
Napton	River Stowe	Yes	N/A	
Northend	Tributary of River Dene	Yes	N/A	
Oxhill	Tributary of Wyngates Brook	Yes	N/A	
Preston on Stour	River Stour	Yes	N/A	
Priors Marston	Highfurlong Brook	No	Yes	Upgrade required
Redditch - Sernal	River Arrow	Yes	N/A	
Redditch – Sernal – Option A	River Arrow	Yes	N/A	
Shipston - Fell Mill	River Stour	Yes	N/A	
Shipston - Fell Mill – Option A	River Stour	Yes	N/A	
Snitterfield	Tributary of Sherbourne Brook	Yes	N/A	
Stratford - Milcote	River Avon	Yes	N/A	
Stratford – Milcote – Option A	River Avon	Yes	N/A	
Stratford – Milcote – Option D	River Avon	Yes	N/A	
Tanworth-in-Arden	River Alne	Yes	N/A	
Tysoe	Tributary of Wyngates Brook	No	Yes	Upgrade required
Wellesbourne	River Dene	No	Yes	Upgrade required
Wellesbourne – Option A	River Dene	No	Yes	Upgrade required
Wootton Wawen	River Alne	Yes	N/A	
Wootton Wawen – Option A	River Alne	Yes	N/A	

4 WATER SUPPLY STRATEGY

4.1 Introduction

Water supply for the majority of the Stratford-on-Avon District Council area is provided by STW, with a small area in the south-east provided by TW. Given that TW supply such a small proportion of Stratford-on-Avon District Council, the water supply assessment of this WCS will only focus on STW.

The Scoping and Outline Warwickshire Sub-Regional WCS²⁶ completed an assessment of the existing environmental baseline with respect to locally available resources in the aquifers and the main river systems. The outline assessment has been based on the Environment Agency's Catchment Management Strategies (CAMS). Stratford-on-Avon District Council falls within two CAMS²⁷;

- The Warwickshire Avon CAMS; and,
- The Tame, Anker and Mease CAMS.

In February 2013, the Environment Agency updated the CAMS water resource availability classifications to show High hydrological regimes, Water available for Licence, Restricted water available for licence, Water not available for licence and Heavily Modified Waterbodies. The results of this update are similar to those previously described in the Scoping and Outline Warwickshire Sub-Regional WCS, with the majority of the areas classed as 'Water not available for licensing' during low flows (Q95). Therefore the process of describing catchment resources is not repeated in this WCS update. Instead this WCS has used STW's revised draft Water Resource Management Plan 2014 (dWRMP) to determine available water supply against predicted demand and has considered how water efficiency can be further promoted and delivered for new homes beyond that which is planned for delivery in STW's dWRMP.

4.1.1 *Water Resource Planning*

Water companies have historically undertaken medium to long term planning of water resources in order to demonstrate that there is a long-term plan for delivering sustainable water supply within its operational area to meet existing and future demand.

As of 2007, it became a statutory requirement for water companies to prepare and maintain WRMPs which demonstrate how water companies are managing the balance between available supply and future demand over a 25 year plan. These plans are subject to consultation and approval by secretary of state every five years, but must be updated on a yearly basis.

WRMPs are a key document for a WCS as they set out how demand for water from growth within a water company's supply area can be met, taking into account the need to for the environment to be protected. As part of the statutory approval process, the plans must be approved by both the Environment Agency and Natural England (as well as other regulators) and hence the outcomes of the plans can be used directly to inform whether growth levels being assessed within a WCS can be supplied with a sustainable source of water supply.

Water companies manage available water resources within key zones, called Water Resource Zones (WRZ). These zones share the same raw resources for supply and are interconnected by supply pipes, treatment works and pumping stations. As such the customers within these zones share the same available 'surplus of supply' of water when it is freely available; but also

²⁶ Warwickshire Sub-Regional Water Cycle Strategy, Stratford-on-Avon Council, Scoping and Outline Final Report, Halcrow, 2010

²⁷ <http://www.environment-agency.gov.uk/business/topics/water/119931.aspx>

share the same risk of supply when water is not as freely available during dry periods (i.e. deficit of supply). Water companies undertake resource modelling to calculate if there is likely to be a surplus of available water or a deficit in each WRZ by 2040, once additional demand from growth and other factors such as climate change are taken into account.

4.2 Water Resource Planning in Stratford-on-Avon

The STW draft 2014 Water Resources Management Plan (dWRMP) was released for public consultation in May 2013. Following comments received on the draft, STW published a revised 2014 dWRMP for consultation in November 2013 and a Statement of Response in January 2014. The final 2014 WRMP is due to be published in 2014; therefore the information within the revised 2014 dWRMP is used to inform this WCS. The Demand Scenarios tested are based on the final planning tables in the Strategic Grid Revised Draft Plan data tables (November 2013). It should be noted that subsequent to consultation, further changes may be made to the dWRMP before the final version is released, therefore the conclusions in the final 2014 WRMP may differ from those made in the dWRMP.

In reviewing the latest update to the STW 2014 dWRMP, and through liaison with STW it has been established that the growth figures assessed for this WCS study are catered for in the 2040 prediction of supply and demand deficits in the relevant WRZs under average conditions. Therefore, conclusions on available water supply from STW's 2014 dWRMP can be used directly in this study to inform and support Stratford-on-Avon District Council's LDF.

4.3 Demand for Water

Likely increases in demand in the study area have been calculated using six different water demand projections based on different rates of water use for new homes that could be implemented through potential future policy.

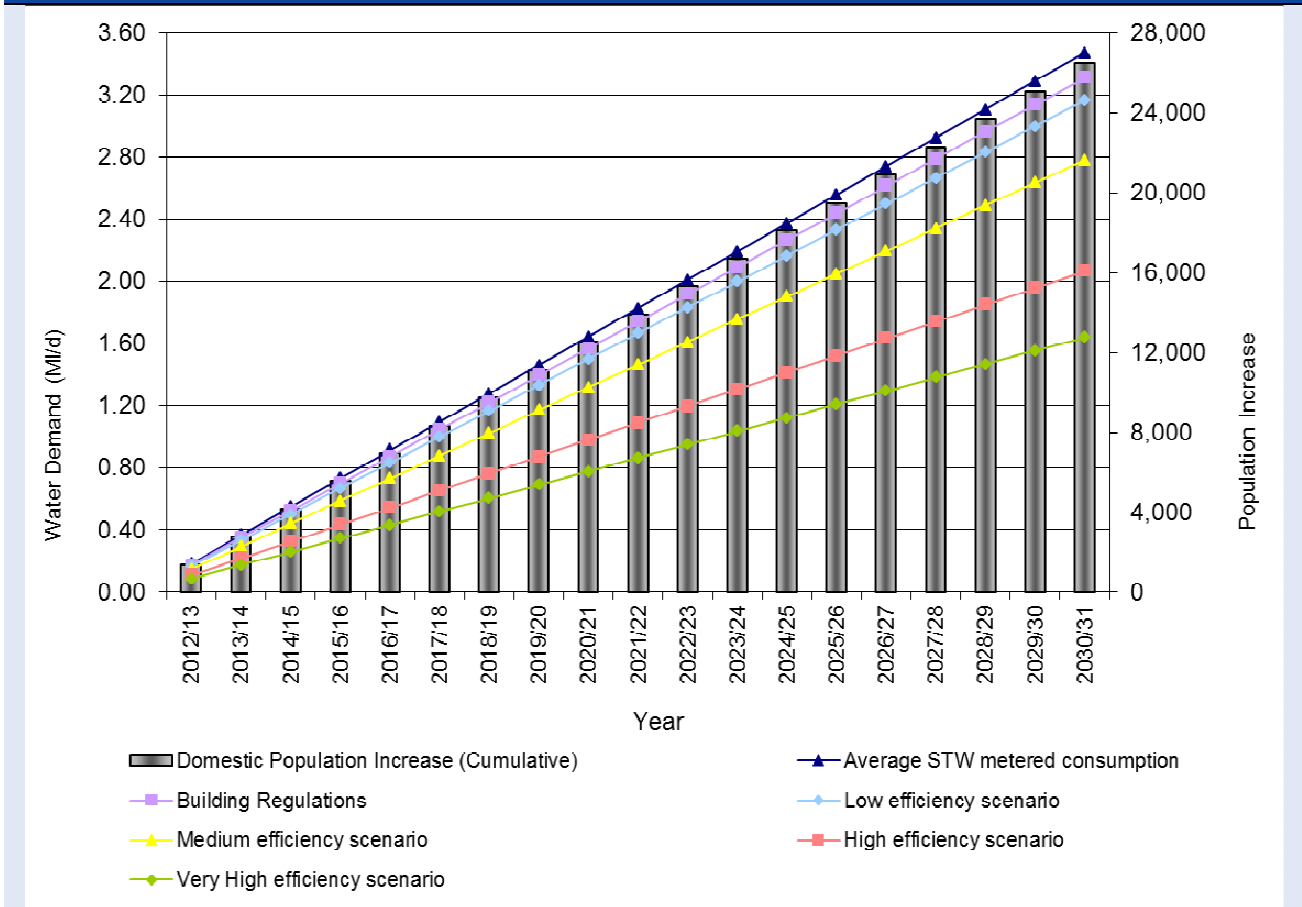
The projections were derived as follows:

- **Projection 1 – Average STW metered consumption** – New homes would use 131 l/h/d²⁸, this reflects the planning consumption used by STW and TW to maintain security of supply;
- **Projection 2 – Building Regulations** – New homes would conform to (and not use more than Part G of the Building Regulations requirement (in force as of the 6th April 2010) of 125 l/h/d (equivalent to the Code for Sustainable Homes (CfSH) Level 1/2 rating of 120 l/h/d plus 5 l/h/d for outdoor use);
- **Projection 3 – Low Efficiency Scenario** – New homes would achieve CfSH Level 1/2 rating of 120 l/h/d;
- **Projection 4 – Medium Efficiency Scenario** – New homes would achieve CfSH Level 3/4 rating of 105 l/h/d;
- **Projection 5 – High Efficiency Scenario** – New homes would achieve CfSH Level 5/6 rating of 80 l/h/d; and,
- **Projection 6 – Very High Efficiency Scenario** – New homes would include both greywater recycling and rainwater harvesting reducing water use to a minimum of 62 l/h/d.

Using these projections, the increase in demand for water could range between 1.64 and 3.47l/d by 2031. The projections are shown in Figure 4-1.

²⁸ Taking into account 5l/h/d for jobs

FIGURE 4-1: RANGE OF WATER DEMANDS ACROSS PLAN PERIOD IN STRATFORD-ON-AVON DEPENDING ON EFFICIENCY LEVELS OF NEW HOMES



4.3.1 **Planned Water Availability Summary**

The revised 2014 dWRMP for STW has been used to summarise water availability to meet the projected demand for Stratford-on-Avon District Council covering the planning period to 2040.

Severn Trent Water – Strategic Grid Water Resource Zone

In the previous STW 2009 WRMP, the Stratford-on-Avon District was located within two Water Resources Zones (WRZs): WRZ3 Severn and WRZ4 Birmingham. In 2010, STW carried out a review of its six WRZs in order to comply with the Environment Agency definition that a WRZ is the “largest possible zone in which customers share the same risk of a resource shortfall”. The Stratford-on-Avon District is now located within the Strategic Grid WRZ, the largest of STW’s 15 WRZs.

The Strategic Grid WRZ includes the two main abstraction catchments covering the Stratford-on-Avon District, the Warwickshire Avon CAMS (which covers the majority of the study area) and the Tame, Anker and Mease CAMS (which covers the north east of the study area). There are water resource issues affecting both groundwater and surface water. Aquifers are under pressure in a number of areas. The River Severn is a major source of water with five key water supply abstractions with potential to impact on a number of SPA, cSAC and Ramsar sites. Within these CAMS there are 171 water dependent SSSIs and 13 Natura 2000 sites.

There is a continued supply-demand risk within the Strategic Grid WRZ, which worsens over the planning period. There is a forecast deficit in 2019-20 which remains negative and is estimated to be approximately -86 MI/d in 2039-40.

Supply-Demand Strategy

STW have identified a number of schemes that will benefit the Strategic Grid WRZ and help to reduce the supply-demand deficit. The strategy is to:

- increase Uckington output in the Shelton zone to facilitate Upper Worfe flow augmentation which will be re-abstracted into the Strategic Grid zone from the River Severn (2015-2020);
- Whitacre aquifer storage and recovery to utilise spare resource and treatment capacity during periods of low demand (2020-2025);
- implement the following schemes to maximise the sustainable use of existing resources:
 - Trimpley-Worcestershire groundwater conjunctive use (2020-2025);
 - Draycote reservoir 6% expansion (2020-2025);
 - Bromsgrove groundwater licence transfer (2020-2025);
 - Upper and Lower Worfe flow augmentation (2020-2025);
- continue to reduce leakage; and,
- carry out measures to help customers become more water efficient and reduce their demand.

This strategy ensures that STW maintain a headroom surplus throughout the planning period.

4.4 Water Efficiency Plan

Through a series of demand management measures and improvement of existing resources (which have been approved at a strategic level by the Environment Agency, Natural Resources Wales and Natural England), STW is predicting a supply surplus of available water in 2040 within the WRZ located within Stratford-on-Avon District, which would provide sufficient water supply to supply the levels of growth within the district through the plan period.

Since development within the District is not proposed to exceed that for which STW are planning, there is no need to evaluate the impacts of water supply in the district independently of the WRMP and its assessments.

However, there are several key drivers for ensuring that water use in the development plan period is minimised as far as possible. This WCS therefore includes an assessment of the feasibility of achieving a 'water neutral' position after growth across the district.

As is the case for all sustainable use of resources, the three 'R's of reduce, reuse and recycle are key to maximising the sustainability and reduce is the first and arguably most important element of sustainable water use to consider.

4.5 Drivers and Justification for Water Efficiency

The study area, and West Midlands generally, is an area of moderate water stress²⁹. Any growth and increase in population will further exacerbate this issue. In addition, the key sources of raw water (rivers and aquifers) supplying Stratford-on-Avon District Council are

²⁹ As classified by the Environment Agency

considered to be close to their limit of water they can continue to yield for abstraction, before ecosystems and other users reliant on these sources would be adversely affected.

In order to ensure surplus raw water supply for growth in the study area, STWs water resource plan over the next 25 years is reliant on more efficient use of existing resources and demand reduction from customers. The proposals and opportunities for new resources are limited, in the main due to the limitation on available new resources locally, which means that looking beyond the next 25 years, further new resources would likely need to be transferred into the area to cater for further increases in population and hence water demand. This creates a very strong driver for new homes in the next 25 years to be made as efficient as economically possible to safeguard the future resources to be made available by STW in the study area,

Stratford-on-Avon District Council is aspiring to promote sustainable development within the District, as such higher levels of efficiency should be considered as part of this WCS and its recommendations for the LDF more widely.

STW have to consider new measures to address supply and demand deficits within the WRZ serving Stratford-on-Avon. Therefore, measures should be taken to reduce demand from new property as far as possible.

Climate Change and Availability of Water

It is predicted that climate change will further reduce the available water resources in Stratford-on-Avon District as rainfall patterns change to less frequent, but more extreme, rainfall events. Climate change and sustainability reductions of abstraction licences are thought to be the most significant risk to water supplies from 2020 and beyond in the Strategic Grid WRZ.

Managing Climate Change

STW recognise in their Strategic Direction Statement³⁰ that the effects of climate change will be a key challenge over the 25 year plan period with the need to increase resilience of assets to cope with greater weather extremes. Similarly within their revised 2014 dWRMP STW highlight that climate change and the Restoring Sustainable Abstraction (RSA) programme are the most significant risks to long term supply/demand balance.

Customers expect STW to provide a continuous supply of water, but the resilience of the supply systems have the potential to be affected by the impact of climate change with severe weather-related events, such as flooding or an 'outage' incident at a source works supplying one of the major centres of population in the region. In STW's PR14 submission, STW addressed the impacts of climate change with a focus on making more sustainable use of existing supplies, through investment in leakage reduction and meter installation.

In planning for future water resources availability, STW have accounted for the impacts of climate change within their calculations of available raw water for use and forecast demand. STW has used assumptions on climate change impacts based on the UKCIP02 scenarios, the information on sustainability changes provided at the time by the Environment Agency and the Environment Agency' Water Resources Plan guideline.

Sustainability Reductions

The STW revised 2014 dWRMP highlights that the Natural Resources Wales' RoC on the River Wye is a significant risk to short term and long term supply/demand balance. After

³⁰ Severn Trent Water (2007) Focus on Water, Strategic Direction Statement 2010 - 2035

reviewing alternative operating scenarios for the Elan Valley system with Natural Resources Wales, the Environment Agency and members of the Usk and Wye Abstractors Group, STW calculated the loss of deployable output from this scheme to be 40MI/d for the Strategic Grid WRZ. However, it is predicted that STW can accommodate this loss by 2020 through plans to reduce leakage and commercial demand. The other abstraction licence reduction schemes across the zone will amount to a further loss of 5MI/d.

Impact on Supplies

STW have undertaken analysis of the impacts of climate change on the future availability of their water resources on both their groundwater and surface water sources, and incorporated these results into their assessment of deployable output. The analysis involved processing 20 'smart' sampled³¹ UKCP09 projections through a number of recognised climate change model methods, for the groundwater and surface water sources in the WRZs considered the most vulnerable to the potential impacts of climate change. The results identified a more significant impact on surface water source yield (reservoir and direct intake) than for groundwater. The results were then processed through the STW Aquator Water Resource model to determine what impact they would have on the Dissolved Oxygen (DO) of each STW WRZ. The Strategic Grid WRZ is impacted by a reduction in surface water flows and reduced reservoir refill.

The impact of climate change on water resources over the plan period within the Strategic Grid WRZ is estimated at a decrease of 55.5 MI/d, whilst the combined impact from confirmed and likely sustainability reductions, and climate change is estimated at a decrease of 100.5 MI/d by 2040.

Impact on Demand

The main impact of climate change on demand is related to periods of extremely hot and dry weather that will increase the peak demand for water. STW have accounted for the impact on the peak demand and the longer duration effect of a dry year through applying factors to the household and non-household water consumption rate in their supply-demand modelling.

Although STW have planned for the anticipated impacts of climate change, the view of STW and other water companies is that, in order to manage the effects of climate change effectively, the single most cost effective step in water resources climate change resilience is to manage demand downwards. The reduction in demand will also help to reduce carbon emissions which aids in reducing impacts of climate change.

4.6 Water Neutrality

4.6.1 *What is Water Neutrality?*

Water neutrality is a concept whereby the total demand for water within a planning area after development has taken place is the same (or less) than it was before development took place³². If this can be achieved, the overall balance for water demand is 'neutral', and there is considered to be no net increase in demand as a result of development. In order to achieve this, new development needs to be subject to planning policy which aims to ensure that where possible, houses and businesses are built to high standards of water efficiency through the use of water efficient fixtures and fittings, and in some cases rainwater harvesting and greywater recycling.

³¹ using a Latin Hypercube Sampling method.

³² Water Neutrality is defined more fully in the Environment Agency report 'Towards water neutrality in the Thames Gateway' (2007)

It is theoretically possible that neutrality can be achieved within a new development area, through the complete management of the water cycle within that development area. In addition to water demand being limited to a minimum, it requires:

- all wastewater to be treated and re-used for potable consumption rather than discharged to the environment;
- maximisation of rainwater harvesting (in some cases complete capture of rainfall falling within the development) for use in the home; and
- abstraction of local groundwater or river flow storage for treatment and potable supply.

Achieving 'total' water neutrality within a development remains an aspirational concept and is usually only considered for an eco-town or eco-village type development, due to the requirement for specific catchment conditions to supply raw water for treatment and significant capital expenditure. It also requires specialist operational input to maintain the systems such as wastewater re-use on a community scale. Total neutrality for a single development site is yet to be achieved in the UK.

For the majority of new development, in order for the water neutrality concept to work, the additional demand created by new development needs to be offset in part by reducing the demand from existing population and employment. Therefore, a 'planning area' needs to be considered where measures are taken to reduce existing or current water demand from the current housing and employment stock. The planning area in this case is considered to be Stratford-on-Avon District Council as a whole.

Twin-Track Approach

Attainment of water neutrality requires a 'twin track' approach whereby water demand in new development is minimised as far as possible, whilst at the same time taking measures, such as retrofitting of water efficient devices on existing homes and business to reduce water use in existing development.

In order to reduce water consumption and manage demand for the limited water resources within the study area, a number of measures and devices are available³³. Generally, these measures fall into two categories due to cost and space constraints, as those that should be installed in new developments and those which could be retrofitted. Appendix 5 provides more detail on the different types of device or system along with the range of efficiency savings they could lead to.

Achieving Total Neutrality – is it feasible?

When considering neutrality within an existing planning area, it is recognised by the Environment Agency³⁴ that achievement of total water neutrality (100%) for new development is often not possible, as the levels of water savings required in existing stock may not be possible for the level of growth proposed. A lower percentage of neutrality may therefore be a realistic target, for example 50% neutrality.

This WCS therefore considers four water neutrality targets and sets out a 'pathway' for how the most likely target (or level of neutrality) can be achieved. The pathway concept is discussed in more detail in Appendix 5, and highlights the importance of developing local policy in Stratford-on-Avon District for delivering aspirations like water neutrality as well as understanding the additional steps required beyond 'business as usual' required to achieve it.

³³ Source: Water Efficiency in the South East of England, Environment Agency, April 2007.

³⁴ Environment Agency (2009) *Water Neutrality, an improved and expanded water management definition*

4.6.2 *Water Neutrality Scenarios*

Four water neutrality targets have been proposed and assessed. Each target moves beyond the Business as Usual scenario which is considered to be:

- 105l/h/d for new affordable homes³⁵ and 125 l/h/d for all other new homes³⁶;
- no mandatory efficiency target for non-domestic property; and,
- continued meter installation in existing homes as planned in STW's WRMP up to 2040.

The existing level of metering within the STW region is 35%. STW's future target for meter penetration³⁷ on domestic water meters is 68% by 2040.

The WRMP assumes this rate will continue to the target of 68% of customers metered by 2040. Therefore, the Water Neutrality scenarios could assume a further 32% meter penetration within the existing housing stock by the end of the plan period in line with STW's WRMP.

The water neutrality scenarios have been developed based on the following generic assumptions. For clarity, Stratford-on-Avon District Council has been considered as a whole when assessing the scenarios:

Very High Scenario

The key assumptions for this scenario are:

- it assumes water neutrality is achieved, however it is considered as aspirational only as it is unlikely to be feasible based on:
- existing research into financial viability of such high levels of water efficiency measures in new homes; and,
- uptake of retrofitting water efficiency measures considered to be at the maximum achievable (35%) in the county.

It would require:

- a significant funding pool and a specific joint partnership 'delivery plan' to deliver the extremely high percentage of retrofitting measures required;
- strong local policy within the LDF on restriction of water use in new homes on a district scale which is currently unprecedented in the UK; and,
- all new development to include water recycling facilities across the district which is currently limited to small scale development in the UK.

The scenario has been developed as a context to demonstrate what is required to achieve the full aspiration of water neutrality.

High Scenario

The key assumptions for this scenario are:

³⁵ Levels 3 and 4 – Code for Sustainable Homes

³⁶ Building regulations Part G Requirement

³⁷ proportion of properties within the STW supply area which have a water meter installed

- A high water neutrality percentage³⁸ is achieved but requires significant funding and partnership working, and adoption of new local policy which is currently unprecedented in the UK.

It would require:

- Uptake of retrofitting water efficiency measures to be very high (25%) in relation to studies undertaken across the UK;
- a significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required; and,
- strong local policy within the LDF on restriction of water use in new homes on a district scale which is currently unprecedented in the UK;

It is considered that, despite being at the upper scale of percentage uptake of retrofitting measures, it is technically and politically feasible to obtain this level of neutrality if a fully funded joint partnership approach could be developed.

Medium Scenario

The key assumptions for this scenario are:

- The water neutrality percentage³⁹ achieved is at least 50% of the total neutrality target and would require funding and partnership working, and adoption of new local policy which has only been adopted in a minimal number of LDFs in the UK.

It would require:

- Uptake of retrofitting water efficiency measures to be reasonably high (20%) in the county;
- a significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required; and,
- local policy within the LDF on restriction of water use in new homes on a district scale which goes beyond that seen generally in the UK.

It is considered that it is technically and politically feasible to obtain this level with a relatively modest funded joint partnership approach and with new developers contributing relatively standard, but high spec water efficient homes.

³⁸ WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue

³⁹ WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue

Low Scenario

The key assumptions for this scenario are:

- The water neutrality percentage⁴⁰ achieved is low but would require small scale level of funding and partnership working, and adoption of new local policy which is likely to be easily justified and straightforward for developers to implement; and,

It would require:

- Uptake of retrofitting water efficiency measures to be fairly low (10%);
- a relatively small funding pool and a partnership working not moving too far beyond 'business as usual' for stakeholders; and,
- local policy within the LDF on restriction of water use would be easy to justify and implement.

It is considered that it is technically and politically straightforward to obtain this level with a small funded joint partnership approach and with new developers contributing standard, but water efficient homes with a relative low capital expenditure.

4.6.3 *Neutrality Scenario Assessment Results*

To achieve total water neutrality, the demand post growth must be the same as, or less than existing demand. Based on estimates of population size, existing demand in Stratford-on-Avon District was calculated to be 14.9 Ml/d.

For each neutrality option and scenario, an outline of the required water efficiency specification was developed for new houses, combined with an estimate of the savings that could be achieved through metering and further savings that could be achieved via retrofitting of water efficient fixtures and fittings in existing property. This has been undertaken utilising research undertaken by groups and organisations such as Waterwise, UKWIR⁴¹, the Environment Agency and Ofwat to determine realistic and feasible efficiency savings as part of developer design of properties, and standards for non-residential properties (Appendix 5).

For each neutrality scenario, total demand was then calculated at three separate stages for housing as follows:

- Stage 1 – total demand post growth without any assumed water efficiency retrofitting for the differing levels of water efficiency in new homes;
- Stage 2 – total demand post growth with effect of metering applied for the differing levels of water efficiency in new homes; and,
- Stage 3 – total demand post growth with metering and water efficient retrofitting applied to existing homes for the differing levels of water efficiency in new homes. Two Water neutrality options have been undertaken. The first option assumes that all of the properties that would remain unmetered by 2035 (the end of STW's WRMP period) would be metered in addition by STW as a specific initiative for the WCS for the Medium, High and Very High water neutrality scenarios. The second looks at STW undertaking a more realistic 'additional' 10% metering initiative (on top of the WRMP commitment), which equates to approximately 1,600 homes.

⁴⁰ WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue

⁴¹ UKWIR – The United Kingdom Water Industry Research group, attended and part funded by all major UK water companies

Option 1

Table 4-1 details the results for achieving total Water Neutrality. This assumes that all properties remaining unmetered in 2040 (at the end of STW's WRMP period) would be metered in addition, through a specific initiative in conjunction with Stratford-on-Avon District Council for the WCS for the medium, high and very high scenarios. If neutrality is achieved, the result is displayed as green. If it is not, but within 20%, it is displayed as amber, and red if not achieved. The percentage of total neutrality achieved per scenario is also provided.

TABLE 4-1: WATER NEUTRALITY SCENARIO ASSESSMENT – OPTION 1

New Homes & Employment Demand Projections	Demand from Growth (MI/d)	Total demand post growth* (MI/d)	Total demand after metering effect (MI/d)	Total demand after metering & WE F&F (MI/d)	% Neutrality Achieved
Baseline Assumption	3.47	18.38	17.78	17.78	13%
Building Regulations	3.31	18.22	17.62	17.62	18%
Low WN Scenario	3.17	18.08	17.48	17.37	26%
Medium WN Scenario	2.78	17.69	16.51	15.84	72%
High WN Scenario	2.07	16.98	15.80	14.42	100%
Very High WN Scenario	1.64	16.55	15.37	13.45	100%

* prior to demand management for existing stock

The results show that total neutrality is achieved by applying the high scenario, whilst the medium neutrality scenario gives 72% neutral water use. This is mainly on the basis that 100% metering (i.e. a further 32% of all current properties metered beyond what STW are currently planning) would offset a large proportion of the additional demand from new development.

Option 2

Table 4-2 details the results for undertaking a more realistic additional metering initiative with Stratford-on-Avon District Council and assuming that only 10% of households that remain unmetered in 2040 (at the end of STW's WRMP period) would be metered additionally (equates to 1,600 dwellings). If neutrality is achieved, the result is displayed as green. If it is not, but within 20%, it is displayed as amber, and red if not achieved. The percentage of total neutrality achieved per scenario is also provided.

TABLE 4-2: WATER NEUTRALITY SCENARIO ASSESSMENT – OPTION 2

New Homes & Employment Demand Projections	Demand from Growth (MI/d)	Total demand post growth* (MI/d)	Total demand after metering effect (MI/d)	Total demand after metering & WE F&F (MI/d)	% Neutrality Achieved
Baseline Assumption	3.47	18.38	17.78	17.78	13%
Building Regulations	3.31	18.22	17.62	17.62	18%
Low WN Scenario	3.17	18.08	17.48	17.37	26%
Medium WN Scenario	2.78	17.69	17.04	16.37	56%
High WN Scenario	2.07	16.98	16.32	14.95	99%
Very High WN Scenario	1.64	16.55	15.89	13.97	100%

* prior to demand management for existing stock

The results show that total neutrality is achieved by applying the very high scenario, whilst the high neutrality scenario gives 99% neutral water use, and the medium neutrality scenario gives 56% neutral water use.

4.6.4 *Delivery Requirements – Technological*

The details of what is required technologically from each scenario in terms of new build are included in Table 4-3.

TABLE 4-3: DETAILS OF NEW BUILD SPECIFICATION REQUIRED TO MEET EACH WATER USE TARGET

Component	150 l/h/d Standard Home	Business as usual	Low (120 l/h/d CSH Level 1/2)	Medium (105 l/h/d CSH Level 3/4)	High (80 l/h/d CSH Level 5/6)	Very High
Toilet flushing	28.8	19.2 b	19.2 b	16.8 d	16.8 d	16.8 d
Taps	42.3 a	31.8 a	31.8 a	24.9 a	18 a	18 a
Shower	30	30	24	18	18	18
Bath	28.8 c	25.6 c	25.6 c	25.6 c	22.4 f	22.4 f
Washing Machine	16.7	15.3	15.3	15.3	15.3	15.3
Dishwasher	3.9	3.9	3.6	3.6	3.6	3.6
Recycled water					-16.1 e	-32.2 g
Total per head	150.5	125.8	119.5	104.2	78	61.9
Total per household	325.08	271.728	258.12	225.072	168.48	133.704

- a Combines kitchen sink and wash hand basin
- b 6/3 litre dual-flush toilet (f) recycled water
- c 160 litre bath filled to 40% capacity, frequency of use 0.4/day
- d 4.5/3 litre dual flush toilet
- e Rainwater harvesting
- f 120 litre bath
- g Rainwater/greywater harvesting for toilet and washing machine

More detail on the specific measures required under each scenario can be found in Appendix 5.

4.6.5 *Financial Cost Considerations*

There are detailed financial and sustainability issues to consider in deciding on a policy for water neutrality. Whilst being water efficient is a key consideration of this study, due to the wider vision for sustainable growth in the district, reaching neutrality should not be at the expense of increasing energy use and potential increasing the carbon footprint of development

It is also important to consider that through using less water, more water efficient homes require less energy to heat water, hence there are energy savings. These elements are broken down in more detail in Appendix 5.

The financial cost of delivering the technological requirements of each neutrality scenario have been calculated from available research and published documents. Summary tables below should be reviewed with Appendix 5 for supporting information.

Neutrality scenario costs

Using the information compiled, the financial costs per scenario has been calculated and are included in Table 4-4 (based on undertaking Water Neutrality Option 1) and Table 4-5 (based on undertaking Water Neutrality Option 2). It should be noted that these are only estimate costs.

TABLE 4-4: ESTIMATED COST OF NEUTRALITY SCENARIOS – OPTION 1

Neutrality Scenario	CSH – Code Level	Outstanding Homes		Existing Properties					Costs Summary		
		Numbers	CSH cost	No. to be metered (10% existing)	Metering cost	Retrofit %	No. to retrofit	Retrofit cost	Developer	Non developer	Total
Low	1 or 2	12,620	-	17,344	£8,672,000	10%	5420	£271,000	-	£8,943,000	£8,943,000
Medium	3 or 4	12,620	£1,577,500	17,344	£8,672,000	20%	10840	£1,788,600	£1,577,500	£10,460,600	£12,038,100
High	5 or 6 (RWH)	12,620	£33,379,900	17,344	£8,672,000	25%	13550	£2,981,000	£33,379,900	£11,653,000	£45,032,900
Very High	5 or 6 (RWH & GWR)	12,620	£50,543,100	17,344	£8,672,000	35%	18970	£4,173,400	£50,543,100	£12,845,400	£63,388,500

TABLE 4-5: ESTIMATED COST OF NEUTRALITY SCENARIOS – OPTION 2

Neutrality Scenario	CSH – Code Level	Outstanding Homes		Existing Properties					Costs Summary		
		Numbers	CSH cost	No. to be metered (10% existing)	Metering cost	Retrofit %	No. to retrofit	Retrofit cost	Developer	Non developer	Total
Low	1 or 2	12,620	-	1,734	£867,200	10%	5420	£271,000	-	£1,138,200	£1,138,200
Medium	3 or 4	12,620	£1,577,500	1,734	£867,200	20%	10840	£1,788,600	£1,577,500	£2,655,800	£4,233,300
High	5 or 6 (RWH)	12,620	£33,379,900	1,734	£867,200	25%	13550	£2,981,000	£33,379,900	£3,848,200	£37,228,100
Very High	5 or 6 (RWH & GWR)	12,620	£50,543,100	1,734	£867,200	35%	18970	£4,173,400	£50,543,100	£5,040,600	£55,583,700

4.6.6 *Carbon Cost Considerations*

As described in this section, there are sustainability issues to consider when considering a policy for promotion of water efficiency and water neutrality. Reaching the very highest levels of efficiency requires the use of recycling technology (either through rainwater harvesting and treatment or greywater recycling) which requires additional energy both embedded in the physical structures required and also in the treatment process required to make the water usable. More detail is provided in Appendix 5 on the methodology used to calculate carbon equivalents of energy used.

The WRMP Direction 2007⁴² and WRP Guideline⁴³ require details of the greenhouse gas emissions that are likely to arise through the delivery of a water company's proposed WRMP. STW estimated⁴⁴ these from calculation of greenhouse gases as tonnes of carbon dioxide equivalent (tCO₂e) for the base year 2007-08 of 251,683 tCO₂e for drinking water treatment and distribution. For subsequent years the value of 0.36 tCO₂e/MI⁴⁵ has been used with the forecast demand to give the mass of CO₂e likely to be emitted on the basis of current technologies. In order to calculate the carbon costs of achieving water efficiency for the proposed growth in Stratford-on-Avon District Council, the value of 0.36 tCO₂e/MI has been used.

Results

The information was used along with estimates of energy used in recycling technology⁴⁶ to provide a carbon cost for each of the WN scenarios for Stratford-on-Avon District. The results are presented in Table 4-6.

The following assumptions have been applied:

- under the 'High' and 'Very high' scenarios, consideration must be taken of carbon use in rainwater harvesting as well as water use;
- A basic assumption that each new home is a 90m² 2-storey house with a small biological system; and,
- insufficient information was available to differentiate between energy used in a building regulations standard home at 125l/h/d and a CSH Code Level 1 or 2 home. Therefore, energy used per home is the same for 'business as usual (i.e. building regulations) and the low WN scenario.

⁴² WRMP Regulations Statutory Instrument 2007 No. 727, WRMP Direction 2007, WRMP (No.2) Direction 2007, WRMP (No.2) (Amendment) Direction 2007, WRMP Direction 2008

⁴³ Water resources planning guideline, Environment Agency, November 2008, <http://www.environment-agency.gov.uk/business/sectors/39687.aspx>

⁴⁴ Severn Trent Water, Greenhouse Gas Emission Data, 2002-2009 & 2010/2011

⁴⁵ Based on the Severn Trent Water 2010 WRMP.

⁴⁶ Environment Agency (2010) Energy and carbon implications of rainwater harvesting and greywater recycling

TABLE 4-6: CARBON COSTS OF WATER NEUTRALITY SCENARIOS

WN Scenario	Relevant CSH Target	Water Use Reductions from retrofit pre WN Scenario (Ml/d)	Carbon reduction per WN scenario (tCO ² e/d)	Carbon use per New Home (kg/y)	Carbon use per New Home (kg/d)	Total Carbon use for New Homes (tCO ² e/d)	Total (tCO ² e/d)
Business as Usual	Building Regs Only	0.00	0.00	681	1.87	17.21	17.21
Low	Level 1/2	0.11	-0.04	681	1.87	17.21	17.17
Medium	Level 3/4	0.67	-0.24	582	1.59	14.70	14.46
High	Level 5/6	1.37	-0.49	578	1.58	14.60	14.11
Very High	Level 5/6	1.92	-0.69	614	1.68	15.54	14.84

The results show that there are significant CO² savings to be made by homes being built to a higher water efficiency level and from the effect of existing homes using less energy to heat water through retrofitting of water efficient devices.

The additional energy used per house for RWH in the High scenario is offset by the savings made in using less water in line with Code Level 5/6 on the CSH; however the additional energy required for greywater recycling in the very high scenario makes this scenario higher in CO² emissions than both the medium and high WN scenarios. This suggests that in order to meet total neutrality there will be an increase in CO² emissions over less intensive WN scenarios and hence there are concerns over the long term sustainability of pursuing such a strategy.

4.6.7 Preferred Strategy – Delivery Pathway

The assessment of water neutrality in this WCS has been undertaken to demonstrate whether moving towards neutrality is feasible and what the cost, and technological implications might be to get as close to neutrality as possible.

To achieve any level of neutrality, a series of policies, partnership approaches and funding sources would need to be developed. This WCS has assumed a ‘medium’ scenario would be favoured and sets out what would be required to support this strategy. This ‘medium’ WN scenario would allow a WN target of 56% to be reached if an additional 10% of households that remain unmetered in 2040 are metered, or a WN target of 72% to be reached if all the households that remain unmetered in 2040 are additionally metered. The medium scenario is considered to require a significant funding pool and a specific joint partnership ‘delivery plan’ to deliver the high percentage of retrofitting measures, as well as the adoption of new local policy within the LDF on restriction of water use in new homes on a district scale which goes beyond that seen generally in the UK

It is considered that it is technically and politically feasible to obtain this level with a relatively modest funded joint partnership approach and with new developers contributing relatively standard, but high spec water efficient homes.

Depending on the success of the first step to neutrality, higher WN scenarios could be aspired to by further developing policies and partnership working to deliver greater efficiencies.

Delivery Requirements – Policy

In order to meet the medium WN scenario, the following measures are suggested to support its delivery.

In order to meet the water neutrality target scenario given above, the following planning policy is recommended:

POLICY RECOMMENDATION 1

Ensure all housing is water efficient, new housing development must go beyond Building Regulations and as a minimum reach Code for Sustainable Homes Level 3 or 4 for water. Where appropriate, specific developments should be identified for water re-use/greywater features to be included.

Ensure all non-residential development is water efficient and goes beyond Building Regulations and as a minimum reach Good BREEAM status.

Developers should prove that the appropriate Code Level for water has been met. When considering planning applications for new development (regardless of size), the planning authority and all consultees should consider whether the proposed design of the development has incorporated water efficiency measures, including (but not necessarily limited to) garden water butts, low flush toilets, low volume baths, aerated taps, and water efficient appliances. New commercial and industrial developments should seek every opportunity to maximise rainwater harvesting, and water efficiency within their development and within their internal processes.

In addition, it is recommended that the following policies be introduced, to assist with the implementation of the above planning policy:

POLICY RECOMMENDATION 2

Carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings. Aim to move towards delivery of 10% of the existing housing stock, additional to that in the WRMP, with easy fit water saving devices.

Policy Recommendation 2 must work in parallel with the promotion and education programme outlined in Policy Recommendation 3. Further recommendations on how to achieve it are included in Section 4.6.8 below, including recommended funding mechanisms.

POLICY RECOMMENDATION 3

Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

4.6.8 *Delivery Requirements – Partnership Approaches*

Housing association partners should be targeted with a programme of retrofitting water efficient devices, to showcase the policy and promote the benefits. This should be a collaborative scheme between the Stratford-on-Avon District Council, STW, TW and Waterwise. In addition, RWH/GWR schemes could be implemented into larger council owned

and maintained buildings, such as schools or community centres. RWH could be introduced to public toilets.

The retrofitting scheme should then be extended to non-Council owned properties, via the promotion and education programme outlined by Policy Recommendation 3.

A programme of water audits should be carried out in existing domestic and non-domestic buildings, again showcased by Council owned properties, to establish water usage and to make recommendations for improving water efficiency measures. The water audits should be followed up by retrofitting water efficient measures in these buildings, as discussed above. In private non-domestic buildings water audits and retrofitting should be funded by the asset owner, the cost of this could be offset by the financial savings resulting from the implementation of water efficient measures. Funding options for domestic properties are discussed above.

In order to ensure the uptake of retrofitting water efficient devices for non-council properties, Stratford-on-Avon District Council should implement an awareness and education campaign, which could include the following:

- working with STW (and TW) to help with its water efficiency initiative, which has seen leaflets distributed directly to customers and at events across the region each year;
- a media campaign, with adverts/articles in local papers and features on a local news programme;
- a media campaign could be supplemented by promotional material, ranging from those that directly affect water use e.g. free cistern displacement devices, to products which will raise awareness e.g. fridge magnets with a water saving message;
- encouraging developers to provide new residents with 'welcome packs', explaining the importance of water efficiency and the steps that they can take to reduce water use;
- working with retailers to promote water efficient products, possibly with financial incentives as were undertaken as part of the Preston Water Initiative⁴⁷;
- carrying out educational visits to schools and colleges, to raise awareness of water efficiency amongst children and young adults;
- working with neighbourhood trusts, community groups and local interest groups to raise awareness of water efficiency; and,
- carrying out home visits to householders to explain the benefits of saving water, this may not be possible for the general population of Stratford-on-Avon District Council, but rather should be used to support a targeted scheme aimed at a specific residential group, as was carried out for the Preston Water Initiative.

Responsibility

The recommendations above are targeted at Stratford-on-Avon District Council and STW, as these are the major stakeholders, although the Environment Agency and other statutory consultees can also influence future development to ensure the water neutrality target is achieved.

It is therefore suggested that responsibility for implementing water efficiency policies be shared as follows:

⁴⁷ Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

- responsibility for ensuring planning applications are compliant with the recommended policies lies with Stratford-on-Avon District Council and Environment Agency (and other statutory consultees as appropriate);
- responsibility for fitting water efficient devices in accordance with the policy lies with the developer, but this should be guided and if necessary enforced by Stratford-on-Avon District Council through the planning application process (as above);
- responsibility to ensure continuing increases in the level of water meter penetration lies with STW and TW;
- responsibility for retrofitting devices lies solely with Stratford-on-Avon District Council for Council owned housing stock and with Stratford-on-Avon District Council and developers (via section 106 agreements and CIL) for privately owned housing stock;
- responsibility for promoting water audits lies with Stratford-on-Avon District Council. It is suggested that the Council sets targets for the numbers of businesses that have water audits carried out and that a specific individual or team within the Council is responsible for promoting and water audits and ensuring the targets are met. The same team or individual could also be act as a community liaison for households (council and privately owned) and businesses where water efficient devices are to be retrofitted, to ensure the occupants of the affected properties understand the need and mechanisms for water efficiency; and
- responsibility for education and awareness of water efficiency should be shared between Stratford-on-Avon District Council, STW, TW and energy companies, as a partnership managed by the Council.

However it should be noted that a major aim of the education and awareness programme, as outlined by Policy Recommendation 2, is to change peoples' attitude to water use and water saving and to make the general population understand that it is everybody's responsibility to reduce water use. Studies have shown that the water efficiencies in existing housing stock achieved by behavioural changes, such as turning off the tap while brushing teeth or reducing shower time, can be as important as the installation of water efficient devices.

Retrofitting funding options

In addition to possible resistance from existing householders, the biggest obstacle to retrofitting is the funding mechanism.

Water companies are embarking on retrofit as part of their response to meeting Ofwat's mandatory water efficiency targets. These programmes are funded out of operational expenditure. If a company has, or is forecasting, a supply-demand deficit over the planning period, water efficiency programmes can form part of a preferred option(s) set to overcome the deficit. However, these options are identified as part of the company's water resource management plans and will have to undergo a cost-benefit analysis.

Stratford-on-Avon District Council could consider developer contributions to the Community Infrastructure Levy (CIL) or through S106 agreements.

Part 11 of the Planning Act 2008⁴⁸ (c. 29) ("the Act") provides for the imposition of a charge to be known as Community Infrastructure Levy (CIL). This is a new local levy that authorities can choose to introduce to help fund infrastructure in their area. CIL will help pay for the infrastructure required to serve new development, and although CIL should not be used to remedy pre-existing deficiencies, if the new development makes the deficiency more severe

⁴⁸ <http://www.legislation.gov.uk/ukpga/2008/29/contents>

(as is the case with water resources in Stratford-on-Avon District) then the use of CIL is appropriate.

Section 106 (S106) of the Town and Country Planning Act 1990⁴⁹ allows a local planning authority (LPA) to enter into a legally-binding agreement or planning obligation with a landowner in association with the granting of planning permission, known as a Section 106 Agreement. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. They are increasingly used to support the provision of services and infrastructure, such as highways, recreational facilities, education, health and affordable housing.

However, there are considerable existing demands on developer contributions and it is unlikely that all of the retrofitting required in Stratford-on-Avon District Council could be funded through these mechanisms; they therefore need to look beyond developer contributions, possibly to the water companies, for further funding sources. Some councils offer council tax rebates to residents who install energy efficient measures (rebates jointly funded by the Council and Energy Company)⁵⁰. Stratford-on-Avon District Council should consider a similar scheme, although this would require the agreement of STW and TW.

There are two possible European funding mechanisms available for the promotion of water efficiencies:

- European Investment Bank; and,
- European Regional Development Funds.

The European Investment Bank's lending policy⁵¹ sets out how they will support water efficiency measures by water service providers and grant loans to promote water efficiency in buildings. This could be a possible funding route for a widespread retrofitting programme.

European Regional Development Funds are more limited, as funds are often preferentially directed towards energy efficiency projects, with the aim of reducing carbon emissions to achieve European targets. Allocated funding for the current programming period (2007 to 2013) are mainly allocated to such projects⁵², although the possibility for funding water efficiency project post-2013 should be investigated.

Retrofitting monitoring

During delivery stage, it will be important to ensure sufficient monitoring is in place to track the effects of retrofitting on reducing demand from existing housing stock. The latest research shows that retrofitting can have a significant beneficial effect and can be a cost effective way of managing the water supply-demand balance⁵³. However, it is acknowledged that savings from retrofitting measures do diminish with time. This means that a long-term communication strategy is also needed to accompany any retrofit programme taken forward. This needs to be supported by monitoring, so that messages can be targeted and water savings maintained in the longer-term. The communication and monitoring message also applies to new builds to maintain continued use of water efficient fixtures and fittings.

⁴⁹ <http://www.legislation.gov.uk/ukpga/1990/8/contents>

⁵⁰ Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

⁵¹ http://www.eib.org/attachments/strategies/water_sector_lending_policy_2008_en.pdf

⁵² Ensuring Water for All, Scoping Study Final Report, Environment Agency, 2010

⁵³ Waterwise (2011): Evidence base for large-scale water efficiency, Phase II Final report

4.7 Water Supply and Climate Change Adaption

Table 4-7 provides a summary of the potential climate change adaptation and mitigation measures that could be considered in Stratford-on-Avon District Council with regards to water resources and water supply infrastructure. The organisations likely to be responsible for leading these measures have been identified alongside the suggested timescale for these actions to start being taken forward (Immediate, Medium (1 - 10 years) and Long (10+ years).

TABLE 4-7: WATER RESOURCES POTENTIAL CLIMATE CHANGE ADAPTION AND MITIGATION MEASURES

Potential Climate Change	Potential Impact	Adaption and Mitigation Measures	Lead Organisation (s)				Timescale for Action
			SoA	EA	STW	NE	
Temperature Rise	<ul style="list-style-type: none"> • Increase in demand for water in summer • Increased evapotranspiration • Increased peak demand • Faster water supply asset deterioration • Changes in process efficiency 	Ensure regional drought plans take into account the impacts of climate change		✓	✓		Medium
		Manage seasonal changes in climate by reducing summer peaks in demand for water	✓		✓		Medium
		Contribute to managing water demand through increased water efficiency in homes, businesses, industry and agriculture and promotion of water efficiency measures	✓	✓	✓		Immediate
Winter rainfall increase	<ul style="list-style-type: none"> • Opportunity for more water storage • Inadequate pump capacity for raw water • Increased diffuse pollution 	Manage seasonal changes in climate by increasing winter storage			✓		Medium
		Endure adequate pump capacity for increased winter storage requirements			✓		Medium
		Where possible, control diffuse pollution runoff through SuDS, particularly for new / redevelopment close to river and water bodies	✓	✓	✓	✓	Immediate
Summer rainfall decrease	<ul style="list-style-type: none"> • More frequent low river flows • Increased competition for water • Increased peak demand • Changing customer expectations 	Manage seasonal changes in climate by reducing summer peaks in demand for water	✓		✓		Medium
		Contribute to managing water demand through increased water efficiency in homes, businesses, industry and agriculture and promotion of water efficiency measures	✓	✓	✓		Immediate
		Ensure that water abstraction is sustainable through monitoring		✓	✓		Medium
Increase in weather extremes (heatwaves, intense rainfall, storms)	<ul style="list-style-type: none"> • Increased run-off reduces recharge of aquifers • Decrease in raw water quality – increased treatment cost • Increased flooding and risk of service loss • Increased flooding and risk of service loss • Increased subsidence – pipe failure • Increased contamination / Peak demand delivery during heat waves 	Improve resilience of key water supply assets such as pumps, including new industry design standards for water assets			✓		Medium
		Where possible, control diffuse pollution runoff through SuDS, particularly for new / redevelopment close to river and water bodies	✓	✓	✓	✓	Immediate
		Improve RBMP Programme of Measures to ensure WFD objectives are met and include climate change allowance		✓			Medium

5 SETTLEMENT AREA ASSESSMENT

5.1 Introduction

Following the assessment of wastewater treatment capacity and water resources at the district level, this section of the WCS addresses infrastructure capacity issues related to the settlement area locations.

5.2 Settlement Area Assessment Methodologies

5.2.1 Wastewater Network

The wastewater strategy to cater for growth requires an assessment of the capacity of the wastewater network (sewer system) to accept and transmit wastewater flows from the new development to the WwTW for treatment.

An assumption has been applied that it is preferential from a cost and phasing perspective to use capacity within the existing sewer network first, before new sewers are built and commissioned.

The capacity of the existing sewer network is an important consideration for growth, as in some cases the existing system is already at, or over its design capacity. Further additions of wastewater from growth can result in sewer flooding in the system (affecting property or infrastructure) or can increase the frequency with which overflows to river systems occur, resulting in ecological impact and deterioration in water quality.

STW and TW have undertaken an internal assessment of the capacity of the network system using local operational knowledge.

The results are presented for each of the Settlement Areas in Section 5.3. A RAG assessment has been undertaken; a key indicating the coding applied to each assessment is provided in Table 5-1.

TABLE 5-1: KEY FOR WASTEWATER NETWORK RAG ASSESSMENT

Development is likely to be possible without upgrades	Pumping station or pipe size may restrict growth; a pre-development enquiry is recommended before planning permission is granted	There is limited capacity in the network, hence solution required to prevent further CSO discharges or sewer flooding
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5.2.2 Flood Risk

Fluvial

The flood risk to each of the Settlement Areas has been considered using the Environment Agency Flood Maps. A green coding has been applied if the majority of the Settlement Area is within Flood Zone (FZ) 1, whilst an amber coding has been applied if there are significant areas in FZ 2 or 3.

Surface Water Flood Risk

A County wide Surface Water Management Plan (SWMP) is currently being undertaken by Warwickshire County Council, as Lead Local Flood Authority (LLFA).

Surface water flooding has only been reviewed on a Settlement Area basis to provide an overview using the Flood Map for Surface Water (FMfSW) produced by the Environment Agency.

5.2.3 *Surface Water Management*

Surface water drainage methods that take account of run-off rates, water quality, pollution control, biodiversity and amenity issues are collectively referred to as Sustainable Drainage Systems (SuDS). Sustainable surface water management takes account of long term environmental and social factors in designing a surface water drainage system that avoids the problems of flooding, pollution or damage to the environment that may occur with conventional surface water management systems.

The National Planning Policy Framework (NPPF) sets out that proposed development should ensure runoff rates from the development are no greater than pre-development rates, and for developments requiring a flood risk assessment, discharge should be reduced to mitigate against the impacts of climate change.

In addition, local planning policy requires that proposed development does not result in an increase in surface water runoff. In order to ensure this, attenuation of runoff is required to manage surface water runoff generated during the 1% annual probability storm event, inclusive of climate change. The Environment Agency recommends that surface water discharge rates be reduced to the greenfield rate of run-off for all major developments.

The CFMP Policy for the Middle Avon, Tributaries, Arrow and Alne, Redditch which includes the area included within the water cycle study states that:

- The Environment Agency plans to reduce dependence on raised flood defences, as this is unsustainable in the long term, by taking opportunities to restore natural storage of floodwater on undeveloped floodplains.
- Surface water flooding is a growing problem. Local authorities are mainly responsible for managing this, but it often has to be integrated with other organisation's assets, for example sewers or rivers.
- Development/redevelopment must be managed to minimise flood risks. Methods must be sustainable over the long term. For example, making more space for rivers through urban areas via 'blue corridors' (i.e. restoring access for floodwater onto key strips of floodplain. This requires redevelopment to be limited to flood compatible land use e.g. parkland).

Policy recommendations:

- Encourage rural and urban best practices in land-use and land-management to restore more sustainable natural floodplains and to reduce run-off.
- Ensure that the run-off from all proposed development is minimised. For example, SuDS must be encouraged and targeted within planning approvals. Encourage the retro-fitting of SuDS where surface water flooding is already a problem.
- SuDS should be designed to support green infrastructure within developments, providing additional water quality and biodiversity benefits. There should be a presumption against underground storage of water.
- It may be beneficial for developers to contribute towards upstream flood storage to reduce the reliance of hard engineered solutions to manage flood risk on their site. The Environment Agency promotes a whole catchment approach to managing flood risk, and will proactively work to implement sustainable flood management schemes. This could be

delivered through a range of techniques including the creation of wetlands/formal flood storage areas, or through the use of woody debris dams:

- This innovative approach utilises trees, undergrowth and woody debris to increase the hydraulic “roughness” of the floodplain, slowing down the passage of flood flows.
- The trees and woody debris direct/concentrate flows, forming multiple channels and backwater pools, enhancing flood storage.
- The net effect is to delay and reduce the size of the flood peak.

Adoption and Maintenance of SuDS

Under the Flood and Water Management Act, responsibility for the adoption and maintenance of SuDS systems has been clarified. Before the implementation of the Act, maintenance and responsibility for SuDS systems in developments was inconsistent, with some SuDS systems becoming ineffective some time before their design life was exceeded, due to inadequate maintenance.

The Act will confirm the exact arrangement for adoption and maintenance of SuDS systems in 2014, but for the purposes of this WCS Update it should be assumed that:

- Warwickshire County Council will become responsible for the adoption and maintenance of new build SuDS;
- Warwickshire County Council will become the SuDS approving body (SAB) for all new build SuDS;
- the requirements for approving new build SuDS will be outlined in forthcoming national standards on the construction and operation of surface water drainage; and
- the current right to connect new developments to the existing public surface water sewerage network has been revoked and new surface water drainage systems will need to be approved in line with forthcoming National Sustainable Drainage Standards before any connection to the public sewerage network is allowed.

In light of the change in SuDS approval and maintenance, this WCS has undertaken a high level review of issues affecting potential SuDS options at specific sites, including:

- Environment Agency Flood Zone (potentially affecting space for surface attenuation features; and,
- Groundwater protection issues (see Section 5.2.4).

5.2.4 *Main Rivers*

Under the Water Resources Act, the Environment Agency is the consenting Authority for main rivers, and any works in, over, under or near a main river or a flood defence will need consent. A main river is a watercourse that is shown on a main river map and includes any structure or appliance for controlling or regulating the flow of water into, in or out of the channel.

Developers need to obtain Environment Agency consent to ensure that their activities do not cause or make existing flood risk worse, interfere with Environment Agency work, and do not adversely affect the local environment, fisheries or wildlife.

Policy recommendations:

- Watercourses should not be culverted or straightened, as these activities cause deterioration of their quality;

- Where watercourses have in the past been culverted or straightened, reinstatement to a more natural landscape should form part of the development;
- Each development should enhance the quality of the local watercourse,
- A minimum easement of 8 meters from the top of bank of a main river is required to allow maintenance of the watercourse. Where possible a larger easement should be provided.

5.2.5 *SuDS and Groundwater Protection*

When considering infiltration SuDS, developers should consider the following with respect to protection of groundwater quality in the study area. The water environment is potentially vulnerable and there is an increased potential for pollution from inappropriately located and/or designed infiltration SuDS.

There are no Environment Agency designated Source Protection Zones (SPZ) within the Stratford-on-Avon District Council area. However, the following considerations should be taken into account with respect to infiltration SuDs:

- Soakaways and other infiltration SuDS must not be constructed in contaminated ground. The use of infiltration drainage would only be acceptable if a phased site investigation (in line with CLR11, 'Model Procedures for the Management of Land Contamination') showed the presence of no significant contamination. The use of non-infiltration SUDS may be acceptable subject to agreement with the Environment Agency. More information on SuDS is available in the SuDS Manual produced by Warwickshire County Council.
- The Environment Agency considers that deep boreholes and other deep soakaways systems are not appropriate in areas where groundwater constitutes a significant resource. Deep soakways increase the risk of groundwater pollution.

5.3 Settlement Area Assessment

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
1	Alcester	MRC	STW	Alcester	The extensive flooding previously noted has been resolved by a project completed towards the end of 2012. This project will have taken into account the extra flows from the proposed development. Provided foul only flows are connected into the system and surface water is dealt with sustainably, subject to the downstream pumping station capacity, it is not envisaged that these developments will cause any adverse impact.	Surface water flooding identified in the north of the MRC. Appears to be associated with ordinary watercourse.	The area to the north-east and west are in FZ 1. The centre of the MRC from north to south is in FZ 2 and FZ 3 of the River Arrow. The south is in FZ 2 and FZ 3 of the River Alne and River Arrow. There is a history of flooding.	River Arrow, River Alne	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the River Arrow
2	Alderminster	LSV	STW	Preston on Stour	A series of PS in the foul combined system in Alderminster eventually discharge to Bell Inn PS which discharges pumped flow to Wimpstone. There are no known operational or capacity issues within the catchment.	Some areas of surface water flooding identified in the centre of the LSV.	The majority of the LSV is within FZ 1. The area to the south-west of A3400 is within FZ 2 and 3 of the River Stour.	River Stour	Alluvium and Mudstone	
3	Alveston	LSV	STW	Stratford – Milcote	Flows from Alveston are pumped to the Tiddington drainage area. Flows from Tiddington drain to Tiddington PS where they are conveyed into the Bridgetown catchment. The cumulative effect of development within the three settlements should be considered. Dependent upon the scale and location of proposed development, the impacts should be quantified using hydraulic modelling.	Some areas of surface water flooding identified in the north and west of the LSV.	The majority of the LSV is within Flood Zone 1; however the area to the north of Alveston Lane, The Rockery and the Woodlands is within FZ 2 and 3 of the Middle Avon, which has a history of flooding.	Middle Avon	Mudstone	
4	Aston Cantlow	LSV	STW	Alcester	Aston Cantlow is a small village that drains South to a pumping station. There is one minor flooding incident next to the pumping station. Due to the size of the village, the system is a very small diameter system that may not have much spare capacity. Without knowing what type of development is planned, where and how many, it isn't possible to fully assess this site.	Some areas of surface water flooding identified in the north and south of the LSV. Surface water flooding areas to the south appear to be associated with ordinary watercourses	The majority of the LSV is within FZ 1. Areas to the north and south-west are within FZ 2 and 3 of the River Alne, and areas in the south east are within FZ 2 and 3 of an un-named brook.	River Alne	Alluvium and Mudstone	
5	Bearley	LSV	STW	Bearley	Bearley is a very small catchment and there are no known operational or capacity issues within the catchment.	Some areas of surface water flooding identified along roads and fields in the centre of the LSV.	FZ 1	Claverdon Brook	Mudstone	
6	Bidford on Avon	MRC	STW	Bidford on Avon	Subject to hydraulic modelling and provided surface water is dealt with sustainably, the foul only flows from these developments are not expected to cause any adverse impact.	Some areas of surface water flooding identified in the south of the MRC. Appears to be associated with ordinary watercourses.	The majority of the MRC is in FZ 1, however there is an area to the south in FZ 2 and FZ 3 of the River Avon and an area to the west within FZ 2 and FZ 3 of Small Brook. There is a history of flooding in these areas.	Small Brook, River Avon	Mudstone	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
7	Billesley	Rural	N/A	N/A	There are no sewers shown on Severn Trent's records in this village.	Some areas of surface water flooding identified. Appears to be associated with ordinary watercourses.	FZ 1		Mudstone	
8	Bishops Itchington	LSV	STW	Itchen Bank	There is an isolated minor flooding incident in the sub-catchment. However, it is not considered that development would affect the risk of flooding at this location.	Some areas of surface water flooding identified in the centre of the LSV.	The majority of the LSV is within FZ1 - although a small area to the east of Bishops Itchington is in FZ 2 and 3 of the River Itchen.	River Itchen	Mudstone	
9	Brailes (Upper)	LSV	STW	Cherington	There are known capacity issues in the downstream reaches of the Cherington catchment. Dependent on the scale of proposed development, capacity improvements may be required.	Some areas of surface water flooding identified. Appears to be associated with ordinary watercourses.	Upper Brailes is located within FZ1. The majority of Lower Brailes is located within FZ1, although a small area through the centre of the LSV is within FZ 2 and 3 of the Sutton Brook.	Sutton Brook	Mudstone	
	Brailes (Lower)	LSV								
10	Burton Dasset	Rural	STW	Northend	This is a very small diameter system draining to Northend STW. However, due to the very small number of proposed development, the impact from the additional foul only flows is not expected to be great.	Area of surface water flooding identified in the south west of the village.	FZ 1		Mudstone	
11	Claverdon	LSV	STW	Claverdon	The majority of the network drains east by gravity. The Western part of the catchment is served by Henley Road PS which pumps flows to the central part of Claverdon. There are some records of minor flooding in the west of the catchment. Dependent on the location and scale of development, hydraulic modelling may be required to quantify the impact of development.	Some areas of surface water flooding identified in the centre of the LSV from the south-west to north-east. Appears to be associated with ordinary watercourse.	FZ 1	Claverdon Brook	Mudstone	
12	Clifford Chambers	LSV	STW	Stratford – Milcote	Flows from Clifford Chambers are pumped directly to the Milcote STW. There are known capacity issues upstream of the Clifford Chambers PS. Development in the settlement may adversely impact upon the existing capacity issues and hydraulic modelling should be undertaken to quantify the impacts.	Area of surface water flooding identified in the centre of the LSV.	The majority of the LSV is within FZ1. An area is within FZ 2 and 3 of the River Stour which flows from the south-east to the north-west of the LSV. There is a history of flooding.	Middle Avon	Mudstone	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
13	Earlwood	LSV	STW	Earlwood – Spring Brook	The northern part of the village is predominantly served by a gravity system with two small pumping stations: Cloweswood Lane PS and Valley Road PS. Foul / combined flow discharges south to the Malthouse Lane PS which subsequently pumps flow directly to the works. The southern part of the area is drained towards the north by gravity to Wood End PS which also discharges directly to the works. There are 6 PS' within the catchment, which are deemed to operate satisfactorily. There are no known capacity issues in the catchment.	Areas of surface water flooding identified in the centre of the LSV.	The area to the east and south-west of the LSV (towards Terry's Green) is within FZ 1, although the area around the River Blyth and Earlwood Lakes is within FZ 2 and 3.	River Blyth	Mudstone	Space for surface attenuation SuDS may be limited within the area identified in FZ 2 and 3.
14	Ettington	LSV	STW	Ettington Works	There is one PS in the catchment: Ettington - Spring Close. There is one unsewered area in the south of the catchment at Ettington Park. There are no known capacity or operational issues within the catchment.	Some areas of surface water flooding identified in the north-east of the LSV. Appears to be associated with ordinary watercourse.	FZ 1		Mudstone	
15	Fenny Compton	LSV	STW	Fenny Compton	There are known capacity issues within the foul sewer located on Bridge Street. Development in the west and north may affect flood risk in this area. Dependent upon the location and scale of development, hydraulic modelling will be required to quantify the impact of development.	Some areas of surface water flooding identified in centre of the LSV. Appears to be associated with ordinary watercourse.	FZ 1		Mudstone	
16	Gaydon	LSV	STW	Gaydon	Flows from Gaydon drain by gravity to the works and there are no PS', CSOs or storage tanks. There are no reported capacity issues within the catchment. However, there are isolated areas that are prone to siltation.	Surface water flooding identified in centre of the LSV. Appears to be associated with ordinary watercourse.	FZ 1		Mudstone	
17	Gaydon Lighthorne	Strategic	SWT	Gaydon	Extensive additional capacity will be required in order to accommodate future development at Lighthorne Heath STW. We do not envisage any issues as there are no land or other physical constraints preventing expansion.	Some areas of surface water flooding throughout the strategic option site. Appears to be associated with ordinary watercourse.	FZ 1	Tach Brook	Limestone and Mudstone	
18	Great Alne	LSV	STW	Alcester	There are two PS in Great Alne. Flows are pumped to a gravity sewer in Upton, which subsequently flows to a PS in Haselor. There are no significant capacity issues in the catchment.	Some areas of surface water flooding identified in the centre of the LSV from the north to the south. Appears to be associated with ordinary watercourse.	The majority of the LSV is within FZ 1. The area to the south of the B4089 is within FZ 2 and 3 of the River Alne. There is a history of flooding.	River Alne	Mudstone	
19	Hampton Lucy	LSV	STW	Wellesbourne	Hampton Lucy drains to the Charlescote PS before pumping directly to Wellesbourne STW. There are no known capacity or operational issues in the catchment.	Isolated areas of surface water flooding identified in the centre of the LSV.	The east of the LSV (including Charlescote Road) is located within FZ 2 and 3 of the River Avon and has a history of flooding. The area to the north-west is within FZ1.	River Avon	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the River Avon.

TABLE 5-2: SETTLEMENT AREA ASSESSMENT

Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
20	Harbury	LSV	STW	Itchen Bank	There are 5 PS in Harbury. There are no significant capacity issues within the Harbury sub-catchment.	Some areas of surface water flooding throughout the LSV. Appears to be associated with ordinary watercourse.	FZ 1	River Itchen	Mudstone and Limestone	
21	Henley-in-Arden	MRC	STW	Wootton Wawen	The area previously identified for development was to the West of the railway line. As responded at the time, this area is not sewered. However, once the development has been connected into Severn Trent's system, provided surface water is dealt with sustainably and foul only flows are connected into the system, it is not envisaged that this development will cause any adverse impact.	Some areas of surface water flooding identified in the centre of the MRC from the north to the south. Appears to be associated with ordinary watercourse.	The area to the west and east of the MRC are in FZ 1. The centre is with FZ 2 and FZ 3 of the River Alne, which flows north to south. Areas in the south are in FZ2 and FZ 3 of an un-named water course.	River Alne	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the River Alne.
22	Ilmington	LSV	STW	Ilmington	The majority of Ilmington drains directly to the works by gravity with the exception of Washbrook, which is pumped to the system via Washbrook Lane PS. This PS has known capacity issues. There are also known operational issues between the combined system at Back Street and storm water in the adjacent ditch. Dependent upon the scale of development, the impacts should be tested using hydraulic modelling.	Area of surface water flooding identified in the centre of the LSV from the south-west to the north-east.	The majority of the LSV is within FZ1 - although a small area through the centre of the village is within FZ2 of an un-named stream, which has a history of flooding.		Mudstone	
23	Kineton	MRC	STW	Kineton	The area previously identified for development is on the opposite of Kineton to the treatment works. Flows will have to pass through the town before being treated. There are currently no known flooding incidents within Kineton, however, 200 developments being connected into a small diameter system may overwhelm any spare capacity. It is recommended that hydraulic modelling is undertaken in order to ascertain the impact of flows from these developments.	Some areas of surface water flooding identified in the centre of the MRC from the north to the south. Appears to be associated with ordinary watercourse.	The majority of the MRC is within FZ 1, however an area in the south is within FZ 2 and FZ 3 of the River Dene.	River Dene	Limestone	
24	Kinwarton	Rural	STW	Alcester	Subject to hydraulic modelling and provided surface water is dealt with sustainably, the foul only flows from these developments are not expected to cause any adverse impact.	Isolated areas of surface water flooding identified in the centre of the village. Areas of surface water flooding to the southeast of the village, associated with ordinary watercourse.	The area to the northwest is within FZ 1, however the area to the southeast is in FZ 2 and FZ 3 of the River Alne.	River Alne	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the River Alne.

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
25	Ladbroke	LSV	STW	Itchen Bank	There do not appear to be any capacity issues in this area. However, it is a small village with a small diameter sewer system. Any development may overwhelm spare capacity. Without knowing what type of development is planned, where and how many, it isn't possible to fully assess this site.	Area of surface water flooding identified in the south of the LSV from the west to east. Some isolated areas of surface water flooding identified in the centre of the LSV.	The majority of the LSV is within FZ 1, however an area through the centre of the village is within FZ 2 and FZ 3 of an un-named stream.		Mudstone	
26	Lighthorne	LSV	STW	Lighthorne	There do not appear to be any capacity issues in this area. However, it is a small village with a small diameter sewer system. Any development may overwhelm spare capacity. Without knowing what type of development is planned, where and how many, it isn't possible to fully assess this site.	Area of surface water flooding identified in the centre of the LSV from the east to west.	The majority of the LSV is within FZ 1, however a small area through the centre of the village is within FZ 2 of an un-named stream.		Mudstone and Limestone	
27	Lighthorne Heath	LSV	STW	Lighthorne Heath	There are occasional capacity issues upstream of Lighthorne Heath PS. Any development should consider the impact on the PS, quantified through hydraulic modelling.	Isolated areas of surface water flooding identified.	FZ 1		Mudstone and Limestone	
28	Long Compton	LSV	STW	Long Compton	The entire Long Compton area drains by gravity to the works. There are known capacity issues in the downstream reaches of the catchment and there are records of flooding in the north of the catchment. Dependent upon the scale and location of proposed development, the impact should therefore be tested using hydraulic modelling.	Area of surface water flooding along A3400 from south to north of LSV.	The majority of the LSV is within FZ1. An area to the north of the LSV is within FZ 2 and 3 of the Nethercote Brook which flows from east to west.	Nethercote Brook	Mudstone	
29	Long Itchington	LSV	STW	Itchen Bank	There are four PS within Long Itchington. There are known operational issues reported downstream of the Whitehall Farm PS and there are known capacity issues at the PS. Dependent upon the scale and location of proposed development, the impact should therefore be tested using hydraulic modelling.	Area of surface water flooding identified in the north and in the centre of the LSV.	The majority of the LSV is within FZ1. The area to the west and south is within FZ 2 and 3 of the River Itchen. There is a history of flooding. A small area is defended (close to the junction of Church Road and Bascote Road).	River Itchen	Mudstone and Limestone	
30	Long Marston	LSV	STW	Long Marston	There is one PS in Long Marston. There are no known capacity issues within the settlement.	Area of surface water flooding identified in the centre of the LSV.	FZ 1	Marchfont Brook	Mudstone	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT

Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
31	Long Marston Airfield	Strategic	STW	Long Marston	The potential impact of the northern site on sewerage infrastructure is low due to the site being situated next to the treatment works. The treatment works however will require extensive additional capacity to cope with the extra flows. The downstream pumping station will require upsizing to accommodate the extra flows. The treatment works will require extra additional capacity also.	Some areas of surface water flooding identified in the strategic option site. Appears to be associated with ordinary watercourse.	The majority of the strategic site is within FZ 1, however the western boundary is within FZ 2 of Marchfont Brook.		Mudstone	
32	Loxley	LSV	STW	Wellesbourne	Loxley is a small village that drains North to a pumping station. There are a few minor flooding incidents downstream near to the pumping station. Due to the size of the village, the system is a very small diameter system that may not have much spare capacity. Without knowing what type of development is planned, where and how many, it isn't possible to fully assess this site.	Area of surface water flooding identified in the centre of the LSV from the south-west to the north-east. Appears to be associated with ordinary watercourse.	FZ 1		Mudstone and Limestone	
33	Mappleborough Green	LSV	STW	Redditch – Spernal	There are a number of known capacity issues in the downstream sewerage network. The impact of any proposed development at Mappleborough Green should be quantified using hydraulic modelling as capacity improvements are likely to be required.	Some areas of surface water flooding identified in the LSV. Appears to be associated with ordinary watercourse.	FZ 1	River Arrow	Mudstone	
34	Moreton Morrell	LSV	STW	Moreton Morrell	The sewerage system at Moreton Morrell drains by gravity to the sewerage system. There are known issues with siltation in parts of the catchment and two minor flood events recorded. Depending on the scale and location of development, the impact on the sewerage network should be quantified using hydraulic modelling.	Some areas of surface water flooding identified in the LSV. Appears to be associated with ordinary watercourse.	FZ 1		Mudstone	
35	Napton-on-the-Hill	LSV	STW	Napton	There are 2 PS in Napton. There is a minor isolated flooding record on the outskirts of the settlement. Depending on the location and scale of development within the network, hydraulic modelling may be required to determine the impact on the sewerage network.	Area of surface water flooding identified in the LSV. Appears to be associated with ordinary watercourse.	The majority of the LSV is within FZ1. The area to the south-west is located within FZ 2 and 3 of the River Stowe.	River Stowe	Mudstone	
36	Newbold-on-Stour	LSV	STW	Shipston – Fell Mill	Newbold-on-Stour is served by Tredington Fosse PS. There are a number of PS' in the settlement: Stratford Road, Rimmell Close and Mill Lane. There are no known significant issues within the sub-catchment.	Areas of isolated surface water flooding identified in the LSV.	The majority of the LSV is within FZ1. However, the eastern part of the LSV is within FZ 2 and 3 of the River Stour. There is a history of flooding.	River Stour	Limestone	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
37	North of Southam	Strategic	STW	Itchen Bank	There is minimal spare capacity at this sewage treatment works. The proposed development is large and the downstream pumping station will require upsizing and Itchen Bank sewage treatment works will require extensive capacity upgrading. The potential impact on sewerage infrastructure is high.	Area of surface water flooding identified to the north and west in the strategic option site	FZ 1 – the western edge of the proposed site is within FZ 2 and FZ 3 of the River Itchen.	River Itchen	Limestone and Shale	
38	Northend	LSV	STW	Northend	There are no PS', CSOs or storage tanks within the Northend catchment. There are no capacity or operational issues.	Areas of isolated surface water flooding identified in the LSV.	FZ 1	River Dene	Mudstone	
39	Oxhill	LSV	STW	Oxhill	The Oxhill area drains to Oxhill STW. Whatcote is pumped to Oxhill where the system drains by gravity to Oxhill PS where it is pumped to the works. There are known capacity issues in the 150mm dia combined sewer that passes to the east of Oxhill adjacent to the watercourse. There are also known capacity issues in the Oxhill SPS. Depending on the scale of proposed development, the impact of new development would need to be quantified using hydraulic modelling.	Area of surface water flooding identified in the south of the LSV. Appears to be associated with ordinary watercourse.	The majority of the LSV is within FZ1. The Wagtail Brook flows from the south-east to the north-west of the LSV with areas within FZ 2 and 3.	Tributary of Wagtail Brook	Mudstone	
40	Pillerton Priors	LSV	STW	Butlers Marston	There are some known capacity issues in the catchment. Dependent upon the location and scale of development, hydraulic modelling may be required to quantify the impact of development.	Area of surface water flooding identified in the north of the LSV. Appears to be associated with ordinary watercourse.	FZ 1	Wagtail Brook	Mudstone	
41	Priors Marston	LSV	TW	Priors Marston	57 properties may be a concern depending on where in the network they were to connect however the current system does not have operational issues but each application would need to be considered for the potential hydraulic impact. It would require further assessment as it is a small catchment.	Area of surface water flooding identified in the centre of the LSV from north-west to south-east.	FZ 1	Highfurlong Brook	Mudstone	
42	Quinton (Lower)	LSV	STW	Long Marston	Lower Quinton - Station Road PS pumps flows from Upper and Lower Quinton to the works. This pumping station has known capacity issues and the impact of development in Lower Quinton on the PS should be quantified using hydraulic modelling.	Area of surface water flooding identified in the centre of the LSV from south to north. Appears to be associated with ordinary watercourse.	FZ 1	Marchfont Brook	Mudstone	
	Quinton (Upper)	LSV								

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
43	Salford Priors	LSV	STW	Bidford on Avon	Salford Priors is one sub-catchment within Bidford on Avon WwTW catchment. The settlement is pumped directly to the works via two parallel rising mains from Salford Priors PS. There are no reported capacity issues within the sub-catchment.	Area of surface water flooding identified in the south of the LSV, specifically Ban Brook Road and the junction between School Road and Station Road.	The majority of the LSV is within FZ1. To the south of School Road there is an area of FZ 2 and 3 of the River Arrow and River Avon, which has a history of flooding.	River Arrow, Ban Brook, River Avon	Mudstone	
44	Shipston-on-Stour	MRC	STW	Shipston - Fell Mill	The area previously identified for development was to the West of the town. This is the opposite side of Shipston to the treatment works. This will mean the flows are required to pass through the small diameter sewer system within the town and pass known external flooding incidents. It is strongly recommended that hydraulic modelling is undertaken in order to ascertain the impact of flows from this site.	Some areas of surface water flooding identified in the MRC. Appears to be associated with ordinary watercourses.	The majority of the MRC is within FZ 1. The east of the MRC is within FZ 2 and 3 of the River Stour and there is a history of flooding.	River Stour	Mudstone	
45	Snitterfield	LSV	STW	Snitterfield	There is one PS and one CSO within the catchment. There is a minor flooding incident in the catchment. Depending on the location and scale of development, hydraulic modelling may be required to quantify the impact of development.	Area of surface water flooding identified in the centre of the LSV from south-west to north-east. Appears to be associated with ordinary watercourses.	The majority of the LSV is within FZ1. An area around The Green and School Road is located within FZ 2 and 3 of the Bell Brook. There is a history of flooding.	Sherbourne Brook (Bell Brook)	Dolomitic Siltstone	
46	South East Stratford-upon-Avon	Strategic	STW	Stratford - Milcote	Potential impact on sewerage infrastructure will be high. The initial proposal of 3000 has been increased to include 8 Ha of employment which will introduce additional flows into an already under capacity network.	Some areas of isolated surface water flooding identified in the strategic option site.	FZ 1		Mudstone, sand/gravel deposits	
47	Southam	MRC	STW	Itchen Bank	The identified areas to the South of Southam for development will require pumping. The current pumping station is not envisaged to have the current required capacity for the expected increase in flows. Hydraulic modelling will be required in order to ascertain the impact and develop solutions. Development to the North of Southam is not envisaged to cause any adverse impact on the system, however, with the possible addition of 4000 properties just to the North of Southam itself, Itchen Bank STW will be overwhelmed. Notice will be required well in advance in order for Severn Trent to provide sufficient capacity within Southam and at the treatment works.	Some areas of surface water flooding identified in the MRC. Appears to be associated with ordinary watercourses.	The majority of the MRC is within FZ 1, however a small area through the centre of the MRC is within FZ 2 and FZ 3 of the River Stowe.	River Stowe	Limestone	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
48	Stockton	LSV	STW	Itchen Bank	There are two PS in Stockton. There are known issues with blockages in the Stockton sub-catchment and there are recorded flooding incidents within the catchment. Dependent upon the location and scale of development.	Areas of isolated surface water flooding identified in the LSV.	FZ 1	River Stowe	Mudstone and Limestone	
49	Stoneythorpe, Southam	Strategic	STW	Itchen Bank	Stoneythorpe is just West of Southam. There is a rising main running from West to East which originates in Ufton. Ground topography means that this area will be able to drain to the pumping station at Ufton. Flows will then be pumped through Southam to Itchen Bank STW. Ufton pumping station only serves a very small catchment and will probably require upsizing to accommodate the extra flows from the proposed 800 properties. As such, this site is envisaged to have a Medium impact on sewerage infrastructure	Some areas of surface water flooding identified in the strategic option site. Appears to be associated with ordinary watercourses.	The majority of the strategic option site is within FZ 1, however a small area from the north east to the south east is within FZ 2 and FZ 3 of the River Itchen	River Itchen	Alluvium, Limestone	
50	Stratford-upon-Avon	Main Town	STW	Stratford - Milcote	There is a lot of development planned around Stratford. Without individual areas identified to be assessed, it is difficult to analyse this potential growth. It is recommended that the possible growth is split between identified areas in order for Severn Trent to formally reply. For now, development to the East and West of Stratford-upon-Avon is not envisaged to cause any adverse impact. However, flows travelling from any proposed development to the North and Centre of Stratford will impact on known hydraulic flooding. Once areas have been identified formally for growth and the number of units realistically split between these areas, it is recommended that a further desktop analysis and potentially hydraulic modelling is undertaken in order to ascertain any impact.	Some areas of surface water flooding identified in the north and south of the Main Town.	The majority of area to the north west of the River Avon is FZ1, with the area to the south east in FZ 2 and 3 of the River Avon. In the west is the FZ2 and FZ3 for the Shottery Brook, where there is a history of flooding. There is an area to the north in FZ2 and FZ3 of an unnamed watercourse.	Shottery Brook, River Avon	Mudstone, sand/gravel deposits	
51	Studley	MRC	STW	Redditch – Spernal	The area previously identified for development is to the North of Studley. Subject to hydraulic modelling and provided surface water is dealt with sustainably, the foul only flows from these developments are not expected to cause any adverse impact.	Some areas of surface water flooding identified in the MRC.	The majority of the MRC is within FZ 1, however there is an area to the northeast within FZ 2 and FZ 3 of the River Arrow. There is history of flooding.	River Arrow	Mudstone, sand/gravel deposits	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
52	Tanworth-in-Arden	LSV	STW	Tanworth-in-Arden	There are two sub-catchments that drain south to the works: the northern part of the catchment drains to a PS before being pumped to the works. The oldest part of the village gravitates directly to the works. There are no known capacity or operational issues in Tanworth-in-Arden.	Area of surface water flooding identified along the roads in the north and south of the LSV.	FZ 1	River Alne	Mudstone	
53	Temple Herdewyke	LSV	N/A	N/A	This village is not connected into Severn Trent's sewer network	Area of surface water flooding identified in the centre of the LSV.	The majority of the LSV is within FZ1. Areas in the west and south west are within FZ 2 and FZ 3 of un-named tributaries of the River Dene.	River Dene	Mudstone	
54	Tiddington	LSV	STW	Stratford – Milcote	Flows from Alveston are pumped to the Tiddington drainage area. Flows from Tiddington drain to Tiddington PS where they are conveyed into the Bridgetown catchment. The cumulative effect of development within the three settlements should be considered. Dependent upon the scale and location of proposed development, the impacts should be quantified using hydraulic modelling.	Areas of isolated surface water flooding identified in the LSV.	The majority of the LSV is within FZ1. The north of the LSV is within FZ 2 and 3 of the Middle Avon which flows from west to east and has a history of flooding.	Middle Avon	Mudstone	
55	Tredington	LSV	STW	Shipston – Fell Mill	There are two minor flooding incidents within the Tredington area. Development to the north of the settlement may require capacity improvements to be constructed. This should be confirmed using hydraulic modelling.	Area of surface water flooding identified in the south of the LSV.	The majority of LSV within FZ1. The south-west is located within FZ1, whilst the area to the north east and east of the LSV is within FZ2 and 3 of the River Stour. There is a history of flooding	River Stour, Back Brook, Wagtail Brook	Mudstone and Limestone	
56	Tysoe (Upper and Middle)	LSV	STW	Tysoe	The Tysoe catchment is split between Upper, Middle and Lower Tysoe which all drain to Lower Tysoe WwTW. The Upper Tysoe sub-catchment is pumped to Middle Tysoe from Smarts Lane SPS, which then drains by gravity to the works. There is a record of minor flooding (E05) in the middle of the village and it is known that there are capacity issues at the Smarts Lane SPS. Dependent on the scale of proposed development, the impact of any development in the south of the village upstream of the recorded incident and in Upper Tysoe should be tested using hydraulic modelling.	Area of surface water flooding identified in the north (Middle Tysoe) of the LSV. Appears to be associated with ordinary watercourse.	The majority of the LSV is within FZ1 - although a small area in the south is within FZ 2 and 3 of an un-named brook.	Tributary of Wagtail Brook	Mudstone	

TABLE 5-2: SETTLEMENT AREA ASSESSMENT										
Site Information			Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
ID	Settlement Area		Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
57	Welford-on-Avon	LSV	STW	Stratford - Milcote	Flows from Welford-on-Avon drain to Weston on Avon SPS where they are pumped directly to the Milton STW. There are known capacity issues in parts of the catchment due to incapacity of a PS during storm conditions. Dependent on the scale and location of growth, proposals may adversely affect flood risk in these areas and the impact should be confirmed using hydraulic modelling.	Some areas of surface water flooding identified in the LSV. Most appear to be associated with ordinary watercourse.	The Middle Avon flows through the LSV, which has a history of flooding. The area to the south and south west are FZ1, whilst areas to the north of Welford-on-Avon are within FZ 2 and 3.	Middle Avon	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the Middle Avon.
58	Wellesbourne	MRC	STW	Wellesbourne	The area previously identified for development is to the South East of Wellesbourne. There are no known flooding incidents downstream of the development site. However, hydraulic modelling is recommended in order to ascertain the level of impact these developments may have on Wellesbourne. This is a very large site which will be connecting into a fairly small diameter sewer system.	Some areas of surface water flooding identified in the north east, south east and south west of the MRC. Most appear to be associated with ordinary watercourse.	The south west area of the MRC is in FZ1. The FZ 2 and FZ 3 for River Dene cuts through the centre of the MRC from south east to north west. An area to the north east is within FZ 2 and FZ 3 of an un-named watercourse.	River Dene	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the River Dene.
59	Wilmcote	LSV	STW	Stratford - Milcote	The majority of the village drains to separate foul and surface water systems. A small part of the village (to the south east) is combined. There are some minor capacity issues in the combined system to the south east (downstream end of the village). If the development occurs upstream of the capacity issues, the impact on this location will need to be considered. The combined system drains towards Stratford upon Avon.	Area of surface water flooding identified in the south-east of the LSV, associated with the un-named brook.	The majority of the LSV is within FZ 1. A small area in the south east of the LSV is within the FZ 2 and FZ 3 of an un-named brook.		Mudstone	
60	Wood End	LSV	STW	Earlwood – Spring Brook	There do not appear to be any capacity issues in this area. However, it is a small village with a small diameter sewer system. Any development may overwhelm spare capacity. Without knowing what type of development is planned, where and how many, it isn't possible to fully assess this site.	Area of surface water flooding identified in the centre of the LSV from south to north, following the railway line. Appears to be associated with ordinary watercourses.	The majority of the LSV is within FZ 1, although an area in the north and west is within FZ 2 and 3 of Spring Brook.	Spring Brook	Mudstone	
61	Wootton Wawen	LSV	STW	Wootton Wawen	There is a 450mm diameter combined sewer that passes north to south through the village. The remainder of the sewers in the village are foul only. There are no separate public surface water sewers in the village. There is a minor known capacity issue in the foul only system in the east of the village but aside from this there are no known capacity issues in the village.	Area of surface water flooding identified through the centre of the LSV.	The majority of the LSV is within FZ1. The River Alne flows from the north to the south of the LSV with areas within FZ 2 and 3.	River Alne	Sandstone and Mudstone	

6 WATER CYCLE STRATEGY RECOMMENDATIONS AND POLICY

The following policy recommendations are made and should be considered by Stratford-on-Avon District Council to ensure that the Stratford-on-Avon LDF considers potential limitations (and opportunities) presented by the water environment and water infrastructure on growth, and phasing of growth. The policy is also recommended as a starting point to the replacement of the regional water based policies within the revoked West Midlands Plan.

6.1 Policy Recommendations Overview

6.1.1 *Wastewater*

WW1 – Development Phasing

It is recommended that a policy is developed in Priors Marston that requires development in the catchments to be subject to a pre-development enquiry with TW to determine process capacity at the WwTW before granting permission.

WW2 – Development Phasing – Itchen Bank and Long Marston

The growth in the Itchen Bank and Long Marston WwTW catchment, based on growth from either Strategic Option C or E would need a potential new solution to be identified by the Environment Agency and STW if either of these options is taken forward. The council should only give planning permission if both the Environment Agency and STW have indicated that they are satisfied that the development can be accommodated

WW3 – Development and Sewerage Network

Development at sites indicated in the WCS (Amber) to have potentially limited sewer network capacity should be subject to a pre-development enquiry with STW (or TW where necessary) to determine upgrades needed to prior to planning permission being granted.

6.1.2 *Water Supply*

WS1 – Water Efficiency in new homes

In order to move towards a more ‘water neutral position’ and to enhance sustainability of development coming forward, a policy should be developed that ensures all housing is as water efficient as possible, and that new housing development should go beyond Building Regulations and as a minimum reach Code for Sustainable Homes Level 3/4. Non-domestic building should as a minimum reach ‘Good’ BREEAM status.

WS2 – Water Efficiency Retrofitting

In order to move towards a more ‘water neutral position’, a policy could be developed to carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings with the aim to move towards delivery of 10% of the existing housing stock with easy fit water savings devices

WS3 – Water Efficiency Promotion

In order to move towards a more ‘water neutral position’, a policy could be developed to establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

6.1.3 *Surface Water Management and Flood Risk*

SWM1 – Sewer Separation

Developers should ensure foul and surface water from new development and redevelopment are kept separate where possible. Where sites which are currently connected to combined sewers are redeveloped, the opportunity to disconnect surface water and highway drainage from combined sewers must be taken.

SWM2 – Above Ground Drainage

Developers should aspire to achieve 100% above ground drainage for all future developments, where feasible. Where this is not feasible due to for example housing densities, land take, ground conditions, topography, or other circumstances, the development proposals should maximise opportunities to use SuDS measures which require no additional land take, i.e. green roofs, permeable surfaces and water butts.

SWM3 – SuDS and Green Infrastructure

Developers should ensure linkage of SuDS to green infrastructure to provide environmental enhancement and amenity, social and recreational value. SuDS design should maximise opportunities to create amenity, enhance biodiversity, and contribute to a network of green (and blue) open space.

SWM4 – SuDS and Water Efficiency

Developers should ensure linkage of SuDS to water efficiency measures where possible, including rainwater harvesting.

SWM5 – Linkages to SWMP, SuDS Handbook, SFRA

Developers should ensure SuDS design supports the findings and recommendations of the Warwickshire Surface Water Management Plan (SWMP), the SuDS Manual (either the CIRIA SuDS Manual or the Warwickshire SuDS Manual when available) and Stratford-on-Avon District Council's SFRA.

SWM6 – Water Quality Improvements

Developers should ensure, where possible, that discharges of surface water are designed to deliver water quality improvements in the receiving watercourse or aquifer where possible to help meet the objectives of the Water Framework Directive.

6.1.4 *Ecology*

There is no indication that additional discharges beyond the current volumetric permit will result in adverse effects on the Sherbourne Meadows SSSI, Welford SSSI, River Blythe SSSI and River Arrow LNR, provided that 'no deterioration' of the water quality is achieved.

ECO1 – Biodiversity enhancement

It is recommended that the Council include a policy in its Core Strategy which commits to seeking and securing (through planning permissions etc.) enhancements to aquatic biodiversity in Stratford-on-Avon District through the use of SuDS (subject to appropriate project-level studies to confirm feasibility including environmental risk and discussion with relevant authorities) in line with the Warwickshire Green Infrastructure Strategy.

6.2 Developer Guidance

A checklist has been developed to assist developers in ensuring their development proposals meet with the requirements of the overall strategy developed for Stratford-on-Avon District. This checklist is included in Appendix 3.

6.3 Further Recommendations

6.3.1 *Stakeholder Liaison*

It is recommended that key partners in the WCS maintain regular consultation with each other as development proposals progress.

6.3.2 *WCS Periodic Review*

The WCS should remain a living document, and (ideally) be reviewed on an annual basis as development progresses and changes are made to the various studies and plans that support it; these include:

- five yearly reviews of STW's WRMP (the final version of the WRMP will need to be reviewed in 2015, the next full review is due in 2019, although interim reviews are undertaken annually);
- second round of RBMP updates due by 2015;
- Periodic review 2014 (PR14) (STW's business plan for AMP6 – 2015 to 2020); and,
- Climate change impact assessment milestones (see Table 6-1)

TABLE 6-1: WATER RELATED PLANNING DOCUMENTS AND CLIMATE CHANGE

Document	Produced By	Date for Review
STW Water Resource Management Plan	STW	2019 (though plan is reviewed annually)
TW Water Resource Management Plan	TW	2019 (though plan is reviewed annually)
River Basin Management Plan – Severn, Thames,	Environment Agency	December 2015
STW Strategic Direction Statement	STW	
TW Strategic Direction Statement	TW	
Catchment Abstraction Management Strategies	Environment Agency	Yearly updates provided. Date of next full review unknown

APPENDIX 1: LEGISLATIVE DRIVERS SHAPING THE WCS UPDATE

Directive/Legislation/Guidance	Description
Birds Directive 2009/147/EC	Provides for the designation of Special Protection Areas.
Code for Sustainable Homes	<p>The Code for Sustainable Homes has been introduced to drive a step-change in sustainable home building practice, providing a standard for key elements of design and construction which affect the sustainability of a new home. It will become the single national standard for sustainable homes, used by home designers and builders as a guide to development and by home-buyers to assist their choice of home.</p> <p>It will form the basis for future developments of the Building Regulations in relation to carbon emissions from, and energy use in homes, therefore offering greater regulatory certainty to developers. The Code sets out a minimum water demand per person as a requirement for different code levels. CLG is currently in consultation on proposals to make certain code levels mandatory for all new homes. At present, only affordable homes must reach a certain code.</p>
Eel Regulations 2009	Provides protection to the European eel during certain periods to prevent fishing and other detrimental impacts.
Environment Act 1995	Sets out the role and responsibility of the Environment Agency.
Environmental Protection Act 1990	Integrated Pollution Control (IPC) system for emissions to air, land and water.
Flood & Water Management Act 2010	<p>The Flood and Water Management Act 2010 is the outcome of a thorough review of the responsibilities of regulators, local authorities, water companies and other stakeholders in the management of flood risk and the water industry in the UK. The Pitt Review of the 2007 flood was a major driver in the forming of the legislation. Its key features relevant to this WCS are:</p> <ul style="list-style-type: none"> • To give the Environment Agency an overview of all flood and coastal erosion risk management and unitary and county councils the lead in managing the risk of all local floods. • To encourage the uptake of sustainable drainage systems by removing the automatic right to connect to sewers and providing for unitary and county councils to adopt SuDS for new developments and redevelopments. • To widen the list of uses of water that water companies can control during periods of water shortage, and enable Government to add to and remove uses from the list. • To enable water and sewerage companies to operate concessionary schemes for community groups on surface water drainage charges. • To make it easier for water and sewerage companies to develop and implement social tariffs where companies consider there is a good cause to do so, and in light of guidance that will be issued by the SoS following a full public consultation.
Future Water, February 2008	Sets the Government's vision for water in England to 2030. The strategy sets out an integrated approach to the sustainable management of all aspects of the water cycle, from rainfall and drainage, through to treatment and discharge, focusing on practical ways to achieve the vision to ensure sustainable use of water. The aim is to ensure sustainable delivery of water supplies, and help improve the water environment for future generations.

Directive/Legislation/Guidance	Description
Groundwater Directive 80/68/EEC	To protect groundwater against pollution by 'List 1 and 2' Dangerous Substances.
Habitats Directive 92/44/EEC and Conservation of Habitats & Species Regulations 2010	To conserve the natural habitats and to conserve wild fauna and flora with the main aim to promote the maintenance of biodiversity taking account of social, economic, cultural and regional requirements. In relation to abstractions and discharges, can require changes to these through the Review of Consents (RoC) process if they are impacting on designated European Sites. Also the legislation that provides for the designation of Special Areas of Conservation provides special protection to certain non-avian species and sets out the requirement for Appropriate Assessment of projects and plans likely to have a significant effect on an internationally designated wildlife site.
Land Drainage Act 1991	Sets out the statutory roles and responsibilities of key organisations such as Internal Drainage Boards, local authorities, the Environment Agency and Riparian owners with jurisdiction over watercourses and land drainage infrastructure.
Making Space for Water, 2004	Outlines the Government's strategy for the next 20 years to implement a more holistic approach to managing flood and coastal erosion risks in England. The policy aims to reduce the threat of flooding to people and property, and to deliver the greatest environmental, social and economic benefit.
National Planning Policy Framework	<p>Planning policy in the UK is set by the National Planning Policy Framework (NPPF). The NPPF revokes most of the previous Planning Policy Statements and Planning Policy Guidance. However, NPPF does not revoke the PPS25 Practice Guide. NPPF advises local authorities and others on planning policy and operation of the planning system.</p> <p>A WCS helps to balance the requirements of various planning policy documents, and ensure that land-use planning and water cycle infrastructure provision is sustainable.</p>
Pollution Prevention and Control Act (PPCA) 1999	Implements the IPPC Directive. Replaces IPC with a Pollution Prevention and Control (PPC) system, which is similar but applies to a wider range of installations.
Ramsar Convention	Provides for the designation of wetlands of international importance
Urban Waste Water Treatment Directive (UWWTD) 91/271/EEC	This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. Its aim is to protect the environment from any adverse effects caused by the discharge of such waters.
Water Act 2003	Implements changes to the water abstraction management system and to regulatory arrangements to make water use more sustainable.

Directive/Legislation/Guidance	Description
Water Framework Directive (WFD) 2000/60/EC	<p>The WFD was passed into UK law in 2003. The overall requirement of the directive is that all river basins must achieve ‘good ecological status’ by 2015 or by 2027 if there are grounds for derogation. The WFD, for the first time, combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level has been adopted. It effectively supersedes all water related legislation which drives the existing licensing and permitting framework in the UK.</p> <p>The Environment Agency is the body responsible for the implementation of the WFD in the UK. The Environment Agency have been supported by UKTAG⁵⁴, an advisory body which has proposed water quality, ecology, water abstraction and river flow standards to be adopted in order to ensure that water bodies in the UK (including groundwater) meet the required status⁵⁵. These have recently been finalised and issued within the River Basin Management Plans (RBMP).</p>
Natural Environment & Rural Communities Act 2006	Covering Duties of public bodies – recognises that biodiversity is core to sustainable communities and that Public bodies have a statutory duty that states that “every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity
Water Resources Act 1991	Protection of the quantity and quality of water resources and aquatic habitats. Parts have been amended by the Water Act 2003.
Wildlife & Countryside Act 1981 (as amended)	Legislation that provides for the protection and designation of SSSIs and specific protection for certain species of animal and plant among other provisions.

⁵⁴ The UKTAG (UK Technical Advisory Group) is a working group of experts drawn from environment and conservation agencies. It was formed to provide technical advice to the UK’s government administrations and its own member agencies. The UKTAG also includes representatives from the Republic of Ireland.

⁵⁵ UK Environmental Standards and Conditions (Phase I) Final Report, April 2008, UK Technical Advisory Group on the Water Framework Directive.

APPENDIX 2: WWTW CAPACITY ASSESSMENT RESULTS

Modelling assumptions and input data

Several key assumptions have been used in the water quality and permit modelling as follows:

- the wastewater generation per new household is based on an assumed Occupancy Rate (OR) of 2.1 people per house and an average consumption of 131 l/h/d (as set out in Section 1.6);
- WwTW current flows were taken as the current permitted dry weather flow (DWF). Future 2031 flows were calculated by adding the volume of additional wastewater generated by new dwellings (using an OR of 2.1, a consumption value of 131l/h/d and allowance for an increase in infiltration) to the current permitted DWF value;
- WwTW current discharge quality was taken as the current permitted limits for each water quality element. Where an element did not have a permitted limit, Ammonia was modelled as 10 mg/l and Phosphate as 4mg/l based on common permitted limits in other locations. Figures for the mean and standard deviation of each element were calculated based on these permit levels using RQP 2.5 (discussed further below).
- River flow data for the RQP modelling has been provided by the Environment Agency based on outputs from the Low Flow Enterprise (LFE) model – data was provided as mean flow and Q95⁵⁶. The receiving watercourse that had the WFD status was used to determine the location to extract the river flow data as there was a lack of monitoring data.
- The WFD 'no deterioration' targets for each WwTW are the downstream status, for each water quality element. The published status from the RBMP was used for this as consistent river monitoring data was not available for all the sites in the study area. Details are provided below along with the full results and outputs from the water quality modelling in Tables A2.1 and A2.2.
- For the purposes of this study, the limits of conventionally applied treatment processes are considered to be:
 - 5mg/l for BOD;
 - 1mg/l for Ammoniacal-N; and
 - 1mg/l for Phosphate.

Assessment techniques

Modelling of the quality permits required to meet the two WFD requirements has been undertaken, using RQP 2.5 (River Quality Planning), the Environment Agency's software for calculating permit conditions. The software is a monte-carlo based statistical tool that determines what statistical quality is required from discharges in order to meet defined downstream targets, or to determine the impact of a discharge on downstream water quality compliance statistics.

The first stage of the modelling exercise was to establish the discharge permit standards that would be required to meet 'No Deterioration'. This would be the discharge permit limit that would need to be imposed on STW at the time the growth causes the flow permit to be

⁵⁶ Defined as the flow value exceeded 95% of the time i.e. a representation of low flows

exceeded. No deterioration is an absolute requirement of the WFD and any development must not result in a decrease in quality downstream from the current status.

The second stage was to establish the discharge permit standards that would be required to meet future Good Status under the WFD in the downstream waterbody. This assessment was only carried out for WwTWs discharging to waterbodies where the current status is less than Good (i.e. currently Moderate, Poor or Bad). This would be the discharge permit standard that may need to be applied in the future, subject to the assessments of 'technical feasibility' and 'disproportionate cost'. Such assessments would be carried out as part of the formal Periodic Review process overseen by OFWAT in order to confirm that the proposed improvement scheme is acceptable.

Step 1 – 'No Deterioration'

A calculation was undertaken to determine if the receiving watercourse can maintain 'No Deterioration' downstream from the current quality with the proposed growth within limits of conventional treatment technology, and what permit limits would be required. If 'No Deterioration' could be achieved, then a proposed discharge permit standard was calculated which will be needed as soon as the growth causes the WwTW flow permit to be exceeded, see Table A2-1.

Step 2 – Meeting Future 'Good' Status

For all WwTW where the current downstream quality of the receiving watercourse *is less than good*, a calculation was undertaken to determine if the receiving watercourse could achieve future 'Good Status', with the proposed growth within limits of conventional treatment technology and what permit limits would be required to achieve this.

The assessment of attainment of future 'Good Status' assumed that other measures will be put in place to ensure 'Good Status' upstream, so that the modelling assumed upstream water quality is at the mid point of the 'Good Status' for each element and set the downstream target as the lower boundary of the 'Good Status' for each element.

If 'Good' could be achieved with growth with permits achievable within the limits of conventional treatment, then a proposed discharge permit standard which may be needed in the future has been given in Table A2-2.

If the modelling showed that the watercourse could not meet future 'Good' status with the proposed growth within limits of conventional treatment technology, a further assessment step three was undertaken.

Step 3 – Is Growth the Factor Causing failure to meet future 'Good Status'?

In order to determine if it is growth that is causing the failure to attain future 'Good Status' downstream, the modelling in step 2 was repeated, but without the growth in place (i.e. using current flows) as a comparison.

If the watercourse could not meet 'Good Status' without growth (assuming the treatment standard were improved to the limits of conventional treatment technology), then it is not the growth that would be preventing future 'Good Status' being achieved and the 'No Deterioration' permit standard given in Table A2-1. (Step 1) above would be sufficient to allow the proposed growth to proceed.

If the watercourse could meet 'Good Status' without growth, then it is the growth that would be preventing future 'Good Status' being achieved. Therefore consideration needs to be

given to whether there are alternative treatment options that would prevent the future failure to attain 'Good Status'.

The methodology is designed to look at the impact of proposed growth alone, and whether the achievement of 'Good Status' will be compromised. It is important that STW have an understanding of what permits may be necessary in the future. The RBMP and Periodic Review planning processes will deal with all other issues of disproportionate costs.

TABLE A2-1: 'NO DETERIORATION' ASSESSMENT									
	Cherington WwTW			Gaydon WwTW – Option B			Itchen Bank WwTW – Option E		
	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate
River Downstream of Discharge									
No Deterioration Target	H	H	G	H	G	P	M	H	P
Designated Salmonid Fishery?	No			No			No		
River Quality Target (90%ile or AA)	4.0	0.3	0.12	4.0	0.6	1.0	6.5	0.3	1.0
Current Permit									
Current DWF (m ³ /day)	365			110			2881		
Permit Limits (95%ile or AA)	25	10	-	25	10	-	10	3	-
Discharge Quality Required									
Future DWF (m ³ /day)	378			1015			3462		
Effluent Quality Required (95%ile or AA)	No Change Required	5.75	1.01	15.55	2.42	1.51	9.63	0.52	1.18
Will Growth prevent WFD 'No Deterioration' being achieved?	No			No			Yes		

TABLE A2-2: IMPROVEMENT TO 'GOOD STATUS' ASSESSMENT									
	Cherington WwTW			Gaydon WwTW – Option B			Itchen Bank WwTW – Option E		
	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate
River Downstream of Discharge									
No Deterioration Target	G	G	G	G	G	G	G	G	G
Designated Salmonid Fishery?	No			No			No		
River Quality Target (90%ile or AA)	-	-	-	-	-	0.12	-	-	0.12
Current Permit									
Current DWF (m ³ /day)	365			110			2881		
Permit Limits (95%ile or AA)						0.41			0.14
Discharge Quality Required									
Future DWF (m ³ /day)	418			1015			3462		
Effluent Quality Required (95%ile or AA)						0.16			0.13
Will Growth prevent WFD 'Improvement to Good'?				No					

TABLE A2-1: 'NO DETERIORATION' ASSESSMENT															
	Long Marston WwTW – Option D			Tysoe WwTW			Wellesbourne WwTW			Wellesbourne WwTW – Option A			Priors Marston WwTW		
	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate
River Downstream of Discharge															
No Deterioration Target	H	G	M	H	H	M	H	H	P	H	H	P	G	H	G
Designated Salmonid Fishery?	No			No			No			No			No		
River Quality Target (90%ile or AA)	4.0	0.6	0.25	4.0	0.3	0.25	4.0	0.3	1.0	4.0	0.3	1.0	5.0	0.3	0.12
Current Permit															
Current DWF (m ³ /day)	835			181			1559			1559			152		
Permit Limits (95%ile or AA)	20	10	4	25	-	-	10	10	-	10	10	-	20	9	-
Discharge Quality Required															
Future DWF (m ³ /day)	1567			196			1630			1671			162		
Effluent Quality Required (95%ile or AA)	11.43	1.75	0.28	No Change Required	6.66	0.99	No Change Required	5.51	No Change Required	No Change Required	5.4	No Change Required	No Change Required	2.9	0.27
Will Growth prevent WFD 'No Deterioration' being achieved?	Yes			No			No			No			No (based on current WwTW performance)		

TABLE A2-2: IMPROVEMENT TO 'GOOD STATUS' ASSESSMENT															
	Long Marston WwTW – Option D			Tysoe WwTW			Wellesbourne WwTW			Wellesbourne WwTW – Option A			Priors Marston WwTW		
	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate
River Downstream of Discharge															
No Deterioration Target	H	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Designated Salmonid Fishery?	No			No			No			No			No		
River Quality Target (90%ile or AA)	-	-	0.12	-	-	-	-	-	-	-	-	0.12	-	-	-
Current Permit															
Current DWF (m ³ /day)	165			181			1559			1559			152		
Permit Limits (95%ile or AA)	-	-	0.15	-	-	0.49	-	-	0.41	-	-	0.41	-	-	-
Discharge Quality Required															
Future DWF (m ³ /day)	171			196			1630			1671			162		
Effluent Quality Required (95%ile or AA)	-	-	0.44	-	-	0.46	-	-	0.39	-	-	0.39	-	-	-
Will Growth prevent WFD 'Improvement to Good'?							No			No					

Key: Green Value – No change to current permit required, Amber Value – Permit tightening required, but within limits of conventionally applied treatment processes, Red Value – Not achievable within limits of conventionally applied treatment processes

APPENDIX 3: RECOMMENDED DEVELOPER CHECKLIST FOR COMPLIANCE WITH THE WATER CYCLE STRATEGY

DEVELOPER CHECKLIST KEY	
	Water Cycle Strategy Recommended Policy
	Environment Agency and Natural England Policy and Recommendations
	Local Policy
	National Policy or Legislation

DEVELOPER CHECKLIST			
	Flood Risk Assessment Checklist		Policy or Legislation
1	Is the Development within Flood Zones 2 or 3 as defined by the flood zone mapping in the SFRA, or where SFRA coverage is not available, the published Environment Agency flood risk maps?	Y - go to 5 N - go to 2	NPPF, Flood & Water Management Act
2	Development is within Flood Zone 1: Site larger than 1 Ha? Site smaller than 1 Ha?	Y - go to 5 Y - go to 3	
3	Is the development residential with 10 or more dwellings or is the site between 0.5Ha and 1Ha?	Y - go to 6 N - go to 4	
4	Is the development non-residential where new floor space is 1,000m ² or the site is 1 Ha or more	Y - go to 6 N - go to 7	
5	The development either constitutes major development or is considered to be in a high risk flood zone and requires a Flood Risk Assessment (NPPF, Local Planning Policy and the relevant SFRA) and the Environment Agency are required to be consulted.	Go to 8	
6	The development constitutes major development and is likely to require a Flood Risk Assessment (in accordance with NPPF, Local Planning Policy and the relevant SFRA) but the Environment Agency may not be required to be consulted (further advice is available via the Environment Agency's Flood Risk Standing Advice webpage).	Go to 8	
7	An FRA is unlikely to be required for this development, although a check should be made against the SFRA and with the LPA to ensure that there is no requirement for a FRA on the grounds of critical drainage issues. Does the SFRA or does the LPA consider a Flood Risk Assessment (FRA) is required?	Y – go to 8 N – go to 9	
8	Has an FRA been produced in accordance with Local Planning Policy, Environment Agency standing advice and the relevant SFRA?	Y/N or N/A	

	Surface Water Checklist		Policy or Legislation
9	A) What was the previous use of the site? B) What was the extent of impermeable area, both before and after development?	% before % after	Environment Agency Requirement for FRA.
10	If development is on a Greenfield site, have you provided evidence that post development run-off will not be increased above the Greenfield runoff rates and volumes using SuDS attenuation features where feasible (see also 18 onwards).	Y/N or N/A	Local Planning Policy
	If development is on a brownfield site, have you provided evidence that the post development run-off rate has not been increased, and as far as practical, will be decreased below existing site runoff rates using SuDS attenuation features where feasible (see also 17 onwards).	Y/N or N/A	
11	Is the discharged water only surface water (e.g. not foul or from highways)?	Y/N	Water Resources Act 1991
	If no, has a discharge consent been applied for?	Y/N	
12	A) Does your site increase run-off to other sites?	Y/N	Local Planning Policy
	B) Which method to calculate run-off have you used?		
13	Have you confirmed that any surface water storage measures are designed for varying rainfall events, up to and including, a 1 in 100 year + climate change event?	Y/N	Local Planning Policy
14	For rainfall events greater than the 1 in 100 year + climate change, have you considered the layout of the development to ensure that there are suitable routes for conveyance of surface flows that exceed the drainage design?	Y/N	Local Planning Policy
15	Have you provided layout plans, cross section details and long section drawings of attenuation measures, where applicable?	Y/N	
16	If you are proposing to work within 20m of a main river or 8m of any watercourse have you applied, and received Flood Defence Consent from the Environment Agency?	Y/N or N/A	Water Resources Act 1991 Land Drainage Act 1991
17	The number of outfalls from the site should be minimised. Any new or replacement outfall designs should adhere to standard available from the local area Environment Agency office. Has the guidance been followed?	Y/N	Guidance Driven by the Water Resources Act 1991

	Sustainable Drainage Systems (SuDS) Checklist		Policy or Legislation
18	<p>A) Has the SuDS hierarchy been considered during the design of the attenuation and site drainage? Provide evidence for reasons why SuDS near the top of the hierarchy have been disregarded.</p> <p>B) Have you provided detail of any SuDS proposed with supporting information, for example, calculations for sizing of features, ground investigation results and soakage tests? See CIRIA guidance for more information. http://www.ciria.org.uk/suds/697.htm</p> <p>C) Have you checked that any proposed SUDS (including maintenance and adoption requirements) meet with the minimum requirements of the SuDS Approving Body (SAB) where applicable?</p>	Y/N	
19	<p>A) Are Infiltration SuDS to be promoted as part of the development? If Yes, the base of the system should be set at least 1m above the groundwater level and the depth of the unsaturated soil zones between the base of the SuDS and the groundwater should be maximised.</p> <p>B) If Yes – has Infiltration testing been undertaken to confirm the effective drainage rate of the SuDS?</p> <p>C) Have you ensured that any proposed soakaways are no greater than 2m below existing ground level?</p>	Y/N Y/N	Local Planning Policy Flood & Water Management Act
20	<p>A) Are there proposals to discharge clean roof water direct to ground (aquifer strata)?</p> <p>B) If Yes, have all water down-pipes been sealed against pollutants entering the system form surface runoff or other forms of discharge?</p>	Y/N Y/N	
21	<p>A) Does proposed surface water drainage require use of smaller drains/channels to connect to a main river?</p> <p>B) If yes, has the relevant drainage authority been consulted?</p>	Y/N Y/N	WCS policy suggestion
22	Have you shown that drainage will be 100% above ground, or where not possible due to housing densities, land take etc.) provided evidence as to why it is not possible.	Y/N	

23	Is the development area in a Source Protection Zone (SPZ) or a safeguard zone?	If Y go to 24 If N go to 25	
24	A) Is the development area within an inner zone (SPZ1)?	Y/N	Groundwater Regulations 1998 Article 7 of the Water Framework Directive
	B) If yes, discharge of Infiltration of runoff from car parks, roads and public amenity areas is likely to be restricted – has there been discussion with the Environment Agency as to suitability of proposed infiltration SuDS?	Y/N	
25	A) For infill development, has the previous use of the land been considered?	Y/N	NPPF
	B) Is there the possibility of contamination or potential for pollution?	Y/N	
	C) If yes, infiltration SuDS may not be appropriate and remediation of the land may be required. A Groundwater Risk Assessment is likely to be required. Has this been undertaken before the drainage design is considered in detail?	Y/N	
26	Have oil separators been designed into the highway and car parking drainage? Environment Agency Pollution Prevention Guideline 3: http://publications.environment-agency.gov.uk/pdf/PMHO0406BIYL-e-e.pdf	Y/N	Environment Agency Pollution Prevention Guideline 3
27	Have you considered whether any of the SuDS proposed can be linked to Green Infrastructure plans as set out in the Water Cycle Study for Stratford-on-Avon District?	Y/N	WCS policy suggestion
Water Consumption Checklist			Policy or Legislation
28	Have you provided the expected level of water consumption to meet the minimum of Code for Sustainable Homes Level as set out in the draft Core Strategy? http://www.planningportal.gov.uk/england/professionals/buildingregs/sustainablehomes/	Y/N	WCS policy suggestion
29	Is the proposed development likely to achieve a water consumption of less than or equal to 125 l/h/d as consistent with the Communities and Local Government Building Regulations Part G (2009)? http://www.communities.gov.uk/publications/planningandbuilding/partg2009divisionalletter and http://www.planningportal.gov.uk/uploads/br/BR_PDF_draftADG_2009.pdf	Y/N	
30	Have you provided details of water efficiency methods to be installed in houses?	Y/N	

31	A) Have you confirmed whether the development will utilise rainwater harvesting and/or required tank sizes? (see http://www.environment-agency.gov.uk/homeandleisure/drought/38559.aspx and http://publications.environment-agency.gov.uk/pdf/GEHO0108BNPN-E-E.pdf)	Y/N	
	B) Have you considered linkage of SuDS to rainwater harvesting or other water efficiency measures?	Y/N	
32	Have you confirmed whether grey water recycling is to be utilised and provided details?	Y/N	
33	Have you provided details of any proposed measures to increase public awareness and community participation in water efficiency?	Y/N	
	Pollution Prevention Checklist		Policy or Legislation
34	Have you provided details of construction phase works, for example method statement, outlining pollution control and waste management measures? See Environment Agency Pollution Prevention Guidelines 2, 5, 6 and 21 (http://www.environment-agency.gov.uk/business/topics/pollution/39083.aspx) and DTI Site Waste Management Plan, (http://www.constructingexcellence.org.uk/resources/publications/view.jsp?id=2568)	Y/N	Environment Agency Pollution Prevention Guidelines 2, 5, 6 and 21
35	A) Have you provided details of pollution prevention measures for the life of the development, such as oil and silt interceptors?	Y/N	
	B) Have you considered whether permeable pavement areas are protected from siltation?	Y/N	WCS policy suggestion
	C) Have you provided details of maintenance – as with the SuDS?	Y/N	
	Sewerage Checklist		Policy or Legislation
36	Have you provided evidence to confirm that sewerage capacity is available via a pre-development enquiry with Severn Trent Water?	Y/N	WCS policy suggestion
37	A) Have sewers been designed in line with 'sewers for adoption'?		
	B) Have discussions regarding adoption and maintenance of on-site sewers taken place with Severn Trent Water?	Y/N	Water Industry Act & Flood & Water Management Act

	Conservation / Enhancement of Ecological Interest Checklist		Policy or Legislation
38	Have you considered that SuDS should link to green Infrastructure to maximise environmental enhancement and amenity? And in addition that any green infrastructure, such as the surface water system, links to the neighbouring green infrastructure (River Corridors) to assist the creation and maintenance of green corridors?	Y/N	WCS policy suggestion
39	A) Have you shown the impacts your development may have on the water environment?	Y/N	Town and Country Planning Regulations 1999
	B) Is there the potential for beneficial impacts? Have you considered, where possible the design of SuDS to deliver water quality improvements in the receiving watercourse or aquifer?	Y/N	
40	Have you confirmed all ponds within 500m of the site boundary have been surveyed for presence of great-crested newt populations?	Y/N	Habitats Directive

APPENDIX 4: ECOLOGICAL BACKGROUND FOR STATUTORY DESIGNATED SITES

Sherbourne Meadows SSSI

Sherbourne Meadows comprises a series of eight adjoining unimproved fields lying on either side of Sherbourne Brook. Seven of the fields have a long history of management as hay meadows, the other is now grazed. Five of the fields along the brook, on alluvium overlying the Mercia Mudstone, have a vegetation characteristic of meadow foxtail - great burnet flood meadow. The other three fields on higher land not adjoining the brook have ridge and furrow topography and overlie Mercia Mudstone. Their herb-rich neutral grassland vegetation is of the common knapweed & crested dog's-tail meadow and pasture type.

There is evidence that in the nineteenth century these grassland types were widespread and common in some parts of Britain, particularly in the Midlands and also southern England in the case of flood-meadows. In the twentieth century, however, they have declined very severely as a result of agricultural improvement.

The extent of flood meadows has been further reduced by neglect of common meadow rights and from gravel extraction. Sherbourne Meadows is the largest area of unimproved neutral grassland in Warwickshire.

The award associated with the meadow foxtail & great burnet community is species rich with a great diversity of herbs. It shows some variation in composition throughout the site due to local drainage conditions. Sixteen species of grass have so far been recorded and characteristically no single one of them appears dominant. The most abundant species are meadow foxtail *Alopecurus pratensis*, crested dog's-tail *Cynosurus cristatus*, red fescue *Festuca rubra*, yellow oat-grass *Trisetum flavescens* and perennial rye-grass *Lolium perenne*. Other species that are very frequent are sweet vernal-grass *Anthoxanthum odoratum*, Yorkshire-fog *Holcus lanatus*, cock's foot *Dactylis glomerata* and common bent *Agrostis capillaris*. The density of herbs in the sward is exceptionally high with great burnet *Sanguisorba officinalis*, ribwort plantain *Plantago lanceolata*, common knapweed *Centaurea nigra*, red clover *Trifolium pratense* and meadow buttercup *Ranunculus acris* all generally abundant.

Other species characteristic of this grassland which occur frequently include quaking grass *Briza media*, meadowsweet *Filipendula ulmaria*, meadow vetchling *Lathyrus pratensis* and rough hawkbit *Leontodon hispidus*.

The common knapweed - crested dog's-tail community on the higher fields away from the brook also has a herb-rich sward which is low growing and especially tight on the ridges. The community is the lady's bedstraw *Galium verum* type subcommunity having lady's bedstraw present as an occasional and yellow oat-grass as a frequent component of the sward. Twelve species of grass have so far been recorded, none of which shows overall dominance. Red fescue, common bent and crested dog's tail are co-dominant with three other species, sweet vernal-grass, cock's-foot and Yorkshire-fog almost as frequent and quaking-grass is a constant occasional species.

Amongst the herb species in the sward there is a high proportion of leguminous herbs with common bird's-foot-trefoil *Lotus corniculatus*, white clover *Trifolium repens* and red clover being the most abundant species. Other species which are frequent include common knapweed, ribwort plantain, meadow buttercup, bulbous buttercup *Ranunculus bulbosus* and yellow rattle *Rhinanthus minor*. In places a marked zonation exists between the two neutral grassland communities.

Mature hedges with large hedgerow trees, particularly along the brook, serve to protect the site from surrounding improved fields and provide additional habitats for wildlife.

Welford Field SSSI

Welford Field is an unimproved field which lies in the flood plain of the River Avon on its south bank in a large river bend near Welford-on-Avon. It is a herb-rich neutral grassland overlying alluvial clays which exhibit a distinct calcareous influence from the close proximity of the Lias limestone to the north. The field has a characteristic flood meadow community of meadow foxtail *Alopecurus pratensis* and great burnet *Sanguisorba officinalis*, where traditional hay meadow management has been applied to seasonally flooded land with alluvial soils.

There is evidence that in the nineteenth century this grassland type was widespread and common in some parts of Britain, particularly in the Midlands and also southern England in the case of flood meadows. In the twentieth century, however, they have declined severely as a result of agricultural improvement, the neglect of common meadow rights and from gravel extraction. Welford Field is now one of the seven last remaining flood meadow sites known in Warwickshire.

The meadow has a sward that is species rich with a diversity of herbs and grasses.

Amongst the many species of grass found in the meadow characteristically none of them appears dominant. The most abundant species are meadow foxtail, red fescue *Festuca rubra* and Yorkshire fog *Holcus lanatus*. The density and variety of herbs in the sward is exceptionally high with great burnet, common knapweed *Centaurea nigra*, meadowsweet *Filipendula ulmaria* and meadow vetchling *Lathyrus pratensis* all generally abundant.

Lady's bedstraw *Galium verum* also grows in abundance in the meadow, this is unusual because in most flood meadows it is a rare component of the sward.

Welford Field is exceptional amongst the Warwickshire flood meadows in having herb species characteristic of more calcareous sites such as the lady's bedstraw but also salad burnet *Sanguisorba minor* grows in equal abundance to the great burnet. Other grasses in this meadow include soft brome *Bromus hordeaceus*, cock's-foot *Dactylis glomerata*, rough meadow-grass *Poa trivialis* and yellow oat-grass *Trisetum flavescens*. Meadow barley *Hordeum secalinum* is also found occasionally although unusual in flood meadows it is characteristic of many unimproved meadows in Warwickshire.

River Blythe SSSI

The 39 kilometre stretch of the River Blythe, from the point at which Spring Brook exits from under the Stratford-upon-Avon to Birmingham railway line to its confluence with the River Tame, is a particularly fine example of a lowland river on clay.

The Blythe has a wide range of natural structural features such as riffles, pools, small cliffs and meanders. These features are combined with a high diversity of substrate types ranging from fine silt and clay in the lower reaches to sands and gravels in the upper and middle reaches and in the riffles. The structure of this river is very variable and its importance is increased because of the rarity of such examples in lowland Britain.

The diverse physical features of the Blythe are mirrored by its diverse plant communities.

The mean number of plant species found in any 1 km stretch is above average for a lowland river, as is the number of species recorded for the whole length of the river.

Botanically, the Blythe is one of the richest rivers in lowland England with the most species-rich sections containing as many species as the very richest chalk streams.

Unlike many lowland rivers, the Blythe shows a clear succession of plant communities from its source to its confluence with the Tame. The substratum in the upper reaches is frequently composed of loose gravel and the margins still retain a high density of trees and shrubs. The vegetation in the channel is, therefore, shade-impooverished but algae and some flowering plants such as waterweeds *Elodea* spp. and water-starworts *Callitriche* spp. provide seasonal cover. The habitats in these upper reaches are important for their invertebrates.

Downstream, the trees and shrubs on the margins become fewer but still remain at a higher density than most lowland rivers. As the river becomes deeper and wider and the shading from trees is reduced, the flora becomes rich and varied. In the shallow, fast-running stretches with gravel beds, water-crowfoots *Ranunculus fluitans* and *R. penicillatus* var. *calcareus* grow in profusion with blanket-weed algae which are abundant through the summer months. Where larger stones are present a rich encrusting algal flora develops along with the fresh water sponge *Ephydatia fluviatilis*.

There is a rich flora in stretches with a moderate rate of flow over a clay bottom. The emergent common clubrush *Schoenoplectus lacustris* and branched bur-reed *Sparganium erectum* occur here alongside submerged species of pondweed *Potamogeton pectinatus*, *P. perfoliatus* and *P. crispus*, lesser bur-reed *Sparganium emersum*, spiked water-milfoil *Myriophyllum spicatum* and many other less common species. On the margins, sedges *Carex* spp. are frequent alongside species of sweet-grass *Glyceria* spp., reed canary-grass *Phalaris arundinacea* and many other flowering plants.

In the lower reaches where shallow stretches alternate with deeper, slower sections, the flora is diverse. Alongside many of the species recorded upstream are flowering rush *Butomus umbellatus*, arrowhead *Sagittaria sagittifolia* and yellow water-lily *Nuphar lutea*.

The marginal flora is rich with mats of aquatic vegetation encroaching from the banks into the water. Amphibious bistort *Polygonum amphibium*, great yellow-cress *Rorippa amphibia* and reed sweet-grass *Glyceria maxima* are typical constituents of this community.

Several damp, unimproved meadows occur along the length of the river. They receive some of their water from annual flooding and are largely dependent upon the river for the maintenance of a high water-table. Rushes *Juncus* spp., sedges and tufted hair grass *Deschampsia cespitosa* are usually the dominant species along with moisture-loving herbs such as meadowsweet *Filipendula ulmaria*, marsh marigold *Caltha palustris* and wild angelica *Angelica sylvestris*. There are several small areas of wet alder *Alnus glutinosa* and willow *Salix* spp. woodland which have a varied ground flora and are an integral part of the river system.

The river supports a diverse invertebrate community with a wide range of molluscs, oligochaetes and caddisflies. The most notable species is the pea-shell cockle *Pisidium moitessierianum* which is at the western edge of its range here. The dragonflies are also well represented with the beautiful demoiselle *Calopteryx virgo* being the least common of the species found.

APPENDIX 5: WATER NEUTRALITY

Water Neutrality is defined in Chapter 4. This appendix provides supplementary information and guidance behind the processes followed.

Twin-Track Approach

Attainment of water neutrality requires a 'twin track' approach whereby water demand in new development is minimised as far as possible. At the same time measures are taken, such as retrofitting of water efficient devices on existing homes and business to reduce water use in existing development.

In order to reduce water consumption and manage demand for the limited water resources within the study area, a number of measures and devices are available⁵⁷, including:

- cistern displacement devices;
- flow regulation;
- greywater recycling;
- low or variable flush replacement toilets;
- low flow showers;
- metering;
- point of use water heaters;
- pressure control;
- rainwater harvesting;
- variable tariffs;
- low flows taps;
- water audits;
- water butts;
- water efficient garden irrigation; and,
- water efficiency promotion and education.

The varying costs and space and design constraints of the above mean that they can be divided into two categories, measures that should be installed for new developments and those which can be retrofitted into existing properties. For example, due to economies of scale, to install a rainwater harvesting system is more cost effective when carried out on a large scale and it is therefore often incorporated into new build schools, hotels or other similar buildings. Rainwater harvesting is less well advanced as part of domestic new builds, as the payback periods are longer for smaller systems and there are maintenance issues. To retrofit a rainwater harvesting system can have very high installation costs, which reduces the feasibility of it.

However, there are a number of the measures listed above that can be easily and cheaply installed into existing properties, particularly if part of a large campaign targeted at a number of properties. Examples of these include the fitting of dual-flush toilets and low flow showers

⁵⁷ Source: Water Efficiency in the South East of England, Environment Agency, April 2007.

heads to social housing stock, as was successfully carried out in Preston by Reigate and Banstead Council in conjunction with Sutton and East Surrey Water and Waterwise⁵⁸.

The Pathway Concept

The term 'pathway' is used here as it is acknowledged that, to achieve any level of neutrality, a series of steps are required in order to go beyond the minimum starting point for water efficiency which is currently mandatory for new development under current and planned national planning policy and legislation.

Whilst it is compulsory that all new homes are given a rating under the Government's Code for Sustainable Homes (CSH), only affordable housing has a minimum rating that must be achieved (Code Level 3); there is no statutory requirement under the Code for all other new housing to have a low water use specification as previous government proposals to make different levels compulsory have been postponed pending government review. For non-domestic development, there is no statutory requirement to have a sustainability rating with the Building Research Establishment Environmental Assessment Method (BREEAM) only being mandatory where specified by a public body in England such as:

- Local Authorities incorporating environmental standards as part of supplementary planning guidance;
- NHS buildings for new buildings and refurbishments;
- Department for Children, Schools and Families for all projects valued at over £500K (primary schools) and £2million (secondary schools);
- English Partnerships (now incorporated into the Homes and Communities Agency) for all new developments involving their land; and,
- Office of Government Commerce for all new buildings;

Therefore, other than potential local policies delivered through the LDF process, the only water efficiency requirements for new development are through the Building Regulations⁵⁹ where new homes must be built to specification to restrict water use to 125l/h/d. However, the key aim of the Localism Bill is to decentralise power away from central government towards local authorities and the communities they serve. It therefore creates a stronger driver for local authorities such as Stratford-on-Avon District Council to propose local policy to address specific local concerns. New local level policy is therefore key to delivering aspirations such as water neutrality and the proposed Localism Bill will assist in providing the legislative mechanism to achieve this in Stratford-on-Avon District Council.

In addition to the steps required in new local policy, the use of a pathway to describe the process of achieving water neutrality is also relevant to the other elements required to deliver it, as it describes the additional steps required beyond 'business as usual' that both developers and stakeholders with a role (or interest) in delivering water neutrality would need to take e.g.

- the steps required to deliver higher water efficiency levels on the ground (for the developers themselves); and,
- the partnership initiative that would be required beyond that normally undertaken by local authorities and water companies in order to minimise existing water use from the current housing and business stock.

⁵⁸ Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

⁵⁹ Part G of the Building Regulations

Therefore, the pathway to neutrality described in this section of the WCS requires a series of steps covering:

- technological inputs in terms of physically delivering water efficiency measures on the ground;
- local planning policies which go beyond national guidance; and,
- partnership initiatives and partnership working.

The following sections outline the types of water efficiency measures which have been considered in developing the technological pathway for the water neutrality target scenarios.

Improving Efficiency in Existing Development

Metering

The installation of water meters in existing housing stock has the potential to generate significant water use reductions because it gives customers a financial incentive to reduce their water consumption. Being on a meter also encourages the installation and use of other water saving products, by introducing a financial incentive and introducing a price signal against which the payback time of new water efficiency measures can be assessed. Metering typically results in a 5-10 per cent reduction from unmetered supply, which equates to water savings of approximately 14.56l/h/d or 33.5l per household, assuming an occupancy rate of 2.3⁶⁰ for existing properties.

In 2009, DEFRA instructed Anna Walker (the Chair of the Office of Rail Regulation) to carry out an independent review of charging for household water and sewerage services (the Walker Review)⁶¹. The typical savings in water bills of metered and unmetered households were compared by the Walker review, which gives an indication of the levels of water saving that can be expected (see Table A5-1).

TABLE A5-1: CHANGE IN TYPICAL METERED AND UNMETERED HOUSEHOLD BILLS

2009-10 Metered	2009-10 Unmetered	2014-15 Metered	2014-15 Unmetered	% change Metered	% change Unmetered
348	470	336	533	-3	13

Low or Variable Flush Toilets

Toilets use about 30 per cent of the total water used in a household⁶². An old style single flush toilet can use up to 13 litres of water in one flush. New, more water-efficient dual-flush toilets can use as little as 2.6 litres⁶³ per flush. A study carried out in 2000 by Southern Water and the Environment Agency⁶⁴ on 33 domestic properties in Sussex showed that the average dual flush saving observed during the trial was 27 per cent, equivalent to a volumetric saving of around 2.6 litres per flush. The study suggested that replacing existing toilets with low or variable flush alternatives could reduce the volume of water used for toilet flushing by approximately 27 per cent on average.

⁶⁰ 2.3 is used for existing properties as opposed to 2.1 for new properties – the latter reflects changes in population over time.

⁶¹ Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009,

<http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/>

⁶² http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/toilet_flushing.html

⁶³ <http://www.lecico.co.uk/>

⁶⁴ The Water Efficiency of Retrofit Dual Flush Toilets, Southern Water/Environment Agency, December 2000

Cistern Displacement Devices

These are simple devices which are placed in the toilet cistern by the user, which displace water and therefore reduce the volume that is used with each flush. This can be easily installed by the householder and are very cheap to produce and supply. Water companies and environmental organisations often provide these for free.

Depending on the type of devices used (these can vary from a custom made device, such as a bag filled with material that expands on contact with water, to a household brick) the water savings can be up to 3 litres per flush.

Low Flow Taps and Showers

Flow reducing aerating taps and shower heads restrict the flow of water without reducing water pressure. Thames Water estimates that an aerating shower head can cut water use by 60 per cent with no loss of performance⁶⁵.

Pressure Control

Reducing pressure within the water supply network can be an effective method of reducing the volume of water supplied to customers. However, many modern appliances, such as Combi boilers, point of use water heaters and electric showers require a minimum water pressure to function. Careful monitoring of pressure is therefore required to ensure that a minimum water pressure is maintained. For areas which already experience low pressure (such as those areas with properties that are included on a water company's DG2 Register) this is not suitable. Limited data is available on the water savings that can be achieved from this method.

Variable tariffs

Variable tariffs can provide different incentives to customers and distribute a water company's costs across customers in different ways.

The Walker review assessed variable tariffs for water, including:

- rising block tariff;
- a declining block tariff;
- a seasonal tariff; and,
- time of day tariff.

A rising block tariff increases charges for each subsequent block of water used. This can raise the price of water to very high levels for customers whose water consumption is high, which gives a financial incentive to not to consume additional water (for discretionary use, for example) while still giving people access to low price water for essential use.

A declining block tariff decreases charges for each subsequent block of water used. This reflects the fact that the initial costs of supply are high, while additional supply has a marginal additional cost. This is designed to reduce bills for very high users and although it weakens incentives for them to reduce discretionary water use, in commercial tariffs it can reflect the economies of scale from bulk supplies.

⁶⁵ <http://www.thameswater.co.uk/cps/rde/xchg/corp/hs.xsl/9047.htm>

A seasonal tariff reflects the additional costs of summer water supply and the fact that fixed costs are driven largely by the peak demand placed on the system, which is likely to be in the summer.

Time-of-day tariffs have a variable cost per unit supply according to the time of the day when the water is used; this requires smart meters. This type of charging reflects the cost of water supply and may reduce an individual household's bill; it may not reduce overall water use for a customer.

Water Efficient Appliances

Washing machines and dishwashers have become much more water efficient over the past twenty years; whereas an old washing machine may use up to 150 litres per cycle, modern efficient machines may use as little as 35 litres per cycle. An old dishwasher could use up to 50 litres per cycle, whereas modern models can use as little as 10 litres. However, this is partially offset by the increased frequency with which these are now used. It has been estimated⁶⁶ that dishwashers, together with the kitchen tap, account for about 8-14 per cent of water used in the home.

The Water Efficient Product Labelling Scheme provides information on the water efficiency of a product (such as washing machines) and allows the consumer to compare products and select the efficient product. The water savings from installation of water efficient appliances therefore vary, depending on the type of machine used.

Non-Domestic Properties

There is also the potential for considerable water savings in non-domestic properties; depending on the nature of the business water consumption may be high e.g. food processing businesses. Even in businesses where water use is not high, such as B1 Business or B8 Storage and Distribution, there is still the potential for water savings using the retrofitting measures listed above. Water audits are useful methods of identifying potential savings and implementation of measures and installation of water saving devices could be funded by the asset owner; this could be justified by significant financial savings which can be achieved through implementation of water efficient measures. Non-domestic buildings such as warehouses and large scale commercial (e.g. supermarkets) property have significant scope for rainwater harvesting on large roof areas.

There is significant potential for water efficiency in the agricultural sector from rainwater harvesting. The Environment Agency guide for farmers⁶⁷ illustrates the potential benefits to both the environment and the farmer from the installation of a RWH system. For example, a farm growing soft fruit in polytunnels could harvest 5,852m³ of water per year from 120 hectares of tunnels, which could give the following benefits:

- better soil drainage between the tunnels,
- improved humidity levels inside them; and,
- an improvement in plant health through the use of harvested water.

Water Efficiency in New Development

The use of efficient fixtures and fittings as described in above also apply to the specification of water use in the building of new homes. The simplest way of demonstrating the reductions

⁶⁶ Water Efficiency Retrofitting: A Best Practice Guide, Waterwise, 2009, www.waterwise.org.uk

⁶⁷ Rainwater Harvesting: an on-farm guide, Environment Agency, 2009

that use of efficient fixtures and fitting has in new builds is to consider what is required in terms of installation of the fixtures and fittings at different ranges of specification to ensure attainment of code levels under the CSH water use requirements. The Cambridge WCS⁶⁸ gave a summary of water use savings that can be achieved by the use of efficient fixtures and fittings, as shown below in Table A5-2.

TABLE A5-2: SUMMARY OF WATER SAVINGS BORNE BY WATER EFFICIENCY FIXTURES AND FITTINGS

Component	150 l/h/d Standard Home	130 l/h/d	120 l/h/d CSH Level 1/2	115 l/h/d	105 l/h/d CSH Level 3/4	80 l/h/d CSH Level 5/6
Toilet flushing	28.8	19.2b	19.2 b	16.8d	16.8 d	8.4 + 8.4 f
Taps	42.3 a	42.3 a	31.8 a	31.8 a	24.9 a	18 a
Shower	30	24	24	22	18	18
Bath	28.8	25.6c	25.6 c	25.6 c	25.6 c	22.4 e
Washing machine	16.7	15.3	15.3	15.3	15.3	7.65 + 7.65 f
Dishwasher	3.9	3.6	3.6	3.6	3.6	3.6
Recycled water	-	-	-	-	-	-16.1
Total per head	150.5	130	119.5	115.1	104.2	78
Outdoor	11.5	11.5	11.5	11.5	11.5	11.5
TOTAL PER HOUSEHOLD	366.68	319.3	293.52	284.14	257.41	195.58

- a Combines kitchen sink and wash hand basin
- b 6/3 litre dual-flush toilet (f) recycled water
- c 160 litre bath filled to 40% capacity, frequency of use 0.4/day
- d 4.5/3 litre dual flush toilet
- e 120 litre bath
- f rainwater/greywater harvesting
- g Assumed garden use

Table 2 highlights that in order for Code Level 5 and 6 to be achieved for water use under the CSH (80 l/h/d); water re-use technology (rainwater harvesting and/or greywater recycling) needs to be incorporated into the development.

In using the BRE Water Demand Calculator⁶⁹, the experience of URS BREEAM/CHS assessors is that it is theoretically possible to get close to 80l/h/d through the use of fixture and fittings, but that this requires extremely high specification efficiency devices which are unlikely to be acceptable to the user and will either affect the saleability of new homes or result in the immediate replacement of the fixtures and fittings upon habitation. This includes baths

⁶⁸ Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

⁶⁹ <http://www.thewatercalculator.org.uk/faq.asp>

at capacity below 120 litres, and shower heads with aeration which reduces the pressure sensation of the user. For this reason, it is not considered practical to suggest that Code Level 5 and 6 can be reached without some form of water recycling.

Rainwater Harvesting

Rainwater harvesting (RWH) is the capture and storage of rain water that lands on the roof of a property. This can have the dual advantage of both reducing the volume of water leaving a site, thereby reducing surface water management requirements and potential flooding issues, and be a direct source of water, thereby reducing the amount of water that needs to be supplied to a property from the mains water system.

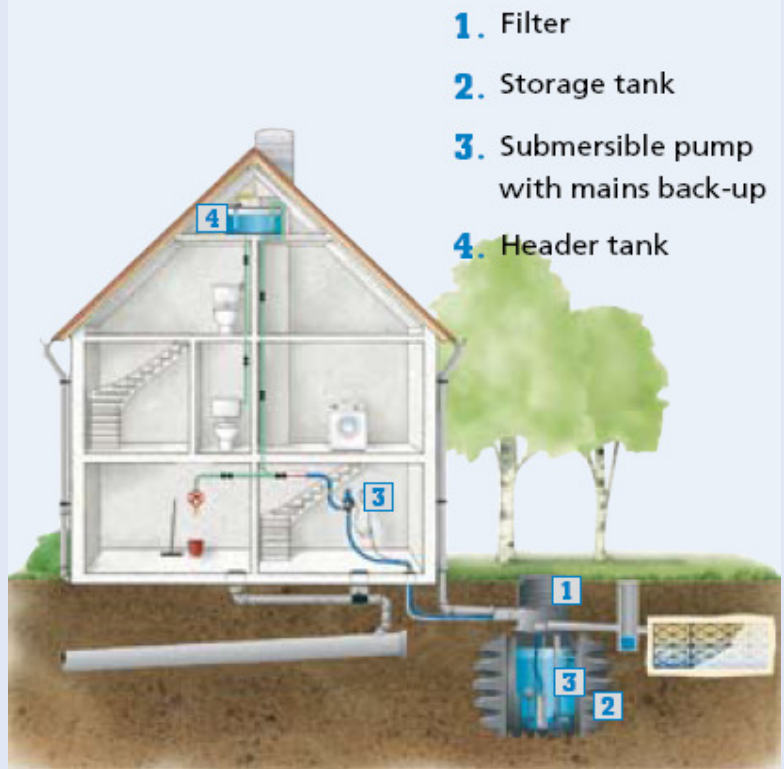
RWH systems typically consist of a collection area (usually a rooftop), a method of conveying the water to the storage tank (gutters, down spouts and pipes), a filtration and treatment system, a storage tank and a method of conveying the water from the storage container to the taps (pipes with pumped or gravity flow). A treatment system may be included, depending on the rainwater quality desired and the source. Figure A5-1 below gives a diagrammatic representation of a typical domestic system⁷⁰.

The level to which the rainwater is treated depends on the source of the rainwater and the purpose for which it has been collected. Rainwater is usually first filtered to remove larger debris such as leaves and grit. A second stage may also be incorporated into the holding tank; some systems contain biological treatment within the holding tank, or flow calming devices on the inlet and outlets will allow heavier particles to sink to the bottom, with lighter debris and oils floating to the surface of the water. A floating extraction system can then allow the clean rainwater to be extracted from between these two layers⁷¹.

⁷⁰ Source: Aquality Intelligent Water management, www.aqua-lity.co.uk

⁷¹ Aquality Rainwater Harvesting brochure, 2008

FIGURE A5-1: A TYPICAL DOMESTIC RAINWATER HARVESTING SYSTEM



- 1. Filter
- 2. Storage tank
- 3. Submersible pump with mains back-up
- 4. Header tank

A recent sustainable water management strategy carried out for a proposed EcoTown development at Northstowe⁷², approximately 10 km to the north west of Cambridge, calculated the size of rainwater storage that may be required for different occupant numbers, as shown below in Table A5-3.

TABLE A5-3: RWH SYSTEMS SIZING

Number of occupants	Total water consumption	Roof area (m ²)	Required storage tank (m ³)	Potable water saving per head (l/d)	Water consumption with RWH (l/h/d)
1	110	13	0.44	15.4	94.6
1	110	10	0.44	12.1	97.9
1	110	25	0.88	30.8	79.2
1	110	50	1.32	57.2	52.8
2	220	25	0.88	15.4	94.6
2	220	50	1.76	30.8	79.2

⁷² Sustainable water management strategy for Northstowe, WSP, December 2007

TABLE A5-3: RWHS SYSTEMS SIZING

Number of occupants	Total water consumption	Roof area (m ²)	Required storage tank (m ³)	Potable water saving per head (l/d)	Water consumption with RWHS (l/h/d)
3	330	25	1.32	9.9	100.1
3	330	50	1.32	19.8	90.2
4	440	25	1.76	7.7	102.3
4	440	50	1.76	15.4	94.6

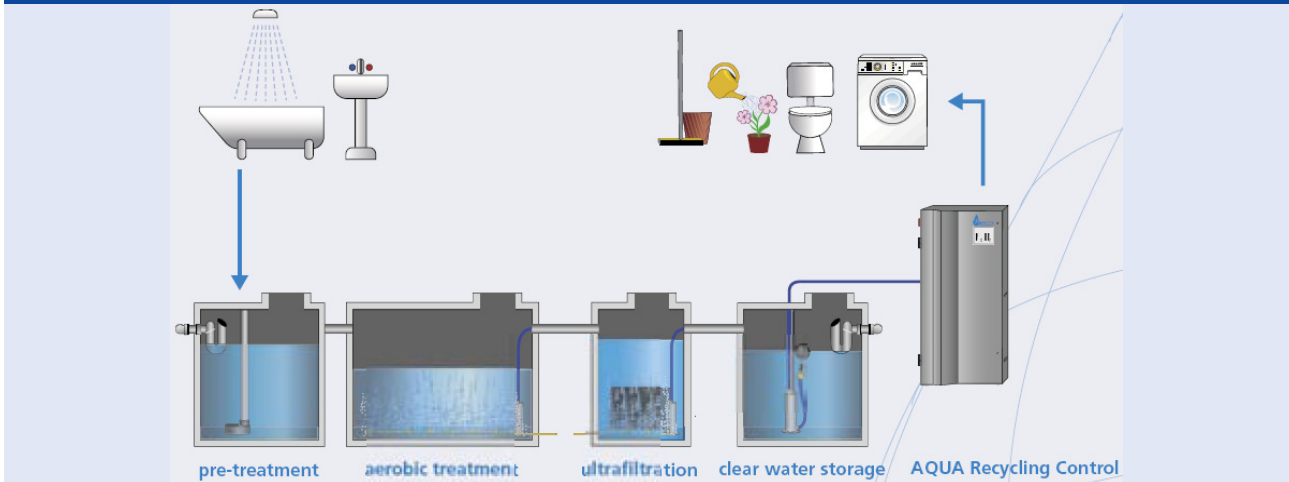
A family of four, with an assumed roof area of 50m³, could therefore expect to save 61.6 litres per day if a RWHS system were installed.

Greywater Recycling

Greywater recycling (GWR) is the treatment and re-use of wastewater from shower, bath and sinks for use again within a property where potable quality water is not essential e.g. toilet flushing. Recycled greywater is not suitable for human consumption or for irrigating plants or crops that are intended for human consumption. The source of greywater should be selected by available volumes and pollution levels, which often rules out the use of kitchen and clothes washing waste water as these tend to be most highly polluted. However, in larger system virtually all non-toilet sources can be used, subject to appropriate treatment.

The storage volumes required for GWR are usually smaller than those required for rainwater harvesting as the supply of greywater is more reliable than rainfall. In domestic situations, greywater production often exceeds demand and a correctly designed system can therefore cope with high demand application and irregular use, such as garden irrigation. Figure A5-2 below gives a diagrammatic representation of a typical domestic system⁷³.

FIGURE A5-2: A TYPICAL DOMESTIC GREYWATER RECYCLING SYSTEM



⁷³ Source: Aquality Intelligent Water management, www.aqua-lity.co.uk

Combined rainwater harvesting and greywater recycling systems can be particularly effective, with the use of rainwater supplementing greywater flows at peak demand times (e.g. morning and evenings).

The Northstowe sustainable water management strategy calculated the volumes of water that could be made available from the use GWR. These were assessed against water demand calculated using the BRE Water Demand Calculator⁷⁴.

Table A5-4 demonstrates the water savings that can be achieved by GWR. If the toilet and washing machine are connected to the GWR system a saving of 37 litres per person per day can be achieved.

TABLE A5-4: POTENTIAL WATER SAVINGS FROM GWR

Appliance	Demand with Efficiencies (l/h/day)	Potential Source	Greywater Required (l/h/day)	Out As	Greywater available (80% efficiency) (l/h/day)	Consumptions with GWR (l/h/day)
Toilet	15	Grey	15	Sewage	0	0
Wash hand basin	9	Potable	0	Grey	7	9
Shower	23	Potable	0	Grey	18	23
Bath	15	Potable	0	Grey	12	15
Kitchen Sink	21	Potable	0	Sewage	0	21
Washing Machine	17	Grey	17	Sewage	0	0
Dishwasher	4	Potable	0	Sewage	0	4
TOTAL	103		31		37	72

The treatment requirements of the GWR system will vary, as water which is to be used for flushing the toilet does not need to be treated to the same standard as that which is to be used for the washing machine. The source of the greywater also greatly affects the type of treatment required. Greywater from a washing machine may contain suspended solids, organic matter, oils and grease, detergents (including nitrates and phosphates) and bleach. Greywater from a dishwasher could have a similar composition, although the proportion of fats, oils and grease is likely to be higher; similarly for wastewater from a kitchen sink. Wastewater from a bath or shower will contain suspended solids, organic matter (hair and skin), soap and detergents. All wastewater will contain bacteria, although the risk of infection from this is considered to be low⁷⁵.

⁷⁴ <http://www.thewatercalculator.org.uk/faq.asp>

⁷⁵ Centre for the Built Environment, www.cbe.org.uk

Treatment systems for GWR are usually of the following four types:

- basic (e.g. coarse filtration and disinfection);
- chemical (e.g. flocculation);
- physical (e.g. sand filters or membrane filtration and reverse osmosis); and,
- biological (e.g. aerated filters or membrane bioreactors).

Table A5-5 below gives further detail on the measures required in new builds and from retrofitting, including assumptions on the predicted uptake of retrofitting from the existing housing and commercial building use.

TABLE A5-5: WATER NEUTRALITY SCENARIOS – SPECIFIC REQUIREMENTS FOR EACH SCENARIO

WN Scenario	New development requirement				Retrofitting existing development	
	New development Water use target (l/h/d)	Relevant CSH target	Water Efficient Fixtures and Fittings	Water Recycling technology	Metering Penetration assumption (a)	Water Efficient Fixtures and Fittings (b)
Business as usual	125	Building Regs only	<ul style="list-style-type: none"> - 3-6 litre dual flush toilet; - Low aeration taps; - 160 litre capacity bath; - High efficiency washing machine 	None	90%	None
Low	120	Level 1/2	<ul style="list-style-type: none"> - 3-6 litre dual flush toilet; - Low spec aeration taps; - 160 litre capacity bath; - low spec low flow shower head - High efficiency dishwasher - High efficiency washing machine 	None	100%	<ul style="list-style-type: none"> - 3-6 litre dual flush toilet or cistern device fitted; - 10% take up across district
Medium	105	Level 3/4	<ul style="list-style-type: none"> - 3-4.5 litre dual flush toilet; - Medium spec aeration taps; - high spec low flow shower head; - 160 litre capacity bath; - high spec flow shower head - High efficiency dishwasher - High efficiency washing machine 	None	100%	<ul style="list-style-type: none"> - 3-4.5 litre dual flush toilet or cistern device fitted; - medium spec aerated taps fitted - 20% take up across district

TABLE A5-5: WATER NEUTRALITY SCENARIOS – SPECIFIC REQUIREMENTS FOR EACH SCENARIO

WN Scenario	New development requirement				Retrofitting existing development	
	New development Water use target (l/h/d)	Relevant CSH target	Water Efficient Fixtures and Fittings	Water Recycling technology	Metering Penetration assumption (a)	Water Efficient Fixtures and Fittings (b)
High	78	Level 5/6	<ul style="list-style-type: none"> - 3-4.5litre dual flush toilet; - High spec aeration taps; - high spec low flow shower head; - 120 litre capacity bath; - high spec low flow shower head - High efficiency dishwasher - High efficiency washing machine 	Rainwater harvesting	100%	<ul style="list-style-type: none"> - 3-4.5 litre dual flush toilet or cistern device fitted; - high spec aerated taps fitted - high spec low flow shower head fitted - 25% take up across district
Very High	62	Level 5/6	<ul style="list-style-type: none"> - 3-4.5litre dual flush toilet; - High spec aeration taps; - high spec low flow shower head; - 120 litre capacity bath; - high spec low flow shower head - High efficiency dishwasher - High efficiency washing machine 	Rainwater harvesting and Greywater recycling	100%	<ul style="list-style-type: none"> - 3-4.5 litre dual flush toilet or cistern device fitted; - high spec aerated taps fitted - high spec low flow shower head fitted - 35% take up across district

a: only the additional metering beyond business as usual has been accounted for (i.e. 10%)

b: refers to fittings above that are included in a standard home using approximately 150l/h/d

Financial Cost Considerations for Water Neutrality scenarios

The financial cost of delivering the technological requirements of each neutrality scenario have been calculated from available research and published documents.

New Build Costs

Costs for water efficiency in new property have been provided based on homes achieving different code levels under the CSH based on the cost analysis undertaken by CLG⁷⁶ and as set out in Table A5-6.

TABLE A5-6: CSH SPECIFICATIONS AND COSTS

Code Level	Estimated water consumption (l/h/d)	Specification	Cost	
			Additional Cost (£)	Cumulative Cost (£)
1 and 2	120	2 x 6/4 litre flush toilets 4 x taps with flow regulators (2.5 l/m) 1 x shower 6 litres/min 1 x standard bath (90 litres per use) 1 x standard washing machine* 1 x standard dishwasher*	£0	£0
3 and 4	105	As Level 1 and 2, except: 2x4/2.5 litre flush toilets 1x smaller shaped bath	£125	£125
5 and 6	80	<u>Houses</u> As Level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	£2,520	£2,645
		<u>Apartments</u> As Level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	£680	£805
Notes:	*Additional cost of washing machine and dishwasher is assumed to be zero as these fittings are 'standard' industry performance. Therefore, if they are typically installed by house builder there would be no additional cost over their current specifications.			

An additional cost was required for the 'very high' neutrality scenario that included for greywater recycling as well as rainwater harvesting and this is detailed in the following section.

Water Recycling

Research into the financial costs of installing and operating GWR systems gives a range of values, as show in Table A5-7.

⁷⁶ CLG (2008) Cost Analysis of the Code for Sustainable Homes

TABLE A5-7: COSTS OF GWR SYSTEMS

Cost	Cost	Comments
Installation cost	£1,750	Cost of reaching Code Level 5/6 for water consumption in a 2-bed flat ⁷⁷
	£2,000	For a single dwelling ⁷⁸
	£800	Cost per house for a communal system ⁷⁹
	£2,650	Cost of reaching Code Level 3/4 for water consumption in a 3-bed semi-detached house ⁸⁰
Operation of GWR	£30 per annum ⁸¹	
Replacement costs	£3,000 to replace ²³	It is assumed a replacement system will be required every 25 years

There is less research and evidence relating to the cost of community scale systems compared to individual household systems, but it is thought that economies of scale will mean that larger scale systems will be cheaper to install than those for individual properties. As shown above, the Cost review of the Code for Sustainable Homes indicated that the cost of installing a GWR system in flats is less than the cost for a semi-detached house. Similarly, the Water Efficient Buildings website estimates the cost of installing a GWR system to be £2,000 for a single dwelling and £800 per property for a share of a communal system.

As it is not possible to determine how many of the outstanding housing developments in Stratford-on-Avon District will be of a size large enough to consider communal recycling facilities, an approximation has been made of an average per house cost (£1,400) using the cost of a single dwelling (at £2,000) and cost for communal (at £800). This has been used for the assessment of cost for a greywater system in a new property required for the 'very high' neutrality scenario.

Installing a Meter

The cost of installing a water meter has been assumed to be £500 per property⁸². It is assumed that the replacement costs will be the same as the installation costs (£500), and that meters would need to be replaced every 15 years⁸³.

⁷⁷ Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008

⁷⁸ http://www.water-efficient-buildings.org.uk/?page_id=1056

⁷⁹ http://www.water-efficient-buildings.org.uk/?page_id=1056

⁸⁰ Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008

⁸¹ Environment Agency Publication - Science Report – SC070010, Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008

⁸² Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

⁸³ Environment Agency Publication - Science Report – SC070010: Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008

Retrofitting of Water Efficient Devices

Findings from the Environment Agency report Water Efficiency in the South East of England⁸⁴, costs have been used as a guide to potential costs of retrofitting of water efficient fixtures and fittings and are presented in Table A5-8 below.

TABLE A5-8: WATER SAVING METHODS

Water Saving Method	Approximate Cost per House (£)	Comments/Uncertainty
Variable flush retrofit toilets	£50 - £140	Low cost for 3-6 litre system and high cost for 3-4.5 litre system. Needs incentive to replace old toilets with low flush toilets.
Low flow shower head scheme	£15 - £50	Low cost for low spec shower head; high costs for high spec. Cannot be used with electric, power or low pressure gravity fed systems.
Aerating taps	£10 - £20	Low cost is med spec, high cost is high spec.

Toilet cistern displacement devices are often supplied free of charge by water companies and this is therefore also not considered to be an additional cost.

Neutrality scenario costs

Using the above information, the financial costs per scenario has been calculated and are included in Table A5-9.

⁸⁴ Ref – Water Efficiency in the South East of England

TABLE A5-9: ESTIMATED COST OF NEUTRALITY SCENARIOS

Neutrality Scenario	CSH – Code Level	Outstanding Homes		Existing Properties					Costs Summary		
		Numbers	CSH cost	No. to be metered (10% existing)	Metering cost	Retrofit %	No. to retrofit	Retrofit cost	Developer	Non developer	Total
Low	1 or 2	5,600	-	16,802	£8,401,000	10%	5420	£271,000	-	£8,672,000	£8,672,000
Medium	3 or 4	5,600	£700,000	16,802	£8,401,000	20%	10,840	£1,788,600	£700,000	£10,189,600	£10,889,600
High	5 or 6 (RWH)	5,600	£14,812,000	16,802	£8,401,000	25%	13,550	£2,981,000	£14,812,000	£11,382,000	£26,194,000
Very High	5 or 6 (RWH & GWR)	5,600	£22,428,000	16,802	£8,401,000	35%	18,970	£4,173,400	£22,428,000	£12,574,400	£35,002,400

Carbon Cost Considerations

As described in this section, there are sustainability issues to consider when deciding on a policy for promotion of water neutrality. Reaching the very highest levels of efficiency requires the use of recycling technology (either through rainwater harvesting and treatment or greywater recycling) which requires additional energy both embedded in the physical structures required and also in the treatment process required to make the water usable.

Whilst being water efficient is a key consideration of this study, due to the wider vision for sustainable growth, reaching neutrality should not be at the expense of increasing energy use and potential increasing the carbon footprint of development

It is also important to consider that through using less water, more water efficient homes require less energy to heat water, hence there are energy savings.

In order to give an overview of the likely sustainability of each of the WN scenarios, a 'carbon cost' has been applied to each of the scenarios based on the water efficiency measures proposed for new homes, and the retrofitting of existing.

Methodology

A joint study by the Environment Agency and the Energy Saving Trust⁸⁵ assessed the energy and carbon implications of the installation of water saving devices (Table A5-10). The report initially calculated a baseline water consumption figure for existing housing stock, using the following assumptions:

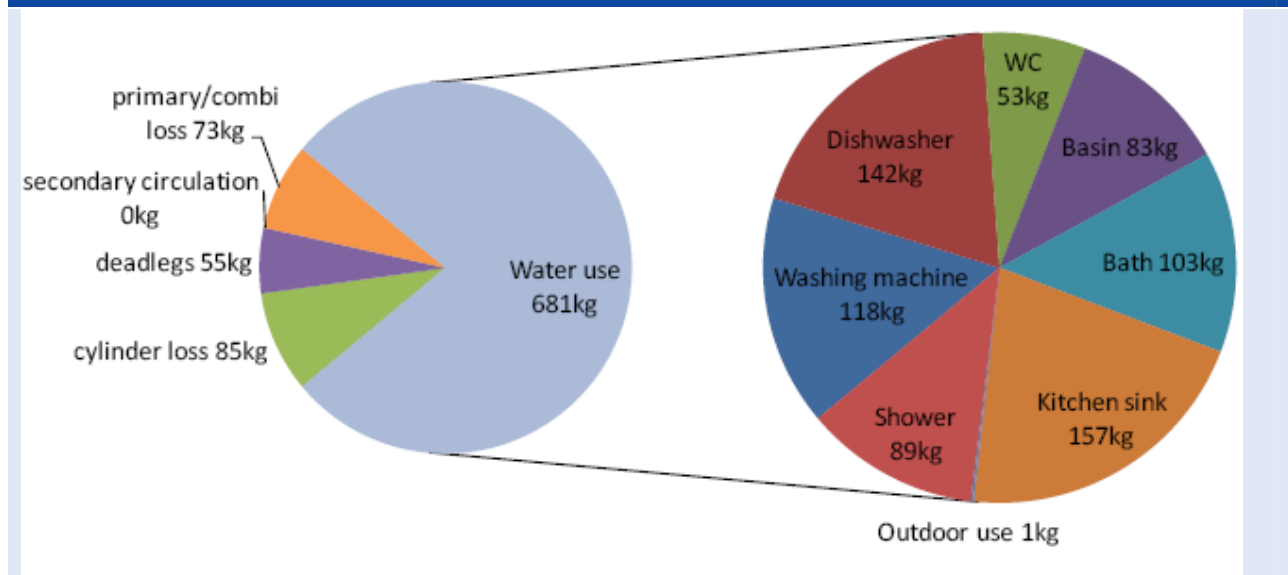
TABLE A5-10: BASELINE ENERGY CONSUMPTION ASSUMPTIONS

Device	Volume of water per use (litres)	Frequency of use (per person per day)
Toilet	9.4	4.66
Kitchen Taps	59	Taps taken as volume/day, 40% cold
Basin taps hot	42	Taps taken as volume/day, 30% cold
Bath	70	0.21
Washing machine	50	0.34
Shower	25.7	0.59
Dishwasher	21.3	0.29

⁸⁵ Quantifying the energy and carbon effects of water saving, Full technical report, Environment Agency and the Energy Saving Trust, 2009

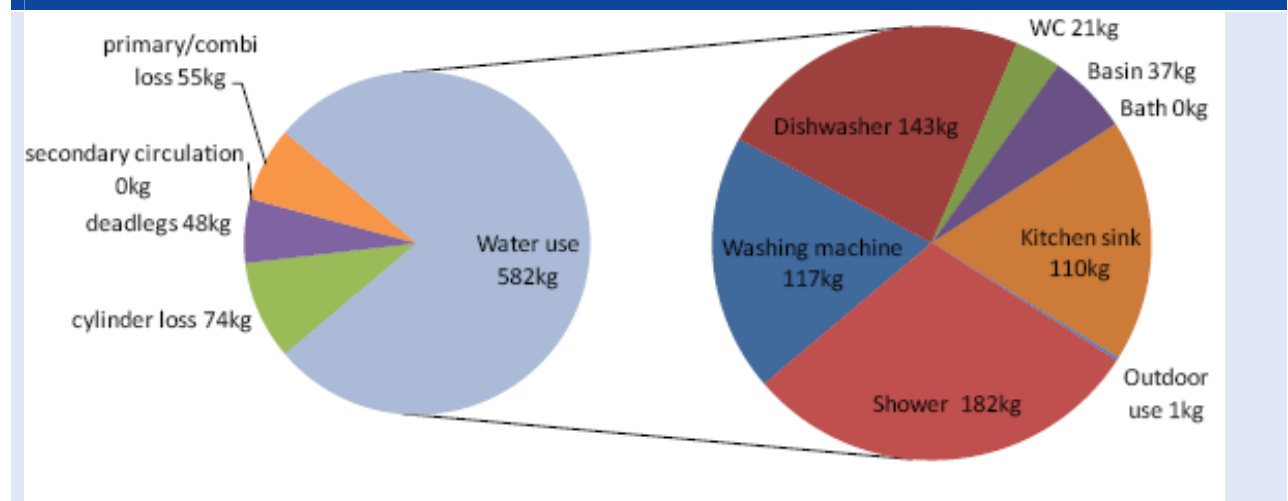
The study then modelled the CO₂ emissions from this 'standard' existing dwelling, as shown below in Figure A5-3. Appliances requiring hot water using appliances dominate, but water use for toilet flushing produces 53kg of CO₂ emissions per year (approximately 50 per cent from water company emissions and 50 per cent due to heat loss as cold mains water in the toilet cistern heats to room temperature).

FIGURE A5-3: CO₂ EMISSIONS FROM A 'STANDARD' EXISTING DWELLING

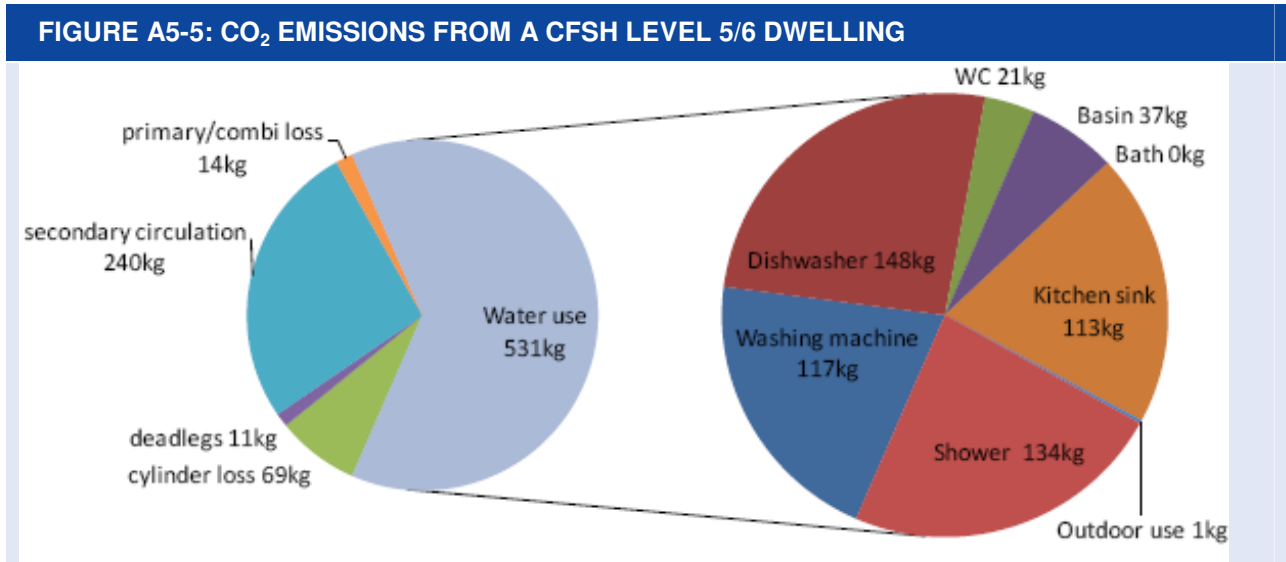


The study then assessed the impacts on this baseline figure of 681 kg CO₂ for water use from a home which has water use compliant with CfSH level 3/4 (Figure A5-4).

FIGURE A5-4: CO₂ EMISSIONS FROM A CFSH LEVEL 3/4 DWELLING



The study then assessed the impacts of a home which has water use compliant with CfSH level 5/6 (Figure A5-5).



It can therefore be seen that the carbon cost of achieving Levels 3/4 and 5/6 compares favourably to the baseline scenario of current average water use of 681kg/CO₂. CfSH level 3/4 represents a carbon saving of 99 kg/CO₂ and CfSH Level 5/6 represents a carbon saving of 150 kg/CO₂.

The energy savings from water efficiency measures within the home would be offset to a certain degree by increased energy demands of RWH or GWR systems, which have been shown to be required to meet CfSH Level 5/6. Energy savings for STW from not treating additional water to potable standard, as with the conventional mains water supply, can be thought of to be simply a transfer of energy consumption away from the STW to the individual householders. While STW will benefit from this reduction in energy demand, which will assist with meeting its Carbon Reduction Commitment (CRC) (as laid down in 2007’s Energy Reduction White Paper⁸⁶), the expense will be passed to householders.

For households with the GWR/RWH required for CfSH Levels 5/6, any financial benefits to householders experienced through a reduction in water bills (for metered properties) will be offset by the increased expense of energy bills for pumping and treating water in GWR and RWH systems.

⁸⁶ Meeting the Energy Challenge - A White Paper on Energy, May 2007, Department of Trade and Industry

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