Water

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Water Cycle Study Update 2015

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List of Acronyms

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
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
LFE	Low Flow Enterprise (low flow model)
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority

Ml	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
ROAN	Review of Objectively Assessed Housing Need
RoC	Review of Consents (under the Habitats Directive)
RQP	River Quality Planning (tool)
RWH	Rainwater Harvesting
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
STW	Severn Trent Water
SuDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
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
WCC	Warwickshire County Council
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

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.

This WCS update does not supersede the 2014 WCS update, but instead it builds on the information provided to ensure that there are solutions to deliver growth for the preferred development allocations, including the policy required to deliver it.

This WCS incorporates the additional development proposed in five strategic allocation sites within the District following the Review of Objectively Assessed Housing Need (ROAN)[1] in July 2015. The ROAN concluded that the Council make provision for 14,480 dwellings between 2011 and 2031 in order to meet the Council's Objectively Assessed Housing Need. In addition, the Inspector's interim conclusions recommended that the Council build in flexibility to the total number of dwellings to be provided; therefore the Council propose an additional 5-7% of the total 14,480 dwellings originally proposed.

The Council has therefore set a target of 15,479 new dwellings to be built between 2011 and 2031 (14,480 plus 5-7%) following the ROAN and Inspector's interim conclusions. Table 2-1 provides a summary of the additional housing figures within the five strategic allocation sites to be assessed. Due to the focus on wastewater treatment, the settlement areas, in which the five strategic allocation sites fall, have been grouped into the WwTW catchments within which they are located.

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
Itchen Bank	WwTW at permit limit after an additional 1643 dwellings
Long Marston	Capacity for all additional growth
Stratford-Milcote	Capacity for all additional growth
Wellesbourne	WwTW at permit limit after an additional 454 dwellings

The WCS has shown that two 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 Itchen Bank and Wellesbourne have some initial capacity within their permit limit, but do not have sufficient capacity to accept all growth within the plan period. Solutions are required to ensure that the increase in wastewater discharge, as a result of growth, does not impact on the current quality of the receiving watercourses and associated ecological sites.

The detailed assessments have shown that improvements at Wellesbourne are possible within the limits of conventionally applied technology.

For Itchen Bank WwTW, the detailed assessment has 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

[1] ERM (2015) Review of Objectively Assessed Housing Need in Stratford-on-Avon District. Available at https://www.stratford.gov.uk/files/seealsodocs/170865/Review%20of%20Objectively%20Assessed%20Housing%20Need%20in%20Stratford%20District%20-%20ERM%20-%20July%202015.pdf

sites are pursued. Therefore a solution needs to be identified by the Environment Agency and Severn Trent Water if this option is taken forward, so that the WwTW has 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 and Severn Trent Water should work together to determine if any of the potential solutions proposed in the study are acceptable. Once appropriate solutions have been identified, development timescales and the amount of development which can be accommodated across the District in the early phases of the Local Plan delivery period can be determined.

In both cases, the detailed assessment has 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.

Sewer Capacity

In order to ensure wastewater from growth can be drained to the WwTWs, an assessment of sewer capacity constraints on potential strategic 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 on the growth assessed for the entire District, 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.

Six 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 (equivalent to reaching Code for Sustainable Homes Level 3/4).. 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.

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 provides a site specific assessment of the potential constraints on each strategic site.

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 (DPD).

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 2010.

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, focusing solely on the Stratford-on-Avon administrative area to 2028. Following the publication of the 2012 Stage 2 Stratford-on-Avon WCS, Stratford-on-Avon District Council proposed a larger growth target within the District and over a longer planning horizon to 2031. An update to the Stage 2 report was subsequently undertaken in 2014 superseding the initial Stage 2 WCS produced in 2012.

The 2014 WCS incorporated Stratford-on-Avon District Council's revised spatial approach of future expected development as detailed in their 2011-2031 Housing Requirement and Strategic Site Options. The 2014 WCS update looked at five alternative strategic options which the Council was proposing 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

1.3 WCS 2015 Scope

This WCS update does not supersede the 2014 WCS update, but instead it builds on the information provided 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 2015 WCS for Stratford-on-Avon District Council:

- determine if solutions to wastewater treatment for the strategic allocation sites are required and how this might impact phasing of development within (and around) each strategic allocation site;
- determine whether additional water resources are required to support growth;
- determine upgrades required to water supply infrastructure relative to 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 strategic allocation site;
- determine impact of infrastructure and mitigation provision on housing delivery phasing; and
- provide policy recommendations.

1.4 Study Drivers

A full list of the key legislative drivers shaping the study is detailed in the Stage 1 Outline WCS, and a summary table is included in Appendix A 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,
- Severn Trent Water (STW) 2014 Water Resource Management Plan.

1.5 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 for the 2014 WCS that a starting assumption of 131l/h/d would be used to calculate wastewater generation and water use per person. The same consumption values have been used for the 2015 WCS.

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 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.

However, this study has, 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.

1.6 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 'strategic allocation site' 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 strategic allocation sites (Chapter 5); and,
- Policy and other recommendations (Chapter 6).

1.7 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;
- Severn Trent Water (STW) Ltd; and
- Environment Agency.

The Steering Group met during the completion of this 2015 study to both guide and feedback on the assessments undertaken in support of the study.

2 Proposed Growth

2.1 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 Options report.

This WCS update is based on figures for homes already built since 2011, committed allocations up to August 2015, and the additional commitments allocated post April 2015. These revised planning figures are presented in the Council's Core Strategy – Proposed modifications in response to the Inspector's Interim Conclusions (August 2015).

2.2 Housing

This WCS incorporates the additional development proposed in five strategic allocation sites within the District following the Review of Objectively Assessed Housing Need (ROAN)[2] in July 2015. The ROAN concluded that the Council make provision for 14,480 dwellings between 2011 and 2031 in order to meet the Council's Objectively Assessed Housing Need. In addition, the Inspector's interim conclusions recommended that the Council build in flexibility to the total number of dwellings to be provided; therefore the Council propose an additional 5-7% of the total 14,480 dwellings originally proposed.

The Council has therefore set a target of 15,479 new dwellings to be built between 2011 and 2031 (14,480 plus 5-7%) following the ROAN and Inspector's interim conclusions.

Table 2-1 provides a summary of the additional housing figures within the five strategic allocation sites to be assessed within this WCS. Due to the focus on wastewater treatment, the settlement areas, in which the five strategic allocation sites fall, have been grouped into the WwTW catchments within which they are located. This WCS only assess the additional growth which has been identified. The 2015 WCS should therefore be read in parallel with the 2014 WCS.

[2] ERM (2015) Review of Objectively Assessed Housing Need in Stratford-on-Avon District. Available at https://www.stratford.gov.uk/files/seealsodocs/170865/Review%20of%20Objectively%20Assessed%20Housing%20Need%20in%20Stratford%20District%20-%20ERM%20-%20July%202015.pdf

Table 2-1 Summary of housing figures to be assessed

WwTW Catchment	Settlement Area	Additional Commitments post 1st April 2015	Built[3]	Committed	Total to be assessed (excluding built)
Itchen Bank	Bishops Itchington	-	3	115	**115**
	Harbury	6	38	90	**96**
	Ladbroke	-	0	0	**0**
	Long Itchington	58	13	157	**215**
	Southam	505	19	510	**1,015**
	Stockton	-	3	100	**100**
	Harbury Cement Works	-	0	200	**200**
Sub-Total					***1,741***
Long Marston	Long Marston	-	1	77	**77**
	Quinton (Upper & Lower)	30	9	54	**84**
	Meon Vale (Long Marston Development)	-	160	890	**890**
	Adjacent Authority (Wychavon)	-	0	380	**380**
Sub-Total					***1,431***
Stratford - Milcote	Alveston	1	2	1	**2**
	Clifford Chambers	3	0	0	**3**
	Stratford-upon-Avon	1,225	459	1,508	**2733**
	Tiddington	19	6	17	**36**
	Welford-on-Avon	-	12	72	**72**
	Wilmcote	-	8	3	**3**
Sub-Total					***2,849***
Wellesbourne	Hampton Lucy	-	0	25	**25**
	Loxley	-	0	-1	**-1**
	Wellesbourne	350	95	386	**736**
Sub-Total					***760***
TOTAL		**2,197**	**828**	**4,584**	**6781**

[3] The number of dwellings completed to date has been subtracted from the scenario dwelling numbers as it is assumed these dwellings are now connected to the wastewater network and are now accommodated for.

The sub-totals for each WwTW catchment in Table 2-1 represent the most up to date housing figures to be located within the WwTW catchment to be assessed in this WCS update. These sub-total figures are also shown in Table 2-2 alongside the housing figures proposed for a number of different growth options previously assessed in the 2014 WCS Update.

Table 2-2 therefore provides a summary of how the housing figures assessed at Itchen Bank WwTW, Long Marston WwTW, Stratford-Milcote WwTW and Wellesbourne WwTW have changed from the 2014 WCS Update following the ROAN and Inspector's interim conclusions.

Table 2-2 Change in housing figures assessed from 2014 WCS Update

WwTW and Growth Option	Total housing assessed 2014 WCS Update	Total housing assessed 2015 WCS Update
Itchen Bank Itchen Bank Option A Itchen Bank Option E	1,072 1,222 3,872	1,741
Long Marston Long Marston Option A Long Marston Option C	569 1,069 4,069	1,431
Stratford-Milcote Stratford-Milcote Option A Stratford-Milcote Option D	3,288 3,938 6,288	2,849
Wellesbourne Wellesbourne Option A	596 746	760

2.3 Employment

This WCS update also takes account of proposed increases in employment throughout the plan period; a total of approximately 5,900 new jobs by 2031 to be provided within the settlement areas listed in Table 2-1. Table 2-3 provides a summary of the employment figures within these settlement areas to be assessed.

Table 2-3 Summary of employment figures to be assessed

WwTW Catchment	Site Name	Jobs
Stratford - Milcote	Long Marston Airfield	3,000
	Stratford Canal Quarter Regeneration Zone	0*
	SUA.2 South of Alcester Road	2,500
Itchen Bank	SOU.1 West of Banbury Road	400
TOTAL		**5,900**

* No net increase in employment proposed at the site

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 discharge 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

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.

This WCS has assessed growth in relation to the four STW WwTWs which have been identified in Section 2. This is because the additional growth assessed within this 2015 WCS update is focused in the catchment areas of these four WwTWs. The 2014 WCS should be referenced to obtain a district wide overview of the wastewater treatment.

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 gives an indication as to what the maximum number of properties that can be connected to a WwTW catchment might be. 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, as well as non-domestic flow and other flows such as groundwater infiltration. 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 usable[4] 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).

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

[4] In some cases, there is a hydraulic restriction on flow within a WwTWs which would limit full use of the maximum permitted headroom

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 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 waterbody[5]; 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 B.

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 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:

[5] 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

- 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.
- then 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;
  - 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.
- Finally, 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 B:

- 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.

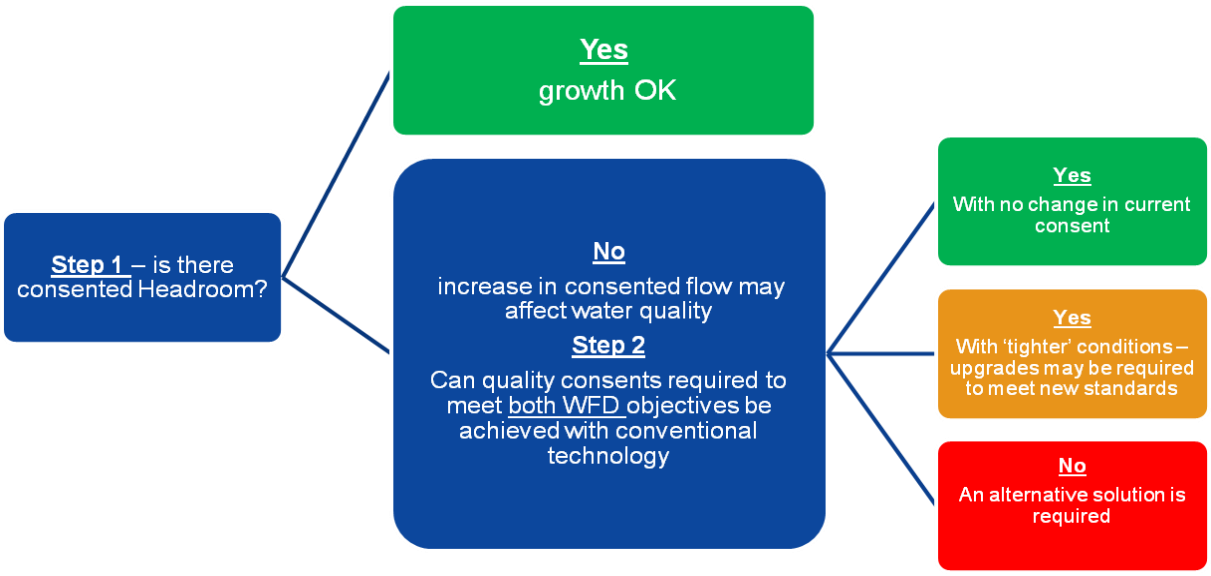


Figure 3-1 RAG Assessment Process Diagram for Wastewater treatment capacity

3.2 Wastewater Treatment Assessment – Results

A Wastewater Treatment Assessment was carried out in the 2014 WCS which assessed the impact of the possible growth options across all WwTWs within the District. The 2014 WCS Update provided:

- A RAG assessment summary table which provides 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 could be accepted within the current permitted headroom; and
- Further detail on the WwTWs requiring a new permit and hence a water quality assessment.

As a consequence of the additional growth as recommended in the ROAN and Inspector's interim conclusions, three WwTWs (Itchen Bank, Long Marston and Stratford-Milcote) within the District require re-assessment. A fourth WwTW (Wellesbourne) also requires re-assessment as a result of the recent planning applications in the surrounding area.

The Wastewater Treatment Assessments in this WCS therefore replace the assessments undertaken in the previous WCS for each of these WwTWs, including any Strategic Growth Options also assessed.

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 of the four affected WwTW and the results presented according to whether there is (or is not) permitted headroom.

3.2.1 WwTW with Permitted Headroom

Table 3-1 details the WwTW's 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.

Table 3-1 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) [6]
Long Marston[7]	835	744	**91**	**332**
Stratford-Milcote	13,110	10,417	**10,128**	**2,693**

Growth in these catchments 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 3-1 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.

[6] Based on an Occupancy rate of 2.1 and consumption rate of 131 l/h/d
[7] On the basis that Long Marston WwTW is closed in 2017 and all flows are pumped to Stratford-Milcote where additional capacity is being provided as part of this solution to accommodate the strategic development on the airfield.

3.2.2 WwTW without Permitted Headroom

The calculations of headroom demonstrated that two WwTW's would not have sufficient headroom by the end of the plan period once all the growth in the catchment is included as detailed in Table 3-2.

Table 3-2 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) [6]
Itchen Bank	2,881	2,915	**-34**	**-98**
Wellesbourne	1,559	1,643	**-84**	**-306**

The WwTWs listed in Table 3-2 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 B.

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

Itchen Bank
Itchen Bank WwTW has available headroom in its existing discharge permit to accept 1,643 of the dwellings proposed after which the volumetric discharge permit will be exceeded. Unless additional headroom can be made available in the catchment any growth beyond 1,643 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions. The growth in the catchment (covering Harbury, Ladbroke, Long Itchington, Stockton and Southam) would cause the WwTW to exceed its existing permit conditions by 34m^3/d by the end of the plan period.

<u>WFD Compliance</u>
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 Ammonia and a new condition would be required for Phosphate. The change that is required for 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 is not possible and a long-term solution is required at this WwTW catchment.

The modelling has shown that future Moderate or Good Status for Phosphate cannot be achieved with the current discharge quality, unless a Phosphate condition was applied beyond the levels of conventional treatment (0.07mg/l for Good Status and 0.18mg/l for Moderate Status). Assessment of growth shows that a similar Phosphate condition would need to be applied beyond the limits of conventional treatment to achieve Good Status or for Moderate Status. As such, growth itself would not prevent future Moderate or Good status for Phosphate from being achieved.

Future Good Status for BOD could also be achieved with both the current and future discharge quality, but would require the BOD permit to be tighter than it currently is (7mg/l), but which remains within the levels of conventional treatment.

<u>Upgrade Requirements and Phasing</u>
The Ammonia condition required for the new permit 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.

A solution needs to be developed between STW and the Environment Agency with the onus being on STW to maintain standards set within their current environmental permit.

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

1) Disconnection of pumping stations and redirect flows to a restored WwTW within the catchment to create headroom at Itchen Bank (STW have stated that there a number of outlying settlements which historically used to have their own WwTW);
2) STW consider whether a permitted ammonia limit less than 1mg/l[8] would be acceptable and achievable at the WwTW;
3) 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;
4) 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 is given a Red status on the basis that a potential new solution is required, and needs to be identified by the Environment Agency and STW.

Wellesbourne
Wellesbourne WwTW has available headroom in its existing discharge permit and can accept an additional 454 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) growth beyond 454 dwellings draining to the WwTW would cause the WwTW to exceed its existing volumetric permit conditions by 84m^3/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 quality conditions on the new discharge permit would need to be tighter than the current conditions for Ammonia[9]. 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 future Moderate or Good Status for Phosphate cannot be achieved with the current discharge quality, unless a Phosphate condition was applied beyond the levels of conventional treatment (0.24mg/l for Good Status and 0.71mg/l for Moderate Status). Assessment of growth shows that a similar Phosphate condition would need to be applied beyond the limits of conventional treatment to achieve Good Status or for Moderate Status. As such, growth itself would not prevent future Moderate or Good status for Phosphate from being achieved.

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 expansion[10], funding for these upgrades may not be available until later in AMP6[11] and hence development beyond 454 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.

STW have stated that a potential option to accommodate all growth within the Wellesbourne WwTW catchment would be to pump flows directly to Stratford-Milcote WwTW. Should this option be taken forward, future long term capacity at Stratford-Milcote would need to be reviewed in light of the additional flows from Wellesbourne WwTW.

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

[8] Based on a 95 percentile compliance
[9] BOD and Phosphate conditions would not need to change
[10] Assuming adjacent land can be made available
[11] Investment programme from April 2015 to 2020

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 D. 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

Welford Field SSSI is downstream of the Stratford – Milcote WwTW. Any need to increase the permitted discharge volumes from this WwTW could have impacts on the downstream designated site. However, the Water Cycle Study identifies that this WwTW has existing permitted headroom, which is sufficient to accommodate all of the proposed growth. Hence no infrastructure upgrades are required to deliver the proposed growth levels in this location. Growth in this catchment 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 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, some of the strategic allocation sites 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.

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 WCS[12] 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 CAMS[13];

- 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 or 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 Final Water Resource Management Plan 2014 (WRMP) 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 STWs WRMP.

4.1.1 Water Resource Planning

Water companies have historically undertaken medium to long term planning of water resources in order to demonstrate that a 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 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.

[12] Warwickshire Sub-Regional Water Cycle Strategy, Stratford-on-Avon Council, Scoping and Outline Final Report, Halcrow, 2010
[13] http://www.environment-agency.gov.uk/business/topics/water/119931.aspx

4.2 Water Resource Planning in Stratford-on-Avon

The STW 2014 Water Resources Management Plan (WRMP) was released for public consultation in May 2013. Following comments received on the draft, STW published a revised 2014 WRMP for consultation in November 2013 and a Statement of Response in January 2014. The Final 2014 WRMP was published in May 2014; therefore the information within the Final 2014 WRMP is used to inform the 2015 WCS Update.

In reviewing STW's Final 2014 WRMP 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 Final 2014 WRMP 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.

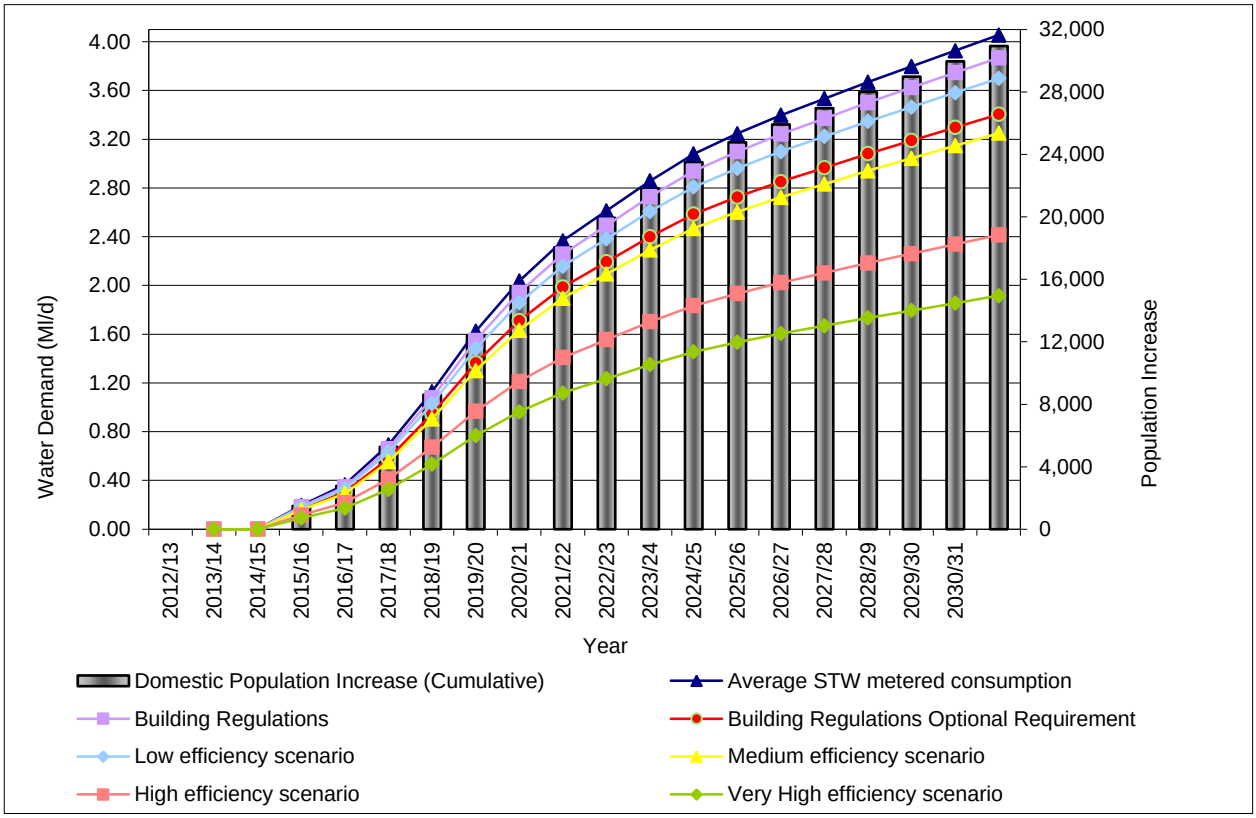
The projections were derived as follows:

- **Projection 1 – Average STW metered consumption –** New homes would use 131 l/h/d[14], this reflects the planning consumption used by STW and TW to maintain security of supply;
- **Projection 2a** – **Building Regulations –** New homes would conform to (and not use more than) Part G of the Building Regulations requirement of 125 l/h/d;
- **Projection 2b – Building Regulations Optional Requirement** – Only applies where a condition that the new home should meet the optional requirement is imposed as part of the process of granting planning permission. Where it applies, new homes would conform to (and not use more than) Part G of the Building Regulations optional requirement of 110 l/h/d;
- **Projection 3** – **Low Efficiency Scenario –** New homes would achieve 120 l/h/d (previously based on Code for Sustainable Homes (CSH) Level 1/2);
- **Projection 4 – Medium Efficiency Scenario** – New homes would achieve 105 l/h/d (previously based on CSH Level 3/4);
- **Projection 5 – High Efficiency Scenario** – New homes would achieve 80 l/h/d (previously based on CSH Level 5/6); 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 1.62 and 3.43l/d by 2031. The projections are shown in Figure 4-1.

[14] 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 final 2014 WRMP 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.

4.3.1.1 Severn Trent Water – Strategic Grid Water Resource Zone

The Environment Agency definition of a WRZ is the "largest possible zone in which customers share the same risk of a resource shortfall". In the STW 2014 WRMP, the Stratford-on-Avon District is 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.

The measures which are proposed by STW to maintain the supply-demand balance show that the available supplies will be sufficient to meet expected demand.

4.3.1.2 Supply-Demand Strategy

STW have identified a number of schemes that will benefit the Strategic Grid WRZ. 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 stress[15]. 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 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, mainly due to the limitation on available new resources locally. Therefore 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, and 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.

4.5.1 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.

4.5.1.1 Managing Climate Change

STW recognise in their Strategic Direction Statement[16] 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 2014 WRMP, STW highlight that climate change and the Restoring Sustainable Abstraction (RSA) programme are the most significant risks to long term supply/demand balance.

[15] As classified by the Environment Agency
[16] Severn Trent Water (2007) Focus on Water, Strategic Direction Statement 2010 - 2035

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.

4.5.1.2 Sustainability Reductions

The STW 2014 WRMP 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 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 40Ml/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 5Ml/d.

4.5.1.3 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' sampled[17] 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 Ml/d, whilst the combined impact from confirmed and likely sustainability reductions, and climate change is estimated at a decrease of 100.5 Ml/d by 2040.

4.5.1.4 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 place[18]. 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.

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:

[17] using a Latin Hypercube Sampling method.
[18] Water Neutrality is defined more fully in the Environment Agency report 'Towards water neutrality in the Thames Gateway' (2007)

- 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.

4.6.2 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 available[19]. 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. 0 provides more detail on the different types of device or system along with the range of efficiency savings they could lead to.

4.6.3 Achieving Total Neutrality – is it feasible?

When considering neutrality within an existing planning area, it is recognised by the Environment Agency[20] 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. 0 discusses the pathway concept is in more detail, 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.

4.6.4 Water Neutrality Scenarios

Four water neutrality scenarios have been proposed and assessed, each with varying levels of water efficiency measures. Each scenario moves beyond the Business as Usual scenario, which is considered to be:

- 125 l/h/d for all new homes[21];
- No mandatory efficiency target for non-domestic property; and
- Continued meter installation in existing homes as planned in AfW's WRMP up to 2040.

The existing level of metering within the STW region is 35%. STW's future target for meter penetration[22] 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.

[19] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.
[20] Environment Agency (2009) Water Neutrality, an improved and expanded water management definition
[21] Building regulations Part G Requirement
[22] proportion of properties within the STW supply area which have a water meter installed

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:

4.6.4.1 Very High Scenario

The scenario has been developed as a context to demonstrate what is required to achieve the full aspiration of water neutrality. In reality, achieving 100% meter penetration across the District is unlikely, due to a proportion of existing properties which either have complicated plumbing or whose water is supplied by bulk (i.e. flats), making it difficult for meter installation.

The key assumptions for this scenario are that 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 District.
- 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 Local Plan 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.

4.6.4.2 High Scenario

The key assumptions for this scenario are that a high water neutrality percentage[23] 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; and
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required.
- 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.

4.6.4.3 Medium Scenario

The key assumptions for this scenario are that the water neutrality percentage[24] 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 Local Plans in the UK.

It would require:

- Uptake of retrofitting water efficiency measures to be reasonably high (20%) in the District; and
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required.
- 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.

4.6.4.4 Low Scenario

The key assumptions for this scenario are that the water neutrality percentage[25] 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.

[23] 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

[24] 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

It would require:

- Uptake of retrofitting water efficiency measures to be fairly low (10%); and
- A relatively small funding pool and a partnership working not moving too far beyond 'business as usual' for stakeholders.
- 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.

4.6.5 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, UKWIR26, 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 (0).

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 (32% meter penetration) by STW as a specific initiative for the WCS for the Medium, High and Very High water neutrality scenarios. The second option looks at STW undertaking a more realistic 'additional' 10% metering initiative (on top of the WRMP commitment), which equates to approximately 1,700 homes.

4.6.5.1 Option 1

Under this option, all properties that would remain unmetered by 2035 would be metered by STW as a specific metering initiative for the WCS.

[25] 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
[26] UKWIR – The United Kingdom Water Industry Research group, attended and part funded by all major UK water companies

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 (Ml/d)	Total demand post growth* (Ml/d)	Total demand after metering effect (Ml/d)	Total demand after metering & WE F&F (Ml/d)	% Neutrality Achieved
Baseline Assumption	4.05	18.96	**18.37**	**18.37**	11%
Building Regulations	3.87	18.78	**18.18**	**18.18**	15%
Building Regulations – Optional Requirement	3.40	18.31	**17.72**	**17.72**	27%
Low WN Scenario	3.70	18.61	**18.01**	**17.90**	23%
Medium WN Scenario	3.25	18.16	**16.98**	**16.31**	64%
High WN Scenario	2.41	17.32	**16.14**	**14.77**	100%
Very High WN Scenario	1.92	16.83	**15.65**	**13.72**	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 64% 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.

4.6.5.2 Option 2

Under this option, STW would undertake a more realistic metering initiative, where only 10% of unmetered properties would be metered by STW, in addition to STW's WRMP commitment. 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 (Ml/d)	Total demand post growth* (Ml/d)	Total demand after metering effect (Ml/d)	Total demand after metering & WE F&F (Ml/d)	% Neutrality Achieved
Baseline Assumption	4.05	18.96	**18.37**	**18.37**	11%
Building Regulations	3.87	18.78	**18.18**	**18.18**	15%
Building Regulations – Optional Requirement	3.40	18.31	**17.72**	**17.72**	27%
Low WN Scenario	3.70	18.61	**18.01**	**17.90**	23%
Medium WN Scenario	3.25	18.16	**17.50**	**16.83**	50%
High WN Scenario	2.41	17.32	**16.67**	**15.29**	90%
Very High WN Scenario	1.92	16.83	**16.17**	**14.24**	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 90% neutral water use, and the medium neutrality scenario gives 50% neutral water use.

4.6.6 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 0.

4.6.7 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 0.

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 0.

4.6.7.1 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

4.6.8 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 0 on the methodology used to calculate carbon equivalents of energy used.

The WRMP Direction 2007[27] and WRP Guideline[28] require details of the greenhouse gas emissions that are likely to arise through the delivery of a water company's proposed WRMP. STW estimated[29] 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/Ml[30] 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/Ml has been used.

4.6.8.1 Results

The information was used along with estimates of energy used in recycling technology[31] 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 $90m^2$ 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 low WN (120l/h/d) home. Therefore, energy used per home is the same for 'business as usual' (i.e. building regulations) and the low WN scenario.

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^2e/d)	Carbon use per New Home (kg/y)	Carbon use per New Home (kg/d)	Total Carbon use for New Homes (tCO^2e/d)	Total (tCO^2e/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 CO_2 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 the very high scenario; however the additional energy required for greywater recycling in the very high scenario makes this scenario higher in CO_2 emissions than the high WN scenario. This suggests that in order to meet total neutrality there will be an increase in CO_2 emissions over less intensive WN scenarios and hence there are concerns over the long term sustainability of pursuing such a strategy.

[27] WRMP Regulations Statutory Instrument 2007 No. 727, WRMP Direction 2007, WRMP (No.2) Direction 2007, WRMP (No.2) (Amendment) Direction 2007, WRMP Direction 2008
[28] Water resources planning guideline, Environment Agency, November 2008, http://www.environment-agency.gov.uk/business/sectors/39687.aspx
[29] Severn Trent Water, Greenhouse Gas Emission Data, 2002-2009 & 2010/2011
[30] Based on the Severn Trent Water 2010 WRMP
[31] Environment Agency (2010) Energy and carbon implications of rainwater harvesting and greywater recycling

4.6.9 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 50% to be reached if an additional 10% of households that remain unmetered in 2040 are metered, or a WN target of 64% 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.

4.6.10 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 (equivalent to reaching Code for Sustainable Homes Level 3/4).

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

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 3

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

When considering planning applications for new development (regardless of size), the planning authority and statutory 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 sufficient to meet 105l/h/d.

Undertaking retrofitting and water audits must work in parallel with the promotion and education programme. Further recommendations on how to achieve it are included in Section 4.6.11 below, including recommended funding mechanisms.

4.6.11 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 Initiative[32];
- 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.

4.6.11.1 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:

- 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.

[32] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

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.

4.6.11.2 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 2008[33] (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 (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 1990[34] 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)[35]. Stratford-on-Avon District Council should consider a similar scheme, although this would require the agreement of STW and TW.

4.6.11.3 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 form 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 balance[36]. 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.

[33] http://www.legislation.gov.uk/ukpga/2008/29/contents
[34] http://www.legislation.gov.uk/ukpga/1990/8/contents
[35] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010
[36] Waterwise (2011): Evidence base for large-scale water efficiency, Phase II Final report

5 Strategic Allocation Sites 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 strategic allocation sites where additional growth has been proposed. In addition, infrastructure capacity has also been reassessed for Wellesbourne WwTW as a result of the recent planning applications in the surrounding area.

5.2 Strategic Allocation Sites 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 have undertaken an internal assessment of the capacity of the network system using local operational knowledge.

The results are presented for each of the strategic allocation sites 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, or upgrades are already underway	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

5.2.2 Flood Risk

Fluvial

The flood risk to each of the strategic allocation sites has been considered using the Environment Agency Flood Maps. A green coding has been applied if the majority of the strategic site 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

Surface water flooding has been reviewed for each strategic site 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.

As of the 6th April 2015 Warwickshire County Council (WCC), as the LLFA, has become a statutory consultee for planning applications for major developments that have a drainage implication. As a statutory consultee, WCC is under a duty to respond to the LPA (Stratford-on-Avon District Council) and report on their performance on providing a substantive response within deadlines set out in legislation.

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.

SuDS

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 5.2.5).

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 Strategic Allocation Sites

Table 5-2 Strategic allocation sites assessment

Site Name	Wastewater Treatment		Wastewater Network Analysis	Surface Water Management and Flood Risk				
	Water Company	WwTW	Foul Sewerage Network Capacity	Surface Water Flood Risk	Fluvial Flood Risk	Potential receiving watercourse for surface water	Geology	SuDS Constraints
Long Marston Airfield (LMA)	STW	Stratford-Milcote	This development is located immediately adjacent to the existing Long Marston WwTW. Due to existing development already approved in the Long Marston catchment, an investment project is already underway to abandon Long Marston WwTW and pump all flows direct to Stratford-Milcote WwTW. Additional capacity to accommodate the strategic development on Long Marston Airfield can be provided as part of this project and is currently programmed for completion in 2017.	Some areas of surface water flooding identified in the strategic 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 and 3 of Marchfont Brook.		Mudstone	
Canal Quarter Regeneration Zone	STW	Stratford-Milcote	Current sewer capacity performance data indicates localised capacity issues in the existing sewerage network in the vicinity of this re-development area, however there are no reports of sewer flooding. More detailed hydraulic modelling will be required once specific development proposals are available but provided surface water run-off from existing impermeable areas is managed sustainable and any connections to the foul/combined sewer removed then the additional foul only flows from this re-development are not envisaged to cause any significant capacity issues.	Some areas of surface water flooding identified to the north east (north side of railway) and south of the strategic site.	FZ1	Racecourse Brook, Stratford-upon-Avon Canal	Mudstone	
Land off Bishopton Lane, Stratford-upon-Avon	STW	Stratford-Milcote	There is a 225mm diameter sewer crossing this site which serves the village of Wilmcote. There are localised capacity issues further downstream. The small diameter sewer is not expected to have sufficient spare capacity to accommodate the strategic development here and so capacity improvements are envisaged. Further detailed hydraulic modelling will be required to determine if any off-site improvements are required.	Area of surface water flooding identified along the A46 to the north and west of the strategic site.	The majority of the strategic site is within FZ1 - although the northern and western areas of the site are within FZ 2 and 3 of the Shottery Brook.	Shottery Brook	Mudstone	Space for surface attenuation SuDS may be limited within FZ 2 and 3 of the Shottery Brook.
South of Alcester Road, Stratford-upon-Avon	STW	Stratford-Milcote	This site is currently remote from the existing sewerage system and due to topography is likely to require pumping in order to connect to the nearest public foul sewerage system in Alcester Road. Existing sewer performance data does not indicate capacity issues although there are historic reports of rainfall related flooding in Shottery Village during extreme rainfall events, however flood risk is currently being managed using non-return valves. The additional foul only flows generated from this development are expected to be low but further detailed hydraulic modelling will be required to confirm if any localised capacity improvements are required.	Some areas of surface water flooding identified in the strategic site. Most appear to be associated with ordinary watercourse.	FZ1	Drayton Brook	Mudstone	
Land off Daventry Road, Southam	STW	Itchen Bank	Any development proposal at this strategic site is expected to drain to an existing pumping station off Welsh Road East. It is envisaged that pumping station capacity upgrades would be required to accommodate the additional foul flows from the additional growth. Capacity assessments will also be required in the downstream gravity system as there are	Small area of surface water flooding identified in the east of the strategic site.	FZ1	River Stowe	Mudstone and Limestone	

			historic reports of localised external flooding to a low lying property where flood risk is currently being effectively managed using non-return valves and bolt down covers.					
Wellesbourne*	STW	Wellesbourne	The Wellesbourne sewerage network currently has good performance. As Wellesbourne WwTW is located to the west of the catchment, new development proposals would have less of a capacity impact if allocations were to the west of the A429. Due to sewage treatment constraints (and environmental constraints in the River Dene) it may be appropriate to pump any strategic development allocations (i.e. the airfield) to Stratford-Milcote WwTW. This would require an 8km rising main to an inlet pumping station at Paddock Lane.	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.

* Not a strategic allocation site. The Wellesbourne settlement area has been reassessed and included here as a result of the recent planning applications in the surrounding area.

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.

6.1 Policy Recommendations Overview

6.1.1 Wastewater

WW1 – Development Phasing – Itchen Bank
The growth in the Itchen Bank WwTW catchment needs a potential solution to be identified by the Environment Agency and STW. The council should only give planning permission if both the Environment Agency and STW are satisfied that development can be accommodated.

WW2 – 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, equivalent to reaching 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. Surface water should be discharged as high up the following hierarchy of drainage options as reasonably practicable, before a connection to the foul network is considered:

- into the ground (infiltration);
- to a surface waterbody;
- to a surface water sewer, highway drain, or another drainage system;
- to a combined sewer.

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 and SFRA
Developers should ensure SuDS design supports the findings and recommendations of the Warwickshire Surface Water Management Plan (SWMP) 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

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 C.

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 next full review is due in 2019, although interim reviews are undertaken annually);
- second round of RBMP updates due by 2015; and,
- Periodic review 2019 (PR19) (STW's business plan for AMP7 – 2020 to 2025).

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
Catchment Abstraction Management Strategies	Environment Agency	Yearly updates provided. Date of next full review unknown

Appendix A. Legislative Drivers Shaping the WCS Update

Directive/Legislation/Guidance	Description
Birds Directive 2009/147/EC	Provides for the designation of Special Protection Areas.
Building Regulations Approved Document H – October 2015	
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	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: • 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.
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.

Directive/Legislation/Guidance	Description
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	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. 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.
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.
Water Framework Directive (WFD) 2000/60/EC	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. The Environment Agency is the body responsible for the implementation of the WFD in the UK. The Environment Agency have been supported by UKTAG37, 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 status38. These have recently been finalised and issued within the River Basin Management Plans (RBMP).
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.

[37] 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.
[38] UK Environmental Standards and Conditions (Phase I) Final Report, April 2008, UK Technical Advisory Group on the Water Framework Directive.

Appendix B. WwTW Capacity Assessment Results

B.1 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 1.5);
- 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 Q95[39]. 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.
- Raw water quality data for modelling was provided by Environment Agency water quality planners. The WFD 'no deterioration' target for each WwTW are the downstream status, for each water quality element, based on river monitoring data collected between 2012 and 2015. Actual data was used in preference over the published status in the RBMP. The mean value and standard deviation was calculated, using this raw data for BOD, Ammonia and Phosphate where available for both the upstream (of the WwTW) and downstream (the discharge) inputs. Details are provided below along with the full results and outputs from the water quality modelling in Table 6-2 and Table 6-3.
- 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.

B.2 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 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

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

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 6-2.

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 6-3.

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 6-2. (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 6-2 'No Deterioration' Assessment

	Wellesbourne			Itchen Bank		
	BOD	Ammonia	Phosphate	BOD	Ammonia	Phosphate
River Downstream of Discharge						
No Deterioration Target	High	High	Poor	Moderate	High	Poor
Designated Salmonid Fishery?						
River Quality Target (90%ile or AA)	4.00	0.30	1.00	6.50	0.30	1.00
Current Permit						
Current DWF (m^3/day)	1559			2881		
Permit Limits (95%ile or AA)	10	10	4	10	3	4
Discharge Quality Required						
Future DWF (m^3/day)	1643			2915		
Effluent Quality Required (95%ile or AA)	**26.31**	**3.81**	**4.48**	**11.39**	**0.58**	**1.51**
Will Growth prevent WFD 'No Deterioration' being achieved?	**No**			**Yes**		

Table 6-3: Improvement to 'Good Status' Assessment

	Wellesbourne				Itchen Bank			
	BOD	Ammonia	Phosphate		BOD	Ammonia	Phosphate	
River Downstream of Discharge								
No Deterioration Target	High	High	Good	Moderate	Good	High	Good	Moderate
Designated Salmonid Fishery?								
River Quality Target (90%ile or AA)	-	-	0.075	0.184	-	-	0.075	0.184
Current Permit								
Current DWF (m^3/day)	1559				2881			
Permit Limits (95%ile or AA)	-	-	**0.24**	**0.71**	**7.59**	**-**	**0.07**	**0.18**
Discharge Quality Required								
Future DWF (m^3/day)	1643				2915			
Effluent Quality Required (95%ile or AA)	-	-	**0.23**	**0.68**	**7.56**	**-**	**0.07**	**0.18**
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 C.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

	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 1,000m2 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). 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 Y/N or N/A	Local Planning Policy
11	Is the discharged water only surface water (e.g. not foul or from highways)? If no, has a discharge consent been applied for?	Y/N Y/N	Water Resources Act 1991
12	A) Does your site increase run-off to other sites? B) Which method to calculate run-off have you used?	Y/N	Local Planning Policy
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	
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	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. 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/Resources/Free_publications/the_suds_manual.aspx C) Have you checked that any proposed SUDS (including maintenance and adoption requirements) meet with the minimum requirements of the LLFA SuDS Guidance?	Y/N	Local Planning Policy Flood & Water Management Act
19	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. B) If Yes – has Infiltration testing been undertaken to confirm the effective drainage rate of the SuDS? C) Have you ensured that any proposed soakaways are no greater than 2m below existing ground level?	Y/N Y/N	
20	A) Are there proposals to discharge clean roof water direct to ground (aquifer strata)? B) If Yes, have all water down-pipes been sealed against pollutants entering the system form surface runoff or other forms of discharge?	Y/N Y/N	
21	A) Does proposed surface water drainage require use of smaller drains/channels to connect to a main river? B) If yes, has the relevant drainage authority been consulted?	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	Groundwater Regulations 1998 Article 7 of the Water Framework Directive
24	A) Is the development area within an inner zone (SPZ1)? 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 Y/N	

25	A) For infill development, has the previous use of the land been considered? B) Is there the possibility of contamination or potential for pollution? 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 Y/N Y/N	NPPF
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 Building Regulations or the Building Regulations Optional Requirement imposed as part of the process of granting planning permission?	Y/N	
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	WCS policy suggestion
31	A) Have you confirmed whether the development will utilise rainwater harvesting and/or required tank sizes? (see http://webarchive.nationalarchives.gov.uk/20140328084622/http:/cdn.environment-agency.gov.uk/geho1110bten-e-e.pdf) B) Have you considered linkage of SuDS to rainwater harvesting or other water efficiency measures?	Y/N 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 (https://www.gov.uk/government/collections/pollution-prevention-guidance-ppg)	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? B) Have you considered whether permeable pavement areas are protected from siltation? C) Have you provided details of maintenance – as with the SuDS?	Y/N Y/N Y/N	WCS policy suggestion
	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? 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 Y/N	Town and Country Planning Regulations 1999
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 D.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 Ð crested dog's-tall 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 Ð 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-impoverished 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 E.Water Neutrality

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 to reduce water use in existing development, such as retrofitting of water efficient devices on existing homes and business.

In order to reduce water consumption and manage demand for the limited water resources within the Borough, a number of measures and devices are available[40], 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 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 Waterwise[41].

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.

There are no statutory requirements for 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

[40] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.
[41] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

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;
- Department of Health for new healthcare buildings and refurbishments;
- Department for Education 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 Local Plan, the only water efficiency requirements for new development are through the Building Regulations[42] where new homes must be built to specification to restrict water use to 125l/h/d or 110l/h/d where the optional requirement applies. However, the key aim of the Localism Act 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-upon-Avon 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 Localism Act provides the legislative mechanism to achieve this in Stratford-upon-Avon.

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, for example:

- 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.
- 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 12.41l/h/d or 33.5l per household per day, assuming an occupancy rate of 2.7[43] 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)[44]. 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 C-1).

[42] Part G of the Building Regulations
[43] 2.7 is used for existing properties and new properties. This figure was agreed with LBC prior to the assessment.
[44] Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009, http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/

Table 6-4 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 household[45]. 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 litres[46] per flush. A study carried out in 2000 by Southern Water and the Environment Agency[47] 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.

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. These can be easily installed by householders and are very cheap to produce and supply. Water companies and environmental organisations often provide these for free.

Depending on the type of device used (which can vary from a custom made device, such 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 performance[48].

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:

- a rising block tariff;
- a declining block tariff;
- a seasonal tariff; and
- a 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

[45] http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/toilet_flushing.html
[46] http://www.lecico.co.uk/
[47] The Water Efficiency of Retrofit Dual Flush Toilets, Southern Water/Environment Agency, December 2000
[48] http://www.thameswater.co.uk/cps/rde/xchg/corp/hs.xsl/9047.htm

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.

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; however, 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. An old washing machine may use up to 150 litres per cycle, whereas 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 estimated[49] 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 a washing machine) and allows the consumer to compare products and select the most efficient product. The water savings from installation of water efficient appliances 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 a business, water consumption may be high, for example 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.

Water Efficiency in New Development

The use of efficient fixtures and fittings as described above also apply to the specification of water use in the building of new homes. The simplest way of demonstrating the reductions 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 water use requirements under the Building Regulations or the optional requirement. The Cambridge WCS[50] gave a summary of water use savings that can be achieved by the use of efficient fixtures and fittings, as shown below in Table C-2.

Table 6-5 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	115 l/h/d	105 l/h/d	80 l/h/d
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

[49] Water Efficiency Retrofitting: A Best Practice Guide, Waterwise, 2009, www.waterwise.org.uk
[50] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

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 C-2 highlights that in order to achieve water use around 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 Calculator[51], 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 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 80l/h/d can be reached without some form of water recycling.

Rainwater Harvesting

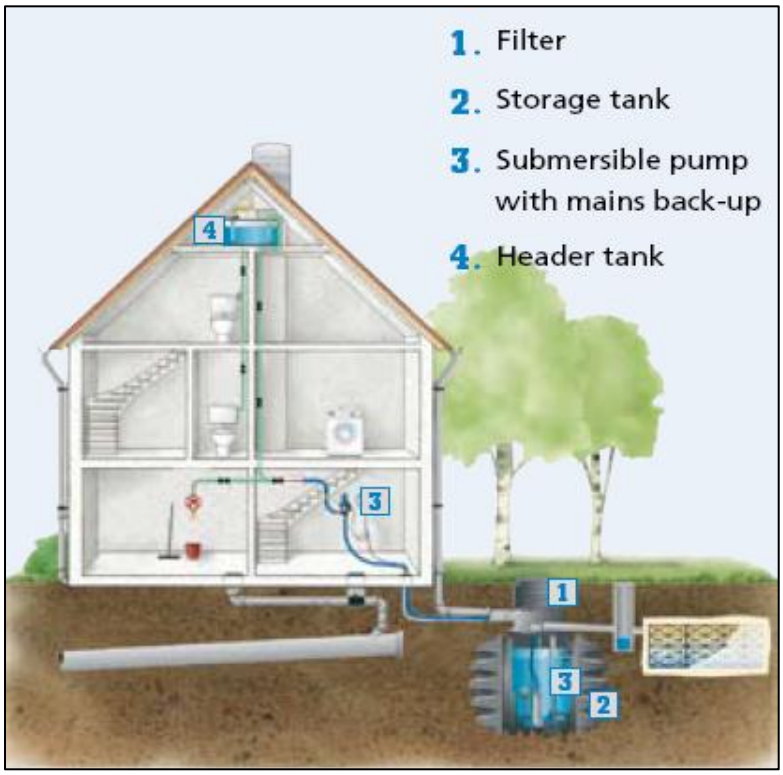
Rainwater harvesting (RWH) is the capture and storage of rain water that lands on the roof of a property. This can have the dual advantage of both reducing the volume of water leaving a site, thereby reducing surface water management requirements and potential flooding issues, and be a direct source 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 C6-1 below gives a diagrammatic representation of a typical domestic system[52].

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 that 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 layers[53].

[51] http://www.thewatercalculator.org.uk/faq.asp
[52] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[53] Aquality Rainwater Harvesting brochure, 2008

Figure 6-1 A typical domestic rainwater harvesting system



A recent sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[54], 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 C-3.

Table 6-6 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
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 $50m^3$, could therefore expect to save 61.6 litres per day if a RWH system was installed.

Greywater Recycling

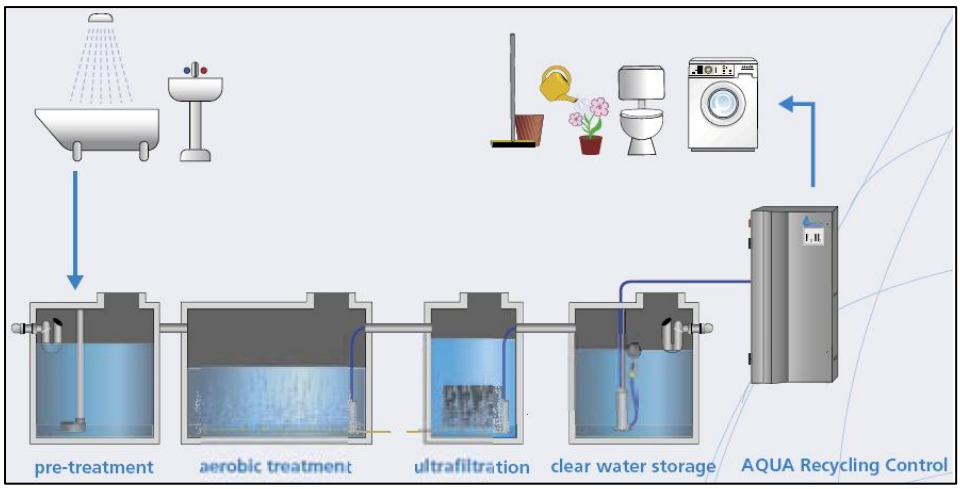
Greywater recycling (GWR) is the treatment and re-use of wastewater from shower, bath and sinks for use again within a property where potable quality water is not essential e.g. toilet flushing. Recycled greywater is not suitable for human consumption or for irrigating plants or crops that are intended for human consumption. The source of

[54] Sustainable water management strategy for Northstowe, WSP, December 2007

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 C-2 below gives a diagrammatic representation of a typical domestic system[55].

Figure 6-2 A typical domestic greywater recycling system



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 Calculator[56].

Table C-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 6-7 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

[55] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[56] http://www.thewatercalculator.org.uk/faq.asp

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 low[57].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 C-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.

[57] Centre for the Built Environment, www.cbe.org.uk

Table 6-8 Water Neutrality Scenarios – specific requirements for each scenario

WN Scenario	New development requirement			Retrofitting existing development	
	New development Water use target (l/h/d)	Water Efficient Fixtures and Fittings	Water Recycling technology	Metering Penetration assumption (a)	Water Efficient Fixtures and Fittings (b)
Business as usual Building Regs	125	- 3-6 litre dual flush toilet; - Low aeration taps; - 160 litre capacity bath; - High efficiency washing machine	None	90%	None
Low	120	- 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%	- 3-6 litre dual flush toilet or cistern device fitted; - 10% take up across the Borough
Medium	105	- 3-4.5 litre dual flush toilet; - Medium spec aeration taps; - High spec low flow shower head; - 160 litre capacity bath; - High efficiency dishwasher; - High efficiency washing machine	None	100%	- 3-4.5 litre dual flush toilet or cistern device fitted; - medium spec aerated taps fitted - 20% take up across the Borough
High	78	- 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%	- 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 the Borough
Very High	62	- 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%	- 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 the Borough

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 has previously been provided based on homes achieving the different code levels under the CSH based on the cost analysis undertaken by DCLG[58] and as set out in Table C-6.

Table 6-9 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	Houses As Level 3 and 4, except: Rainwater harvesting 2 x 6/4 litre flush toilets	£2,520	£2,645
		Apartments 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 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 shown in Table C-7.

Table 6-10 Costs of GWR systems

Cost	Cost	Comments
Installation cost	£1,750 £2,000 £800 £2,650	Cost of reaching Code Level 5/6 for water consumption in a 2-bed flat[59] For a single dwelling[60] Cost per house for a communal system[61] Cost of reaching Code Level 3/4 for water consumption in a 3-bed semi-detached house[62]
Operation of GWR	£30 per annum[63]	
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 than 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

[58] DCLG (2008) Cost Analysis of the Code for Sustainable Homes
[59] Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
[60] http://www.water-efficient-buildings.org.uk/?page_id=1056
[61] http://www.water-efficient-buildings.org.uk/?page_id=1056
[62] Code for Sustainable Homes: A Cost Review, Department for Communities and Local Government, 2008
[63] Environment Agency Publication - Science Report – SC070010, Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008

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-upon-Avon 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 property[64]. 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 years[65].

Retrofitting of Water Efficient Devices

Findings from the Environment Agency report Water Efficiency in the South East of England[66], costs have been used as a guide to potential costs of retrofitting of water efficient fixtures and fittings and are presented in Table C-8 below.

Table 6-11 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 have been calculated and are included in Table C-9.

Table 6-12 Estimated Cost of Neutrality Scenarios

Neutrality Scenario	Costs Summary		
	Developer	Non developer	Total
Low	-	£4,086,115	£4,086,115
Medium	£2,198,125	£6,166,319	£8,364,444
High (RWH)	£46,512,325	£7,800,765	£54,313,090
Very High (RWH & GWR)	£70,427,925	£9,435,211	£79,863,136

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.

[64] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010

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

[66] Environment Agency (2007) Water Efficiency in the South East of England

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 Trust[67] assessed the energy and carbon implications of the installation of water saving devices (Table C-10). The report initially calculated a baseline water consumption figure for existing housing stock, using the following assumptions:

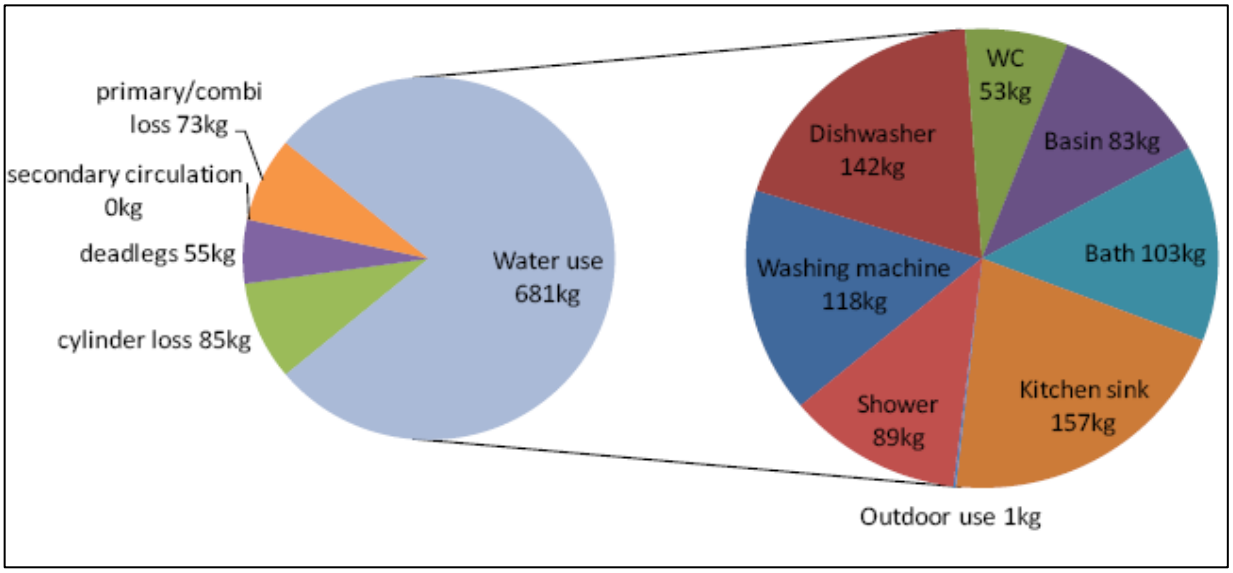
[67] Quantifying the energy and carbon effects of water saving, Full technical report, Environment Agency and the Energy Saving Trust, 2009

Table 6-13 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

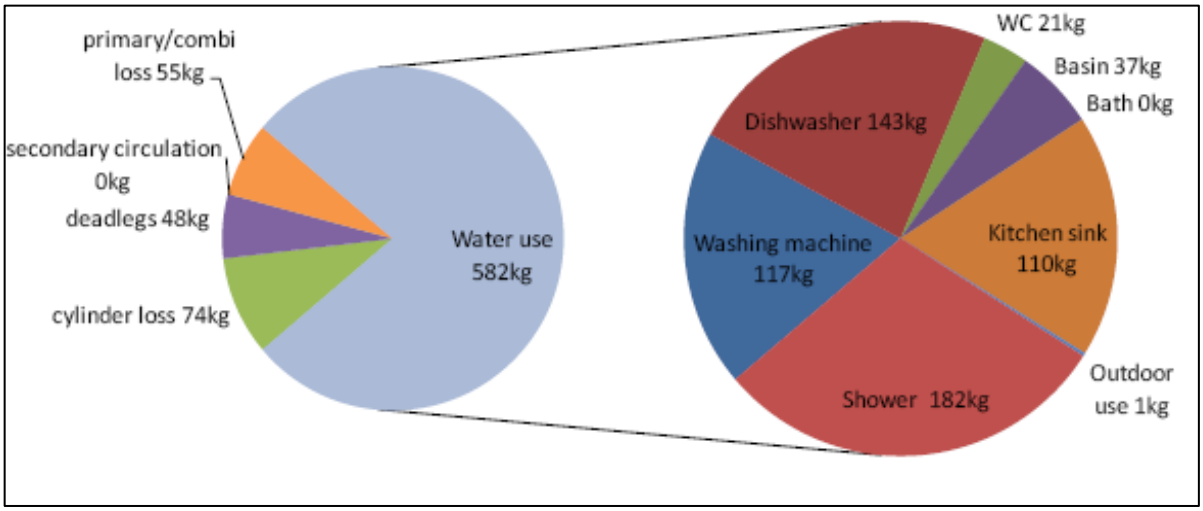
The study then modelled the CO_2 emissions from this 'standard' existing dwelling, as shown below in Figure C6-3. Appliances requiring hot water using appliances dominate, but water use for toilet flushing produces 53kg of CO_2 emissions per year (approximately 50 per cent from water company emissions and 50 per cent due to heat loss as cold mains water in the toilet cistern heats to room temperature).

Figure 6-3 CO2 emissions from a 'standard' existing dwelling



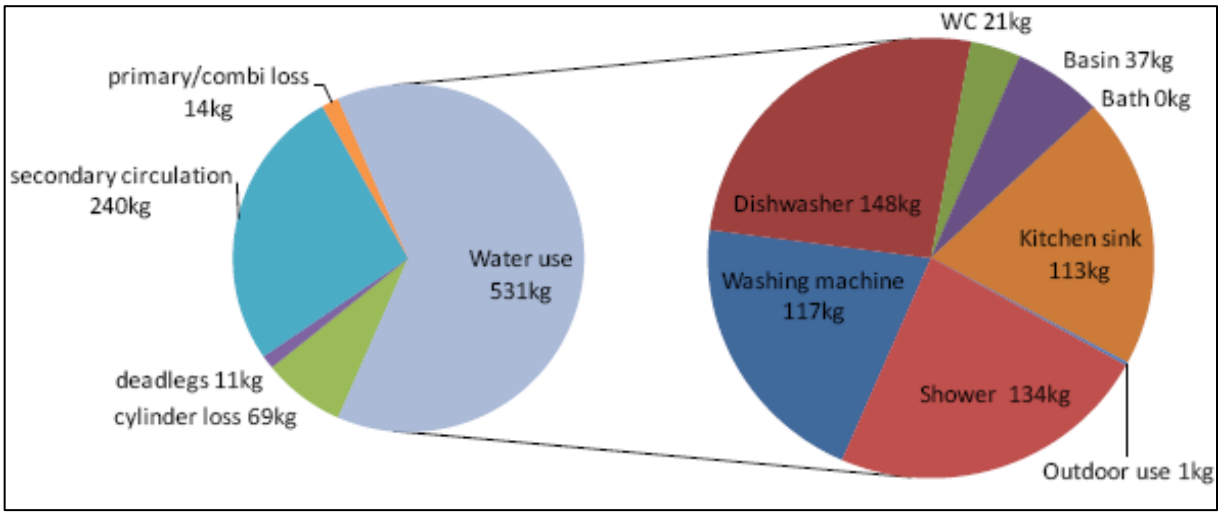
The study then assessed the impacts on this baseline figure of 681 kg CO_2 for water use from a home which has water use of 105 l/h/d (Figure C-4).

Figure 6-4 CO2 emissions from a CSH Level 3/4 dwelling



The study then assessed the impacts of a home which has water use of80 l/h/d (Figure C-5).

Figure 6-5 CO2 emissions from a CSH Level 5/6 dwelling



It can therefore be seen that the carbon cost of achieving water efficiency levels of105l/h/d and 80l/h/d compares favourably to the baseline scenario of current average water use of 681kg/CO_2. 105l/h/d represents a carbon saving of 99 kg/CO_2 and 80l/h/d represents a carbon saving of 150 kg/CO_2.

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. Energy savings for AfW 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 AfW to the individual householders. While AfW 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 Paper[68]), the expense will be passed to householders.

For households with the GWR/RWH, 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.

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

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