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South Kesteven District Council

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South Kesteven District Council – Water Cycle Study Update

Final Report

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AMP	Asset Management Plan
AWS	Anglian Water Services
BOD	Biochemical Oxygen Demand
BREEAM	Building Research Establishment Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CIRIA	Construction Industry Research and Information Association
DEFRA	Department for Environment, Food and Rural Affairs
DO	Deployable Output
DWF	Dry Weather Flow
GWR	Greywater Recycling
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LFE	Low Flow Enterprise (low flow model)
Ml	Mega Litre (a million litres)
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
OR	Occupancy Rate
P	Phosphorous
Q95	The river flow exceeded 95% of the time
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RoC	Review of Consents (under the Habitats Directive)
RQP	River Quality Planning (tool)
RWH	Rainwater Harvesting
SKDC	South Kesteven District Council
UKWIR	United Kingdom Water Industry Research group
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WN	Water Neutrality
WRMP	Water Resource Management Plan
WRZ	Water Resource Zone (in relation to a water company's WRMP)
WSI	Water Services Infrastructure
WwTW	Wastewater Treatment Works

Executive Summary

Background

An outline and detailed Water Cycle Study (WCS) was completed for South Kesteven District Council in 2011, in addition to a town specific WCS for Grantham in January 2010 and these WCS assessed growth as planned in the Local Development Framework (LDF) for implications on the water environment and water infrastructure provision in the District. The previous WCS acted as key evidence bases to the development of the LDF to demonstrate workable solutions to water environment and water infrastructure constraints as a result of proposed growth levels and locations.

With a revision to the growth strategy proposed, an update to the assessment of water environment and water infrastructure provision was required, taking into account differences in growth targets. The two key areas of wastewater treatment (and environmental capacity) alongside water supply provision have been considered within this update. This report provides the conclusions of this updated assessment for the District.

Wastewater Strategy

Wastewater Treatment and Water Quality

Assessment of the revised growth locations and numbers has demonstrated that additional treatment capacity will be required at two Wastewater Treatment Works (WwTW), namely Marston and Little Bytham, serving the District as a result of additional wastewater likely to be generated by the proposed growth. New discharge permits and potential upgrade solutions are required at these WwTW to ensure that water quality targets, set to meet the requirements of European legislation such as the Water Framework Directive (WFD) and Habitats Directive (HD) are not exceeded within the rivers which will receive the additional treated wastewater flow. This affects growth proposed in Barrowby, Great Gonerby, Barkston, Grantham and Castle Bytham.

This WCS Update report has identified that workable infrastructure solutions in the long term can be delivered to ensure that growth proposed for Barrowby, Great Gonerby, Barkston, Grantham and Castle Bytham is sustainable and does not adversely affect the water environment. However, planning applications for these locations in the short-term should be subject to pre-development enquiries with both Anglian Water Services (AWS) and the Environment Agency to ensure that growth phasing does not result in water body deterioration until such time as solutions are implemented.

Water Supply

Water Resource Availability

Raw water availability within the District is currently limited and issuing of licences to abstract water from the District's rivers and underlying aquifers is restricted by the Environment Agency in all conditions expect medium and high river flows. As a result, supply of water for additional demand from new development is largely dependent on strategic management of resources by Anglian Water Services.

Anglian Water Services has set out how future demand in the District will be met as part of its current Water Resources Management Plan (2015). A twin-track approach is proposed whereby existing demand is managed and new supply sources are provided. Demand would be managed through a reduction of leakage within the supply network and through reductions in consumption via water efficiency measures.

AWS has confirmed that the level of growth assessed within the WCS update is factored into the current Water Resources Management Plan which has been approved by the Environment Agency and Defra. The WCS update therefore concludes that a sufficient sustainable water supply is available to meet planned demand without impacting adversely on the environment.

Water efficiency

The WCS Update has shown that water availability within the District is finite and that, to compliment proposals within AWS' Water Resource Management Plan, consideration is given towards minimising water use in planned development through the use of development control policy and contributing to management of demand from the existing population within the District.

To set out how this could be achieved, the WCS update has considered the feasibility of attaining a 'water neutral' position in the District, whereby the District's total demand for water at the end of the plan period is equal to (or less than) current demand levels in 2016. The assessment demonstrated that water neutrality is theoretically attainable by the end of the plan period, but is unlikely to be achievable in practice, given the significant funding and practicality implications of doing so. Therefore, recommendations for a lower target of efficiency have been made, along with policy for recommendations for how this could be achieved.

1 Introduction

1.1 Background

The South Kesteven Water Cycle Study (WCS) has previously been completed as an Outline WCS for South Holland, South Kesteven and Rutland (January 2011)[1] with a further, more detailed assessment completed in November 2011 (South Kesteven District Council – Detailed WCS). A separate Outline WCS was conducted for Grantham in December 2008[2], with a Detailed WCS undertaken in two phases in April 2009 and January 2010. Since these studies were completed, South Kesteven District Council (SKDC) are proposing minor changes to the spatial distribution of growth and total housing/employment numbers, to support the Local Plan development. This Water Cycle Study Update determines whether the key conclusions of the previous 2011 Detailed WCS remain valid, and where required, provides details of additional water cycle solutions to support the revised growth strategy and developing Local Plan.

In addition to the planning changes, a review of updated water resources and water environment management plans has been undertaken to update the baseline since the previous WCSs were completed. The updated Anglian Water Service's (AWS) Water Resource Management Plan (WRMP) has been reviewed to determine whether sufficient water resources have been planned for with respect to the revised growth scenarios as well as identify any available options to address deficiencies. A review of the updated Catchment Management Abstraction Strategies (CAMS) has also been undertaken to determine available water supply specific to the growth areas, and a review of the updated Anglian River Basin Management Plan (RBMP) has been completed to determine changes to the baseline condition of affected water bodies in the District.

The focus of this WCS update has been on reviewing and updating the key conclusions from the previous WCS which have the potential to materially affect the soundness of the Local Plan, and relate to:

- Wastewater treatment Works (WwTW) capacity and specifically, the environmental capacity of water bodies to accept increases in treated wastewater within the limits imposed by European Directives and associated UK Regulations; and,
- Whether there are sufficient water resources available to supply planned growth without adversely impacting on the water environment and the targets required by European Directives and associated UK Regulations.

The scope of the update has therefore been to update the conclusions related to these two key areas only, to demonstrate whether the revisions to the proposed growth numbers and spatial distribution affect the Local Plan soundness with respect to the water environment and water infrastructure.

This report provides a summary of the key conclusion review and makes reference to the previous WCS where required. For details of the need for a WCS and the legislative drivers, the reader is referred to the previous studies undertaken in 2011 and 2008.

1.2 Previous WwTW and Environmental Capacity Assessments

The previous 2011 Detailed WCS identified that all 12 WwTW assessed for growth within the South Kesteven District had sufficient headroom capacity to support the anticipated growth within each catchment. However, it was determined that some WwTW could accommodate the increase in Dry Weather Flows (DWF) generated by growth more than others. The study identified that Marston, Deeping, Harlaxton, Ancaster and South Witham WwTW have little or no existing capacity to support further growth within their catchments.

In addition to this, a Water Framework Directive (WFD) Assessment was completed on 8 of the 12 WwTW to determine whether the growth predicted for the catchments would impact on the WFD objectives of receiving waterbodies. Table 1-1 provides a summary of the findings of the 2011 Detailed WCS.

[1] South Kesteven District Council – Detailed Water Cycle Study (2011) http://www.southkesteven.gov.uk/CHttpHandler.ashx?id=5545&p=0
[2] Grantham Water Cycle Strategy – Stage 1 Outline Strategy (2008) http://www.southkesteven.gov.uk/CHttpHandler.ashx?id=5545&p=0

Table 1-1 2011 South Kesteven Detailed WCS Summary - WwTW Capacity

WwTW	Remaining Headroom 2011 Growth Scenario 1	Remaining Headroom 2011 Growth Scenario 2	WFD Limiting Factor to reach 'Good Status'	Recommended WwTW Upgrades
Ancaster	No existing capacity	No existing capacity	phosphate	None recommended
Bourne	16%	15%	phosphate	Bourne WwTW assessed as currently having capacity, although this is theoretically assigned to the Elsea Park development
Caythorpe	38%	37%	phosphate	None recommended
Colsterworth	45%	44%	Biological Oxygen Demand (BOD), Ammonia, phosphate	Works expected to remain flow compliant, anticipate that tertiary treatment will be required to maintain effluent quality
Corby Glen	26%	24%	No constraint	Works expected to remain fully compliant
Deeping	No existing capacity	No existing capacity	Ammonia and phosphate	New permit will be required
Harlaxton	No existing capacity	No existing capacity	phosphate	New permit required. Grantham Canal discharges into the River Witham. Additional flows will need to be considered within the Grantham WCS.
Horbling	33%	33%	No constraint	None recommended
Long Bennington	41%	41%	phosphate	Works expected to remain fully compliant
Marston	6%	6%	phosphate	Should be taken under consideration as part of the Grantham WCS
South Witham	No existing capacity	No existing capacity	phosphate	None recommended
Stamford	32%	32%	phosphate	Works expected to remain flow compliant, anticipate that tertiary treatment will be required to maintain effluent quality

1.3 Previous Supply/Demand Summary

An assessment was completed in the 2011 Outline Water Cycle Study for South Holland, South Kesteven and Rutland to determine whether sufficient water supply was present within the South Kesteven region to support growth. A review was completed of the 2010 Anglian Water Resource Management Plan as well as the Lincolnshire Fens Water Resource Zone (WRZ) CAMS and it was identified that a deficit would be present within the region during the planning period of 2006 – 2031 without additional measures to address it.

Anglian Water proposed several mitigation measures to meet supply within the plan which included intra-WRZ transfers, enhanced metering and pressure reduction. With these measures in place it was deemed there was sufficient water to supply any future growth within the region.

No further analysis was completed during the 2011 South Kesteven WCS with the following stated:

"Anglian Water has confirmed that there are no issues constraining its ability to continue supplying existing properties or to provide supplies to the development sites that have been identified."

2 Growth Scenarios and Infrastructure Capacity

2.1 Growth Scenario

Two new growth target scenarios for up to 2040 have been assessed in this WCS update, with Growth Scenario 1 consisting of a total of 15,403 dwellings and Growth Scenario 2 consisting of a total of 16,944 dwellings.

In order to adequately assess growth, it was determined that the assessed growth figures should encompass both allocated and committed housing numbers. This approach differs from that presented within the 2011 Detailed WCS in that only allocated growth was assessed and it was assumed that any committed housing numbers were already accounted for within the district water infrastructure baseline capacity information. In only accounting for allocated growth, there is potential that the required water infrastructure within the district is not sized to adequately support all proposed growth that has yet to be connected to water services infrastructure and therefore for the purposes of this WCS Update both allocated and committed housing numbers have been assessed.

Table 2-1 provides a summary of the housing figures assessed in this WCS Update. This has been calculated from a total of Objectively Assessed Need (OAN) minus completions.

Table 2-1 Growth Scenarios to be assessed

Settlement	Growth Scenario 1 (Allocated and Committed)	Growth Scenario 2 (Allocated and Committed)
Bourne	1,450	1,595
Grantham	8,992	9,891
Stamford	1,868	2,055
The Deepings - Deeping - Deeping St James - Market Deeping	1,257	1,383
Local Service Centres[3]		
Ancaster, Barkston, Barrowby, Baston, Billingborough, Castle Bytham, Caythorpe, Claypole, Colsterworth, Corby Glen, Great Gonerby, Harlaxton, Langtoft, Long Bennington, Morton, Ropsley, South Witham, Thurlby.	1,045	1,150
Rural Settlements	791	870
Total	**15,403**	**16,944**

2.2 Wastewater Treatment Works Capacity Assessment

2.2.1 Wastewater Treatment Assessment Approach

Increases in 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 WwTW to treat the additional wastewater;
- what new infrastructure is required to provide for the additional wastewater treatment; and
- whether waterbodies receiving the treated flow can cope with the additional flow without affecting water quality.

[3] Growth Figures distributed equally amongst Local Service Centres

Therefore, there are 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).

It should be noted that this assessment of WwTW headroom capacity is solely based on wastewater flows. Once growth figures are confirmed for each WwTW, AWS will determine the need for investment in infrastructure capacity upgrades for both flow and process capacity.

2.2.2 Wastewater Treatment in South Kesteven

Wastewater treatment in the District is provided via WwTW operated and maintained by AWS, all of which discharge to surface watercourses. Each of these WwTW 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 WwTW 'catchment'.

Due to the dispersed nature of development within the District (and the costs and energy required to pump wastewater over large distances), most settlements tend to have their own designated WwTW, hence numerous WwTW are affected by growth in the District. Table 2-2 provides a summary of the WwTW where additional growth is allocated and the settlements associated with that growth. The settlement areas have been grouped into the WwTW catchments within which they are located.

Rural settlements have been excluded from this WCS Update due to no allocations being designated within these areas. It should be noted however, that development is not restricted in these areas and therefore any planning applications submitted should be assessed based on their individual merits and any impacts on associated infrastructure adequately addressed.

Due to the complexity of allocating employment across the district and to simplify the approach of including employment growth figures within the WCS calculations, a factor of 16 l/h/d[4] consumption has been added to the daily consumption figure for each new dwelling and applied to the entire district. It is considered that this approach is conservative to predict the impact of future employment growth will have on wastewater infrastructure within the South Kesteven District.

[4] Water Key Performance Indicators and benchmarks for offices and hotels (CIRIA C657)

Table 2-2 Summary of housing figures to be assessed

WwTW	Settlement Area	Growth Scenario 1 Commitments and Allocations	Growth Scenario 2 Commitments and Allocations	Growth Scenario 1 Total Housing by WWTW	Growth Scenario 2 Total Housing by WWTW
Ancaster	Ancaster	58	64	58	64
Bourne	Bourne	1,450	1,595	1,566	1,723
	Morton	58	64		
	Thurlby	58	64		
Caythorpe	Caythorpe	58	64	58	64
Claypole	Claypole	58	64	58	64
Colsterworth	Colsterworth	58	64	58	64
Corby Glen	Corby Glen	58	64	58	64
Deeping	The Deepings	1,257	1,383	1,373	1,511
	Deeping St. James				
	Market Deeping				
	Langtoft	58	64		
	Baston	58	64		
Harlaxton	Harlaxton	58	64	58	64
Horbling	Horbling	58	64	58	64
Little Bytham	Castle Bytham	58	64	58	64
Long Bennington	Long Bennington	58	64	58	64
Marston	Grantham	8,992	9,891	9,166	10,083
	Barrowby	58	64		
	Great Gonerby	58	64		
	Barkston	58	64		
Ropsley	Ropsley	58	64	58	64
South Witham	South Witham	58	64	58	64
Stamford	Stamford	1,868	2,055	1,868	2,055
	Rural Settlements	791	870	791	870
TOTAL[5]		15,403	16,944	15,403	16,944

2.2.3 Management of WwTW Discharges

All WwTW 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 WwTW.

5 Calculations are based on a total of 15,403 and 16,944 dwellings (for Growth Scenarios 1 & 2 respectively) within the district, with 1045 and 1150 dwellings (for Growth Scenarios 1 & 2 respectively) distributed amongst 18 Local Service Centres. Due to rounding the above columns do not add to the total shown.

The volume element of the discharge permit determines the maximum number of properties that can be connected to a WwTW catchment. When discharge permits are issued for the first time, they are generally set with a volume 'freeboard', which acknowledges that allowance needs to be made for additional connections. This allowance is termed 'permitted headroom'. The quality conditions applied to the discharge permit are derived to ensure that the water quality of the receiving waterbody is not adversely affected, even when the maximum amount of flow is discharged. For the purposes of this WCS, a simplified assumption is applied that the permitted headroom is usable[6] and would not affect downstream water quality[7]. 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 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 WwTW 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 drivers which determine the quality conditions of any new permit to discharge are the Water Framework Directive (WFD) and the Habitats Directive (HD). The Habitats Directive has not been considered within this Update as the screening of sites within the previous WCS has highlighted that no designated sites have the potential to be affected by discharges from the WwTWs.

2.2.4 WFD Compliance

The WFD is the most significant piece of water legislation since the creation of the European Union (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[8]; 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. Results of water quality modelling can be found in Appendix A.

2.2.5 Assessment Methodology Summary

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

- determine the amount of growth draining to each WwTW and calculate the additional flow generated;
- calculate available headroom at each WwTW;
- determine whether the growth can be accommodated within existing headroom;
- for those WwTW 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.

[6] In some cases, there is a hydraulic restriction on flow within a WwTW which would limit full use of the maximum permitted headroom
[7] In reality, some local deterioration in quality is likely to result through the use of available headroom, however, the assumption is made on the basis that AWS and the Environment Agency would discuss and agree any changes to the permit required to manage any localised deterioration as part a review of process capacity and likely compliance with the permit conditions.
[8] 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 whether any quality conditions required to meet WFD objectives would be beyond the limits of conventional treatment for WwTW;
- where the conditions are achievable, indicate where infrastructure upgrades are required to be undertaken by AWS to meet the new permit conditions and implications of these upgrades on proposed development; and
- where the conditions are not achievable, indicate where there are alternative solutions for treatment in that catchment which would need to be pursued by AWS.
- undertake an ecological site screening assessment to determine if any designated sites (national or local) 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 A):

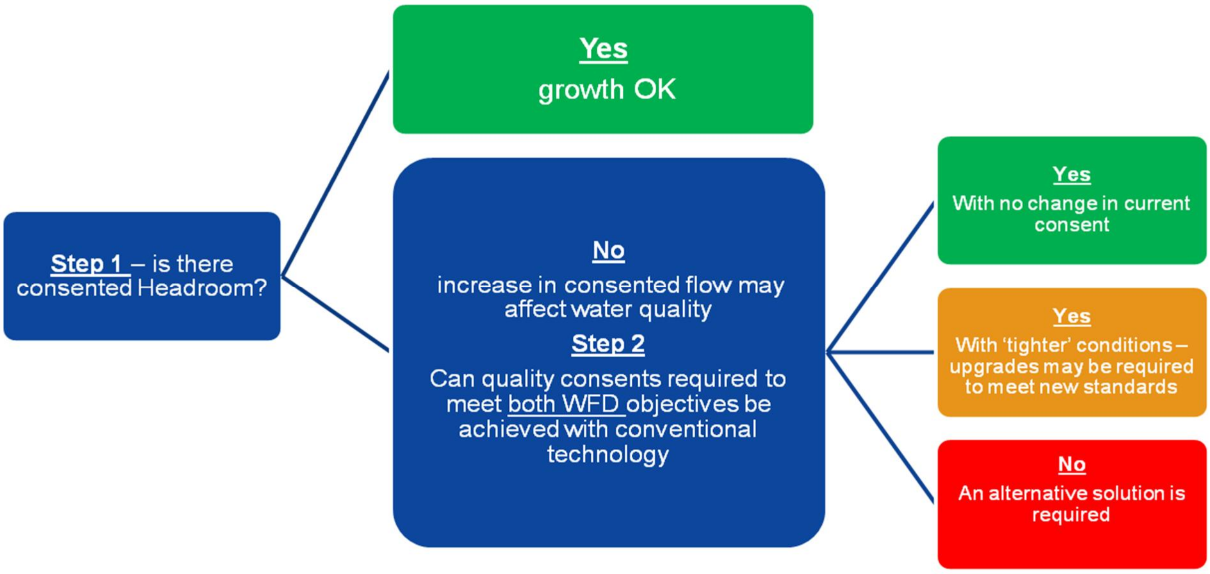
- a headroom calculation spreadsheet was developed; and,
- a water quality modelling procedure was agreed with the Environment Agency using Environment Agency software (RQP) designed for determining discharge permit conditions.

2.2.6 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 2-1.

- 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 2-1 RAG Assessment



2.3 Wastewater Treatment Assessment – Results

This section presents the wastewater treatment assessment results. Catchments where growth can be accepted within the current consented headroom have been reported together in a single subsection, whilst those requiring a new consent and hence a water quality, have been reported in individual subsections.

2.3.1 WwTW with Permitted Headroom

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

Table 2-3 details the WwTW where existing permitted headroom is sufficient to accommodate all of the proposed growth and hence no significant infrastructure upgrades are required to deliver the proposed growth levels in these locations.

Growth in these catchments and for the scenarios stipulated would not deteriorate water quality 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 2-3 also includes information on how many additional homes could be connected before the headroom would be exceeded to inform potential variations to the spatial strategy.

Table 2-3 WwTW with permitted headroom

Relevant WwTW	Settlement Area(s)	Current Permitted DWF (m3/day)	Current Dwelling Capacity (No. of Dwellings)	Future 2040 DWF after Growth (m3/day)		2040 Headroom Capacity (m3/day)		Approximate Residual Housing Capacity after Growth (2040)	
				Growth Scenario 1	Growth Scenario 2	Growth Scenario 1	Growth Scenario 2	Growth Scenario 1	Growth Scenario 2
Ancaster[1]	Ancaster	190	160	157	159	33	31	100	100
Bourne	Bourne, Morton and Thurlby	6,210	2,340	5,971	6,019	239	191	750	600
Caythorpe	Caythorpe	360	130	337	339	23	21	50	50
Claypole	Claypole	249	200	229	231	20	18	50	50
Colsterworth	Colsterworth	360	400	255	257	105	103	350	350
Corby Glen	Corby Glen	150	100	137	139	13	11	50	50
Deeping	The Deepings, Deeping St. James, Market Deeping, Langtoft, Baston	5,370	1,940	5,195	5,238	175	132	550	450
Harlaxton[1]	Harlaxton	300	280	230	232	70	68	250	200
Horbling	Horbling	878	440	759	761	119	117	400	400
Long Bennington	Long Bennington	639	560	484	486	155	153	500	500
Ropsley	Ropsley	136	200	91	93	45	43	150	150
South Witham[9]	South Witham	285	510	144	146	141	139	450	450
Stamford	Stamford	6,000	9,040	3,774	3,832	2,226	2,168	7,200	7,000

[9] Current Permitted Dry Weather Flows differ from those recorded within the 2011 Detailed WCS due to revision of consent conditions following monitoring at these sites by Anglian Water and the Environment Agency since 2011

2.3.2 WwTW without Permitted Headroom

The calculations of headroom demonstrated that several WwTW would not have sufficient headroom once all the growth in the catchment is included as detailed in Table 2-4.

Table 2-4 WwTW without Permitted Headroom

Relevant WwTW	Settlement Area(s)	Current Permitted DWF (m3/day)	Current Dwelling Capacity (No. of Dwellings)	Future 2040 DWF after Growth (m3/day)		2040 Headroom Capacity (m3/day)		Approximate Residual Housing Capacity after Growth (2040)	
				Growth Scenario 1	Growth Scenario 2	Growth Scenario 1	Growth Scenario 2	Growth Scenario 1	Growth Scenario 2
Marston	Grantham, Barrowby, Great Gonerby and Barkston	14,500	700	17,123	17,408	-2,623	-2,908	-8,450	-9,350
Little Bytham	Castle Bytham	800	40	805	807	-5	-7	<0	<0

Discharge volumes from Marston and Little Bytham WwTW 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. A summary of the results and proposed infrastructure upgrades required are included in the following subsections for each of the WwTW.Detailed results from the modelling are provided in Appendix A.

2.3.2.1 Marston WwTW

Marston WwTW has some available flow headroom in its existing discharge consent and can accept growth of approximately 700 dwellings (from the 9,166 allocated in Growth Scenario 1 and 10,083 allocated in Growth Scenario 2). It should be noted that this number could vary on the basis that decreases in water usage over time are likely to occur as a result of planned demand measures leading to increases in the available headroom within the WwTW. After approximately 700 homes are completed and connected, the volumetric discharge consent will be exceeded. Unless additional headroom can be made available in the catchment after 700 dwellings, any growth draining to the WwTW would cause the WwTW to exceed its existing volumetric consent conditions, by a total volume of approximately 2,600 m^3/d for Growth Scenario 1 and 2,900 m^3/d for Growth Scenario 2 by the end of the plan period.

<u>WFD Compliance</u>

Water quality modelling has shown that in order to maintain the current WFD status of the River Witham (conf Cringle Bk to conf Brant) with predicted discharge volumes (from new connections), the permit conditions (during both Low Flow and High Flow conditions in the River Witham i.e. < 1.4 m^3/s and >1.4 m^3/s respectively) on discharge quality for ammonia and phosphate would need to be tighter than they currently are. The calculations show that the permit conditions should be set at a 1.5mg/l 95 percentile limit for ammonia[10] and <1mg/l annual average limit for phosphate[11]. During high flow conditions, water quality modelling also shows permit conditions on discharge quality for BOD[12] would need to be tighter than they currently are with new limits to be set at 10 mg/l 95 percentile limit.

Modelling was undertaken to assess the impact of growth on preventing Future Good Status being reached in the River Witham for phosphate due to this elements status being recorded as Moderate. As discussed within the Grantham Detailed WCS, the River Witham currently has high nutrient concentrations (namely phosphorous and nitrates) attributable to surrounding land uses (in addition to point sources of discharge). The modelling has shown that Good Status cannot be reached within the River Witham (conf Cringle Bk to conf Brant) for phosphate under current discharge volumes (before growth is considered) within the limits of conventional treatment, and therefore, the assessed growth would not prevent future Good Status being met.

<u>Upgrade Requirements and Phasing</u>

The theoretical quality condition for phosphate is considered to be slightly beyond the limits of conventional treatment. It was determined that the discharge criteria would need to be equivalent to 0.81 mg/l annual average or less to maintain the existing status of the river. Whilst this limit is theoretically below the limits which could be achieved with conventional treatment, due to limitations within the basic Monte Carlo simulation performed, it is considered that applying a discharge limit of 1 mg/l for phosphate would most likely allow for no deterioration of the current river status, particularly where new technologies for treating phosphorous emerge. There is currently a national trial by Water Companies in England, testing new treatment processes with the ability to treat phosphorous to less than 0.5mg/l annual average (due to report in 2017). AWS is in the process of testing this technology for WwTW in its region and once results of these trials have been published a potential scheme to address this problem could be implemented within the Marston WwTW should a limit of 1mg/l prove to be insufficient to maintain current WFD status.

It is therefore concluded that there is a treatment solution likely within the plan period to accommodate growth within the Marston catchment. The timing of when this solution will be required cannot be determined until detailed information on phasing is known. The timing of it will also depend on actual build rates, changes in water use from non-residential uses in the catchment, and the effect that reductions in demand has on wastewater generation going forward. Because development phasing is not readily available for this WCS update, it is recommended that discussion between SKDC, the Environment Agency and AWS should take place as planning applications come forward to ensure sufficient available headroom within the WwTW is available to allow growth prior to the flow permit conditions being exceeded and a new solution needing to be in place.

[10] Currently at 3mg/l in the existing permit
[11] Currently at 2mg/l in the existing permit
[12] Currently at 20mg/l in the existing permit

Ecological Assessment

Marston WwTW discharges to the River Witham approximately 2 km upstream from Marston (to the north of Grantham). A review of the 2011 Detailed WCS and the Grantham WCS has not identified any protected sites located on the River Witham downstream from Marston WwTW.

RAG Assessment

On the basis that a potential treatment solution has been identified, a RAG rating of amber has been applied for the purposes of this WCS to demonstrate that a potential constraint exists and a solution to upgrade treatment processes will be required to ensure growth can be delivered without affecting WFD objectives.

2.3.2.2 Little Bytham

Little Bytham WwTW has some available flow headroom in its existing discharge consent and can accept growth of approximately 40 dwellings (from the 58 allocated in Growth Scenario 1 and 64 allocated in Growth Scenario 2), after which volumetric discharge consent will be exceeded. Unless additional headroom can be made available in the catchment after 40 dwellings, any growth draining to the WwTW would cause the WwTW to exceed its existing volumetric consent conditions, and by a total volume of 5 m^3/d by the end of the plan period.

WFD Compliance

Water quality modelling has shown that in order to maintain the current WFD status of the River Tham with predicted discharge volumes (from new connections), the permit conditions on discharge quality for ammonia[13] can remain as they currently are. No assessment was completed on BOD due to insufficient data being available from the Environment Agency for The Tham.

Currently no permit condition is set for phosphate discharge to the River Tham. However, modelling demonstrated that a theoretical condition for phosphate would be required and that the required quality condition is beyond the limits of conventional treatment. It was determined that the discharge quality condition would need to be equivalent to 0.51 mg/l annual average or less to maintain the existing status of the river under current (i.e. without growth) discharge volumes and 0.41 mg/l with additional flow from the proposed growth. These results suggest that the Little Bytham WwTW is already treating phosphate to a high quality (beyond that expected of conventional treatment), in order for the watercourse to still be at High Status for Phosphorous.

Upgrade Requirements and Phasing

The technical modelling exercise has demonstrated that, in theory, upgrades would be required for treating phosphate which are outside the limits of conventional treatment. However, the modelling demonstrates that the impact of growth makes only a limited difference to the quality on the discharge which needs to be maintained in order to continue to meet High Status in the water body. It is therefore concluded that, with upgrades, the WwTW could continue to discharge at a quality sufficient to maintain High Status in the Tham. The condition which would need to be applied on the revised consent would need to be assessed in detail by the Environment Agency and AWS once the existing consented capacity is reached. However, should it be agreed that a limit less than 1mg/l of P is required, it is likely that a solution will be possible based on the national trials described for the Marston WwTW solution.

Through the consultation process with respect to the WCS Update, the Environment Agency provided the following position statement regarding waterbodies failing to comply with Good Status.

“We are working with partners, including AWS, using a catchment based approach to put in place measures to improve the status of the waterbodies failing to comply with Good Status. As part of these measures, there may be a need to tighten phosphorous permit limits at particular sites, which would require changes to treatment infrastructure.”

No development phasing is readily available for this WCS update, therefore discussion between SKDC, the Environment Agency and AWS should take place as planning applications come forward to ensure sufficient available headroom within the WwTW is available to allow growth prior to the flow permit conditions being exceeded and a new solution needing to be in place.

[13] Currently at 4 mg/L

RAG Assessment

On the basis that a potential treatment solution has been identified, a RAG rating of amber has been applied for the purposes of this WCS to demonstrate that a potential constraint exists and a solution to upgrade treatment processes will be required to ensure growth can be delivered without affecting WFD objectives.

2.4 Wastewater Summary

Table 2-5 provides a summary of the RAG assessment of the WwTW within the South Kesteven WCS study area.

Table 2-5 Wastewater Treatment Summary

WwTW	Is Headroom Available for all planned growth to 2036?	Is a quality permit update possible within Limits of Conventional Treatment (LCT)?	Solution Available?
Ancaster	Yes	N/A	
Bourne	Yes	N/A	
Caythorpe	Yes	N/A	
Claypole	Yes	N/A	
Colsterworth	Yes	N/A	
Corby Glen	Yes	N/A	
Deeping	Yes	N/A	
Harlaxton	Yes	N/A	
Horbling	Yes	N/A	
Little Bytham	No	No	Yes – with new investment
Long Bennington	Yes	N/A	
Marston	No	No	Yes – with new investment
Ropsley	Yes	N/A	
South Witham	Yes	N/A	
Stamford	Yes	N/A	

3 Water Supply and Demand Strategy

3.1 Introduction

Water supply for the SKDC area is provided by AWS. An assessment of the existing environmental baseline with respect to locally available resources in the aquifers and the main river systems has been completed to update the previous findings of the Detailed WCS[14]. The assessment has been based on the Environment Agency's CAMS.

This Study has also used the final version of AWS' 2015 WRMP[15] 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 AWS WRMP.

3.2 Catchment Management Strategies

The Environment Agency manages water resources at the local level through the use of CAMS.

Within the CAMS, the Environment Agency's assessment of the availability of water resources is based on a classification system that gives a resource availability status which indicates:

- The relative balance between the environmental requirements for water and how much is licensed for abstraction;
- Whether water is available for further abstraction; and
- Areas where abstraction needs to be reduced.

The South Kesteven District is covered by two CAMS areas, the Witham[16] and Welland[17]. Below is a summary of the available water sources in each.

3.2.1 Welland

The majority of the Welland catchment is defined as being over-licensed during periods of low flows with water available generally only at very high or extremely high flows. There is restricted water available for licencing in the Lower Welland system.

In the case of groundwater, the Welland CAMS is broken down into two groundwater sources namely the Lincolnshire Limestone and Secondary aquifers. The Lincolnshire Limestone is considered to be fully utilised by existing users for consumptive licences. Non-consumptive licences maybe considered on a case-by-case basis. The Secondary aquifers support localised small abstractions and some opportunity may be available for consumptive abstraction licencing.

This analysis indicates that there are limited options for local abstractions specific to individual development sites. Some high flow abstraction would be possible, but this would not provide sufficient water resource to support demand in a dry year and hence new development is reliant upon water supply sources strategically by AWS or potentially inset water companies.

[14] AMEC (2011) South Kesteven District Council: Detailed Water Cycle Study. November 2011
[15] Anglian Water Services - Water Resources Management Plan, Main Report (2015) http://www.anglianwater.co.uk/_assets/media/WRMP_2015.pdf
[16] Witham Abstraction Licence Strategy, February 2013 https://www.gov.uk/government/publications/cams-witham-catchment-abstraction-management-strategy
[17] Welland Abstraction Licence Strategy, February 2013 https://www.gov.uk/government/publications/welland-abstraction-management-strategy

3.2.2 Witham

The majority of rivers within the Witham CAMS area have water available for licencing during high and medium flows but no water available during low flows. In the case of groundwater, the Witham CAMS area is broken down into four groundwater sources namely the Lincolnshire Limestone, Lincolnshire Chalk, Spilsby Sandstone and Bain Sands and Gravels. The Lincolnshire Limestone, Lincolnshire Chalk, Spilsby Sandstone aquifers are all considered to be fully committed from groundwater abstraction. Some abstraction may be available from the Bain Sands and Gravels provided no hydraulic connectivity exists between it and surface water features, Linconlshire Limestone, Lincolnshire Chalk and Spilsby Sandstone aquifers.

This analysis indicates that there are options for local abstractions specific to individual development sites. Some high and medium flow abstraction would be possible, but this would not provide sufficient water resource to support demand in a dry year and hence new development is likely to be reliant upon water supply sources strategically by AWS or potentially inset water companies.

3.3 Water Resource Planning

AWS has produced an updated 2015 WRMP covering the South Kesteven District. WRMPs are a statutory document demonstrating how water companies are managing the balance between available supply and future demand over a 25 year plan. The documents are subject to a Strategic Environmental Assessment, Habitats Regulation Assessment and ultimately approval by the Secretary of State every 25 years. They are therefore a key document for a WCS as they set out an environmentally assessed and approved plan for how demand for water from growth within a water company's supply area can be met. 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.

AWS 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). AWS 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.

3.4 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 population projections are based on the housing figures used within this report and assuming an occupancy rate of 2.2. This occupancy rate has been used as a conservative estimate to determine likely water use once all proposed development has been built.

The projections were derived as follows:

- **Projection 1** – **Building Regulations –** New homes would conform to (and not use more than) Part G of the Building Regulations requirement of 125 l/h/d, an additional 16 l/h/d has been included to account for employment figures to give a total of 141 l/h/d;
- **Projection 1a – 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, an additional 16 l/h/d has been included to account for employment figures to give a total of 126 l/h/d;
- **Projection 2** – **Low Efficiency Scenario –** New homes would achieve 120 l/h/d (to reflect the now superseded Code for Sustainable Homes Level[18] of 1 or 2), an additional 16 l/h/d has been included to account for employment figures to give a total of 136 l/h/d;
- **Projection 3** – **Medium Efficiency Scenario –** New homes would achieve 105 l/h/d (to reflect the now superseded Code for Sustainable Homes Level of 3 or 4), an additional 16 l/h/d has been included to account for employment figures to give a total of 121 l/h/d;
- **Projection 4** – **High Efficiency Scenario –** New homes would achieve 80 l/h/d (to reflect the now superseded Code for Sustainable Homes Level of 5 or 6), an additional 16 l/h/d has been included to account for employment figures to give a total of 96 l/h/d; and,

[18] Although the Code for Sustainable Homes is superseded, it has been used as a guideline for achievable water use targets for the water efficiency scenarios.

- **Projection 5** – **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, an additional 16 l/h/d has been included to account for employment figures to give a total of 78 l/h/d.

It has been assumed no water efficiency reductions will be implemented for commercial properties.

Using these projections, the increase in demand for water could range between 2.64 and 4.78 Ml/d by 2040 for Growth Scenario 1 and 2.90 and 5.26 Ml/d by 2040 for Growth Scenario 2. The projections are shown in Figure 3-1 and Figure 3-2 respectively.

Figure 3-1 Range of water demands across plan period in South Kesteven for Growth Scenario 1 depending on efficiency levels of new homes

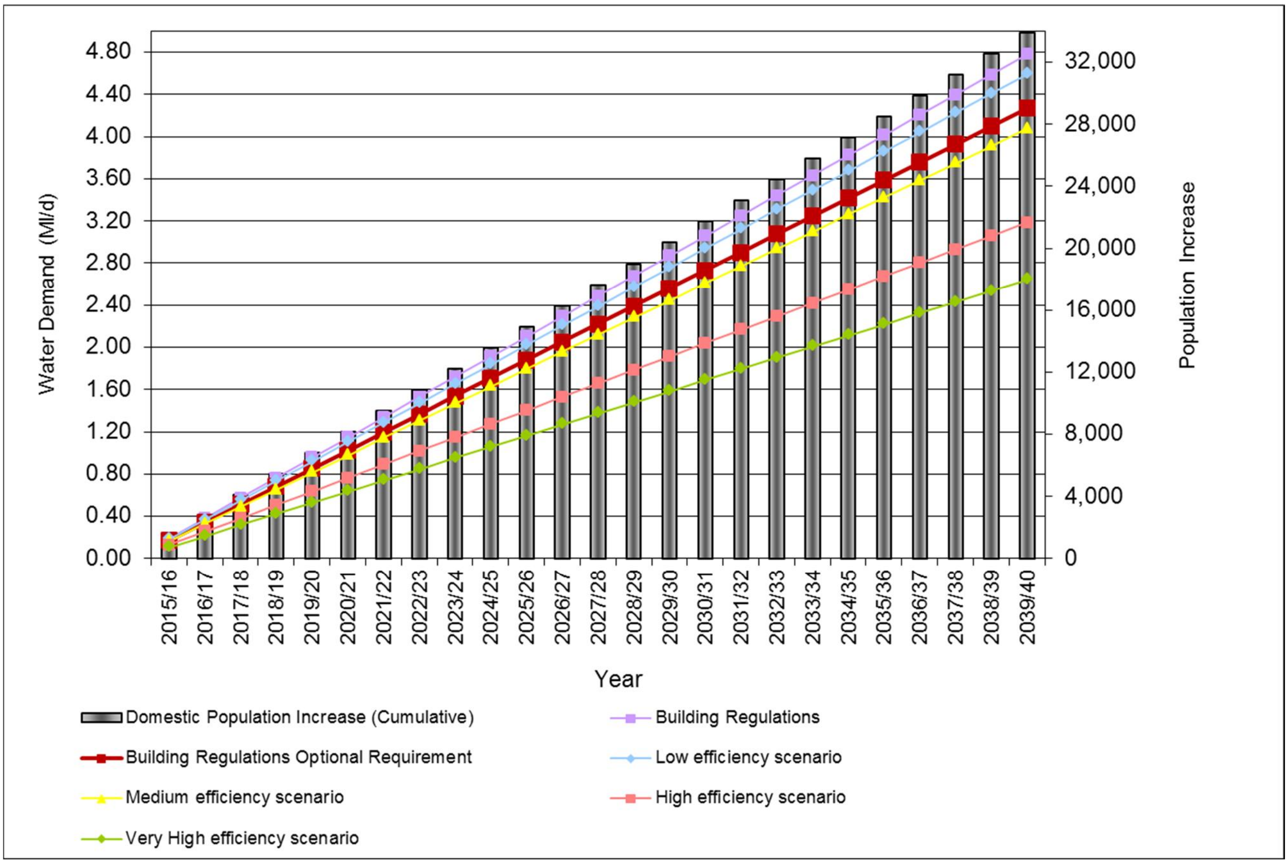
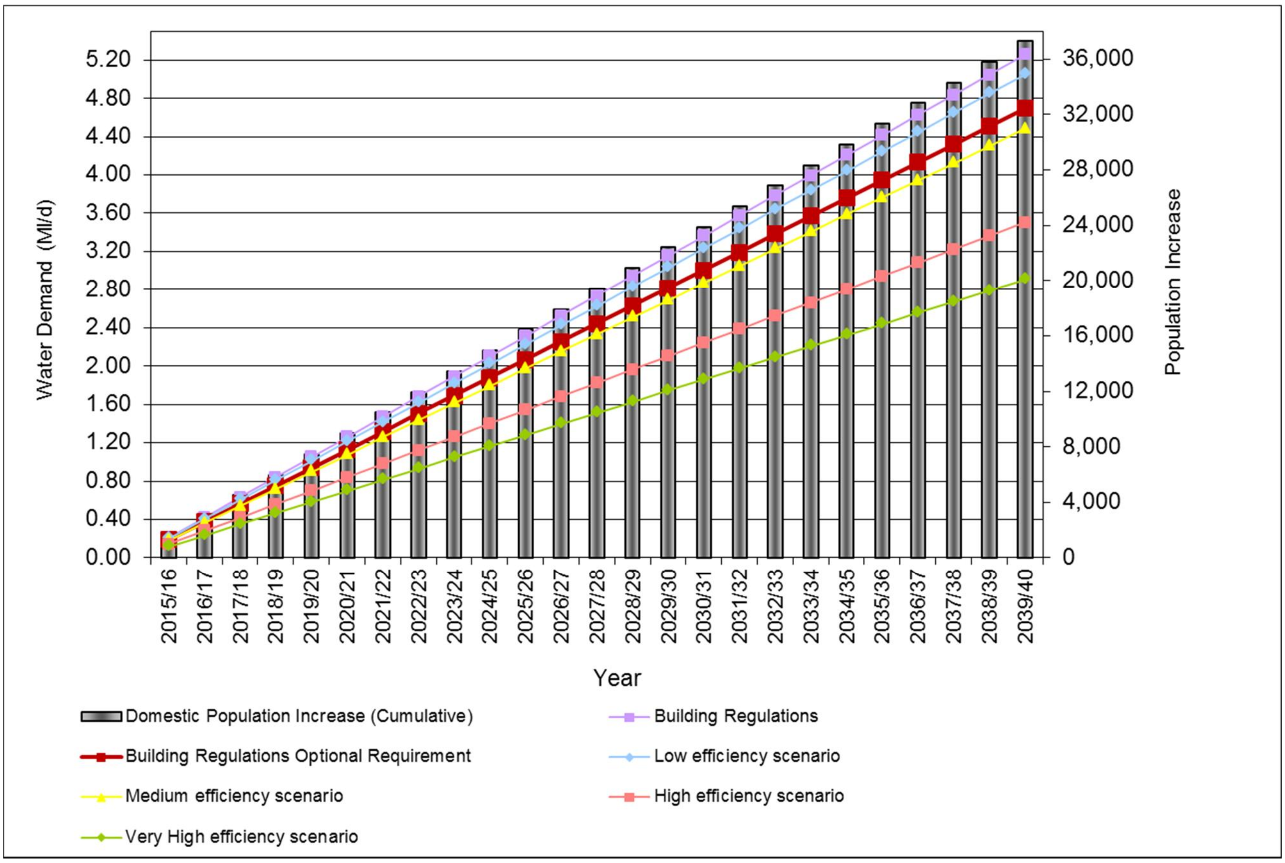


Figure 3-2 Range of water demands across plan period in South Kesteven for Growth Scenario 2 depending on efficiency levels of new homes



3.4.1 Planned Water Availability Summary

The 2015 WRMP for AWS has been used to summarise water availability to meet the calculated projected demand for the South Kesteven District covering the planning period to 2040 and any additional resource capacity that may be required to meet this demand. South Kesteven District is located within the Central and East Lincolnshire Water Resource Zones (WRZ). In reviewing the final AWS 2015 WRMP, it has been established that the growth figures assessed for this WCS update are catered for in the 2040 prediction of demand in the relevant Planning Zones under average conditions within the WRMP.

3.4.1.1 Anglian Water –Central Lincolnshire Water Resource Zone

With respect to the South Kesteven District, this WRZ covers the key settlement of Grantham and local service centres of Ancaster, Barkston, Barrowby, Billingborough, Caythorpe, Claypole, Colsterworth, Corby Glen, Great Gonerby, Harlaxton, Ropsley, and South Witham.

Water within this area is supplied via groundwater that is pumped from the Sherwood Sandstone and Lincolnshire Limestone aquifers as well as surface water abstracted from the River Ancholme. For this WRZ, AWS predict that in the Asset Management Period (AMP) 10 (2039/40) there will be a supply-demand surplus of 14.60 Ml/d during the Dry Year Annual Average and a 35.44 Ml/d surplus under the Critical Period conditions. The total number of household customers within the resource zone which were billed on the basis of measured supplies was 68%.

3.4.1.2 Anglian Water –East Lincolnshire Water Resource Zone

With respect to the South Kesteven District, this WRZ covers the key settlements of Bourne, Stamford and The Deepings and local service centres of Baston, Castle Bytham, Langtoft, Morton and Thurlby.

Water supply within this area is split into north and south with the northern supplies primarily groundwater abstractions from the Chalk and Spilsby Sandstone aquifers as well as surface water abstraction from the Louth Canal pumped to a storage reservoir. Water transfers from the adjacent Central Lincolnshire WRZ also occur. The southern portion of the WRZ is supplied from the Lincolnshire Limestone aquifer or imported from the Ruthamford North WRZ.

For this WRZ, AWS predict that in the Asset Management Period (AMP) 10 (2039/40) there will be a supply-demand surplus of 12.82 Ml/d during the Dry Year Annual Average and a 72.76 Ml/d surplus under the Critical Period conditions. The total number of household customers within the resource zone which were billed on the basis of measured supplies was 68%.

Since development within the District is not proposed to exceed that for which AWS are planning, the conclusions of the WRMP can be used to conclude that a sustainable supply of water is available to meet the demands of the planned growth within the Local Plan to 2040. However, there are several key drivers for ensuring that water use in the development plan period is minimised as far as possible through the adoption of water efficiency policy. This WCS therefore includes an assessment of the feasibility of achieving a 'water neutral' position after growth across the District. This is set out in the following subsections.

3.5 Drivers and Justification for Water Efficiency

3.5.1 Water Stress

In 2013, the AWS supply area was classified by the Environment Agency as an 'Area of serious water stress'[19] based on a 'Water Exploitation Index' as derived by the European Environment Agency. Part of this classification is based on climate change effects as well as increases in demand driven by Local Plan growth targets.

3.5.2 Sustainability Drivers

Within the CAMS areas described in Sections 3.2.1 and 3.2.2 above, restrictions have been applied by the Environment Agency for abstraction licencing to ensure the environmental objectives of the catchment are achieved and that actual flows do not fall short of the Environmental Flow Indicators.

Due to the existing pressures placed on these catchments by the volume of existing abstraction, it is necessary that AWS include sustainability reductions (reductions in the volumes they can abstract) within the WRMP to meet these objectives. A review of the AWS WRMP identifies that these sustainability reductions have be accounted for in their forecast supply and demand for the WRZs serving South Kesteven. Although there is sufficient surplus of water to implement these reductions, it demonstrates a need for resources to be managed sustainably to account for growth.

3.5.3 Climate Change and Availability of Water

In their 2015 WRMP, AWS highlight that over the planning period the key water resources challenges they face are from the impacts of growth and climate change. Overall, AWS predict their supply-demand balance could be at risk from adverse changes which may be as large as approximately 50% of their 2012/13 Distribution Input.

It is predicted that climate change will further reduce the available water resources serving South Kesteven as rainfall patterns change to less frequent, but more extreme, rainfall events in the summer months, and winter rainfall patterns become more frequent and intense.

In their Strategic Direction Statement, AWS state that climate change is the biggest single risk facing their business to 2035. Customers expect AWS 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.

AWS reported that the changes most significant for managing water resources in their supply area are:

- the increase in rainfall in the winter;
- reduction in the summer rainfall; and
- an increase in summer temperatures that will reduce the length of the winter recharge season and potentially increase the demand for water.

At a strategic level, AWS highlighted that it will be important to store more run-off from winter rainfall and to enhance the natural groundwater recharge.

3.5.3.1 Impact on Supplies

AWS 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.

[19] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244333/water-stressed-classification-2013.pdf

The analysis involved processing median, mean, best and worst case scenarios through a number of recognised climate change models, for 20 groundwater and 100 surface water sources considered vulnerable to the potential impacts of climate change on source yield. The results identified a more significant impact on surface water source yield (reservoir and direct intake) than for groundwater. The modelling results also indicated that in some cases potential groundwater yield could increase, as the climate change scenarios not only predict higher temperatures but increased periods of prolonged and heavy rainfall.

3.5.3.2 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. AWS 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. The effect of peak demand varies between WRZ due to factors such as the location of holiday resorts and heavy industry and socio-economic factors reflected in the type and age of housing stock and customers' behaviour.

Although AWS have planned for the anticipated impacts of climate change, the view of AWS 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. Planning Policy has a significant role to play in helping to achieve this.

3.6 Water Neutrality Assessment

3.6.1 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[20]. 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:

- 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 in some cases,
- 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 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 (albeit reduced) 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 South Kesteven District Council as a whole.

3.6.2 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 property.

In order to reduce water consumption and manage demand within the study area, a number of measures and devices are available[21]. 4.3.2Appendix B provides more detail on the different types of device or system along with the range of efficiency savings they could deliver.

[20] Water Neutrality is defined more fully in the Environment Agency report 'Towards water neutrality in the Thames Gateway' (2007)
[21] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.

3.6.3 Achieving Total Neutrality – is it feasible?

Even when considering neutrality within an existing planning area, it is recognised by the Environment Agency[22] that achievement of total water neutrality (100 per cent) 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 update therefore considers four water neutrality targets and sets out a ‘pathway’ for how the most likely target (or level of neutrality) can be achieved. The pathway concept is discussed in more detail in Appendix B, and highlights the importance of developing local policy in South Kesteven for delivering aspirations like water neutrality as well as understanding the additional steps required beyond ‘business as usual’ required to achieve it.

3.6.4 Water Neutrality Scenarios

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

- 125 l/h/d for all new homes[23];
- 16 l/h/d to account for employment figures[24];
- No mandatory efficiency target for non-domestic property; and
- Continued meter installation in existing homes as planned in AWS’ WRMP up to 2040.

The existing level of metering within the AWS region is 83%. AWS’ future target for meter penetration[25] on domestic water meters is 97.5% by 2040.

The WRMP assumes this metering rate will continue to the target of 97.5% of customers metered by 2040. Therefore, the Water Neutrality scenarios could assume a further 2.5% meter penetration within the existing housing stock by the end of the plan period in line with AWS’ WRMP.

The water neutrality scenarios have been developed based on the District as a whole when assessing the scenarios.

3.6.4.1 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;
- 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.

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[22] Environment Agency (2009) *Water Neutrality, an improved and expanded water management definition*
[23] Building regulations Part G Requirement
[24] Water Key Performance Indicators and benchmarks for offices and hotels (CIRIA C657)
[25] proportion of properties within the AWS supply area which have a water meter installed

3.6.4.2 High Scenario

The key assumptions for this scenario are that a high water neutrality percentage[26] 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.

3.6.4.3 Medium Scenario

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

3.6.4.4 Low Scenario

The key assumptions for this scenario are that the water neutrality percentage achieved is low but would only 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.

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.

3.6.5 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 South Kesteven District was calculated to be 19.4 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, UKWIR[27], the Environment Agency and OFWAT to determine realistic and feasible efficiency savings as part of developer design of properties, and standards for non-residential properties (Appendix B).

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

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

- Stage 1 – total demand post growth without any assumed water efficiency retrofitting to existing homes;
- Stage 2 – total demand post growth without any assumed water efficiency retrofitting to existing homes, but with the effect of metering additional metering (beyond AWS plans) applied; and,
- Stage 3 – total demand post growth with metering and water efficient retrofitting applied to existing homes.

Table 3-1 and Table 3-2 details the results for each Growth Scenario. If neutrality is achieved, the result is displayed as green. If it is not, but is within 20%, it is displayed as amber, and red if not achieved. The percentage of total neutrality achieved per scenario is also provided.

Table 3-1 Results of the Neutrality Scenario Assessments Growth Scenario 1

Neutrality Scenario	New Homes demand projections	Percentage of existing properties to be retrofitted	Demand from Growth (Ml/d)	Total demand post growth[28] (Ml/d)	Total demand after metering effect (Ml/d)	Total demand after metering & retrofitting (Ml/d)	% Neutrality Achieved
Low	Projection 1a: Building Regulations Mandatory	0%	4.78	24.22	23.74	23.74	9.9%
	Projection 1b: Building Regulations optional requirement	0%	4.27	23.71	23.23	23.23	20.5%
	Projection 3: Low efficiency scenario	10%	4.59	24.03	23.56	23.42	16.6%
Medium	Projection 4: Medium efficiency scenario	20%	4.07	23.51	22.96	22.15	43.3%
High	Projection 5: High efficiency scenario	25%	3.19	22.62	22.07	20.41	79.7%
Very High	Projection 6: Very High efficiency scenario	35%	2.64	22.08	21.53	19.20	105.1%

[28] prior to demand management for existing and new housing stock

Table 3-2 Results of the Neutrality Scenario Assessments Growth Scenario 2

Neutrality Scenario	New Homes demand projections	Percentage of existing properties with retrofit	Demand from Growth (Ml/d)	Total demand post growth*[29] (Ml/d)	Total demand after metering effect (Ml/d)	Total demand after metering & retrofitting (Ml/d)	% Neutrality Achieved
Low	Projection 1a: Building Regulations Mandatory	0%	5.26	24.69	24.22	24.22	9%
	Projection 1b: Building Regulations optional requirement	0%	4.70	24.13	23.66	23.66	19.6%
	Projection 3: Low efficiency scenario	10%	5.05	24.49	24.02	23.88	15.4%
Medium	Projection 4: Medium efficiency scenario	20%	4.48	23.62	23.37	22.56	40.7%
High	Projection 5: High efficiency scenario	25%	3.50	22.94	22.39	20.73	75.5%
Very High	Projection 6: Very High efficiency scenario	35%	2.90	22.34	21.79	19.46	99.6%

It can be seen from the above results that water neutrality can only be achieved for Growth Scenario 1 under a Very High Efficiency Scenario. While this is achievable in theory, it is anticipated that this would come with significant cost to the District. It is recommended that a water neutrality target of Low (Projection 1b) be set for the district in order to balance the objective of achieving a more water neutral position as well as limiting the cost implications of implementing such an initiative.

In order to achieve this target and enhance sustainable development moving forward, policy should be developed that ensures all new housing is as water efficient as possible and that objectives are set that new housing development is required to achieve the Building Regulations Optional Requirement water use of 110 l/h/d. Non-domestic buildings should as a minimum reach 'Good' BREEAM status. Further details of how a target of 110 l/h/d can be achieved is detailed in Appendix B.

To further promote 'water neutrality' in the district, it is recommended a policy 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.

[29] prior to demand management for existing and new housing stock

4 Conclusions and Recommendations

4.1 Conclusions

4.1.1 Wastewater Strategy

Assessment of the revised growth locations and numbers has demonstrated that additional treatment capacity will be required at two WwTW serving the District as a result of additional wastewater likely to be generated by the proposed growth. New discharge permits and potential upgrade solutions are required at both the Marston and Little Bytham WwTW to ensure that water quality targets, set to meet the requirements of the WFD are not exceeded within the rivers which will receive the additional treated wastewater flow. This affects growth proposed in Barrowby, Great Gonerby, Barkston, Grantham and Castle Bytham.

This WCS Update report has identified that workable infrastructure solutions in the long term can be delivered to ensure that growth proposed for Barrowby, Great Gonerby, Barkston, Grantham and Castle Bytham is sustainable and does not adversely affect the water environment. However, planning applications for these locations in the short-term should be subject to a pre-development enquiry with both AWS and the Environment Agency to ensure that growth phasing does not result in water body deterioration until such time as solutions are implemented.

In comparing the findings of this WCS Update and the 2011 Detailed WCS, it has been found that the new proposed growth figures have not significantly changed the conclusions of the Detailed WCS with respect to wastewater infrastructure and environmental capacity and thus have not impacted the soundness of the Local Plan.

4.1.2 Water Supply and Efficiency

Analysis of raw water availability within the District identified that no water is available for abstraction from water resources (surface and groundwater) during low flows and is restricted during medium and high flows, thus supply is reliant on the strategic management of resources by Anglian Water.

It was predicted in AWS WRMP that all WRZs within the South Kesteven District would be in surplus until the end of the plan period (2040) and that sufficient sustainable water supply would be available to ensure demand is met.

This WCS Update has shown that there are sustainability concerns with long terms abstraction within the District and that, to compliment proposals within AWS WRMP, consideration is given towards minimising water use in planned development through the use of development control policy and contributing to management of demand from the existing population within the District.

To set out how this could be achieved, the WCS update has considered the feasibility of attaining a ‘water neutral’ position in the District, whereby the District’s total demand for water at the end of the plan period is equal to (or less than) current demand levels in 2016. The assessment demonstrated that water neutrality is theoretically attainable by the end of the plan period, but is unlikely to be achievable in practice, given the significant funding and practicality implications of doing so. Therefore, recommendations for a lower target of efficiency have been made, along with policy for recommendations for how this could be achieved. Policy recommendations can be found in the section below.

In comparing the findings of this WCS Update and the 2011 Detailed WCS, it has been found that the new proposed growth figures have not significantly changed the conclusions of the Detailed WCS with respect to water supply and environmental capacity and thus have not impacted the soundness of the Local Plan

4.2 Policy Recommendations

The following recommendations for potential policy are made and should be considered by South Kesteven District Council to ensure that the South Kesteven Local Plan considers potential limitations (and opportunities) presented by the water environment and water infrastructure on growth, and phasing of growth.

4.2.1 Wastewater

WW1 – Development Phasing – Barrowby, Great Gonerby, Barkston, Grantham and Castle Bytham,
At some point in the Local Plan implementation timetable, the proposed growth in Barrowby, Great Gonerby, Barkston, Grantham and Castle Bytham will require a change in discharge permit conditions for the WwTWs serving the growth with the potential need for a treatment solution close to the limits of conventional technology at some point in the plan period (to be determined in detail by the Environment Agency and AWS). Whilst early phasing can be accommodated within existing treatment headroom, the council should only give planning permission for applications coming forward if both the Environment Agency and AWS have indicated that they are satisfied that the development can be accommodated. At these locations SKDC should discuss plans with AWS and include provision for managed phasing within the Local Plan.

4.2.2 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 mandatory Building Regulations requirements. It is recommended that South Kesteven consider a policy of setting the Building Regulations optional requirement target of 110 l/h/d. Non-domestic buildings 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.

4.3 Further Recommendations

4.3.1 Stakeholder Liaison

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

4.3.2 WCS Periodic Review

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

- Five yearly reviews of AWS' WRMP (the next full review is due in 2019, although interim reviews are undertaken annually);
- Third round of RBMP updates in 2020; and,
- Periodic Review 2019 (PR19) (AWS' business plan for AMP7 – 2020 to 2025).

Appendix A. WwTW Capacity Assessment Results

A.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 2.2 people per house and an average consumption of 125 l/h/d. An additional employment consumption rate of 16 l/h/d has been added to account for employment figures within the district.
- WwTW current flows were taken as the current permitted dry weather flow (DWF). Future 2040 flows were calculated by adding the volume of additional wastewater generated by new dwellings (using an OR of 2.2, a consumption value of 125 l/h/d and employment consumption value of 16 l/h/d) 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[30]
- 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 A-1, Table A-2, Table A-3 and Table A-4.
- 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.

A.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 AWS 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 WwTW 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.

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

A.2.1 Step 1 – 'No Deterioration'

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

A.2.2 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 A-3 and Table A-4.

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.

A.2.3 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 A-1 and Table A-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 AWS 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 A-1 'No Deterioration' Assessment' Growth Scenario 1

	Marston Low Flow (River Witham < 1.4 m3/s)			Marston High Flow (River Witham > 1.4 m3/s)			Little Bytham		
	BOD	Ammonia	phosphate	BOD	Ammonia	phosphate	BOD	Ammonia	phosphate
River Downstream of Discharge									
No Deterioration Target	High	High	Moderate	High	High	Moderate	-	High	High
River Quality Target (90%ile or AA)	4.0	0.3	0.25	4.0	0.3	0.25	-	0.3	0.05
Current DWF (m^3/day)	14280			14280			787		
Permit Limits (95%ile or AA)	10.0	3.0	2.0	20.0	5.0	2.0	15	4	-
Future DWF (m^3/day)	17123			17123			805		
Effluent Quality Required (95%ile or AA)	**10.61**	**1.68**	**0.81**	**10.87**	**1.74**	**0.81**	**-**	**4.14**	**0.41**
Will Growth prevent WFD 'No Deterioration' being achieved?	**Yes**			**Yes**			**Yes**		

Table A-2 'No Deterioration' Assessment' Growth Scenario 2

	Marston Low Flow (River Witham < 1.4 m3/s)			Marston High Flow (River Witham > 1.4 m3/s)			Little Bytham		
	BOD	Ammonia	phosphate	BOD	Ammonia	phosphate	BOD	Ammonia	phosphate
River Downstream of Discharge									
No Deterioration Target	High	High	Moderate	High	High	Moderate	-	High	High
River Quality Target (90%ile or AA)	4.0	0.3	0.25	4.0	0.3	0.25	-	0.3	0.05
Current DWF (m^3/day)	14280			14280			787		
Permit Limits (95%ile or AA)	10.0	3.0	2.0	20.0	5.0	2.0	15	4	-
Future DWF (m^3/day)	17123			17123			805		
Effluent Quality Required (95%ile or AA)	**10.53**	**1.66**	**0.8**	**10.77**	**1.72**	**0.8**	**-**	**4.13**	**0.41**
Will Growth prevent WFD 'No Deterioration' being achieved?	**Yes**			**Yes**			**Yes**		

Table A-3 Improvement to 'Good Status' Assessment for Growth Scenario 1

	Marston Low Flow (River Witham < 1.4 m3/s)	Marston High Flow (River Witham > 1.4 m3/s)
	Phosphate	Phosphate
River Downstream of Discharge		
WFD Status Target	Good	Good
River Quality Target (90%ile or AA)	0.12	0.12
Current DWF (m^3/day)	14280	14280
Permit Limits (95%ile or AA)	0.28	0.28
Future DWF (m^3/day)	17123	17123
Effluent Quality Required (95%ile or AA)	0.23	0.23
Will Growth prevent WFD 'Improvement to Good'?	No	No

Table A-4 Improvement to 'Good Status' Assessment for Growth Scenario 2

	Marston Low Flow (River Witham < 1.4 m3/s)	Marston High Flow (River Witham > 1.4 m3/s)
	Phosphate	Phosphate
River Downstream of Discharge		
WFD Status Target	Good	Good
River Quality Target (90%ile or AA)	0.12	0.12
Current DWF (m^3/day)	14280	14280
Permit Limits (95%ile or AA)	0.28	0.28
Future DWF (m^3/day)	17408	17408
Effluent Quality Required (95%ile or AA)	0.23	0.23
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 B. Water Neutrality

B.1 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 District, a number of measures and devices are available[31], 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, 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[32].

B.2 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.

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

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 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[33] 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 South Kesteven 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 South Kesteven.

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.

B.3 Improving Efficiency in Existing Development

B.3.1 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 23.25l/h/d or 50l per household per day[34], assuming an occupancy rate of 2.15[35] 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)[36]. 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 B-1).

[33] Part G of the Building Regulations
[34] Anglian Water 2015 Water Resource Management Plan
[35] 2.15 is used for existing properties and 2.2 for new properties. This figure was agreed with SKC prior to the assessment.
[36] 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 B-1 Change in typical metered and unmetered household bills

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

B.3.2 Low or Variable Flush Toilets

Toilets use about 30 per cent of the total water used in a household[37]. 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[38] per flush. A study carried out in 2000 by Southern Water and the Environment Agency[39] 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.

B.3.3 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.

B.3.4 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[40].

B.3.5 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.

B.3.6 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 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.

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

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

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

B.3.7 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[41] 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.

B.4 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.

B.5 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[42] gave a summary of water use savings that can be achieved by the use of efficient fixtures and fittings, as shown below in Table B-2.

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

Table B-2 Summary of water savings borne by water efficiency fixtures and fittings

Component	150 l/h/d Standard Home	125 l/h/d	120 l/h/d	110 l/h/d	105 l/h/d	80 l/h/d	62 l/h/d
Toilet flushing	28.8	19.2b	19.2 b	16.8 d	16.8 d	8.4 + 8.4 f	8.4 + 8.4 f
Taps	42.3 a	31.8 a	31.8 a	24.9 a	24.9 a	18 a	18a
Shower	30	30	24	24	18	18	18
Bath	28.8	25.6c	25.6 c	25.6 c	25.6 c	22.4 e	22.4
Washing machine	16.7	15.3	15.3	15.3	15.3	7.65 + 7.65 f	7.65 + 7.65 f
Dishwasher	3.9	3.9	3.6	3.6	3.6	3.6	3.6
Recycled water	-	-	-	-	-	-16.1	-32.2
Total per head	150.5	125.8	119.5	110.2	104.2	78	61.9
TOTAL PER HOUSEHOLD	**331.1**	**276.76**	**262.9**	**242.44**	**229.24**	**171.6**	**136.18**

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 B-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[43], the experience of AECOM 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.

B.5.1 Rainwater Harvesting

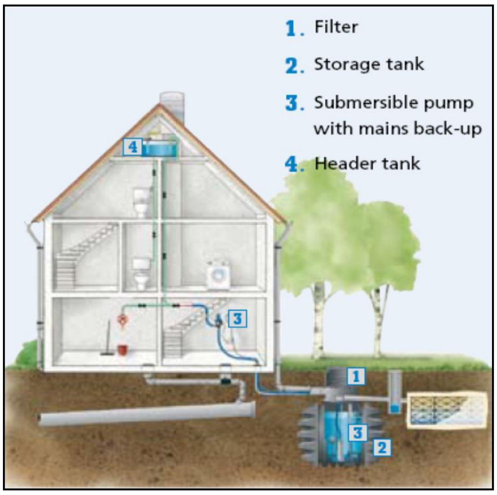
Rainwater harvesting (RWH) is the capture and storage of rain water that lands on the roof of a property. This can have the dual advantage of both reducing the volume of water leaving a site, thereby reducing surface water management requirements and potential flooding issues, and be a direct source 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 B1 below gives a diagrammatic representation of a typical domestic system[44].

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[45].

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

Figure B1 A typical domestic rainwater harvesting system



A sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[46], 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 B-3.

Table B-3 RWH systems sizing

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

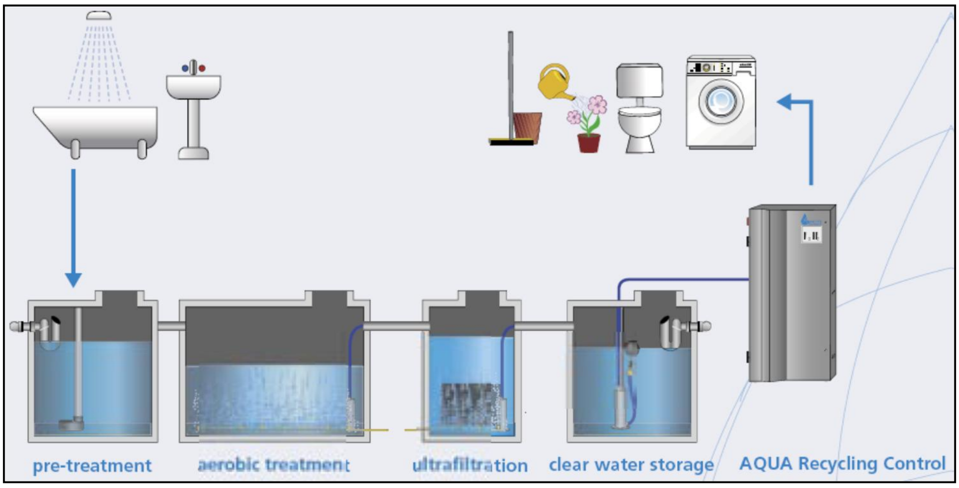
B.5.2 Greywater Recycling

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

The storage volumes required for GWR are usually smaller than those required for rainwater harvesting as the supply of greywater is more reliable than rainfall. In domestic situations, greywater production often exceeds demand and a correctly designed system can therefore cope with high demand application and irregular use, such as garden irrigation. Figure B-2 below gives a diagrammatic representation of a typical domestic system[47].

[46] Sustainable water management strategy for Northstowe, WSP, December 2007
[47] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk

Figure B2 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[48].

Table B-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 B-4 Potential water savings from GWR

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

The treatment requirements of the GWR system will vary, as water which is to be used for flushing the toilet does not need to be treated to the same standard as that which is to be used for the washing machine. The source of the greywater also greatly affects the type of treatment required. Greywater from a washing machine may contain suspended solids, organic matter, oils and grease, detergents (including nitrates and phosphates) and bleach. Greywater from a dishwasher could have a similar composition, although the proportion of fats, oils and grease is likely to be higher; similarly for wastewater from a kitchen sink. Wastewater from a bath or shower will contain suspended solids, organic matter (hair and skin), soap and detergents. All wastewater will contain bacteria, although the risk of infection from this is considered to be low[49].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 B-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.

48 http://www.thewatercalculator.org.uk/faq.asp
49 Centre for the Built Environment, www.cbe.org.uk

Table B-5 Water Neutrality Scenarios – specific requirements for each scenario

WN Scenario	New development requirement			Retrofitting existing development	
	New development Water use target (l/h/d)	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
Building Regs Optional Scenario	110	- 3-4.5 litre dual flush toilet; - Medium spec aeration taps; - Low spec low flow shower head; - 160 litre capacity bath; - High efficiency dishwasher; - 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 District
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 District
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 District

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)
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 District

About AECOM

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