Greater Norwich Water Cycle Study

Greater Norwich Authorities

Final Draft

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Quality information

Prepared by	Checked by	Verified by	Approved by
Hannah Booth Graduate Water Consultant Laura Soothill Graduate Engineer Christina Bakopoulou Flood Risk Engineer	Carl Pelling Regional Director	Sarah Kelly Regional Director	Carl Pelling Regional Director

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Prepared for:

Broadland District Council, Norwich City Council and South Norfolk District Council

Prepared by:

AECOM Infrastructure & Environment UK Limited
Midpoint, Alencon Link
Basingstoke
Hampshire RG21 7PP
United Kingdom

T: +44(0)1256 310200
aecom.com

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List of Acronyms

AMP	Asset Management Plan
AWS	Anglian Water Services
BDC	Broadland District Council
BOD	Biochemical Oxygen Demand
BP	Business Plan
BREEAM	Building Research Establishment Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CSH	Code for Sustainable Homes
DCLG	Department for Communities and Local Government
DEFRA	Department for Environment, Food and Rural Affairs
DWF	Dry Weather Flow
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
GNA	Greater Norwich Area
GNLP	Greater Norwich Local Plan
GNDP	Greater Norwich Development Partnership
HRA	Habitats Regulations Appraisal
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LNR	Local Nature Reserve
LPA	Local Planning Authority
Ml	Mega Litre (a million litres)
NCiC	Norwich City Council
NCoC	Norfolk County Council
NE	Natural England
NPPF	National Planning Policy Framework
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
ONS	Office for National Statistics
OR	Occupancy Rate
PE	Population Equivalent
PR	Price Review
Q70	The river flow exceeded 70% of the time
Q95	The river flow exceeded 95% of the time
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RNAG	Reasons for Not Achieving Good
RoC	Review of Consents (under the Habitats Directive)
RQP	River Quality Planning (tool)
SAC	Special Area for Conservation
SNDC	South Norfolk District Council
SNVC	South Norfolk Village Clusters
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
UKCP09	United Kingdom Climate Projections 2009
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UKWIR	United Kingdom Water Industry Research group
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WRC	Water Recycling Centre
WRMP	Water Resource Management Plan
WRMU	Water Resource Management Unit (in relation to CAMS)
WRZ	Water Resource Zone (in relation to a water company's WRMP)
WSI	Water Services Infrastructure
WRC	Water Recycling Centre

Executive summary

The three local planning authorities within the Greater Norwich Area (GNA) are a preparing a new Local Plan that will deliver housing growth over a 20-year planning period. There is significant pressure to deliver new homes in the three districts within the GNA as the need for housing has increased. This growth represents a challenge in ensuring that both the water environment and water services infrastructure has the capacity to sustain the level of growth and development proposed.

This Outline Water Cycle Study (WCS) forms an important part of the evidence base that will help the authorities determine the most appropriate options for development within the study area (with respect to water infrastructure and the water environment) to be identified in the new Local Plan.

Planned future development throughout the study area has been assessed with regards to water supply capacity, wastewater capacity and associated environmental capacity. Any water quality issues, water infrastructure upgrades, and potential constraints have subsequently been identified and reported, wherever possible. This WCS then provides information at a level suitable to demonstrate that there are workable solutions to key constraints to deliver future development for the development sites presented, including recommendations on the policy required to deliver it.

Wastewater Strategy

Wastewater in the GNA is treated at a number of treatment facilities referred to by Anglian Water Services (AWS) as Water Recycling Centres (WRC). Wastewater from property and business is received at the WRC, treated and discharged back to the environment. The WCS has identified that there are several WRC within the study area that do not have sufficient capacity to treat all additional wastewater flows from the proposed level of growth within their catchments (Acle, Aylsham, Barnham Broom, Beccles, Ditchingham, Long Stratton, Whitlingham Trowse, Woodton and Wymondham). The study also identified that some WRCs have capacity, but using that capacity may impact significantly on the water quality and ecology of watercourses receiving the treated discharge (Cantley, Freethorpe, and Saxlingham). Finally, future discharge volumes from Reepham and Foulsham WRC were also assessed, irrespective of capacity, due to their discharge within the River Wensum Special Area of Conservation (SAC). Water quality and ecological assessments have been undertaken for these future discharges.

The assessment has shown that subject to the revision of discharge permits and the implementation of the necessary treatment process upgrades (using conventional treatment technologies), changes in water quality as a result of additional discharge can be managed to ensure there is no adverse change in water quality or connected water dependent ecologically protected sites as a result of growth.

The analysis has demonstrated that treatment upgrades required to deliver this outcome will be significant for several of the WRCs and this will require substantial investment from AWS over the longer term. This may affect early phasing of development (up to 2025) in some locations of the study area. Key locations where this will need to be considered include Long Stratton, Wymondham and Whitlingham.

Some major development sites would experience known capacity restrictions in the wastewater network and hence developer contributions to new sewer networks would be required alongside AWS investment. Funding for water infrastructure improvements is provided through a standard charge levied by AWS on all new homes. Through their Water Recycling Long-term Plan, AWS have already identified planned investment to upgrade WRC capacity at Aylsham, Long Stratton and Woodton in the plan period as well as increased drainage capacity at Whitlingham and Wymondham.

In addition to wastewater from property and business, AWS have also indicated that no capacity is available for additional surface water connections to the public sewerage network. The provision of SuDS will need to be fully explored at all new sites to ensure no increase in sewer flood risk across the study area. The potential for this to be achieved has been considered for all major allocations within the Greater Norwich Local Plan (GNLP).

Water Supply Strategy

AWS is the potable water provider for the GNA. As part of the Environment Agency water stressed areas classification (2013)[1], the Anglian Water supply area is concluded to be in an area of 'serious water stress'.

AWS plan for the long-term provision of water supplies through a five yearly planning cycle, through the production of statutory Water Resource Management Plans (WMRP). The WRMP sets out how changes in demand for water and changes in available water in the environment will be managed, including measures to manage how much water customers use (demand management) and measures to provide new sources of supply to current and future customers. The latest AWS WRMP from 2019 indicates that through the introduction of strategic demand management options and supply side schemes within the supply areas serving the GNA, adequate water supplies will be available up to 2045 and will cater for the proposed levels of growth.

The emphasis on meeting future supply and demand is on demand management. It is therefore essential that the efficient use of water is promoted throughout the planning process. To support this conclusion, this WCS has tested and proposed seven water efficiency scenarios to demonstrate what additional reductions can be secured (over and above AWS statutory delivery) to achieve different levels of demand reduction in the study area.

The water efficiency assessment can be used by GNA to develop a water use policy that requires developers to build new homes to meet the higher Building Regulation standards of 110/l/h/d as a minimum, improving on it where possible and to consider working with AWS and other stakeholders to develop further options for retrofitting existing properties with efficiency fixtures and fittings.

[1] Environment Agency (2013). Water stressed areas – final classification. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/244333/water-stressed-classification-2013.pdf

1 Introduction

1.1 Background

The Greater Norwich Area (GNA) comprises the administrative areas of Broadland District Council (BDC), Norwich City Council (NCiC) and South Norfolk District Council (SNDC), shown in Figure 1-1. The GNA has experienced moderate population growth in the past decade and is expected to experience a significant increase in housing requirement and economic growth over the period to 2038. The Greater Norwich authorities, working with Norfolk County Council (NCoC), are developing an updated Local Plan which will consider the requirements for development and growth up to 2038. A new Water Cycle Study (WCS) is required to support the development of the new Local Plan for the Greater Norwich area, as well as providing a robust planning document for the Councils to use on a day-to-day basis.

Figure 1-1 Overview of the study area

This Water Cycle Study (WCS) forms an important part of the evidence base that will help to ensure that development does not have a detrimental impact on the water environment within the GNA. The WCS will also help to guide the development towards the most appropriate locations (with respect to water infrastructure and the water environment) to be identified in the new Local Plan.

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

1.2 Study Governance

This WCS has been carried out with the guidance of the Steering Group established at the project inception meeting comprising the following organisations:

- Broadland District Council;

- Norwich City Council;
- South Norfolk District Council;
- Anglian Water Services (AWS); and,
- The Environment Agency.

Additionally, information and input from Natural England has been also used in this WCS.

1.3 WCS Scope

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

The outcome is the development of a water cycle strategy for the three Districts which informs the Council's new Local Plan, sustainability appraisals and appropriate assessments specific to the water environment and WSI issues.

The following sets out the key objectives of the WCS:

- provide a strategy for wastewater treatment across the GNA which determines if solutions to wastewater treatment are required and if the solutions are viable in terms of balancing environmental capacity with cost;
- describe how the wastewater treatment strategy might impact phasing of development;
- determine whether any designated ecological sites have the potential to be impacted by the wastewater treatment strategy via a screening process;
- determine whether additional water resources, beyond those already planned by AWS are required to support growth;
- determine where upgrades might be required to water and wastewater network infrastructure relative to potential options for growth through collaboration with AWS;
- consider whether growth can be delivered and achieve a 'neutral water use' condition;
- provide a pathway to achievement of water neutrality;
- determine impact of infrastructure and mitigation provision on housing delivery phasing; and
- provide recommendations to support the Local Plan and policy development.

1.4 Key Assumptions and Conditions

1.4.1 Water Company Coverage

AWS is the wastewater undertaker for the GNA providing wastewater treatment via a number of Water Recycling Centres (WRC). AWS also supplies potable water for the entire GNA.

1.4.2 Household Occupancy Rate

The latest Office for National Statistics (ONS) population projections and household projections[2] have been used to determine the occupancy rate of each household coming forward in the plan period, and have been provided in Table 1-1.

2 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29

Table 1-1 Calculation of Occupancy Rate

Projection for 2038	
Population	452,000
Number of households	213,700
Calculated Occupancy Rate (people per household)	2.07

1.4.3 Wastewater Treatment

As a wastewater treatment provider, AWS are required to use the best available techniques (defined by the Environment Agency as the best techniques for preventing or minimising pollution load and impacts on the environment) to ensure discharge quality values stipulated within each WRCs permit conditions are met.

Through application of the best available technologies in terms of wastewater treatment, the reliable limits of conventional treatment (LCT) have been determined for the key parameters of Biochemical Oxygen Demand (BOD)[3] ammonia and phosphate, and are provided in Table 1-2.

Table 1-2 Reliable limits of conventional treatment technology for wastewater

Water Quality Parameter	LCT
Ammonia	1.0 mg/l 95 percentile limit[4]
BOD	5.0 mg/l 95 percentile limit
Phosphate	0.25 mg/l annual average[5]

1.5 Report Structure

This report has been structured as follows:

- The drivers shaping the direction of the WCS are presented in Section 2.
- The first stage of the WCS process is set out in Section 3 and outlines the total proposed number of dwellings which will need to be catered for in terms of water supply and wastewater treatment.
- Understanding what the level of growth is and where it might be located informs the second stage of the study (reported in Section 4), assessing the current wastewater treatment facilities in regards to both capacity and compliance with legislation and environmental permits. The results of the assessment identifies the WRCs which are at capacity or have remaining capacity. The wider, supporting environment has also been considered, including hydrologically linked ecological designations.
- Subsequent to the wastewater assessment, Section 5 outlines water resource planning targets, discusses current and proposed water efficient measures and introduces the concept of water neutrality.
- Finally, the report also covers the proposed major development sites (defined as having more than 10 dwellings) in more detail (Section 6), assessing each site by identifying local receptors such as watercourses, outlining current and future flood risks (inclusive of surface water and groundwater flood risks) and assessing the current wastewater network.
- Ultimately, recommendations have been made as part of the WCS (Section 7.3) in regard to wastewater, water supply, surface water management and flood risk, ecology and stakeholder liaison.

[3] Amount of oxygen needed for the biochemical oxidation of the organic matter to carbon dioxide in 5 days. BOD is an indicator for the mass concentration of biodegradable organic compounds
[4] Considered within the water industry to be the current LCT using best available techniques
[5] Environment Agency (2015) Updated River Basin Management Plans Supporting Information: Pressure Narrative: Phosphorus and freshwater eutrophication

2 Study Drivers

There are two key overarching drivers shaping the direction of the WCS as a whole:

- Delivering sustainable water management – ensure that provision of WSI and mitigation is sustainable and contributes to the overall delivery of sustainable growth and development and that the Local Plan meets with the requirements of the National Planning Policy Framework (NPPF) with respect to water, wastewater and water quality; and
- compliance with environmental standards including Water Framework Directive (WFD) and Habitats Directive (HD) – to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies within the three Districts (and more widely) from achieving the standards required of them as set out in the WFD regulations and specific standards for water dependent Special Areas of Conservation (SAC) protected under the HD.

A full list of the key legislative drivers shaping the study is detailed in a summary table in Appendix A for reference.

Other relevant studies that have a bearing on the provision of water services infrastructure for development are provided in Appendix B and include, but are not limited to, key documents including AWS's Water Resources Management Plan (WRMP) (2019)[6], hereafter referred to as WRMP19, and the Environment Agency's latest Anglian RBMP (2015).

2.1 OFWAT Price Review

The Price Review (PR) is a financial review process governed by the Water Services Regulatory Authority (Ofwat) - the water industry's economic regulator. Through the PR, Ofwat determines the price limits that water companies can charge to customers over consecutive five-year periods based on Business Plans submitted by water companies for period (or Asset Management Period [AMP]).

The industry is currently in the 7th AMP cycle, and the price limits for the AMP7 (2020 to 2025) were set at the end of 2019 and took effect on 1st April 2020. Investment for schemes not included in the current AMP will need to be sought for the next AMP period (AMP8 from 2025 to 2030) and set out in the Business Plans to be compiled and submitted in 2024. The WCS therefore acts as a key evidence base for requesting funding for future schemes (new infrastructure or upgrades) which may be required to serve planned growth within the 2024 Business Plan submission.

2.1.1 Price Review and wastewater investment

As the wastewater undertaker for the three Districts, AWS has a general duty under Section 94 of the Water Industry Act 1991 to provide effectual drainage which includes providing additional capacity as and when required, to accommodate planned development. However, this legal requirement must also be balanced with the price controls as set by the regulatory body Ofwat which ensure AWS has sufficient funds to finance its functions, and at the same time protect consumers' interests. The price controls affect the bills that customers pay and the sewerage services consumers receive, and ultimately ensure wastewater assets are managed and delivered efficiently.

Consequently, to avoid potential inefficient investment, AWS generally do not provide additional infrastructure to accommodate growth until there is certainty that development is due to come forward. However, AWS have published a 'Water Recycling Long Term Plan' (WRLTP)[7], which identifies where investment is likely to be required for new infrastructure over a 25 year period based on predicted Local Plan growth.

2.2 Water Framework Directive

The environmental objectives of the WFD relevant to this WCS are:

- to prevent deterioration of the status of surface waters and groundwater (the no deterioration principle),

[6] Anglian Water (2019). Water Resources Management Plan. https://www.anglianwater.co.uk/_assets/media/Anglian_Water_revised_dWRMP_2019.pdf
[7] Anglian Water (2018) Water Recycling Long Term Plan. September 2018. Available at https://www.anglianwater.co.uk/siteassets/household/in-the-community/water-recycling-long-term-plan.pdf

- to achieve objectives and standards for protected areas, and
- to aim to achieve good status for all water bodies or, for heavily modified water bodies and artificial water bodies, good ecological potential and good surface water chemical status.

These environmental objectives are legally binding, and all public bodies should have regard to these objectives when making decisions that could affect the quality of the water environment. The Environment Agency publishes the status and objectives of each surface waterbody on the Catchment Data Explorer[8], and describes the status of each waterbody as detailed in Table 2-1.

Table 2-1 Description of status in the WFD

Status	Description
High	Near natural conditions. No restriction on the beneficial uses of the water body. No impacts on amenity, wildlife or fisheries.
Good	Slight change from natural conditions as a result of human activity. No restriction on the beneficial uses of the water body. No impact on amenity or fisheries. Protects all but the most sensitive wildlife.
Moderate	Moderate change from natural conditions as a result of human activity. Some restriction on the beneficial uses of the water body. No impact on amenity. Some impact on wildlife and fisheries.
Poor	Major change from natural conditions as a result of human activity. Some restrictions on the beneficial uses of the water body. Some impact on amenity. Moderate impact on wildlife and fisheries.
Bad	Severe change from natural conditions as a result of human activity. Significant restriction on the beneficial uses of the water body. Major impact on amenity. Major impact on wildlife and fisheries with many species not present.

Source: Environment Agency RBMPs

2.3 Habitats Directive

The HD has designated some sites as areas that require protection in order to maintain or enhance the habitats associated with them. In some cases, sites protected under the HD have specific water quality, water level, or flow targets required to maintain favourable condition for habitat. These targets may differ to those set under the WFD, and hence additional assessment may be required against HD targets in some cases.

[8] Environment Agency (2019) Catchment Data Explorer. http://environment.data.gov.uk/catchment-planning/

3 Proposed Growth

3.1 Preferred Growth Strategy

The purpose of the WCS is to assess the potential impact of increased development upon the water environment and WSI across the GNA, including water resources, wastewater infrastructure, water quality, flood risk, surface water drainage and aquatic ecology. The increased development is to accommodate the minimum housing requirement for the GNA. This level of projected growth has required the Greater Norwich Authorities to revise their spatial approach of future expected development up to 2038. These growth figures therefore form the basis for the WCS.

3.1.1 Housing

As of December 2020, the authorities within the GNA have identified a revised total housing provision of approximately 49,450 dwellings to be delivered between 2018 and 2038. This number includes dwellings which have already been delivered between 2018 and April 2020 (a total of approximately 5,250). The WCS considers that growth which is still to be completed from this total provision, giving an assessed total of approximately 44,200 dwellings. A breakdown of the delivery types assessed is shown in Table 3-1.

Table 3-1: GNA Housing allocations assessed within the WCS

Delivery Type	Approximate No. Dwellings
Existing commitment (April 2020 to 2038)	31,350
New allocations (including Diss Neighbourhood Plan)	10,700
Policy 7.5 delivery	800
Windfall allowance	1,350
Total Housing Figure	**44,200**

Exact site information was not available for windfall and Policy 7.5 delivery as well as approximately 1,200 dwellings of the new allocations total which are proposed for the South Norfolk Village Clusters (SNVC). This gives a total of approximately 3,350 dwellings which had no specific spatial information and as such, site specific assessment has not been possible for this growth. However, approximate locations for this growth were agreed with the planning authorities by making reasoned judgement as to where sites would most likely be identified in and around each relevant settlement. This allowed an estimation of how the levels of growth would be served by WSI at a strategic level such that the full 44,200 dwellings total could be assessed for strategic-level wastewater treatment and water supply capacity in the study area.

It should be noted that the 1,200 SNVC delivery which remains to be allocated as sites, will be allocated via a separate South Norfolk local plan and hence site-specific assessment will be considered for this growth separate to the GNLP.

Finally, the wastewater capacity assessment has also considered growth from neighbouring authorities where that growth would be served by wastewater treatment infrastructure which also serves future GNA growth. This assures that cumulative growth impacts on water quality are addressed.

3.1.2 Employment

The WCS takes account of the projected increase in employment across the GNA. Local evidence has shown that the total amount of allocated and permitted employment land is more than sufficient to provide for expected and promoted growth. Local needs may exist in some areas, with the need for new small-scale allocations to provide job growth in the towns and villages.

Local Plan evidence shows that around 33,000 additional jobs are expected to be created in the GNA by 2038. It has been assumed that this number of jobs is yet to be created and so this number of jobs and the location of employment land has been considered in the water resources and wastewater assessment based on likely locations for employment land allocation.

4 Wastewater Treatment Strategy

4.1 Wastewater in the Greater Norwich Area

Wastewater treatment in the GNA is provided via wastewater recycling centres (WRCs) operated and maintained by AWS, ultimately discharging treated wastewater to a nearby water body. Each of the WRCs is connected to development by a network of wastewater pipes (the sewerage system) which collects wastewater generated by homes and businesses to the WRC; this is defined as the WRCs 'catchment'.

Wastewater from the GNA is treated at 71 WRCs. After analysing the spatial distribution of sites, the following 36 WRC catchments are expected to receive additional wastewater as a result of growth:

- Acle-Damgate Lane
- Alburgh Church Road
- Aylsham
- Barford Chapel Street
- Barnham Broom
- Beccles Marsh Lane
- Belaugh
- Burston Station Road
- Cantley
- Carleton Rode
- Diss
- Ditchingham
- Earsham-Bungay Rd
- Ellingham-Braces Lane
- Forncett St Peter - Low Road
- Forncett-Forncett End
- Foulsham-Station Rd
- Freethorpe-Halvergate Rd
- Harleston
- Hempnall Fritton Road
- Long Stratton
- Norton Subcourse
- Pulham St Mary
- Rackheath
- Reedham
- Reepham
- Rushall Harleston Road
- Saxlingham
- Seething Mill Lane
- Sisland
- Stoke Holy Cross
- Swardeston-Common
- Whitlingham Trowse
- Winfarthing Chapel Close
- Woodton
- Wymondham

4.2 Management of WRC Discharges

All WRCs are issued with a permit to discharge by the Environment Agency. Larger WRC will have a numeric permit which sets out limits on the volume of treated wastewater that it can discharge and also limits on the quality of the treated discharge. These limits are set in order to protect the water quality and ecology of the receiving waterbody. They also dictate how much wastewater each WRC can accept, as well as the type of treatment processes and technology required at the WRCs to achieve the quality permit limits. Smaller facilities generally have a descriptive permit which do not set numerical limits.

The flow element of the discharge permit determines an approximation of the maximum number of properties that can be connected to a WRC catchment and is referred to as Dry Weather Flow (DWF). When discharge permits are issued, they are generally set with a flow 'headroom', which acknowledges that allowance needs to be made for future development and the additional wastewater generated. This allowance is referred to as '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, up to the maximum permitted headroom of the discharge permit.

The headroom determines how many additional properties can be connected to the WRC catchment before AWS would need to apply for a new or revised discharge permit (and hence how many properties can connect without significant changes to the treatment infrastructure). Additionally, for the purposes of this WCS, an analysis of additional flow received by each WRC due to growth has been made to identify those WRC catchments that are receiving significant growth but would still have available headroom. In this context, significant growth is assumed to be when post growth headroom is less than or equal to 10% of the current permitted DWF value and has been agreed in collaboration with the Environment Agency.

4.3 WFD Compliance

The definition of a waterbody's overall WFD 'status' is a complex assessment that combines standards for chemical quality and hydromorphology (habitat and flow conditions), with the ecological requirements of an individual waterbody catchment. A waterbody's 'overall status' is derived from the classification hierarchy made up of 'elements', and the type of waterbody will dictate what types of elements are assessed within it. The following is an example of the classification hierarchy and Figure 4-1 illustrates the classifications applied within the hierarchy;

Overall water body status or potential

- Ecological or Chemical status (e.g. ecological)
  - Component (e.g. biological quality elements)
    - Element (e.g. fish)

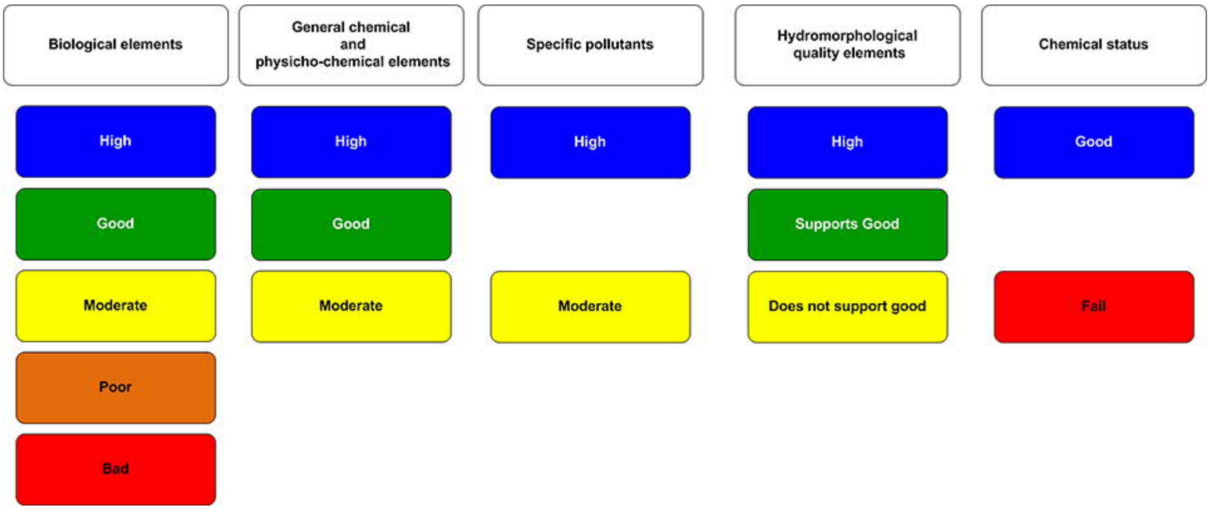


Figure 4-1 WFD status classifications used for surface water elements

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 WFD status of a waterbody; and
- Development must not prevent a waterbody from achieving its Future Target Status (usually at least good status).

It is important to note that, if a waterbody's overall status is less than good as a result of another element, it is not acceptable to justify a deterioration in another element because the status of a waterbody is already less than good. It is also important to note that for a waterbody at bad status for any quality element, no deterioration is acceptable according to the Wesser Ruling[9] made by the Court of Justice of the European Union.

Where permitted headroom at a WRC would be exceeded by proposed growth, or there is a WRC that has headroom but is expected to receive a significant growth allocation, a water quality modelling assessment has been undertaken to determine the quality conditions that would need to be applied to the a new or revised discharge permit to ensure the two policy requirements of the WFD are met. The modelling process (assumptions and modelling tools) is described in detail in Appendix C.

It is important to note that the modelling exercise specifically considers key physico-chemical elements which form a component part of the WFD Ecological Status of waterbodies. The Wesser Ruling also made clear that deterioration in any single element (in this case, phsyico-chemical elements) would constitute deterioration as defined by the Directive, even if the overall status of the waterbody is not changed.

4.4 Habitats Directive

The HD and the associated UK Habitats Regulations has designated some sites as areas that require protection in order to maintain or enhance the rare ecological species or habitat associated with them.

Although the Habitats Directive does not directly stipulate conditions on discharge for WRC, the Habitats Regulations can, by the requirement to ensure no detrimental impact on designated sites, require restrictions on discharges to (or abstractions from) water dependent habitats that could be impacted by anthropogenic manipulation of the water environment. The River Wensum SAC and the Broads SAC have been identified as sites within the study area which are potentially affected by future WRC discharges and have specific water quality targets that differ to the WFD. The Wensum targets have been considered specifically in the WCS, whilst the total load discharging to the Broads SAC downstream has been considered by modelling the potential to maintain current quality as well as ensuring load standstill.

In addition to the SAC sites specifically, where future discharge from a WRC is likely to be significant due to proposed levels of growth, a Habitats Regulations assessment screening exercise has also been undertaken to identify whether internationally or nationally important sites which are hydrologically linked to watercourses receiving wastewater flows from growth would be adversely affected. The scope of this assessment includes non-Habitats Directive sites such as nationally designated Sites of Special Scientific Interest (SSSI) and Local Nature Reserves (LNRs). This assessment is reported in Section 4.9 (Ecological Appraisal) of this chapter and the outcome has informed the HRA of the GNLP.

When a new or revised 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 remain unchanged, the increased flow of wastewater received at the WRC would result in an increase in the pollutant load[10] 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 provide a higher standard of treatment may result in an increase in the intensity of treatment processes at a WRC, which may also require improvements or upgrades to be made to the WRC 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 not achievable 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.

4.5 Wastewater Assessment Overview

4.5.1 Objectives

An increase in residential and employment growth will have a corresponding increase in the volume and flow of wastewater generated within the study area, therefore it is essential to consider infrastructure and environmental capacity.

[9] https://curia.europa.eu/jcms/upload/docs/application/pdf/2015-07/cp150074en.pdf
[10] Concentration is a measure of the amount of a pollutant in a defined volume of water, and load is the amount of a substance discharged during a defined period of time.

4.5.1.1 Infrastructure Capacity

Infrastructure capacity is defined in this WCS as the ability of the wastewater infrastructure to collect, transfer and treat wastewater from homes and business. The following objectives are answered in the results section:

- Is there sufficient treatment capacity within existing wastewater infrastructure treatment facilities (WRCs)?
- What new infrastructure is required to provide for the additional wastewater treatment?

4.5.1.2 Environmental Capacity

Environmental capacity is defined in this WCS as the water quality needed in the receiving waterbodies to maintain the aquatic environments. The following objectives are answered in the results section:

- Could development cause deterioration in water quality?
- Could development cause deterioration in WFD status of any element? It is a requirement of the WFD to prevent status deterioration.
- Could development alone prevent the receiving water from achieving its Future Target Status or Potential? Also a requirement of the WFD, which can be separated into the following two objectives:
  - Is the Future Target Status possible now assuming adoption of best available technology? To determine if it is limits in conventional treatment that would prevent the Future Target Status being achieved.
  - Is the Future Target Status technically possible after development and adoption of best available technology? To determine if it is growth that would prevent the Future Target Status being achieved.
- Will development cause deterioration in the River Wensum SAC?

4.5.2 Methodology

4.5.2.1 WRC Headroom Assessment

This assessment is a scoping exercise to determine which WRC will require water quality assessment as a result of housing and employment growth based on how much treatment headroom a WRC has after growth has been considered. It also informs the type and complexity of water quality assessment required.

A WRC flow headroom calculator was developed and used to inform this assessment. The calculator identified which WRC within the study area will receive future growth and what the quantity of growth is in order to determine the additional wastewater flow generated at each WRC; an allowance of 25% for infiltration is applied to all the WRC as advised by AWS and allocated and committed housing from outside the study area which drains to a WRC receiving growth from the GNA area is also accounted for. The remaining permitted flow headroom at each WRC was then calculated. A detailed explanation of this methodology is provided in Appendix C. Results are presented in Section 4.6.

Water quality assessment is required whenever levels of growth (and hence wastewater generation) are significant in relation to the available headroom at a WRC or the sensitivity of the watercourse receiving the treated flows. The water quality assessment determines whether significant growth served by a WRC has the potential to result in water quality impacts on receiving watercourse and is a key tool to determine where WRC treatment upgrades, or new treatment solutions may be required. In the context of the WCS aims, significant growth is defined as being when the future wastewater flows would result in:

- a WRC exceeding its permitted headroom and require a new discharge permit; or,
- a WRC having less than 10% remaining headroom when compared to the DWF permit limit.

WRC which would receive significant growth and discharge to non-tidal waterbodies were identified for water quality modelling (using the River Quality Planning tool [RQP]); additionally, WRC discharging to the Wensum SAC (or upstream tributaries) and which would receive growth were also modelled in RQP, irrespective of the headroom capacity. WRC which discharge to tidal waterbodies or which would receive growth but where the growth is considered not to be significant (greater than 10% residual headroom after growth) have a simpler load standstill calculation undertaken to consider water quality implications. WRC which would receive no growth were scoped out of the assessment. This process is summarised in Table 4-1.

Table 4-1: WRC Headroom Assessment scoping criteria

Scope in for RQP assessment	Scoped in for Load Standstill assessment	Scope Out
WRCs where permitted flow headroom capacity would be exceeded as a result of growth.	WRCs which would have permitted headroom post growth, and greater than 10% residual headroom capacity.	WRC's which would not receive any additional flow as a result of growth.
WRCs where permitted headroom would be less than 10% of the permitted DWF limit as a result of growth.	WRCs which discharge into a tidal waterbody irrespective of headroom.	
WRCs which discharge into the River Wensum SAC (regardless of residual headroom capacity After growth).		

It was agreed with the Environment Agency that smaller WRCs with descriptive permits would only need to be considered for further assessment where additional growth would result in the Population Equivalent (PE) that the WRC treats increasing above 250. Analysis of the likely growth locations in these WRCs has demonstrated that the future PE would not exceed 250 in any location as show in Table 4-2 and these WRC were not considered further in the water quality assessment.

Table 4-2 Future PE estimates for WRC with descriptive permits

WRC	Current PE	Approximate number of new dwellings in catchment	Future PE
Alburgh Church Road	184	31	215
Burston Station Road	55	3	58
Carleton Rode	108	6	131
Forncett St Peter – Low Road	101	91	192
Rushall Harleston Road	20	124	144
Seething Mill Lane	69	9	78
Winfarthing Chapel Close	16	71	87

4.5.2.2 Water Quality Assessment

RQP software was agreed with the Environment Agency as a suitable tool to undertake the required water quality modelling for determining the required discharge permit quality condition for the WRC's which will receive wastewater flows from significant growth, or where they discharge to the River Wensum SAC. There are limitations associated with the RQP software (see Appendix C) and so a stepped methodology of scenario runs was developed to ensure uncertainty which may arise as a result of these limitations is fully understood.

RQP modelling has been performed to check for compliance with the WFD objectives in terms of permit conditions for Ammonia, BOD and Phosphate. This approach follows Environment Agency guidelines and best practice.

The stepped methodology (provided in Appendix C) sets out modelling scenarios which have been developed in line with the water quality assessment objectives listed in Section 4.5.1 and was agreed with the Environment Agency (Appendix C) at the inception meeting. The modelling scenarios undertaken are detailed in Table 4-3.

Table 4-3 Water quality modelling scenarios

Scenario	Description	Objective
Maintain Current Quality	Maintaining the current river quality for the physico-chemical sub-element (determinand) after growth.	A precautionary approach which demonstrates that discharge can be managed to ensure no deterioration beyond current conditions.
10% Deterioration Limit	Limiting deterioration in a waterbody to 10% based on the current river quality for the physico-chemical sub-element (determinand) after growth.	A test requested by the Environment Agency to determine what is required to minimise deterioration **within** WFD status class to protect environmental capacity for future phases of development.
Status Deterioration Limit	Ensuring no deterioration from the current WFD status for the sub-element (determinand) after growth.	Aligns with the WFD policy requirement 'development must not cause a deterioration in WFD status'.
Future Target Status	Where a Future Target WFD Status has been set for the sub-element and is not currently being achieved by the waterbody.	Aligns with the WFD policy requirement 'development must not prevent a waterbody from achieving its Future Target Status'.

Where Load Standstill calculations have been used, these consider a single test of maintaining current quality by not increasing overall pollutant load.

4.5.2.3 WRC Infrastructure Requirements

AWS' Business Plan for AMP7 outlines their investment programme from April 2020 to 2025. AWS' approach to wastewater treatment asset management requires that sufficient certainty is given that the quantum of development proposed by local planning authorities within Local Plans will come forward during the plan period before improvements to WRC assets can be justified and funding sought.

Development information provided in this WCS represents the first stage in providing the most up to date plans for future development coming forward in the plan period. These can be used by AWS to inform the next Business Plan (2024) and investment programme (AMP8) as well as future programmes (AMP9 and AMP10) to ensure the provision of additional capacity is planned and development is not delayed. Once funding has been confirmed, there will be a lead-in time for the necessary upgrades to be completed. AWS are currently producing Drainage and Wastewater Management Plans (DWMP) and the conclusions of this WCS will be key to informing future investment decisions supported by the DWMPs.

Potential upgrade requirements have been identified following the headroom and water quality assessments and are provided in Section 4.7.

4.5.3 Assessment Results

The results for each WRC assessment 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 4-2.

- **Green** – WFD and/or HD objectives will not be adversely affected. Growth can be accepted with no significant changes to the WRC infrastructure or permit required.
- **Amber** – in order to meet WFD and/or HD objectives, changes to the discharge permit are required, and upgrades may be required to WRC infrastructure which may have phasing implications;
- **Red** - in order to meet WFD and/or HD 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.

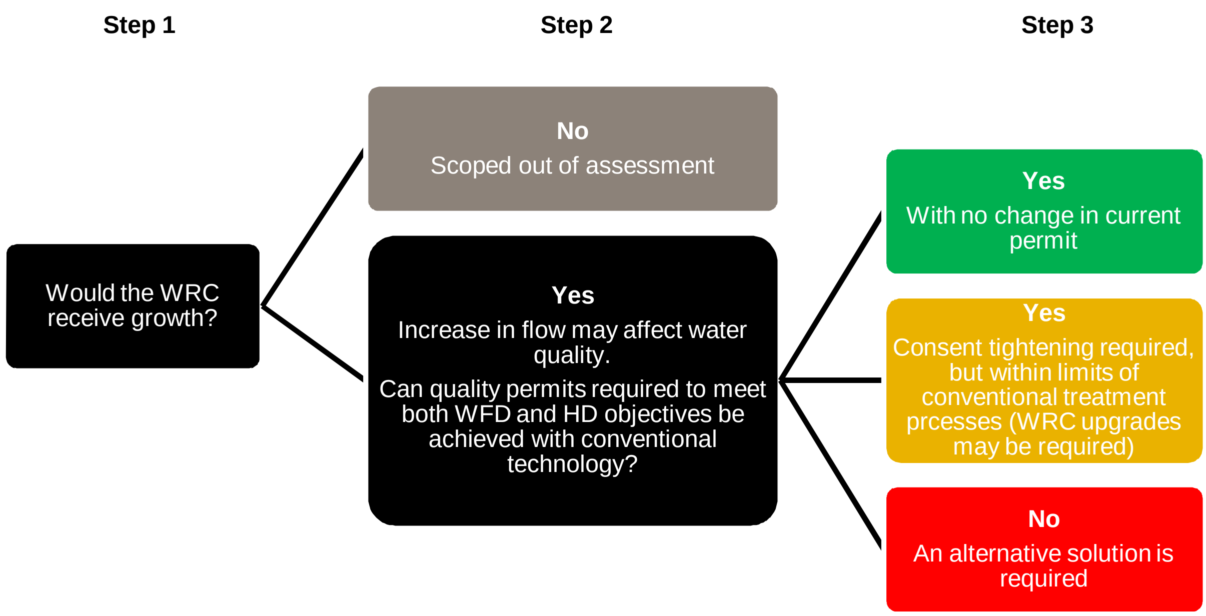


Figure 4-2 RAG Assessment process diagram for infrastructure capacity

4.6 WRC Headroom Assessment

The volume of wastewater, measured as DWF, which would be generated from the proposed housing and employment growth over the plan period within each WRC catchment has been calculated and assessed against the permitted flow headroom capacity at each WRC which has a numerical permit; this includes growth from neighbouring authorities which would likely drain wastewater to WRCs affected by growth in the GNA. A summary of the assessment conclusion is provided in Table 4-4.   This table also sets out the water quality assessment which was required as a result of the headroom capacity assessment.

Table 4-4 WRC headroom capacity assessment for facilities with a numerical permit[11]

Growth Assessment			Headroom Assessment							
Water Recycling Centres (WRCs)	GNA Dwelling Numbers Assumptions	Neighbouring Authority Dwelling Assumption	DWF Permitted flow (m^3/d)	Measured DWF (Q80)[12] (m^3/d)	Headroom Capacity pre-growth (m^3/d)	Additional flow from growth[13] (m^3/d)	Post growth DWF estimate (m^3/d)	Headroom Capacity post-growth (m^3/d)	Percentage capacity after growth[14]	Outcome
Barford Chapel Street	15	-	127	99	28	5	104	23	18%	Available permitted headroom, and growth not significant (residual post growth headroom greater than 10% of current DWF limit): **Load Standstill calculations required**
Belaugh	230	109	2,273	1,874	399	74	1,948	325	14%	
Diss	836	43	4,032	2,154	1,878	284	2,438	1,594	40%	
Earsham-Bungay Rd	42	-	195	130	65	14	144	51	26%	
Ellingham-Braces Lane	64	-	199	149	50	21	170	29	15%	
Forncett (Forncett End)	70	-	350	268	82	23	291	59	17%	
Harleston	735	-	1,392	868	524	237	1,105	287	21%	
Hempnall (Fritton Rd)	153	-	478	247	231	49	296	182	38%	
Norton Subcourse	44	-	170	109	61	14	123	47	28%	
Pulham St Mary	91	-	310	174	136	29	203	107	34%	
Rackheath	231	-	260	56	204	75	131	129	50%	
Reedham	70	-	224	100	124	23	123	101	45%	
Sisland	759	-	1,600	1,008	592	245	1,253	347	22%	

[11] Approximately 410 of the assessed total dwellings could not be allocated to a WRC catchment owing to the uncertainty of exact site location – in these cases, development could potentially drain to on of three WRC and as such, a reasonable estimate of which WRC would be affected could not be determined.
[12] Data provided by Anglian Water Services
[13] Includes allowance for employment growth (16l/h/d), infiltration (25%) and an assumed consumption rate of 125 l/h/d and 2038 occupancy rate for domestic property
[14] As a percentage of the permitted DWF

Growth Assessment			Headroom Assessment							
Water Recycling Centres (WRCs)	GNA Dwelling Numbers Assumptions	Neighbouring Authority Dwelling Assumption	DWF Permitted flow (m^3/d)	Measured DWF (Q80)[12] (m^3/d)	Headroom Capacity pre-growth (m^3/d)	Additional flow from growth[13] (m^3/d)	Post growth DWF estimate (m^3/d)	Headroom Capacity post-growth (m^3/d)	Percentage capacity after growth[14]	Outcome
Stoke Holy Cross	19	-	341	261	80	6	267	74	22%	
Swardeston Common	259	-	1,100	668	432	84	752	348	32%	
Cantley	4	-	110	99	11	1	100	10	9%	Available permitted headroom, but growth is significant (Less than 10% residual headroom after growth): **RQP modelling required**
Saxlingham	206	-	530	458	72	67	525	5	1%	
Acle	544	-	900	758	142	181	939	-39	Capacity Exceeded	Growth is significant, but discharge to a tidal waterbody **Load Standstill calculations required**
Freethorpe	61	-	200	174	26	20	194	6	3%	
Aylsham	763	23	1,440	1,387	53	274	1,661	-221	Capacity Exceeded	Insufficient headroom (significant growth): **RQP modelling required**
Barnham Broom	67	-	158	144	14	22	166	-8	Capacity Exceeded	
Beccles	91	306	2,000	1,950	50	128	2,078	-78	Capacity Exceeded	
Ditchingham	56	-	280	286	Capacity Exceeded	18	304	-24	Capacity Exceeded	
Long Stratton	1,913	-	1,200	750	450	618	1,368	-168	Capacity Exceeded	
Whitlingham Trowse	33,517	-	66,250	63,756	2,494	11,249	75,005	-8,755	Capacity Exceeded	
Woodton	68	-	176	176	No capacity	22	198	-22	Capacity Exceeded	

Growth Assessment			Headroom Assessment							
Water Recycling Centres (WRCs)	**GNA Dwelling Numbers Assumptions**	**Neighbouring Authority Dwelling Assumption**	**DWF Permitted flow (m^3/d)**	**Measured DWF (Q80)[12] (m^3/d)**	**Headroom Capacity pre-growth (m^3/d)**	**Additional flow from growth[13] (m^3/d)**	**Post growth DWF estimate (m^3/d)**	**Headroom Capacity post-growth (m^3/d)**	**Percentage capacity after growth[14]**	**Outcome**
Wymondham	2,356	-	4,400	3,991	409	761	4,752	-352	Capacity Exceeded	
Foulsham-Station Rd	26	-	299	190	109	14	204	95	32%	Available permitted headroom and growth not significant, but discharge to Wensum SAC **RQP modelling required**
Reepham (Norfolk)	270	-	1,000	780	220	115	895	105	10%	

4.7 RQP Water Quality Assessment

A summary of the results from the water quality assessment using RQP are included in the following report sections for each of the WRCs which were modelled. This includes a summary of the likely impact on water quality and any requirement for a new discharge permit. A summary of likely implications, including whether there might be phasing considerations or need for new wastewater treatment infrastructure to facilitate these permit requirements is included in section 4.10.

4.7.1 Aylsham WRC

4.7.1.1 Receiving Watercourse

The Bure (Scarrow Beck to Horstead Mill) waterbody (GB105034050932) receives treated effluent from Aylsham WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided Table 4-5. Because the current element status are High, the objective for 2027 is to remain as High.

Table 4-5 Physico-chemical elements Classification for Bure (Scarrow Beck to Horstead Mill) waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
BOD	High	High	N/A
Phosphate	High	High	N/A

4.7.1.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-6. A green value denotes no change would be required to the current permit limit for that scenario, an orange value denotes a change in permit limit would be required for that scenario, and a red value denotes that a change would be required for that scenario, but the change would not be achievable within the current limits of conventional treatment.

Table 4-6 Required permit quality conditions for Aylsham WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**5**	**2.62**	**3.31**	**19.44**	N/A – not less than good
BOD (mg/l 95%ile)	**High**	**40**	**4.52**	**18.01**	**178.68**	N/A – not less than good
Phosphate (mg/l annual average)	**High**	**0.6**	**0.53**	**0.78**	**0.63**	N/A – not less than good

Aylsham WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the quality standards (compared to the current permit conditions) to ensure there was no deterioration in the River Bure as a result of the additional treated discharge.

These changes are possible within the limits of conventional treatment for ammonia and phosphate. For BOD, monitoring data shows the WRC is currently discharging at a quality beyond what is theoretically achievable with conventional treatment (4.23 mg/l) and modelling confirms that a permit similar to this value and hence below the limit of conventional treatment (5 mg/l) would be required to ensure no change in water quality at mixing point. However, modelling has shown that a permit value of 5 mg/l would be sufficient to prevent WFD deterioration and would not result in a waterbody level deterioration compared to the current discharge. It would be possible to set a new permit that ensures no deterioration in the current quality of the Bure as a result of future Aylsham WRC discharges.

This means there is a solution to ensure that growth at the WRC would not impact on downstream water dependent designated sites. The analysis also shows that the WFD status of the river would be unlikely to be impacted, even if no changes to the permit quality conditions were implemented. This is a result of the relatively small discharge flow from the WRC compared to the large river flow in the Bure at the point of discharge.

4.7.2 Barnham Broom WRC

4.7.2.1 Receiving Watercourse

The Yare (u/s confluence with Tiffey - Lower) waterbody (GB105034051290) receives treated effluent from Barnham Broom WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided in Table 4-7. Because the current element status' are either High or Good, the objective for 2027 is to remain as High or Good for these elements.

Table 4-7 Physico-chemical elements Classification for the Yare (u/s confluence with Tiffey – Lower) waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Good	Good	N/A

4.7.2.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-8.

Table 4-8 Required permit quality conditions for Barnham Broom WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**30**	10.47	14.9	29.16	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**40**	9.36	56.87	319.20	N/A – not less than good
Phosphate (mg/l annual average)	**Good**	N/A	5.24	6.53	This test could not be carried out[15]	N/A – not less than good

Barnham Broom WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the quality standards for BOD and ammonia (compared to the current permit conditions) and for phosphate, a new limit may be required to ensure there was no deterioration in the Yare as a result of the additional treated discharge.

These changes are possible within the limits of conventional treatment for all parameters assessed, and it would be possible to set a new permit that ensures no deterioration in the current quality of the Yare as a result of future Barnham Brook WRC discharges. This means there is a solution to ensure that growth at the WRC would not

[15] EA data shows upstream measured mean water quality in this waterbody is already worse than good - Published status is good, but measured data shows river is moderate.

impact on downstream water dependent designated sites. The analysis also shows that the WFD status of the river would be unlikely to be impacted, even if no changes to the permit quality conditions were implemented. This is a result of the relatively small discharge flow from the WRC compared to the large river flow in the Yare at the point of discharge.

4.7.3 Beccles WRC

4.7.3.1 Receiving Watercourse

The River Waveney (Ellingham Mill - Burgh St. Peter) waterbody (GB105034045903) receives treated effluent from Beccles WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided in Table 4-9.

Phosphate is currently not achieving the minimum requirement of good status. The two reasons for not achieving good status (RNAG) are poor livestock management and continuous sewage discharges. The future objective status for phosphate remains as moderate with the reasons why summarised in Table 4-9.

Table 4-9 Physico-chemical elements Classification for the Waveney (Ellingham Mill – Burgh St. Peter) waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Moderate	Moderate	No known technical solution is available

4.7.3.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-10.

Table 4-10 Required permit quality conditions for Beccles WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**20**	6.55	7.67	9.93	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**40**	10.81	32.53	56.28	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	**2**	0.64	1.2	6.98	N/A – Target status is Moderate

Beccles WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the quality standards for all parameters (compared to the current permit conditions) to ensure there was no deterioration in the River Waveney as a result of the additional treated discharge.

These changes are possible within the limits of conventional treatment for all parameters assessed, and it would be possible to set a new permit that ensures no deterioration in the current quality of the Waveney as a result of future Beccles WRC discharges. This means there is a solution to ensure that growth at the WRC would not impact on downstream water dependent designated sites.

4.7.4 Cantley WRC

4.7.4.1 Receiving Watercourse

The Yare (Wensum to tidal) waterbody (GB105034051370) receives treated effluent from Cantley WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided in Table 4-11.

Phosphate is currently not achieving the minimum requirement of good status. The RNAG are: poor livestock management, poor nutrient management (agriculture and rural land management), transport drainage and, continuous sewage discharges. The future objective status for phosphate remains as moderate with the reasons why summarised in Table 4-11.

Table 4-11 Physico-chemical elements Classification for the Yare (Wensum to tidal) waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
BOD	High	High	N/A
Phosphate	Moderate	Moderate	No known technical solution is available

4.7.4.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-12.

Table 4-12 Required permit quality conditions for Cantley WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**-**	**452.55**	**559.16**	**1671**	N/A – not less than good
BOD (mg/l 95%ile)	**High**	**45**	**95.29**	**1358.10**	**6442.3**	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	**-**	**0.6**	**41.82**	**289.16**	N/A – Target status is Moderate

Growth within the Cantley WRC catchment up to 2038 would not result in the current permitted flow volume being exceeded; however, it would result in a small remaining headroom (less than 10%) and so modelling has been undertaken to determine if changes to the current permit quality limits may be required to manage the water quality impact of growth.

The modelling has shown that the new permit would potentially need a phosphate limit to be applied (no limit currently), to ensure there is no change in phosphate loading as a result of growth. The required permit would be achievable within the limits of conventional treatment. No change to the BOD limit would be required and whilst there is currently no ammonia limit, modelling has shown that a limit on ammonia would unlikely be needed as a result of growth. The analysis also shows that the WFD status of the river would unlikely be impacted, even if no changes to the permit quality conditions were implemented.

The assessment has shown that changes that may be required are possible within the limits of conventional treatment for all parameters assessed, and that it if required, it would be possible to set a new permit that ensures no deterioration in the current quality of the Yare as a result of future Cantley WRC discharges. This means there is a solution to ensure that growth at the WRC would not impact on downstream water dependent designated sites.

4.7.5 Ditchingham WRC

4.7.5.1 Receiving Watercourse

The Broome Beck waterbody (GB105034045930) receives treated effluent from Ditchingham WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided Table 4-13.

Phosphate is currently not achieving the minimum requirement of good status. The RNAG are: poor soil and nutrient management (agriculture and rural land management), and continuous sewage discharges. The future objective status for phosphate remains as moderate with the reasons why summarised in Table 4-13.

Table 4-13 Physico-chemical elements Classification for Broome Beck waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Moderate	Moderate	No known technical solution is available

4.7.5.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-14.

Table 4-14 Required permit quality conditions for Ditchingham WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**8.7**	3.14	4.17	8.03	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**20**	4.07	13.37	76.6	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	**1**	0.73	1.35	2	N/A – Target status is Moderate

Ditchingham WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the quality standards for all parameters to ensure there was no deterioration in the Broome Beck as a result of the additional treated discharge. These changes are possible within the limits of conventional treatment for ammonia and phosphate.

For BOD, monitoring data shows the WRC is currently discharging at a quality beyond what is theoretically achievable with conventional treatment (4.09 mg/l) and modelling confirms that a permit similar to this value and hence below the limit of conventional treatment (5 mg/l) would be required to ensure no change in water quality at mixing point. However, modelling has shown that a permit value of 5 mg/l would be sufficient to prevent WFD deterioration and would not result in a waterbody level deterioration compared to the current discharge. It would therefore be possible to set a new permit that ensures no deterioration in the current quality of the Broome Beck as a result of future WRC discharges.

The analysis also shows that the WFD status of the river would be unlikely to be impacted, even if no changes to the permit quality conditions were implemented for BOD and phosphate and only a minor improvement for ammonia.

4.7.6 Foulsham WRC

4.7.6.1 Receiving Watercourse

The Foulsham Tributary waterbody (GB105034055850) receives treated effluent from Foulsham WRC and currently has an overall 2019 waterbody status of moderate. The Foulsham Tributary discharges into the River Wensum SAC downstream. The 2019 status of the physico-chemical elements for the Foulsham Tributary considered in this assessment are provided in Table 4-15.

Phosphate is currently not achieving the minimum requirement of good status. There is no RNAG information currently available related to phosphate because the status change is recent at the time of assessment, moving from a constant classification of good between 2014 and 2018. The future objective status for phosphate will be to improve to good.

Table 4-15 Physico-chemical elements Classification for Foulsham Tributary waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Moderate	Good	N/A

4.7.6.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-16.

Table 4-16 Required permit quality conditions for Foulsham WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**-**	2.24	3.09	6.83	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**40**	6.3	12.63	60.4	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	**1**	0.81	1.06	0.61	0.61

The Foulsham WRC catchment would not receive a large amount of growth (approximately 20 dwellings) and post growth capacity of the WRC would be relatively unaffected (greater than 10% of the permitted DWF); however, RQP modelling has been completed for the WRC because it discharges into a tributary of the River Wensum SAC.

In relation to no deterioration, there may be a need for improvements to the quality standards for BOD and phosphate, and a new limit for Ammonia (currently there is no limit) may be required to ensure there was no deterioration in the Foulsham Tributary as a result of the additional treated discharge. Modelling has also shown that future WFD status target of Good for phosphate can be achieved for the watercourse once growth has been considered with changes to the phosphate permit limit and a new ammonia limit; no change in BOD limits would be required.

The assessment has shown that changes are possible within the limits of conventional treatment for all parameters assessed, and that it would be possible to alter the permit to ensure no deterioration in the current quality of the tributary as a result of future Foulsham WRC discharges.

An assessment of targets required for the Wensum SAC are discussed in section 4.9 (wastewater ecological appraisal).

4.7.7 Long Stratton WRC

4.7.7.1 Receiving Watercourse

The Hempnall Beck (GB105034045720) receives treated effluent from Long Stratton WRC and currently has an overall 2019 waterbody status of poor. The 2019 status of the physico-chemical elements considered in this assessment are provided Table 4-17.

Phosphate is currently not achieving the minimum requirement of good status. The RNAG are: poor livestock management, poor nutrient management (agriculture and rural land management), and continuous sewage discharges. The future objective status for phosphate remains as poor with the reasons why summarised in Table 4-17.

Table 4-17 Physico-chemical elements Classification for Hempnall Beck waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Poor	Poor	No known technical solution is available

4.7.7.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-18.

Table 4-18: Required permit quality conditions for Long Stratton WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**1**	2.47	2.72	0.46	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**20**	6.69	7.36	6.35	N/A – not less than good
Phosphate (mg/l annual average)	**Poor[16]**	**1**	0.76	0.84	**0.22 (uses EA target of moderate[16])**	Moderate target status cannot be achieved with or without growth

Long Stratton WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the permit limits for BOD and phosphate to ensure there was no deterioration in the Hempnall Beck as a result of the additional treated discharge; no changes to the ammonia limit would be required. The changes are possible within the limits of conventional treatment, and it would be possible to set a new permit that ensures no deterioration in the current quality of the Hempnall Brook as a result of future Long Stratton WRC discharges.

Modelling has also been undertaken to understand if the high WFD status of the Beck for ammonia can be achieved at the mixing point of the discharge. This modelling shows that it would not be possible to achieve this status at this point in the watercourse once growth has been considered within the limits of conventional treatment. However, model runs demonstrate that this would also not be possible with the current volume of discharge (requiring a permit limit of 0.47 mg/l 95 percentile) which demonstrates that growth is not a factor in the waterbody not achieving high for ammonia at mixing point. Despite the findings of the modelling, the overall

[16] Although the 2019 status was updated to Poor from Moderate in November 2020, the assessment has used Moderate to reflect current phosphate data as requested by the Environment Agency

status of the waterbody for ammonia is High, which suggests that the mixing point quality is not a concern for the overall waterbody classification and that maintaining the current mixing point quality after growth is sufficient to ensure no deterioration in current river WFD status for ammonia.

Modelling has also been undertaken to determine if moderate status can be achieved for phosphate at the mixing point of the discharge (the current 2019 status is poor). This modelling shows that it would not be possible to achieve this status at this point in the watercourse once growth has been considered within the limits of conventional treatment. However, model runs demonstrate that this would also not be possible with the current volume of discharge (requiring a permit limit of 0.23 mg/l mean) which demonstrates that growth is not a factor in the waterbody not being able to achieve moderate for phosphate at mixing point. The overall status of the waterbody for phosphate is poor (2019) and modelling shows it is not possible to achieve moderate with current discharge volumes and this is reflected in the current future status for phosphate remaining as poor.

Maintaining the current mixing point quality after growth is sufficient to ensure no deterioration in current river quality and therefore growth is achievable.

4.7.8 Reepham WRC

4.7.8.1 Receiving Watercourse

The Blackwater Drain (Wensum) waterbody (GB105034051120) receives treated effluent from Reepham WRC and currently has an overall 2019 waterbody status of moderate. The Blackwater Drain is a tributary of the River Wensum SAC downstream. The 2019 status of the physico-chemical elements for the Blackwater Drain considered in this assessment are provided Table 4-19. Because the current element status are High, the objective for 2027 is to remain as High.

Table 4-19 Physico-chemical elements Classification for Blackwater Drain waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	High	High	N/A

4.7.8.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-20.

Table 4-20 Required permit quality conditions for Reepham WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**10**	4.35	4.86	1.51	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**30**	12.36	14.92	20.43	N/A – not less than good
Phosphate (mg/l annual average)	**High**	**1**	0.59	0.69	**0.24**	N/A – not less than good

Reepham WRC would not exceed its permitted flow once all growth in the catchment is delivered to 2038 and post growth capacity of the WRC would still be greater than 10% of the permitted DWF; however, RQP modelling has been completed for the WRC because it discharges into a tributary of the River Wensum SAC.

In relation to the no deterioration assessment, there may be a need for improvements to the quality standards for all parameters assessed to ensure there was no deterioration in the Blackwater Drain as a result of the additional treated discharge. The changes are all within the limtis of conventional treatment demonstrating that growth can be achieved without impacting on current water quality in the Blackwater Drain.

Further modelling has also shown that the current WFD status can be achieved for ammonia and BOD; however, the target of high for phosphate cannot be achieved for the watercourse at the point of mixing once growth has been considered. This result is not considered to be significant for the following reasons:

- A new permit limit of 0.59 mg/l (mean) which is achievable within the limits of conventional treatment would ensure that growth has no change in mixing point quality compared to the current discharge. Because the current discharge does not affect overall high status for phosphate in the WFD waterbody, then a future discharge based on this new permit level would also ensure high status can be achieved.
- The theoretical permit limit required is only marginally below the limit of conventional treatment for phosphate (0.25 mg/l mean). The RQP modelling method is conservative, as it only considers mixing point quality and it is likely that a limit of 0.25mg/l (or less stringent) would adequately achieve high status when the waterbody is considered as a whole.
- Modelling of the current discharge volumes show a limit of 0.27 mg/l (mean) would be required, suggesting growth (requiring 0.24 mg/l mean) makes little difference. The current mean discharge quality for Reepham is 0.65 mg/l, which is worse than the modelled required limit but still ensures high status of the waterbody.

An assessment of targets required for the SAC are discussed in section 4.9 (wastewater ecological appraisal).

4.7.9 Saxlingham WRC

4.7.9.1 Receiving Watercourse

The Tas (Tasburgh to R. Yare) (GB105034051230) receives treated effluent from Saxlingham WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided in Table 4-21.

Phosphate is currently not achieving the minimum requirement of good status. The RNAG are: poor livestock management, poor soil management (agriculture and rural land management), and continuous sewage discharges. The future objective status for phosphate remains as moderate with the reasons why summarised in Table 4-21.

Table 4-21 Physico-chemical elements Classification for The Tas (Tasburg to R.Yare) waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Moderate	Moderate	No known technical solution is available

4.7.9.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-22.

Table 4-22 Required permit quality conditions for Saxlingham WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**13**	**3.17**	**3.51**	**1.06**	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**25**	**8.98**	**10.34**	**14.37**	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	**-**	**5.13**	**5.68**	**0.18**	Moderate target status cannot be achieved with or without growth

Saxlingham WRC's flow permit would not be exceeded once all the growth within its catchment is delivered by 2038; however, residual headroom would be small (less than 10%) and so water quality modelling has been undertaken to determine if changes are required to the current permit quality limits to protect water quality of the Tas.

Modelling has shown that changes to the permit would likely be required in terms of improvements to the permit limits for BOD and phosphate and the introduction of a phosphate limit to ensure there was no deterioration in the Tas as a result of the additional treated discharge. The changes are possible within the limits of conventional treatment, and it would be possible to set new permit limits that ensure no deterioration in the current quality of the Tas as a result of future Saxlingham WRC discharges.

Modelling has also been undertaken to understand if the moderate WFD status of the Tas for phosphate can be achieved at the mixing point of the discharge. This modelling shows that it would not be possible to achieve this status at this point in the watercourse once growth has been considered within the limits of conventional treatment. However, model runs demonstrate that this would also not be possible with the current volume of discharge (requiring a permit limit of 0.19 mg/, mean) which demonstrates that growth is not a factor in the waterbody not achieving moderate for phosphate at mixing point. Maintaining the current mixing point quality after growth is sufficient to ensure no deterioration in current river quality.

4.7.10 Whitlingham Trowse WRC

4.7.10.1 Receiving Watercourse

The Yare (Wensum to tidal) waterbody (GB105034051370) receives treated effluent from Whitlingham Trowse WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided Table 4-23.

Phosphate is currently not achieving the minimum requirement of good status. The RNAG are: poor livestock management, poor nutrient management (agriculture and rural land management), transport drainage and, continuous sewage discharges. The future objective status for phosphate remains as moderate with the reasons why summarised in Table 4-23.

Table 4-23 Physico-chemical elements Classification for the Yare (Wensum to tidal) waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
BOD	High	High	N/A
Phosphate	Moderate	Moderate	No known technical solution is available

4.7.10.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-24.

Table 4-24: Required permit quality conditions for Whitlingham Trowse WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**7**	1.42	1.63	1.1	N/A – not less than good
BOD (mg/l 95%ile)	**High**	**20**	6.63	8.01	10.75	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	**1**	0.69	0.82	0.62	N/A – future target is moderate

The large majority of the GNLP growth would drain to Whitlingham Trowse WRC. As a result, the flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the quality limits for all parameters to ensure there was no deterioration in the Yare (and WFD status maintained) as a result of the additional treated discharge.

These changes are possible within the limits of conventional treatment for all parameters assessed, and it would be possible to set a new permit that ensures no deterioration in the current quality of the Yare as a result of future Ditchingham WRC discharges. This means there is a solution to ensure that growth at the WRC would not impact on downstream water dependent designated sites.

4.7.11 Woodton WRC

4.7.11.1 Receiving Watercourse

The Broome Beck waterbody (GB105034045930) receives treated effluent from Woodton WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided in Table 4-25.

Phosphate is currently not achieving the minimum requirement of good status. The RNAG are: poor soil and nutrient management (agriculture and rural land management) and continuous sewage discharges. The future objective status for phosphate remains as moderate with the reasons why summarised in Table 4-11.

Table 4-25 Physico-chemical elements Classification for Broome Beck waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	High	High	N/A
Phosphate	Moderate	Moderate	No known technical solution is available

4.7.11.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-26.

Table 4-26 Required permit quality conditions for Woodton WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**High**	**10**	1.83	2.57	5.55	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**33**	4.58	9.92	50.43	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**	-	3.8	4.4	3.04	N/A – future target is moderate

Woodton WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the quality standards for all parameters to ensure there was no deterioration in the Broome Beck as a result of the additional treated discharge.

These changes are possible within the limits of conventional treatment for ammonia and phosphate. For BOD, monitoring data shows the WRC is currently discharging at a quality beyond what is theoretically achievable with conventional treatment (4.93 mg/l) and modelling confirms that a permit similar to this value and hence below the limit of conventional treatment (5 mg/l) would be required to ensure no change in water quality at mixing point. However, modelling has shown that a permit value of 5 mg/l would be sufficient to prevent WFD deterioration and would not result in a waterbody level deterioration compared to the current discharge. Therefore it would be possible to set a new permit that ensures no deterioration in the current quality of the Broome Beck as a result of future Woodton WRC discharges. This means there is a solution to ensure that growth at the WRC would not impact on downstream water dependent designated sites.

4.7.12 Wymondham WRC

4.7.12.1 Receiving Watercourse

The Tiffey (GB105034051282) receives treated effluent from Wymondham WRC and currently has an overall 2019 waterbody status of moderate. The 2019 status of the physico-chemical elements considered in this assessment are provided Table 4-27.

Phosphate is currently not achieving the minimum requirement of good status. There is no RNAG information currently available related to phosphate because the status change is recent at the time of assessment, moving from a constant classification of good between 2015 and 2018. The future objective status for phosphate will be to improve to good.

Table 4-27 Physico-chemical elements Classification for the Tiffey waterbody

Classification Element	Current Status (2019)	Future Objective	Reason for Objective less than good
Ammonia	Good	Good	N/A
Phosphate	Moderate	Good	N/A

4.7.12.2 Revised Permit Conditions – Modelling Results

The revised discharge permit required by the end of the plan period for each determinant and for each modelled scenario are presented in Table 4-28.

Table 4-28 Required permit quality conditions for Wymondham WRC throughout the plan period

Determinant	2019 element status	Current permit quality limit (mg/l)	Future permit quality limit required (mg/l)			
			Maintain current mixing point quality	Limit mixing point deterioration to 10%	No deterioration in 2019 WFD element status at mixing point	Achieve future WFD target status (where 2019 status is less than good)
Ammonia (mg/l 95%ile)	**Good**	**1**	**1.55**	**1.73**	**1.06**	N/A – not less than good
BOD (mg/l 95%ile)	**N/A**	**12**	**4.92**	**5.83**	**12.89**	N/A – not less than good
Phosphate (mg/l annual average)	**Moderate**[17]	**0.8**	0.6	0.69	**0.1 (uses EA target of good)**	Good status not achievable with or without growth

Wymondham WRC's flow permit would be exceeded once all the growth within its catchment is delivered by 2038 and a new permit would be required. Water quality modelling has shown that the new permit would require improvements to the permit limits for all parameters to ensure there was no deterioration in the Tiffey as a result of the additional treated discharge. The changes are possible within the limits of conventional treatment for ammonia and phosphate. For BOD, modelling has shown a permit slightly below the limit of conventional treatment (5mg/l) would be required, however modelling has also shown that a permit condition of 5mg/l would be sufficient to prevent WFD deterioration and ensure no change in the overall WFD waterbody quality. Therefore, it would be possible to set a new permit that ensures no deterioration in the current quality of the Tiffey as a result of future Wymondham WRC discharges.

Modelling has also been undertaken to determine if Good status can be achieved for phosphate at the mixing point of the discharge (the current 2019 status is moderate). This modelling shows that it would not be possible to achieve this status at this point in the watercourse once growth has been considered within the limits of conventional treatment. However, model runs demonstrate that this would also not be possible with the current volume of discharge (requiring the same permit limit of 0.1 mg/l mean) which demonstrates that growth is not a factor in the waterbody not being able to achieve good for phosphate at mixing point.

4.8 Load Standstill Results

For the WRCs which have been identified as remaining within their permitted flow headroom after accepting all the proposed growth, and the growth is not classed as significant growth, load standstill calculations have been used to determine the future permit conditions for BOD, Ammonia and Phosphate. Load standstill calculations have also been used for Freethorpe WRC as it discharges to a tidal water body.

A summary of the Load Standstill calculations are provided in Table 4-29. The Load Standstill results show that there may be a need for improvements to the quality standards for all parameters at WRC where growth is not significant to ensure there is no deterioration in the receiving watercourses. However, the assessment has shown that these changes are possible within the limits of conventional treatment for all parameters assessed and for all WRC, and that it would be possible to alter the permits to ensure no deterioration in the current quality of the watercourses as a result of future WRC discharges. This means there is are solutions to ensure that growth at these WRCs would not impact on downstream water dependent designated sites.

[17] Although the 2019 status was updated to Moderate from Good in November 2020, the assessment has used Good to reflect current phosphate data as requested by the Environment Agency

Table 4-29 Summary of BOD, Ammonia and Phosphate Load Standstill calculations for WRCs

	Acle-Damgate Lane	Barford-Chapel Street	Belaugh	Diss	Earsham-Bungay Road	Ellingham-Braces Lane	Forncett-Forncett End	Freethorpe
Waterbody	Bure and Thurne	Yare	Bure	River Waveney	River Waveney	River Waveney	Tas	The Fleet
Current BOD Limit of Conventional Treatment (mg/l)	5	5	5	5	5	5	5	5
Current Ammonia Limit of Conventional Treatment (mg/l)	1	1	1	1	1	1	1	1
Current Phosphate Limit of Conventional Treatment (mg/l)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Current DWF Permit (m3/day)	900	127	2,273	4,032	195	199	350	200
Measured flow Q80 (m^3/day)	**758**	**99**	**1,874**	**2,154**	**130**	**149**	**268**	**174**
Current DWF capacity (m^3/day)	**142**	**28**	**399**	**1,878**	**65**	**50**	**82**	**26**
BOD Permit limits (95% percentile)	35	50	30	12	35	40	20	40
Ammonia Permit Limits (95% percentile)	14	25	10	5	20	-	15	15
Phosphate Permit Limits (95% percentile)	-	-	1	2	-	1	-	1
Permit exceeded?	Yes (tidal discharge)	No	No	No	No	No	No	No (tidal discharge)
Discharge Permit required								
Future DWF (m^3/day)	**939**	**104**	**1,948**	**2,438**	**144**	**170**	**291**	**194**
Effluent Quality permit required for BOD	**28.3**	**47.6**	**28.9**	**10.6**	**31.6**	**35.1**	**18.4**	**35.9**
Effluent Quality permit required for Ammonia	**11.3**	**23.8**	**9.6**	**4.4**	**18.1**	**-**	**13.8**	**13.5**
Effluent Quality permit required for Phosphate	-	-	**0.96**	**1.77**	-	**0.88**	-	**0.9**

	Harleston	Hempnall-Fritton Road	Norton Subcourse	Pulham St Mary	Rackheath	Reedham	Sisland	Stoke Holy Cross	Swardeston-Common
Waterbody	Starston Brook	Hempnall Beck	River Chet	Starston Brook	Spixworth Beck	Blackwater Drain	River Chet	Tas	Intwood Stream
Current BOD Limit of Conventional Treatment (mg/l)	5	5	5	5	5	5	5	5	5
Current Ammonia Limit of Conventional Treatment (mg/l)	1	1	1	1	1	1	1	1	1
Current Phosphate Limit of Conventional Treatment (mg/l)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Current DWF Permit (m3/day)	1,392	478	170	310	260	224	1,600	341	1,100
Measured flow Q90 (m^3/day)	**868**	**247**	**109**	**174**	**56**	**100**	**1,008**	**261**	**668**
Current DWF capacity (m3/day)	**524**	**231**	**61**	**136**	**204**	**124**	**592**	**80**	**432**
BOD Permit limits (95% percentile)	17	9	30	15	10	40	20	50	15
Ammonia Permit Limits (95% percentile)	5	4	20	5	14	-	5	-	5
Phosphate Permit Limits (95% percentile)	1	-	-	-	2	-	1	-	-
Permit exceeded?	No	No	No	No	No	No	No	No	No
Discharge Permit required									
Future DWF (m^3/day)	**1,105**	**296**	**123**	**203**	**131**	**123**	**1,253**	**267**	**752**
Effluent Quality permit required for BOD	**13.4**	**7.5**	**26.6**	**12.9**	**4.3**	**32.5**	**16.4**	**48.9**	**13.3**
Effluent Quality permit required for Ammonia	**3.9**	**3.3**	**17.7**	**4.3**	**6**	-	**4**	-	**4.4**
Effluent Quality permit required for Phosphate	**0.79**	-	-	-	**0.85**	-	**0.8**	-	-

Key to "Effluent Quality Required": 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

4.9 Wastewater - Ecological Appraisal

This section discusses the potential impacts of wastewater discharges (and associated changes in water quality) on internationally and nationally designated water dependent habitats in the GNA.

4.9.1 Water quality and ecology

Elevated BOD in treated effluent can result in lower oxygen levels when discharged to freshwater habitats; in turn this can result in death to organisms and habitat degradation[18]. BOD is not relevant to terrestrial habitats.

Ammonia is directly toxic to aquatic organisms in freshwater environments. Low levels of exposure to ammonia may result in reduced growth rates, fecundity and fertility, increase stress and susceptibility to bacterial infections and diseases in fish. Higher levels of exposure can cause fish to increase respiratory activity thus increasing oxygen uptake and increased heart rate. It can also lead to tissue damage, lethargy, convulsions, coma and death[19]. Ammonia itself does not interact with terrestrial habitats.

Nitrification of ammonia results in increased nitrogen in freshwater environments. Nitrogen is a growth-limiting nutrient in terrestrial and marine environments, although generally not in freshwater. Elevated levels of nitrogen can result in increased plant growth of those plant species that can readily take advantage of increased levels of nitrogen, outcompeting less competitive plant species, thus potentially altering the species composition of a site.

For most freshwater environment's phosphates are growth-limiting nutrients. Increased phosphate levels in freshwater environments can result in the death of aquatic plants and animals via the process of eutrophication.

4.9.2 Sources, pathways and receptors

This appraisal has considered all WRC where growth is considered significant as defined in section 4.5.2. Several designated water dependent sites (receptors) have been identified within the GNA which have the potential to be directly, or indirectly affected by changes in water quality as a result of future discharges from WRCs.

The relevant nationally and internationally important wildlife sites that are linked to the nine identified WRCs are:

- River Wensum SSSI and SAC;
- The Broads SAC;
- Broadland SPA;
- Yare Broads & Marshes SSSI (also part of The Broads SAC and Broadland SPA);
- Bure Broads & Marshes SSSI (also part of The Broads SAC and Broadland SPA);
- Halvergate Marshes SSSI (also part of The Broads SAC and Broadland SPA);
- Cantley Marshes SSSI (also part of The Broads SAC and Broadland SPA);
- Geldeston Meadows SSSI (also part of The Broads SAC and Broadland SPA);
- Stanley and Alder Carrs, Aldeby SSSI (also part of The Broads SAC and Broadland SPA);
- Barnby Broad & Marshes SSSI (also part of The Broads SAC and Broadland SPA); and,
- Breydon Water SSSI and SPA.

Other SSSIs and European sites are present in and around the Greater Norwich area, but no linkages were identified. Reasons for designation of the wildlife sites have been gathered primarily from the websites of the following sources:

- Joint Nature Conservation Committee (JNCC); and
- Natural England (NE).

[18] EPA (2012) *Dissolved Oxygen and Biochemical Oxygen Demand*. [Online] Available from: https://archive.epa.gov/water/archive/web/html/vms52.html. Accessed: 11/04/19
[19] CSP2 (2010) *A Literature Review of Effects of Ammonia on Fish*. [Online] Available from: https://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/alaska/sw/cpa/Documents/L2010ALR122010.pdf Accessed: 11/04/19

4.9.3 Impact on Statutory Designated Sites

4.9.3.1 River Wensum SSSI and SAC

The River Wensum is a low gradient, groundwater dominated river originating in north-west Norfolk, flowing south-east to Norwich where it joins the River Yare. Two WRCs that will be required to serve additional growth within the study area discharge to watercourses that ultimately drain to this nationally and internationally important site: Foulsham-Station Rd WRC and Reepham (Norfolk) WRC.

The Wensum is a calcareous lowland river. The upper reaches are fed by springs that rise from the chalk. This gives rise to beds of submerged and emergent vegetation characteristic of a chalk stream. Lower down, the chalk is overlain with boulder clay and river gravels, resulting in aquatic plant communities more typical of a slow-flowing river on mixed substrate.

The SSSI has the following notified features:

- Flowing waters - Type I: naturally eutrophic lowland rivers with a high base flow
- Flowing waters - Type III: base-rich, low-energy lowland rivers and streams, generally with a stable flow regime
- Population of RDB mollusc - *Vertigo moulinsiana*, Desmoulin's Whorl Snail
- *Phragmites australis - Eupatorium cannabinum* tall-herb fen
- *Carex paniculata* swamp
- *Phragmites australis* swamp and reed-beds
- *Glyceria maxima* swamp
- *Carex acutiformis* swamp
- White-clawed (or Atlantic stream) crayfish, *Austropotamobius pallipes*

The SAC is designated for its:

- Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation ('Rivers with floating vegetation dominated by water-crowfoot. This habitat type is typically characterised by the abundance of the water-crowfoots *Ranunculus* spp., subgenus Batrachium (*Ranunculus fluitans, R. penicillatus ssp. penicillatus, R. penicillatus ssp. pseudofluitans*, and *R. peltatus* and its hybrids); and
- Its population of Desmoulin's whorl snail (*Vertigo moulinsiana*), white clawed crayfish (*Austropotamobius pallipes*), brook lamprey (*Lampetra planeri*) and bullhead (*Cottus gobio*).

The RQP modelling reported in section 4.7 indicated that Foulsham WRC can ensure that the current river quality can be maintained after growth, with the introduction of new permit limits for BOD, ammonia and phosphate. This demonstrates that the impact of growth on the SAC can be managed.

However, Natural England's published water quality objective for the River Wensum[20] is to '*Restore the natural nutrient regime of the river, with any anthropogenic enrichment above natural/background concentrations limited to levels at which adverse effects on characteristic biodiversity are unlikely'*. To achieve this, the phosphate targets set for the River Wensum itself are '*Soluble Reactive Phosphorus (SRP) CSM by 2027 (Interim goal by 2021): Main river below Sculthorpe Mill 30 (50) µg/l. River Tat and River Wensum above Sculthorpe Mill 20 (40) µg/l'*.[21] The targets for the stretch below Sculthorpe Mill are relevant to this assessment.

There are also targets for the SAC to achieve BOD concentrations of 1.5 mg/l[22] by 2021 and to reduce ammonia levels to, or to less than, 0.6mg/l throughout the river. Given these targets, it is not only necessary to assess whether the effluent quality can preserve a given WFD status (or keep any deterioration to less than 10%) but specifically whether the growth at Foulsham WRC and/or Reepham WRC will compromise the ability of the SAC

[20] Natural England. 2019. European Site Conservation Objectives: Supplementary advice on conserving and restoring site features River Wensum Special Area of Conservation (SAC) Site code: UK0012647
[21] ibid
[22] 90th percentile

to achieve an SRP target of 50 µg/l by 2021 and 30 µg/l by 2027, a BOD target of 1.5 mg/l by 2021, or an ammonia target of 0.6 mg/l.

In addition to WFD/no deterioration target modelling, additional water quality modelling was also undertaken for Reepham and Foulsham WRC to determine whether future discharge volumes would compromise the ability of the River Wensum to achieve its stringent water quality targets. For simplicity this was done by applying the stringent Natural England targets for the River Wensum SAC (i.e. 0.6 mg/l of ammonia 90th percentile, 1.5 mg/l of BOD 90th percentile and 0.03 mg/l of phosphate, mean) to the receiving watercourses at the point of discharge. However, it should be noted that the receiving watercourses are several kilometres upstream of the River Wensum itself for both WRCs). This presents a precautionary assessment because discharge loads from the WRCs would be both diluted and attenuated within the tributaries before reaching the SAC.

Reepham WRC water quality modelling results

The modelled permit limits (achievable within the limits of conventional treatment) for maintaining current quality would ensure that new GNLP development within the Reepham WRC catchment would not have an additional effect on the SAC above and beyond current discharges. However, the required Wensum targets have also been modelled directly to analyse the relative effect of growth compared to the current discharge from the WRC in relation to SAC targets. Full results are provided in Appendix C.

Due to limitations of the RQP method, the Wensum targets can only be considered at the point of discharge within the Blackwater Drain waterbody as it is not possible to model effects of discharge several kilometres downstream where the Blackwater Drain joins the Wensum where it is designated.

The SAC target for ammonia in the Wensum is less stringent than the current WFD high status requirement. Because modelling for no WFD deterioration has shown the WFD high status can be maintained within the limits of conventional treatment, then it is also possible to achieve the Wensum ammonia target at the point of discharge in the Blackwater Drain, ensuing the Wensum target downstream can be met both with and without growth.

The SAC target for phosphate[23] and BOD[24] is more stringent than the current WFD high status limit for the Blackwater Drain WFD waterbody for these parameters. The upstream river quality of the Blackwater Drain does not currently meet these targets. Modelling has shown that, even if upstream quality in the tributary is improved to meet the targets, it would not be possible to meet the phosphate or BOD SAC target at the point of discharge in the Blackwater Drain with current discharge volumes within the limit of conventional treatment[25]. This demonstrates that growth would not be a limiting factor and that solutions are needed both to improve the Blackwater Drain upstream of the WRC and to manage current WRC discharge quality. These measures would also ensure growth could be accommodated without affecting the SAC targets someway downstream.

Foulsham WRC water quality modelling results

The modelled permit limits (achievable within the limits of conventional treatment) for maintaining current quality would ensure that new GNLP development within the Foulsham WRC catchment would not have an additional effect on the SAC above and beyond current discharges. However, the required Wensum targets have also been modelled directly to analyse the relative effect of growth compared to the current discharge from the WRC in relation to SAC targets.

Because modelling for no deterioration has shown the WFD high status can be maintained within the limits of conventional treatment, then it is also possible to achieve the Wensum ammonia target at the point of discharge in the Foulsham tributary, ensuing the Wensum target downstream can be met both with and without growth.

The upstream river quality of the Foulsham Tributary does not currently meet the stringent phosphate or BOD target. Modelling has shown that, even if upstream quality in the tributary is improved to meet the targets, it would not be possible to meet the BOD or phosphate SAC target at the point of discharge in the Foulsham Tributary with current discharge volumes within the limit of conventional treatment[26]. This demonstrates that growth would not be a limiting factor and that solutions are needed both to improve the Foulsham Tributary upstream of the

[23] 0.03mg/l mean value for the Wensum P target.
[24] 1.5mg/l 90th percentile value for the Wensum BOD target
[25] a limit of 0.03 mg/l (mean) would be required both with and without growth for phosphate, and 2.64 mg/l (95th percentile) required for BOD without growth.
[26] a limit of 0.02 mg/l (mean) would be required both with and without growth for phosphate, and 4.22 mg/l 95th percentile required for BOD without growth

WRC and to manage current WRC discharge quality. These measures would also ensure growth could be accommodated without affecting the SAC targets someway downstream.

Wensum SSSI and SAC summary

It is therefore reasonable to conclude with a high degree of confidence that, based on these precautionary modelling exercises alone, future wastewater discharges from Reepham WRC and Foulsham WRC would not compromise the ability of the River Wensum SAC to achieve its stringent water quality targets. This is because the targets could be met for the receiving watercourses if necessary for ammonia and BOD (with commensurate improvements in upstream BOD quality). For phosphate, the modelling has shown growth has no material impact on attainment of the phosphate target which would not be possible with conventional treatment for the current levels of discharge, even if the upstream water quality were significantly improved.

4.9.3.2 Other designated sites

Yare Broads & Marshes SSSI, Bure Broads & Marshes SSSI, Halvergate Marshes SSSI, Cantley Marshes SSSI, The Broads SAC, and Broadland SPA are considered together as they are functionally interlinked. The broads and marshes of the Rivers Yare and Bure, as well as Halvergate Marshes, are the key components of The Broads SAC and Broadland SPA within the Greater Norwich area. With respect to discharges to the Yare, Breydon Water SSSI and SPA is also considered.

Several WRCs receiving significant growth are located within the catchments of the Bure and Yare upstream of one or more of the designated sites. These WRC will either need a new discharge permit, or likely changes to the existing permit to protect water quality of the receiving watercourses due to the additional wastewater flows from growth:

- Aylsham WRC – discharges to the River Bure several kilometres upstream of component parts of the Broads SAC and Broadland SPA;
- Whitlingham Trowse WRC, which discharges to the River Yare 4km upstream of the Yare Broads & Marshes SSSI; and,
- Cantley WRC, which discharges into the Yare within the Cantley Marshes SSSI.

RQP modelling for these WRCs has demonstrated that it is possible to implement permit conditions within the limits of conventional treatment which would achieve current water quality, ensuring no deterioration from the current quality. This demonstrates that growth will not result in additional water quality impacts on these water dependent designated sites if measures are implemented to achieve these identified permit limits. Acle WRC also discharges to the tidal reaches of the Yare, and load standstill calculations have demonstrated that permit limits to ensure no increase in pollutant load can be readily achieved with significant scope to improve discharges further.

There are other WRCs much further upstream from the designated sites (upstream of Norwich) within the Yare catchment which will receive significant additional growth. This includes Wymondham WRC (discharges to the River Tiffey, a tributary of the Yare), Saxlingham, and Long Stratton WRC (discharge to the River Tas system, a tributary of the Yare) and Barnham Broome which discharges direct to the Yare over 18km upstream of Norwich. RQP modelling has demonstrated that it is also possible to implement permit conditions within the limits of conventional treatment which would achieve current water quality for these WRCs. Implementing these improvements at a catchment level would ensure no deterioration from the current quality in the catchment as a result of growth.

As well as the Yare and Bure catchments, three SSSIs (which also form part of The Broads SAC and Broadland SPA) are hydrologically connected with the River Waveney and hence the Beccles, Woodton and Ditchingham WRCs (all will receive significant growth) which discharge to this catchment and are located upstream of these sites. These SSSI are:

- Geldeston Meadows SSSI (also part of The Broads SAC and Broadland SPA);
- Stanley and Alder Carrs, Aldeby SSSI (also part of The Broads SAC and Broadland SPA);
- Barnby Broad & Marshes SSSI (also part of The Broads SAC and Broadland SPA);

Breydon Water SSSI and SPA is also considered here due to its location downstream on the Waveney after the confluence with the River Yare.

RQP modelling for these WRCs has demonstrated that it is possible to implement permit conditions within the limits of conventional treatment which would achieve current water quality, ensuring no deterioration from the current quality. This demonstrates that growth will not result in additional water quality impacts on these water dependent designated sites if measures are implemented to achieve these identified permit limits.

The Natural England Site Improvement Plan for The Broads and Broadland states that '*Many point sources of pollution have been addressed in the Broads. However, some point sources require additional work to reduce their contribution of nutrients and/ or other pollutants to the Broads' water bodies*'. It is understood that this applies primarily to the offline lakes rather than those parts of the SAC and SPA that constitute the floodplain of the River Yare. Stalham WRC in North Norfolk District is the only WRC specifically mentioned and that WRC does not serve the Greater Norwich study area. It is understood from the Natural England supplementary advice on Broadland[27] that Diffuse Water Pollution Plans are being developed for the Bure Broads and Marshes, the Ant, Trinity Broads and Marshes, Upper Thurne and Shallam Dyke Marshes, Waveney and the Yare Broads and Marshes and these are due in 2020. The RQP modelling set out in this WRC should be built upon to support ongoing development of the nutrient management plans for the designated sites.

4.10Wastewater Treatment Overview

The water quality assessment and ecological appraisal has identified that there are no WRCs that would need improvements beyond conventional treatment in order to ensure no deterioration in current quality. Therefore, it is theoretically possible to provide wastewater treatment to an adequate level for the Local Plan growth.

Despite this conclusion, the assessment has shown that significant changes to discharge permits in some cases will be required. Therefore, it is important to set out where there is a need for additional investment in wastewater treatment infrastructure, and where there is potential for phasing implications on proposed development whilst any new infrastructure or upgrade work is completed. It is noted that AWS has already identified the need for investment in WRC capacity for Aylsham during AMP7 (2020 – 2025) and Long Stratton WRC in AMP 9 (2030 – 2035).

Table 4-30 provides a summary of the phasing and infrastructure upgrade issues for each of the WRC where assessment of growth required water quality assessment and/or ecological appraisal.

Wastewater treatment technologies are continuously being developed and improved, and hence capacity for additional wastewater flow from growth would need to be reconsidered in the context of achieving the future target status' up to the end of the plan period and beyond as the limits of conventional treatment are gradually improved.

[27] Natural England. 2019. European Site Conservation Objectives: Supplementary advice on conserving and restoring site features The Broads Special Area of Conservation (SAC) Site code: UK0013577

Table 4-30 Wastewater treatment works assessment summary

WRC	Assessment undertaken	Discussion	Phasing Implications	Further Steps
• Acle. • Barford – Chapel Street. • Belaugh. • Diss. • Earsham – Bungay Rd. • Ellingham – Braces Ln. • Forncett – Forncett End. • Freethorpe. • Hempnall (Fritton Rd). • Norton Subcourse • Pulham St Mary. • Reedham. • Sisland. • Stoke Holy Cross. • Swardeston.	Load Standstill	• Adequate flow headroom for proposed growth. • Minor changes to the discharge permit would be required to ensure no increase in overall pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	• Unlikely to be phasing implications in the short term (end of 2020) or longer term (2021 to 2025) as permitted flow will not be exceeded. • Changes to permit conditions to maintain load input are minimal- hence it is likely that current treatment processes are likely to be adequate. AWS will need to consider this as part of their wastewater planning and next business plan submission (2024).	• None required.
Aylsham	RQP	• A new permit would be required – flow condition would be exceeded. AWS have confirmed upgrades are planned between 2020 and 2025. • Current quality can be maintained with significant changes to the ammonia and BOD limits, but these would be achievable within the limits of conventional treatment. Unlikely to require any phosphate treatment upgrades to maintain current quality. • Compliance with WFD objectives are likely to be possible with no changes required.	• Limited flow headroom capacity - a new permit will be required early in the Local Plan period and AWS have confirmed upgrades are planned between 2020 and 2025. • Early phasing (to 2025) may be affected whilst a new permit is considered by the Environment Agency and planned upgrade works are implemented by AWS. • For each planning application from 2020, developers should contact AWS to confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows. • 2025 onwards: the scale of process upgrades will depend on the target the Environment Agency would want to implement but significant investment and process upgrade may be required to meet BOD targets.	• AWS have identified upgrade improvements up to 2025. • EA to determine permit required to meet regulatory compliance and inform scope of AWS upgrades.
Barnham Broom	RQP	• A new permit would be required – flow condition would be exceeded.	• Unlikely to be phasing implications in the short term (end of 2025) but a new permit will likely be required beyond 2030 (into AMP9).	• EA to determine permit required to

WRC	Assessment undertaken	Discussion	Phasing Implications	Further Steps
		• Current quality can be maintained with significant changes to the ammonia and BOD limits, but these would be achievable within the limits of conventional treatment. Introduction of a phosphate limit may be required to maintain current quality, but this would be achievable within the limits of conventional treatment.	• 2025 onwards: some process upgrades may be required for ammonia and BOD limits. To maintain current quality would require investment in treatment processes for ammonia, with potential for further phasing implications. Investment for phosphate would be limited. • Developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9
Beccles	RQP	• A new permit would be required – flow condition would be exceeded. • Current quality can be maintained with significant changes to the permit limit for all parameters, but these would be achievable within the limits of conventional treatment. • Compliance with WFD objectives would be possible without significant changes to permits except for ammonia which may require a new permit.	• Unlikely to be phasing implications in the short term (end of 2025) as permitted flow will not be exceeded. • 2025 onwards: a new flow permit is likely to be required and some process upgrades may be required for all determinands. Significant investment is likely to be required for treatment processes to maintain current quality. • Developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	• EA to determine permit required to meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9.
Cantley	RQP	• Adequate flow headroom for proposed growth. • Although no new flow condition is required on the permit, significant growth is proposed in the catchment - modelling has assessed the implication of using this headroom. • Current quality can be maintained without significant changes to the permit limit for all parameters.	• No phasing implications associated with levels of growth.	• None required.
Ditchingham	RQP	• There is currently no flow headroom at the WRC – a new permit is required. • Current quality can be maintained with significant changes to the permit limit for BOD and ammonia, but these would be achievable within the limits of conventional treatment. Changes are unlikely to be required related to phosphate. • Compliance with WFD objectives would be possible without major changes to permit limits	• Limited flow headroom capacity - a new permit will be required early in the Local Plan period • Early phasing (to end of 2021) may be affected whilst a new permit is considered by the Environment Agency • For each planning application in 2020/21, developers should contact AWS to confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows • 2025: investment in process upgrades is likely to be required in AMP8 for BOD and ammonia.	• EA to determine permit required to meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9.
Foulsham	RQP	• Adequate flow headroom for proposed growth. • Although no new flow condition is required on the permit, consideration has been given to the requirements of the Wensum SAC as result of using some of this headroom.	• Unlikely to be phasing implications in the short term (end of 2025) as permitted flow will not be exceeded; • 2025 onwards: process upgrades are likely to be required for all parameters to maintain current quality and ensure growth has no	• EA and Natural England to determine if a new permit is required to meet regulatory compliance

WRC	Assessment undertaken	Discussion	Phasing Implications	Further Steps
		• Current quality can be maintained with significant changes to the permit limit for all parameters, but these would be achievable within the limits of conventional treatment and would ensure growth does not impact on the Wensum SAC.	impact on the Wensum SAC; further catchment modelling is recommended to determine the permit requirements based on the impact further downstream on the SAC. • Developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9.
• Harleston • Rackheath	Load Standstill	• Adequate flow headroom for proposed growth • Some potentially significant changes to the discharge permit would be required to ensure no increase in overall pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	• Unlikely to be phasing implications as permitted flow will not be exceeded; • 2025 onwards: some changes to permit may be required as to maintain load input particularly for phosphate and BOD and this is likely to require some investment in treatment processes beyond 2025.	• EA to determine if a new permit is required to meet regulatory compliance and inform scope of AWS upgrades to plan for AMP 8 (post 2025)
Long Stratton	RQP	• Flow headroom would be exceeded – a new permit is required. AWS have confirmed upgrades are planned between 2025 and 2030. • Current quality can be maintained without significant changes to the permit limit for ammonia and phosphate, and these would be achievable within the limits of conventional treatment. More significant changes are required related to BOD but this will be achievable within the limits of conventional treatment.	• Limited flow headroom capacity - a new permit will be required towards the end of the Local Plan period. • Phasing prior to 2030 is unlikely to be impacted due to planned works in the current investment period (AMP7). Further BOD upgrades may be required post 2030 depending on the level of improvement provided by current AMP7 works.	• AWS to consider the need for further works in AMP9.
Reepham	RQP	• Adequate flow headroom for proposed growth. • Although no new flow condition is required on the permit, consideration has been given to the requirements of the Wensum SAC as result of using some of this headroom. • Current quality can be maintained with some changes to the permit limit for all parameters, but these would be achievable within the limits of conventional treatment and would ensure growth does not impact on the Wensum SAC.	• Unlikely to be phasing implications in the short term (end of 2025) as permitted flow will not be exceeded but quality conditions may need to change; • 2025 onwards: process upgrades are likely to be required for all parameters (but particularly phosphate) to maintain current quality and ensure protection of the Wensum SAC. • Developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	• EA and Natural England to determine if a new permit is required to meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9.
Saxlingham	RQP	• Adequate flow headroom for proposed growth • Although no new flow condition is required on the permit, significant growth is proposed in the catchment - modelling has assessed the implication of using this headroom. • Current quality can be maintained with significant changes to the permit limit for BOD and ammonia and the introduction of a phosphate limit, but these would be achievable within the limits of conventional treatment.	• No early phasing implications as permitted flow is not exceeded. • 2025 onwards: process upgrades are likely to be required for all determinands to ensure using available headroom does not affect WFD compliance or current water quality. The scale of process upgrades is likely to require investment in AMP8 and may affect longer term phasing. • Developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development	• EA to determine if a new permit is required to meet regulatory compliance and inform scope of AWS upgrades.

WRC	Assessment undertaken	Discussion	Phasing Implications	Further Steps
			enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	• AWS to consider phasing of new works in AMP8.
Whiltingham Trowse	RQP	• Flow headroom would be exceeded – a new permit is required. • Current quality can be maintained with significant changes to the permit limit for all parameters, but these would be achievable within the limits of conventional treatment and would ensure growth does not impact on the Wensum SAC.	• Limited flow headroom capacity - a new permit will be required during the Local Plan period, likely from 2025 . • 2025 onwards: process upgrades are likely to be required for all determinands to ensure additional flows to do not affect current quality or WFD targets (a new flow permit will also be required). The scale of process upgrades will require investment in AMP8 and may affect longer term phasing. • Developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	• EA to determine permit required to meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 and AMP9.
Woodton		• Flow headroom would be exceeded – a new permit is required. • Current quality can be maintained with significant changes to the permit limit for BOD and ammonia and the introduction of a phosphate limit, but these would be achievable within the limits of conventional treatment.	• Limited flow headroom capacity - a new permit will be required early in the Local Plan period. • Early phasing (to end of 2025) may be affected whilst a new permit is considered by the Environment Agency. • 2025 onwards: process upgrades will be required for Ammonia and phosphate. • Up to 2025, developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate that the WRC can accept the additional flows whilst any upgrade works are planned and implemented.	• EA to determine permit required to meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9.
Wymondham	RQP	• Flow headroom would be exceeded – a new permit is required. • Current quality can be maintained with significant changes to the permit limit for BOD and small changes for phosphate; no changes would be required for ammonia. These changes would be achievable within the limits of conventional treatment.	• Limited flow headroom capacity - a new permit will be required during the Local Plan period. • Early phasing (to end of 2025) unlikely to be significantly affected. • 2025 onwards: process upgrades will be required for BOD and possibly for phosphate to ensure current quality and WFD compliance. The scale of process upgrades is likely to require investment in AMP8 and may affect longer term phasing • From 2025, developers should be encouraged to request that AWS confirm flow rates and intended connection points (via a pre-development enquiry) to demonstrate the WRC can accept the additional flows whilst upgrade works are planned and implemented.	• EA to determine permit required to meet regulatory compliance and inform scope of AWS upgrades. • AWS to plan for upgrades in AMP8 or AMP9.

5 Water Supply Strategy

5.1 Introduction

Water supply for the study area is provided by AWS. Water scarcity is a key issue for future development within the GNA. Several of the sources from which water is abstracted to supply existing development (and other water users) within the GNA are under pressure from climate change and both agricultural and public water supply abstraction impacts. This is reflected in the number locations where AWS is expected to implement reductions in the licenced volumes they are able to abstract from (called sustainability reductions) in order to protect sensitive ecologically designated sites such as the Wensum SSSI and SAC.

Recognising the pressures on the water environment within the GNA and their operational area, AWS has produced a Defra approved WRMP[6] for the period 2020 to 2025, setting out how water resources will be managed sustainably in the next 25 year statutory planning period and beyond. This plan has considered the impact of sustainability reductions, existing pressures and looked at options to both reduce demand and to supply new, climate resilient sources of water to supply future growth. In so doing, the WRMP includes all required regulatory assessments (Habitats Regulation Assessment, Strategic Environmental Assessment) to demonstrate the water supply can be delivered sustainably to 2045 and beyond. The WRMP is therefore a key reference point for this WCS which has considered whether the GNLP forecasts for housing and employment are accounted for within the WRMP and sets out measures for growth which align with the WRMP strategy to provide sufficient, resilient and sustainable water supply to the GNA for the next 40 years.

To set the context, an assessment of the existing environmental baseline with respect to locally available resources in the aquifers and the main river systems has been completed. The assessment has been based on the Environment Agency's Catchment Abstraction Licensing Strategy. The study area falls within the Broadland CAMS area therefore this management strategy has been used for this report.

This study then uses the WRMP to determine available water supply against predicted demand and considers how water efficiency can be further promoted and delivered for new homes beyond that which is planned for delivery AWS's WRMP19 to support the sustainable water supply agenda.

5.2 Abstraction Licensing Strategies

The Environment Agency manages water resources at the local level through the use of abstraction licensing strategies. Within the abstraction licensing strategies, 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 categories of resource availability status are shown in Table 5-1. The classification is based on an assessment of a river system's ecological sensitivity to abstraction-related flow reduction. This classification can then be used to assess the potential for additional water resource abstractions.

Table 5-1 Water resource availability status categories

Indicative Resource Availability Status	License Availability
Water available for licensing	There is more water than required to meet the needs of the environment. New licences can be considered depending on local and downstream impacts.
Restricted water available for licencing	Full Licensed flows fall below the Environmental Flow Indictors (EFIs). If all licensed water is abstracted there will not be enough water left for the needs of the environment. No new consumptive licences would be granted. It may also be appropriate to investigate the possibilities for reducing fully licensed risks. Water may be available if you can 'buy' (known as licence trading) the entitlement to abstract water from an existing licence holder.
No water available for licencing	Recent actual flows are below the EFI. This scenario highlights water bodies where flows are below the indicative flow requirement to help support Good Ecological Status (as required by the Water Framework Directive (Note: we are currently investigating water bodies that are not supporting GES / GEP). No further consumptive licences will be granted. Water may be available if you can buy (known as licence trading) the amount equivalent to recently abstracted from an existing licence holder.

The classification for each of the Water Resource Management Units (WRMU) in the GNA has been summarised for surface waterbodies in Table 5-2.

Table 5-2 Resource availability classification

River – WRMU	CAMS Area	Surface Water (flow exceedance scenarios)			
		Q30	Q50	Q70	Q95
AP2- River Bure (Ingworth)					
AP3- River Bure (Horstead)					
AP4- Spixworth Beck					
AP8- River Wensum Hellesdon SAC					
AP9- River Wensum New Mill SAC					
AP10- River Tud at New Costessey	Broadland				
AP11- River Tiffey					
AP12- River Yare					
AP13- River Tas					
AP14- River Chet					
AP15- River Waveney (Billingford)					
AP17- Lower River Waveney Shipmeadow					

All rivers are defined as having restricted or no water available for licencing during periods of very low flow (Q95 or less), and the majority for low flows between Q70 and Q95. This demonstrates the restricted nature of raw water resources where lower flows need to be protected to ensure sufficient water for environmental needs (e.g. water dependent habitats and river habitats).

This analysis indicates that there is potential for some localised high flow abstraction (and subsequent storage) for agricultural purposes but limited potential to use the existing surface water sources for additional public water supply; this is reflected in the AWS WRMP which proposes to meet the future supply and demand balance through a combination of demand management and other strategic supply side sources.

5.3 Water Resource Planning

Water companies have a statutory duty to undertake medium to long term planning of water resources in order to demonstrate that there is a long-term plan for delivering sustainable water supply within its operational area to meet existing and future demand. This is reported via WRMPs on a 5 yearly cycle.

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

Water companies manage available water resources within key zones, called Water Resource Zones (WRZ). These zones share the same raw resources for supply and are interconnected by supply pipes, treatment works and pumping stations. As such the customers within these zones share the same available 'surplus of supply' of water when it is freely available; but also share the same risk of supply when water is not as freely available during dry periods (i.e. deficit of supply). For current WRMPs, Water companies have undertaken 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.

5.4 Water Resource Planning in the Greater Norwich Area

It has been confirmed by Anglian Water that the growth figures assessed for this WCS study are catered for in the 2040 prediction of supply and demand deficits in the relevant WRZs under average conditions. Therefore, conclusions on available water supply from AWS WRMP19[6] can be used directly in this study to inform and support the Local Plan.

5.4.1 Water Supply

The GNA falls within the AWS Norwich and the Broads, Norfolk Rural and North Norfolk Coast WRZ's[28]. The three WRZs are supplied with water from the following sources:

- The Norwich and the Broads WRZ is supplied with groundwater pumped from the Chalk aquifer.
- The Norfolk Rural WRZ is supplied with groundwater pumped from the Chalk aquifer and surface water which is abstracted from the River Wensum.
- The North Norfolk Coast WRZ is supplied with groundwater pumped from the Chalk aquifer with a minority in the extreme east of the WRZ receiving some supplies from the adjacent Norwich and the Broads WRZ[6].

[28] Happisburgh WRZ was split from the North Norfolk Coast WRZ following the 2015 WRMP and does not fall within the GNA; however, it is proposed to provide future water supply between the Norwich and the Broads WRZ and Happisburgh WRZ in the future.

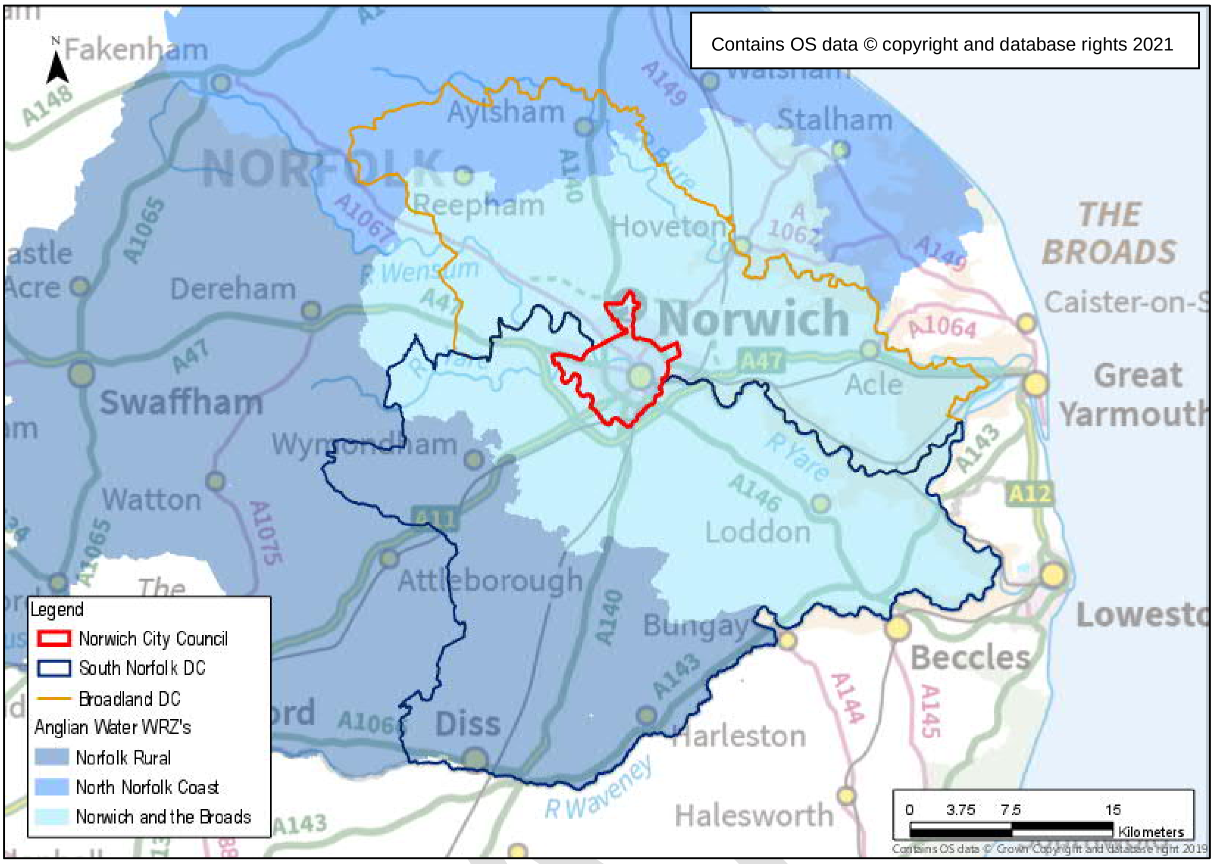


Figure 5-1 Anglian Water WRZ's that serve the Greater Norwich area

AWS has confirmed that they have accounted for the proposed levels of growth assessed within this WCS when developing their WRMP. The new residential properties included in the AWS WRMP19 for the WRZs in the GNA are illustrated in Table 5-3.

Table 5-3 Growth distribution in AWS's Water Resource Zones (2020-2045)[29]

Water Resource Zone	Numbers of residential properties catered for in WRMP19
North Norfolk Coast	13,207
Norwich and the Broads	41,761
North Norfolk Rural	11,284

Table 5-4 show the baseline supply demand balances for the above three WRZs for the following three scenarios at 2045:

- Demand balance with a Do-Nothing scenario;
- Demand balance with demand management;
- Demand balance with demand management and supply-side scheme[30].

Demand management options across WRZs are shown in Section 5.5 below and are based AWS achieving the 'Extended Plus' Strategy. In AWS' view, this option has the strongest economic business case and it strikes the right balance between ambition and deliverability, affordability and the environment and therefore, it meets customer expectations. For the WRZs in the GNA, there is significant emphasis on demand reduction being the key tool to manage future supply and demand deficits. This emphasises the importance of new development in the GNA being as water efficient as possible.

[29] Numbers of residential properties were provided by AWS in April 2019.
[30] Including transfer between Norwich and the Broads WRZ and Happisburgh WRZ

Table 5-4 Water Resource Zones supply-demand balances[6]

Water Resource Zone	Baseline supply –demand balance at 2045 (Ml/d)	Baseline supply –demand balance with demand management at 2045 (Ml/d)	Baseline supply –demand balance with demand management and supply-side scheme at 2045 (Ml/d)
North Norfolk Coast	-2	0.69	0.69
Norwich and the Broads	-0.57	7.27	2.36
North Norfolk Rural	-5.85	-2.71	0.00

The demand management measures and the supply-side schemes are indicated in Sections 5.4.1.1 and 5.4.1.2.

5.4.1.1 Demand management measures in the AWS region

The AWS' strategic demand management options are mainly related to:

- Smart metering;
- Leakage reduction and
- Water efficiency.

Three strategic options are described in Table 5-5 below.

Table 5-5 Strategic demand management options (extracted from AWS WRMP19[6])

	Extended Plus
Smart Metering	2 AMP AMI roll-out 10 Year roll-out to practical limit of meter penetration (95%) 51 Ml/d savings in 2045 including: • 23 Ml/d savings from reduced consumption • 22 Ml/d CSPL savings • 6 Ml/d distribution loss savings
Leakage reduction	Leakage reduced to 142 Ml/d by 2025 and 106 Ml/d by 2045 (this includes cspl and distribution loss reductions from smart metering described above)
Water efficiency	30 Ml/d savings by 2045 In addition to the Extended option ('Bits and Bobs', for installation of water butts, portal sign up reward scheme): • Provide and install water butts to certain customers • Rebate to replace old toilets • Retrofit 'smart devices' (such as taps) that can send data to the customer portal.
TOTAL SAVINGS	• End of AMP7: 43Ml/d • 2045: 123Ml/d

5.4.1.2 Supply-side schemes in the AWS region

A supply-side 'option' refers to a series of investments which together increase deployable output. Component parts can include the development of raw water assets, raw and treated water pumping stations, treatment processes, raw and potable water mains as well as connectivity into the existing potable or non-potable supply system.

A number of different types of supply-side options were considered in the development of the feasible option set. A description of each of these options is presented in Table 5-6.

Table 5-6 Types of supply-side options considered in the development of the feasible option set (extracted from AWS WRMP19[6])

Option Type	Description	Included in Final Feasible Option Set
Potable water transfer	The potable transfers are conduits for transferring water between WRZs rather than new water resources. They can either transfer existing surpluses from one zone to another, or transfer water from new resource development in one zone to another zone in deficit.	Yes
Raw water transfer	The raw water transfers are moving resource into the Anglian Water region, for example from the River Trent.	Yes
Desalination	Abstraction of water from coastal or estuarine locations and treatment capacity.	Yes
Water reuse	Indirect use of recycled water through river augmentation.	Yes
Groundwater development	Development of new groundwater abstraction assets.	No - screened out due to environmental and licensing constraints.
Surface water development	Development of new direct surface water abstraction assets.	No - screened out due to environmental and licensing constraints.
New reservoir	Creating new reservoir storage capacity to maximise the use of winter flows.	Yes
Dam raising	Increasing the capacity of existing reservoir storage to maximise the use of winter flows.	No - screened out due to short term impact on deployable output and operation of existing reservoir systems during delivery. Will be considered as longer term options for WRMP 2024.

The supply-side preferred strategy is presented in Figure 5-2.

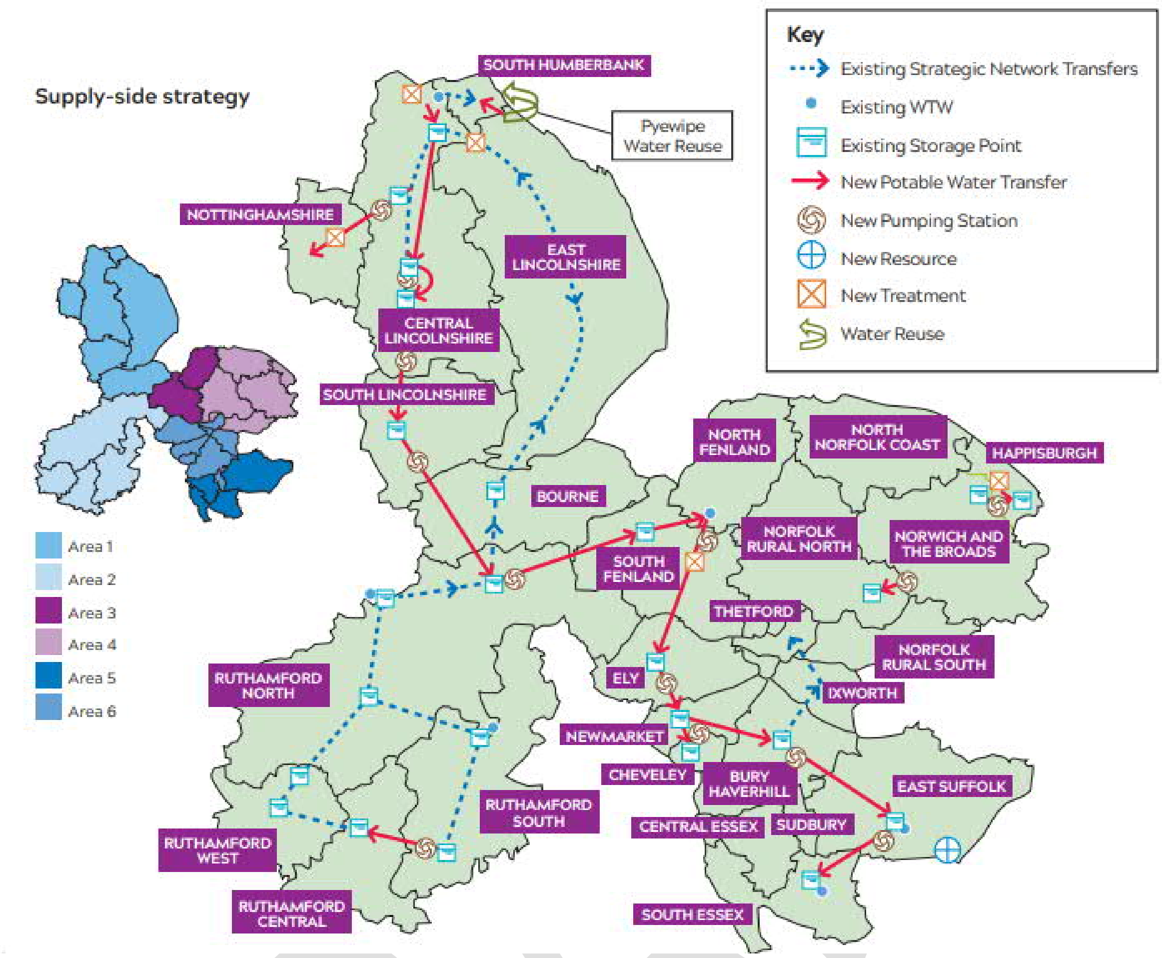


Figure 5-2 Supply-side strategy (extracted from AWS WRMP19[6])

5.5 Water Efficiency Plan

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 GNA.

It should be noted that this assessment of water neutrality has been undertaken to set out what can be achieved to support initiatives to minimise water use as part of the GNLP delivery; the measures set out in the following sections are not essential to secure sustainable water supplies for the purposes of growth which has already been addressed through the statutory WMRP process. These measures are additional to support the WRMP strategy.

5.5.1 Drivers and Justification for Water Efficiency

In 2013, the Anglian Water supply area was classified by the Environment Agency as an 'Area of serious water stress' 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. This creates a very strong driver for new homes in the next 25 years to be made as efficient as economically possible to safeguard the future resources to be made available by AWS in the GNA.

It is predicted that climate change will further reduce the available water resources in the study area. Rainfall patterns are predicted to change to less frequent, but more extreme, rainfall events. AWS has recognised the risk climate change poses to the three crucial areas of their business, abstraction, treatment and distribution of water. 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.

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 forecasting the increased demand of water and accounting for it in their plans.

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.

The sustainability of some abstractions currently used by AWS in the study area has also been investigated over several years as part of the review of consents process in relation to the Wensum SAC and other protected sites. The WRMP currently states a reduction of 13 Ml/d has been planned for in order to provide environmental protection within the WRZs covering the GNA and a further 3.1 Ml/d reduction in the neighbouring Happisburgh WRZ. Whilst reductions in abstraction volumes and changes in abstraction conditions have been accounted for by AWS in their WRMP19, these investigations and proposed reductions indicate the pressures on water resources during low flow conditions in the GNA and hence, further supports the need to consider water efficiency and water use reduction as a key need in the study area.

5.6 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[31]. 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.

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

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

In order to reduce water consumption and manage demand for the limited water resources within the three Districts, a number of measures and devices are available[32]. Generally, these measures fall into two categories due to cost and space constraints, as those that should be installed in new developments and those which could be retrofitted. Appendix D provides more detail on the different types of device or system along with the range of efficiency savings they could lead to.

5.6.2 Achieving Total Neutrality – is it feasible?

When considering neutrality within an existing planning area, it is recognised by the Environment Agency[33] that achievement of total water neutrality (100%) for new development is often not possible, as the levels of water savings required in existing stock may not be possible for the level of growth proposed. A lower percentage of neutrality may therefore be a realistic target, for example 50% neutrality.

This WCS therefore considers different water neutrality targets and sets out a 'pathway' for how the most likely target (or level of neutrality) can be achieved. Appendix D discusses the pathway concept in more detail, and highlights the importance of developing local policy in the study area for delivering aspirations like water neutrality as well as understanding the additional steps required beyond 'business as usual' required to achieve it.

[31] Water Neutrality is defined more fully in the Environment Agency report 'Towards water neutrality in the Thames Gateway' (2007)
[32] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.
[33] Environment Agency (2009) Water Neutrality, an improved and expanded water management definition

5.6.3 Water Neutrality Scenarios

5.6.3.1 Theoretical Scenario (Water Neutrality)

The scenario has been developed as a context to demonstrate what is required to achieve a neutral position in the study area. In practice achieving 100% neutrality across the study area is unrealistic for two main reasons:

- Developers would be required to voluntarily provide homes where water use is reduced below Building Regulation Part G Optional Requirements, through incorporation of water re-use technologies in all major development to meet non-potable demands. Local Authorities are currently limited to setting policies with specific water efficiency targets which link to existing technical standards and without a policy to drive higher specification homes, developers are unlikely to deliver homes with lower water use designed in.
- A significant proportion of existing homes would need to be retrofitted with efficient fixtures and fittings which would require a significant funding pool and a specific project management resource to ensure the retrofitting programme is implemented.

They key assumptions for this scenario are:

- Meter installation should be undertaken into all existing residential properties where metering is technically feasible.
- All new homes would be built to deliver a water use of 62 litres per person per day, based on high specification fixtures and fittings, as well as rainwater harvesting and/or greywater recycling to meet non-potable demands generated by toilet flushing and washing machine use.
- Significant uptake of water efficiency retrofit measures would be required at 54.6% of existing GNA households.

To deliver, 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 to encourage restriction of water use in new homes beyond Building regulations; and
- All new development to include water recycling facilities across the study area.

5.6.3.2 Optional requirements Scenario plus retrofit

This scenario considers the savings which could be made including a policy within the Local Plan to require developers to build houses to meet the optional standard for water efficiency (Building Regulation Part G Optional Requirements) in addition to a modest programme of additional retrofitting.

The key assumptions for this scenario are:

- All new homes would be built to deliver a water use of 110 litres per person per day (Building Regulation Part G Optional); and
- 5% of existing homes would be retrofitted with low flush cisterns, as well as aerated taps and shower heads.

The scenario has primarily been developed to demonstrate (and provide an evidence based for) the added benefit of adopting policy based on Building Regulation Part G Optional as well as undertaking a joint programme of retrofit.

5.6.3.3 Mandatory requirement Scenario plus retrofit

This scenario considers a more realistic scenario, and considers the savings which could be made based on developers building houses to meet the minimum expected technical requirements for water use (Building Regulation Part G Mandatory Requirements) in addition to a modest programme of additional retrofitting.

The key assumptions for this scenario are:

- All new homes would be built to deliver a water use of 125 litres per person per day (Building Regulation Part G Mandatory); and
- 5% of existing homes would be retrofitted with low flush cisterns, as well as aerated taps and shower heads.

5.6.4 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, current demand in the study area was calculated to be 54.30 Ml/d.

For each neutrality option and neutrality 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, UKWIR34, 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 D). The results are provided in Table 5-7 which also includes the effect of just implementing Building Regulation Optional and Mandatory policy control without retrofit for context.

Table 5-7 Results of the Neutrality Scenario Assessment

Neutrality Scenario	New homes consumption rate (l/h/d)	% of existing properties to be retrofitted	Demand from Growth (Ml/d)	Total demand post growth* (Ml/d)	Total demand after retrofitting (Ml/d)	% Neutrality Achieved
Business As Usual	133	0%	13.27	67.58	**67.58**	0%
Mandatory requirements	125	0%	12.50	66.81	**66.81**	6%
Mandatory requirements plus retrofit	125	5%	12.50	66.81	**66.27**	10%
Optional requirements	110	0%	11.06	65.36	**65.36**	17%
Optional requirements plus retrofit	110	5%	11.06	65.36	**64.77**	21%
Theoretical Water Neutrality	62	54.6%	6.44	60.75	**54.30**	100%

Table 5-7 indicates that to achieve water neutrality would require the implementation of unrealistic measures as all new development would need to minimise water demand through the use of extensive and expensive recycling technologies; all water companies would need to meet maximum water meter penetration in existing housing stock; and, a large funding pot would be required to allow retrofit of just over a half (54.6%) of existing housing stock within the GNA with water efficient fixtures and fittings. Therefore, two more realistic water demand management scenarios have been tested.

- *Mandatory requirements scenario plus retrofit*
- *Optional requirements scenario plus retrofit*

The water neutrality analysis demonstrated that both the mandatory and optional requirement scenarios would reduce post development demand by the end of the plan period (2038) compared to the Business As Usual scenario. The mandatory requirements scenario plus 5% retrofit would potentially deliver a post development demand reduction of 1.31 Ml/d, whilst the optional requirement plus 5% retrofit would deliver a potential reduction of 2.8 Ml/d (compared to the Business As Usual demand). The Optional requirements scenario plus 5% retrofit, which would achieve 21% neutrality, would require new homes to be designed to use water at rate of 110 l/h/d. However, as the neutrality proportion is still relatively low, it would be advisable to extend meter penetration or to increase the number of retrofitting properties.

5.6.5 Preferred Strategy – Delivery Pathway

In order to set out a feasible route for how the proposed scenarios could be delivered, this study has considered delivery requirements for the 'optional requirement plus retrofit scenario'. This has been undertaken to allow the Greater Norwich Councils to consider the potential costs and benefits of developing a water use policy to require developers to build new homes to meet the Building Regulation Part G Optional water standards, and to consider working with water companies to develop further options for retrofitting existing properties with efficiency fixtures and fittings.

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

Table 5-8 summarises the delivery requirement and includes a high-level assessment of the likely ease with which each element could be perused and delivered, along with recommendations on the likely responsible organisation that could take each option forward.

Table 5-8 Water efficiency and retrofit measures and recommended responsible organizations

Delivery requirements	Ease of adoption and delivery	Responsible stakeholder
Ensure planning applications for Major Development are compliant with the recommended policies on water use requirements	High Some officer training may be required, but policing of policy compliance would be a reasonably straightforward procedure. Examples for water efficiency policy guidance are available[35]	Greater Norwich Councils (LPA – Planning teams)
Fitting water efficient devices in accordance with policy	High A significant library of information base is available on available water efficiency measures to meet a range of standards including online water calculators.	Developers and LPAs (Building Control)
Provide guidance on the installation of water efficient devices through the planning application process	High Pre-application advice could be provided specific to water efficiency options and specific information made available on each LPA's website or on Greater Norwich's website	Greater Norwich Councils (LPAs)
Ensure continuing increases in the level of water meter penetration where the maximum possible is not already achieved	Medium This initiative should reflect commitments in current and future WRMPs	AWS
• Retrofit devices within council owned housing stock; and, • Retrofit devices within privately owned housing stock	Low to Medium A significant funding pool and staff resource requirement would need to be identified to deliver feasibility studies and retrofit implementation. Water companies are embarking on retrofit as part of their response to meeting OFWAT's mandatory water efficiency targets. These programmes are funded out of operational expenditure. If a company has, or is forecasting, a supply-demand deficit over the planning period, water efficiency programmes can form part of a preferred option(s) set to overcome the deficit. These options are identified as part of the companies' WRMPs and will have to undergo a cost-benefit analysis but further analysis subsequent to this study could inform a greater investment in retrofitting measures as a means to offset demand from new property, particularly where funding could be supplemented through developer contributions (although this is considered unlikely)	AWS in partnership with Greater Norwich Councils LPAs – AWS would need to fund this, but Greater Norwich Councils LPAs could consider providing a programme lead to identify suitable properties and manage the programme delivery
Promote water audits and set targets for the number of businesses that have water audits carried out.	Medium Allocate a specific individual or team within each of the local authorities to be responsible for promoting and undertaking water audits (a relatively low cost option) and ensuring the targets are met. The same team or individual could also act as a community liaison for households (council and privately owned) and businesses where water efficient devices are to be retrofitted, to ensure the occupants of the affected properties understand the need and mechanisms for water efficiency.	Greater Norwich Councils (LPAs)
Educate and raise awareness of water efficiency[36]	High All stakeholders could use existing tools such as website information, pre-development application responses and public events to increase awareness and education regards the importance of water efficiency.	All stakeholders

[35] https://www.eastcambs.gov.uk/sites/default/files/FD.EVR23%20-%20Final.pdf

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

6 Major Development Site Assessment

6.1 Introduction

This section of the WCS addresses local infrastructure capacity issues, flood risk and it provides an overall RAG rating for each of the proposed Preferred sites for major development. A brief methodology is outlined below. A summary table detailing the outcome of the site assessments is set out in Section 6.3.

6.2 Assessment Methodologies

6.2.1 Wastewater network

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

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

As the wastewater undertaker for the study area AWS has a general duty under Section 94 of the Water Industry Act 1991 to provide effectual drainage which includes providing additional capacity as and when required to accommodate planned development. However this legal requirement must also be balanced with the price controls as set by the regulatory body Ofwat which ensure AWS has sufficient funds to finance its functions, but at the same time protect consumers' interests. The price controls affect the bills that customers pay and the sewerage services consumers receive, and ultimately ensure wastewater assets are managed and delivered efficiently.

AWS have undertaken an internal assessment of the capacity of the network system using local operational knowledge. A RAG assessment has been undertaken for the surface water connection capacity, the foul sewer network capacity and the WRC capacity. The keys indicating the coding applied to each surface water network, foul network and WRC capacity assessments are provided in Table 6-1 and Table 6-3.

Table 6-1 Key for surface water network capacity RAG assessment

There is capacity to receive surface water flows	**Limited capacity to receive surface water flows and only subject to a design following the SUDS hierarchy**	**There is no capacity to receive surface water flows**

Table 6-2 Key for foul water network capacity RAG assessment

No capacity restrictions in network	**None OR Potential environmental impact from storm overflow**	**Confirmed capacity restrictions in network**

6.2.2 Water supply network

As already stated in Section 5.4.1, AWS, with the capacity as clean water provider, has confirmed that there are sufficient water resources to cater for the proposed growth within the affected Water Resource Zones.

In addition to available water resources, there is a requirement to consider whether there is the infrastructure capacity to move water to where the demand will increase.

AWS has undertaken an assessment of the capacity of the water supply system using local operational knowledge and modelling. A RAG assessment has been undertaken; a key indicating the coding applied to each assessment is provided in Table 6-3.

Table 6-3 Key for water supply network RAG assessment

No reinforcement is required in the water supply network	**Off site reinforcement required in the water supply network**	**N/A**

6.2.3 Flood Risk

The fluvial and tidal flood risk to each of the major development sites has been considered using the Flood Maps for Planning[37] mapping produced by the Environment Agency. Surface water flooding has been reviewed for each of the major development sites using the Risk of Flooding from Surface Water (RoFSW)[38] mapping produced by the Environment Agency. The flooding data sets have been used to determine the extent of site boundaries that are at risk from flooding from different sources. This assessment gives an indication of which sites may need additional mitigation to manage the risk.

6.3 Site assessment table summary

The following section contains the detail of the assessment of each of the major allocated sites in the study area.

AECOM POSITION STATEMENT – JANUARY 2021

Updated inputs are awaited from AWS for the new allocation sites before this table can be fully updated. This will be completed after comments are received on the main report text

[37] Environment Agency (2019). Flood Map for Planning. Available at: https://flood-map-for-planning.service.gov.uk/ Accessed: November 2019

[38] Environment Agency (2019). Long term flood risk information. Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map. Accessed at: November 2019

Table 6-4 Site assessments summary table for Preferred sites

Parish	District	Site reference	Housing numbers	Proposed site use	Clean Water	Wastewater			Flood Risk						Water Resources	Overall RAG rating
					Supply network	Water Recycling Centre (WRC)	Surface water connection capacity	Foul sewer connection capacity	Flood Zone 1	Flood Zone 2	Flood Zone 3	High RoFSW	Medium RoFSW	Low RoFSW	Groundwater sources affected	
Norwich	Norwich	GNLP0068	25	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	9%	73%	175 /Thorpe St Andrew/2	Amber
Diss	South Norfolk	GNLP0102	200	Residential	Green	Diss	Red	Amber	100%	0%	0%	0%	0%	3%		Amber
Horsham and Newton St Faith	Broadland	GNLP0125	30	Residential	Green	Whitlingham Trowse	Red	Red	100%	0%	0%	0%	0%	0%		Red
Sprowston	Broadland	GNLP0132	1226	Mixed use	Amber		Red	Amber	100%	0%	0%	0%	0%	1%		Amber
Norwich	Norwich	GNLP0133-B	0	University related	Green	Whitlingham Trowse	Red	Green	100%	0%	0%	0%	0%	0%	33 /Bowthorpe (Bland Road)/2; 46 /Colney/2	Amber
Norwich	Norwich	GNLP0133-C	400	University related	Green	Whitlingham Trowse	Red	Green	100%	0%	0%	0%	1%	3%		Amber
Norwich	Norwich	GNLP0133-D	0	University related	Amber	Whitlingham Trowse	Red	Green	100%	0%	0%	0%	0%	7%		Amber
Norwich	Norwich	GNLP0133-E	400	University related	Green	Whitlingham Trowse	Amber	Green	100%	0%	0%	0%	0%	0%		Amber
Hethersett	South Norfolk	GNLP0177-A	200	Mixed use	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	1%	1%	4%		Amber
Salhouse	Broadland	GNLP0188	15	Residential	Green	Belaugh	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Norwich	Norwich	GNLP0282	15	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	0%		Amber

Parish	District	Site reference	Housing numbers	Proposed site use	Clean Water	Wastewater			Flood Risk						Water Resources	Overall RAG rating
					Supply network	Water Recycling Centre (WRC)	Surface water connection capacity	Foul sewer connection capacity	Flood Zone 1	Flood Zone 2	Flood Zone 3	High RoFSW	Medium RoFSW	Low RoFSW	Groundwater sources affected	
Roydon/Diss	South Norfolk	GNLP0291, GNLP0119, GNLP0342 and GNLP0250	200	Residential	Amber	Diss	Red	Amber	100%	0%	0%	0%	0%	1%		Amber
Cawston	Broadland	GNLP0293	85	Residential	Green	Reepham	Red	Red	100%	0%	0%	0%	1%	2%		Red
Buxton with Lamas	Broadland	GNLP0297	40	Residential	Green	Aylesham	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Cringleford	South Norfolk	GNLP0307 and GNLP0327	400	Residential	Green		Red	Amber	100%	0%	0%	1%	2%	5%	33 /Bowthorpe (Bland Road)/2; 46 /Colney/2	Amber
Loddon	South Norfolk	GNLP0312	180	Residential	Amber	Sisland	Red	Amber	100%	0%	0%	1%	1%	2%		Amber
Colney	South Norfolk	GNLP0331R-B	0	Employment	Green		Red	Green	100%	0%	0%	0%	0%	0%	33 /Bowthorpe (Bland Road)/2; 46 /Colney/2	Amber
Colney	South Norfolk	GNLP0331R-C	0	Employment	Amber	Whitlingham Trowse	Red	Green	100%	0%	0%	0%	1%	2%	33 /Bowthorpe (Bland Road)/2; 46 /Colney/2	Amber
Taverham	Broadland	GNLP0337	200	Residential	Amber	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	1%	5%	50 /Costessey Pits/2	Amber
Rackheath	Broadland	GNLP0351	15	Residential	Green	Rackheath	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Wymondham	South Norfolk	GNLP0354	50	Residential	Green	Wymondham	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Norwich	Norwich	GNLP0360	2000	Mixed use	Amber	Whitlingham Trowse	Red	Amber	91%	7%	2%	0%	0%	4%	175 /Thorpe St Andrew/1; 175 /Thorpe St Andrew/2	Amber
Acle	Broadland	GNLP0378	100	Residential	Green	Acle-Damgate Lane	Red	Amber	100%	0%	0%	2%	4%	10%		Amber

Parish	District	Site reference	Housing numbers	Proposed site use	Clean Water	Wastewater			Flood Risk						Water Resources	Overall RAG rating
					Supply network	Water Recycling Centre (WRC)	Surface water connection capacity	Foul sewer connection capacity	Flood Zone 1	Flood Zone 2	Flood Zone 3	High RoFSW	Medium RoFSW	Low RoFSW	Groundwater sources affected	
Lingwood and Burlingham	Broadland	GNLP0379	60	Residential	Amber	Whitlingham Trowse	Red	Amber	100%	0%	0%	1%	3%	9%		Amber
Lingwood and Burlingham	Broadland	GNLP0380	25	Residential	Amber	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	4%	15%		Amber
South Walsham	Broadland	GNLP0382	25	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Norwich	Norwich	GNLP0401	100	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	3%	6%	14%	175 /Thorpe St Andrew/2	Amber
Norwich	Norwich	GNLP0409R	300	Mixed use	Green	Whitlingham Trowse	Red	Red	100%	0%	0%	5%	12%	44%	175 /Thorpe St Andrew/2	Red
Norwich	Norwich	GNLP0451	40	Mixed use	Green	Whitlingham Trowse	Red	Red	100%	0%	0%	0%	0%	9%	175 /Thorpe St Andrew/2	Red
Chedgrave	South Norfolk	GNLP0463	20	Residential	Green	Sisland	Red	Amber	100%	0%	0%	0%	2%	5%		Amber
Hingham	South Norfolk	GNLP0503	20	Residential	Green	Wymondham	Red	Amber	100%	0%	0%	0%	0%	2%		Amber
Norwich	Norwich	GNLP0506	1200	Residential	Amber	Whitlingham Trowse	Red	Amber	100%	0%	0%	5%	12%	24%	175 /Thorpe St Andrew/2	Amber
Hingham	South Norfolk	GNLP0520	80	Residential	Amber	Wymondham	Red	Red	100%	0%	0%	0%	1%	11%		Red
Foulsham	Broadland	GNLP0605	15	Residential	Green	Foulsham	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Great Witchingham	Broadland	GNLP0608	20	Residential	Green	Reepham	Red	Red	99%	1%	0%	0%	0%	3%		Red

Parish	District	Site reference	Housing numbers	Proposed site use	Clean Water	Wastewater			Flood Risk						Water Resources	Overall RAG rating
					Supply network	Water Recycling Centre (WRC)	Surface water connection capacity	Foul sewer connection capacity	Flood Zone 1	Flood Zone 2	Flood Zone 3	High RoFSW	Medium RoFSW	Low RoFSW	Groundwater sources affected	
Reedham	Broadland	GNLP1001	30	Residential	Amber	Reedham	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Blofield	South Norfolk	GNLP1048	80	Residential	Green	Whitlingham Trowse	Red	Red	100%	0%	0%	0%	0%	0%		Red
Coltishall	Broadland	GNLP2019	25	Residential	Green	Belaugh	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Freethorpe	Broadland	GNLP2034	50	Residential	Green	Freethorpe	Red	Amber	100%	0%	0%	0%	0%	1%		Red
Aylsham	Broadland	GNLP2060, GNLP 0311 and GNLP0595	300	Residential	Amber	Aylesham	Red	Amber	100%	0%	0%	3%	6%	11%		Amber
Norwich	Norwich	GNLP2062	250	Mixed Use	Green	Whitlingham Trowse	Red	Red	100%	0%	0%	0%	0%	1%	175 /Thorpe St Andrew/2	Red
Harleston	South Norfolk	GNLP2108	150	Residential	Amber	Harleston	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Bracon Ash	South Norfolk	GNLP2109	0	Employment	Green	Saxlingham	Red	Green	100%	0%	0%	0%	0%	0%		Amber
Norwich	Norwich	GNLP2114	150	Mixed Use	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	0%	175 /Thorpe St Andrew/2	Amber
Harleston	South Norfolk	GNLP2136	300	Mixed Use	Amber	Harleston	Red	Amber	100%	0%	0%	1%	1%	5%		Amber
Marsham	Broadland	GNLP2143	35	Residential	Green	Aylesham	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Norwich	Norwich	GNLP2159	150	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	0%	175 /Thorpe St Andrew/2	Amber
Blofield	Broadland	GNLP2161	15	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	0%		Amber

Parish	District	Site reference	Housing numbers	Proposed site use	Clean Water	Wastewater			Flood Risk						Water Resources	Overall RAG rating
					Supply network	Water Recycling Centre (WRC)	Surface water connection capacity	Foul sewer connection capacity	Flood Zone 1	Flood Zone 2	Flood Zone 3	High RoFSW	Medium RoFSW	Low RoFSW	Groundwater sources affected	
Norwich	Norwich	GNLP2163	40	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	5%	175 /Thorpe St Andrew/2	Amber
Norwich	Norwich	GNLP2164	25	Residential	Green	Whitlingham Trowse	Red	Amber	100%	0%	0%	0%	0%	5%	175 /Thorpe St Andrew/1; 175 /Thorpe St Andrew/2	Amber
Reedham	Broadland	GNLP3003	30	Residential	Green	Reedham	Red	Amber	100%	0%	0%	0%	0%	0%		Amber
Wymondham	South Norfolk	GNLP3013	50	Residential	Green	Wymondham	Red	Amber	100%	0%	0%	0%	1%	2%		Amber

7 Water Cycle Strategy Summary and Recommendations

This WCS study has set out the water environment and water infrastructure baseline for GNA and how it may be affected by growth numbers and locations proposed over the Local Plan period. This section of the WCS sets out the key conclusions, next steps and policy recommendations to support the WCS findings.

7.1 Wastewater and Water Quality

Wastewater treatment for the proposed housing growth will be provided by several WRCs in the GNA. Many of the WRCs have available permitted flow headroom to treat wastewater from the proposed growth; however, several will need a new permit and some that do have sufficient headroom, may still require a new permit with new quality limits to ensure using the headroom does not significantly impact on WFD compliance and the Wensum SAC.

The assessment has shown that subject to the revision of discharge permits and the implementation of the necessary treatment process upgrades (using conventional treatment technologies), changes in water quality as a result of additional discharge can be managed to ensure WFD compliance as well as compliance with the Wensum SAC water quality targets.

The analysis has demonstrated that upgrades required to deliver this outcome will be significant for several of the WRCs and this will require substantial investment from AWS over the longer term. In some cases, this may affect early phasing of development (to the end of 2020 and up to 2025) in some locations of the study area.

AWS have also indicated that there is no capacity within the public sewerage networks for additional surface water flows. The implementation of SuDS should be fully explored for all new developments in accordance with best practise guidance and the surface water drainage hierarchy to manage surface water and sewer flood risk. Additionally, some major development sites would experience known capacity restrictions in the foul network, with potential risk to combined sewer overflows, and hence developer contributions to new sewer networks would be required alongside AWS investment in AMP7 in order to enable growth at some identified sites.

7.2 Water Resources

The GNA falls within the Broadland CAMS area. The AWS WRZ areas are: Norwich and the Broads, Norfolk Rural and North Norfolk Coast WRZ's. All rivers are defined as having restricted or no water available for licensing during periods of low flow. As illustrated in Section 5.4, AWS has confirmed that there are sufficient resources within the WRZs to cater for the proposed growth between 2020 and 2045.

The AWS WRMP19 indicates that for the three WRZs within the GNA, the baseline supply-demand balance at 2045 will be negative if no strategic demand management options or supply-side schemes were not introduced. The AWS WRMP19 shows that with the introduction of strategic demand management options (for example smart metering, leakage reduction, water efficiency) or supply-side schemes (for example potable and raw water transfers, desalination, water re-use), water will be available to 2045 and caters for the levels of growth proposed in the GNLP.

Chapter 5 also assesses whether total neutrality can be achieved. It is indicated that the achievement of total water neutrality would require the implementation of unrealistic or expensive measures. Consequently, the 'optional requirement plus 5% retrofit' scenario would achieve 21% neutrality and it would require new homes to be designed to use water at rate 110 l/h/d.

AWS has also undertaken an assessment of the capacity of the water supply system using local operational knowledge and modelling showing that for the majority of the 'Preferred sites', no reinforcement in the water supply network would be required; however some sites would potentially require off-site reinforcement in the water supply network.

7.3 Recommendations and Policy

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

7.4 Policy Recommendations Overview

7.4.1 Wastewater

WW1 – Development and the Sewerage Network

It is recommended that Major Development sites assessed by AWS as part of the WCS as Amber or Red for wastewater network constraints should be subject to a pre-development enquiry[39] with AWS at an early stage, and if possible before submitting a planning application, to inform the asset management plans prior to planning permission being granted. Assessments made within this WCS consider each site in isolation and network capacity will change depending on when and where sites come forward.

WW2 – Development in the wastewater catchments of: Ditchingham, and Woodton

These WRC have limited current treatment capacity. It is recommended that the GNA authorities consider embedding a development control policy within the Local Plan to require that developers provide evidence to them that they have consulted with AWS regarding wastewater treatment capacity, and the outcome of this consultation, prior to development approval. The GNA authorities should consider the response from AWS when deciding if the expected timeframe for the development site in question is appropriate.

It is recommended that any planning permission for Major Development proposed to drain to these WRCs up to 2025, is subject to consultation with and discharge of any conditions imposed by the Environment Agency and AWS. Prior to development, both organisations should be satisfied that the development can be accommodated either within the limits of capacity at the WRC or by sufficient additional capacity being made available, and that the water quality requirements of the WFD will not be compromised.

If necessary, a Grampian condition could be imposed by the respective local authority, prohibiting development authorised by the planning permission or other aspects linked to the planning permission (e.g. occupation of dwellings) until the provision of the necessary infrastructure to accept the additional flows.

WW3 – Development in the wastewater catchments of: Aylsham, Foulsham, Long Stratton, Reepham, Rackheath, Diss, Saxlingham Whitlingham Trowse and Woodton

These WRCs are likely to require significant upgrades in AWS' next investment period (2025 onwards – AMP8). It is recommended that the GNA authorities consider embedding a development control policy within the Local Plan to require that developers provide evidence to them that they have consulted with AWS regarding wastewater treatment capacity, and the outcome of this consultation, prior to development approval. The GNA authorities should consider the response from AWS when deciding if the expected timeframe for the development site in question is appropriate.

It is recommended that any planning permission for Major Development proposed to drain to these WRCs up to 2030, is subject to consultation with and discharge of any conditions imposed by the Environment Agency and AWS. Prior to development, both organisations should be satisfied that the development can be accommodated either within the limits of capacity at the WRC or by sufficient additional capacity being made available, and that the water quality requirements of the WFD will not be compromised.

If necessary, a Grampian condition could be imposed by the respective local authority, prohibiting development authorised by the planning permission or other aspects linked to the planning permission (e.g. occupation of dwellings) until the provision of the necessary infrastructure to accept the additional flows.

[39] https://www.anglianwater.co.uk/developers/development-services/pre-planning-services/

WW4 – Development outside the three Districts

It is recommended that communication with neighbouring local authorities, as part of the duty to co-operate, should continue to be pursued, to ensure that future WCS assessments closely represent the future growth scenarios at WRCs which discharge into the Waveney, Bure, Yare and Wensum (and their tributaries).

WW5 - Treatment Capacity Review
It is recommended that each Council continues to update AWS on future development phasing and changes to growth allocations to ensure that plans for WRC upgrades in response to permit change requirements or flow capacity constraints take account of the most up to date planning position.

7.4.2 Water Supply

WS1 – Water Efficiency in New Homes and Buildings

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 including maximisation of water re-use, and that new housing development should go beyond mandatory Building Regulations requirements, with a minimum of the optional requirement of 110 l/h/d.

WS2 – Water Efficiency Retrofitting

In order to move towards a more 'water neutral position' throughout the three Districts, GNA should seek to advocate the achievement of further water efficiency savings through their planning policies and development management, working with AWS to develop further options for retrofitting. This could be considered further through the preparation of the Local Plan. It is recommended that GNA adopts a facilitating role of encouraging private landlords, owner-occupiers and businesses to retrofit existing dwellings and non-domestic buildings with water efficient devices, where sufficient resources are available.

WS3 – Water Supply Demand Balance

It is recommended that the GNA continues to update AWS on future development phasing and changes to growth allocations via the GNA authorities' Annual Monitoring Reports, to ensure the future supply-demand balance can be appropriately captured in the next asset planning period (AMP7).

7.4.3 Surface Water Management

SM1 – Sewer Separation

Developers should ensure foul and surface water from new development and redevelopment are kept separate where possible. Surface water should be discharged as high up the following hierarchy of drainage options as reasonably practicable, before a connection to the foul network is considered:

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

Where sites which are currently connected to combined sewers are redeveloped, the opportunity to disconnect surface water and highway drainage from combined sewers must be taken. This approach will also aid in improving capacity constraints at WRCs.

SM2 – Watercourse Discharge Controls

Discharges of surface water to watercourses should provide pollution prevention control measures prior to discharge. The use of SuDS should be encouraged to provide water quality improvements.

SM3 – Surface Water Sewer Capacity

The surface water and combined sewer systems in the study area are generally at capacity and it is therefore necessary for developers to implement SuDS systems to reduce runoff rates to as close to greenfield runoff as possible and achieve greenfield rates for all undeveloped sites.

7.4.4 Ecology

ECO1 – Biodiversity Enhancement

It is recommended that the GNA include a policy within its Local Plan which commits to seeking and securing (through planning permissions etc.) enhancements to aquatic biodiversity in the three Districts through the use of SuDS (subject to appropriate project-level studies to confirm feasibility including environmental risk and discussion with relevant authorities).

7.5 Further Recommendations

7.5.1 Stakeholder Liaison

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

7.5.2 WCS Review

Development phasing and new sites should continue to be monitored by GNA when future development plans evolve via the Council's Annual Monitoring Reports, to enable continued assessment on water supply and wastewater treatment. Where growth is expected to be significant, the Council should consider carrying out an update to the WCS to account for additional growth. In any future updates to the WCS, note should be taken of changes to the various studies and plans that support it.

7.5.3 Further water quality modelling

The assessment of wastewater capacity in this study has been undertaken by considering each WRC individually, and conservatively assessing the ability of watercourses to meet water quality conditions at the point of discharge.

A catchment approach to modelling discharges, considering opportunities to make improvements at different WRC locations, and to consider wider catchment inputs should be considered by AWS, Natural England and the Environment Agency. Such an approach would allow more certainty to be provided on the scale of WRC upgrades required and allow the investment process to be optimised to obtain the most favourable environmental outcome. This is particularly important for improvements required at the designated Broads SAC and Broadland SPA sites which are hydrologically linked to many of the WRC discharges within the GNA. As well as maintaining current quality once the plan has been delivered, there is considerable scope to improve water quality through a combination of WRC improvements at key locations where the pollutant load is the highest, and growth will not prevent these improvements from being delivered.

Appendix A Policy and Legislative Drivers Shaping the WCS

Directive/Legislation/Guidance	Description
Birds Directive 2009/147/EC	Provides for the designation of Special Protection Areas.
Building Regulations Approved Document G – sanitation, hot water safety and water efficiency (March 2010)	The current edition covers the standards required for cold water supply, water efficiency, hot water supply and systems, sanitary conveniences and washing facilities, bathrooms and kitchens and food preparation areas.
Eel Regulations 2009	Provides protection to the European eel during certain periods to prevent fishing and other detrimental impacts.
Environment Act 1995	Sets out the role and responsibility of the Environment Agency.
Environmental Protection Act 1990	Integrated Pollution Control (IPC) system for emissions to air, land and water.
Flood & Water Management Act 2010	The Flood and Water Management Act 2010 is the outcome of a thorough review of the responsibilities of regulators, local authorities, water companies and other stakeholders in the management of flood risk and the water industry in the UK. The Pitt Review of the 2007 flood was a major driver in the forming of the legislation. Its key features relevant to this WCS are: • To give the Environment Agency an overview of all flood and coastal erosion risk management and unitary and county councils the lead in managing the risk of all local floods. • To encourage the uptake of sustainable drainage systems by removing the automatic right to connect to sewers and providing for unitary and county councils to adopt SuDS for new developments and redevelopments. • To widen the list of uses of water that water companies can control during periods of water shortage, and enable Government to add to and remove uses from the list. • To enable water and sewerage companies to operate concessionary schemes for community groups on surface water drainage charges. • To make it easier for water and sewerage companies to develop and implement social tariffs where companies consider there is a good cause to do so, and in light of guidance that will be issued by the SoS following a full public consultation.
Future Water, February 2008	Sets the Government's vision for water in England to 2030. The strategy sets out an integrated approach to the sustainable management of all aspects of the water cycle, from rainfall and drainage, through to treatment and discharge, focusing on practical ways to achieve the vision to ensure sustainable use of water. The aim is to ensure sustainable delivery of water supplies, and help improve the water environment for future generations.
Groundwater Directive 80/68/EEC	To protect groundwater against pollution by 'List 1 and 2' Dangerous Substances.
Habitats Directive 92/44/EEC and Conservation of Habitats & Species Regulations 2010	To conserve the natural habitats and to conserve wild fauna and flora with the main aim to promote the maintenance of biodiversity taking account of social, economic, cultural and regional requirements. In relation to abstractions and discharges, can require changes to these through the Review of Consents (RoC) process if they are impacting on designated European Sites. Also the legislation that provides for the designation of Special Areas of Conservation provides special protection to certain non-avian species and sets out the requirement for Appropriate Assessment of projects and plans likely to have a significant effect on an internationally designated wildlife site.
Land Drainage Act 1991	Sets out the statutory roles and responsibilities of key organisations such as Internal Drainage Boards, local authorities, the Environment Agency and Riparian owners with jurisdiction over watercourses and land drainage infrastructure.
Making Space for Water, 2004	Outlines the Government's strategy for the next 20 years to implement a more holistic approach to managing flood and coastal erosion risks in England. The policy aims to reduce the threat of flooding to people and property, and to deliver the greatest environmental, social and economic benefit.

Directive/Legislation/Guidance	Description
National Planning Policy Framework	Planning policy in the UK is set by the National Planning Policy Framework (NPPF). NPPF advises local authorities and others on planning policy and operation of the planning system. A WCS helps to balance the requirements of various planning policy documents, and ensure that land-use planning and water cycle infrastructure provision is sustainable.
Pollution Prevention and Control Act (PPCA) 1999	Implements the IPPC Directive. Replaces IPC with a Pollution Prevention and Control (PPC) system, which is similar but applies to a wider range of installations.
Ramsar Convention	Provides for the designation of wetlands of international importance
Urban Waste Water Treatment Directive (UWWTD) 91/271/EEC	This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. Its aim is to protect the environment from any adverse effects caused by the discharge of such waters.
Water Act 2003	Implements changes to the water abstraction management system and to regulatory arrangements to make water use more sustainable.
Water Framework Directive (WFD) 2000/60/EC	The WFD combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level has been adopted. The overall requirement of the directive is that all river basins must achieve 'good ecological status' by 2015 or by 2027 if there are grounds for derogation. The Environment Agency is the body responsible for the implementation of the WFD in the UK. The Environment Agency have been supported by UKTAG[40], an advisory body which has proposed water quality, ecology, water abstraction and river flow standards to be adopted in order to ensure that water bodies in the UK (including groundwater) meet the required status[41]. Standards and water body classifications are published via River Management Plans (RBMP) the latest of which were completed in 2015.
Natural Environment & Rural Communities Act 2006	Covering Duties of public bodies – recognises that biodiversity is core to sustainable communities and that Public bodies have a statutory duty that states that "every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity
Water Resources Act 1991	Protection of the quantity and quality of water resources and aquatic habitats. Parts have been amended by the Water Act 2003.
Wildlife & Countryside Act 1981 (as amended)	Legislation that provides for the protection and designation of SSSIs and specific protection for certain species of animal and plant among other provisions.

[40] The UKTAG (UK Technical Advisory Group) is a working group of experts drawn from environment and conservation agencies. It was formed to provide technical advice to the UK's government administrations and its own member agencies. The UKTAG also includes representatives from the Republic of Ireland.
[41] UK Environmental Standards and Conditions (Phase I) Final Report, April 2008, UK Technical Advisory Group on the Water Framework Directive.

Appendix B Relevant Planning Documents to the WCS

Category	Document Name	Publication Date
Water	Environment Agency Anglian River Basin District: River Basin Management Plan	2015
Environment	Broadland, Norwich and South Norfolk: Adopted Joint Core Strategy	2014
Housing	Central Norfolk Strategic Housing Market Assessment	2017
	Broadlands Authority: Housing and Economic Land Availability Assessment	2017
	North Norfolk Housing and Economic Land Availability Assessment: Part 1 - Assessment of Housing Land	2018
Employment	North Norfolk Housing and Economic Land Availability Assessment: Part 2 - Assessment of Employment Land	2018
Flood Risk	Greater Norwich Area Strategic Flood Risk Assessment	2017
Water	Anglian Water - Water Resource Management Plan 2019	2019
Climate Change	United Kingdom Climate Projections 2018 (UKCP18)	2018

Appendix C WRC Capacity Assessment results

C.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 2.07 people per house and an average consumption of 125 l/h/d (as set out in Section 1.4.2);
- For WRC's with numerical permits, the WRC current discharge flows were taken as the current measured dry weather flow (DWF) (Q80) as provided by AWS in 2019. Future 2038 discharge flows were calculated by adding the volume of additional wastewater generated by new dwellings (using an OR of 2.07 and a consumption value of 125l/h/d) to the current permitted DWF value;
- WRC current discharge quality was taken as the current permitted limits for each water quality element. Figures for the mean and standard deviation of each element were calculated based on these permit levels using RQP 2.5 software (discussed further below),
- Raw water quality data for modelling was provided by Environment Agency water quality planners. The WFD 'no deterioration' target for each WRC are the downstream status, for each water quality element, based on river monitoring data for the most recent three years of sampling data. 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 WRC) and downstream (the discharge) inputs. Details are provided below along with the full results and outputs from the water quality modelling,
- The Environment Agency provided the most up to date WFD status.
- 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
  - 0.25mg/l for Phosphate.

C.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.

Modelling was completed for four tests to determine:

1. The permit required after growth but which would maintain the same river quality at the discharge mixing point as modelled for the current discharge volume. This would ensure no deterioration from the current river condition.
2. The permit required after growth but which would limit deterioration in the river at the mixing point to less than 10% of the current modelled quality.
3. The permit required after growth that would ensure no deterioration in WFD status of the waterbody at the mixing point.
4. Whether growth would prevent future objective WFD status from being attained.

C.3 Headroom Assessment

The permitted flow headroom capacity within an existing permit is assumed to be usable; therefore the following steps have been applied to calculate approximately how much available headroom each WRC has:

1. Determine the quantity of growth within a WRC catchment to determine the additional flow expected at each WRC (housing and employment land);
2. Calculate the additional wastewater flow generated at each WRC;
3. For WRC with numerical consents, calculate the remaining permitted flow headroom at each WRC and for WRC with descriptive consents, calculate remaining PE capacity before PE would exceed 250;
4. Determine whether the growth can be accommodated within existing headroom (or PE allowance).

C.4 Water Quality Assessment

For WRC where the criteria as set out below has been met, RQP modelling has been undertaken to determine the new quality conditions required for each WRC discharge:

- PE would exceed 250 (for descriptive consents);
- permitted DWF would be exceeded and discharge is to a fluvial system;
- remaining headroom would be less than 10% of the current DWF permit limit and discharge is to a fluvial system; or
- WRC discharges to the Wensum SAC.

Load standstill calculations have been undertaken for any WRC which receives growth but remaining headroom would be 10% or greater after growth, or where the discharge from the WRC is to a tidal waterbody.

For RQP, there are two steps to the process: the first focuses on different requirements to ensure no (or limited) deterioration, and the second considers future WFD targets and whether growth impacts on attaining these.

Step 1 – 'No Deterioration'

Table C-1 provides detail on each of the modelling steps related to no deterioration and the sequence in which these are performed.

Table C-1 Step 1 – 'No Deterioration' – C1, C2 and C3

Ref	Calculation Name	Calculation Detail	Reason for Calculation
C1	Maintain mixing point quality	No change in current modelled discharge quality at mixing point	To determine if it is technically feasible to ensure no change in current quality as a result of growth
C2	Limit deterioration to 10%	No deterioration from current downstream quality + 10% with future effluent flow	To determine if it is technically feasible to limit deterioration to no more than 10% of the current downstream water quality
C3	No deterioration (Current)	No deterioration from current status with current effluent flow	To calculate what quality condition is currently needed to avoid deterioration in the current status downstream with the current flow

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 WRC flow permit to be exceeded, see Table C-2.

Step 2 – Meeting Future 'Good' Status – C4 and C5

For all WRC meeting the requirement for RQP modelling and 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 its future objective status as set out in the online Catchment Data Explorer[42], 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 status assumed that other measures will be put in place to ensure the target status upstream, so that the modelling assumed upstream water quality is at the midpoint of the target status for each element and set the downstream target as the lower boundary of the target status for each element.

[42] Environment Agency: https://environment.data.gov.uk/catchment-planning/ accessed Dec 2020

If the target status 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 C-2.

If the modelling showed that the watercourse could not meet future target status with the proposed growth within limits of conventional treatment technology, then the scenario is rerun with current WRC flows. If the additional run shows that future targets could be met without growth, then it is concluded that growth would be a limiting factor in achieving the future target status and a detailed study is required to find suitable mitigation. If the modelling shows the future target status could not be achieved either with, or without growth, then the planned growth is concluded not to be a limiting factor in future target status requirements.

Table C-3 Step 2 – Meeting Future 'Good' Status – C4 and C5

Ref	Calculation Name	Calculation Detail	Reason for Calculation
C4	Achieve target status (Current)	Achieving target status with current effluent flow	To test what effluent quality would be needed to achieve target status with the current flow permit
C5	Achieve target status (Future)	Achieving target status with future effluent flow	To assess whether the future quality permit limits needed to achieve target status will be significantly more onerous and difficult to achieve than those currently needed (calculation 4)

Table C-2: RQP Assessment Results

WRC	**Aylsham WRC**			**Barnham Broom WRC**			**Beccles WRC**		
Is there flow headroom in the Permit? If so, what is the volume of flow headroom available after growth (m³/d)	None (flow permit exceeded)			None (flow permit exceeded)			None (flow permit exceeded)		
Parameters considered	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)
Permit condition	5	40	0.6	30	40	N/A	20	40	2
Measured quality of current discharge (taken from RQP output)	2.86	4.23	0.48	11.25	7.98	5.31	7.03	11.35	0.91
Limit of Conventional Treatment (LCT)	1	5	0.25	1	5	0.25	1	5	0.25
WFD receiving waterbody and ID	**River Bure (GB105034050930)**			**River Yare**			**River Waveney**		
Parameters considered	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)
Receiving waterbody Quality Element Published Status (2019)	**High**	**High**	**High**	**High**	N/A - not assessed	**Good**	**High**	N/A - not assessed	**Moderate**
Upstream sample point	**BUR070**			**YAR050**			**WAV120**		
Measured quality upstream of discharge(90 percentile Ammonia & BOD, annual average Phosphate) based on data PROVIDED BY EA and calculated in RQP	0.05	1.47	0.04	0.17	2.2	0.10	0.11	3.31	0.11
Quality Element Status based on measured data	**High**	**High**	**High**	**High**	**High**	**Moderate**	**High**	**High**	**Moderate**
Test 1 - Maintain Current Quality and limit to 10% deterioration	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Mixing Point Quality with current WRC flow (90 percentile Ammonia & BOD, annual average Phosphate)	0.08	1.47	0.050	0.21	2.20	0.14	0.23	3.32	0.12
Modelled status at mixing point with current flow	**High**	**High**	**High**	**High**	**High**	**Moderate**	**High**	**High**	**Moderate**
Permit condition required to maintain mixing point quality (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**2.62**	**4.52**	**0.53**	**10.47**	**9.36**	**5.24**	**6.55**	**10.81**	**0.64**
river target to limit to 10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	0.088	1.617	0.055	0.23	2.42	0.15	0.253	3.652	0.13
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**3.31**	**18.01**	**0.78**	**14.9**	**58.8**	**6.53**	**7.67**	**32.53**	**1.2**
Test 2 - WFD Status: no deterioration (waterbody status)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	4.00	0.052	0.30	4.00	0.095 (from EA)	0.30	4.00	0.232
permit condition required at mixing point - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(discharge quality 95%)**	**23.39**	**212.85**	**0.74**	**33.51**	**366.52**	**This test cannot be carried out - EA data shows upstream measured mean water quality is already worse than the deterioration target mean (provded by EA as Good target) - Published status is good, but measured data shows river is actually moderate.**	**10.55**	**59.31**	**7.42**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**19.44**	**178.68**	**0.63**	**29.16**	**319.20**		**9.93**	**56.28**	**6.98**
Test 3 - Future Status	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
Is current status less than good for the quality element	No - test not required	No - test not required	No - test not required	No - test not required	No - test not required	N/A - test not required	N/A - test not required	N/A - test not required	Yes
Target future status (2019)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**Moderate**
Permit condition required - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(Discharge quality mean quality)**									No Test required - target status same as current
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)									
Will Growth prevent future target status									N/A

Key to 'Effluent Quality Required' : Green value – no change to current permit required / Amber value – Permit tightening required, but within limits of conventioanlly applied treatment processes / Red value – not achievable within limits of conventioanlly applied treatment processes

WRC	Cantley WRC			Ditchingham WRC			Foulsham WRC		
Is there flow headroom in the Permit? If so, what is the volume of flow headroom available after growth (m³/d)	Yes - 10 m³/d			None (flow permit exceeded)			Yes (95 m3/d)		
Parameters considered	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)
Permit condition	-	45	-	8.7	20	1	-	40	1
Measured quality of current discharge (taken from RQP output)	4.61	8.27	4.02	3.25	4.09	0.76	2.46	6.63	0.8
Limit of Conventional Treatment (LCT)	1	5	0.25	1	5	0.25	1	5	0.25
WFD receiving waterbody and ID	**River Yare**			**Broome Beck GB105034045930**			**Foulsham Tributary GB105034055850**		
Parameters considered	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)
Receiving waterbody Quality Element Published Status (2019)	**High**	**High**	**Moderate**	**High**	N/A - not assessed	**Moderate**	**High**	N/A - not assessed	**Moderate**
Upstream sample point	**YAR230**			**None**			**None**		
Measured quality upstream of discharge(90 percentile Ammonia & BOD, annual average Phosphate) based on data PROVIDED BY EA and calculated in RQP	0.14	2.41	0.14	0.15	2.01	0.166	0.15	2.01	0.07
Quality Element Status based on measured data	**High**	**High**	**Moderate**	**High**	**High**	**Moderate**	**High**	**High**	**Good**
Test 1 - Maintain Current Quality and limit to 10% deterioration	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Mixing Point Quality with current WRC flow (90 percentile Ammonia & BOD, annual average Phosphate)	0.14	2.39	0.14	0.2	1.98	0.19	0.19	2.04	0.1
Modelled status at mixing point with current flow	**High**	**High**	**Moderate**	**High**	**High**	**Moderate**	**High**	**High**	**Moderate**
Permit condition required to maintain mixing point quality (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**452.55**	**95.29**	**0.6**	**3.14**	**4.07**	**0.73**	**2.24**	**6.3**	**0.81**
river target to limit to 10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	0.154	2.629	0.154	0.22	2.178	0.21	0.209	2.24	0.11
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**559.16**	**1358.10**	**41.82**	**4.17**	**13.37**	**1.35**	**3.09**	**12.63**	**1.06**
Test 2 - WFD Status: no deterioration (waterbody status)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	4.00	0.232	0.30	4.00	0.231	0.30	4.00	0.092
permit condition required at mixing point - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(discharge quality 95%)**	**1686.2**	**6508.30**	**291.8**	**8.52**	**81.16**	**2.11**	**7.29**	**64.47**	**0.64**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**1671**	**6442.30**	**289.16**	**8.03**	**76.6**	**2.00**	**6.83**	**60.4**	**0.61**
Test 3 - Future Status	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
Is current status less than good for the quality element	N/A - test not required	N/A - test not required	Yes	N/A - test not required	N/A - test not required	Yes	N/A - test not required	N/A - test not required	Yes
Target future status (2019)	N/A	N/A	**Moderate**	N/A	N/A	**Moderate**	N/A	N/A	**Good**
Permit condition required - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(Discharge quality mean quality)**			No Test required - target status same as current			No Test required - target status same as current			N/A - Test 2 above uses Good Status limit as measured data is Good and current status of Moderate only recently changed in 2019 - Test 2 shows Good can be reached with growth
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)									
Will Growth prevent future target status			N/A			N/A			
Natural England (NE) assessment							Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
NE target							**0.6**	**1.5**	**0.03**
Permit required with current WRC flows and current u/s quality							18.74	Not possible - u/s quality needs improving	Not possible - u/s quality needs improving
Permit required with future WRC flows and current u/s quality							17.51		
Would growth limit NE target compared to current flows assuming u/s river quality remains as current?							**No - required permit is achievable with and without growth**		
If upstream quality is improved to NEW target - what is the permit required with current WRC flows							**N/A - can be achieved with current quality**	**4.22**	**0.02**
If upstream quality is improved to NEW target - what is the permit required with future WRC flows								**4.01**	**0.02**
Would growth limit NE target compared to current flows assuming u/s river quality is improved to the target quality?								**No - required permit is not achievable with or without growth, so growth is not the limitng factor**	**No - required permit is not achievable with or without growth, so growth is not the limitng factor**

Key to 'Effluent Quality Required' : Green value – no change to current permit required / Amber value – Permit tightening required, but within limits of conventioanlly applied treatment processes / Red value – not achievable within limits of conventioanlly applied treatment processes

WRC	Long Stratton WRC			Reepham WRC			Saxlingham WRC		
Is there flow headroom in the Permit? If so, what is the volume of flow headroom available after growth (m³/d)	None (flow permit exceeded)			Yes (105 m3/d)			Yes (5 m3/d)		
Parameters considered	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)
Permit condition	1	20	1	10	30	1	13	25	-
Measured quality of current discharge (taken from RQP output)	2.46	6.63	0.76	4.88	13.56	0.65	3.38	9.56	5.6
Limit of Conventional Treatment (LCT)	1	5	0.25	1	5	0.25	1	5	0.25
WFD receiving waterbody and ID	**Tas (Head to Tasburgh) (GB105034045730)**			**Blackwater Drain (GB105034051120)**			**Tas (Tasburgh to R. Yare) GB105034051230**		
Parameters considered	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)
Receiving waterbody Quality Element Published Status (2019)	**High**	N/A - not assessed	**Poor**	**High**	N/A - not assessed	**High**	**High**	N/A - not assessed	**Moderate**
Upstream sample point	**None**			**WEN203**			**None**		
Measured quality upstream of discharge(90 percentile Ammonia & BOD, annual average Phosphate) based on data PROVIDED BY EA and calculated in RQP	0.15	2.01	0.17	0.15	2.01	0.03	0.15	2.01	0.07
Quality Element Status based on measured data	**High**	**High**	**Moderate**	**High**	**High**	**High**	**High**	**High**	**Moderate**
Test 1 - Maintain Current Quality and limit to 10% deterioration	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Mixing Point Quality with current WRC flow (90 percentile Ammonia & BOD, annual average Phosphate)	1.59	5.26	0.73	0.67	2.97	0.09	0.75	3.53	1.26
Modelled status at mixing point with current flow	**Moderate**	**Moderate**	**Poor**	**Moderate**	**High**	**Moderate**	**Moderate**	**High**	**Bad**
Permit condition required to maintain mixing point quality (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**2.47**	**6.69**	**0.76**	**4.35**	**12.36**	**0.59**	**3.17**	**8.98**	**5.13**
river target to limit to 10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	1.749	5.786	0.80	0.737	3.267	0.10	0.825	3.883	1.39
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**2.72**	**7.36**	**0.84**	**4.86**	**14.92**	**0.69**	**3.51**	**10.34**	**5.68**
Test 2 - WFD Status: no deterioration (waterbody status)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	5.00 (based on EA advice - Good)	0.223	0.30	4.00	0.053	0.30	5.00 (based on EA advice - Good)	0.096
permit condition required at mixing point - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(discharge quality 95%)**	**0.47**	**6.38**	**0.23**	**1.68**	**22.8**	**0.27**	**1.14**	**15.67**	**0.19**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**0.46**	**6.35**	**0.22**	**1.51**	**20.43**	**0.24**	**1.06**	**14.37**	**0.18**
Test 3 - Future Status	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
Is current status less than good for the quality element	N/A - test not required	N/A - test not required	N/A - test not required	N/A - test not required	N/A - test not required	N/A - test not required	N/A - test not required	N/A - test not required	Yes -Test Required
Target future status (2019)	N/A	N/A	**Moderate**	N/A	N/A	N/A	N/A	N/A	**Moderate**
Permit condition required - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(Discharge quality mean quality)**			N/A - test not required - moderate status was used for the no deterioration test. It is not possible to achieve current moderate status with or without growth						N/A - Test 2 above uses Moderate Status limit as measured data is Moderate - Test 2 shows Moderate cannot be reached with current discharge so growth is not a limiting factor
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)									
Will Growth prevent future target status									
Natural England (NE) assessment				Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)			
NE target				**0.6**	**1.5**	**0.03**			
Permit required with current WRC flows and current u/s quality				7.99	Not possible - u/s quality needs improving	**0.03**			
Permit required with future WRC flows and current u/s quality				7.11		**0.03**			
Would growth limit NE target compared to current flows assuming u/s river quality remains as current?				**No - required permit is achievable with and without growth**		**No - required permit is not achievable with or without growth, so growth is not the limitng factor**			
If upstream quality is improved to NEW target - what is the permit required with current WRC flows				**N/A - can be achieved with current quality**	**2.64**	**N/A - same as text above (u/s current quality is 0.03 and at NE target)**			
If upstream quality is improved to NEW target - what is the permit required with future WRC flows					**2.58**				
Would growth limit NE target compared to current flows assuming u/s river quality is improved to the target quality?					**No - required permit is not achievable with or without growth, so growth is not the limitng factor**				

Key to 'Effluent Quality Required' : Green value – no change to current permit required / Amber value – Permit tightening required, but within limits of conventioanlly applied treatment procesess / Red value – not achievable within limits of conventioanlly applied treatment processes

WRC	Whitlingham Trowse WRC			Woodton WRC			Wymondham WRC		
Is there flow headroom in the Permit? If so, what is the volume of flow headroom available after growth (m^3/d)	None (flow permit exceeded)			None (flow permit exceeded)			None (flow permit exceeded)		
Parameters considered	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)	Ammonia (mg/l - 95%ile)	BOD (mg/l - 95%ile)	Phosphate (mg/l - mean)
Permit condition	7	20	1	10	33	-	1	12	0.8
Measured quality of current discharge (taken from RQP output)	1.51	6.82	0.76	2	4.93	4.13	1.68	5.03	0.65
Limit of Conventional Treatment (LCT)	1	5	0.25	1	5	0.25	1	5	0.25
WFD receiving waterbody and ID	**Yare (Wensum to tidal) (GB105034051370)**			**Broome Beck (GB105034045930)**			**Tiffey (GB105034051282)**		
Parameters considered	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)	Ammonia (mgl - 90%ile)	BOD (mgl - 90%ile)	Phosphate (mgl - mean)
Receiving waterbody Quality Element Published Status (2019)	**High**	**High**	**Moderate**	**High**	N/A - not assessed	**Moderate**	**Good**	N/A - not assessed	**Moderate**
Upstream sample point	**YAR190**			**None**			**TIF050**		
Measured quality upstream of discharge(90 percentile Ammonia & BOD, annual average Phosphate) based on data PROVIDED BY EA and calculated in RQP	0.19	2.71	0.11	0.15	2.01	0.078	0.13	2.37	0.09
Quality Element Status based on measured data	**High**	**High**	**Moderate**	**High**	**High**	**Moderate**	**High**	**High**	**Good**
Test 1 - Maintain Current Quality and limit to 10% deterioration							Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Mixing Point Quality with current WRC flow (90 percentile Ammonia & BOD, annual average Phosphate)	0.35	3.12	0.25	0.19	2.00	0.27	0.41	2.75	0.25
Modelled status at mixing point with current flow	**Good**	**High**	**Poor**	**High**	**High**	**Poor**	**Good**	**High**	**Poor**
Permit condition required to maintain mixing point quality (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**1.42**	**6.63**	**0.69**	**1.83**	**4.58**	**3.8**	**1.55**	**4.92**	**0.6**
river target to limit to 10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	0.385	3.432	0.28	0.209	2.20	0.30	0.451	3.025	0.28
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate) **(95% discharge quality)**	**1.63**	**8.01**	**0.82**	**2.57**	**9.92**	**4.4**	**1.73**	**5.83**	**0.69**
Test 2 - WFD Status: no deterioration (waterbody status)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	4.00	0.23	0.30	4.00	0.231	0.30	5.00 (based on EA advice - Good)	0.094 (based on EA advice - Good)
permit condition required at mixing point - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(discharge quality 95%)**	**1.20**	**11.61**	**0.68**	**6.18**	**55.19**	**3.37**	**1.18**	**12.89**	**0.1**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**1.10**	**10.75**	**0.62**	**5.55**	**50.43**	**3.04**	**1.06**	**12.01**	**0.1**
Test 3 - Future Status	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
Is current status less than good for the quality element	N/A - test not required	N/A - test not required	Yes -Test Required	N/A - test not required	N/A - test not required	Yes	N/A - test not required	N/A - test not required	N/A - test not required
Target future status (2019)			**Moderate**			**Moderate**			**Good**
Permit condition required - current WRC flow (95 percentile Ammonia & BOD, annual average Phosphate) **(Discharge quality mean quality)**	N/A	N/A	N/A - Test 2 above uses Moderate Status limit as measured data is Moderate - Test 2 shows Moderate can be reached with and without growth	N/A	N/A	N/A - Test 2 above uses Moderate Status limit as measured data is Moderate - Test 2 shows Moderate can be reached with and without growth	N/A	N/A	N/A - Test 2 above uses Good Status limit as measured data is Good - Test 2 shows Good cannot be reached without growth, so growth is not a limiting factor
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)									
Will Growth prevent future target status									

Key to 'Effluent Quality Required' : Green value – no change to current permit required / Amber value – Permit tightening required, but within limits of conventioanlly applied treatment procesess / Red value – not achievable within limits of conventioanlly applied treatment processes

Appendix D Water Neutrality

Water Neutrality is defined in Section 4, and the assumptions used outlined in Section 1.6. This appendix provides supplementary information and guidance behind the processes followed.

D.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. At the same time measures are taken, such as retrofitting of water efficient devices on existing homes and business to reduce water use in existing development.

In order to reduce water consumption and manage demand for the limited water resources within the study area, a number of measures and devices are available[43], including:

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

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

However, there are a number of the measures listed above that can be easily and cheaply installed into existing properties, particularly if part of a large campaign targeted at a number of properties. Examples of these include the fitting of dual-flush toilets and low flow showers heads to social housing stock, as was successfully carried out in Preston by Reigate and Banstead Council in conjunction with Sutton and East Surrey Water and Waterwise[44].

D.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.

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;
- NHS buildings for new buildings and refurbishments;

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

- Department for Children, Schools and Families for all projects valued at over £500K (primary schools) and £2million (secondary schools);
- 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 a Local Plan, the only water efficiency requirements for new development are through the Building Regulations[45] 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 to propose local policy to address specific local concerns.

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.

D.3 Improving Efficiency in Existing Development

Metering

The installation of water meters in existing housing stock has the potential to generate significant water use reductions because it gives customers a financial incentive to reduce their water consumption. Being on a meter also encourages the installation and use of other water saving products, by introducing a financial incentive and introducing a price signal against which the payback time of new water efficiency measures can be assessed. Metering typically results in a 5-10 per cent reduction from unmetered supply, which equates to water savings of approximately 50l per household per day, assuming an occupancy rate of 2.3[46] 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 view)[47]. 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 D-1).

Table D-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

[45] Part G of the Building Regulations
[46] 2.3 is used for existing properties and new properties. This figure was agreed with STW prior to the assessment
[47] Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69459/walker-review-final-report.pdf

Low or Variable Flush Toilets

Toilets use about 30 per cent of the total water used in a household[48]. 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[49]per flush. A study carried out in 2000 by Southern Water and the Environment Agency[50] on 33 domestic properties in Sussex showed that the average dual flush saving observed during the trial was 27 per cent, equivalent to a volumetric saving of around 2.6 litres per flush. The study suggested that replacing existing toilets with low or variable flush alternatives could reduce the volume of water used for toilet flushing by approximately 27 per cent on average.

Cistern Displacement Devices

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

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

Low Flow Taps and Showers

Flow reducing aerating taps and shower heads restrict the flow of water without reducing water pressure. Thames Water estimates that an aerating shower head can cut water use by 60 per cent with no loss of performance[51].

Pressure Control

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

Variable tariffs

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

The Walker review assessed variable tariffs for water, including:

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

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

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

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.

[48] http://www.waterwise.org.uk/pages/indoors.html
[49] http://www.thegreenage.co.uk/tech/water-saving-toilet/
[50] The Water Efficiency of Retrofit Dual Flush Toilets, Southern Water/Environment Agency, December 2000
[51] http://www.thameswater.co.uk/cps/rde/xchg/corp/hs.xsl/9047.htm

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

Water Efficient Appliances

Washing machines and dishwashers have become much more water efficient over the past twenty years; whereas an old washing machine may use up to 150 litres per cycle, modern efficient machines may use as little as 35 litres per cycle. An old dishwasher could use up to 50 litres per cycle, whereas modern models can use as little as 10 litres. However, this is partially offset by the increased frequency with which these are now used. It has been estimated[52] that dishwashers, together with the kitchen tap, account for about 8-14 per cent of water used in the home.

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

Non-Domestic Properties

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

Water Efficiency in New Development

The use of efficient fixtures and fittings as described in above also apply to the specification of water use in the building of new homes. The simplest way of demonstrating the reductions 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 building regulation and building regulation optional water use requirements. Part G of The Building Regulations 2010 has been used to develop these figures. For 80l/h/d and 62l/h/d houses, The Building Regulations Water Efficiency Calculator has been used in association with the Department of Communities and Local Government – Housing Standard Review (September 2014). These are shown below in Table D-2.

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

Component	133 l/h/d Standard Home	Building Regulations 125 l/h/d	Building Regulations Optional Target 110 l/h/d	Anglian Water target 100 l/h/d	62 l/h/d (water recycling)
Toilet flushing	28.2	18.7	12.3	11.2	12.3
Taps	25.6	22.7	20.5	19.6	15.3
Shower	39.8	39.8	31.8	28.9	23.9
Bath	18.5	18.5	17.0	15.5	14.5
Washing Machine	15.6	15.6	15.6	15.6	15.6
Dishwasher	4.1	4.1	4.1	4.1	4.1
Recycled water				-	-29.5
External Use	5	5	5	5	0
Total per head	136.7	124.4	106.3	98.1	63.9

a Combines kitchen sink and wash hand basin

b 6/4 litre dual-flush toilet (f) recycled water

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

c 185 litre bath

d 4/2.6 litre dual flush toilet

e Rainwater harvesting for external and toilet use

f 170 litre bath

g Rainwater/greywater harvesting for toilet, external and washing machine

h 145 litre bath

Table D-2 highlights that in order for high and very high efficiencies to be achieved for water use under 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[53], 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 or lower can be reached without some form of water recycling.

Rainwater Harvesting

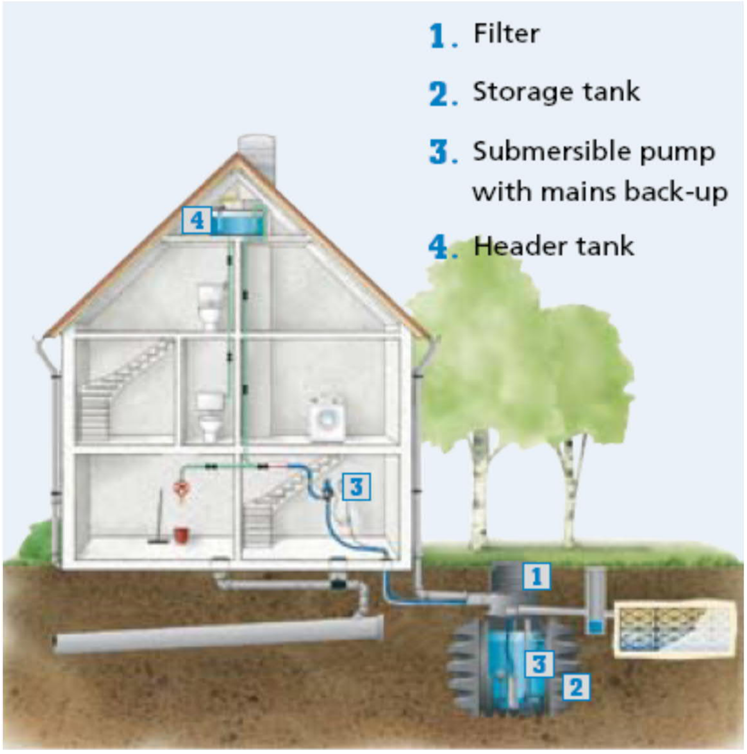
Rainwater harvesting (RWH) is the capture and storage of rain water that lands on the roof of a property. This can have the dual advantage of both reducing the volume of water leaving a site, thereby reducing surface water management requirements and potential flooding issues, and be a direct source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

RWH systems typically consist of a collection area (usually a rooftop), a method of conveying the water to the storage tank (gutters, down spouts and pipes), a filtration and treatment system, a storage tank and a method of conveying the water from the storage container to the taps (pipes with pumped or gravity flow). A treatment system may be included, depending on the rainwater quality desired and the source. Figure D-1 below gives a diagrammatic representation of a typical domestic system[54].

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[55].

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

Figure D-1: A typical domestic rainwater harvesting system



A sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[56], 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 D-3.

Table D-3: Rainwater Harvesting Systems Sizing

Number of occupants	Total water consumption	Roof area (m2)	Required storage tank (m3)	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 were installed.

Greywater Recycling

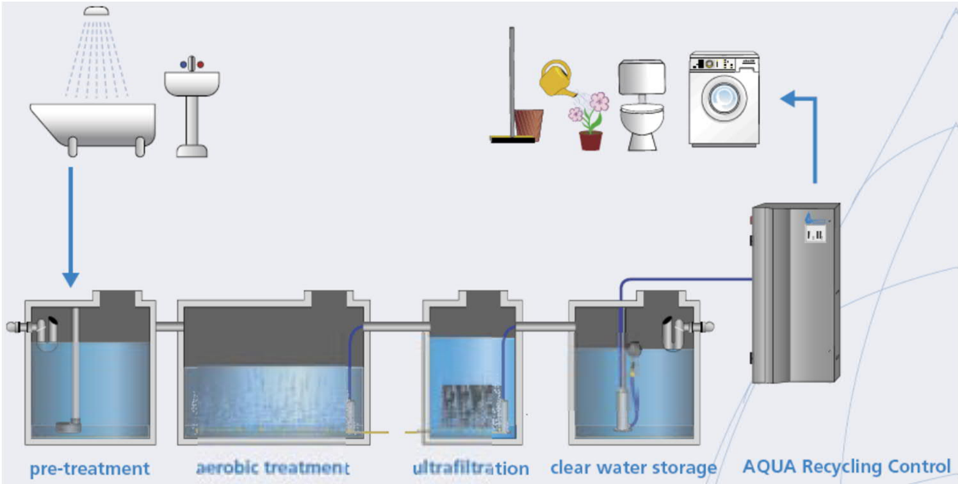
Greywater recycling (GWR) is the treatment and re-use of wastewater from shower, bath and sinks for use again within a property where potable quality water is not essential e.g. toilet flushing. Recycled greywater is not suitable for human consumption or for irrigating plants or crops that are intended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

The storage volumes required for GWR are usually smaller than those required for rainwater harvesting as the supply of greywater is more reliable than rainfall. In domestic situations, greywater production often exceeds

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

demand and a correctly designed system can therefore cope with high demand application and irregular use, such as garden irrigation. Figure D-2 below gives a diagrammatic representation of a typical domestic system[57].

Figure D-2: A typical domestic greywater recycling system



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

The Northstowe sustainable water management strategy calculated the volumes of water that could be made available from the use GWR. These were assessed against water demand calculated using the BRE Water Demand Calculator[58].

Table D-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 D-4: Potential water savings from greywater recycling

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[59].

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

- basic (e.g. coarse filtration and disinfection);

[57] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[58] http://www.thewatercalculator.org.uk/faq.asp
[59] Centre for the Built Environment, https://www.cbe.berkeley.edu/

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

Table D-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	Water Efficient Fixtures and Fittings
Low (Building Regulations)	125	- WC 6/4 litres dual flush or - 4.5 litres single flush - Shower 10 l/min - Bath 185 litres - Basin taps 6 l/min - Sink taps 8 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	95%	None
Low (Building Regulations + Retrofit)	125	- WC 6/4 litres dual flush or - 4.5 litres single flush - Shower 10 l/min - Bath 185 litres - Basin taps 6 l/min - Sink taps 8 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	95%	10% take up across study area: - WC 6/4 litres dual flush or - 4.5 litres single flush - Shower 10 l/min - Basin taps 6 l/min - Sink taps 8 l/min
Medium (Building Regulations Optional Requirement)	110	- WC 4/2.6 litres dual flush - Shower 8 l/min - Bath 170 litres - Basin taps 5 l/min - Sink taps 6 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	95%	None
Medium (Building Regulations Optional Requirement + Retrofit)	110	- WC 4/2.6 litres dual flush - Shower 8 l/min - Bath 170 litres - Basin taps 5 l/min - Sink taps 6 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	95%	15% take up across study area: - WC 4/2.6 litres dual flush - Shower 8 l/min - Basin taps 5 l/min - Sink taps 6 l/min

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	Water Efficient Fixtures and Fittings
Theoretical Water Neutrality	62	- WC 4/2.6 litres dual flush; - Shower 6 l/min - Bath 145 litres - Basin taps 2 l/min - Sink taps 4 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	Rainwater harvesting and Greywater recycling	100%	25% take up across study area: - WC 4/2.6 litres dual flush; - Shower 6 l/min - Basin taps 2 l/min - Sink taps 4 l/min