Vale of White Horse District Council Draft Water Cycle Study Addendum

Vale of White Horse District Council

September 2017

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
01	31/08/17	Draft		Jon Robinson	Director
02	08/09/17	Incorporation of Client Comments		Sarah Kelly	Regional Director

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List of Acronyms

AMP	Asset Management Plan
BAP	Biodiversity Action Plan
BGS	British Geological Society
BOD	Biochemical Oxygen Demand
BREEAM	Building Research Establishment Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CBA	Cost Benefit Analysis
CFMP	Catchment Flood Management Plan
CIL	Community Infrastructure Levy
CIRIA	Construction Industry Research and Information Association
CLG	Communities and Local Government
CRC	Carbon Reduction Commitment
DEFRA	Department for Environment, Food and Rural Affairs
DWF	Dry Weather Flow
EA	Environment Agency
EFI	Environmental Flow Indicator
GI	Green Infrastructure
GWR	Greywater Recycling
HA	Highways Agency
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LFE	Low Flow Enterprise (low flow model)
LLFA	Lead Local Flood Authority
LNR	Local Nature Reserve
LPA	Local Planning Authority
Ml	Mega Litre (a million litres)
NE	Natural England
NPPF	National Planning Policy Framework
OAHN	Objectively Assessed Housing Need
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
ONS	Office for National Statistics
OR	Occupancy Rate
P	Phosphorous
Q95	The river flow exceeded 95% of the time
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RoC	Review of Consents (under the Habitats Directive)
RQP	River Quality Planning (tool)
RWH	Rainwater Harvesting
S106	Section 106 (Town and Country Planning Act 1990)
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
TWUL	Thames Water Utilities Limited
UKCIP02	United Kingdom Climate Impacts Programme 2002
UKCP09	United Kingdom Climate Projections 2009
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UKWIR	United Kingdom Water Industry Research group
UWWTD	Urban Wastewater Treatment Directive
VoWH	Vale of White Horse
WCS	Water Cycle Study
WFD	Water Framework Directive
WN	Water Neutrality
WwTW	Waste Water Treatment Works
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

Non-Technical Summary

The District of the Vale of White Horse is expected to experience a significant increase in housing provision and economic growth over the period between 2011 and 2031. This growth represents a challenge in ensuring that both the water environment and water services infrastructure has the capacity to sustain this level of growth and development proposed.

VoWH District Council is currently preparing a new Local Plan which will compliment Local Plan 2031 Part 1 (LPP1), will set out the Council's strategy for future development and growth up to 2031 and will supersede current policies under the Local Plan 2011. This Vale of White Horse District Council Water Cycle Study (WCS) forms an important part of the evidence base of the new Local Plan that will help to ensure that development does not have a detrimental impact on the water environment within the district. It also contains information of relevance to the implementation of the adopted Local Plan, and will help to guide development towards the most appropriate locations (with respect to water infrastructure and the water environment) to be identified in the Local Plan Part 2.

The WCS has assessed proposed future development with regards to water supply capacity, wastewater capacity and environmental capacity. Any water quality issues, associated water infrastructure upgrades that may be required and potential constraints have subsequently been identified and reported. This WCS then provides information at a level suitable to demonstrate that there are workable solutions to key constraints for any proposed development site.

Wastewater Strategy

The WCS identifies that in total 13 Wastewater Treatment Works (WwTW) will serve the proposed future development across the District. The table below provides an indication of the WwTWs which have available capacity and those that are likely to require changes to environmental permits that control discharge and potentially infrastructure upgrades.

WwTW	Summary
Abingdon WwTW	Flow capacity available for planned growth with some flow capacity available for growth beyond the plan period. Current treatment processes and discharge permit are sufficient.
Appleton WwTW	Limited flow capacity, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.
Buckland WwTW	Flow capacity available for planned growth with some flow capacity available for growth beyond the plan period. Current treatment processes and discharge permit are sufficient.
Didcot WwTW	No flow capacity available for planned growth, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.
Drayton WwTW	Limited flow capacity, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ensure compliance with legislative water quality targets as well as meet more stringent, non-statutory river quality targets.
Faringdon WwTW	Limited flow capacity, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.

WwTW	Summary
Kingston Bagpuize WwTW	No flow capacity available for planned growth, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.
Littleworth WwTW	Small WwTW (dry weather flow < $50m^3/d$), therefore no flow provided. Housing allocated to this works will need to be assessed by Thames Water.
Oxford WwTW	No flow capacity available for planned growth, therefore growth upgrades and careful development phasing will be required immediately. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.
Shrivenham WwTW	Limited flow capacity, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.
Stanford in the Vale WwTW	Limited flow capacity, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ensure compliance with legislative water quality targets as well as meet more stringent, non-statutory river quality targets.
Uffington WwTW	Flow capacity available for planned growth with some flow capacity available for growth beyond the plan period. Current treatment processes and discharge permit are sufficient.
Wantage WwTW	No flow capacity available for planned growth, therefore growth upgrades and careful development phasing will be required. Treatment process upgrades using conventional treatment technology can ultimately ensure compliance with legislative water quality targets. Alternative solutions (non-conventional treatment technologies for some parameters) may be required to meet more stringent, non-statutory river quality targets.

Wastewater Treatment

Four WwTWs (Didcot, Kingston Bagpuize, Oxford and Wantage) do not currently have sufficient flow capacity and/or have insufficient treatment processes to accept all future development proposed within the plan period. Therefore solutions are required in order to accommodate the growth to ensure that the increased wastewater flow discharged does not impact on the current quality of the receiving watercourses, their associated ecological sites and also to ensure that the watercourses can still meet with legislative requirements.

The WCS has concluded that feasible solutions are possible to ensure legislative objectives are met. However, this WCS recommends that the Vale of White Horse District Council, the Environment Agency, and Thames Water Utilities Limited continue to work together to determine the nature of upgrades which will need to be implemented in order to conclude the timing and quantity of development that can be accommodated across the District in the early phases of the Local Plan delivery period.

To ensure that the planned level of development within the Plan period does not result in a negative impact upon wildlife both inside and outside of designated sites, it is recommended that the Vale of White Horse District Council and Thames Water Utilities Limited use the results of this WCS to inform the Local Plan documents and asset management plans respectively. By working together, this will ensure that as developments come online there is sufficient capacity available locally to ensure all objectives of the Water Framework Directive (WFD) continue to be met.

Water Supply Strategy

Based on the growth assessed, the WCS has concluded that, allowing for the planned resource management of Thames Water's supply area, there would be adequate water resources to cater for growth over the plan period.

However, the WCS has identified that there are long term limitations on further abstraction from the raw water resources supplying the District. Hence there are key drivers requiring that water demand is managed in the District for all new development in order to achieve long term sustainability in terms of water resources.

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

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

Four water neutrality scenarios have been proposed and assessed to demonstrate what is required to achieve different levels of neutrality in the District. The assessment concluded that measures should be taken to deliver the first step on the neutrality pathway. The following initial measures are therefore suggested by the WCS:

- Encourage a programme of retrofitting and water audits of existing dwellings and non-domestic buildings. Aim to move towards delivery of at least 15% of the existing housing stock, with easy fit water saving devices; and,
- Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

Overall Impact of Development

The WCS sets out recommendations for what is required, when, and where in order to address any emerging issues from investigating the key questions. These recommendations must take account of potential environmental impacts, and the availability of funding and future management arrangements to ensure that adverse impact on the water environment is minimised as a result of development arising from the Local Plan process.

In order to support the further development of the Vale of White Horse District Council's Local Plan with respect to water services infrastructure and the water environment; the WCS provides a site specific assessment of the potential constraints on each of the Local Plan Part 2 (LPP2) proposed major development sites.

1. Introduction

1.1 Background

The District of the Vale of White Horse (VoWH) is located in the County of Oxfordshire. The District has experienced significant growth in the past decade, and is expected to experience a significant increase in housing requirement and economic growth over the period to 2031.

VoWH District Council is currently preparing a new Local Plan which will compliment Local Plan 2031 Part 1 (LPP1), will set out the Council's strategy for future development and growth up to 2031 and will supersede current policies under the Local Plan 2011. The Objectively Assessed Housing Needs (OAHN) Study for VoWH identified 20,560[1] homes would be required in the District from 2011 to 2031 (1028 homes per annum).The District is also required to provide a proportion of Oxford's unmet housing need which is 2,200 houses up to 2031. The total requirement in the District is therefore 22,760. These homes will be located primarily in the towns and service villages as well as a number of strategic growth locations.

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 District. 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 should provide 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 WCS History

A full WCS was prepared for the VoWH LPP1 in 2014. LPP1 identified the areas that will receive growth and the number of houses that will be allocated within the district. The assessment found that Drayton, Faringdon, Kingston Bagpuize, Oxford and Shrivenham WwTWs are particularly constrained as upgrades would be required by 2021 to enable them to accommodate expected growth without failing their consents. It was recommended that improvements were made to water efficiency to ensure water resources availability in the district.

A Phase 1 high level assessment was undertaken of the initial site options for Local Plan Part 2 (LPP2) in January 2017. LPP2 sets out policies and locations for housing the Vale's proportion of Oxford's unmet housing need up to 2031. It also allocates additional development sites for housing. This study provided supporting evidence to support the Preferred Options Consultation. The assessment determined the current headroom in wastewater treatment works (WwTW) and identified any potential capacity problems. The Phase 1 study with reference to wastewater found that Abingdon, Didcot, Drayton, Kingston Bagpuize, Oxford and Wantage WwTW's would be over the consented permitted headroom when the growth from the proposed LPP1 and LPP2 housing sites were considered together.

This LPP2 WCS will build on the findings from the Local Plan Part 1 WCS. It should be noted that, whilst this full LPP2 WCS has considered LPP1 and LPP2 growth in combination, allocation of additional development for LPP2 is confined to the eastern portion of the district impacting Wantage WwTW, Kingston Bagpuize WwTW, Didcot WwTW, Appleton WwTW and Abingdon WwTW. Therefore, conclusions raised in this LPP2 WCS regards WCS impacts are not solely to be attributed to LPP2 growth in isolation, and should be considered as a holistic assessment of the total housing requirement for the District for LPP1, LPP2 and unplanned growth.

[1] http://www.whitehorsedc.gov.uk/sites/default/files/Binder1.pdf.

1.3 Study Governance

This WCS has been carried out with the guidance of the Steering Group established at the project inception meeting held on 14th July 2017, comprising the following organisations:

- VoWH District Council;
- Environment Agency;
- Thames Water Utilities Limited (TWUL)

Natural England were not part of the Steering Group, but were consultees for the WCS.

1.4 WCS Scope

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

The outcome is the development of a water cycle strategy for the District which informs the Councils update to the 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 District which determines if solutions to wastewater treatment are required and if the solutions are viable in terms of balancing environmental capacity with cost;
- determine whether any Habitats Directive designated ecological sites have the potential to be impacted by the wastewater treatment strategy via a screening process;
- determine whether additional water resources, beyond those already planned by TWUL are required to support growth;
- determine upgrades required to water supply infrastructure relative to potential options for growth through collaboration with TWUL;
- consider whether growth can be delivered and achieve a ‘neutral water use’ condition;
- provide a pathway to achievement of water neutrality; and
- provide policy recommendations.

1.5 Key Assumptions and Conditions

1.5.1 Water Company Coverage

One water company operates within the District; Thames Water Utilities Limited (TWUL) is the wastewater undertaker and potable water supplier for the entire District.

1.5.2 Water Use

The forecast household consumption for new dwellings in TWUL’s Swindon & Oxfordshire (SWOX) Water Resource Zone (WRZ) of 137 l/h/d[2] (litres per head per day) has been applied. This consumption rate has been assumed across the whole District. Currently the District’s LPP1 Core Policy 40 seeks all “new developments are required to be designed to a water efficiency standard of 110 litres/head/day (l/h/d) for new homes”. It is acknowledged that the assumption used within the WCS is greater than the Core Policy requirement, however, Thames Water undertake water resource planning based on average uses across their wider planning areas and to ensure consistency with that process, the WCS has used similar starting assumptions. The effectiveness of lower consumption rates (including Core Policy 40) have been tested for the District specifically for the WCS and the results are reported in Section 5.

[2] Thames Water WRMP14 (2014) Section 3 – Current and future demand for water

For the wastewater assessments, a different assumption was made on the likely consumption of water per new household going forward in the plan period. A starting assumption of 130.5 l/h/d was agreed with TWUL to calculate wastewater generated per person. In addition, to account for employment an additional16 l/h/d was added. To account for infiltration of surface water, groundwater and misconnections to the sewer network in the future, an additional proportion of 'unaccounted for' flows has been included in the calculations for each WwTW. An additional flow[3] specific to each WwTW has therefore been added to the starting assumption of 130.5l/h/d, giving a range of final wastewater generated of between 146 l/h/d and 190.45 l/h/d. It is therefore important that conclusions made on infrastructure capacity within this study are consistent with TWUL planning strategies. This represents a precautionary approach and the assessments are based on a 'worst case scenario' for water consumption in the District.

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

1.5.3 Household Occupancy Rate

The latest Office for National Statistics (ONS) population projections[4] and household projections[5] for the Vale of White Horse 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 below.

Table 1-1 Calculation of Occupancy Rate

Projection for 2031	
Population	140,800
Number of households	60,016
Calculated Occupancy Rate (people per household)	2.35

Source: ONS

1.5.4 Wastewater Treatment

As a wastewater treatment provider, TWUL are required to use the best available techniques (defined by the Environment Agency as the best techniques for preventing or minimising emissions and impacts on the environment) to ensure emission limit values stipulated within each WwTWs 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)[6], 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[7]
BOD	5.0 mg/l 95 percentile limit
Phosphate	0.5 mg/l annual average[8]

[3] As provided by TWUL for each individual WwTW
[4] 2014-based Subnational Population Projections (ONS) (May 2016) for the VoWH District Available at https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2015-10-29
[5] 2014-based Household Projections to 2039 for England (ONS) (July 2016). Available at https://www.gov.uk/government/statistical-data-sets/live-tables-on-household-projections
[6] 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
[7] Considered within the water industry to be the current LCT using best available techniques
[8] Environment Agency (2015) Updated River Basin Management Plans Supporting Information: Pressure Narrative: Phosphorus and freshwater eutrophication

1.6 Report Structure

The first stage of the WCS process is set out in Section 3 of this document 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), which involves assessing the current wastewater treatment facilities in regards to both capacity and compliance with legislation and environmental permits. The results of the assessment will identify the WwTWs which are at capacity or have remaining capacity. The wider, supporting environment has also been considered, including climate change and local ecology.

In parallel 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.

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 the current wastewater network and whether the site will require an odour assessment.

Ultimately, recommendations have been made as part of the WCS (Section 7) in regards to wastewater, water supply, ecology and stakeholder liaison.

2. Study Drivers

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

a. Delivering sustainable water management – ensure that provision of Water Services Infrastructure (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; and

b. Water Framework Directive (WFD) compliance – to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies within the District (and more widely) from achieving the standards required of them as set out in the WFD River Basin Management Plans (RBMPs).

A full list of the key legislative drivers shaping the study is detailed in a summary table in Appendix A for reference. However, it is important to note that the key driver for this study is WFD compliance.

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 the VoWH Phase 1 WCS (JBA Consulting, 2014), VoWH District Council SFRA Update (AECOM, 2017), TWUL's WRMP and the Environment Agency's latest Thames River Basin Management Plan (RBMP) (2015).

2.1 OFWAT Price Review

The price review is a financial review process governed by the Water Services Regulatory Authority (Ofwat) - the water industry's economic regulator. Ofwat determines the limits that water companies can increase or decrease the prices charged to customers over consecutive five year periods.

Figure 2-1 summarises the timescale in the build up towards the next price review. The price limits for the next period (2020 to 2025) will be set at the end of 2019 to take effect on 1st April 2020 and is referred to as Price Review 19 (PR19). Each water company will submit a Business Plan (BP) for the next period which will be assessed by Ofwat, before being agreed. Price limit periods are referred to as AMP (Asset Management Plan) periods, with the current AMP period being referred to as AMP6.

Figure 2-1 Proposed timescales for PR19 (Water 2020) programme

As the wastewater undertaker for the District, TWUL 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 TWUL 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, TWUL generally do not provide additional infrastructure to accommodate growth until there is certainty that development is due to come forward.

2.2 Water Framework Directive

The environmental objectives of the WFD, as published in the Environment Agency's RBMPs and relevant to this WCS are:

- to prevent deterioration of the status of surface waters and groundwater,
- 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[9], 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

[9] 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 District, including water resources, wastewater infrastructure, water quality, flood risk, surface water drainage and ecological issues. The increased development is to accommodate the minimum housing requirement for the Council. This level of projected growth has required the Council to revise their spatial approach of future expected development up to 2031. These growth figures therefore form the basis for the WCS.

The administrative area of VoWH District Council covers the towns of Abingdon, Wantage, Harwell and Faringdon and the key service villages of East Hanney, Stanford in the Vale, Hatford, Marcham, Cumnor and Watchfield.

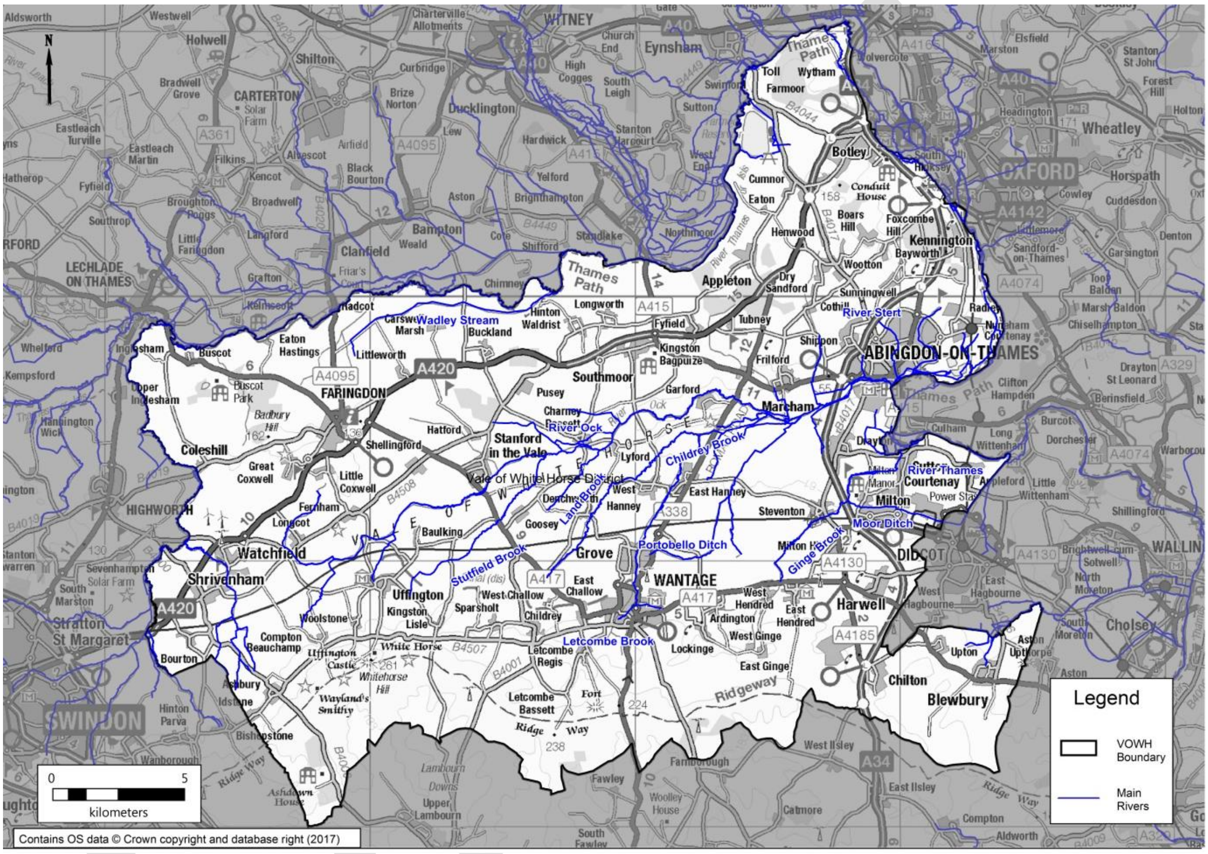


Figure 3-1 Main rivers and settlements within the Vale of White Horse District

3.2 Housing

The total housing target to 2031 for Oxfordshire as identified in the Oxfordshire Strategic Housing Market Assessment (SHMA) is 93,560 – 106,560 new residential dwellings. This is based on meeting the housing need identified and supporting committed economic growth. The assessed housing need for the VoWH has been identified as 20,560 new dwellings to be delivered in the District from 2011 to 2031 (1,028 dwellings per annum). This target will be met under the adopted Local Plan Part 1 which sets out the strategy for the growth of the District from 2011 to 2031 and Local Plan Part 2, which allocates additional housing required to meet Oxford’s unmet need within the district.

This WCS incorporates all proposed major development sites across the District at differing stages of development which have been put forward to meet this target, including;

- Committed developments (with planning permission, under construction),
- Outstanding commitments (with planning permission, construction not yet started),
- Current allocations (without full planning permission), and
- Proposed allocations (no planning permission).

Table 3-1 provides an overview of the number of dwellings to be built within the plan period and therefore assessed as part of the WCS. The WCS does not include assessment of windfall sites (770 dwellings), but which form part of the 24,856 new dwellings to be delivered in the District. This WCS has assumed that wastewater flows and water demand from dwellings completed up to October 2016 are already accounted for in the measured data provided by the water companies and therefore form part of the baseline. The WCS assesses all housing that is required to be completed in order to meet the Objectively Assessed Needs for the VoWH DC.

Table 3-1 VoWH District Council Housing Commitments and Allocations assessed within the WCS[10]

Housing Allocations	No. Dwellings
Known Commitments	5,143
LPP1 Site Allocations	11,348
LPP2 Site allocations	3,850
Total potential dwellings to be assessed	**20,341**

[10] Housing figures assessed as part of this WCS has been taken from Vale of White Horse District Council Housing Supply Data (April 2017)

4. Wastewater Treatment

4.1 Wastewater in the District

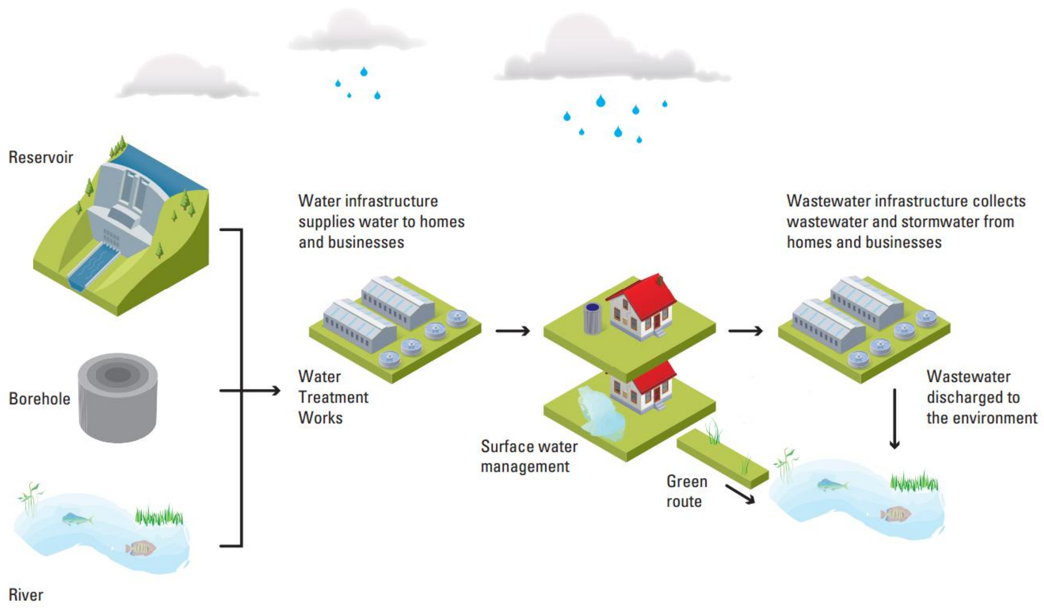


Figure 4-1 The water environment and infrastructure components[11]

A broad overview of the water cycle and the role of water and wastewater infrastructure within the cycle is illustrated in Figure 4-1. Wastewater is generally produced following the use of potable water in homes, businesses, industrial processes and in certain areas can include surface water runoff.

Wastewater treatment in the District is provided via wastewater infrastructure (WwTWs) operated and maintained by TWUL, ultimately discharging treated wastewater to a nearby fluvial watercourse. Each of the WwTWs is connected to a network of wastewater pipes (the sewerage system) which collects wastewater generated by homes and businesses to the WwTW; this is defined as the WwTWs 'catchment'.

Wastewater from the District is treated at 22 WwTWs. The following 13 WwTW catchments are expected to receive additional wastewater as a result of growth and their location illustrated in Figure 4-2

- Abingdon WwTW (LPP1, LPP2 and unplanned growth)
- Appleton WwTW (LPP2 and unplanned growth)
- Buckland WwTW (Unplanned growth)
- Didcot WwTW (LPP1, LPP2 and unplanned growth)
- Drayton WwTW (LPP1 and unplanned growth)
- Faringdon WwTW (LPP1 and unplanned growth)
- Kingston Bagpuize WwTW (LPP1 and unplanned growth)
- Littleworth WwTW (Unplanned growth)
- Oxford WwTW (LPP1 and unplanned growth)
- Shrivenham WwTW (LPP1 and unplanned growth)
- Stanford in the Vale WwTW (LPP1 and unplanned growth)
- Uffington WwTW (Unplanned growth)
- Wantage WwTW (LPP1, LPP2 and unplanned growth)

[11] Adapted from the Sustainable Urban Drainage Scottish Working Party's Water Assessment and Drainage Assessment Guide (2016)

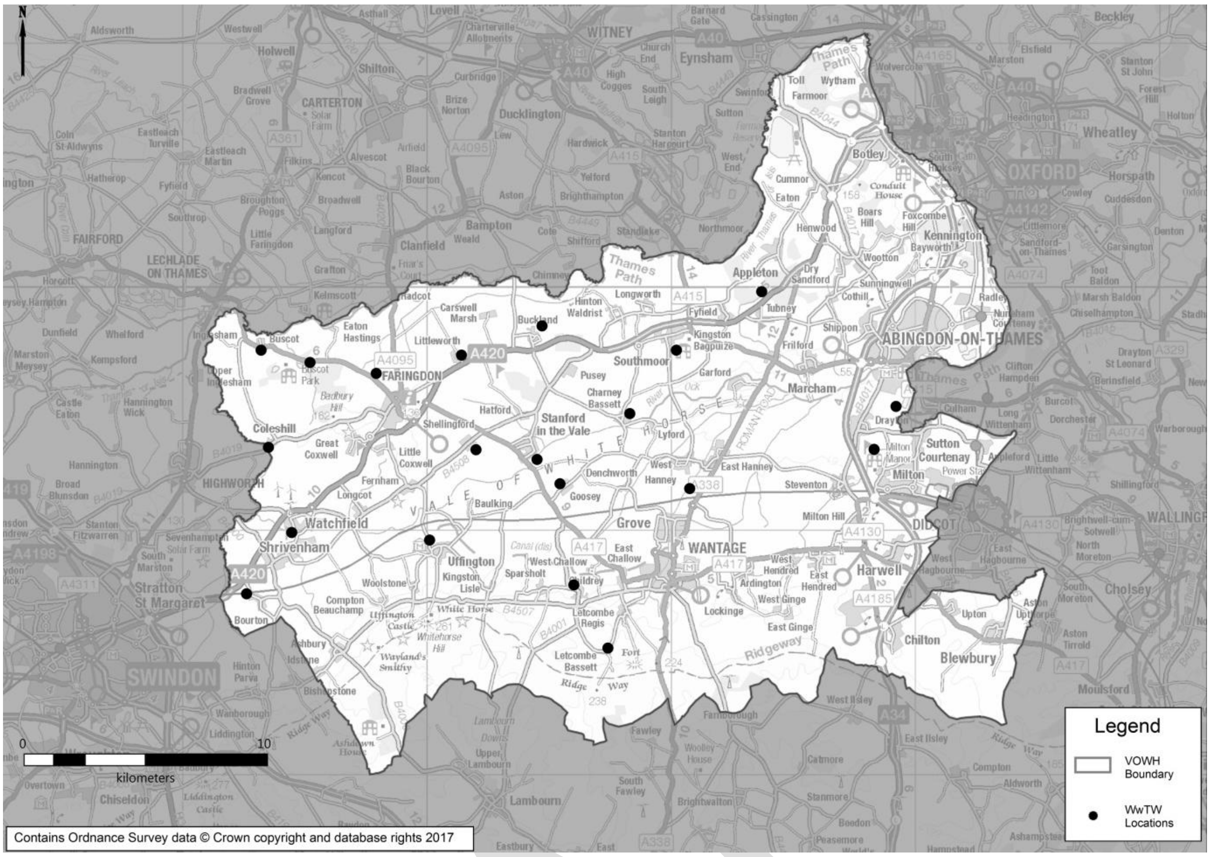


Figure 4-2 Location of WwTW's affected by all proposed development within VoWH (excluding Windfall sites)

4.2 Management of WwTW Discharges

All WwTWs are issued with a permit to discharge by the Environment Agency, which sets out conditions on the maximum volume of treated 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 WwTW can accept, as well as the type of treatment processes and technology required at the WwTWs to achieve the quality permit limits.

The flow element of the discharge permit determines an approximation of the maximum number of properties that can be connected to a WwTW catchment. 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.

For the purposes of this WCS, the assumption is applied that the permitted headroom is usable[12] and would not affect downstream water quality. This headroom therefore determines how many additional properties can be connected to the WwTW catchment before TWUL 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).

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 WwTW would result in an increase in the pollutant load[13] 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.

[12] In some cases, there is a hydraulic restriction on flow within a WwTW which would limit full use of the maximum permitted headroom.
[13] 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.

The requirement to provide a higher standard of treatment may result in an increase in the intensity of treatment processes at a WwTW, which may also require improvements or upgrades to be made to the WwTW to allow the new conditions to be met. In some cases, it may be possible that the quality conditions required to protect water quality and ecology are 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.

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

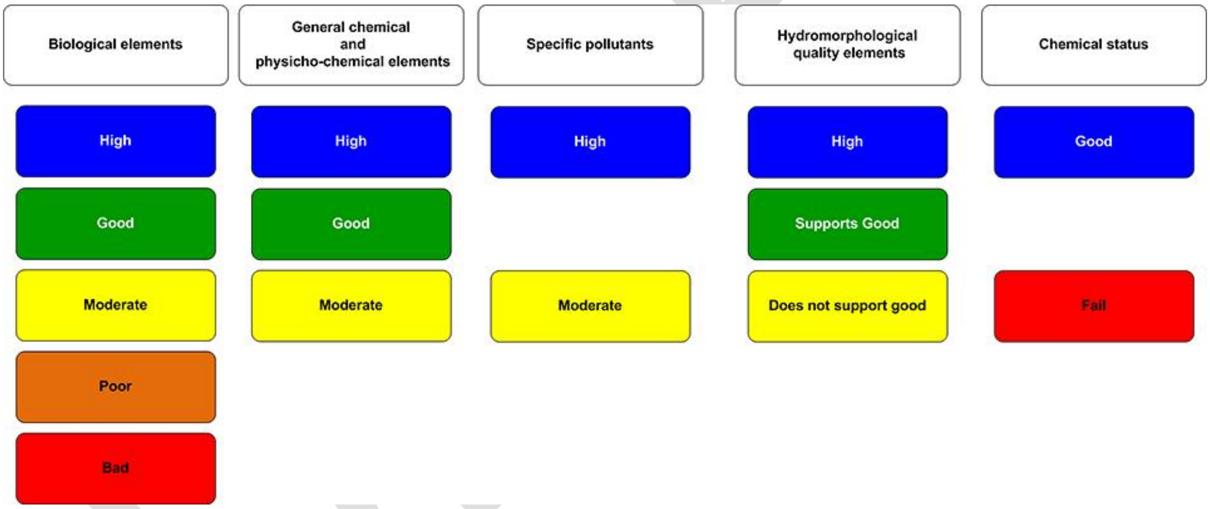
4.3 WFD Compliance

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 4-3 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 4-3 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 not acceptable to allow a deterioration from High status to Good status, even though the overall target of Good status as required under the WFD is still maintained, this would still represent a deterioration. In addition, 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.

Where permitted headroom at a WwTW would be exceeded by proposed growth, 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.

4.4 Habitats Directive

The Habitats Directive 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. A retrospective review process has been on-going since the translation of the Habitats Directive into the UK Habitats Regulations called the Review of Consents (RoC). The RoC process requires the Environment Agency to consider the impact of the abstraction licences and discharge permit it has previously issued on sites which became protected (and hence designated) under the Habitats Regulations.

If the RoC process identifies that an existing licence or permit cannot be ruled out as having an impact on a designated site, then the Environment Agency are required to either revoke or alter the licence or permit. As a result of this process, restrictions on some discharge permits have been introduced to ensure that any identified impact on downstream sites is mitigated. Although the Habitats Directive does not directly stipulate conditions on discharge, the Habitats Regulations can, by the requirement to ensure no detrimental impact on designated sites, require restrictions on discharges to (or abstractions) from water dependent habitats that could be impacted by anthropogenic manipulation of the water environment.

Where permitted headroom at a WwTW would be exceeded by proposed levels of growth, a Habitats Regulations assessment exercise has been undertaken in this WCS to ensure that Habitats Directive sites which are hydrologically linked to watercourses receiving wastewater flows from growth would not be adversely affected. The scope of this assessment also includes non-Habitats Directive sites such as nationally designated Sites of Special Scientific Interest (SSSI) and Local Nature Reserves (LNRs). This assessment is reported in Section 4.8 (Ecological Appraisal) of this chapter.

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 District, therefore it is essential to consider infrastructure and environmental capacity.

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:

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

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 greater than 10% deterioration in water quality?
- Can a feasible solution be implemented to limit deterioration to 10%? To ensure that all the environmental capacity is not taken up by one phase of development and there is remaining environmental capacity for future growth beyond the plan period.
- Could development cause deterioration in WFD status of any element? This 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.

4.5.2 Methodology

4.5.2.1 WwTW Headroom Assessment

This assessment is a scoping exercise to determine which WwTW's will require water quality assessment as a result of growth. A WwTW flow headroom calculator has been developed and used to inform this assessment. Results are presented in Section 4.6.

The first step identifies which WwTWs within the District will receive future growth and what the quantity of growth is in order to determine the additional wastewater flow generated at each WwTW. The remaining permitted flow headroom at each WwTW is then calculated. A detailed explanation of this methodology is provided in Appendix C.

The scoping criteria detailed in Table 4-1 have therefore been applied to determine whether the quantity of growth will trigger the requirement for a WwTW to undergo a water quality assessment and subsequent review of its current discharge permit.

Table 4-1 WwTW Headroom Assessment scoping criteria

Scope In	Scope Out
WwTWs where permitted flow headroom capacity is exceeded as a result of growth	-
WwTWs which are already at or exceed their permitted flow headroom capacity and will also receive additional flow from growth	WwTWs which are already at or exceed their permitted flow headroom capacity but do not receive any additional flow from growth
WwTWs which remain within their permitted flow headroom capacity but the growth is >=10% of the WwTW's current DWF permit m3/d as monitored by the Environment Agency	WwTWs which remain within their permitted flow headroom capacity but the growth is <10% of the WwTW's calculated DWF permit

4.5.2.2 Water Quality Assessment

AECOM has determined that River Quality Planning (RQP) software (as used by the Environment Agency) is a suitable tool to undertake the required water quality modelling for determining the required discharge permit quality condition for each individual WwTW (Section 4.7). There are limitations associated with the RQP software which have been acknowledged in this WCS (Appendix C) and a stepped methodology has been developed to ensure uncertainty which may arise as a result of these limitations is minimal.

Statistical based water quality modelling (using RQP software) has been performed to check for compliance with the WFD objectives in terms of permit conditions for Ammonia and Phosphate. Load standstill calculations have been used to determine the future permit conditions for BOD. 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 4-2.

Table 4-2 Water quality modelling scenarios

Scenario	Description	Objective
10% Deterioration Limit	Limiting deterioration 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. Applied where it is not technically feasible to limit deterioration to 10%.	Aligns with the WFD policy requirement 'development must not cause a deterioration in WFD status'.
Maintain Current Quality	Maintaining the current river quality for the physico-chemical sub-element (determinand) after growth.	Where there is considered to be significant risk that a 10% deterioration could lead to a deterioration in status, this scenario is applied as a precautionary approach.
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'.

The 10% deterioration test cannot be completed for certain WwTW's due to either no permit limit or discharge effluent quality data. For the WFD no deterioration test, an artificial mean discharge quality has been applied (e.g. 5mg/l for Ammonia and 2mg/l for Phosphate) so this test could be completed. For these cases, the downstream quality target is determined using the current river waterbody status. The permit limits are required to maintain this status and current discharge quality. Further information is provided in Appendix C.

4.5.2.3 WwTW Infrastructure Requirements

TWUL are currently preparing for Asset Management Plan 7 (AMP7) and their PR19 business plan which will outline their investment programme from April 2020 to 2025. TWUL's approach to wastewater treatment asset management requires that sufficient certainty is given that the quantum of development proposed will come forward during the plan period before improvements to WwTW 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, and can be used by TWUL to inform the next investment programme (AMP7) and future programmes (AMP8 and AMP9) 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.

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 WwTW 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 4-4.

- **Green** – WFD objectives will not be adversely affected. Growth can be accepted with no significant changes to the WwTW infrastructure or permit required.
- **Amber** – in order to meet WFD objectives, changes to the discharge permit are required, and upgrades may be required to WwTW infrastructure which may have phasing implications;
- **Red** - in order to meet WFD objectives changes to the discharge permit are required which are beyond the limits of what can be achieved with conventional treatment. An alternative solution needs to be sought.

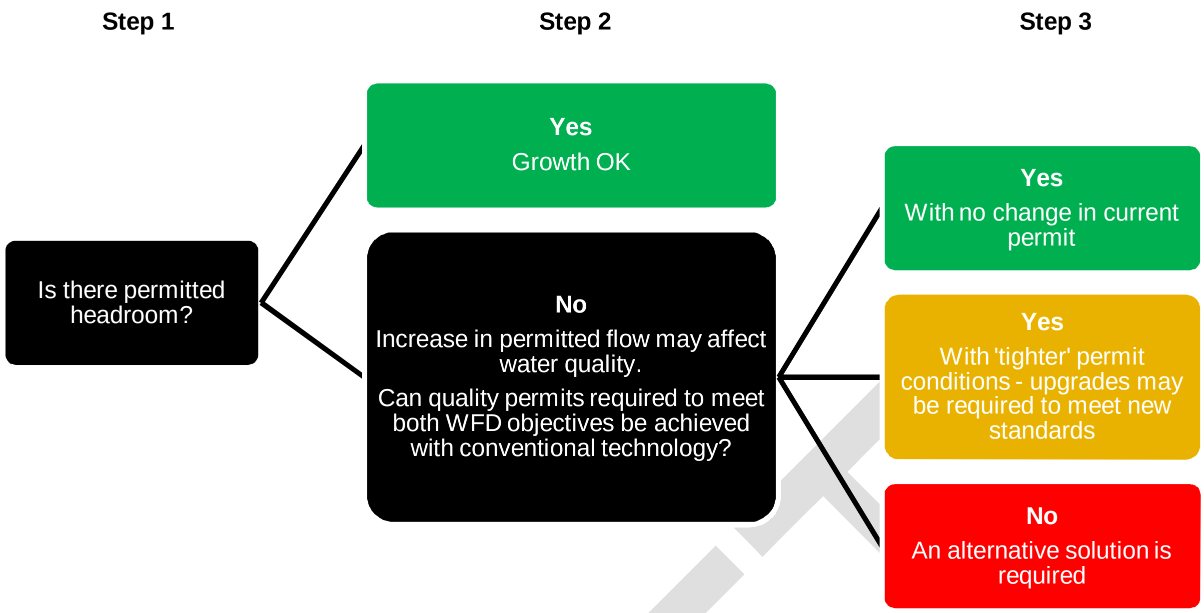


Figure 4-4 RAG Assessment process diagram for infrastructure capacity

4.6 WwTW Headroom Assessment

The volume of wastewater, measured as Dry Weather Flow (DWF), which would be generated from the proposed housing and employment growth (LPP1, LPP2 and unplanned) over the plan period within each WwTW catchment has been calculated and assessed against the permitted flow headroom capacity at each WwTW. A summary of this assessment is provided in Table 4-3 with further explanation provided in the following subsections.

4.6.1 Available Permitted Headroom

The growth proposed within the WwTW catchments listed below is not considered to be significant (equal to or less than 10% of the current population equivalent of the receiving WwTWs) and can be accepted within the current permitted headroom of the WwTWs current flow permit:

- Abingdon WwTW
- Buckland WwTW
- Littleworth WwTW
- Uffington WwTW

On this basis, it has been assumed that the Ammonia, BOD and Phosphate quality conditions on the current discharge permit are sufficient to ensure there is no significant deterioration in water quality.

A water quality assessment is not required for these WwTWs.

4.6.2 Available Permitted Headroom – Significant Growth

Significant growth has been defined as the quantity of development within a WwTW catchment which would be equal to or greater than 10% of the current dry weather flow permit of the receiving WwTWs. This is due to certain WwTW discharge permits having flow headroom capacity, but if operated to their full permitted discharge volumes (i.e. all permitted headroom is used up by growth), there is a high risk of significant deterioration in water quality and potentially deterioration in WFD status.

The WwTWs which have been identified as having permitted headroom but receiving significant growth, as defined above, are;

- Appleton WwTW,
- Drayton WwTW,
- Faringdon WwTW,
- Shrivenham WwTW and,
- Stanford in the Vale WwTW.

It should be noted that Appleton WwTW is the only WwTW within this list which receives growth from the LPP2 housing allocations.

To ensure that the significant quantity of growth proposed within these WwTW catchments and the use of available permitted headroom does not impact on downstream water quality objectives, these WwTWs have been scoped in for the water quality assessment to determine whether theoretically achievable quality conditions for Ammonia, BOD and Phosphate can be applied to revised discharge permits.

4.6.3 No Available Permitted Headroom

The calculations of flow headroom capacity found that the following four WwTWs would not have sufficient headroom once all the growth within each of the WwTW catchments is accounted for.

- Didcot WwTW;
- Kingston Bagpuize WwTW;
- Oxford WwTW[14]; and,
- Wantage WwTW.

These WwTWs would exceed their maximum permitted DWF under their existing discharge permits. Additional headroom can be made available through an application by TWUL for a new or revised discharge permit from the Environment Agency.

To ensure that an increase in permitted DWF required to serve the proposed growth would not impact on water quality objectives, water quality modelling has been undertaken to determine whether theoretically achievable quality conditions can be applied to revised discharge permits.

4.6.4 Summary

The WwTW headroom assessment has identified nine WwTWs, as shown in Table 4-3, which will require water quality assessment to determine whether theoretically achievable quality conditions can be applied to revised discharge permits in order to meet the WFD objectives of the receiving waterbody.

The results of the water quality modelling are provided in Section 4.7, with detailed results from the modelling provided in Appendix C.

[14] It should be noted that Oxford WwTW has limited headroom capacity for any growth and is subject to ongoing improvements works by TWUL at the time of undertaking this WCS.

Table 4-3 WwTW headroom capacity assessment

	Headroom Assessment							
WwTW	Measured DWF (Q_{80}) (m^3/d)	DWF Permit (m^3/d)	Headroom Capacity pre-growth (m^3/d)	Headroom Capacity pre-growths (dwellings)	Additional flow from growth (m^3/d)	Headroom Capacity post-growth (m^3/d)	Headroom Capacity post-growth (dwellings)	Outcome
Abingdon	10939	12859	1,920	5586	1,115	805	2,344	Available permitted headroom, but growth not significant: scoped out for water quality assessment
Buckland	51	91	40	116	1	39	113	
Littleworth	No flow provided	18	N/A	N/A	0	N/A	N/A	
Uffington	135	162	27	79	3	24	69	
Appleton	987	2559	1,572	4574	312	1,260	3,667	Sufficient headroom but significant growth: scoped in for water quality assessment
Drayton	1198	1672	474	1379	378	96	280	
Faringdon	1548	2812	1,264	3678	409	855	2,488	
Shrivenham	1220	2842	1,622	4719	456	1,166	3,393	
Stanford in the Vale	339	650	311	905	105	206	598	
Didcot	9390	11476	2,086	6069	2,740	-654	-1,904	Insufficient headroom and significant growth: scoped in for water quality assessment
Kingston Bagpuize	626	633	7	20	497	-490	-1,427	
Oxford[15]	53618	50985	-2,633	-7661	383	-3,016	-8,775	
Wantage	4891	6250	1,359	3954	2,539	-1,180	-3,433	

[15] It should be noted that Oxford WwTW has limited headroom capacity for any growth and is subject to ongoing improvements works by TWUL at the time of undertaking this WCS.

4.7 Water Quality Assessment & Infrastructure Requirements

A summary of the results and proposed infrastructure upgrades required are included in Sections 4.7.1 to 4.7.9 for each of the WwTWs.

Under each WwTW, the following detail is provided:

- Environmental baseline for receiving watercourse,
- WFD compliance assessment – No Deterioration,
- WFD compliance assessment– Achieve Future Target Status (where test is required),
- Infrastructure upgrade requirements,

The 10% deterioration test can't be completed for certain WwTW's due to either there being no permit limit or discharge effluent quality data. For the WFD no deterioration test, an artificial mean discharge quality has been applied (eg 5mg/l for Ammonia and 2mg/l for Phosphate) so this test could be completed. For these cases, the downstream quality target is determined using the current river waterbody status. The permit limits are required to maintain this status and current discharge quality.

4.7.1 Appleton WwTW

4.7.1.1 Environmental Baseline

The Frilford and Marcham Brook waterbody (GB106039023420) receives treated effluent from Appleton WwTW and currently has an overall waterbody status of 'Moderate', with the alternative objective to maintain 'Moderate' status by 2021.

The current overall status is limited to 'Moderate' due to the less than 'Good' status classification of the elements listed in Table 4-4.

Table 4-4 Classification elements of less than Good status for Frilford and Marcham Brook waterbody (GB106039023420)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Phosphate	Moderate	Moderate by 2021	No known technical solution is available – Technically infeasible
Macrophytes and Phytobenthos Combined	Moderate	Good by 2021	

The current 'Moderate' status of Phosphate is suspected to be due to continuous sewage discharge and has a 'probable' level of activity certainty. The status of Phosphate is expected to remain 'Moderate' by 2021.

The Reasons for Not Achieving Good (RNAG) as outlined in the Thames RBMP, relevant to the Frilford and Marcham Brook waterbody have been provided in Table 4-5 below.

Table 4-5 Reasons for Not Achieving Good status for the Frilford and Marcham Brook waterbody(GB106039023420)

Category	Activity	Activity Certainty	Classification Element
Water Industry	Sewage discharge (continuous)	Probable	Phosphate
	Sewage discharge (Intermittent)	Suspected	

4.7.1.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-6.

Table 4-6 Required permit quality conditions for Appleton WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain Current Quality	Achieve Future Target Status
BOD (mg/l 95%ile)	16	N/A	13.9	N.A	N/A	N/A
Ammonia (mg/l 95%ile)	4	1.2	N/A	0.9	1.03	N/A
Phosphate (mg/l annual average)	2	N/A	N/A	N/A	N/A	N/A

4.7.1.3 WwTW Assessment Summary

Table 4-7 Appleton WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	Yes	Calculated headroom capacity post-growth of 1,260m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	Yes	Due to significant level of growth in catchment during plan period.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	Yes	No assessment was undertaken for Phosphate as there is no discharge or permit limit and also no upstream monitoring data for Appleton WwTW.
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from4 mg/l to 1.2 mg/l. BOD permit condition will need to be tightened from 16 mg/l to 13.9 mg/l.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	No	Ammonia permit condition will need to be tightened from 5 mg/l to 0.9 mg/l. Current limit of conventional treatment is 1 mg/l. Therefore, growth may cause a deterioration in status unless improvements in technology or non-conventional technologies are used. It should be noted that under the current situation (pre-growth) an Ammonia condition below the limit of conventional treatment would also be required indicating that the attainment of the status at the point of mixing is reliant on the WwTW discharging at a quality better than the current permit requires. Further analysis has been undertaken as a precautionary approach to determine whether current river quality can be maintained (see Criteria 3c). 'No deterioration' can be achieved for BOD through tightening the existing permit condition from 16 mg/l to 13.9 mg/l.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from 5 mg/l to 1.03 mg/l. In the absence of catchment scale modelling, it can be demonstrated that an Ammonia permit condition within the current limit of conventional treatment can be applied to maintain the current Ammonia quality (at the mixing point) in the Marcham Brook. Therefore, there are feasible solutions to ensure overall compliance with the WFD.

	d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	**Not Assessed**	Ammonia is already at High status - therefore ensuring no deterioration is adequate. Phosphate - An alternative objective of Poor status has been set by the Environment Agency in place of the default objective to reach Good status. The alternative objective has been set due to the need for a technically infeasible solution to resolve the less than Good status of Phosphate (see Appendix F for details). No assessment has been undertaken due to insufficient data. BOD - No Future Target Status.
4.	Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**No**	Appleton WwTW is located in the upper reaches of the Marcham Brook (a tributary of the River Ock) with no other significant WwTW discharges upstream.
5.	Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied for in order to inform TWUL's PR19 Business Plan.

4.7.2 Didcot WwTW

4.7.2.1 Environmental Baseline

The Moor Ditch and Ladygrove Ditch waterbody (GB106039023630) receives treated effluent from Didcot WwTW and currently has an overall waterbody status of Poor, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-8.

Table 4-8 Classification elements of less than Good status for Moor Ditch and Ladygrove Ditch waterbody (GB106039023630)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Phosphate	Moderate	Moderate by 2021	No known technical solution is available – Technically infeasible
Macrophytes and Phytobenthos Combined	Moderate	Moderate by 2021	
Invertebrates	Poor	Good by 2027	

The current Moderate status of Phosphate is suspected to be due to continuous sewage discharge and has a 'probable' level of activity certainty. The status of Phosphate is expected to remain Moderate by 2021.

The current Moderate status of Macrophytes and Phytobenthos Combined is suspected to be due to continuous sewage discharge and has a 'Suspected' level of activity certainty. The status is expected to remain Moderate by 2021.

The status of Invertebrates is currently Poor and is suspected to be a result of Sewage Discharge, Invasive non-native species, Land Drainage and Urbanisation. The status is expected to be Good by 2021.

The Reasons for Not Achieving Good (RNAG), as outlined in the Thames RBMP, relevant to the Moor Ditch and Ladygrove Ditch waterbody have been provided in Table 4-9.

Table 4-9 Reasons for not achieving good status on the Moor Ditch and Ladygrove Ditch waterbody (GB106039023630)

Category	Activity	Activity Certainty	Classification Element
Water Industry	Sewage discharge (continuous)	Probable	Phosphate
		Suspected	Macrophytes and Phytobenthos Combined
			Invertebrates
Invasive non-native species	North American signal crayfish	Suspected	Invertebrates
Urban and transport	Urban Development	Suspected	Invertebrates
Agriculture and rural land management	Land drainage - operational management	Probable	Invertebrates

4.7.2.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-10. A load standstill calculation has been used to determine the future BOD permit conditions.

Table 4-10 Required permit quality conditions for Didcot WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain Current Quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**10**	N/A	7.7		N/A	N/A
Ammonia (mg/l 95%ile)	**9**	3.4	N/A	0.7	3.1	N/A
Phosphate (mg/l annual average)	**-**	0.9	N/A	0.2	0.8	N/A

4.7.2.3 WwTW Assessment Summary

Table 4-11 Didcot WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**No**	Calculated headroom deficit post-growth of 654m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Not Applicable**	The WwTW does not have sufficient permitted headroom to accommodate the growth and therefore a new permit will be required.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	**Yes**	
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	**Yes**	Ammonia permit condition will need to be tightened from 9 mg/l to 3.4 mg/l. BOD permit condition will need to be tightened from 10 mg/l to 7.7 mg/l. There is currently no Phosphate permit condition. A permit condition of 0.9 mg/l would be required.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**No**	Ammonia permit condition will need to be tightened from 9 mg/l to 0.7 mg/l. Current limit of conventional treatment is 1 mg/l.

Assessment Criteria	Yes / No	Additional Comments
		A Phosphate permit condition of 0.2 mg/l would be required. Current limit of conventional treatment is 0.5 mg/l. Growth may cause deterioration in status for Ammonia and Phosphate unless improvements in technology or non-conventional technologies are used. It should be noted that under the current situation (pre-growth) a condition below the limit of conventional treatment would also be required for both Ammonia and Phosphate indicating that the attainment of the status at the point of mixing is reliant on the WwTW discharging at a quality better than the current permit allows. Further analysis has been undertaken as a precautionary approach to determine whether current river quality can be maintained (see Criteria 3c). 'No deterioration' can be achieved for BOD through tightening the existing permit condition from 10 mg/l to 7.7 mg/l.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from 9 mg/l to 3.1 mg/l. A Phosphate permit condition of 0.8 would be required. In the absence of catchment scale modelling, it can be demonstrated that permit conditions within the current limit of conventional treatment can be applied to maintain the current Ammonia and Phosphate quality (at the mixing point) in the Moor Ditch. Therefore, there are feasible solutions to ensure overall compliance with the WFD.
d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	**Not Assessed**	Ammonia is already at High status - therefore ensuring no deterioration is adequate. Phosphate - An alternative objective has been set by the Environment Agency in place of the default objective to reach 'Good status. The alternative objective has been set due to the need for a technically infeasible solution to resolve the less than Good status of Phosphate (see Appendix F for details). This target is Moderate status which is the current status and hence the no deterioration assessment results (see Criteria 3b and 3c) apply equally to the Future Target Status objective. BOD - No Future Target Status.
4. Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**No**	Didcot WwTW is located in the upper reaches of the Moor Ditch (a tributary of the River Thames) with no other significant WwTW discharges upstream.
5. Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan. It should be noted that the current treatment performance of Didcot WwTW in terms of Ammonia is shown to be well within its current quality conditions, and well below what is considered achievable with conventional technology, demonstrating that the WwTW is capable of achieving a much higher quality discharge. This may influence the type of upgrades required and hence the cost and timeframe to implement the upgrades.

4.7.3 Drayton WwTW

4.7.3.1 Environmental Baseline

The Ginge Brook and Mill Brook waterbody (GB106039023660) receives treated effluent from Drayton WwTW and currently has an overall waterbody status of Moderate, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-12.

Table 4-12 Classification elements of less than Good status for Ginge Brook and Mill Brook waterbody (GB106039023660)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Phosphate	Moderate	Moderate by 2021	Disproportionately Expensive
Macrophytes and Phytobenthos Combined	Moderate	No target	-

The current Moderate status of Phosphate is suspected to be due to continuous sewage discharge and has a ‘probable’ level of activity certainty. The status of Phosphate is expected to remain Moderate by 2021.

The Reasons for Not Achieving Good (RNAG), as outlined in the Thames RBMP, relevant to the Ginge Brook and Mill Brook waterbody have been provided in Table 4-13 below.

Table 4-13 Reasons for not achieving good status on the Ginge Brook and Mill Brook waterbody (GB106039023660)

Category	Activity	Activity Certainty	Classification Element
Water Industry	Sewage discharge (continuous)	Probable	Phosphate

4.7.3.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-14. A load standstill calculation has been used to determine the future BOD permit conditions. Phosphate has not been assessed in the 10% deterioration test as there is no permitted or measured outflow data from the WwTW.

Table 4-14 Required permit quality conditions for Drayton WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain Current Quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**20**	18.27	15.4	N/A	N/A	N/A
Ammonia (mg/l 95%ile)	**12**	5.4	N/A	3.4	N/A	N/A
Phosphate (mg/l annual average)	**-**	N/A	N/A	0.8	N/A	N/A

4.7.3.3 WwTW Assessment Summary

Table 4-15 Drayton WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**Yes**	Calculated headroom capacity post-growth of 96m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Yes**	Due to significant level of growth in catchment during plan period.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	**Yes**	No assessment was undertaken for Phosphate due to no current permit quality condition.
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	**Yes**	Ammonia permit condition will need to be tightened from 12 mg/l to 5.4 mg/l. BOD permit condition will need to be tightened from 20 mg/l to 18.27 mg/l.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**Yes**	Ammonia permit condition will need to be tightened from 12 mg/l to 3.4 mg/l. BOD permit condition will need to be tightened from 20 mg/l to 15.4 mg/l.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	**Not Assessed**	No assessment was required because it is demonstrated in Criteria 3b that the WFD objective of 'no deterioration' can be achieved within the current limits of conventional treatment.
d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	**Not Assessed**	Ammonia is already at High status - therefore ensuring no deterioration is adequate. Phosphate - An alternative objective has been set by the Environment Agency in place of the default objective to reach Good status. The alternative objective has been set due to disproportionately expensive to resolve the less than Good status of Phosphate (see Appendix F for details). This target is Moderate status which is the current status and hence the no deterioration assessment results apply equally to the Future Target Status objective. BOD - No Future Target Status.
4. Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**No**	Drayton WwTW is located on the Mill Brook with no other significant WwTW discharges upstream.
5. Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan. It should be noted that the current treatment performance of Drayton WwTW in terms of Ammonia and Phosphate is shown to be well within its current quality conditions, and well below what is considered achievable with conventional technology, demonstrating that the WwTW is capable of achieving a much higher quality discharge. This may influence the type of upgrades required and hence the cost and timeframe to implement the upgrades.

4.7.4 Faringdon WwTW

4.7.4.1 Environmental Baseline

The (River) Thames (Leach to Evenlode) waterbody (GB106039030333) receives treated effluent from Faringdon WwTW and currently has an overall waterbody status of Moderate, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-16.

Table 4-16 Classification elements of less than Good status for Thames (Leach to Evenlode) waterbody (GB106039030333)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Fish	Poor	Poor by 2021	Disproportionately Expensive
Hydrological Regime	-	Does not support good-2021	-
Invertebrates	Moderate	Moderate by 2021	No known technical solution is available – Technically infeasible
Mitigation Measures Assessment	Moderate or less	Moderate or less by 2021	Disproportionately Expensive
Phosphate	Moderate	Moderate	No known technical solution is available – Technically infeasible

The current Moderate status of Phosphate is suspected to be due to continuous sewage discharge and mixed agriculture. It has a 'probable' level of activity certainty. The status of Phosphate is expected to remain 'Moderate' by 2021.

The Reasons for Not Achieving Good (RNAG), as outlined in the Thames RBMP, relevant to the Thames (Leach to Evenlode) waterbody have been provided in Table 4-17 below.

Table 4-17 Reasons for not achieving good status on the Thames (Leach to Evenlode) waterbody (GB106039030333)

Category	Activity	Activity Certainty	Classification Element
Water Industry	Physical Modifications	Probable	Fish
Invasive non-native species	North American signal crayfish	Suspected	
Other	Land drainage - operational management	Probable	
Other	Ecological Discontinuity	Confirmed	
Navigation	Inland boating and structures	Confirmed	
Water Industry	Surface Water Abstraction	Suspected	Hydrological Regime
Agriculture and rural land management	Land drainage - operational management	Suspected	Invertebrates
Water Industry	Sewage discharge (continuous)	Probable	Phosphate
Agriculture and rural land management	Mixed agricultural	Probable	

4.7.4.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-18. Phosphate and Ammonia has not been assessed in the 10% deterioration test as there is no permitted or measured outflow data from the WwTW.

Table 4-18 Required permit quality conditions for Faringdon WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)			
		Limit to 10% deterioration	No deterioration in status	Maintain Current Quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**30**	15.9	6.2	N/A	N/A
Ammonia (mg/l 95%ile)	**N/A**	N/A	**0.5**	N/A	N/A
Phosphate (mg/l annual average)	**N/A**	N/A	**0.2**	N/A	N/A

4.7.4.3 WwTW Assessment Summary

Table 4-19 Faringdon WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**Yes**	Calculated headroom capacity post-growth of 855m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Yes**	Due to significant level of growth in catchment during plan period.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	**Yes**	No assessment was undertaken for Phosphate and Ammonia for the 10% deterioration test due to no current permit quality condition.
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	**Unknown**	BOD permit condition will need to be tightened from 30 mg/l to 15.9 mg/l. No assessment was undertaken for Phosphate and Ammonia due to lack of current permit quality condition.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**No**	An Ammonia permit condition of 0.46 mg/l would be required. Current limit of conventional treatment is 1 mg/l. A Phosphate permit condition of 0.24 mg/l would be required. Current limit of conventional treatment is 0.5 mg/l. Growth may cause deterioration in status for Ammonia and Phosphate unless improvements in technology or non-conventional technologies are used. It should be noted that under the current situation (pre-growth) a condition below the limit of conventional treatment would also be required for both Ammonia (0.48 mg/l) and Phosphate (0.25mg/l). 'No deterioration' can be achieved for BOD through tightening the existing permit condition from 30 mg/l to 6.2 mg/l.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	**Not Assessed**	Ammonia and Phosphate cannot be assessed using the no deterioration test as there is no current permit limit.
d. Can the WFD Future Target Status be	**Not**	Ammonia is already at High status - therefore ensuring no

Assessment Criteria		Yes / No	Additional Comments
	achieved after growth with current conventional treatment technology?	**Assessed**	deterioration is adequate. Phosphate - An alternative objective has been set by the Environment Agency in place of the default objective to reach Good status. The alternative objective has been set due to the need for a technically infeasible solution to resolve the less than Good status of Phosphate (see Appendix F for details). This target is Moderate status which is the current status and hence the no deterioration assessment results apply equally to the Future Target Status objective. BOD - No Future Target Status.
4.	Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**Yes**	Faringdon WwTW is located on the River Thames. The Trout Public House WwTW and The Swan Hotel WwTW is located approximately 5.5km upstream of Faringdon WwTW on the River Thames. However, the contributing flow of the WwTW's upstream into the River Thames is likely to be small in comparison. Therefore, the River Thames provides significant dilution of the WwTW's discharge and it has been concluded that the impact of growth on water quality upstream of Faringdon WwTW would be minimal.
5.	Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan.

In analysing results from Assessment Criteria 3b, it can be seen that the WFD Objective of 'no deterioration' cannot be achieved within the limits of conventional treatment for both the current situation and with future growth for both Ammonia and Phosphate. In considering whether future growth will significantly result in deterioration of waterbody status, a comparison between the current and future modelling results can be completed. It was determined that in the current situation a permit limit of 0.48mg/l for Ammonia and 0.25mg/l for Phosphate would be required in order to ensure no deterioration from the current WFD waterbody status. Future growth results demonstrated a permit limit of 0.46mg/l and 0.24mg/l is required for Ammonia and Phosphate respectively. These results demonstrate that future growth would require approximately a 4% reduction in permit limits for both Ammonia and Phosphate from the current situation. On this basis, it is considered that this reduction is insignificant in relation to the strict limits already required in the current situation and therefore future growth contributing to Faringdon WwTW is not considered to be causing a deterioration within the WFD Waterbody.

4.7.5 Kingston Bagpuize WwTW

4.7.5.1 Environmental Baseline

The (River) Ock and tributaries (Land Brook confluence to Thames) waterbody (GB106039023430) receives treated effluent from Kingston Bagpuize WwTW and currently has an overall waterbody status of Poor, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-20.

Table 4-20 Classification elements of less than Good status for Ock and tributaries (Land Brook confluence to Thames) waterbody (GB106039023430)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Fish	Poor	Good	No known technical solution is available – Technically infeasible
Phosphate	Moderate	Moderate	No known technical solution is available – Technically infeasible

The current Moderate status of Phosphate is suspected to be due to continuous sewage discharge and mixed agriculture. It has a 'probable' level of activity certainty. The status of Phosphate is expected to remain Moderate by 2021.

The Reasons for Not Achieving Good (RNAG), as outlined in the Thames RBMP, relevant to the Ock and tributaries (Land Brook confluence to Thames) waterbody have been provided in Table 4-21 below.

Table 4-21 Reasons for not achieving good status on the Ock and tributaries (Land Brook confluence to Thames) waterbody (GB106039023430)

Category	Activity	Activity Certainty	Classification Element
Agriculture	Land drainage	Suspected	Fish
	Barriers - ecological discontinuity	Suspected	
Water Industry	Sewage discharge (continuous)	Probable	Phosphate
	Sewage discharge (Intermittent)	Probable	
Agriculture	Livestock field	Probable	
	Land use - arable	Suspected	

4.7.5.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-22. A load standstill calculation has been used to determine the future BOD permit conditions. Phosphate has not been assessed in the 10% deterioration test as there is no permitted or measured outflow data from the WwTW.

Table 4-22 Required permit quality conditions for Kingston Bagpuize WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain Current Quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**15**	N/A	7.4	N/A	N/A	N/A
Ammonia (mg/l 95%ile)	**7**	1.7	N/A	**0.5**	1.5	N/A
Phosphate (mg/l annual average)	N/A	N/A	N/A	1.2	N/A	N/A

4.7.5.3 WwTW Assessment Summary

Table 4-23 Kingston Bagpuize WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**No**	Calculated headroom deficit post-growth of 490m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Not Applicable**	The WwTW does not have sufficient permitted headroom to accommodate the growth and therefore a new permit will be required.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge	**Yes**	No assessment was undertaken for Phosphate due to no current permit quality condition.

Assessment Criteria	Yes / No	Additional Comments
permit and treatment process upgrades required?		
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from 7 mg/l to 1.7 mg/l. BOD permit condition will need to be tightened from 15 mg/l to 7.4 mg/l.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	No	Ammonia permit condition will need to be tightened from 7 mg/l to 0.5 mg/l. Current limit of conventional treatment is 1 mg/l. Growth may cause a deterioration in status for Ammonia unless improvements in technology or non-conventional technologies are used. It should be noted that under the current situation (pre-growth) a condition below the limit of conventional treatment would also be required for Ammonia indicating that the attainment of the status at the point of mixing is reliant on the WwTW discharging at a quality better than the current permit allows. Further analysis has been undertaken as a precautionary approach to determine whether current river quality can be maintained (see Criteria 3c). 'No deterioration' can be achieved for Phosphate; a permit condition of 1.2 mg/l would be required. 'No deterioration' can be achieved for BOD through tightening the existing permit condition from 15 mg/l to 7.4 mg/l.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from 7 mg/l to 1.5 mg/l. In the absence of catchment scale modelling, it can be demonstrated that permit conditions within the current limit of conventional treatment can be applied to maintain the current Ammonia and Phosphate quality (at the mixing point) in the River Ock. Therefore, there are feasible solutions to ensure overall compliance with the WFD.
d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	Not Assessed	Ammonia is already at High status – therefore ensuring no deterioration is adequate. Phosphate - An alternative objective has been set by the Environment Agency in place of the default objective to reach Good status. The alternative objective has been set due to the need for a technically infeasible solution to resolve the less than Good status of Phosphate (see Appendix F for details). This target is Poor status which is the current status and hence the no deterioration assessment results apply equally to the Future Target Status objective. BOD - No Future Target Status.
4. Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	Yes	Kingston Bagpuize WwTW is located on the River Ock. The Charney Basset WwTW and Stanford in the Vale WwTW's are located approximately 2.5km and 6.6km upstream of Kingston Bagpuize WwTW on the River Ock. A small amount of growth has been allocated to the Stanford in the Vale WwTW and none has been allocated to the Charney Basset WwTW. The contributing flow of the WwTW's upstream into the River Ock is likely to be small in comparison. Therefore, it is considered that the River Ock provides significant dilution of the WwTW's discharge and it has been concluded that the impact of growth on water quality upstream of the Kingston Bagpuize WwTW would be minimal.
5. Are WwTW infrastructure upgrades required?	Yes	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan.

4.7.6 Oxford WwTW

4.7.6.1 Environmental Baseline

The Northfield Brook (Source to Thames) waterbody (GB106039030180) at Sandford receives treated effluent from Oxford WwTW and currently has an overall waterbody status of Bad, with the alternative objective set to reach Poor status by 2027. The Northfield Brook is approximately 1.7km long, and is a small tributary of the River Thames (Evenlode to Thame) WFD waterbody. To ensure the impact of growth within the Oxford WwTW does not cause significant deterioration in the downstream Thames (Evenlode to Thame) WFD waterbody, a precautionary approach to the water quality modelling has been applied by assuming Oxford WwTW discharges directly into the River Thames, and therefore the more stringent water quality objectives associated with the Thames (Evenlode to Thame) WFD waterbody have been applied.

4.7.6.2 Revised Permit Conditions – Modelling Results

As part of the Cherwell WCS, approximate housing allocations from the surrounding districts were incorporated into the assessment of Oxford WwTW. The allocation of housing from the Vale of White Horse was 2,022 and this was assessed in the water quality modelling of Oxford WwTW in the Cherwell WCS. As this is above the 857 houses that have been allocated to Oxford WwTW in this WCS, the results from the Cherwell WCS have been used in this WCS for Oxford to represent a worst case scenario.

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

Table 4-24 Required permit quality conditions for Oxford WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)			
		Limit to 10% deterioration	No deterioration in status	Maintain current quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**10.0**	Current permit OK	-	-	
Ammonia (mg/l 95%ile)	**3.0**	By 2021: 2.5 By 2026: 2.4 By 2031: 2.4	-	-	N/A
Phosphate (mg/l annual average)	**1.0**	By 2021: 0.9 By 2026: 0.8 By 2031: 0.8	-	-	

4.7.6.3 WwTW Assessment Summary

Table 4-25 Oxford WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**No**	Calculated headroom deficit post-growth of 3,016m^3/d. Oxford WwTW has limited headroom capacity for any growth and is subject to ongoing improvements works by TWUL at the time of undertaking this WCS.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Yes**	The WwTW does not have sufficient permitted headroom to accommodate the growth and therefore a new permit will be required.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	**Yes**	The results from the Cherwell WCS show a worst case scenario for Oxford WwTW,

Assessment Criteria	Yes / No	Additional Comments
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from 3 mg/l to the following; - By 2021: 2.5 mg/l - By 2026: 2.4 mg/l - By 2031: 2.4 mg/l Phosphate permit condition will need to be tightened from 1 mg/l to the following; - By 2021: 0.9 mg/l - By 2026: 0.8 mg/l - By 2031: 0.8 mg/l The current BOD permit condition of 10 mg/l is sufficient to accommodate the proposed growth.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**Not Assessed**	As it can be demonstrated that the growth can be delivered through meeting the Environment Agency's aspirational target of limiting deterioration to 10% or less this assessment is not required.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	**Not Assessed**	As it can be demonstrated that the growth can be delivered through meeting the Environment Agency's aspirational target of limiting deterioration to 10% or less this assessment is not required.
d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	**Not Assessed**	Ammonia is already at High status - therefore ensuring no deterioration is adequate. Phosphate - An alternative objective has been set by the Environment Agency in place of the default objective to reach Good status. The alternative objective has been set due to the need for a technically infeasible solution to resolve the less than Good status of Phosphate (see Appendix F for details). This target is Moderate status which is the current status and hence the no deterioration assessment results apply equally to the Future Target Status objective. BOD - is already at High status - therefore ensuring no deterioration is adequate.
4. Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**Yes**	Cassington WwTW is located approximately 13km upstream of Oxford WwTW on the River Thames (Evenlode to Thame). Cassington WwTW is likely to receive significant growth during the plan period (as assessed in the Cherwell WCS). However, the flow of the River Thames is considered to provide significant dilution of the Cassington WwTW discharge. Additionally, there will no deterioration as a result of growth downstream of Cassington WwTW as to fulfil requirement by Natural England, it has been illustrated that 'maintain current condition' can be achieved with conventional treatment technology. It has therefore been concluded that the impact of growth on water quality upstream of Oxford WwTW would be minimal.
5. Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan. It is also recommended that developers within the Oxford WwTW catchment are required to complete a pre-development enquiry with TWUL which confirms that the WwTW can accept the flow without impacting on water quality, and that this detail is provided as part of the development planning application.

4.7.7 Shrivenham WwTW

4.7.7.1 Environmental Baseline

The Tuckmill Brook and tributaries waterbody (GB106039022920) receives treated effluent from Shrivenham WwTW and currently has an overall waterbody status of Poor, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-26.

Table 4-26 Classification elements of less than Good status for Tuckmill Brook and tributaries waterbody (GB106039022920)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Macrophytes and Phytobenthos Combined	Poor	Moderate	No known technical solution is available – Technically infeasible
Phosphate	Moderate	Moderate	No known technical solution is available – Technically infeasible

The current Moderate status of Phosphate is suspected to be due to continuous sewage discharge. It has a ‘probable’ level of activity certainty. The status of Phosphate is expected to remain Moderate by 2021.

The Reasons for Not Achieving Good (RNAG), as outlined in the Thames RBMP, relevant to the Tuckmill Brook and tributaries waterbody have been provided in Table 4-27 below.

Table 4-27 Reasons for not achieving good status on the Tuckmill Brook and tributaries waterbody (GB106039022920)

Category	Activity	Activity Certainty	Classification Element
Water Industry	Sewage discharge (continuous)	Suspected	Macrophytes and Phytobenthos Combined
		Probable	Phosphate

4.7.7.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-28. A load standstill calculation has been used to determine the future BOD permit conditions. Phosphate has not been assessed in the 10% deterioration test as there is no permitted or measured outflow data from the WwTW.

Table 4-28 Required permit quality conditions for Shrivenham WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain current quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**11**	N/A	8.0		N/A	N/A
Ammonia (mg/l 95%ile)	**2.5**	**0.5**	N/A	1.2	N/A	N/A
Phosphate (mg/l annual average)	N/A	N/A	N/A	0.6	N/A	N/A

4.7.7.3 WwTW Assessment Summary

Table 4-29 Shrivenham WwTW Assessment Summary

Assessment Criteria		Yes / No	Additional Comments
1.	Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	Yes	Calculated headroom capacity post-growth of 1,166m^3/d.
2.	Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	Yes	Due to significant level of growth in catchment during plan period.
3.	Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	Yes	No assessment was undertaken for Phosphate due to no current permit quality condition.
	a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	No	Ammonia permit condition will need to be tightened from 2.5 mg/l to 0.5 mg/l. Current limit of conventional treatment is 1 mg/l. A technical solution is not available to maintain less than 10% deterioration for this determinand. BOD permit condition will need to be tightened from 11 mg/l to 8 mg/l.
	b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	Yes	Ammonia permit condition will need to be tightened from 2.5 mg/l to 1.2 mg/l. BOD permit condition will need to be tightened from 11 mg/l to 8 mg/l.
	c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	Not Assessed	No assessment was required because it is demonstrated in Criteria 3b that the WFD objective of 'no deterioration' can be achieved within the current limits of conventional treatment.
	d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	Not Assessed	Ammonia is already at High status - therefore ensuring no deterioration is adequate. Phosphate - An alternative objective has been set by the Environment Agency in place of the default objective to reach Good status. The alternative objective has been set due to the need for a technically infeasible solution to resolve the less than Good status of Phosphate (see Appendix F for details). This target is Moderate status. BOD - No Future Target Status.
4.	Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	No	Shrivenham WwTW is located on the Tuckmill Brook with no other significant WwTW discharges upstream.
5.	Are WwTW infrastructure upgrades required?	Yes	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan.

4.7.8 Stanford in the Vale WwTW

4.7.8.1 Environmental Baseline

The (River) Ock (to Cherbury Brook) waterbody (GB106039023400) receives treated effluent from Stanford in the Vale WwTW and currently has an overall waterbody status of Moderate, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-30.

Table 4-30 Classification elements of less than Good status for Ock (to Cherbury Brook) waterbody (GB106039023400)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Phosphate	Moderate	Moderate	No known technical solution is available – Technically infeasible

The current Moderate status of Phosphate is due to continuous sewage discharge and agriculture and rural land management. It has a 'probable' level of activity certainty. The status of Phosphate is expected to remain Moderate by 2021.

The Reasons for Not Achieving Good (RNAG), as outlined in the Thames RBMP, relevant to the Ock (to Cherbury Brook) waterbody have been provided in Table 4-31 below.

Table 4-31 Reasons for not achieving good status on the Ock (to Cherbury Brook) waterbody (GB106039023400)

Category	Activity	Activity Certainty	Classification Element
Water Industry	Sewage discharge (continuous)	Probable	Phosphate
Agriculture and rural land management	Livestock field		
	Land use - arable		

4.7.8.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-32. A load standstill calculation has been used to determine the future BOD permit conditions. Phosphate and Ammonia has not been assessed in the 10% deterioration test as there is no permitted or measured outflow data from the WwTW.

Table 4-32 Required permit quality conditions for Stanford in the Vale WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain current quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**30**	N/A	25.9	N/A	N/A	N/A
Ammonia (mg/l 95%ile)	N/A	N/A	N/A	4.9	N/A	N/A
Phosphate (mg/l annual average)	N/A	N/A	N/A	2.1	N/A	0.5

4.7.8.1 WwTW Assessment Summary

Table 4-33 Stanford in the Vale WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**Yes**	Calculated headroom capacity post-growth of 206m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Yes**	Due to significant level of growth in catchment during plan period.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	**Yes**	No assessment was undertaken for Phosphate and Ammonia for the 10% deterioration test due to no current permit quality condition.
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	**Unknown**	BOD permit condition will need to be tightened from 30 mg/l to 25.9 mg/l. No assessment was undertaken for Phosphate and Ammonia due to no current permit quality condition.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**Yes**	Ammonia permit condition of 4.9 mg/l would be required. BOD permit condition will need to be tightened from 30 mg/l to 25.9 mg/l. Phosphate permit condition of 2.1 mg/l would be required
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	**Not Assessed**	No assessment was required because it is demonstrated in Criteria 3b that the WFD objective of 'no deterioration' can be achieved within the current limits of conventional treatment.
d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	**Yes**	Phosphate permit condition of 0.5mg/l would be required to ensure growth does not compromise the River Ock from achieving its Future Target Status of Good by 2027. As this can be achieved with conventional treatment technology, it is considered that future growth would not prevent future Good Phosphate status from being met. Ammonia was not assessed as the waterbody is already at High status – therefore ensuring no deterioration is adequate. BOD was not assessed - No Future Target Status.
4. Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**No**	Stanford in the Vale WwTW is located on the River Ock with no other significant WwTW discharges upstream.
5. Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan.

4.7.9 Wantage WwTW

4.7.9.1 Environmental Baseline

The Letcombe Brook waterbody (GB106039023350) receives treated effluent from Wantage WwTW and currently has an overall waterbody status of Poor, with the alternative objective to maintain Moderate status by 2021.

Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 4-34.

Table 4-34 Classification elements of less than Good status for Letcombe Brook waterbody (GB106039023350)

Classification Element	Current Status (2016)	Objective	Justification for alternative objective
Fish	Poor	N/A	N/A

4.7.9.2 Revised Permit Conditions – Modelling Results

The revised discharge permit quality conditions required for each phase of growth and by the end of the plan period for each determinand and for each modelled scenario are presented in Table 4-35. A load standstill calculation has been used to determine the future BOD permit conditions.

Table 4-35 Required permit quality conditions for Wantage WwTW throughout the plan period

Determinand	Current permit quality condition (mg/l)	Future permit quality condition required to (mg/l)				
		Limit to 10% deterioration	Load Standstill	No deterioration in status	Maintain current quality	Achieve Future Target Status
BOD (mg/l 95%ile)	**30**	N/A	24	N/A	N/A	N/A
Ammonia (mg/l 95%ile)	**5**	2.9	N/A	1.1	N/A	N/A
Phosphate (mg/l annual average)	**2**	1.3	N/A	**0.03**	1.2	N/A

4.7.9.3 WwTW Assessment Summary

Table 4-36 Wantage WwTW Assessment Summary

Assessment Criteria	Yes / No	Additional Comments
1. Is there sufficient permitted headroom to accept, treat and discharge the expected volume of wastewater as a result of growth proposed by the end of the plan period?	**No**	Calculated headroom deficit post-growth of 1,180m^3/d.
2. Has the water quality assessment demonstrated that utilising the headroom would risk non-compliance with water quality objectives?	**Not Applicable**	The WwTW does not have sufficient permitted headroom to accommodate the growth and therefore a new permit will be required.
3. Has the water quality assessment demonstrated that to accept and treat all of the additional wastewater flow expected from development without impacting on water quality objectives, the quality conditions of the a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	**Yes**	
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	**Yes**	Ammonia permit condition will need to be tightened from 5 mg/l to 2.9 mg/l. Phosphate permit condition will need to be tightened from 2 mg/l to 1.3 mg/l. BOD permit condition will need to be tightened from 30 mg/l to 24 mg/l.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**No**	Phosphate permit condition will need to be tightened from 2 mg/l to 0.03 mg/l. Current limit of conventional treatment is 0.5 mg/l. Growth may cause a deterioration in status for Phosphate unless improvements in technology or non-conventional

Assessment Criteria	Yes / No	Additional Comments
		technologies are used. It should be noted that under the current situation (pre-growth) a condition below the limit of conventional treatment would also be required for Phosphate indicating that the attainment of the status at the point of mixing is reliant on the WwTW discharging at a quality better than the current permit allows. Further analysis has been undertaken as a precautionary approach to determine whether current river quality can be maintained (see Criteria 3c). 'No deterioration' can be achieved for Ammonia through tightening the existing permit condition from 5 mg/l to 1.1 mg/l. 'No deterioration' can be achieved for BOD through tightening the existing permit condition from 30 mg/l to 24 mg/l.
c. Where 'no deterioration' cannot be achieved, can the current river quality be maintained after growth with current conventional treatment technology?	Yes	Phosphate permit condition will need to be tightened from 5 mg/l to 1.1 mg/l. In the absence of catchment scale modelling, it can be demonstrated that permit conditions within the current limit of conventional treatment can be applied to maintain the current Phosphate quality (at the mixing point) in the Letcombe Brook. Therefore, there are feasible solutions to ensure overall compliance with the WFD.
d. Can the WFD Future Target Status be achieved after growth with current conventional treatment technology?	**Not Assessed**	Ammonia is already at High status – therefore ensuring no deterioration is adequate. Phosphate - Already at Good status – therefore ensuring no deterioration is adequate BOD - No Future Target Status.
4. Is there the potential for a cumulative impact on water quality upstream of the WwTW from growth proposed in the study area?	**No**	Wantage WwTW is located on the Letcombe Brook with no other significant WwTW discharges upstream.
5. Are WwTW infrastructure upgrades required?	**Yes**	The exact technical specification of the upgrades required should be determined by TWUL for the AMP7 (2020 – 2025) asset planning period, in line with revised quality conditions for Ammonia, BOD and Phosphate. The Environment Agency and TWUL should plan work to determine the exact requirements of the future discharge permit and the specific treatment upgrades that would need to be applied in order to inform TWUL's PR19 Business Plan.

4.8 Ecological Appraisal

WwTW that do not need to change their current discharge permits are not discussed in this appraisal. This is on the basis that the ecological impacts of permits that do not require change should have already been considered as part of the permitting process and/or (for European designated wildlife sites) through the Environment Agency's Review of Consents process.

To undertake this appraisal, those WwTWs that would exceed current discharge permits as a result of the need to accommodate the planned future development in their catchments were identified. The headroom assessment identified four WwTWs that do not have sufficient consent headroom. As such, they would exceed their maximum permitted DWF under their existing discharge permits. These WwTWs are:

- Didcot;
- Kingston Bagpuize;
- Oxford; and
- Wantage

4.8.1 Impact on Designated Sites

Having identified the WwTWs exceeding current discharge permits, the receiving watercourses for those WwTWs were traced downstream from the WwTW discharge location. Where a receiving watercourse enters, or passes adjacent to, a statutory designated wildlife site that has potential to be vulnerable to changes in hydrology (based on the available information such as citations), these are identified and discussed in the following section. The discussion relating to individual WwTWs includes, where required, recommendations to ensure that future development does not adversely affect statutory or non-statutory designated wildlife sites. Where available, reasons for designation of the wildlife sites have been gathered primarily from the following sources:

- Joint Nature Conservation Committee (JNCC)
- Environment Agency;
- Natural England (NE); and,
- Vale of White Horse District Council.

Where it was not possible to determine if a site was hydrologically linked to the watercourse (i.e. merely in close proximity), the site was included in the discussion of the assessment as a precaution. Following this process, two statutory designated wildlife sites have been identified as being hydrologically connected to WwTWs that are unable to meet expected development needs during the Plan period without a change to their discharge permits. The designated sites connected to these WwTWs (even if just located adjacent to the watercourse but not confirmed to be hydrologically dependent upon it) are (listed alphabetically):

- Culham Brake (SSSI)
- Holies Down (SSSI)
- Hartslock (SSSI)
- Hartslock Wood (SAC)
- Little Wittenham SAC
- Little Wittenham SSSI

All other designated sites identified within the district are remote from watercourses into which WwTWs discharge treated effluent. Table 4-37 lists the wildlife sites that contain linking pathways to each relevant WwTW.

Table 4-37: Wildlife Sites that contain linking pathways to each relevant WwTW

WWTW	Wildlife Site	Hydrologically connected to the River	Comments
Didcot (discharges into Moor Ditch)	Little Wittenham (SAC)	X	10.1 km downstream on the River Thames
	Little Wittenham (SSSI)	X	Same as above
Kingston Bagpuize (discharges into Land Brook)	Little Wittenham (SSSI)	X	28.6 km downstream on the River Thames
	Little Wittenham (SAC)	X	Same as above
Oxford (discharges into the River Thames)	Culham Brake (SSSI)	ü	9.3 km downstream on the River Thames
	Little Wittenham (SAC)	x	22.8 km downstream on the River Thames
	Little Wittenham (SSSI)	x	Same as above
	Holies Down (SSSI)	x	41.3 km downstream on the River Thames
	Hartslock (SSSI)	x	43.6 km downstream on the River Thames
	Hartslock Wood (SAC)	x	Same as above
Wantage (discharges into Letcombe brook)	Little Wittenham (SSSI)	X	27.3 km downstream on the River Thames
	Little Wittenham (SAC)	X	Same as above

The internationally important wildlife sites that are linked to the watercourses within this geographical area include:

- Oxford Meadows SAC is designated for lowland hay meadows and receives surface water via seasonal flooding from the Thames River which is connected to both Faringdon WwTW (11.5 km upstream) and Shrivenham WwTW (0.9 km upstream). However, both of these are identified to still have headroom when future growth is taken into consideration.

- Little Wittenham SAC is designated for great crested newt populations but is not hydrologically connected to the River Thames. The section of the River Thames which surrounds the site is connected to all of the WwTWs which do not currently have adequate headroom for future growth, although the closest (Didcot WwTW) is 10.1 km upstream.

4.8.1.1 Effects of Nutrient Inputs Upon Ecological Receptors

Designated wildlife sites identified in Table 4-37are in general either freshwater aquatic habitats or terrestrial habitats that are influenced by inundation from freshwater riverine environments, or are not influenced by discharged flood waters. This section discusses the potential impacts of modelled determinants (BOD, ammonia and phosphate) on freshwater aquatic habitats, terrestrial habitats influenced by riverine conditions and their associated flora and fauna.

Biochemical Oxygen Demand (BOD)

Elevated Biochemical Oxygen Demand (BOD) in treated effluent can result in lower oxygen levels when discharged to freshwater habitats that can in turn result in death to plants and animals. BOD is not relevant to terrestrial habitats.

Ammonia

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. 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.

Phosphate

In the vast majority of freshwater environments phosphates are growth-limiting nutrients. Increases in phosphate levels in freshwater environments can result in the death of aquatic plants and animals via the process of eutrophication.

Each relevant WwTW is discussed further below.

4.8.1.2 Didcot WwTW

Moor Ditch and Ladygrove Ditch currently have a WFD status of ‘High’ for ammonia and ‘Moderate’ for phosphate; there is no WFD status for BOD. With conventional treatment processes, ammonia levels can be maintained such that there will be less than 10% deterioration when all growth planned for this WwTW is taken into account. This is similarly the case for BOD and phosphate. Therefore actual deterioration in water quality can be controlled adequately. It is not possible, using best available technology, to achieve sufficient improvement in effluent to achieve no deterioration in WFD status but this is already the case with the existing flows at the WwTW. The additional growth makes little difference.

The only statutory designated wildlife sites downstream (10.1km) of the discharge point are Little Wittenham (SAC) and Little Wittenham (SSSI). However, neither site is hydrologically connected to Moor Ditch and Ladygrove Ditch. As such there will be no negative impacts to the designations.

4.8.1.3 Kingston Bagpuize WwTW

Kingston Bagpuize WwTW discharges into the Land Brook. Its WFD status at the point of discharge is 'High' for ammonia and 'Poor' for phosphate; there is no WFD status for BOD. With conventional treatment processes, ammonia levels and BOD can be maintained such that there will be less than 10% deterioration when all growth planned for this WwTW is taken into account. Therefore actual deterioration in water quality can be controlled adequately. Phosphate was not included in this part of the model, due to a lack available measured data. However, the 'no deterioration in WFD status' test was applied using a mean discharge quality value and this shows that the WFD 'No Deterioration Status' can be achieved with permit tightening within the limits of conventionally applied treatment processes. This is also case for BOD levels. For ammonia, levels to achieve the WFD 'No Deterioration Status' to maintain the current quality then the permit tightening would need to be beyond the current recognised limits of conventional treatment. However, as for Didcot WwTW, this is already the case with the existing flows at the WwTW. The additional growth makes little difference.

Both Little Wittenham SAC and SSSI are 28.6 km downstream of the point of discharge and so increase concentrations of ammonia, BOD and phosphate will be very well diluted. Additionally, the designated sites are not hydrologically connected to the discharge. It can therefore be concluded that increased levels of ammonia, BOD and phosphate will have minimal negative impacts to the quality of these designated sites.

4.8.1.4 Oxford WwTW

This WwTW discharges into the River Thames. Downstream of the discharge point by 9.3 km is Culham Brake SSSI. The next nearest statutory designated site is over 22km downstream. The current WFD status at the discharge point is 'High' for BOD and ammonia and 'Good' for phosphates. Therefore water quality in the receiving watercourse is generally very good. Modelling has identified that, even with a revised condition permit, some deterioration in all three parameters at the point of discharge is expected over the plan period but it will be small (less than 10%) and will not result in the status of the receiving watercourse being negatively affected.

Culham Brake SSSI is dependent on regular nutrient enrichment via flooding from the river (and the associated deposition of relatively nutrient rich silt). An excessive increase in the loading of ammonia (and thus nitrogen) and phosphate within the floodwaters could cause a significant change to conditions within the meadow system. However, the increases in ammonia and phosphate predicted at the point of discharge are small and will not affect the actual WFD status of the receiving watercourse. Moreover, the increase in phosphate and ammonia at point of discharge will be heavily diluted further downstream from the discharge point and Culham Brake SSSI is 9.3 km downstream. Therefore, it is unlikely that the planned increase in growth within the catchment of Oxford WwTW will have a significant detrimental effect on hydrologically sensitive statutory designated sites.

4.8.1.5 Wantage WwTW

The receiving water body of the discharge is Letcombe Brook. Here, the WFD status for ammonia is 'High' and 'Good' for phosphate; BOD has not been assessed for WFD. The model predicts that deterioration of ammonia, BOD and phosphate can be restricted to less than 10% with permit tightening within the limits of conventionally applied treatment processes. For ammonia and BOD the WFD 'No deterioration Status' can also be achieved within the limits of conventional technology. . For phosphate, although actual deterioration in water quality can be controlled adequately, achieving no deterioration in WFD status would require treatment beyond the current recognised limits of conventional treatment. However, as for Didcot and Kingston Bagpuize WwTWs, this is already the case with the existing flows at the WwTW. The additional growth makes no difference to the model.

Due to the distance downstream (27.3 km) and the fact that they are not hydrologically connected, it is expected that negative impacts to the ecology of Little Wittenham (SSSI, SAC) will be negligible.

4.8.2 Impacts on Ecology outside Designated Sites

Whilst the above assessment is primarily focused on the impact on ecologically designated sites, the following section discusses ecology outside of designated sites. The limitations of a Water Cycle Study report make it impossible for such a discussion to be exhaustive or spatially very specific.

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

- Freshwater Crayfish (Wildlife & Countryside Act 1981)

- Great Crested Newt (Wildlife & Countryside Act 1981)
- Slow-worm (Wildlife & Countryside Act 1981)
- Common Lizard (Wildlife & Countryside Act 1981)
- Grass Snake (partially protected through Wildlife & Countryside Act 1981),
- Adder (Wildlife & Countryside Act 1981)
- Common toad (Wildlife & Countryside Act 1981)
- Birds such as barn owl, kingfisher (protected through Wildlife & Countryside Act 1981 and a UK BAP species)
- European Water Vole (Wildlife & Countryside Act 1981)
- Bats (Wildlife & Countryside Act 1981)
- European Otter (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981)
- Eurasian Badger (Badger Act 1992)
- Hazel Dormouse (Wildlife & Countryside Act 1981)

Similarly important habitats (all listed as UK Priority Habitats in Oxfordshire)

- Lowland grasslands
- Lowland woodlands
- Lowland fens
- Ponds and rivers
- Reedbeds
- Eutrophic standing waters
- Coastal and floodplain grazing marsh
- Hedgerows
- Lowland heath

All of these habitats and species are present (or possibly present) in the District.

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

The assessment in the previous section of designated wildlife sites identified that the majority of wildlife sites assessed that were close enough to the WwTW discharge points to be vulnerable to changes in discharge volumes are freshwater and terrestrial features, and thus limited by phosphate and ammonia (nitrogen via nitrification of ammonia) levels. Phosphates are the primary limiting compound in freshwater systems; where levels are high it can lead to the death of aquatic plants and animals via the process of eutrophication. The impacts of ammonia on freshwater systems can result in death of plants and animals. In terrestrial habitats the primary limiting compound is nitrogen (from nitrified ammonia) which can result in less competitive plant species being out competed by plant species that are more able to assimilate nitrogen for growth.

Levels of development identified during the Plan period have potential (albeit probably only cumulatively with the existing exceedances) to have an adverse effect on wildlife of the receiving saline habitats and watercourses downstream and avoidance measures will be required as already outlined.

4.8.3 Ecological Opportunities Associated with Proposed Development Locations

To ensure that the planned level of development within the Plan period does not result in a negative impact upon wildlife both inside and outside of designated sites, it is recommended that policy is included within the Local Plan to ensure that these matters are addressed at a strategic level and water quality at these locations will be improved to suitable WFD levels and permit levels. This may include the requirement for new infrastructure to be in place prior to the delivery of new development or the need for phased infrastructure to ensure that the WwTWs can accommodate the increased capacity and not result in a detrimental impact upon wildlife features.

4.9 Wastewater Summary

WwTWs which are shown to exceed their volumetric permits have undergone water quality modelling (Wantage, Kingston Bagpuize and Didcot WwTW). The results demonstrate that there is environmental capacity for the proposed options for growth as long as permit changes and any required process upgrades are undertaken.

Therefore, from a WFD perspective there is capacity to accept growth and comply with current WFD targets based on the limits achievable with current technology. However, environmental capacity should be considered to be ultimately limited on the basis that limitations on current treatment technologies are preventing the optimal target of future good status from being achieved. The capability and performance of treatment technologies are likely to improve over time, and hence capacity for additional wastewater flow would need to be reconsidered in the context of achieving good status up to the end of the plan period and beyond.

4.10 Overall RAG Assessment

Table 4-38 provides a RAG assessment of the WwTWs within the District which have been assessed and the results against the full range of water quality objectives tested. The key for the RAG assessment is shown below:

- **Green** – water quality objectives will not be adversely affected. Growth can be accepted with no changes to the WwTW infrastructure or quality permit required.
- **Amber** – in order to meet the required water quality objectives, changes to the quality permit are required, and upgrades may be required to WwTW infrastructure which may have phasing implications.
- **Red** - in order to meet water quality objectives changes to the quality permit are required which are beyond the limits of what can be achieved with conventional treatment.

The water quality modelling results demonstrate that, subject to the revision or issuing of new discharge permits and the necessary treatment process upgrades (using conventional treatment technologies) being implemented, there is environmental capacity for the proposed growth to ensure WFD water quality objectives can be met.

In nearly all cases, the assessment has also shown that subject to the revision of discharge permits and the necessary treatment process upgrades (using conventional treatment technologies) being implemented, changes in water quality as a result of additional discharge can be maintained at 10% or less. The exception would be Shrivenham WwTW where non-conventional treatment technologies would be required to ensure deterioration in ammonia quality does not exceed 10% within the receiving waterbodies. However, the critical assessment outcome is that WFD objectives, of no status deterioration, can be met.

Whilst the WCS has shown technical solutions are possible to maintain WFD objectives, it should be noted that all water bodies are not expected to be able to meet overall requirement of ‘Good’ status as set out in the WFD. Therefore, the assessments undertaken should be considered within the context of the lower current and future baseline quality of the waterbodies assessed. As published in the latest Thames RBMP by the Environment Agency, current WwTW discharges are believed to be one of the causes for high nutrient concentrations in the River Ock, Tuckmill Brook, River Thames, Ginge Brook, Moor Ditch and Marcham Brook, and therefore they are currently contributing to the waterbodies not meeting the required ‘Good’ status under the WFD. As stated in the WwTW assessments above, the reason is due to no technical solution currently available (i.e. beyond current limits of conventional treatment technology), or disproportionately expensive and consequently alternative (lower) WFD objectives have been set.

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.

Table 4-38 Wastewater treatment works assessment summary

WwTW	Watercourse	Is Headroom available for anticipated growth?	Is a revised quality condition required?	Limit deterioration to 10% or less?	Load Standstill Assessment- New permit needed?	Ensure no deterioration in status?[16]	Maintain Current Quality	Future Status	Overall RAG
Appleton	Marcham Brook	Yes – But levels of growth significant for this WwTW.	Ammonia	Yes	N/A	No	N/A	N/A	
			BOD	N/A	Yes	N/A	Yes	N/A	
			Phosphate	N/A	N/A	N/A	N/A	N/A	
Didcot	Moor Ditch	No	Ammonia	Yes	N/A	No	Yes	N/A	
			BOD	N/A	Yes	N/A	N/A	N/A	
			Phosphate	Yes	N/A	No	Yes	N/A	
Drayton	Mill Brook	Yes – But levels of growth significant for this WwTW.	Ammonia	Yes	N/A	Yes	N/A	N/A	
			BOD	Yes	N/A	N/A	N/A	N/A	
			Phosphate	N/A	N/A	Yes	N/A	N/A	
Faringdon	River Thames	Yes – But levels of growth significant for this WwTW.	Ammonia	N/A	N/A	No	N/A	N/A	Insufficient data[17]
			BOD	Yes	N/A	Yes	N/A	N/A	
			Phosphate	N/A	N/A	No	N/A	N/A	
Kingston Bagpuize	River Ock	No	Ammonia	Yes	N/A	No	Yes	N/A	
			BOD	Yes	N/A	N/A	N/A	N/A	
			Phosphate	N/A	N/A	Yes	N/A	N/A	
Oxford	River Thames	No	Ammonia	Yes	N/A	N/A	N/A	N/A	
			BOD	Yes	N/A	N/A	N/A	N/A	
			Phosphate	Yes	N/A	N/A	N/A	N/A	

[16] If no deterioration cannot be achieved it has been shown in the Maintain Current Quality test that growth will not have an impact on water quality.
[17] Insufficient data due to a lack of current permit limits and no upstream sampling point for Ammonia and Phosphate.

WwTW	Watercourse	Is Headroom available for anticipated growth?	Is a revised quality condition required?	Limit deterioration to 10% or less?	Load Standstill Assessment- New permit needed?	Ensure no deterioration in status?[16]	Maintain Current Quality	Future Status	Overall RAG
Shrivenham	Tuckmill Brook	Yes – But levels of growth significant for this WwTW.	Ammonia	No	N/A	Yes	N/A	N/A	
			BOD	N/A	Yes	N/A	N/A	N/A	
			Phosphate	N/A	N/A	Yes	N/A	N/A	
Stanford in the Vale	River Ock	Yes – But levels of growth significant for this WwTW.	Ammonia	N/A	N/A	Yes	N/A	N/A	
			BOD	N/A	Yes	N/A	N/A	N/A	
			Phosphate	N/A	N/A	Yes	N/A	Yes	
Wantage	Letcombe Brook	No	Ammonia	Yes	N/A	Yes	N/A	N/A	
			BOD	N/A	Yes	N/A	N/A	N/A	
			Phosphate	Yes	N/A	No	Yes	N/A	

5. Water Supply Strategy

5.1 Introduction

Water supply for the study area is provided by TWUL. 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 Thames Catchment Abstraction Licensing Strategy.

This study has also used TWULs 2015 WRMP[18] to determine available water supply against predicted demand and has considered how water efficiency can be further promoted and delivered for new homes beyond that which is planned for delivery in TWUL's WRMP.

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.
Water available for licensing, due to Thames Q50	The lower River Thames is classed as water not available for licensing. Consequently all tributaries to the River Thames are protected from consumptive abstraction to ensure flows to the River Thames are maintained. A bespoke strategy for new consumptive abstractions has been produced by the Environment Agency to ensure these requirements are met.
Restricted water available for licencing	Full Licensed flows fall below the Environmental Flow Indicators (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: The Environment Agency is currently investigating water bodies that are not supporting Good Ecological Status / Good Ecological Potential). 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 District has been summarised in Table 5-2. The Environment Agency aims to protect the annual flow variability in rivers, from low to high flow conditions through the application of flow statistics derived from flow data collected at river gauging stations. Flow statistics are expressed as the percentage of time that flow is exceeded. Resource availability is calculated by the Environment Agency at four different flow scenarios:

[18] Thames Water Utilities Limited Final Water Resources Management Plan (2015) https://corporate.thameswater.co.uk/About-us/Our-strategies-and-plans/Water-resources/Our-current-plan-WRMP14

- Q_{95} (lowest),
- Q_{70},
- Q_{50}, and
- Q_{30} (highest).

Q_{95} is the flow exceeded for 95% of the time, and is used as a low flow indicator. Q_{30} is the flow exceeded for 30% of the time; and is considered to be a high flow. Figure 5-1 below illustrates an example gauged daily flow across a period of time and the calculated flow percentiles associated to the flow measured in the river.

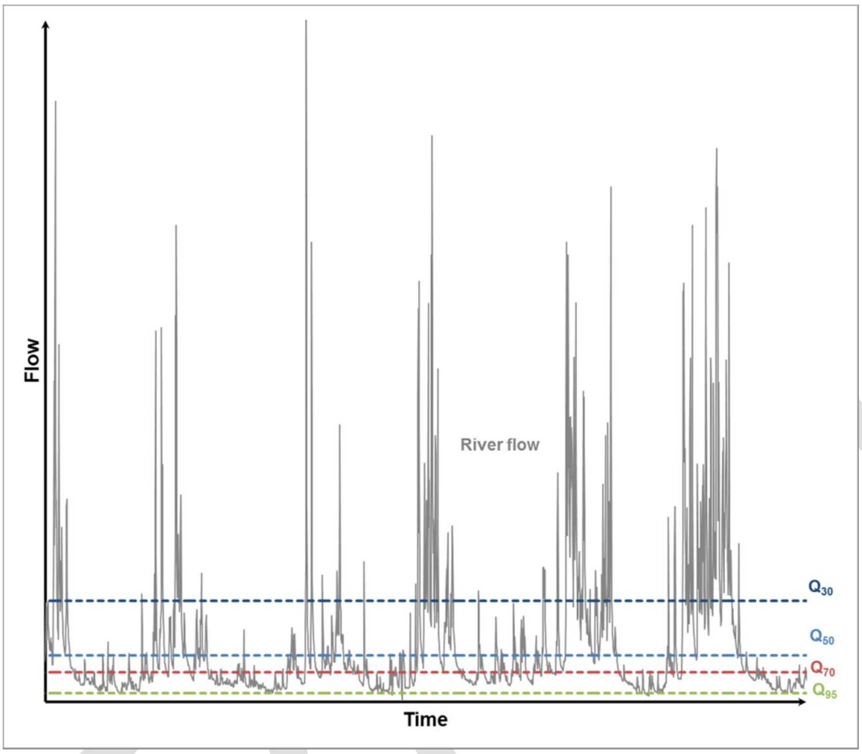


Figure 5-1 Example of gauged daily flow and calculated flow statistics

There is one Water Resource Management Unit (WRMU) in the District, the River Ock, and its resource availability classification has been summarised in Table 5-2.

Table 5-2 Resource availability classification

River – WRMU	Surface Water (flow exceedance scenarios)				Licence restriction
	Q30	Q50	Q70	Q95	
AP3- River Ock -					§ Water available for licencing during high flows. § New abstractions will be subject to Thames Q50 Hands off Flow (HOF). § Groundwater licences, which do not have a direct and immediate impact on river flow may be permitted all year.

The River Ock is defined as having water available for licencing during high flows. This analysis indicates that there is potential for local abstraction to support major site development at a local level. The constraint on water available in the River Ock at Q70 is due to the River Ock being a tributary of the River Thames, and therefore subject to the licensing requirements associated with the River Thames catchment.

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 a 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 for the environment to be protected. As part of the statutory approval process, the plans must be approved by both the Environment Agency and Natural England (as well as other regulators) and hence the outcomes of the plans can be used directly to inform whether growth levels being assessed within a WCS can be supplied with a sustainable source of water supply.

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

AECOM Position Statement – September 2017

AECOM's review of the Thames Water Utilities Limited (TWUL) Water Resource Management Plan (WRMP) suggests that the proposed VoWH growth figures have been accounted for within the WRMP, although due to growth figures not being explicitly stipulated per District, confirmation is required from TWUL that this is in fact the case.

5.5 Demand for Water

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

The projections were derived as follows:

- **Baseline Projection** – **Average TW metered consumption –** Existing consumption of 137 l/h/d
- **Projection 1** – **Low Scenario (Building Regulations) –** New homes would conform to (and not use more than) Part G of the Building Regulations requirement of 125 l/h/d;
- **Projection 2 – Medium Scenario (Building Regulations Optional Requirement)** – Only applies where a condition that the new home should meet the optional requirement is imposed as part of the process of granting planning permission. New homes would conform to a limit of 110 l/h/d as required by the VoWH DC Local Plan 2031 Part 1 Core Policy 40[19];
- **Projection 3 – High Efficiency Scenario** – New homes would achieve 80 l/h/d (to reflect the now superseded Code for Sustainable Homes Level of 5 or 6); and,
- **Projection 4** – **Very High Efficiency Scenario –** New homes would include both greywater recycling and rainwater harvesting reducing water use to a minimum of 62 l/h/d.

[19] http://www.whitehorsedc.gov.uk/sites/default/files/359975%20VWH%20Plan_Body_DIGITAL%205-7.pdf

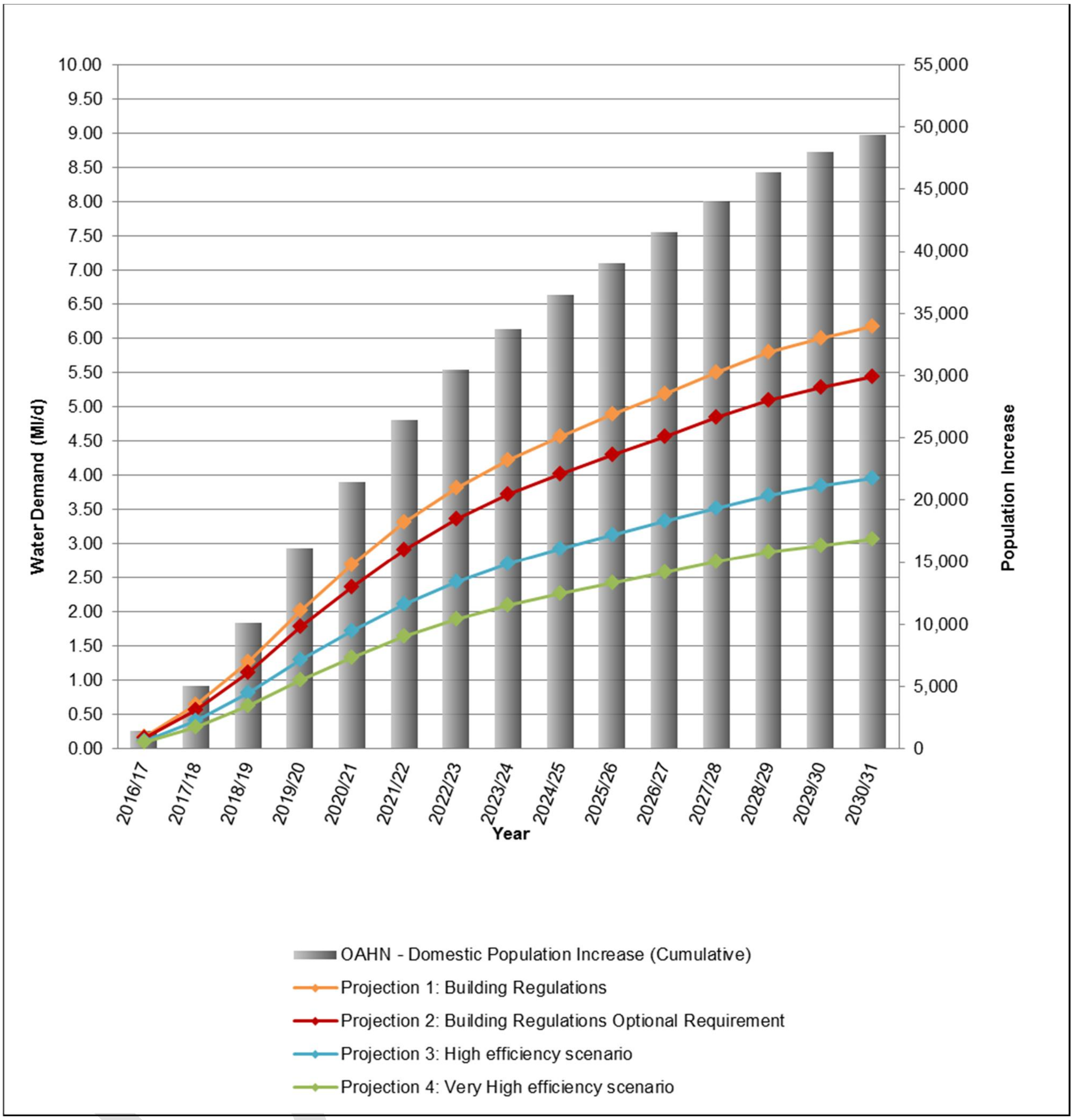


Figure 5-2 Range of water demands across plan period in VoWH depending on efficiency levels of new homes

5.6 Planned Water Availability Summary

The final 2015 WRMP for TWUL has been used to summarise water availability to meet the projected demand for the District covering the planning period to 2031.

The VoWH District is located in the TWUL Swindon & Oxfordshire (SWOX) WRZ.

TWUL's SWOX WRZ covers the VoWH, Cherwell, Oxford area and Swindon area. The WRZs outside London are referred to collectively as the 'Thames Valley'. The Thames Valley region abstracts 30% of its water supply from surface water sources and 70% from groundwater.

5.6.1 SWOX Water Resource Zone (TWUL)

5.6.1.1 Supply-Demand Strategy

TWUL's assessment of available water identifies that SWOX WRZ does not have sufficient water for the whole of the 25 year planning period to meet its customers' need. The baseline supply and demand assessment demonstrates that the SWOX WRZ will have a dry year annual average surplus from 2015 (26 Ml/d) through to a deficit in 2035 (-27 Ml/d).

TWUL has therefore identified a number of schemes that will benefit the WRZ. This strategy ensures that TWUL maintains a headroom surplus throughout the planning period. The measures are focused on demand management and include:

Short term (2015-2020)

- Promote water efficiency

Long term (2020-2040)

- Full meter penetration for household customers from 2020;
- Transfer from Slough, Wycombe and Aylesbury WRZ; and
- Continue to promote water efficiency.

5.7 Water Efficiency Plan

In order to ensure water efficiency in the future, TWUL has proposed plans to reduce water consumption through a series of demand management measures as agreed with the Environment Agency. It is hoped that by reducing the long term demand for water, the supply of water can be controlled to aid in ensuring that water is available in the future. The majority of these measures will be undertaken from 2020. Lowering water consumption levels is considered to be a priority in offsetting resource development.

Proposed demand management measures across the SWOX WRZ include:

- Leakage reduction;
- Progressive household metering;
- Optant metering[20];
- Water efficiency; and
- Tariffs and behaviour change.

There are several key drivers for ensuring that water use in the development plan period is minimised as far as possible through the adoption of water efficiency policy. This WCS therefore includes an assessment of the feasibility of achieving a 'water neutral' position after growth across the District.

5.8 Drivers and Justification for Water Efficiency

The District is surrounded by a number of different authorities that each has different environments and plans for future development. It is important to ensure that development and other additional factors do not have a damaging effect on the water environment for other authorities within the region.

The District is an area of serious water stress, as classified by the Environment Agency[21]. Any growth and increase in population will further exacerbate this issue. In order to ensure surplus raw water supply for growth in the District, TWUL's current WRMP covering the next 25 years takes an approach of more efficient use of existing resources and demand reduction from customers. The proposals and opportunities for abstraction from existing river systems and aquifers in the supply area are limited, mainly due to the limitation on available new resources locally. 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 TWUL in the District.

[20] The Optant metering programme allows the Thames Water customers to move to a metered bill when they request it.
[21] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244333/water-stressed-classification-2013.pdf

5.8.1 Managing Climate Change and Availability of Water

It is predicted that climate change will further reduce the available water resources in the District. Rainfall patterns are predicted to change to less frequent, but more extreme, rainfall events.

TWUL has recognised the risk climate change poses to the three crucial areas of their business: abstraction, treatment and distribution of water. The impact of climate change on groundwater poses the most significant risks to long term supply/demand balance due to reductions in rainfall, particularly during consecutive seasons, reducing the amount of groundwater recharge that occurs.

In addition, customers expect TWUL 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.

In planning for future water resources availability, TWUL has accounted for the impacts of climate change within their supply-demand forecasts as outlined below.

5.8.1.1 Impact on Supplies

TWUL have calculated that climate change is likely to produce a deficit on a dry year annual average scenario of -8.5 Ml/d by 2035 in the SWOX WRZ. This has been attributed to the impact of climate change on the deployable output of groundwater sources.

5.8.1.2 Impact on Demand

The main impact of climate change on demand is related to periods of extremely hot and dry weather that will increase the peak demand for water. TWUL 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 TWUL have planned for the anticipated impacts of climate change, the view of both TWUL 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.

5.8.2 Sustainability reductions

Water abstraction can contribute to low flows in some rivers, which in turn can contribute to ecological damage in the river. To ensure compliance with the EU Water Framework Directive, TWUL is required to reduce existing abstractions. The TWUL 2015 WRMP indicates that groundwater levels are the most significant risk to water supply. The WRMP explains that a reduction of 4Ml/d (dry year annual average) has been agreed with the Environment Agency for existing abstractions at Axford (Wiltshire). The potential for further sustainability reductions from classification sources is also being explored, with a possible further 6.7Ml/d (dry year annual average) reduction at Ogbourne (Wiltshire) and Childrey Warren (South Stoke, South Oxfordshire).

Whilst these reductions in licenced abstraction have been considered within the WRMP, they indicate the pressure on existing sources and the limits to which they can be managed further.

5.9 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[22]. 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.

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

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

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

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

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 District as a whole.

5.9.1 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 District, a number of measures and devices are available[23]. Generally, these measures fall into two categories due to cost and space constraints; 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.

5.9.2 Achieving Total Neutrality – is it feasible?

When considering neutrality within an existing planning area, it is recognised by the Environment Agency[24] that achievement of total water neutrality (100%) for new development is often not possible, as the levels of water savings required in existing stock may not be possible for the level of growth proposed. A lower percentage of neutrality may therefore be a realistic target, for example 50% neutrality.

This WCS therefore considers four water neutrality targets and sets out a 'pathway' for how the most likely target (or level of neutrality) can be achieved. 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.

5.9.3 Metering Assumptions

Installing water meters within existing residential properties is an important element of TWUL's WRMP to manage their customers' demand for water. TWUL's metering programmes (as described below) has been applied to the five water neutrality scenarios (outlined in Section 5.5) and details the level of additional metering that could be undertaken.

The existing level of metering within the SWOX WRZ is 50%. TWUL's future target for meter penetration on domestic water supplies is 92.7% by 2031. As stated in the TWUL WRMP, meter installation will continue to the target of 93.1% of domestic water supplies to be metered by 2040. Therefore, the water neutrality scenarios could, in line with TWUL's WRMP, assume that 93.1% is achieved earlier than 2040 and instead 92.7% meter penetration is achieved by the end of the plan period (2031) allowing a further possible 0.4% within the existing housing stock by 2040..

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[23] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.
[24] Environment Agency (2009) Water Neutrality, an improved and expanded water management definition

5.9.4 Water Neutrality Scenarios

5.9.4.1 Very High Scenario

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

The key assumptions for this scenario are that water neutrality is achieved; however it is considered as aspirational only as it is unlikely to be feasible based on:

- Existing research into financial viability of such high levels of water efficiency measures in new homes; and
- Uptake of retrofitting water efficiency measures considered to be at the maximum achievable (20%) in the District.

It would require:

- Meter installation into all existing residential properties (100% meter penetration);
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the extremely high percentage of retrofitting measures required;
- Strong local policy within the Local Plan on restriction of water use in new homes on a local authority scale which is currently unprecedented in the UK; and
- All new development to include water recycling facilities across the District.

5.9.4.2 High Scenario

The key assumptions for this scenario are that a high water neutrality percentage[25] is achieved but requires significant funding and partnership working, and adoption of new local policy which is currently unprecedented in the UK.

It would require:

- Meter installation up to the maximum planned (up to 2040) as per TWUL WRMP by 2031 (93.1% meter penetration);
- Uptake of retrofitting water efficiency measures to be very high (18%) in relation to studies undertaken across the UK into feasibility of retrofitting;
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required; and,
- All new development would need to include rainwater harvesting.

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

5.9.4.3 Medium Scenario

The key assumptions for this scenario are that the water neutrality percentage[25] achieved is at least 50% of the total neutrality target and would require funding and partnership working, and adoption of new local policy which has only been adopted in a minimal number of Local Plans in the UK.

It would require:

- Meter installation estimated as a linear projection between 2016 and 2040 TWUL WRMP figures (92.7% meter penetration by 2031);

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

- New housing development should go beyond mandatory Building Regulations requirements, ideally to 110 l/h/d optional Building Regulations requirements in accordance with LPP1 Core Policy 40;
- Uptake of retrofitting water efficiency measures to be reasonably high (15%) in the District; and
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required.

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

5.9.4.4 Low Scenario

The key assumptions for this scenario are that the water neutrality percentage[25] achieved is low but would require small scale level of funding and partnership working, and adoption of new local policy which is likely to be easily justified and straightforward for developers to implement.

It would require:

- Meter installation estimated as a linear projection between 2016 and 2040 TWUL WRMP figures (92.7% meter penetration by 2031);
- New housing development should go beyond mandatory Building Regulations requirements, ideally to 110 l/h/d optional Building Regulations requirements;
- Uptake of retrofitting water efficiency measures to be fairly low (10%); and
- A relatively small funding pool and a partnership working not moving too far beyond 'business as usual' for stakeholders.

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

5.9.5 Neutrality Scenario Assessment Results

To achieve total water neutrality, the demand post growth must be the same as, or less than existing demand. Based on estimates of population size, current demand in the District was calculated to be 22.65 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, UKWIR[26], 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).

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

- Stage 1 – total demand post growth without any assumed water efficiency retrofitting for the differing levels of water efficiency in new homes;
- Stage 2 – total demand post growth with effect of metering applied for the differing levels of water efficiency in new homes; and,
- Stage 3 – total demand post growth with metering and water efficient retrofitting applied to existing homes for the differing levels of water efficiency in new homes. The results are provided in Table 5-3. If neutrality is achieved, the result is displayed as green. If it is not, but is within 5%, it is displayed as amber, and red if neutrality above the 5% threshold is not achieved. The percentage of total neutrality achieved per scenario is also provided.

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

Table 5-3 Results of the Neutrality Scenario Assessments

Neutrality Scenario	New Homes demand projections	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 metering (Ml/d)	Total demand after metering & retrofitting (Ml/d)	% Neutrality Achieved
Baseline	Baseline Projection: Average metered consumption	137	0	6.77	29.42	**27.96**	**27.96**	22%
Low	Projection 1a: Building Regulations	125	0	6.17	28.83	**27.37**	**27.37**	30%
	Projection 1b:Building Regulations + retrofit	125	10	6.17	28.83	**27.37**	**27.17**	33%
Medium	Projection 2a: Building Regulations optional requirement	110	0	5.43	28.09	**26.63**	**26.63**	41%
	Projection 2b: Building Regulations optional requirement + retrofit	110	15	5.43	28.09	**26.63**	**25.91**	52%
High	Projection 3: High efficiency + retrofit	80	18	3.95	26.61	**25.13**	**23.89**	82%
Very High	Projection 4: Very High efficiency + retrofit	62	20	3.06	25.72	**24.01**	**22.62**	100%

* prior to demand management for existing housing stock

The results show that total neutrality is only achieved by applying the Very High water neutrality scenario, requiring new homes to use water at a rate of 62 l/h/d. The Medium water neutrality scenario would give a minimum of 41% neutrality which would require only new homes to be designed to use water at a rate of 110 l/h/d (Projection 3a). A further 12% neutrality (up to 52%) could be achieved through retrofitting 15% of the existing housing stock with water efficiency fittings equivalent to the optional requirement standard.

5.9.6 Financial Cost Considerations

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

Using the information compiled, the financial costs per neutrality scenario has been calculated and are included in Table 5-4. It should be noted that these are only estimated costs based on strategic level research into water efficiency implementation and cost.

Table 5-4 Estimated Cost of Neutrality Scenarios

Neutrality Scenario	New Homes		Existing Properties					Costs Summary		
	No.	Efficiency cost	No. to be metered	Metering cost	Population Retrofit %	No. to retrofit	Retrofit cost	Developer	Non developer	Total
Low	19,964	£-	3,606	£1,803,100	10.00%	4940	£247,000	£-	£2,050,100	£2,050,100
Medium	19,964	£179,680	3,606	£1,803,100	15.00%	7410	£1,407,900	£179,680	£3,211,000	£3,390,680
High	19,964	£53,843,987	3,606	£1,803,100	18.00%	8892	£1,956,240	£53,843,987	£3,759,340	£57,603,327
Very High	19,964	£81,794,147	3,606	£1,803,100	20.00%	9880	£2,173,600	£81,794,147	£3,976,700	£85,770,847

5.9.7 Preferred Strategy – Delivery Pathway

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

To achieve any level of neutrality, a series of partnership approaches and funding sources would need to be developed. This WCS has adopted a 'medium' scenario as the favoured option based on the Local Plan 2031 Part 1 Core Policy 40 of new housing development achieving a minimum consumption of 110l/h/d. This 'medium' scenario would allow a water neutrality target of between 41% and 52% to be reached if metering were to occur in line with the proposed TWUL strategy. The medium scenario is considered to require a significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures, as well as the adoption of new local policy within the Local Plan on restriction of water use in new homes on a District scale which goes beyond that seen generally in the UK. It would require:

- Meter installation estimated as a linear projection between 2016 and 2040 TWUL WRMP figures (92.7% meter penetration by 2031);
- New housing development to adhere to the requirements of LPP1 Core Policy 40, being design to limit water use to 110 l/h/d (in line with the optional Building Regulations requirements);
- Uptake of retrofitting water efficiency measures to be reasonably high (15%) in the District; and
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required.

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

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

5.9.8 Current Policy

The VoWH District Council has already set a requirement in the LPP1 (Core Policy 40) that all new developments incorporate water efficiency measures in order to limit water use to 110 l/h/d (as per the optional Building Regulations requirements); therefore, this policy element of the preferred strategy is in place. It is recommended that the Council consider ways to support developer implementation of this policy via information sources on their website. Measures can include (but not necessarily limited to) garden water butts, low flush toilets, low volume baths, aerated taps, and water efficient appliances.

5.9.9 Delivery Requirements – Partnership Approaches

Housing association partners could be targeted with a programme of retrofitting water efficient devices, to showcase the policy and promote the benefits. This could be a collaborative scheme between VoWH District Council, TWUL, and Waterwise. In addition, Rain Water Harvesting (RWH) and Greywater Recycling (GWR) schemes could be implemented into larger council owned and maintained buildings, such as schools or community centres. RWH could be introduced to public toilets. The retrofitting scheme could then be extended to non-Council owned properties, via a promotion and education programme.

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

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

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

5.9.9.1 Responsibility

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

It is therefore suggested that responsibility for implementing water efficiency policies be shared as detailed in Table 5-5.

Table 5-5 Responsibility for implementing water efficiency

Responsibility	Responsible stakeholder
Ensure planning applications are compliant with the recommended policies	VoWH District Council
Fitting water efficient devices in accordance with policy	Developers
Provide guidance and if necessary enforce the installation of water efficient devices through the planning application process	VoWH District Council
Ensure continuing increases in the level of water meter penetration	TWUL
Retrofit devices within council owned housing stock	VoWH District Council
Retrofit devices within privately owned housing stock (via section 106 agreements)	Developers
Promote water audits and set targets for the number of businesses that have water audits carried out. Allocate a specific individual or team within each of the local authorities to be responsible for promoting and undertaking water audits 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.	VoWH District Council
Educate and raise awareness of water efficiency	VoWH District Council and TWUL

A major aim of the education and awareness programme, as outlined by Policy Recommendation WS3 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.

5.9.9.2 Retrofitting funding options

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

VoWH District Council could consider developer contributions to the Community Infrastructure Levy (CIL) or through S106 agreements or even through development of an offset policy. Part 11 of the Planning Act 2008[27] (c. 29) ("the Act") provides for the imposition of a charge to be known CIL. This is a local levy that authorities can choose to introduce to help fund infrastructure in their area. CIL will help pay for the infrastructure required to serve new development, and although CIL should not be used to remedy pre-existing deficiencies, if the new development makes the deficiency more severe than the use of CIL is appropriate.

Section 106 (S106) of the Town and Country Planning Act 1990[28] allows a local planning authority (LPA) to enter into a legally-binding agreement or planning obligation with a landowner in association with the granting of planning permission, known as a Section 106 Agreement. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. They are increasingly used to support the provision of services and infrastructure, such as highways, recreational facilities, education, health and affordable housing.

However, there are considerable existing demands on developer contributions and it is unlikely that all of the retrofitting required in the District could be funded through these mechanism; they therefore need to look beyond developer contributions, possibly to the water companies, for further funding sources. Some councils offer council tax rebates to residents who install energy efficient measures (rebates jointly funded by the Council and Energy Company)[29]. VoWH District Council should consider a similar scheme, although this would require the agreement of TWUL.

5.9.9.3 Retrofitting monitoring

During delivery stage, it will be important to ensure sufficient monitoring is in place to track the effects of retrofitting on reducing demand form existing housing stock. The latest research shows that retrofitting can have a significant beneficial effect and can be a cost effective way of managing the water supply-demand balance[30]. However, it is acknowledged that savings from retrofitting measures do diminish with time. This means that a long-term communication strategy is also needed to accompany any retrofit programme taken forward. This needs to be supported by monitoring, so that messages can be targeted and water savings maintained in the longer-term. The communication and monitoring message also applies to new builds to maintain continued use of water efficient fixtures and fittings.

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

6. Major Development Site Assessment

6.1 Introduction

Following the assessment of wastewater treatment capacity and water resources, this section of the WCS addresses infrastructure capacity issues, and an update to the odour assessment for each of LLP2 sites. The results are presented for each of the major development sites in Appendix G.

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 WwTW 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 District, TWUL 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 TWUL 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, TWUL generally do not provide additional capacity until there is certainty that the development is due to commence. Where development proposals are likely to require additional capacity upgrades to accommodate new development flows, it is highly recommended that potential developers contact TWUL as early as possible to confirm flow rates and intended connection points. This will ensure the provision of additional capacity is planned into TWUL's investment programme to ensure development is not delayed.

TWUL have undertaken an internal assessment of the capacity of the network system using local operational knowledge.

The results are presented for each of the Preferred Sites in Appendix G. A RAG assessment has been undertaken; a key indicating the coding applied to each assessment is provided in Table 6-1.

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TWUL to provide confirmation RAG Assessment adequately reflects that of their network.

Table 6-1 Key for wastewater network RAG assessment

Development is likely to be possible without upgrades	**Pumping station or pipe size may restrict growth, or non-sewered areas, where there is a lack of infrastructure; a pre-development enquiry is recommended before planning permission is granted**	**There is limited capacity in the network, hence solution required to prevent further CSO discharges or sewer flooding**

6.2.2 Odour Assessment

Where new development encroaches upon existing wastewater treatment works, odours from the works can cause a nuisance for residents. Managing the odour from WwTW's can increase the cost to WwTW's. National Planning Policy Guidance recommends that plan-makers considering whether new development is appropriate near to sites used (or proposed) for water and wastewater infrastructure, in particular due to the risk of odour impacting on residents and requiring additional investment to address. The same methodology from the 2014 WCS has been used. TWUL's policy for whether a new development will need an odour assessment is if the site is less than 800m from a WwTW and is encroaching closer to the WwTW than existing urbanised areas. A GIS exercise was carried out to identify which of the nine sites that are less than 800m from a WwTW and encroaching closer to the WwTW than existing urbanised areas.

7. Water Cycle Strategy Recommendations and Policy

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

7.1 Policy Recommendations Overview

7.1.1 Wastewater

Major Development in the Didcot, Wantage and Kingston Bagpuize WwTW catchments
It is recommended that the Vale of White Horse District Council consider embedding a development control policy within their Local Plan that requires developers provide evidence to them both that they have consulted with TWUL regarding wastewater treatment capacity, and the outcome of this consultation, prior to development approval. The Council should consider the response from TWUL when deciding if the expected timeframe for the development site in question is appropriate, and should also be taken into consideration for Local Plan Part 2.

Where there is uncertainty from TWUL that the necessary capacity is available, a Grampian condition could be imposed, 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 treatment infrastructure to accept the additional flows is in place.

Major Development in the Oxford WwTW catchment
Planning permission for all Major Development proposed to drain to Oxford WwTW during the plan period should be subject to consultation with both the Environment Agency and TWUL, and discharge of any conditions imposed by the Environment Agency. The Environment Agency should also be satisfied that the development can be accommodated either within the limits of capacity at the WwTW or by sufficient capacity being made available, and that the requirements of the WFD will not be compromised.

If necessary, a Grampian condition could be imposed by Vale of White Horse District Council, 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.

Treatment Capacity Review
In addition to the Council publishing its Annual Monitoring Report (AMR) on the Council's website, it is recommended that the Vale of White Horse District Council continues to consult all appropriate sewerage undertakers on Local Plan proposals to ensure that plans for WwTW upgrades in response to permit change requirements or flow capacity constraints take account of the most up to date planning position. Further to this, all Major Development at sites which are located within the catchments of the WwTWs assessed as Amber within this WCS, should be subject to a pre-development enquiry[31] with the appropriate sewerage undertaker at an early stage, and if possible before submitting a planning application, to determine process capacity at the WwTW prior to planning permission being granted.

Development and the Sewerage Network
It is recommended that Major Development sites assessed by TWUL as part of the WCS as Amber or Red for wastewater network constraints should be subject to a pre-development enquiry31 with the appropriate sewerage undertaker 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.

Development Outside of the District
It is recommended that communication with neighbouring local authorities, as part of the Vale of White Horse District Councils duty to co-operate, should continue to be pursued, to ensure that future WCS assessments closely represent the future growth scenarios at WwTWs which receive growth from within and outside the District.

[31] Pre-development enquiries to TWUL can be made via the Thames Water website: https://developers.thameswater.co.uk/developing-a-large-site/planning-your-development/wastewater

7.1.2 Water Supply

Water Efficiency Retrofitting
In order to move towards a more 'water neutral position' throughout the District, the Council should seek to advocate the achievement of further water efficiency savings through their planning policies and development management. This could be considered further through the preparation of Local Plan Part 2, review of the Local Plan and the Sustainable Buildings Supplementary Planning Document. It is recommended that the Council 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.

Water Supply Demand Balance
It is recommended that the Vale of White Horse District Council continues to update TWUL on future development phasing and changes to growth allocations via the Councils Annual Monitoring Reports, to ensure the future supply-demand balance can be appropriately captured in the next asset planning period (AMP7).

7.1.3 Surface Water Management

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 WwTWs.

7.1.4 Ecology

ECO1 – Biodiversity Enhancement

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

7.2 Further Recommendations

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.

WCS Review
Development phasing and new sites should continue to be monitored by VoWH District Council 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.

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.

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, for the first time, combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level has been adopted. 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[32], 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[33]. 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.

[32] 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.
[33] 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 Thames River Basin Management Plan	2015
Housing	Oxfordshire Strategic Housing Market Assessment	2014
Local Plan	VoWH District Council. Adopted Local Plan Part 1	2016
Flood Risk	VoWH District Council Draft Strategic Flood Risk Assessment	2017
Water	Affinity Water Final Water Resource Management Plan 2015 - 2020	2014
Water	Thames Water Utilities Limited Final Water Resource Management Plan 2015 - 2040	2014
Climate Change	United Kingdom Climate Projections 2009 (UKCP09)	2009

Appendix C WwTW Capacity Assessment results

C.1 Modelling Software

Modelling of the quality permits required to meet the water quality objectives 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 the statistical quality required from discharges in order to meet defined downstream targets, or to determine the impact of a discharge on downstream water quality compliance statistics.

It is recognised that RQP has limitations including:

- It can only calculate the river quality at the mixing point, and therefore the downstream sampling point (from which the waterbody status is defined) cannot easily be incorporated without some degree of uncertainty, and
- The tool is unable to assess the cumulative impact of growth of WwTWs upstream of each other.

The methodology detailed in this appendix has been developed in order to minimise the effect of the limitations and thereby reducing the uncertainty in the results produced.

C.2 Input Data

Table C-1 RQP input data sources

WwTW	Upstream river flow	Upstream river quality	WFD status derived from
Appleton	Estimated using LowFlows Enterprise software	Frilford and Marcham Brook (GB106039023420)	Overall waterbody Frilford and Marcham Brook (GB106039023420)
Didcot	Estimated using LowFlows Enterprise software	TH-PTHR0041 Moor Ditch Above Didcot WwTW	Overall waterbody Moor Ditch and Ladygrove Ditch (GB106039023630)
Drayton	Estimated using LowFlows Enterprise software	TH-PTHR0314 Ginge Brook Above Clear Water Fish Farm	Overall waterbody Ginge Brook and Mill Brook (GB106039023660)
Faringdon	Estimated using LowFlows Enterprise software	No u/s sampling point. Midpoint of status of river taken	Overall waterbody Thames (Leach to Evenlode) (GB106039030333)
Kingston Bagpuize	Estimated using LowFlows Enterprise software	No u/s sampling point. Midpoint of status of river taken	Overall waterbody Ock and tributaries (Land Brook confluence to Thames) (GB106039023430)
Shrivenham	Estimated using LowFlows Enterprise software	PUTR0117 - Tuckmill Brook Above Shrivenham WwTW	Overall waterbody Tuckmill Brook and tributaries (GB106039022920)
Stanford in the Vale	Estimated using LowFlows Enterprise software	POCR0019 - Ock At Stanford In The Vale Road Bridge	Overall waterbody Ock (to Cherbury Brook) (GB106039023400)
Wantage	Estimated using LowFlows Enterprise software	POCR0008 - Letcombe Brook just above Wantage WwTW	Letcombe Brook (GB106039023350)

C.3 Modelling Assumptions

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

WwTW discharge flow

- WwTW current flows were taken as the current measured dry weather flow (DWF) (mean) as provided by Thames Water;
- The wastewater generation per new household is based on an assumed Occupancy Rate (OR) of 2.35 people per house and an average consumption of 130.5l/h/d and 16 l/h/d added to factor in employment; and
- WwTW future flows were calculated by adding the volume of additional wastewater generated by new dwellings to the current observed DWF value.

WwTW discharge quality

- The current discharge quality for each determinand (Ammonia, BOD and Phosphate) was calculated from the WwTW discharge quality monitoring data collected between 2012 and 2014;
- The future discharge quality for each determinand was calculated based on the current permit and the coefficient of variance (calculated by dividing the current standard deviation by the mean);
- BOD and Ammonia discharge qualities have been reported as 95 percentiles (as per discharge permits);
- Phosphate discharge qualities have been reported as annual averages (as per discharge permits); and
- For the purposes of this study, the limits of conventionally applied treatment processes are considered to be:
  - 5mg/l 95%ile for BOD;
  - 1mg/l 95%ile for Ammoniacal-N; and
  - 0.5mg/l annual average for Phosphate.

River water quality

- River water quality monitoring data was provided by the Environment Agency for the period between 2012 and 2014 (where this date range was not available, the most recent 3 years of data has been used);
- The Environment Agency provided the published 2016 WFD status for each downstream sampling point (status defined using water quality data collected between 2012 and 2014);
- BOD and Ammonia river water qualities have been reported as 90 percentiles; and
- Phosphate discharge qualities have been reported as means.

C.4 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 WwTW has:

Determine the quantity of growth within a WwTW catchment to determine the additional flow expected at each WwTW;

Calculate the additional wastewater flow generated at each WwTW;

Calculate the remaining permitted flow headroom at each WwTW;

Determine whether the growth can be accommodated within existing headroom by applying the scoping criteria detailed in Table C-2.

Table C-2 Scoping criteria

Scope In	Scope Out
WwTWs where permitted flow headroom capacity is exceeded as a result of growth	-
WwTWs which are already at or exceed their permitted flow headroom capacity and will also receive additional flow from growth	WwTWs which are already at or exceed their permitted flow headroom capacity but do not receive any additional flow from growth
WwTWs which remain within their permitted flow headroom capacity but the dry weather flow of growth is >=10% of the WwTW's existing permit as monitored by the Environment Agency	WwTWs which remain within their permitted flow headroom capacity but the PE of growth is <10% of the WwTW's calculated PE

C.5 Water Quality Modelling Methodology

For those WwTWs which are scoped in, the following steps have been applied:

Baseline Review

Effect of Current Discharge
By modelling the current WwTW discharge flow (pre-growth) and measured discharge quality, does the current WwTW discharge cause the river quality at the mixing point to fall below the status threshold?

Test 1-10% Deterioration

1a. Effect of current WwTW discharge	
Modelling the current WwTW discharge flow (pre-growth).	
1b. 10% deterioration limit	
Determine the 10% deterioration target for the 10% deterioration test.	
1c. 10% deterioration test	
Modelling of the future WwTW discharge flow (post-growth) and 10% deterioration target, is the future permit technically feasible with conventional technology?	
Yes: Limiting deterioration to 10% is possible. A tighter permit and treatment upgrades using conventional technology will be required.	No: Limiting deterioration to 10% is not possible because the tighter permit cannot be achieved with conventional technology.

The 10% deterioration test cannot be completed for certain WwTW's due to either no permit limit or discharge effluent quality data. For the WFD no deterioration test, an artificial mean discharge quality has been applied (e.g. 5mg/l for Ammonia and 2mg/l for Phosphate) so this test could be completed. For these cases, the downstream quality target is determined using the current river waterbody status. The permit limits are required to maintain this status and current discharge quality.

Test 2- Status Deterioration Target

2a. Current permit required to ensure no deterioration in status
Modelling of the current WwTW discharge flow (pre-growth) and current status, is the permit required technically feasible with conventional technology?

2b. Future permit required to ensure no deterioration in status Modelling of the future WwTW discharge flow (post-growth) and current status, is the permit required technically feasible with conventional technology?	
Yes: Ensuring no deterioration in status is possible. A tighter permit and treatment upgrades using conventional technology will be required.	No: Ensuring no deterioration in status is not possible because the tighter permit cannot be achieved with conventional technology. Therefore, growth may cause a deterioration in status, unless improvements in technology or non-conventional technologies are used. Test 4.- Maintain current quality test needs to be carried out

Test 3- Future Target Status Target

Applied where the receiving waterbody has a Future Target Status below Good status.

3a. Required discharge quality (Current) to achieve Future Target Status Modelling the current WwTW discharge flow and permitted discharge quality, and assuming the upstream water quality is the midpoint of the future target status. Can the river quality achieve the target status at the mixing point now (pre-growth), with a technically feasible future permit and conventional technology?	
3b. Required discharge quality (Future) to achieve Future Target Status Modelling the future WwTW discharge flow and permitted discharge quality, and assuming the upstream water quality is the midpoint of the future target status. Can the river quality achieve the future target status at the mixing point now (post-growth), with a technically feasible future permit and conventional technology?	
Yes: The Future Target Status can be achieved.	No: It is not possible to achieve the Future Target Status based on current discharge flow (pre-growth). Therefore it is not growth that would be preventing the Future Target Status from being achieved, but current limits in technology.

Test 4-Maintain Current Quality Target

4. Revised future permit required to maintain current quality Modelling of the future WwTW discharge flow (post-growth) and current discharge quality, is the permit technically feasible with conventional technology to maintain current quality?	
Yes: maintaining current quality is possible. A tighter permit and treatment upgrades using conventional technology will be required.	No: maintaining current quality is not possible because the tighter permit cannot be achieved with conventional technology. Catchment modelling is required to provide sufficient confidence there will be no deterioration in status at the downstream sampling point.

C.6 Assessment Tables

WwTW	Wantage WwTW			Stanford in the Vale WwTW		
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)			206 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)
Permit condition	5	30	2	N/A	30	N/A
Limit of Conventional Treatment (LCT)	1	5	0.5	1	5	0.5
WFD receiving waterbody and ID	**Letcombe Brook (GB106039023350)**			**Ock (to Cherbury Brook) (GB106039023400)**		
Parameters considered	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 (Cycle 2 - 2016)	**High**	**N/A - not assessed**	**Good**	**High**	**N/A - not assessed**	**Moderate**
Upstream sample point	**POCR0008 - LETCOMBE BROOK JUST ABOVE WANTAGE STW**			**POCR0019 - OCK AT STANFORD IN THE VALE ROAD BRIDGE**		
Measured quality upstream of discharge (2012 to 2014)	0.036	N/A	0.049	0.092	N/A	0.12
Quality Element Status based on measured data	**High**	N/A - not assessed	**Good**	**High**	N/A - not assessed	**Moderate**
Test 1 - 10% deterioration	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)	Ammonia (mg/l)	BOD (mg/l)	Phosphate (mg/l)
Mixing Point Quality with current WwTW flow (90 percentile Ammonia & BOD, annual average Phosphate)	0.71	N/A - load standstill used	0.5	N/A	N/A - load standstill used	N/A
Modelled status at miixing point with current flow	**Moderate**		**Poor**	N/A		N/A
10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	0.781		0.55	N/A		N/A
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate)	**2.87**	**24**	**1.29**	N/A	**25.91**	N/A
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)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	N/A - load standstill used	0.042	0.30	N/A - load standstill used	0.196
permit condition required at mixing point - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	**1.21**		**0.03**	**5.64**		**2.39**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**1.07**	**24**	**0.03**	**4.91**	**25.91**	**2.10**
Maintain current quality	N/A - test not required	N/A - test not required	**1.16**	N/A - test not required	N/A - test not required	N/A - test not required
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)
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	Yes -Test Required
Target future status (2015 Cycle 2 published status target)	N/A	N/A	N/A	N/A	N/A	**Good**
Permit condition required - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)						**0.61**
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)						**0.54**
Will Growth prevent future target status	N/A	N/A	N/A	N/A	N/A	N/A
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**	

WwTW	Shrivenham WwTW			Kingston Bagpuize WwTW		
Is there flow headroom in the Permit? If so, what is the volume of flow headroom available after growth (m^3/d)	1,166 m3/d			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)
Permit condition	2.5	11	-	7	15	-
Limit of Conventional Treatment (LCT)	1	5	0.5	1	5	0.5
WFD receiving waterbody and ID	**Tuckmill Brook and tributaries (GB106039022920)**			**Ock and tributaries (Land Brook confluence to Thames) (GB106039023430)**		
Parameters considered	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)
Receiving waterbody Quality Element Published Status (Cycle 2 - 2016)	**High**	**N/A - not assessed**	**Moderate**	**High**	**N/A - not assessed**	**Poor**
Upstream sample point	**PUTR0117 - Tuckmill Brook Above Shrivenham Stw**			**No Upstream Samping Point - Take Mid-point of status for River Quality**		
Measured quality upstream of discharge (2012 to 2014)	0.1161	N/A	0.065	0.3	N/A	0.62
Quality Element Status based on measured data	**High**	N/A - not assessed	**Good**	No measured data available	N/A - not assessed	No measured data available
Test 1 - 10% deterioration	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)
Mixing Point Quality with current WwTW flow (90 percentile Ammonia & BOD, annual average Phosphate)	0.14	N/A - load standstill used	N/A	0.99	N/A - load standstill used	N/A
Modelled status at miixing point with current flow	**High**		N/A	**Moderate**		N/A
10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	0.15		N/A	1.09		N/A
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate)	**0.50**	**8**	N/A	**1.69**	**7.4**	N/A
Test 2 - WFD Status: no deterioration (waterbody 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)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	N/A - load standstill used	0.184	0.30	N/A - load standstill used	1.073
permit condition required at mixing point - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	**1.50**		**0.70**	**0.51**		**1.23**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**1.23**	**8**	**0.57**	**0.45**	**7.4**	**1.15**
Maintain current quality	N/A - test not required	N/A - test not required	N/A - test not required	**1.53**	N/A - test not required	N/A - test not required
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)
Is current status less than good for the quality element	No - test not required	No - test not required	No - Technically infeasable	No - test not required	No - test not required	No - Technically infeasable
Target future status (2015 Cycle 2 published status target)	N/A	N/A	N/A	N/A	N/A	N/A
Permit condition required - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)						
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)						
Will Growth prevent future target status	N/A	N/A	N/A	N/A	N/A	N/A
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**	

WwTW	Faringdon WwTW			Drayton WwTW		
Is there flow headroom in the Permit? If so, what is the volume of flow headroom available after growth (m^3/d)	855 m3/d			96 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)
Permit condition	N/A	30	N/A	12	20	-
Limit of Conventional Treatment (LCT)	1	5	0.5	1	5	0.5
WFD receiving waterbody and ID	**Thames (Leach to Evenlode) (GB106039030333)**			**Ginge Brook and Mill Brook (GB106039023660)**		
Parameters considered	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)
Receiving waterbody Quality Element Published Status (Cycle 2 - 2016)	**High**	**High**	**Moderate**	**High**	**N/A - not assessed**	**Moderate**
Upstream sample point	**No Upstream Samping Point - Take Mid-point of status for River Quality**			**PTHR0314 Ginge Brook Above Clear Water Fish Farm**		
Measured quality upstream of discharge (2012 to 2014)	0.3	4	0.1385	0.039	1.52	0.1455
Quality Element Status based on measured data	No measured data available	No measured data available	N/A	**High**	**High**	**Moderate**
Test 1 - 10% deterioration	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)
Mixing Point Quality with current WwTW flow (90 percentile Ammonia & BOD, annual average Phosphate)	N/A	8.47	N/A	0.43	2.78	N/A
Modelled status at miixing point with current flow	N/A	**Poor**	N/A	**Good**	**High**	N/A
10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	N/A	9.32	N/A	0.47	3.06	N/A
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate)	N/A	**15.19**	N/A	**5.44**	**18.27**	N/A
Test 2 - WFD Status: no deterioration (waterbody 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)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	4	0.196	0.30	N/A - load standstill used	0.205
permit condition required at mixing point - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	**0.48**	**6.49**	**0.25**	**4.20**		**0.94**
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**0.46**	**6.20**	**0.240**	**3.36**	**15.4**	**0.77**
Maintain current quality	N/A - test not required as there is no permit limit	N/A - test not required	N/A - test not required as there is no permit limit	N/A - test not required	N/A - test not required	N/A - test not required
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)
Is current status less than good for the quality element	No - test not required	No - test not required	No - Technically infeasable	No - test not required	No - test not required	No - Disproportionately Expensive
Target future status (2015 Cycle 2 published status target)	N/A	N/A	N/A	N/A	N/A	N/A
Permit condition required - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)						
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)						
Will Growth prevent future target status	N/A	N/A	N/A	N/A	N/A	N/A
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**	

WwTW	Didcot WwTW			Appleton WwTW		
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)			1,260 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)
Permit condition	9	10	-	4	16	-
Limit of Conventional Treatment (LCT)	1	5	0.5	1	5	0.5
WFD receiving waterbody and ID	**Moor Ditch and Ladygrove Ditch (GB106039023630)**			**Frilford and Marcham Brook (GB106039023420)**		
Parameters considered	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)
Receiving waterbody Quality Element Published Status (Cycle 2 - 2016)	**High**	**N/A - not assessed**	**Moderate**	**High**	**N/A - not assessed**	**Bad**
Upstream sample point	**PTHR0041 Moor Ditch Above Didcot STW**			**No Upstream Samping Point - Take Mid-point of status for River Quality**		
Measured quality upstream of discharge (2012 to 2014)	0.117	N/A - not assessed	0.1	0.3	N/A - not assessed	1.058
Quality Element Status based on measured data	**High**	N/A - not assessed	**Moderate**	No measured data available	N/A - not assessed	No measured data available
Test 1 - 10% deterioration	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)
Mixing Point Quality with current WwTW flow (90 percentile Ammonia & BOD, annual average Phosphate)	1.32		0.64	0.36		N/A
Modelled status at miixing point with current flow	**Poor**	N/A - load standstill used	**Poor**	**High**	N/A - load standstill used	N/A
10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	1.45		0.70	0.40		N/A
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate)	**3.42**	**7.7**	**0.92**	**1.24**	**13.9**	N/A
Test 2 - WFD Status: no deterioration (waterbody 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)
Threshold at which status deterioration would occur (90 percentile Ammonia & BOD, annual average Phosphate)	0.30	N/A - load standstill used	0.201	0.30	N/A - load standstill used	N/A
permit condition required at mixing point - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	**0.73**		**0.25**	**0.94**		N/A
permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**0.67**	**7.7**	**0.24**	**0.87**	**13.9**	N/A
Maintain current quality	**3.11**	N/A - test not required	**0.84**	**1.03**	N/A - test not required	N/A
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)
Is current status less than good for the quality element	No - test not required	No - test not required	No - Technically infeasable	No - test not required	No - test not required	No - Technically infeasable
Target future status (2015 Cycle 2 published status target)						
Permit condition required - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	N/A	N/A	N/A	N/A	N/A	N/A
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)						
Will Growth prevent future target status	N/A	N/A	N/A	N/A	N/A	N/A
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**	

	Oxford WwTW		
	Ammonia 95%ile (mg/l)	BOD 95%ile (mg/l)	Phosphate mean (mg/l)
Current permit quality condition (95%ile or AA)	3	10	1
Limit of Conventional Treatment (LCT) (95%ile or AA)	1	5	0.5
Receiving waterbody	Northfield Brook (for purpose of modelling, discharge assumed into the Thames (Evenlode to Thame))		
Upstream sample point	PTHR0186		
Downstream sample point	PTHR0098		
A. Baseline Review	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
Baseline river quality at downstream sampling point	0.17	2.40	0.143
Baseline river quality at downstream sampling point + 10%	0.19	2.64	0.157
Threshold at which status deterioration would occur	0.30	4.00	0.198
Is the current quality at the downstream sampling point considered to be at risk of status deterioration (i.e. within 10% of status threshold)?	*No - baseline river quality is not within 10% of status threshold*	*No - baseline river quality is not within 10% of status threshold*	*No - baseline river quality is not within 10% of status threshold*
	Continue to step B	*Continue to step B*	*Continue to step B*
B. Effect of the Current Discharge	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
Current DWF mean (m^3/day)	57976		
Baseline river quality at mixing point	0.16	2.42	0.15
Threshold at which status deterioration would occur	0.30	4.00	0.198
Is the current discharge already causing a status deterioration at the mixing point?	*No*	*No*	*No*
Modelling scenario selected	**10% Deterioration Limit**	**10% Deterioration Limit**	**10% Deterioration Limit**
C. 10% Deterioration Limit	Ammonia 90%ile (mg/l)	BOD 90%ile (mg/l)	Phosphate mean (mg/l)
10% deterioration limit at mixing point	0.18	2.66	0.165
Assessment	Ammonia 95%ile (mg/l)	BOD 95%ile (mg/l)	Phosphate mean (mg/l)
Growth Phase 1 Future DWF mean (m^3/day)	59124		
Future river quality at mixing point	0.21	2.52	0.18
Level of deterioration caused by future growth	31%	4%	20%
Revised permit quality condition required (95%ile or AA)	**2.5**	**Current permit OK**	**0.9**
If permit quality condition beyond LCT, permit quality condition required to ensure no deterioration in waterbody status (95%ile or AA)	-	-	-
If permit quality condition beyond LCT, permit quality condition required to ensure no deterioration in mixing point status (95%ile or AA)			
Growth Phase 2 Future DWF mean (m^3/day)	60543		
Future river quality at mixing point	0.22	2.52	0.18
Level of deterioration caused by future growth	38%	4%	20%
Revised permit quality condition required (95%ile or AA)	**2.4**	**Current permit OK**	**0.8**
If permit quality condition beyond LCT, permit quality condition required to ensure no deterioration in status (95%ile or AA)	-	-	-
If permit quality condition beyond LCT, permit quality condition required to ensure no deterioration in mixing point status (95%ile or AA)			
Growth Phase 3 Future DWF mean (m^3/day)	61943		
Future river quality at mixing point	0.22	2.54	0.18
Level of deterioration caused by future growth	38%	5%	20%
Revised permit quality condition required (95%ile or AA)	**2.4**	**Current permit OK**	**0.8**
If permit quality condition beyond LCT, permit quality condition required to ensure no deterioration in status (95%ile or AA)	-	-	-
If permit quality condition beyond LCT, permit quality condition required to ensure no deterioration in mixing point status (95%ile or AA)			
Future Target Status	Ammonia 95%ile (mg/l)	BOD 95%ile (mg/l)	Phosphate mean (mg/l)
Current status at d/s sampling point	**High**	**High**	**Moderate**
WFD waterbody future target status	**High**	**High**	**Moderate by 2021**
River quality target (90%ile or AA)	Future target status already being achieved	Future target status already being achieved	Alternative Moderate objective to be achieved in the overall waterbody. This is already being achieved.
Permit quality condition required today (95%ile or AA)			
Permit quality condition required in the future (2032) (95%ile or AA)			
Will growth prevent the future target status from being achieved?	*N/A*		

Appendix D Water Neutrality

Water Neutrality is defined in Section 5.9 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[34], 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[35].

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;

[34] Water Efficiency in the South East of England, Environment Agency, April 2007.
[35] 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[36] 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[37] 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)[38]. 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

[36] Part G of the Building Regulations
[37] 2.3 is used for existing properties and new properties. This figure was agreed with TWUL prior to the assessment
[38] Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009, http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/

Low or Variable Flush Toilets

Toilets use about 30 per cent of the total water used in a household[39]. 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[40]per flush. A study carried out in 2000 by Southern Water and the Environment Agency[41] 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[42].

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.

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

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

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

Water Efficient Appliances

Washing machines and dishwashers have become much more water efficient over the past twenty years; whereas an old washing machine may use up to 150 litres per cycle, modern efficient machines may use as little as 35 litres per cycle. An old dishwasher could use up to 50 litres per cycle, whereas modern models can use as little as 10 litres. However, this is partially offset by the increased frequency with which these are now used. It has been estimated[43] 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.

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

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

Component	137 l/h/d Standard Home	Building Regulations 125 l/h/d	Building Regulations Optional Target 110 l/h/d	High 80 l/h/d	62 l/h/d (water recycling)
Toilet flushing	28.15	18.7 b	12.3 d	12.3 d	12.3 d
Taps	25.6 a	22.7 a	20.5 a	15.3 a	15.3 a
Shower	39.76	39.8	31.8	23.9	23.9
Bath	18.5 c	18.5 c	17.0 f	14.5 h	14.5 h
Washing Machine	15.6	15.6	15.6	15.6	15.6
Dishwasher	4.0	4.1	4.1	4.1	4.1
Recycled water				-13.4 e	-26.8 g
External Use	5	5	5	0	0
Total per head	136.7	124.4	106.3	77.3	63.9
Total per household	315.39	297.4	264.7	192.6	159.1

- a Combines kitchen sink and wash hand basin
- b 6/4 litre dual-flush toilet (f) recycled water
- 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[44], the experience of AECOM BREEAM 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.

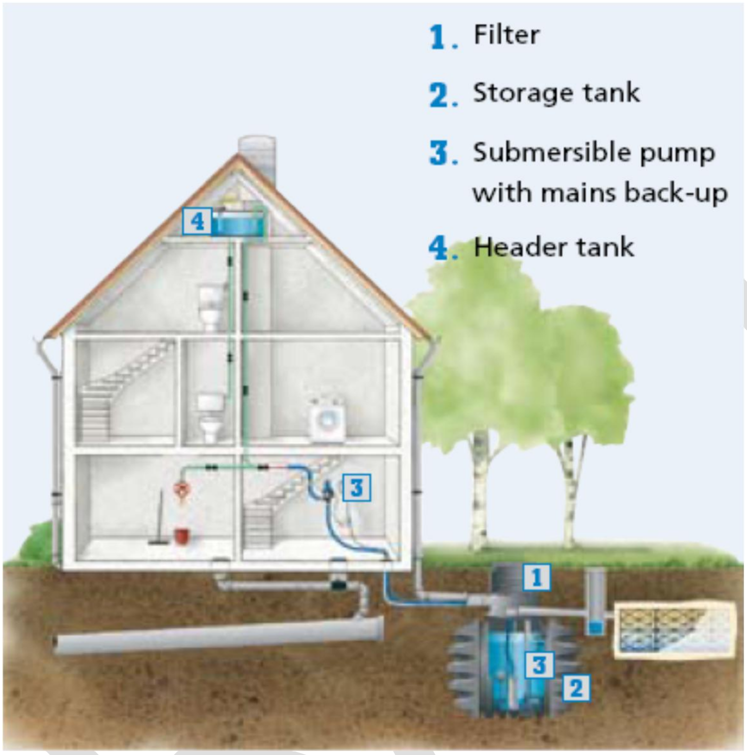
RWH systems typically consist of a collection area (usually a rooftop), a method of conveying the water to the storage tank (gutters, down spouts and pipes), a filtration and treatment system, a storage tank and a method of conveying the water from the storage container to the taps (pipes with pumped or gravity flow). A treatment

[44] http://www.thewatercalculator.org.uk/faq.asp

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[45].

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[46].

Figure D-1: A typical domestic rainwater harvesting system



A recent sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[47], 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

[45] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[46] Aquality Rainwater Harvesting brochure, 2008
[47] Sustainable water management strategy for Northstowe, WSP, December 2007

4	440	50	1.76	15.4	94.6

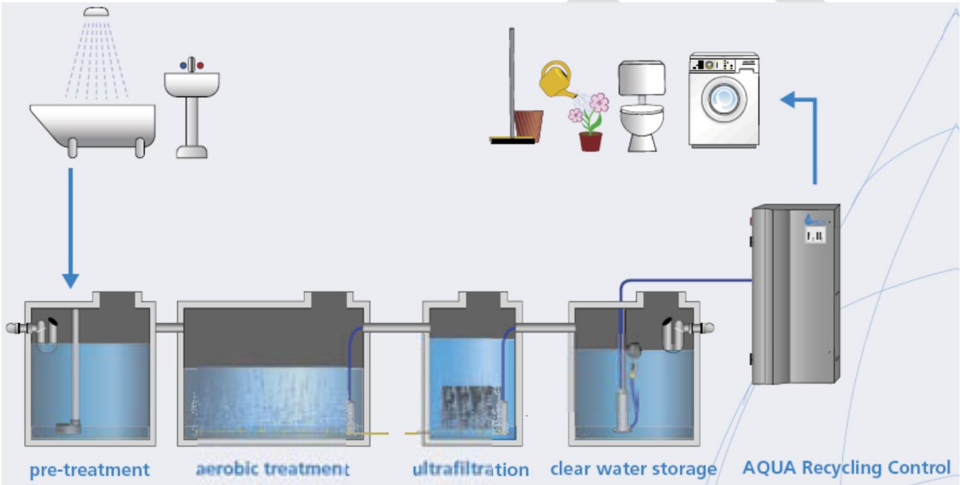
A family of four, with an assumed roof area of 50m^3, could therefore expect to save 61.6 litres per day if a RWH system were installed.

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 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[48].

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[49].

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

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

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[50].

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

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

Table 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.

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

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	92.7%	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	92.7%	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	92.7%	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	92.7%	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
High	80	- WC 4/2.6 litres dual flush;	Rainwater harvesting	93.1%	18% take up across study area:

		- 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			- WC 4/2.6 litres dual flush; - Shower 6 l/min - Basin taps 2 l/min - Sink taps 4 l/min
Very High	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%	20% 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

D.4 Financial Cost Considerations for Water Neutrality scenarios

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

New Build Costs

The Department for Communities and Local Government (DCLG) published the Housing Standards Review in September 2014. A cost impacts report[51] formed part of this publication, providing the costs of the proposed standards, including the proposed Building Regulations optional requirement water efficiency standard.

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

Table D-6: Building Regulation Specification and costs

	1B Apartment	2B Apartment	2B Terrace	3B Semi-detached	4B Detached
Cost all dwellings (extra over usual industry practice)					
Water, Code Level 1	-	-	-	-	-
Water, Code Level 2	-	-	-	-	-
Water, Code Level 3	£6	£6	£6	£9	£9
Water, Code Level 4	£6	£6	£6	£9	£9
Water, Code Level 5	£900	£900	£2,201	£2,697	£2,697
Water, Code Level 6	£900	£900	£2,201	£2,697	£2,697
Alternative standards					
Rainwater only	£887	£887	£2,181	£2,674	£2,674

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

Water Recycling

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

Table D-7: Costs of greywater recycling systems

Cost	Cost	Comments
Installation cost	£1,750	Cost of reaching Code Level 5/6 for water consumption in a 2-bed flat[52]
	£2,000	For a single dwelling[53]
	£800	Cost per house for a communal system[54]
	£2,650	Cost of reaching Code Level 3/4 for water consumption in a 3-bed semi-detached house[55]
Operation of	£30 per annum[56]	

51 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/353387/021c_Cost_Report_11th_Sept_2014_FINAL.pdf
52 Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
53 http://www.water-efficient-buildings.org.uk/?page_id=1056
54 http://www.water-efficient-buildings.org.uk/?page_id=1056
55 Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
56 Environment Agency Publication - Science Report – SC070010, Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008

Cost	Cost	Comments
GWR		
Replacement costs	£3,000 to replace23	It is assumed a replacement system will be required every 25 years

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

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

Installing a Meter

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

Retrofitting of Water Efficient Devices

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

Table D-8: Water saving methods

Water Saving Method	Approximate Cost per House (£)	Comments/Uncertainty
Variable flush retrofit toilets	£50 - £140	Low cost for 4-6 litre system and high cost for 2.6-4 litre system. Needs incentive to replace old toilets with low flush toilets.
Low flow shower head scheme	£15 - £50	Low cost for low spec shower head; high costs for high spec. Cannot be used with electric, power or low pressure gravity fed systems.
Aerating taps	£10 - £20	Low cost is med spec, high cost is high spec.

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

Appendix E Designated Site Background Detail

E.1 Culham Break SSSI

Culham break is a small area (approximately 1.4 ha) of willow carr on a seasonally flooded back water of the River Thames to the south east of Abingdon. The site is dominated by well grown crack willow and the wet clay soils and humid conditions within the willow thicket supports lush fen carr flora in which one of the largest British populations of summer snowflake a red data book species resides. Around the clumps of summer snowflake the flora is dominated by large sedges and yellow iris as well as valerian and meadow sweet. An open shrub layer of guelder rose, red current and hop is also present. An unusual feature is the occurance of polypody *Polypodium vulgare* as an epiphyte on the willow trees. A stand of moribund elms on slightly higher ground overlooking the site are also included within it.

E.2 Little Wittenham SAC & SSSI

This site supports one of the largest known breeding populations of great crested newt Triturus cristatus in the UK. The site also supports an outstanding breeding assemblage of amphibians, which include smooth newt, common frogs and common toads, and of dragonflies and damselflies.

The calcareous flushes in the woodland have extensive deposits of tufa and support a specialized invertebrate fauna which includes a number of rare species. These include the soldier flies *Oxycera analis* and *O. pardalina*.

The woodland ponds and streams support a wide diversity of dragonflies and damselflies. A total of 16 species are known to breed on the site including the brown hawker Aeshna grandis, migrant hawker *A. mixta*, emperor dragonfly *Anax imperator* and ruddy darter *Sympetrum sanguineum*.

Additional aquatic habitat is provided by a backwater of the River Thames which provides suitable conditions for the white-legged damselfly *Platycnemis pennipes*, club-tailed dragonfly *Gomphus vulgatissimus* and red-eyed damselfly *Erythromma najas*. The associated riverine woodland supports the Loddon lily *Leucojum aestivum*.

The nationally scarce plant greater dodder *Cuscuta europaea* is regularly seen growing parasitically on nettle *Urtica dioica* alongside the River Thames.

The site is less than 3km from the district boundary.

Features of European Interest

The site is designated as a SAC for its:

- Great crested newt populations.

Condition Assessment

The Conservation Objectives for the European interests on the SSSI are, subject to natural changes:

- to maintain , in favourable condition, the species of European importance.

During the most recent Condition Assessment process (October 2010), the entire site was in favourable condition.

From examination of the UK Air Pollution System (www.apis.ac.uk) it can be seen (Table 4) that the SAC is currently suffering from poor air quality. Little Wittenham SAC currently exceeds the minimum critical load for nitrogen deposition.

The Site Improvement Plan for Little Wittenham indicates the following threats that, at the least, are identified as requiring investigation:

- Invasive species; and
- Public access and disturbance.

Key Environmental Conditions

The key conditions that support the features of European interest are:

- Suitable foraging and refuge habitat within 500m of the pond.
- Relatively unpolluted water of roughly neutral pH.
- Some ponds deep enough to retain water throughout February to August at least one year in every three.
- In a wider context, great crested newts require good connectivity of landscape features (ponds, hedges etc) as they often live as meta-populations in a number of ponds.

Appendix F Reason for Alternative Objective

Where certain conditions apply and are met then alternative WFD objectives have been set by the Environment Agency for water bodies; these involve taking an extended time period to reach the objective or meeting a lower status or a combination of both. In some water bodies it is recognised that time constraints on putting actions in place, or the time taken for the environment to respond once actions are implemented, mean that the objective will only be achieved over more than one river basin management planning cycle. An objective of less than good status is set where:

- there is currently no solution to the problem;
- the costs of taking action exceed the benefits; and/or
- background conditions in the environment mean achieving good status is not possible.

F.1 Justification for alternative Ecological Status Objective

Section 5.4 of the Thames RBMP Part 2: River basin management planning overview and additional information[57] sets out the specific circumstances for the particular elements and the justification behind the alternative objective. The individual sub-elements and the alternative objectives for each waterbody are set out below.

Waterbody	Element	Alternative objective for 2021 and 2027
Marcham Brook	Phosphate	Moderate
Moor Ditch	Phosphate	Moderate
	Macrophytes and Phytobenthos Combined	Moderate
River Thames	Phosphate	Moderate
	Invertebrates	Moderate
River Ock	Phosphate	Moderate
Northfield Brook	Macrophytes and Phytobenthos Combined	Poor
	Phosphate	Poor
Tuckmill Brook	Macrophytes and Phytobenthos Combined	Moderate
	Phosphate	Moderate

The reason the alternative objective has been set is described as '**Technically infeasible – No known technical solution is available'**.

The explanation for the use of this exemption, as detailed in Table 6 of the Thames RBMP, is provided below.

This reason has been used to justify setting less stringent objectives for water bodies under Article 4(5) and in a limited number of cases it has been used to justify extending the deadline for achieving protected area objectives under Article 4(4).

As well as being applied where there is no known practical technique for making the necessary improvement, this reason has also been used in cases where:

- *techniques are under development but are not yet known to be effective in practice*
- *there is a known technical solution but that solution cannot be applied in a specific location due to specific local conditions*

[57] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/500573/Part_2_River_basin_management_planning_process_overview_and_additional_information.pdf

Phosphate

In England it is generally currently considered to be technically infeasible to build a sewage treatment works that will reduce Phosphate in discharges to less than 0.5mg/l.

If a waterbody requires discharges of less than 0.5mg/l Phosphate to achieve good status then this reason has been used to justify a less stringent objective under Article 4(5).

The exemptions apply to the Phosphate and the impacted biological elements such as phytobenthos and macrophytes.

Trials are underway involving water and sewerage companies to investigate sewage treatment technologies that could be used to reduce Phosphate below 0.5 mg/l. The trials will determine how effective these technologies are and are due to be completed by 2017. The results of the trials will inform the review and update of River Basin Management Plans in 2021.

This exemption has been used when the environmental and socioeconomic needs served by the sewage treatment works to dispose of sewage cannot be achieved by other means which are a significantly better environmental option not entailing disproportionate costs, as required by article 4(5)(a).

Waterbody	Element	Alternative objective for 2021 and 2027
Mill Brook	Phosphate	Moderate
River Thames	Fish	Poor
Northfield Brook	Invertebrates	Poor
	Ammonia	Bad
	Dissolved Oxygen	Poor

The reason the alternative objective has been set is described as '**Unfavourable balance of costs and benefits-Disproportionately expensive**'

The explanation for the use of this exemption, as detailed in Table 6 of the Thames RBMP, is provided below.

This reason has been used to justify setting less stringent objectives for water bodies under Article 4(5).
This exemption has been used in situations where:

- *There is no environmental problem to solve and therefore the costs of taking any action would exceed the benefits.*

Although WFD classification tools and the monitoring programme represent best science, due to the varied nature of the environment they sometimes flag a problem where no problem exists. Additional information including risk assessments and information from third parties can be used to establish if there is an environmental problem.

- *Economic appraisal has determined that the costs of implementing the most cost effective and technically feasible measures needed to reach good status are greater than the benefits to be gained from achieving good status*

In some cases, although a less stringent objective has been set action will still happen to improve the water body to the best possible status, as required by Article 4.5(b). Measures will be implemented up to the point where doing more would be disproportionately expensive. In these cases pressures may be partially resolved or, where there are multiple sources in a catchment, some may be addressed whilst others are not.

Phosphorus, Ammonia and Dissolved Oxygen
Engineering measures and technologies to improve water quality of discharges from sewage treatment works can have high costs relative to other measures within a catchment bundle of measures. Although these measures can be technically feasible, the cost of implementation can exceed the benefits to be gained from achieving good status. This is especially true in cases where improvements are limited to an individual water body which limits the overall relative benefit in the catchment.

In these circumstances a less stringent objective has been set under Article 4(5).

This exemption has been used when the environmental and socioeconomic needs served by the sewage treatment works to dispose of sewage cannot be achieved by other means which are a significantly better environmental option not entailing disproportionate costs, as required by article 4(5)(a).

Fish

In some cases the fish classification tool gives a result of less than good status due to the absence of a certain species but it is known from other data, such as angling match records, that the species is both present and at expected densities in the water body. Therefore there is no environmental problem to solve and action to take.

In these circumstances a less stringent objective has been set under Article 4(5).

Fish, Invertebrates, Mitigation Measures Assessment

The costs of implementing some mitigation measures to address pressures from physical modifications are very high. For example, in urban areas where improvement works are often technically and spatially challenging there are increased costs for ground works and securing land availability as well as spatial limitations.

In these circumstances a less stringent objective has been set under Article 4(5). The exemption applies to the Mitigation Measures Assessment and the impacted biological elements.

This exemption has been used when the environmental and socioeconomic needs served by the physical modifications cannot be achieved by other means which are a significantly better environmental option not entailing disproportionate costs, as required by article 4(5)(a).

Appendix G Development Site Assessment - LPP2 sites

The key for the RAG assessment is set out below:

Key for wastewater network RAG assessment

Development is likely to be possible without upgrades	Pumping station or pipe size may restrict growth, or non-sewered areas, where there is a lack of infrastructure; a pre-development enquiry is recommended before planning permission is granted	There is limited capacity in the network, hence solution required to prevent further Combined Sewer Overflows, discharges or sewer flooding

				Wastewater and Water Supply		Odour Assessment	
Site Name	Locality	Site Area (ha)	Total Dwellings	Catchment	Wastewater Network Constraints	WwTW	Encroachment
Dalton Barracks	Shippon	28867	1,200	Abingdon WwTW		Abingdon WwTW	No
East of East Hanney	East Hanney	239	50	Wantage WwTW		Wantage WwTW	No
East of Kingston Bagpuize with Southmoor	Kingston Bagpuize	3473	600	Kingston Bagpuize WwTW		Kingston Bagpuize WwTW	No
Harwell Campus	Harwell Campus	3445	1,000	Harwell SPS		Didcot WwTW	No
North West of East Hanney	East Hanney	344	80	Wantage WwTW		Wantage WwTW	No
North West of Grove	Grove	2835	300	East & North West Grove SPS Wantage		Wantage WwTW	No
South East of Marcham	Marcham	346	120	Appleton WwTW		Appleton WwTW	No