Basingstoke and Deane Water Cycle Study

Basingstoke and Deane Borough Council

Project number: 60616914

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Quality information

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The Basingstoke and Deane Local Plan 2011-2029 was adopted in May 2016. Basingstoke and Deane Borough Council (BDBC) has since undertaken a review and is currently progressing an update to the Local Plan focusing on strategic issues, in line with national policy and guidance.

This Water Cycle Study (WCS) has been developed to provide evidence to support decision making relating to future development and inform the approach taken within the updated Local Plan (2019-2039), ensuring that the scale and location of development proposed can be met without adversely impacting on the borough's water environment. It will also help to ensure that required water infrastructure can be planned for and brought forward alongside new development, in a timely and phased manner.

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

1. 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 the requirements of the National Planning Policy Framework (NPPF) with respect to water; and
2. Water Framework Directive (WFD) and Habitats Regulations compliance – to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies within the study area (and more widely) from achieving the standards required of them as set out in the WFD River Basin Management Plans (RBMPs) and would not have an impact on the protected species and habitats designated under the Habitats Regulations.

Planned future development throughout the study area has been assessed with regards to water supply capacity, wastewater capacity and environmental capacity in the water environment. Any water quality issues associated with water infrastructure upgrades and potential constraints have subsequently been identified and reported, including recommendations on the policy required to deliver it.

Wastewater strategy

Thames Water and Southern Water are the sewerage and wastewater treatment providers within the study area and wastewater is treated at sixteen Wastewater Treatment Works (WwTW) located across the borough and one WwTW located outside of the borough. Of the seventeen WwTWs, twelve are expected to receive additional wastewater as a result of growth within the borough.

As wastewater treatment providers, Thames Water and Southern Water are required to use the best available techniques (defined by the Environment Agency as the best techniques for preventing or minimising pollutants and impacts on the environment) to ensure limit values stipulated within each WwTW's discharge permit conditions are met. All WwTWs are issued with a permit to discharge by the Environment Agency, and for larger WwTW these set out conditions on the maximum volume of treated wastewater that it can discharge and also limits on the quality of the treated discharge (in respect of ammonia, Total Inorganic Nitrogen (TIN), Biological Oxygen Demand (BOD) and phosphate). These limits are set in order to protect the water quality and ecology of the receiving waterbody.

The WCS identified that the majority of WwTWs within the study area (Basingstoke, Sherborne St John, Sherfield on Loddon, Washwater, Kingsclere, Silchester, North Waltham and Barton Stacey) have capacity to treat the additional wastewater flows from proposed growth in the borough. Water quality and ecological assessments have been undertaken for potential future discharges at these WwTWs to determine the impact on the water quality and ecology of watercourses receiving the treated discharge. The WCS also identified that Whitchurch, Overton and Oakley WwTWs have limited capacity to treat additional wastewater flows from the proposed level of growth, whilst Ashford Hill WwTW has no capacity to treat additional wastewater flows based on current permit conditions. Barton Stacey WwTW is situated within Test Valley, with the majority of the catchment within the Test Valley Borough Council (TVBC) boundary and minimal amount of planned future development from the BDBC area. It was reported by the Environment Agency that Barton Stacey WwTW is likely to be subject to transfer from another WwTW within TVBC, therefore assessing additional cross boundary discharge from TVBC within the water quality assessment was outside the scope for this WCS.

Water quality assessments were undertaken using the current (as of 2022) permit conditions for the twelve WwTW's expected to receive additional wastewater as a result of growth within the borough, the 2019 published WFD status classifications and available water quality monitoring data. The assessment has shown that subject to the revision of discharge permits and the implementation of the necessary treatment process upgrades (using conventional treatment technologies), changes in water quality as a result of additional discharge can be managed at all WwTW's to ensure compliance with required water quality standards. In many cases, it will be possible to maintain the current quality of watercourses with further improvements in treated discharge quality. An ecological screening exercise has indicated that there would be no detrimental impact to designated, water dependent ecological sites as long as the required infrastructure solutions are delivered.

The 2009 Water Cycle Study identified that the major environmental constraint to growth in the borough was the impact of treated sewage effluent on the ecology of the River Loddon. In this latest WCS, the results of catchment scale water quality modelling of discharges from Basingstoke WwTW, Sherfield on Loddon WwTW and Sherborne St John WwTW indicate that, with growth, there would be slight increases in watercourse phosphate concentrations compared to the current baseline (2022), but with no change to the current WFD status classification for Bow Brook and the River Loddon. The water quality modelling has shown that the current WFD target status for the River Loddon and Bow Brook could be achieved by further limiting phosphate pollutants from Basingstoke WwTW and Sherfield on Loddon WwTW. The lack of recent sampling data for the Vyne Stream limits the conclusions which can be drawn for Sherborne St John WwTW but recent improvements to treatment at Sherborne St John WwTW appears to have reduced watercourse phosphate concentrations and the effects of future development could be mitigated by further reducing the phosphate discharge limits.

Discharges from Sherfield on Loddon and Basingstoke WwTW are not expected to have additional impacts on BOD and ammonia concentrations in Bow Brook and the River Loddon following future developments. Again, the lack of sampling data for the Vyne Stream limits the confidence to which conclusions can be drawn for Sherborne St John WwTW but future development is not expected to have adverse impacts on any parameters for the Vyne Stream and is unlikely to change current WFD status or limit future status from being achieved.

The rise in nitrate concentrations is a particular concern in the River Test and Itchen catchments where the majority of the drinking water comes from groundwater. Water quality assessments for the WwTWs that discharge to the River Test Chalk has shown that ammonia, BOD, phosphate and TIN inputs from growth across the borough can be managed by imposing new permit limits. However, the new permit levels required to manage ammonia and TIN regarding wastewater discharges are not sufficient to meet Natural England's requirement of no net additional nitrogen input from future development within the River Test and River Itchen catchment areas in order to protect the Solent wildlife sites. If the Ammonia and TIN permits could be tightened further this would reduce the nitrogen balance that will need to be addressed by developers and better protect the Solent wildlife sites.

The WCS has concluded that feasible solutions are possible to ensure legislative objectives are met. The WCS has also recommended that BDBC, the Environment Agency, Thames Water and Southern Water continue to work together to co-ordinate regular updates about the timing and quantity of development that can be accommodated across the borough throughout the Local Plan delivery period. Thames Water and Southern Water (as sewerage undertakers) are responsible for identifying future investment at existing WwTWs to accommodate further growth (where required) and applying to the Environment Agency for any revisions to existing permits where necessary. In respect of water infrastructure investment planning, water companies are currently in Asset Management Plan (AMP) period 7 which covers the period from 1st April 2020 to 31st March 2025.

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 BDBC, Thames Water and Southern Water use the results of this WCS to inform their 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 WFD continue to be met.

It should be noted that other wastewater discharge and water quality determinands such as copper, zinc, tributyl-tin and nickel have not been considered as part of this WCS. These have not been reported as an issue by Thames Water or Southern Water for this study area.

Flood risk

The WCS assessed the potential flood risk impact from the additional discharges from the various WwTWs into the receiving watercourses and concluded that these additional flows would not result in a significant increase in flood levels (all less than 1%).

Water supply strategy

South East Water and Southern Water are the potable water providers within the study area. Water companies plan for the long-term provision of water supplies on a five yearly planning cycle, through the production of statutory Water Resource Management Plans (WMRP). The WRMP for each company sets out how changes in demand for water and changes in available water in the environment will be managed, including measures to manage how much water customers use (demand management) and measures to provide new sources of supply to current and future customers. The South East Water WRMP (2020) and Southern Water WRMP (2019) indicate that through the introduction of strategic demand management options and supply enhancement schemes within the supply areas serving the Basingstoke and Deane borough, adequate water supplies will be available up to 2040 and will cater for the proposed levels of growth.

Since development within the study area is not proposed to exceed that for which both South East Water and Southern Water are planning, it is not necessary to evaluate the impacts of water supply in the study area independently of the WRMPs and their assessments.

The WRMPs set out some of the water resource pressures in the study area which include significant increases in demand from new housing, the need to manage and reduce levels of abstraction from some groundwater and surface water sources and the increasing influence of climate change on the quality and availability of raw water resources. It is therefore essential that the efficient use of water is promoted throughout the planning process. To support this conclusion, this WCS has tested and proposed three water efficiency scenarios to demonstrate what is required to achieve different levels of demand reduction in the study area.

The water efficiency assessment can be used by BDBC to justify retaining the current water use policy that requires developers to build new homes to meet the higher Building Regulation standards of 110/l/h/d as a minimum, and to consider working with South East Water and Southern Water to develop further options for retrofitting existing properties with efficiency fixtures and fittings.

List of acronyms

AMP	Asset Management Plan
ACDP	Areas with Critical Drainage Problems
BDBC	Basingstoke and Deane Borough Council
BGS	British Geological Society
BOD	Biochemical Oxygen Demand
CAMS	Catchment Abstraction Management Strategy
DCLG	Department for Communities and Local Government
DEFRA	Department for Environment, Food and Rural Affairs
Dpa	Developments per annum
DWF	Dry Weather Flow
EA	Environment Agency
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LNR	Local Nature Reserve
LPA	Local Planning Authority
Ml	Mega Litre (a million litres)
NE	Natural England
NPPF	National Planning Policy Framework
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
ONS	Office for National Statistics
OR	Occupancy Rate
Q95	The river flow exceeded 95% of the time
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RNAG	Reasons for Not Achieving Good (in relation to WFD status)
RQP	River Quality Planning (tool)
S106	Section 106 (Town and Country Planning Act 1990)
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SGZ	Safeguard Zones
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
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
WwTW	Wastewater Treatment Works

1. Introduction

The Basingstoke and Deane Local Plan 2011-2029 was adopted in May 2016. Basingstoke and Deane Borough Council (BDBC) has since undertaken a review of the plan and is currently progressing an update to the Local Plan focusing on strategic issues, in line with national policy and guidance.

A Water Cycle Study (WCS) has been developed to provide evidence to support decision making relating to future development and inform the approach taken within the updated Local Plan (2019-2039), ensuring that the scale and location of development proposed can be met without adversely impacting on the borough's water environment. It will also help to ensure that required infrastructure can be planned for and brought forward alongside new development, in a timely and phased manner.

1.1 WCS Scope

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, including the planning policy required to deliver it. 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. A broad overview of the interaction between the water environment and WSI which the WCS is concerned with is provided in Figure 1-1.

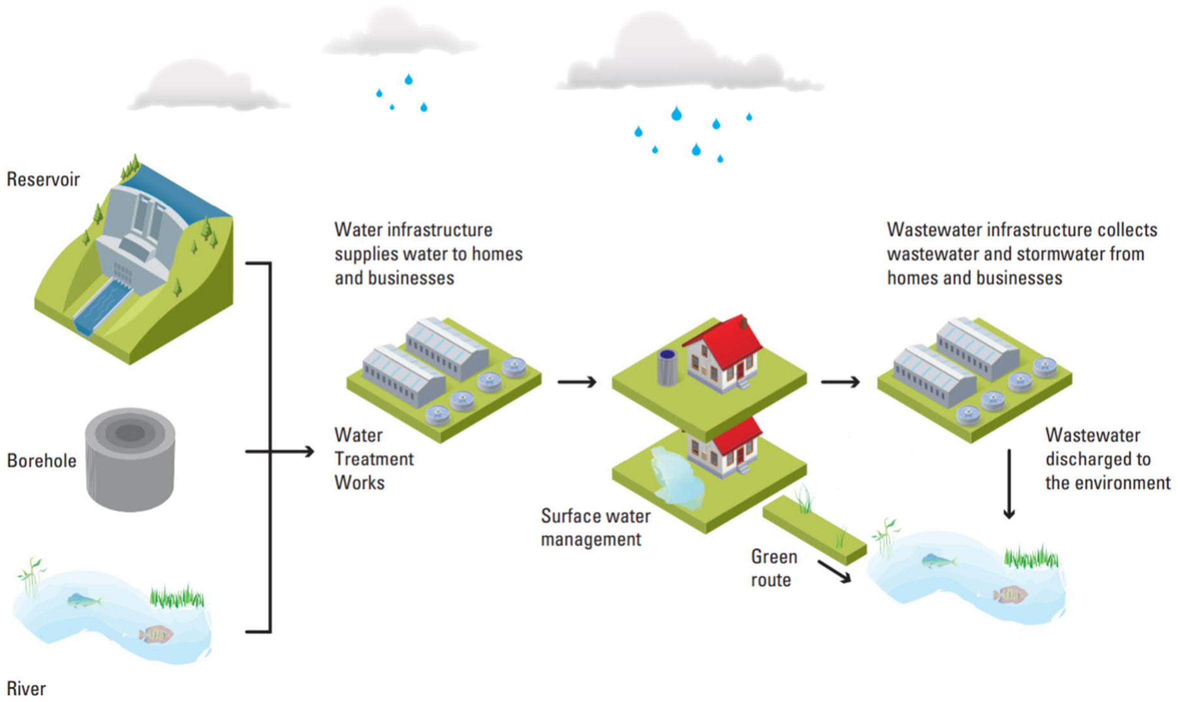


Figure 1-1: The water environment and water services infrastructure components

Considering each element of water management in isolation often overlooks the potential for single solutions to provide multiple benefit in the most efficient way. The outcome is the development of a water cycle strategy for the study area which informs the Local Plan, sustainability appraisal and appropriate assessment specific to the water environment and WSI issues. This will need to be considered in bringing growth forward at various sites, including guidance for developers in conforming to the requirements of the strategy.

1.1.1 Objectives

The key objectives of the WCS are as follows:

- Provide a strategy for wastewater treatment across the study area 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 Regulations 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 are required to support growth;
- Consider whether growth can be delivered and achieve a 'neutral water use' condition;
- Provide a pathway to achievement of water neutrality;
- Consider whether growth can be delivered without the increased wastewater flows increasing flood risk; and
- Provide policy recommendations.

1.1.2 Study governance

The Basingstoke and Deane WCS has been carried out with the guidance and input of the following organisations:

- Basingstoke and Deane Borough Council (BDBC);
- Hampshire County Council (HCC);
- Thames Water Utilities Limited (TWUL);
- Southern Water Services (SWS);
- South East Water Limited (SEWL);
- Environment Agency; and
- Natural England.

1.2 WCS history

An outline WCS (Phase 1) published in 2007 identified that the major potential water environment constraint to growth in the borough was the impact of treated sewage effluent on the ecology of the River Loddon. As a result, a detailed study supported by an ecological assessment specifically examined the ecology of the River Loddon which was then used to inform the decision-making process (Phase 2 WCS report 2009).

The WCS (2009) considered three growth scenarios, 14,800 dwellings (740 developments per annum (dpa)), 16,500 dwellings (825 dpa) and 19,800 dwellings (990 dpa) and covered the proposed plan period at the time of 2006-2026. The majority of development was to be focussed in and around Basingstoke and would be served by Basingstoke Wastewater Treatment Works (WwTW) which discharges into the River Loddon. The WCS demonstrated that each of the tested development levels could be accommodated, although it was highlighted that the discharge permit condition for the WwTWs may need to be tightened as phosphate levels were already high in the river.

The Local Plan, which was submitted for examination in October 2014, covered the time period 2011-2029. As the plan period and quantum of development were different to the scenarios originally modelled in the WCS, the Environment Agency undertook further water quality modelling at this time, preparing a report and statement of common ground with relevant partners. The modelling assumed that all additional development would be in and around Basingstoke and served by the Basingstoke WwTW. The overall conclusion from the updated modelling undertaken by the Environment Agency was confidence that as a result of the sites allocated in the adopted Local Plan there would be no deterioration in the chemical or physiochemical status of the River Loddon. However, there remained a minor risk relating to the impact on biological and ecological status which it was determined could be mitigated through regular monitoring. Furthermore, it concluded that in order to improve the classification of the River Loddon to reach Good Ecological Status, a phosphate limit of 0.1 mg/l[1] would be needed on the discharge permit for Basingstoke WwTW.

1.3 Report structure

This WCS report provides a succinct overview of the technical review and assessments which has been developed and is supported by a series of detailed technical appendices which expand on the themes within the report, or provide detail of the analysis and wider evidence base that has supported each aspect of the strategy.

The remainder of this report is structured as follows:

- Section 2: **Study area** definition and growth assessed.
- Section 3: **Study baseline** – including policy context, current water infrastructure services and water-based constraints and opportunities.
- Section 4: **Wastewater treatment** – a review of the current and future wastewater flow within the study area to identify where proposed growth might be constrained by treatment capacity.
- Section 5: **Water quality assessment** – a summary of the technical assessments to identify where proposed growth might hinder compliance with the legislative requirements of the Water Framework Directive and Habitats Regulations.
- Section 6: **Flood risk** – a summary of the potential impact of the increased wastewater flow from the proposed growth on flooding.
- Section 7: **Water supply strategy** – a review of the planned water supply strategies and a summary of the water neutrality assessment for the study area.
- Section 8: **Recommendations** – water management policies and approaches that should be taken forward in the updated Local Plan to support the sustainability of the water environment.

[1] Compliance as a mean value.

2. Study Area and Growth

A clear definition of the study area is required to support the development of the WCS. The study area includes growth planned across the borough of Basingstoke and Deane.

2.1 Study area

The WCS study area is the borough of Basingstoke and Deane which is the administrative boundary of BDBC (See Figure 2-1).

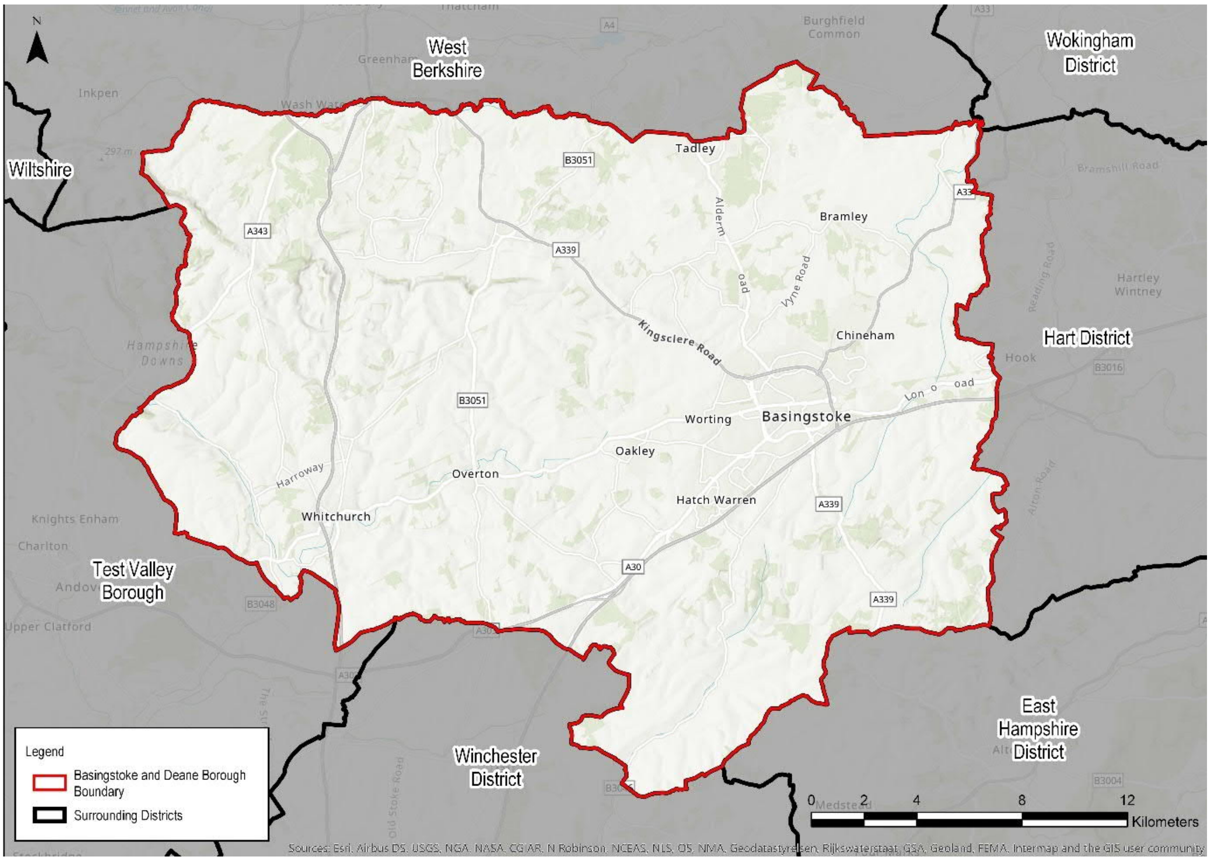


Figure 2-1: WCS Study Area

2.2 Housing growth scenarios

The WCS incorporates all proposed major development sites across the borough at differing stages of development which have been put forward to meet the required target for the delivery of homes over the proposed plan period. These include:

- Existing Commitments (sites with planning permission, but not yet completed as of April 2021);
- Allocations within the Adopted Local Plan and Made Neighbourhood Plans;
- Sites identified in the Brownfield Land Register or Strategic Housing and Economic Land Availability Assessment; and
- Windfall Sites.

Since the final housing target for the borough is not yet finalised, BDBC have outlined two different growth scenarios to be tested within the WCS (excluding the existing commitments which will be the same for both scenarios). Growth scenario 2 is a potentially maximum growth scenario for different areas and settlements which are for testing purposes only and to give a worst-case position from a WCS perspective. The scenarios provided reflect sites that have been promoted to the council, potential overall housing requirements, and previous testing levels from sustainability appraisal related work. Lower levels of growth have also been tested in growth scenario 1 to consider the impacts of potentially more realistic growth levels, depending on the outcomes of other evidence base studies. It must be noted that the scenarios used do not indicate any preference from the Council at this stage regarding suitable levels of growth in different locations. The number of residential units under each growth scenario for the relevant WwTW catchment is summarised in Table 2-1. A further scenario was assessed, as a sensitivity related to water quality in the Vyne Stream, to reduce the amount of growth being directed to the Sherborne St John WwTW with Basingstoke WwTW being used as an alternative location for 250 of the 326 units instead (referred to as growth scenario 3).

Table 2-1: Growth scenarios for the WwTWs to be tested within the WCS[2]

Treatment Works	Settlements	Growth Scenario 1 Units	Growth Scenario 2 Units	Growth Scenario 3 Units
Ashford Hill	Ashford Hill	20	20	20
Barton Stacey	St Mary Bourne	200	200	200
Basingstoke	Basingstoke, Cliddesden & Old Basing	12,936	15,222	**15,472**
Kingsclere	Kingsclere	269	594	594
North Waltham	North Waltham, Dummer, Preston Candover, Herriard & Upton Grey	134	134	134
Oakley	Oakley	590	880	880
Overton	Overton	390	630	630
Sherborne St John	Sherborne St John	326	326	**76**
Sherfield on Loddon	Bramley & Sherfield on Loddon	176	1,121	1,121
Silchester	Tadley & Silchester	549	1,144	1,144
Washwater	Burghclere, Woolton Hill & Highclere	83	83	83
Whitchurch	Whitchurch & Popham	2,881	3,871	3,871
	Total:	**18,554**	**24,225**	**24,225**

2.2.1 Household Occupancy Rate

The latest Office for National Statistics (ONS) population projections[3] and household projections[4] have been used to determine the occupancy rate of each household coming forward in the plan period and have been provided in Table 2-2.

Table 2-2: Calculation of Occupancy Rate

	Projection for 2039
Population	189,142
Number of households	83,793
Calculated Occupancy Rate (people per household)	2.26

2.3 Employment

In terms of employment projections, the current Local Plan has a jobs target of 450 to 700 jobs per annum, which would be 8,100 to 12,600 over the plan period. The overall employment projection used

[2] Windfall sites were assumed at 50 units per annum over the plan period applied proportionately across the WwTWs relative to historic trends.
[3] 2018-based Subnational Population Projections (ONS) (October 2019). Available at https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/nationalpopulationprojections/2018based
[4] 2016-based Household Projections in England (ONS) (September 2018). Available at https://www.ons.gov.uk/releases/2016basedhouseholdprojectionsinengland

for the borough over the updated Local Plan period (up to 2039) is 12,386 jobs. The spatial distribution of the employment growth relative to WwTW catchments is summarised in Table 2-3.

Table 2-3: Spatial distribution of employment growth across the borough to be tested within the WCS

Treatment works	Comments	Projected number of jobs
Basingstoke	Majority of employment growth anticipated within Basingstoke	11,441
Sherfield on Loddon	Employment space in Bramley	100
Whitchurch	Employment space proposed at Ardglen and Popham	845
	TOTAL:	**12,386**

2.4 Growth outside the study area

Consideration to growth outside the study area has been considered for this WCS. However, this was limited to a small number of WwTWs where the existing discharge catchment extends beyond the borough boundary.

Barton Stacey WwTW is situated within Test Valley, with the majority of the discharge catchment within the Test Valley Borough Council (TVBC) boundary. It was reported by the Environment Agency in 2020 that Barton Stacey WwTW is likely to be subject to transfer from another WwTW within TVBC, therefore assessing additional cross boundary discharge from TVBC within the water quality assessment was outside the scope for this WCS.

3. Study Baseline

The existing water environment and water infrastructure baseline has formed the basis upon which constraints to development have been assessed. The baseline consists of a legislative and policy review, existing infrastructure provision, water environment and current flood risk baseline.

3.1 Legislative and policy context

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

1. Delivering sustainable water management – ensure that provision of WSI and mitigation is sustainable and contributes to the overall delivery of sustainable growth and development and that the Local Plans meet with the requirements of the National Planning Policy Framework (NPPF) with respect to water; and
2. Water Framework Directive (WFD) and Habitats Regulations compliance – to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies within the study area (and more widely) from achieving the standards required of them as set out in the WFD River Basin Management Plans (RBMPs) and would not have an impact on the protected species and habitats designated under the Habitats Regulations.

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 legislative driver for this study is WFD and Habitats Regulations compliance.

3.1.1 Water Framework Directive

The environmental objectives of the WFD, as published in the Environment Agency's River Basin Management Plans (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 (such as Local Plan making) that could affect the quality of the water environment. The Environment Agency publishes the status and objectives of each surface water and groundwater body on the Catchment Data Explorer[5]. Surface water bodies can be classed as high, good, moderate, poor or bad status; Table 3-1 gives a description of each of the status classes. Groundwater body status is classified on the basis of quantitative and chemical status and can be classified as good or poor.

[5] https://environment.data.gov.uk/catchment-planning/

Table 3-1: Description of the surface water body status in respect of 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.

3.1.2 Habitats Regulations

The Habitats Directive and the Habitats Regulations have designated some sites as areas that require protection in order to maintain or enhance the rare ecological species or habitat associated with them. Although the Habitats Directive does not directly set overarching environmental quality standards related to water quality, the Habitats Regulations can, by the requirement to ensure no detrimental impact on designated sites, require site specific water quality targets which in turn require restrictions on discharges to (or abstractions) from water dependent habitats that could be impacted by anthropogenic manipulation of the water environment.

3.1.3 Adopted Local Plan 2011-2029

Due to the environmental sensitivity of the River Loddon at Basingstoke the adopted Local Plan contains two policies that relate to water quality which are linked directly to monitoring to ensure that water quality is protected (Policy SS4 and EM6). These policies restrict the release of further sites/granting of planning permissions if further deterioration is identified, until measures have been taken to improve water quality.

The adopted Local Plan also contains a policy relating to sustainable water use (Policy EM9). The policy requires new homes to meet a water efficiency standard of 110 litres or less per person per day and non-residential development of 1000sqm or more to meet BREEAM excellent standards for water consumption.

3.1.4 Other planning documents

Details of other relevant studies that have a bearing on the provision of water services infrastructure for development are also provided in Appendix A and include, but are not limited to, key documents including;

- Level 1 Strategic Flood Risk Assessment (SFRA) (2021);
- Thames and South East RBMPs (2015) required under the WFD (and draft updates 2021);
- South East Water's Water Resource Management Plan (WRMP) 2020; and
- Southern Water's WRMP (2019).

3.2 Current infrastructure provision

A number of infrastructure providers operate within the study area, which are summarised below.

Sewerage and wastewater treatment providers:

- Thames Water are responsible for providing sewerage and wastewater treatment to the eastern portion of the borough, including the town of Basingstoke.
- Southern Water are responsible for providing sewerage and wastewater treatment to the western portion of the borough, which includes the rural settlements of Whitchurch, Overton and Oakley.

Potable water supply and network providers:

- South East Water are responsible for providing clean water to the eastern portion of the borough, with approximately two thirds of the borough supplied with water from Water Resource Zone 4 (WRZ4) (Bracknell) (see Figure 3.1).
- Southern Water are responsible for providing clean water to the western portion of the borough, with approximately one third supplied with water from Hampshire Kingsclere WRZ (see Figure 3.2).

Figure 3-1: Map of South East Water WRZ4 (Bracknell)[6]

Figure 3-2 Map of Southern Water Western WRZs[7]

[6] South East Water Water Resources Management Plan (2020)

[7] Southern Water Water Resources Management Plan (2019)

The measured household consumptions for both South East Water and Southern Water are published in their respective WRMPs and are summarised as follows:

- 157.2 l/h/d (litres per head per day) within South East Water WRZ4 Bracknell); and
- 171.9 l/h/d within Southern Water Hampshire Kingsclere WRZ.

3.2.1 Water Company Planning

It is important to consider the planning timelines, both in terms of the Local Plan and for Water and Sewerage providers in terms of the funding mechanisms for new water supply and water treatment infrastructure. There are two elements of water company planning that are pertinent to the WCS and specifically, with regard to integration with spatial planning timelines for Local Planning Authorities (LPAs).

Financial and Asset Planning

Water company planning for asset management and funding is governed by the Asset Management Plan (AMP) process which runs in 5 year cycles. The Office of Water Services (Ofwat) is the economic regulator of the water and sewerage industry in England and Wales and regulates this overall process.

In order to undertake maintenance of its existing assets and to enable the building of new assets (asset investment), water companies seek funding by charging customers according to the level of investment they need to make. The process of determining how much asset investment required is undertaken in conjunction with:

- the Environment Agency as the regulator determining investment required to improve the environment;
- the Drinking Water Inspectorate (DWI) who determine where investment is required to improve quality of drinking water; and,
- Ofwat who along with the Environment Agency require water companies to plan sufficiently to ensure security of supply (of potable water) to customers during dry and normal years.

The outcome is a Business Plan which is produced by each water company setting out the required asset investment over the next 5 year period, the justification for it and the price increases required to fund it.

Overall, the determination of how much a water company can charge its customers is undertaken by Ofwat. Ofwat will consider the views of the water company, the other regulators (Environment Agency, DWI) and consumer groups such as the Consumer Council for Water when determining the price limits it will allow a Water Company to set in order to enable future asset investment. This process is known as the Price Review (PR) and is undertaken in 5 year cycles. When Ofwat make a determination on a water company's business plan, the price limits are set for the following five years allowing the water company to raise the funds required to undertake the necessary investment within the AMP round. The current AMP period is known as AMP7 and it covers PR19 which runs from 1st April 2020 to 31st March 2025.

3.3 Settlement pattern

The borough covers over 63,000 hectares (245 square miles) within north Hampshire. Basingstoke town is the main settlement and the focus for key services and employment. The borough is predominately rural with less than 8% of the land built up. Approximately 60% of the population live in Basingstoke town with the remaining 40% within a scattering of rural towns and villages in the main concentrating on a few larger settlements. The adopted Local Plan builds on existing settlement patterns focusing development primarily on Basingstoke town to 2029.

3.4 Water environment

The borough's water environment is dominated by the underlying geology which is split into two distinct geological areas, namely the Thames Basin and Hampshire Downs. The southern two thirds of the borough are characterised by the permeable chalk downland, a large proportion of which forms part of the Test and Itchen Catchment (see Figure 3-3).

The northern portion of the borough forms part of the Thames catchment which is influenced by clay and sand and is generally less permeable than the chalk downland, (with the exception of the chalk river Loddon at Basingstoke town). The location of the rivers within the borough are shown in Figure 3-3.

The River Enborne rises near the villages of Inkpen and West Woodhay and flows into the River Kennet which discharges into the Thames. Part of its course forms the borough boundary with West Berkshire to the north. The River Enborne and its tributaries contain important water meadows and other habitats which are home to protected species.

The River Test, a nationally renowned chalk river and Site of Special Scientific Interest (SSSI), rises upstream of Overton and runs through the southwest portion of the borough. It joins with its tributary the Bourne rivulet, just before it leaves the borough. It is also subject to the EU Freshwater Fish Directive and designated an Environment Agency salmonid river.

The Candover stream is also a chalk watercourse and a tributary of the River Itchen (designated a SSSI and Special Areas of Conservation (SAC)), which rises at the southeast corner of the borough. The River Loddon and its tributaries rise in the north east part of the borough. The River Loddon is classified as a high-quality chalk river, warranting special protection for both water quality and ecology. It is also subject to the EU Freshwater Fish Directive and designated an Environment Agency salmonid river. It contains a number of designated Sites of Importance for Nature Conservation (SINC).

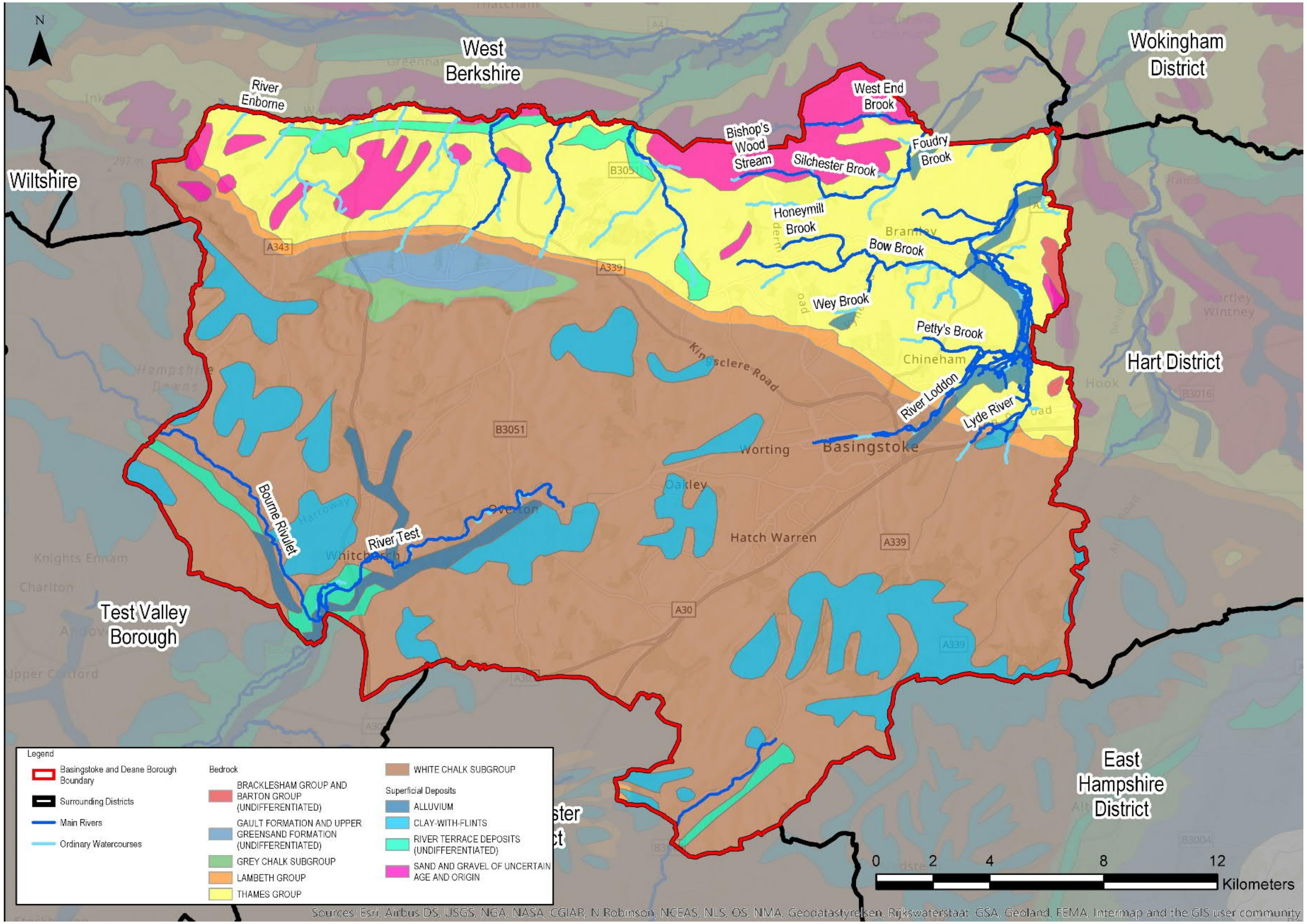


Figure 3-3: Rivers and geology within the study area

3.4.1 Water quality - rivers

The WFD classifications for surface water bodies in the borough, as taken from 2019 published data, are provided in Appendix B. Where the status of the water bodies is less than Good Status, the 'Reasons for Not Achieving Good' (RNAG) status identifies where abstractions and/or discharges are a confirmed pressure for waterbodies within the borough. This includes a number of WFD waterbodies within the Kennet and Loddon catchments.

The RNAG status has been taken from the latest information available on the Environment Agency's Catchment Data Explorer (January 2021). It should be noted that the draft RBMPs were published for public consultation from 22nd October 2021 until 22nd April 2022. For reference, it has been identified in Appendix B if there is a proposed change within the draft RBMP (compared to the current 2015 RBMP) to the overall target status of the surface water bodies in the borough.

3.4.2 Water quality – groundwater

The WFD classifications for groundwater bodies in the borough, as taken from the 2019 published data, are provided in Appendix B. The RNAG status has been taken from the latest information available on the Environment Agency's Catchment Data Explorer (January 2021). It should be noted that the draft RBMPs are published for public consultation from 22nd October 2021 until 22nd April 2022. For reference, it has been identified in Appendix B if there is any change to the proposed target status of the groundwater bodies in the borough.

The RNAG status identifies that abstractions and/or poor nutrient management are a confirmed pressure for the groundwater bodies within the borough, which are classified as 'Poor' status. These include the Berkshire Downs Chalk, Basingstoke Chalk, River Itchen Chalk and River Test Chalk.

In order to protect water resources it is necessary to ensure that it is not being polluted with additional substances leading to the need for more treatment. To do this the Environment Agency identify Safeguard Zones for any raw water sources that are 'at risk' of deterioration which would result in the need for additional treatment. Within England there is a widespread rise in nitrate concentrations in groundwater. With this widespread rise in nitrate concentrations water supply companies are now installing treatment plants to deal with this issue.

The rise in nitrate concentrations is a particular concern in the Test and Itchen catchments where the majority of the drinking water comes from groundwater. Some of the areas of the groundwater bodies within these catchments are designated as Drinking Water Protected Areas withSafeguard Zones (SGZ) designated as a result of nitrate impact. These zones are areas where the land use is causing pollution of the raw water. Action is targeted in these zones to address pollution so that extra treatment of raw water can be avoided. SGZs are one of the main tools for delivering the drinking water protection objectives of the WFD. In particular, SGZs have been designated due to elevated nitrate concentrations in groundwater at Whitchurch, Overton and Woodgarston.

Due to the geology, the interaction between ground and surface waters in the Test and Itchen catchments are also key. Groundwater provides a significant proportion of the base flow to the river network.

3.4.3 Water dependent habitats

There is a total of thirteen SSSI within the borough, four of which are potentially hydrologically linked to Wastewater Treatment Works (WwTWs) discharges as identified in Table 3-2.

Table 3-2: SSSIs located within the Borough hydrologically linked to discharges from WwTW

Site Name	SSSI Area (ha)	Main habitat	Condition	Potential hydrological connectivity to WwTW
Bere Mill Meadows SSSI	10.27	• Neutral Grassland – Lowland	Unfavourable - Recovering	Within flood plain of River Test
Ashford Hill Woods and Meadows SSSI	141.55	• Acid Grassland – Lowland • Broadleaved, mixed and Yew woodland – Lowland	76% Favourable 64% Unfavourable – Recovering	Flushed areas drained by a watercourse
Stanford End Mill and River Loddon SSSI	11.80	• Neutral Grassland – Lowland • Rivers and Streams	Favourable	Water dependent species including waterlogged hay meadows & fish species
River Test SSSI	437.98	• Broadleaved, mixed and Yew woodland – Lowland • Neutral Grassland – Lowland • Fen, Marsh and Swamp – Lowland	18% Favourable 38% Unfavourable – Recovering 43% Unfavourable – No change 1% Unfavourable - Declining	River system with baseflow from groundwater

Of the seven Local Nature Reserves within the borough, two are potentially hydrologically linked since they are located downstream of WwTW discharges:

- Pamber Forest LNR; and
- Hosehill Lake LNR.

It is also worth noting that any discharges within the Test catchment have the potential to impact upon the European protected sites within the Solent since they are hydrologically linked (either by groundwater or discharges direct to the River Test which subsequently discharge into Southampton Water). These sites include the Solent and Southampton Water Special Protection Area (SPA) / Ramsar and Solent and Dorset Coast SPA, Solent Maritime SAC and Solent and Isle of Wight Lagoons SPA. There is an identified issue with the impact of nitrogen on the Solent and Southampton Water SPA which Natural England are working closely on with the relevant local authorities to address in respect of future developments. The nitrogen balance will be addressed through the Habitats Regulations Assessment of the Local Plan Update.

3.5 Flood risk

An overview of the key flood risk characteristics within the study area, drawn from the Level 1 SFRA (2021), are summarised in the sections below.

3.5.1 Fluvial flooding

Approximately 2.76% (61.92 hectares) of the borough lies within present-day Flood Zone 3 and approximately 3.06% (68.75 hectares) lies within present-day Flood Zone 2. Fluvial flood extents are limited by the geology and the location of the borough at the catchment watersheds of several river systems including the River Loddon (and its tributaries), the River Test, Candover stream (a tributary of the River Itchen) and tributaries of the River Kennet. The River Enborne forms part of the northern boundary of the borough.

3.5.2 Surface water flooding

Overland flow and surface water flooding typically arise following periods of intense rainfall, sometimes of short duration, that is unable to soak into the ground or enter drainage systems. It can run quickly off land and result in localised flooding.

Large parts of Basingstoke town (and further north in Tadley) are designated as Local Critical Drainage Areas in the adopted Local Plan where flood risk assessments are required to support development proposals. Local Critical Drainage Areas have been defined by BDBC as 'areas where a new development is likely to overload the capacity of the existing drainage system (in particular at those locations where the localised flooding from surface water drainage is indicated)'. It should be noted that these Local Critical Drainage Area designations are not the same as Areas with Critical Drainage Problems (ACDPs) notified by the Environment Agency.

3.5.3 Groundwater flooding

Groundwater poses a significant risk of flooding to the borough. The risk is predominantly associated with the extensive chalk (and other permeable rock) bedrock geology underlying the majority of the Basingstoke and Deane area.

Groundwater flooding in the borough is typically caused by three mechanisms:

- Rising water levels in superficial deposits;
- Rising water levels in aquifers; and
- Groundwater flooding and fluvial flooding interactions - the chalk rivers (River Test, River Loddon and tributaries of the River Itchen) are characterised by high groundwater-fed base flow which when combined with storms may lead to overtopping of riverbanks.

Reference to the British Geological Society (BGS) dataset ‘Susceptibility to Groundwater Flooding’ indicates that areas of central and southern Basingstoke town, Whitchurch and Overton, as well as the corridors along the course of the Enborne and its tributaries, may have ‘potential for groundwater flooding of property situated below ground level’ or ‘potential for groundwater flooding to occur at the surface’.

The area of Buckskin (in south west Basingstoke) experienced significant flooding of both land and property during February and March 2014. The primary flooding was attributed to groundwater and surface water, which also led to secondary foul water flooding caused by inundation of the foul network. Historic groundwater flooding at Preston Candover led to the development of an Action Plan.

3.5.4 Sewer flooding

During heavy rainfall, flooding from the sewer system may occur if the rainfall event exceeds the capacity of the sewer system/drainage system, the system becomes blocked by debris or sediment and/or the system surcharges due to high water levels in receiving watercourses.

Sewer systems are vulnerable to groundwater through two main mechanisms:

- Groundwater ingress forced through cracks in the access chambers or pipes;
- Groundwater creating surface flows that flow into drain and sewers.

There are very few recorded incidents of internal sewer flooding within the borough. The areas with the most incidents are located in the north of the borough and are predominantly rural. These areas also have the highest number of incidents of external sewer flooding. In particular there are known sewer flooding issues at Bramley affecting both existing and newly constructed properties. Other areas with a high number of external sewer flooding incidents include Sherfield on Loddon, Brighton Hill and Hatch Warren, in south west Basingstoke.

3.5.5 Flooding from artificial sources

The Environment Agency dataset 'Risk of Flooding from Reservoirs' identifies areas that could be flooded if a large reservoir were to fail and release the water it holds. Three areas within the borough are shown to be at risk of reservoir flooding, including:

- Southern Bramley (unnamed reservoir to the south of Bramley Green)
- The village of Stoney Heath (Ewhurst Pond)
- The village of Aldermaston Stoke (Decoy Pond located outside of the Borough)

These areas at risk are predominantly rural, however, a number of individual properties would be at risk if the reservoir were to fail.

4. Wastewater Treatment

A review of the current and future wastewater flow within the study area is undertaken to identify where proposed growth might be constrained by treatment capacity within the current discharge permit for the relevant WwTWs.

4.1 Wastewater in the Study Area

Wastewater from the study area is treated at sixteen WwTWs located across the borough and one WwTW outside of the borough (see Figure 4-1), operated by either Thames Water or Southern Water. The discharge of treated wastewater is either to a nearby surface waterbody or to the groundwater waterbody. An overview of the operator and discharge location for each WwTWs is provided in Table 4-1. Of the seventeen WwTWs, twelve are expected to receive additional wastewater as a result of growth (those highlighted in bold in Table 4-1).

Table 4-1: Summary of WwTWs in the study area

WwTW	Water Company	Settlements served	Receiving Waterbody
Basingstoke	Thames Water	Basingstoke, Chineham, Old Basing, Oakridge, Popley, Hatch Warren, Kempshott, South Ham, Buckskin, Black Dam, Cranbourne, Winklebury and Cliddesden	River Loddon
Sherborne St John	Thames Water	Sherborne St John, Monk Sherborne, Pamber End, Charter Alley, Ramsdell and Elm Lea	Wey Brook (Trib of River Loddon)
Sherfield on Loddon	Thames Water	Sherfield on Loddon and Bramley	Bow Brook (Trib of River Loddon)
Washwater	Thames Water	Woolton Hill, Highclere, Ball Hill, Gore End, Penwood and Burghclere	Pound Street Brook (Trib of River Enborne)
Adbury Holt	Thames Water	The Gables Albury holt	Adbury Stream
Kingsclere	Thames Water	Kingsclere, Ecchinswell, Headley and Mill Green	Kingsclere Brook (Trib of River Enborne)
Ashford Hill	Thames Water	Ashford Hill	Baughurst Brook (Trib of River Enborne
Silchester	Thames Water	Silchester, Pamber Heath, Pamber Green, Little London, Tadley, Aldermaston Soke, Old Warren and Baughurst	Silchester Brook (Trib of River Enborne)
Greenham Common	Thames Water	Bishop's Green	River Enborne
Hartley Wintney	Thames Water	Newnham	Not identified
Whitchurch	Southern Water	Whitchurch	River Test Chalk
Overton	Southern Water	Overton, Laverstoke and Freefolk	River Test Chalk
Oakley	Southern Water	Oakley	River Test Chalk
North Waltham	Southern Water	North Waltham	River Test Chalk
Ashmansworth	Southern Water	Ashmansworth	River Test Chalk
Hannington	Southern Water	Hannington	River Test Chalk
Barton Stacey	Southern Water	Stoke, St Mary Bourne and Hurstbourne Priors	River Dever

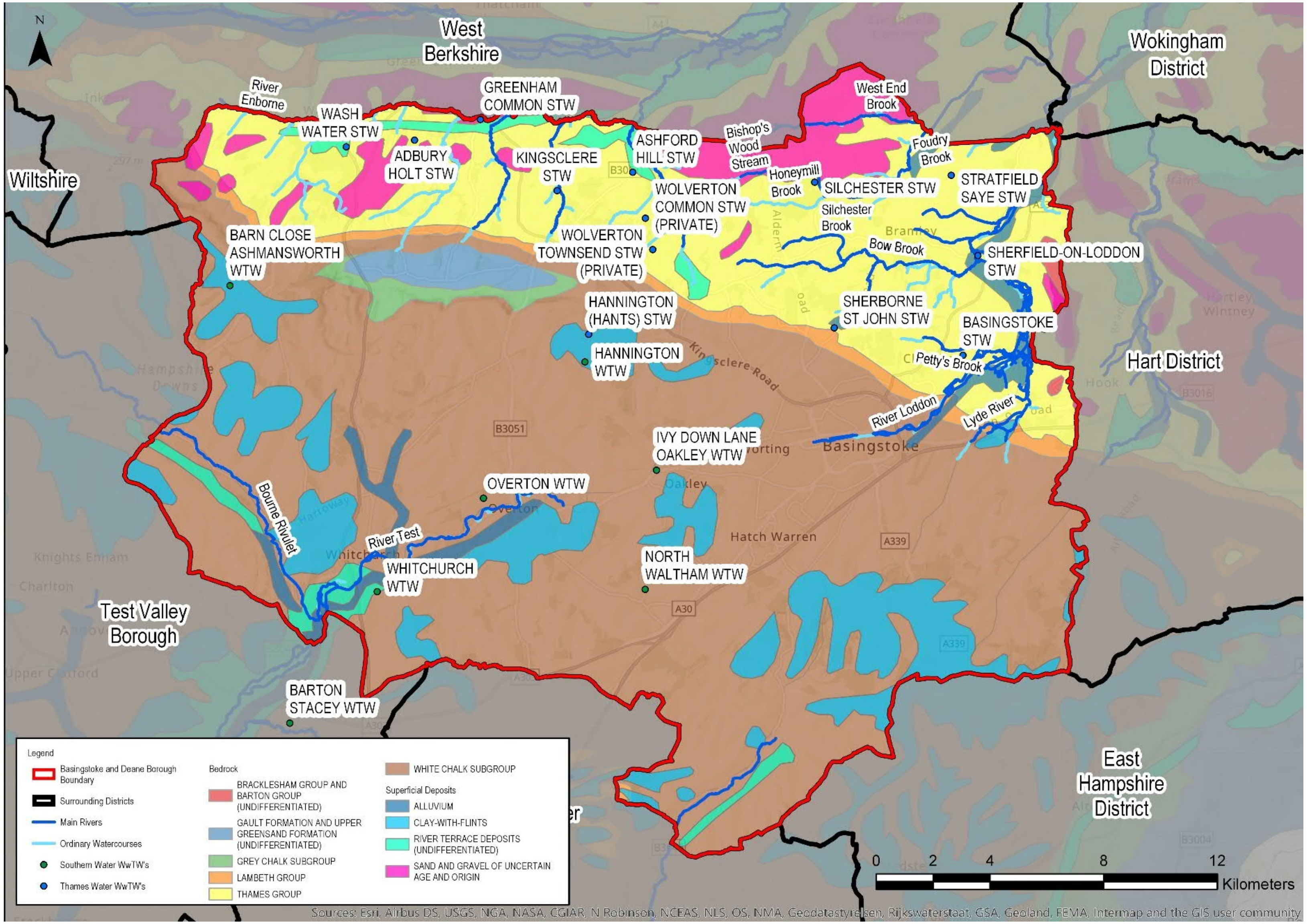


Figure 4-1: Location of WwTWs within the study area (shown in relation to rivers and geology)

The WwTWs which have been identified as discharging via groundwater all discharge into the River Test Chalk. A review was undertaken of the Institute of Geological Sciences (IGS) Hydrogeology Map Sheet 9[8], the Environment Agency-delineated WFD groundwater bodies[9], source protection zones[10], and BGS bedrock geology mapping[11] to build a conceptual model of groundwater sub-catchment boundaries for the area. The boundaries of the groundwater sub-catchment for the River Test and River Itchen surface water catchments within the borough have been delineated as follows:

- The eastern boundary of the groundwater sub-catchment has been delineated using a groundwater divide identified on the published (IGS) Hydrogeology Map Sheet 9 and corresponding mapped boundary of the Basingstoke Chalk groundwater body;
- The northern boundary of the groundwater sub-catchment has been delineated using the outlines of source protection zones delineated by the Environment Agency to protect groundwater sources used for public drinking supply; and
- The north-western, southern, south-western and south-eastern boundary of Chalk groundwater sub-catchment has been delineated following the jurisdictional boundary limit of the borough, even though the Chalk groundwater catchment in these directions extends several kilometres beyond the borough boundary as indicated in Figure 4-2.

Further details on the assumptions to delineate the groundwater sub-catchment are provided in Appendix C.

[8] Institute of Geological Sciences, 1977. Hydrogeological Map of Hampshire and the Isle of Wight. Map sheet 9. http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1003979
[9] https://data.gov.uk/dataset/2a74cf2e-560a-4408-a762-cad0e06c9d3f/wfd-groundwater-bodies-cycle-2
[10] https://data.gov.uk/dataset/09889a48-0439-4bbe-8f2a-87bba26fbbf5/source-protection-zones-merged
[11] http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSHydroMap

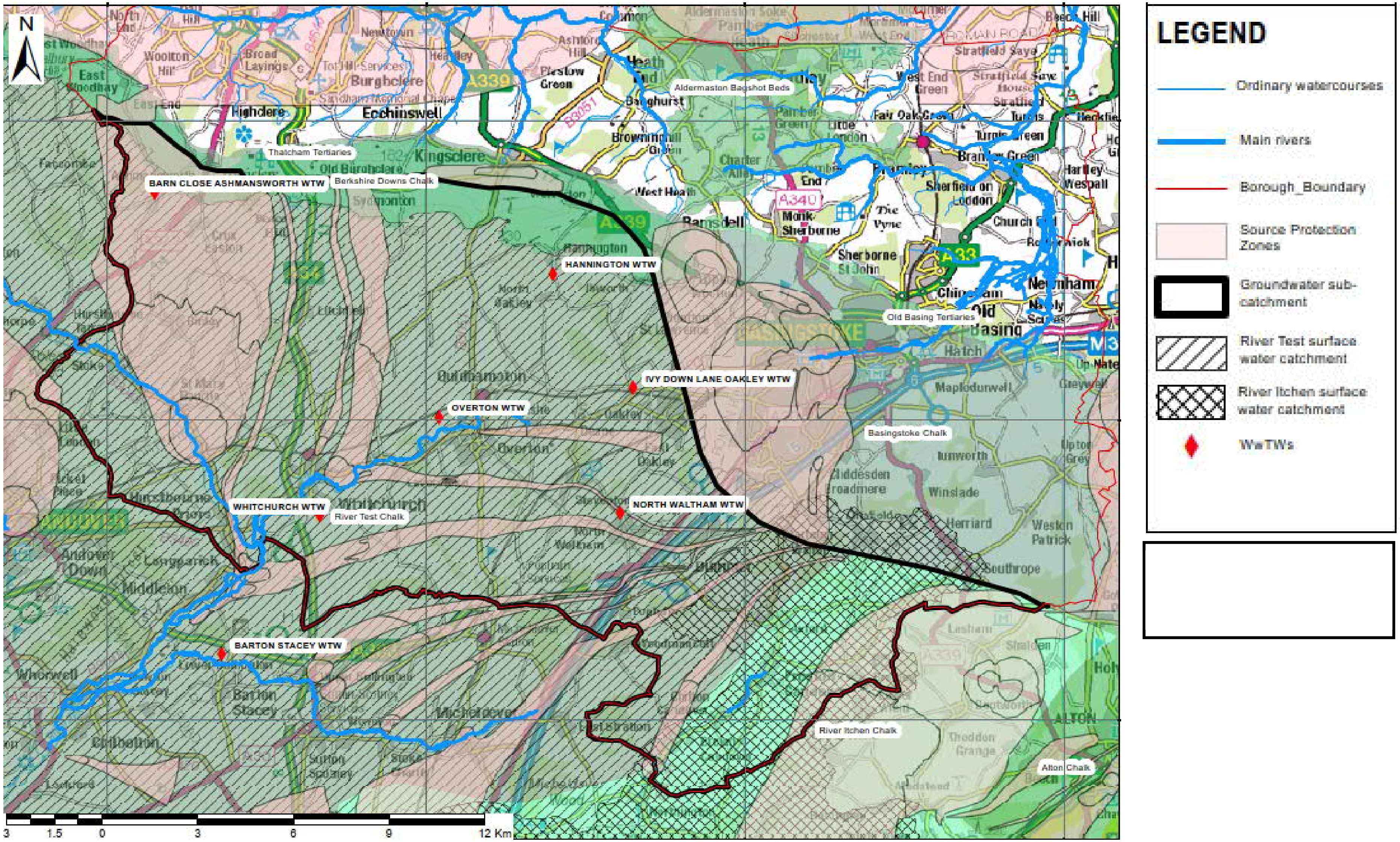


Figure 4-2: Location of WwTWs which discharge to ground in relation to the groundwater Source Protection Zones and river catchments

4.2 Management of WwTW Discharges

4.2.1 Wastewater Treatment

As wastewater treatment providers, Thames Water and Southern Water are required to use the best available techniques (defined by the Environment Agency as the best techniques for preventing or minimising pollutants and impacts on the environment) to ensure emission limit values stipulated within each WwTW's discharge permit conditions are met.

Through application of the best available techniques in terms of wastewater treatment, the reliable limits of conventional treatment (LCT) have been determined for the key parameters of Biochemical Oxygen Demand (BOD)[12], ammonia and phosphate, and are provided in Table 4-2.

Table 4-2: Reliable limits of conventional treatment technology for wastewater

Water Quality Parameter	Limits of Conventional Treatment
Ammonia	1.0 mg/l 95 percentile limit[13]
BOD	5.0 mg/l 95 percentile limit
Phosphate	0.25 mg/l annual average[14]

Ammonia present in treated sewage effluent is likely to primarily transform to nitrate once in aerobic ground conditions which are common in the Chalk aquifer or in surface waters. However, using ammonia limits on these discharges to control nitrate is unlikely to be sufficient. This is because the standard treatment within sewage treatment works is likely to primarily oxidise the ammonia (NH4) to nitrates (NO3). Unless the treatment technology specifically removes nitrogen, it is likely that nitrogen will be transformed from one form to another. This is often seen as a decrease in ammonia concentrations which is associated with an increase in the concentration of nitrate in the final effluent. Therefore, the majority of nitrogen in treated sewage has already been transformed to nitrates prior to discharge into the environment. Conditions on permits for discharges can be used to regulate the contribution of nitrate entering surface waters and groundwater from wastewater (sewage) treatment works. Conventional primary and secondary treatment at sewage works removes 20-30% of the nitrogen in raw sewage. As a guide, where effluent needs tertiary treatment, levels of nitrate reduction can be around 70-80% to meet effluent nitrogen standards of 10-15 mg/l[15]. A number of WwTWs which discharge to ground have total nitrogen limits included in the permit to manage the impact of nitrates within the treated effluent on the groundwater environment; these include Whitchurch WwTW, Oakley WwTW and North Waltham WwTW.

As the wastewater undertakers for the study area, Thames Water and Southern Water have 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 Water Services Regulatory Authority (Ofwat) which ensure Thames Water and Southern Water have sufficient funds to finance their 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, Thames Water and Southern Water generally do not provide additional infrastructure to accommodate growth until there is certainty that development is due to come forward. WCS' therefore have an important role in the water company planning process

[12] 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
[13] Considered within the water industry to be the current LCT using best available techniques
[14] National Asset Management Plan 6 (AMP6) trials to investigate new sewage treatment technologies to reduce Phosphate treatment were completed in 2017 and a new Technically Achievable Limit (TAL) of 0.25 mg/l for Phosphate has been agreed between water companies and the Environment Agency.
[15] 2021 River Basin Management Plan: Nitrates (Environment Agency, 2019). Available at https://consult.environment-agency.gov.uk/++preview++/environment-and-business/challenges-and-choices/user_uploads/nitrates-pressure-rbmp-2021.pdf.

by helping to identify areas for potential future investment based on long-term plans for growth and development.

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.

4.2.2 Flow Condition

The flow element of the discharge permit, measured as Dry Weather Flow (DWF)[16], 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'.

This headroom provides an indication as to the quantity of new dwellings which can be connected to the WwTW before a new discharge permit would need to be considered.

4.2.3 Quality Conditions

The quality conditions applied to discharge permits are derived to ensure that the water quality of the receiving waterbody is not adversely affected in terms of concentration of physico-chemical elements including ammonia, nitrate, BOD and phosphate. However, currently not all WwTW discharge permits are set to equate to maintaining the current WFD status of the receiving waterbody due to the discharge permits being issued prior to implementation of the WFD. Consequently, some discharge permits, if operated to the full flow limit (i.e. all permitted headroom is used), could lead to a significant deterioration in water quality and possibly WFD status.

An assessment needs to be undertaken to determine what new quality conditions would need to be applied to the discharge under the following circumstances:

- When a new or revised discharge permit is required, or
- When a new or revised discharge permit is not required, but a significant quantity of development is proposed to connect to a WwTW.

If the quality conditions remain unchanged, the increased flow of wastewater received, treated and discharged at the WwTW would result in an increase in the quantity and load[17] of determinands being discharged to the receiving waterbody. This may have the effect of deteriorating water quality and hence, an increase in permitted discharge flow can result in the need for more stringent (or tighter) conditions on the quality of the discharge.

The requirement to provide a higher standard of treatment may result in an increase in the intensity of treatment processes at a 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.

4.3 Headroom Assessment Results

The volume of wastewater, measured as DWF, which would be generated from the proposed housing and employment growth over the plan period within each WwTW catchment has been calculated and assessed against the permitted flow headroom capacity at each WwTW. This headroom comparison then determined where water quality assessment would be required. This assessment (consisting of either modelling or calculations) is required to determine whether:

[16] DWF is a measure of the flow of foul water only to a WwTW (excludes additional flow as a result of excessive rainfall or groundwater the infiltration entering the sewer network).
[17] 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.

a) Significant growth levels could impact on water quality (and WFD) objectives through the use of available permitted headroom; or

b) Where permitted flow headroom is predicted to be exceeded, 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 assessment are summarised in Section 5.

Two growth scenarios for each WwTW expected to receive additional wastewater have been used in this assessment to determine headroom capacity. A summary of the assessment for growth scenario 1 and 2 are provided in Table 4-3 and 4-4 respectively.

Table 4-3: WwTW headroom capacity assessment (Growth Scenario 1)

WwTW Catchment	Current DWF Permit (m^3/d)	Current Headroom Capacity		Quantity of proposed dwellings in growth scenario 1	Quantity of jobs to be created in growth scenario 1	Future 2039 DWF after growth scenario 1 (m^3/d)	Headroom Assessment after growth scenario 1 (2039)	
		Current measured DWF (m^3/d)	Calculated Headroom (m^3/d)				Headroom Capacity (m^3/d)	Approx. residual housing capacity
Basingstoke	65,000	21,288	43,712	12,936	11,226 jobs	26,343	38,657	124,549
Sherborne St John	1,000	554	446	326		724	276	890
Sherfield on Loddon	2,034	1,140	894	176	100 jobs	1,209	825	2,658
Washwater	2,319	1,451	868	83		1,487	832	2,682
Adbury Holt	5	3	2	0		3	No growth identified for this WwTW.	
Kingsclere	1,261	676	585	269		785	476	1,535
Ashford Hill	6	9	-3	20		17	-11	-36
Silchester	8,000	4,336	3,664	549		4,623	3,377	10,880
Greenham Common	-	-	-	0		-	No data provided for this WwTW but minimal growth identified.	
Hartley Wintney	6,833	3,744	3,089	0		3,744	No growth identified for this WwTW.	
Whitchurch	2,336	1,753	584	2,881	845 jobs	2,884	-548	-1,765
Overton	1,160	1,001	159	390		1,153	7	23
Oakley	722	534	188	590		763	-41	-132
North Waltham	167	36	131	134		88	79	256
Ashmansworth	5	-	-	0		-	Current DWF data not provided for this WwTW but no growth identified.	
Hannington WwTW	10	3	7	0		3	No growth identified for this WwTW.	
Barton Stacey	1,746	1,821	-75	200		1,899	-153	-492

Table 4-4: WwTW headroom capacity assessment (Growth Scenario 2)

WwTW Catchment	Current DWF Permit (m^3/d)	Current Headroom Capacity		Quantity of proposed dwellings in growth scenario 2	Quantity of jobs to be created in growth scenario 2	Future 2039 DWF after growth scenario 2 (m^3/d)	Headroom Assessment after growth scenario 2 (2039)	
		Current DWF (m^3/d)	Calculated Headroom (m^3/d)				Headroom Capacity (m^3/d)	Approx. residual housing capacity
Basingstoke	65,000	21,288	43,712	15,222	11,226 jobs	27,144	37,856	121,969
Sherborne St John	1,000	554	446	326		724	276	890
Sherfield on Loddon	2,034	1,140	894	1,121	100 jobs	1,572	462	1,489
Washwater	2,319	1,451	868	83		1,487	832	2,682
Adbury Holt	5	3	2	0		3	No growth identified for this WwTW.	
Kingsclere	1,261	676	585	594		916	345	1,112
Ashford Hill	6	9	-3	20		17	-11	-36
Silchester	8,000	4,336	3,664	1,144		4,934	3,066	9,879
Greenham Common	-	-	-	0		-	No data provided for this WwTW but minimal growth identified.	
Hartley Wintney	6,833	3,744	3,089	0		3,744	No growth identified for this WwTW.	
Whitchurch	2,336	1,753	584	3,871	845 jobs	3,268	-932	-3,002
Overton	1,160	1,001	159	630		1,246	-86	-277
Oakley	722	534	188	880		875	-153	-494
North Waltham	167	36	131	134		88	79	256
Ashmansworth	5	-	-	0		-	Current DWF data not provided for this WwTW but no growth identified.	
Hannington WwTW	10	3	7	0		3	No growth identified for this WwTW.	
Barton Stacey	1,746	1,821	-75	200		1,899	-153	-492

5. Water Quality Assessment

Technical assessments are undertaken to identify where proposed growth might hinder compliance with the legislative requirements of the Water Framework Directive and Habitats Regulations.

Technical assessments undertaken for the WCS include modelling (SIMCAT and RQP), load standstill calculations and an ecological appraisal.

5.1 Wastewater Assessment Overview

5.1.1 Objectives

An increase in residential and employment growth will have a corresponding increase in the volume and flow of wastewater generated within the study area and hence it is essential to consider:

Infrastructure Capacity

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)?

Environmental Capacity

Defined in this WCS as the water quality needed in the receiving waterbodies to maintain the aquatic environments. Where possible, 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%? This is a check 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? This is also a requirement of the WFD, which can be separated into the following two assessment steps:
  - Is the future target status possible now with current technology but no growth? This step determines if it is limits in current technology that would prevent the future target status being achieved.
  - Is the future target status technically possible after development and any potential WwTW upgrades? This step determines if it is growth that would prevent the future target status being achieved.

5.1.2 Methodology

A stepped assessment approach has been developed for the WCS to determine the impact of the proposed growth on infrastructure capacity and the environmental capacity of the receiving watercourse.

In order to assess both infrastructure and environmental capacity for each WwTW, the following assessment techniques were developed:

- Development of a WwTW flow headroom calculator (reported in Section 4.4).
- Application of SIMCAT software (as used by the Environment Agency) to model river water quality at a catchment scale where multiple WwTW discharges exist within a catchment, to assess the

cumulative effect of multiple discharges and ensure their compliance with water quality standards (Section 5.3).

- Application of River Quality Planning (RQP) software (as used by the Environment Agency) to determine the required discharge permit quality condition for an individual WwTW in a catchment (Section 5.4).
- Application of load standstill calculations to determine the required discharge permit quality condition for an individual WwTW which discharges to ground in a catchment (Section 5.5).

5.1.3 RAG Assessment

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;

- Green: water quality objectives will not be adversely affected. Growth can be accepted with no changes to the WwTW infrastructure or discharge permit required.
- Amber: in order to meet the required water quality 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 water quality objectives changes to the discharge permit are required which are beyond the limits of what can be achieved with conventional treatment.

5.2 Modelling requirements

The WwTWs identified in Section 4.3 as requiring water quality modelling are:

- Basingstoke WwTW (discharges to River Loddon)
- Sherborne St John WwTW (discharges to Vyne Stream, a tributary of Bow Brook)
- Sherfield on Loddon WwTW (discharges to Bow Brook, a tributary of River Loddon)
- Washwater WwTW (Pound Street Brook, a tributary of River Enborne)
- Kingsclere WwTW (discharges to Kingsclere Brook, a tributary of River Enborne)
- Ashford Hill WwTW (discharges to Baughurst Brook, a tributary of River Enborne)
- Silchester WwTW (discharges to Silchester Brook, a tributary of River Kennet)
- Whitchurch WwTW (discharges to ground)
- Overton WwTW (discharges to ground)
- Oakley WwTW (discharges to ground)
- North Waltham WwTW (discharges to ground)
- Barton Stacey WwTW (discharges to River Dever)

5.2.1 Catchment modelling

Consultation with the Environment Agency as part of this WCS has identified the need for catchment scale modelling of the River Loddon to determine the required discharge permit quality conditions for Basingstoke WwTW, Sherborne St John WwTW and Sherfield on Loddon WwTW.

The requirement for a catchment scale model has been outlined by the Environment Agency due to the location and number of WwTW discharges within the catchment, and in particular, their cumulative effect on ammonia, BOD and phosphate concentrations. The Environment Agency's SIMCAT model of the River Thames catchment has therefore been used to model phosphate and ammonia and BOD effects related to discharge at Basingstoke, Sherborne St John and Sherfield on Loddon WwTWs.

5.2.2 Discharge modelling

A standalone statistical based model (River Quality Planning, RQP) has been applied to Washwater WwTW, Kingsclere WwTW, Ashford Hill WwTW and Silchester WwTW which also require water quality modelling for phosphate and ammonia but are located outside of the River Loddon catchment.

The limited availability of river quality monitoring data for BOD within the relevant watercourses meant modelling for BOD could not be undertaken for Washwater, Kingsclere, Ashford Hill and Silchester WwTWs.

5.2.3 Load Standstill

A load standstill calculator has been used to determine the required BOD permit quality conditions in order to maintain the current quality of the discharge as flows increase. This has been applied for Washwater WwTW, Kingsclere WwTW, Ashford Hill WwTW and Silchester WwTW. The calculator does not require river quality or discharge quality monitoring data and is considered a suitable approach given the lack of available BOD river quality monitoring data in respect of these four WwTWs.

A load standstill calculator has also been used to determine the required ammonia, BOD and phosphate or TIN permit quality conditions in order to maintain the current quality of the discharge as flows increase for the WwTWs which discharge to ground. This has been applied for Whitchurch WwTW, Overton WwTW, Oakley WwTW, North Waltham WwTW. The same approach has also been used to determine the required permit quality conditions in order to maintain the current quality of the discharge as flows increase from potential growth within BDBC for Barton Stacey WwTW. This WwTW lies outside of the borough and while it would be possible to factor the planned growth within the catchment from Test Valley Borough Council (TVBC) into the water quality assessment, the situation at this WwTW is not as straight forward. It is reported that Southern Water and the Environment Agency are currently discussing a potential need to transfer effluent from another WwTW in TVBC to Barton Stacey WwTW. Since the capacity issues with the adjacent WwTW are outside of the study boundary these are outside of the scope of this WCS and therefore a simple load standstill water quality assessment approach was undertaken for this WwTW.

5.3 River Loddon Catchment Model

The River Loddon is one operational catchment within the River Thames river basin district. It is separated into eighteen WFD waterbody catchments each with its own status and target. The WFD waterbody catchments of relevance for the WwTW discharges within the River Loddon catchment include the Loddon (Basingstoke to River Lyde confluence at Hartley Wespall), Loddon (Hartley Wespall to Sherfield on Loddon), Bow Brook (Bramley to Sherfield Green) and Vyne Stream.

The WFD parameters of relevance to this model are ammonia, BOD and phosphate, however it is acknowledged that these sub-elements only make up part of the overall status classification for the River Loddon WFD waterbodies, and that there are other sub-elements (e.g. Fish, Dissolved Oxygen, etc.) which are the main cause for the alternative ‘overall waterbody target status’ as set by the Environment Agency.

The Loddon catchment water quality modelling has been reported on a subcatchment scale, but with reference made to the individual WwTWs throughout. The current environmental WFD baseline against which the modelling has been applied is detailed in Table 5-1. The status of each WFD catchment is derived from the latest published classifications (2019).

Table 5-1: River Loddon WFD Baseline (2019)

WFD Catchment	Type of status	Ammonia	BOD	Phosphate
Vyne Stream	Current	High	-	Poor
	Target (RBMP 2015)	Good by 2015	-	Poor by 2015
	Target (draft RBMP 2021)	No change	-	Good by 2027
Bow Brook (Bramley to Sherfield Green)	Current	High	-	Poor
	Target (RBMP 2015)	Good by 2015	-	Moderate by 2015
	Target (draft RBMP 2021)	No change	-	No change
Loddon (Basingstoke to River Lyde confluence at Hartley Wespall)	Current	High	High (2016)	High
	Target (RBMP 2015)	Good by 2015	Not specified	Good by 2015
	Target (draft RBMP 2021)	No change	-	No change
Loddon (Hartley Wespall to Sherfield on Loddon)	Current	High	-	Moderate
	Target (RBMP 2015)	Good by 2015	-	Moderate by 2015
	Target (draft RBMP 2021)	No change	-	Good by 2027

Note that observed phosphate data downloaded from the Environment Agency website (Appendix D) are consistent with Good existing status for phosphate in Bow Brook, in contrast with the Environment Agency classification of Poor as highlighted in Table 5-1. In order to avoid underestimating the impact of the WwTW discharges on water quality, the SIMCAT model has been calibrated using the existing observed data, and so the existing status of Bow Brook is taken to be Good in the following analysis, with a target of Good to reflect the non-deterioration principle.

The improved water quality in Bow Brook may be partly due to improved water quality in Vyne Stream following improvement works at Sherborne St John WwTW in 2020 and the imposition of a phosphate limit in the final treated effluent for this site of 0.6mg/l. The SIMCAT results discussed below indicate the Vyne Stream is now expected to be at Moderate status for phosphate, however there is a lack of sampling data on Vyne Stream to confirm this. For consistency with known data used in the SIMCAT modelling, the current status of Vyne Stream is considered to be Moderate for phosphate and the status target has been set at Good based on the draft 2021 RBMP. The non-deterioration target has been set at Moderate.

Details of the catchment model calibration have been provided in Appendix D. The Environment Agency's 2009 SIMCAT model of the River Loddon catchment has been used to model phosphate, ammonia and BOD effects related to discharge at Basingstoke WwTW, Sherborne St John WwTW and Sherfield on Loddon WwTW. The catchment model takes into account the increased discharges as a result of growth within the study area from the three WwTWs which discharge into the River Loddon, Bow Brook and Vyne Stream. The model also takes into account diffuse pollution from surrounding land (including urban runoff, agricultural run-off, etc.) as well as Combined Sewer Overflows (CSOs) and storm tank discharges.

The modelling scenarios undertaken are detailed in Table 5-2 below and Figure 5-1 shows the relevant area of the River Loddon catchment and WwTWs for which results are reported.

Table 5-2 SIMCAT Modelling Scenarios

Scenario	Description	Objective
2022 Baseline Scenario	SIMCAT model showing existing water quality in the River Loddon, based on Environment Agency water quality datasets[18] and NRFA river flow gauge data[19].	Updated SIMCAT model which assesses the impact of effluent flows from WwTW on water quality in the River Loddon using most recent river flow and water quality data
2039 Scenario 1	Model run to show the impacts of additional flows at WwTW in 2039 (growth scenario 1)	Assessment of impacts on future water quality in the River Loddon arising from increased development under growth scenario 1 (change from 2022 Baseline)
2039 Scenario 2	Model run to show the impacts of additional flows at WwTW in 2039 (growth scenario 2)	Assessment of impacts on future water quality in the River Loddon arising from increased development under growth scenario 2 (change from 2022 Baseline)
2039 Scenario 3	Model run to show the impacts of additional flows at WwTW in 2039 (growth scenario 3, option to divert some growth in the Sherborne St John catchment to the larger Basingstoke catchment)	Assessment of impacts on future water quality in the River Loddon arising from increased development under growth scenario 3 (change from 2022 Baseline). The objective of this run is to determine if transferring Sherborne St John flow to the larger WwTW is a better environmental solution.
Goal seek	Additional runs of Scenario 1, 2 and 3to determine future discharge consent requirements at WwTWs to achieve target status in the River Loddon, Vyne Stream and Bow Brook	Aligns with the WFD policy requirement to achieve good status in watercourses

[18] https://environment.data.gov.uk/water-quality/view/landing, data from 2015-2020 were used where available, otherwise the entire record from each data point was applied.
[19] https://nrfa.ceh.ac.uk/data/search, daily mean flow data were used to calculate the mean and Q_{95} flows

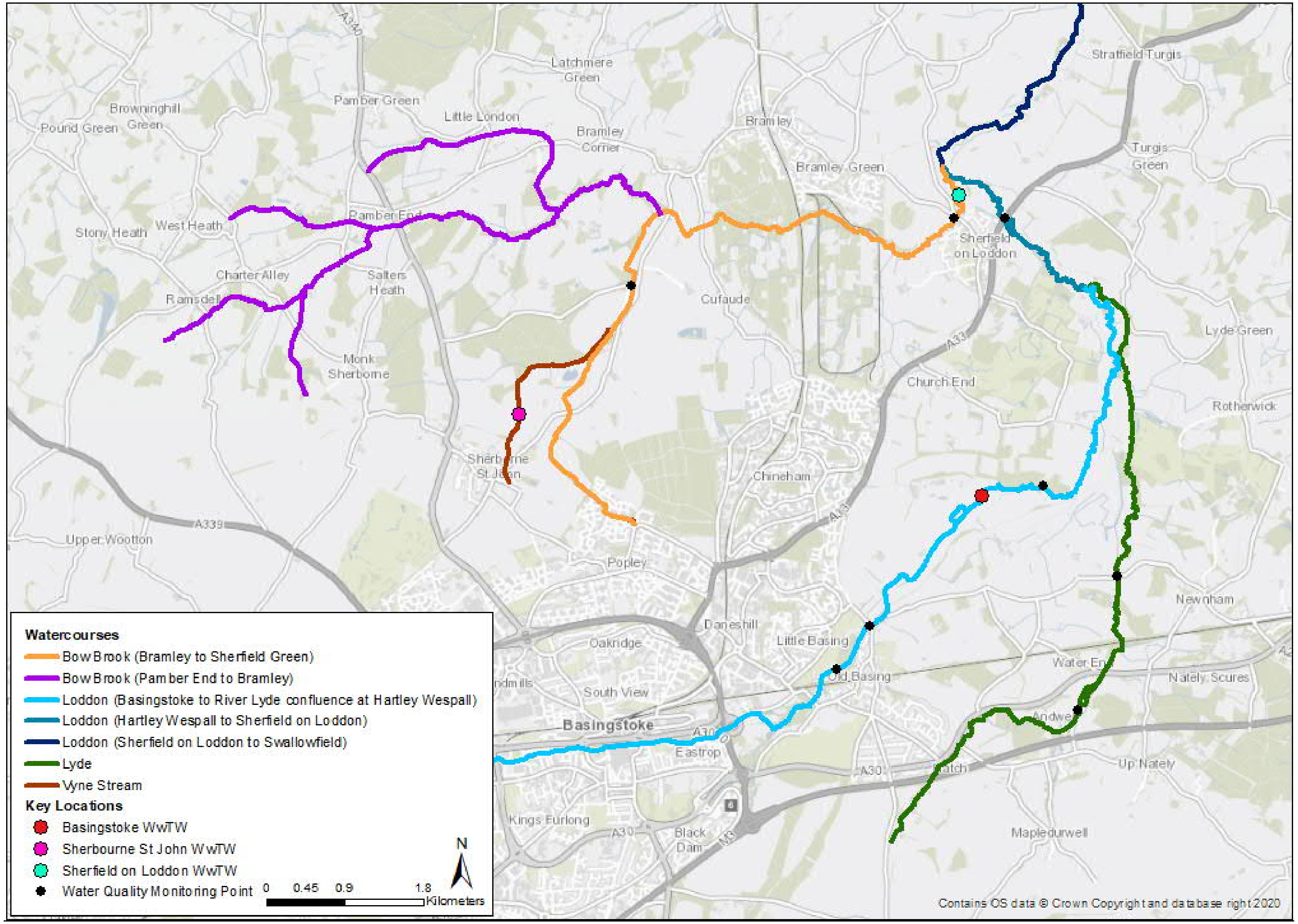


Figure 5-1: Watercourse and Key Location Schematic for SIMCAT Modelling

5.3.1 Baseline Scenario

Phosphate

Figure 5-2 shows the modelled mean phosphate concentrations along the River Loddon catchment for the baseline (2022) condition. The model shows that the current discharge from Sherborne St John WwTW results in a small increase in phosphate concentrations in Vyne Stream (0.07mg/l). Sherfield on Loddon WwTW has a more significant impact (0.19mg/l) and reduces water quality in Bow Brook from Good to Poor status with respect to phosphate. The phosphate discharged from Basingstoke WwTW increases modelled phosphate concentrations in the River Loddon by 0.18mg/l, reducing the status from High to Moderate.

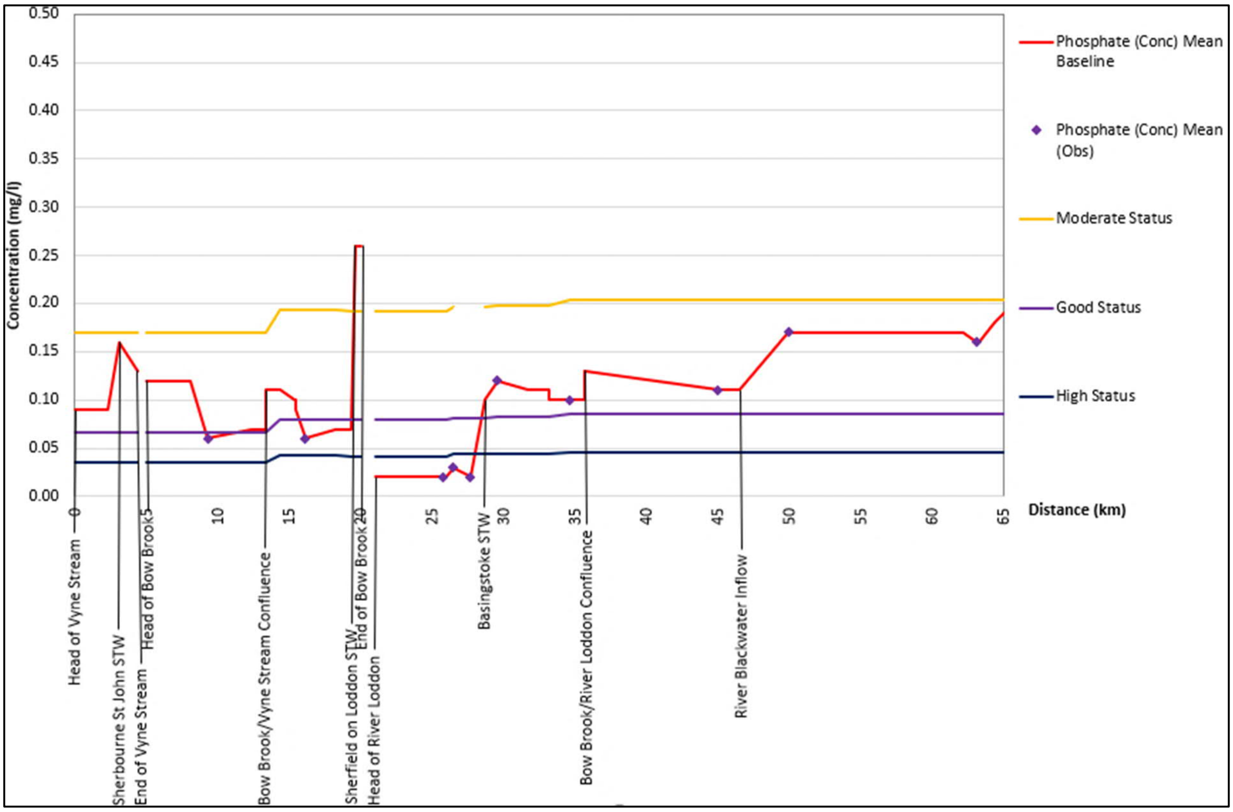


Figure 5-2: Modelled and Observed Mean Phosphate Concentrations in the River Loddon Catchment (with WwTW locations and WFD Water Quality Standards)

Ammonia and BOD

Figure 5-3 and Figure 5-4 show the modelled baseline impact of the WwTWs on ammonia and BOD concentrations. Basingstoke and Sherfield on Loddon WwTW discharges do not cause significant increase in ammonia concentrations in the receiving watercourses and cause only small, localised impact in terms of BOD concentrations. These impacts are not sufficient to impact the WFD status classification of Bow Brook or the River Loddon in terms of ammonia and BOD.

The SIMCAT model also shows that discharges from Sherborne St John WwTW increase ammonia concentrations in Vyne Stream by 0.19mg/l but this is not sufficient to reduce the status of Vyne Stream from High to Good with respect to ammonia. Discharges from Sherborne St John WwTW reduce 90%ile BOD concentrations in Vyne Stream, however this is because the model has very high initial 90%ile BOD concentrations in Vyne Stream upstream of the WwTW discharge. There are no observed data for this watercourse to enable checking of the actual ammonia and BOD concentrations upstream of Sherborne St John WwTW outfall so there is some uncertainty in the actual extent of the impacts of this discharge.

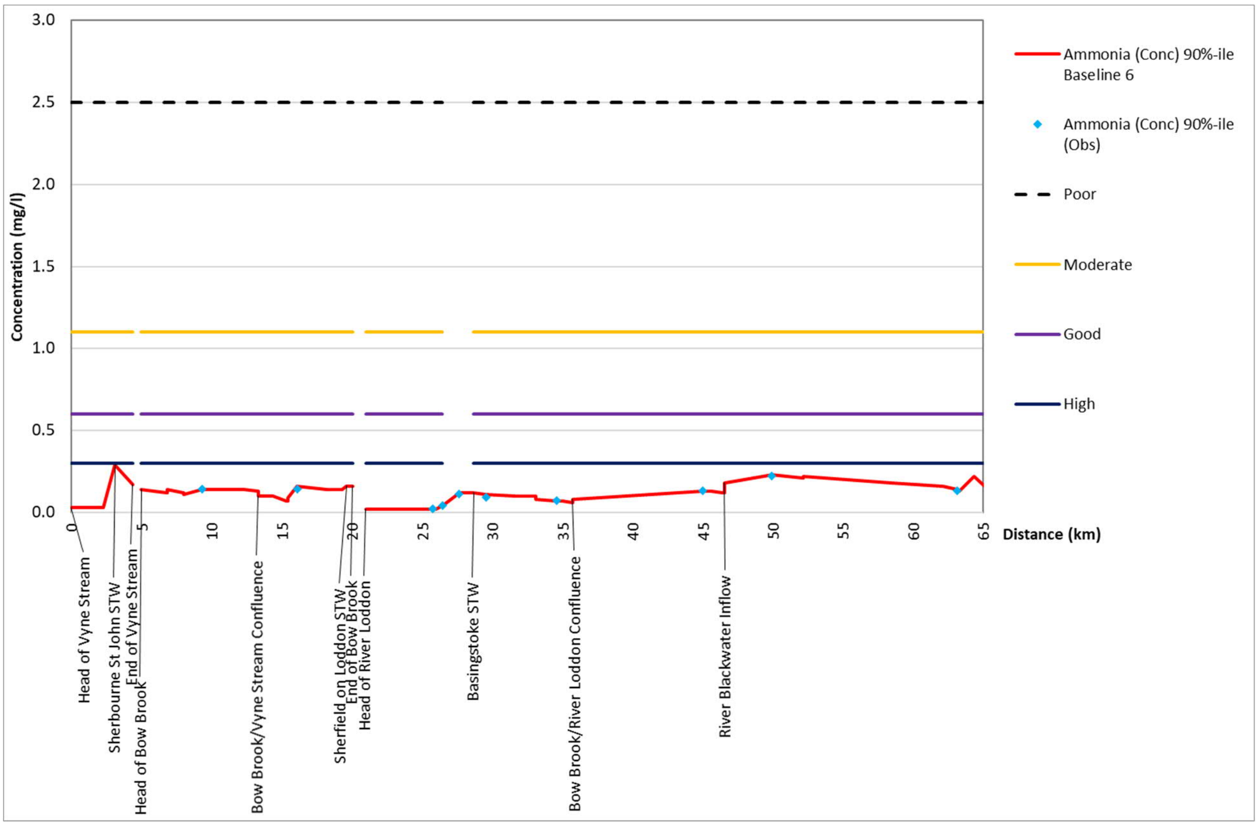


Figure 5-3: Modelled 90%ile Ammonia Concentrations in the River Loddon Catchment (with WwTW locations and WFD Water Quality Standards)

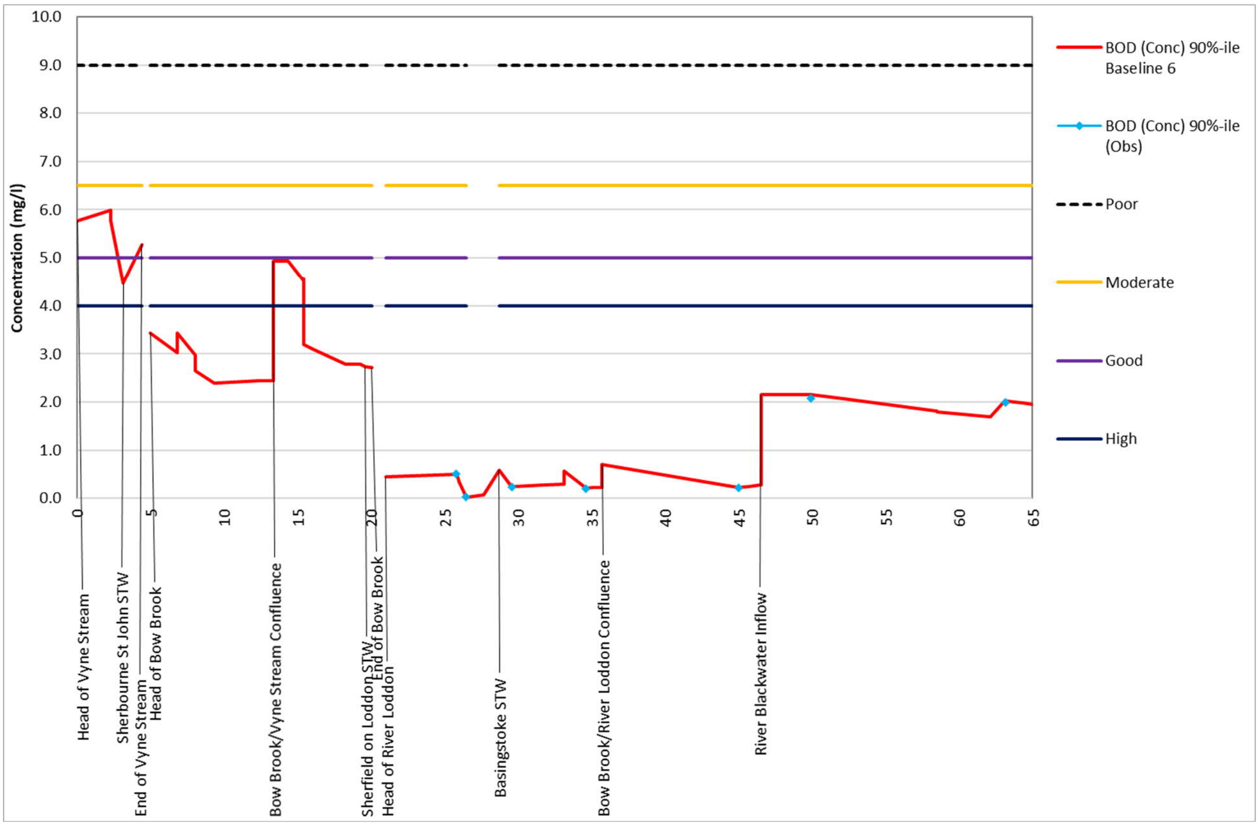


Figure 5-4: Modelled Mean and 90%ile BOD Concentrations in the River Loddon Catchment (with WwTW locations and WFD Water Quality Standards)

5.3.2 Future Discharges

No changes to the permitted limits for phosphate, BOD, ammonia or dry weather flow are expected in the AMP7 (2020 to 2025) for the three WwTWs considered in the SIMCAT modelling. The SIMCAT model has been run, as set out in Table 5-3, to determine the impacts of the proposed future development within the catchment on watercourse water quality.

The current discharge permit condition for each parameter is detailed in Table 5-4. It should be noted that the future water quality in the River Loddon downstream of the study area will also depend on future development in other tributary catchments, particularly in the Blackwater and Whitewater tributaries. These watercourses enter the Loddon downstream of the study area and are therefore excluded from the current assessment.

The SIMCAT model was run for three future development scenarios, as follows:

- Growth Scenario 1: Future development within Basingstoke and Deane Borough increase flows from Basingstoke WwTW by 24%, increase flows from Sherborne St John WwTW by 31% and increase flows from Sherfield on Loddon WwTW by 6%
- Growth Scenario 2: Future development within Basingstoke and Deane Borough increase flows from Basingstoke WwTW by 28%, increase flows from Sherborne St John WwTW by 31% and increase flows from Sherfield on Loddon WwTW by 38%
- Growth Scenario 3: Future development within Basingstoke and Deane Borough increase flows from Basingstoke WwTW by 28%, increase flows from Sherborne St John WwTW by 7% and increase flows from Sherfield on Loddon WwTW by 38%

The effluent flow rates from the WwTW are set out in Table 5-3 for each scenario. The full results of the SIMCAT modelling are set out in Appendix D.

Table 5-3: Future Flows from Loddon Catchment WwTWs used in Modelling

WwTW	Current Mean Flow (Ml/d)	Current Standard Deviation (Ml/d)	2039 Projected Mean Flow (Ml/d)			2039 Projected Standard Deviation (Ml/d)		
			Growth Scenario 1	Growth Scenario 2	Growth Scenario 3	Growth Scenario 1	Growth Scenario 2	Growth Scenario 3
Basingstoke	26.29	6.12	32.67	33.66	33.77	7.61	7.84	7.87
Sherborne St John	1.15	0.74	1.50	1.50	1.23	0.96	0.96	0.79
Sherfield on Loddon	1.66	0.67	1.77	2.30	2.30	0.71	0.93	0.93

Table 5-4: Current discharge permit condition for each parameter

WwTW	Phosphate (mean mg/l)	Ammonia (95%ile mg/l)	BOD (95%ile mg/l)
Basingstoke	0.5	1	10
Sherborne St John	0.6	10 – Winter 5 - Summer	8
Sherfield on Loddon	-	3	21

Phosphate – No Deterioration Future Scenario Modelling

Figure 5-5 compares the mean concentrations of phosphate along the River Loddon under the baseline scenario (red) and under growth scenario 1 (blue), growth scenario 2 (green) and growth scenario 3 (orange). The modelling shows that, under growth scenarios 2 and 3, there is an increase in phosphate concentrations downstream of Sherborne St John WwTW compared to the baseline, which results in a very localised reduction in status from Moderate to Poor at the discharge point in Vyne Stream, returning to Moderate status immediately downstream. There is no significant change in phosphate concentrations in Vyne Stream under growth scenario 3. It should be noted that the actual impacts of the increased discharge from Sherborne St John WwTW is uncertain due to the lack of sampling data with which to classify the status of the watercourse.

In order to determine whether the simulated potential phosphate impact associated with growth in the Sherborne St John WwTW catchment can be managed, a further model simulation was undertaken. This was undertaken to determine the permit limit which would need to be applied for phosphate at the WwTW in order to maintain moderate status as per the current discharge volumes. The results showed a permitted discharge limit of 0.35 mg/l would be required under growth scenarios 1 and 2, however a further tightening of phosphate emissions limits would not be required under growth scenario 3. The limit required under growth scenarios 1 and 2 is within the limits of conventional treatment, however, to determine whether this permit limit is actually required to prevent WFD status deterioration, monitoring of river quality up and downstream of the WwTW may be required.

The current discharge from Sherfield on Loddon WwTW reduces the status of a short section of Bow Brook from Good to Poor status, and slightly greater impact will be seen under the growth scenarios; this does not affect the overall status of the Bow Brook (Bramley to Sherfield Green) waterbody.

The modelled growth scenarios also result in a small increase in phosphate concentration in the River Loddon downstream of Basingstoke WwTW and the Bow Brook/River Loddon confluence (downstream of all three WwTW). The increase in phosphate concentration downstream in the River Loddon is small and there is no change in WFD status compared to the baseline.

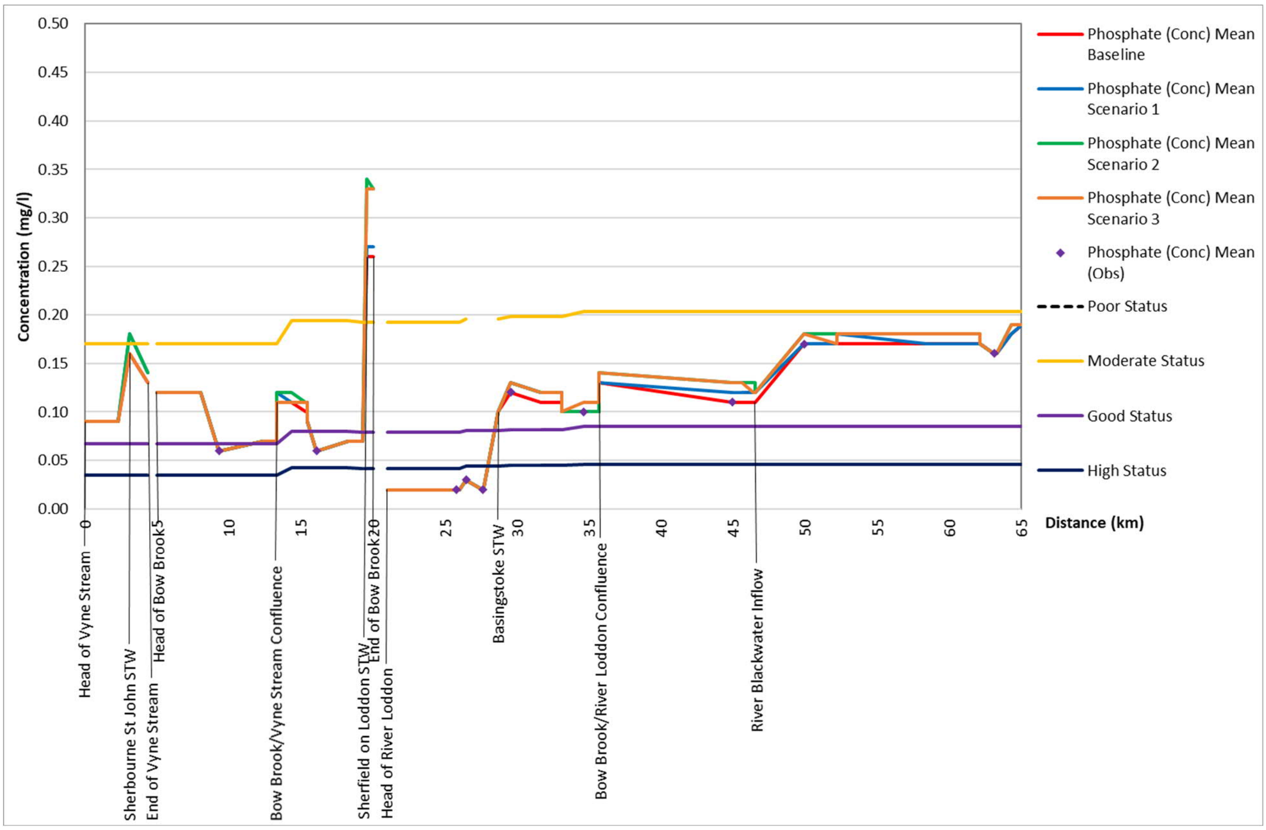


Figure 5-5: Modelled Mean Phosphate Concentrations in the River Loddon Catchment (Baseline and under Growth Scenarios)

Phosphate – future target status

The target status for phosphate in the receiving watercourses varies as discussed in Section 5.3:

- Vyne Stream = Good.

- Bow Brook = Good (2015 target is Moderate with no change in the draft 2027 target, but the current data show the status is already at Good for phosphate).
- River Loddon = Good (2015 target is Moderate).

The SIMCAT model has been run to determine the required effluent concentrations for phosphate in WwTW effluent which would achieve the target status in the receiving watercourses under the baseline and post-development scenarios. The results are summarised in Table 5-5. It is not possible to simulate an upstream Good Status in the SIMCAT model to fully test this scenario for Vyne Stream; results are therefore presented in Table 5-5 for the non-deterioration standard of Moderate. Water quality sampling upstream and downstream of Vyne Stream would be required to update the model, confirm the current status and the impacts of future WwTW discharges in terms of status classification and set appropriate future discharge limits, however this is outside the scope of this study.

Table 5-5: Results of SIMCAT Modelling of Required WwTW Phosphate Discharge Limits for Achieving Target Status

WwTW	Target Status	Target Mean Concentration (mg/l)	Required Discharge Limit – 2022 (mg/l)	Required Discharge Limit – Growth Scenario 1 (mg/l)	Required Discharge Limit – Growth Scenario 2 (mg/l)	Required Discharge Limit – Growth Scenario 3 (mg/l)
Sherborne St John	Moderate	0.17	**Current permit is sufficient**	**0.35**	**0.35**	**Current permit is sufficient**
Sherfield on Loddon	Good	0.08	**0.55**	**0.52**	**0.41**	**0.41**
Basingstoke	Good	0.08	**0.34**	**0.29**	**0.28**	**0.28**

These model runs have shown that the impact of future development on Vyne Stream could be largely offset by further reducing the discharge limits for phosphate from this site. Good status in Bow Brook could be achieved by limiting phosphate discharges from Sherfield on Loddon WwTW to 0.52mg/l under growth scenario 1 and 0.41mg/l under growth scenarios 2 and 3. Good status for the River Loddon can be achieved using current best treatment technology at Basingstoke WwTW and limiting phosphate concentrations in the final treated effluent to below 0.28mg/l under all future development scenarios.

Whilst the results presented show that based on growth scenario 3, no tightening of the current phosphate permit limit would be required at Sherborne St John WwTW, and the permit requirements at Basingstoke WwTW, which would receive the additional growth from Sherborne St John WwTW, would be the same as required under growth scenarios 1 and 2, additional infrastructure would likely be required to transfer flows to Basingstoke, which will incur additional costs and environmental impacts. As such, given the very minor impacts modelled for growth scenario 1 and 2, which shows the discharge does not alter the overall status of the waterbody (it is only shown at the point of discharge), and the uncertainty around the current status of the Vyne Stream due to lack of water quality monitoring, it is considered that growth scenarios 1 and 2 would provide a better environmental solution than transferring flows to Basingstoke WwTW.

Ammonia and BOD

Figure 5-6 and Figure 5-7 show the results of modelling the increased flows in terms of ammonia and BOD in the receiving watercourses. There are no significant differences in impact for either parameter under growth scenarios 1 to 3 and growth scenarios 1 and 2 show almost identical results.

Future development (for all three growth scenarios) does not significantly increase ammonia concentrations in either Bow Brook or the River Loddon downstream of Sherfield on Loddon or Basingstoke WwTW. Increased development upstream of Sherborne St John WwTW is shown to result in very small increases in ammonia concentrations in Vyne Stream. This has the effect of reducing the status of the watercourse locally at the discharge point from High to Good status following development under growth scenarios 1 and 2, although the watercourse returns to High status immediately downstream and there is no impact on Bow Brook downstream; there is no impact shown for growth scenario 3. The minor impact for growth scenario 1 and 2 would not alter the overall status of the waterbody as the minor impact is only shown at the point of discharge. Therefore, none of the growth scenarios are likely to result in WFD status deterioration.

The proposed development results in a slight lowering (i.e. improvement) of modelled BOD concentrations in Vyne Stream and Bow Brook.

There is no water quality monitoring data available for Vyne Stream to determine the current upstream water quality and WFD status which limits the conclusions which can be drawn for Sherborne St John WwTW. However, based on the modelling undertaken for ammonia and BOD, future development is not expected to have adverse impacts on any parameters for the Vyne Stream and is unlikely to change current WFD status or limit future status from being achieved. Water quality monitoring would be needed to confirm actual upstream ammonia and BOD concentrations in Vyne Stream to allow a full assessment of the impacts of WwTW discharges and identify the potential for WFD status change, but such work is outside the scope of this study.

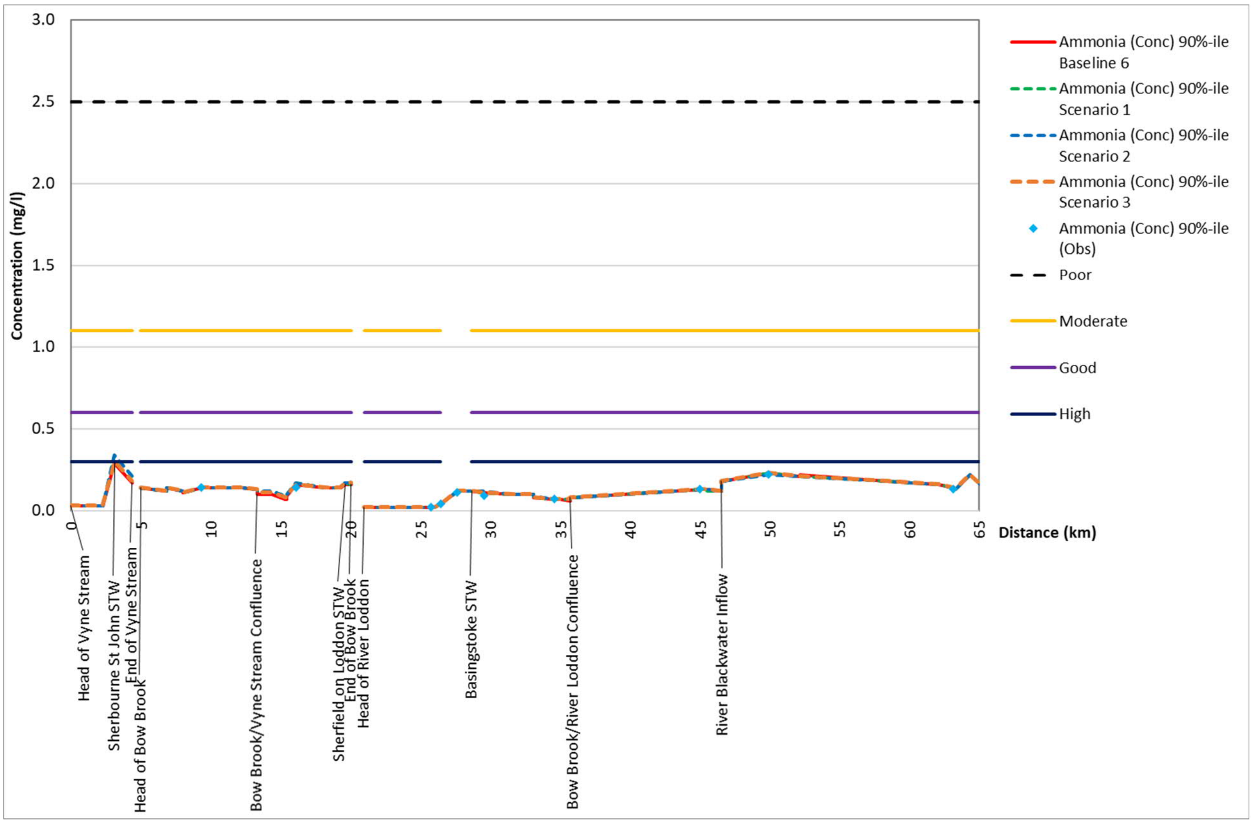


Figure 5-6: Modelled 90%ile Ammonia Concentrations in the River Loddon Catchment (Baseline and under Growth Scenarios)

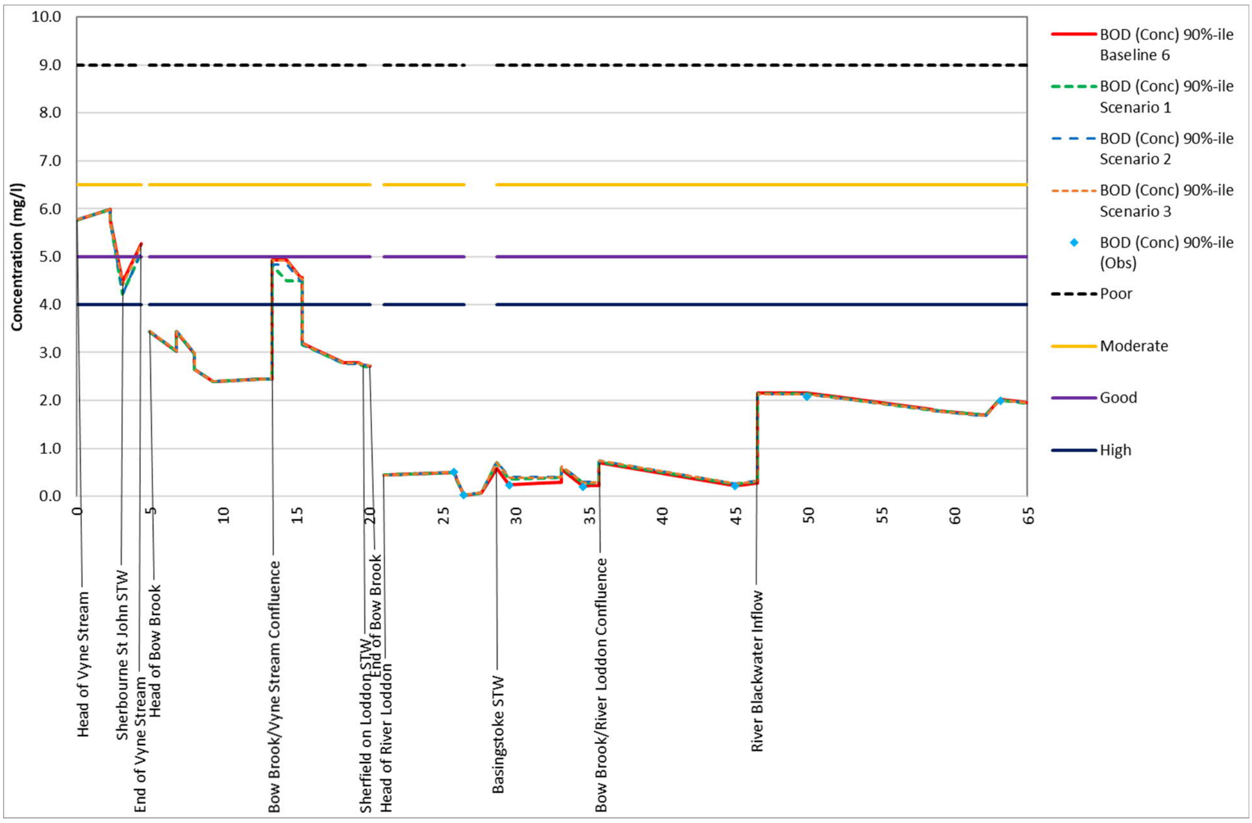


Figure 5-7: Modelled 90%ile BOD Concentrations in the River Loddon Catchment (Baseline and under Development Scenarios)

5.3.3 SIMCAT Modelling Summary

The results of the modelling of discharges from Basingstoke WwTW, Sherfield on Loddon WwTW and Sherborne St John WwTW have shown that there is sufficient permitted headroom to accept, treat and discharge the expected additional volume of wastewater resulting from the proposed growth in these WwTW catchments by the end of the plan period.

For Bow Brook and the River Loddon, proposed development would result in a slight increase in modelled watercourse phosphate concentrations compared to the current baseline as a result of the additional discharges from WwTW in the catchment but there would be no deterioration in WFD status classification for phosphate, ammonia or BOD beyond the existing baseline conditions.

For the Vyne Stream, proposed development would result in a slight and very localised increase in modelled watercourse phosphate and ammonia concentrations under Growth Scenarios 1 and 2 but would be unlikely to alter status at the waterbody level. There would be no discernible impacts under Growth Scenario 3. The localised change in status at the discharge point for phosphate could be managed by the imposition of a new permit limit within the limits of conventional treatment at Sherborne St John WwTW if required, though this is unlikely as only a very small, localised section of the watercourse would be impacted.

WwTW discharges to receiving watercourses are controlled by a combination of licenced discharge limits and the limits of treatment technology. Future discharge limits which would assist in achieving target WFD status in the receiving watercourses have been modelled for phosphate and the results are summarised for each WwTW as follows:

- Sherborne St John WwTW: SIMCAT modelling has shown that tthe draft RBMP target status of Good for phosphate in Vyne Stream cannot be achieved because the model assumes Moderate status upstream of the discharge point. Based on the assumed upstream water quality, Moderate status could be maintained at the point of discharge after development by reducing the permit limit for phosphate to 0.35mg/l, which is achievable within the limits of conventional treatment.
- Sherfield on Loddon WwTW: The impact of this discharge is significant, as there is currently no phosphate limit in place, although it only affects a short section of Bow Brook. The current

discharge reduces the status of Bow Brook from Good to Poor downstream of the outfall, and this impact will be slightly exacerbated following development. A phosphate limit of 0.52mg/l in final treated effluent would be required to maintain Good status under future growth Scenario 1, and 0.41mg/l under Scenarios 2 and 3; these limits would be achievable using current treatment technologies.

- Basingstoke WwTW: The impact of the existing discharge is significant, reducing the status of the River Loddon from High to Moderate with respect to phosphate against a target status of Good. However, the current impact and additional impact of future development could be reduced to allow Good status to be achieved in the River Loddon using best available technology to restrict phosphate discharges to below 0.28mg/l.

5.4 Discharge Modelling

For WwTWs outside of the Loddon catchment, statistical based water quality modelling using RQP has been undertaken. This modelling takes account of the increased wastewater flows from the proposed development until 2039(using the worst-case growth scenario) to determine if there is a need for new or revised quality conditions for ammonia and phosphate.

To assess environmental capacity, modelling scenarios have been developed in line with the objectives listed in Section 5.1.1 in order to assess infrastructure capacity, environmental capacity and ensure compliance with water quality objectives. The modelling scenarios are:

- Limiting deterioration to 10% of current river quality for each physico-chemical sub-element (where technically and economically feasible),
- Ensuring no deterioration in status for each sub-element,
- Achieving the future target status for each sub-element, and
- Maintaining the current discharge quality.

Further details on the modelling scenarios and detailed summary of the results are provided in Appendix E.

5.4.1 Washwater WwTW

The headroom assessment has demonstrated that Washwater WwTW currently has sufficient flow headroom in its existing discharge permit and can accept all proposed development without exceeding the existing discharge permit. However, there is a risk that if the WwTW were to be operated to its full permitted flow, this could potentially lead to a significant deterioration in water quality and possibly WFD status.

Additional flow headroom is therefore not required at this WwTW, however, to ensure that the quantity of growth proposed within the WwTW catchment does not impact on downstream water quality objectives, revised quality conditions are likely to be required before all growth is connected. The following assessment and calculated values have been based on the growth scenario which would see the greatest quantity of development within the WwTW catchment (both growth scenarios result in the same level of growth).

Environmental Baseline

The River Enborne (downstream A34 to Burghclere) receives treated effluent from Washwater WwTW (via Pound Street Brook) and currently has an overall waterbody status of Moderate with the alternative objective to maintain Moderate status by 2015[20]. Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 5-6. It should be noted that there are no proposed changes to these objectives reported in the draft Thames RBMP (2021).

[20] RBMP3 are scheduled to be published by the Environment Agency in 2021 but at the time of writing this WCS they were not available.

Table 5-6: Classification elements of less than Good status for the River Enborne (downstream A34 to Burghclere)

Classification Element	Current Status (2019)	Objective	Justification for alternative objective
Dissolved Oxygen	Moderate	Good by 2015	Not applicable
Phosphate	Poor	Poor by 2015	Unfavourable balance of costs and benefits

The Reasons for Not Achieving Good (RNAG) for the dissolved oxygen and phosphate elements, as identified on the Environment Agency's Catchment Data Explorer (January 2022), relevant to the River Enborne (downstream A34 to Burghclere) waterbody have been provided in Table 5-7 below.

Table 5-7: Reasons for not achieving good status on the River Enborne (downstream A34 to Burghclere) waterbody

Category	Activity[21]	Activity Certainty	Classification Element
No sector responsible	Natural conditions	Suspected	Dissolved Oxygen
Water Industry	Sewage discharge (continuous)	Probable	
Agriculture and rural land management	Poor livestock management	Suspected	Phosphate
Water Industry	Sewage discharge (continuous)	Suspected	

Revised Permit Conditions – Modelling Results

To assess the impact of the additional discharge on water quality in the River Enborne (downstream A34 to Burghclere), and to determine the required quality conditions on the discharge, RQP runs have been completed for Washwater WwTW covering the scenarios set out in Section 5.1.1.

The revised discharge permit quality conditions required by the end of the plan period for each determinant for each modelled scenario are presented in Table 5.8 and a summary discussion of the water quality results is provided in Table 5-9.

Table 5-8: Required permit quality conditions for Washwater WWTW by the end of the plan period

Determinant	Current WFD Status (2015)	Current permit quality condition (mg/l)	Future Permit conditions required (mg/l)			
			Limit to 10% deterioration	No deterioration in status	Maintain current quality	Achieve Future Target Status
Ammonia (mg/l 95%ile	High	5	5.99	N/A	5.44	N/A
Phosphate (mg/l annual average)	Poor	-	4.46	1.18	4.03	1.18

[21] Where an element is classified as being at less than good status an assessment is needed of the measures that could be taken to improve the status to good. In order to identify appropriate measures it is first necessary to understand the cause of the failure and this is recorded using a defined set of reasons within the RBMP.

Table 5-9: Required permit quality conditions for Washwater WWTW by the end of the plan period

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 832 m^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 new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	Possibly	The results indicate that no changes are required to the existing permit condition for Ammonia. There is no current permit condition for Phosphate but the results indicate that if one were required it is possible that the objectives of WFD could be achieved within the limits of conventional treatment considering the impact of future growth.
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	Yes	Limiting the deterioration to 10% can be achieved for Ammonia with no required changes to the existing permit condition.
	Yes	Phosphate permit condition of 4.46 mg/l will need to be applied and is achievable within limits of conventional treatment.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	**N/A**	Simulations for Ammonia were undertaken for this test but this demonstrated that it is not technically feasible to achieve the current waterbody status at the point of mixing under current discharge volumes (i.e. no growth), therefore, the "No Deterioration" test could not be applied using the RQP software at the point of mixing. As a conservative measure, the Maintain Current Quality test (see Criteria 3c below) has been applied.
	Yes	'No deterioration' can be achieved for Phosphate with a permit condition of 1.18 mg/l and is achievable within limits of conventional treatment.
c. Where 'no deterioration' cannot be achieved (or the test cannot be applied using RQP), can the current river quality be maintained after growth with current conventional treatment technology?	Yes	Current river quality can be achieved for Ammonia with no required changes to the existing permit condition.
	Yes	Current river quality can be achieved for Phosphate with a permit condition of 4.03 mg/l and is achievable within limits of conventional treatment.
d. Will growth prevent the future status targets from being achieved?	**Not Assessed**	Ammonia is already at High status – therefore ensuring no deterioration is adequate. Phosphate is at Poor status and the future status target is Poor for this element – 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?	**No**	Washwater WwTW is located on a tributary of the River Enborne with no other significant WwTW discharges upstream.
5. Are WwTW infrastructure upgrades required?	**Potentially**	If needed, the exact technical specification of the upgrades required should be determined by TWUL for the AMP8 (2025 – 2030) asset planning period,

Assessment Criteria	Yes / No	Additional Comments
		in line with revised quality conditions for 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 next Business Plan.

5.4.2 Kingsclere WwTW

The headroom assessment has demonstrated that Kingsclere WwTW currently has sufficient flow headroom in its existing discharge permit and can accept all proposed development without exceeding the existing discharge permit. However, there is a risk that if the WwTW were to be operated to its full permitted flow, this could potentially lead to a significant deterioration in water quality and possibly WFD status.

Additional flow headroom is therefore not required at this WwTW, however, to ensure that the significant quantity of growth proposed within the WwTW catchment does not impact on downstream water quality objectives, revised quality conditions are likely to be required before all growth is connected. The following assessment and calculated values have been based on the growth scenario which would see the greatest quantity of development within the WwTW catchment (growth scenario 2).

Environmental Baseline

The Kingsclere Brook (Source to Enborne) receives treated effluent from Kingsclere WwTW and currently has an overall waterbody status of Moderate with the alternative objective to maintain Moderate status by 2015. Its current overall status is limited to Moderate due to the less than Good status classification of phosphate which has a current status of Poor with an alternative objective of Poor by 2015 justified by 'unfavourable balance of costs and benefits'. It should be noted that there is no change proposed to this objective reported in the draft Thames RBMP (2021).

The Reasons for Not Achieving Good (RNAG) for the phosphate element, as identified on the Environment Agency's Catchment Data Explorer (January 2022), relevant to the Kingsclere Brook (Source to Enborne) waterbody is suspected continuous sewage discharge resulting from the water industry.

Revised Permit Conditions – Modelling Results

To assess the impact of the additional discharge on water quality in Kingsclere Brook (Source to Enborne), and to determine the required quality conditions on the discharge, RQP runs have been completed for Kingsclere WwTW covering the scenarios set out in Section 5.1.1.

The revised discharge permit quality conditions required by the end of the plan period for each determinant for each modelled scenario are presented in Table 5-10 and a summary discussion of the water quality results is provided in Table 5-11.

Table 5-10: Required permit quality conditions for Kingsclere WWTW by the end of the plan period

Determinant	Current WFD Status (2019)	Current permit quality condition (mg/l)	Future Permit conditions required (mg/l)			
			Limit to 10% deterioration	No deterioration in status	Maintain current quality	Achieve Future Target Status
Ammonia (mg/l 95%ile	High	4	3.86	2.04	3.45	N/A
Phosphate (mg/l annual average)	Poor	-	4.76	3.84	3.96	3.84

Table 5-11: Required permit quality conditions for Kingsclere WWTW by the end of the plan period

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 345 m^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 new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	Yes	The results indicate that changes may be required to the existing permit condition for Ammonia. There is no current permit condition for Phosphate but the results indicate that if one were required it is possible that the objectives of WFD could be achieved within the limits of conventional treatment considering the impact of future growth.
a. Can deterioration be limited to 10% based on the current river quality after growth with current conventional treatment technology?	Yes	Ammonia permit condition of 3.86 mg/l will need to be applied and is achievable within limits of conventional treatment.
	Yes	Phosphate permit condition of 4.76 mg/l will need to be applied and is achievable within limits of conventional treatment.
b. Can the WFD objective of 'no deterioration' be achieved after growth with current conventional treatment technology?	Yes	'No deterioration' can be achieved for Ammonia with a permit condition of 2.04 mg/l and is achievable within limits of conventional treatment.
	Yes	'No deterioration' can be achieved for Phosphate with a permit condition of 3.84 mg/l and is achievable within limits of conventional treatment.
c. Where 'no deterioration' cannot be achieved (or the test cannot be applied using RQP), can the current river quality be maintained after growth with current conventional treatment technology?	N/A	'No deterioration' can be achieved within limits of conventional treatment for Ammonia and Phosphate (see Criteria 3b above).
d. Will growth prevent the future status targets from being achieved?	Not Assessed	Ammonia is already at High status – therefore ensuring no deterioration is adequate. Phosphate is at Poor status and the future status target is Poor – 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?	No	Kingsclere WwTW is located on Kingsclere Brook with no other significant WwTW discharges upstream.
5. Are WwTW infrastructure upgrades required?	Potentially	If needed, the exact technical specification of the upgrades required should be determined by TWUL for the AMP8 (2025 – 2030) asset planning period, in line with revised quality conditions for Ammonia 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 next Business Plan.

5.4.3 Ashford Hill WwTW

The headroom assessment has demonstrated that Ashford Hill WwTW would not have sufficient headroom in its existing discharge permit once all the growth within the catchment is accounted for. To ensure that the quantity of growth proposed within the WwTW catchment does not impact on downstream water quality objectives, revised quality conditions are likely to be required before all growth is connected. The following assessment and calculated values have been based on the growth scenario which would see the greatest quantity of development within the WwTW catchment (both growth scenarios result in the same level of growth).

Environmental Baseline

Baughurst Brook receives treated effluent from Ashford Hill WwTW and currently has an overall waterbody status of Moderate with the objective of achieving Good Potential by 2027. Its current overall status is limited to Moderate due to the less than Good status classification of Macrophytes and Phytobenthos Combined which has a current status of Moderate. It is noted that an alternative objective of Good by 2027 is reported in the draft Thames RBMP (2021). The Reasons for Not Achieving Good (RNAG) for the Macrophytes and Phytobenthos Combined element, as identified on the Environment Agency's Catchment Data Explorer (January 2022), is detailed as 'suspect data'.

Revised Permit Conditions – Modelling Results

To assess the impact of the additional discharge on water quality in Baughurst Brook, and to determine the required quality conditions on the discharge, RQP runs have been completed for Ashford Hill WwTW covering the scenarios set out in Section 5.1.1.

The revised discharge permit quality conditions required by the end of the plan period for each determinant for each modelled scenario are presented in Table 5-13 and a summary discussion of the water quality results is provided in Table 5-14.

Table 5-12: Required permit quality conditions for Ashford Hill WWTW by the end of the plan period

Determinant	Current WFD Status (2019)	Current permit quality condition (mg/l)	Future Permit conditions required (mg/l)			
			Limit to 10% deterioration	No deterioration in status	Maintain current quality	Achieve Future Target Status
Ammonia (mg/l 95%ile	High	-	8.48	3.10	7.47	N/A
Phosphate (mg/l annual average)	Good	-	5.73	0.28	5.14	N/A

Table 5-13: Required permit quality conditions for Ashford Hill WWTW by the end of the plan period

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 11 m^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 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 of 8.48 mg/l will need to be applied and is achievable within limits of conventional treatment.
	Yes	Phosphate permit condition of 5.73 mg/l will need to be applied and is achievable within limits of conventional treatment.
b. Can the WFD objective of ‘no deterioration’ be achieved after growth with current conventional treatment technology?	**Yes**	‘No deterioration’ can be achieved for Ammonia with a permit condition of 3.10 mg/l and is achievable within limits of conventional treatment.
	Yes	‘No deterioration’ can be achieved for Phosphate with a permit condition of 0.28 mg/l and is achievable within limits of conventional treatment.
c. Where ‘no deterioration’ cannot be achieved (or the test cannot be applied using RQP), can the current river quality be maintained after growth with current conventional treatment technology?	**N/A**	‘No deterioration’ can be achieved within limits of conventional treatment for Ammonia and Phosphate (see Criteria 3b above).
d. Will growth prevent the future status targets from being achieved?	**Not Assessed**	Ammonia is already at High status – therefore ensuring no deterioration is adequate. Phosphate is already at Good 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?	**No**	Ashford Hill WwTW is located on Baughurst 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 AMP8 (2025 – 2030) asset planning period, in line with revised quality conditions for Ammonia 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 next Business Plan.

5.4.4 Silchester WwTW

The headroom assessment has demonstrated that Silchester WwTW currently has sufficient flow headroom in its existing discharge permit and can accept all proposed development without exceeding the existing discharge permit. However, there is a risk that if the WwTW were to be operated to its full permitted flow, this could potentially lead to a significant deterioration in water quality and possibly WFD status.

Additional flow headroom is therefore not required at this WwTW, however, to ensure that the significant quantity of growth proposed within the WwTW catchment does not impact on downstream water quality objectives, revised quality conditions are likely to be required before all growth is connected. The following assessment and calculated values have been based on the growth scenario which would see the greatest quantity of development within the WwTW catchment (both growth scenarios result in the same level of growth).

Environmental Baseline

The Silchester Brook receives treated effluent from Silchester WwTW and currently has an overall waterbody status of Moderate with the alternative objective to maintain Moderate status by 2015. Its current overall status is limited to Moderate due to the less than Good status classification of the elements listed in Table 5-15. It should be noted that there are no proposed changes to these objectives reported in the draft Thames RBMP (2021).

Table 5-14: Classification elements of less than Good status for the Silchester Brook

Classification Element	Current Status (2019)	Objective	Justification for alternative objective
Macrophytes and Phytobenthos Combined	Moderate	Moderate by 2015	No known technical solution is available
Dissolved Oxygen	Moderate	Good by 2015	
Phosphate	Poor	Poor by 2015	No known technical solution is available

The Reasons for Not Achieving Good (RNAG) for the Macrophytes and Phytobenthos Combined and phosphate elements, as identified on the Environment Agency's Catchment Data Explorer (January 2022), relevant to the Silchester Brook waterbody have been provided in Table 5-16 below.

Table 5-15: Reasons for not achieving good status on the Silchester Brook

Category	Activity	Activity Certainty	Classification Element
Water Industry	Sewage discharge (continuous)	Confirmed	Macrophytes and Phytobenthos Combined
Water Industry	Sewage discharge (continuous)	Probable	Dissolved Oxygen
Sector under investigation	Sewage discharge (intermittent)	Probable	
No sector responsible	Private Sewage Treatment	Probable	
Water Industry	Sewage discharge (continuous)	Confirmed	Phosphate
Sector under investigation	Sewage discharge (intermittent)	Probable	

Revised Permit Conditions – Modelling Results

To assess the impact of the additional discharge on water quality in Silchester Brook, and to determine the required quality conditions on the discharge, RQP runs have been completed for Silchester WwTW covering the scenarios set out in Section 5.1.1.

The revised discharge permit quality conditions required by the end of the plan period for each determinant for each modelled scenario are presented in Table 5-17 and a summary discussion of the water quality results is provided in Table 5-18.

Table 5-16: Required permit quality conditions for Silchester WWTW by the end of the plan period

Determinant	Current WFD Status (2019)	Current permit quality condition (mg/l)	Future Permit conditions required (mg/l)			
			Limit to 10% deterioration	No deterioration in status	Maintain current quality	Achieve Future Target Status
Ammonia (mg/l 95%ile	Good	5	2.29	1.07	2.06	N/A
Phosphate (mg/l annual average)	Poor	2	1.45	1.76	1.31	N/A

Table 5-17: Required permit quality conditions for Silchester WWTW by the end of the plan period

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 3,066 m^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 a new discharge permit would need to be altered compared to the current discharge permit and treatment process upgrades required?	Yes	The results indicate that changes may be required to the existing permit condition for Ammonia and Phosphate.
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 2.29 mg/l and is achievable within limits of conventional treatment.
	Yes	Phosphate permit condition will need to be tightened from 2 mg/l to 1.45 mg/l and is achievable within limits of conventional treatment.
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 5 mg/l to 1.07 mg/l and is achievable within limits of conventional treatment.
	Yes	Phosphate permit condition will need to be tightened from 2 mg/l to 1.76 mg/l and is achievable within limits of conventional treatment.
c. Where 'no deterioration' cannot be achieved (or the test cannot be applied using RQP), can the current river quality be maintained after growth with current conventional treatment technology?	**N/A**	'No deterioration' can be achieved within limits of conventional treatment for Ammonia and Phosphate (see Criteria 3b above).
d. Will growth prevent the future status targets from being achieved?	**Not Assessed**	Ammonia is already at High status – therefore ensuring no deterioration is adequate.

Assessment Criteria	Yes / No	Additional Comments
		Phosphate is at Poor status and the future status target is Poor – 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?	**No**	Silchester WwTW is located on a tributary of the River Kennet 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 AMP8 (2025 – 2030) asset planning period, in line with revised quality conditions for Ammonia 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 next Business Plan.

5.5 Load standstill calculations

5.5.1 Results - BOD

Load standstill calculations have been applied to the future discharge flow predicted by 2039(using the worst-case growth scenario) to determine the quality condition required to maintain the current BOD quality at Washwater WwTW, Kingsclere WwTW, Ashford Hill WwTW and Silchester WwTW (Table 5-19).

Table 5-18: Required BOD permit quality conditions for Washwater, Kingsclere, Ashford Hill and Silchester WwTWs

WwTW	Current discharge permit quality for BOD (95%ile mg/l)	Future discharge permit quality for BOD (95%ile mg/l)
Washwater	16	**15.6**
Kingsclere	12	**8.9**
Ashford Hill	30	**15.9**
Silchester	7	**6.2**

The results show that a revised (tighter) BOD quality condition would be required to maintain the current quality of the discharge at each of the WwTWs. However, these tighter BOD quality conditions for each of the WwTWs can be achieved with current conventional treatment technology (within the limits of conventional treatment), ensuring the current BOD quality within the respective receiving waterbodies is maintained and therefore ensuring no deterioration in status.

5.5.2 Results – WwTWs discharging to ground

Load standstill calculations have been applied to the future discharge flow predicted by 2039(using the worst-case growth scenario) to determine the quality conditions required to maintain the current ammonia, BOD and phosphate or Total Inorganic Nitrogen (TIN) quality at the WwTWs which discharge to ground. These include Whitchurch WwTW, Overton WwTW, Oakley WwTW and North Waltham WwTW (Table 5-20).

Table 5-19: Required permit quality conditions for Whitchurch, Overton, Oakley, North Waltham and Barton Stacey WwTWs

WwTW	Determinand	Current discharge permit quality (95%ile mg/l for Ammonia & BOD; mean mg/l for Phosphate and Total Inorganic Nitrogen)	Future (2039) discharge permit quality (95%ile mg/l for Ammonia & BOD; mean mg/l for Phosphate)
Whitchurch	Ammonia	5	2.7
	TIN	32	17.2
	BOD	40	21.5
	Phosphate	-	-
Overton	Ammonia	5	4.0
	TIN	-	-
	BOD	40	32.1
	Phosphate	1	0.8
Oakley	Ammonia	5	3.1
	TIN	35	21.4
	BOD	40	24.4
	Phosphate	-	-
North Waltham	Ammonia	5	2.0
	TIN	20	8.1
	BOD	40	16.2
	Phosphate	-	-
Barton Stacey	Ammonia	3	2.9
	BOD	15	14.4
	Phosphate	0.5 (by 2025)	0.48

Revised Permit Conditions – Ammonia and BOD

The results show that a revised (tighter) ammonia and BOD quality condition would be required to maintain the current quality of the discharge at each of the WwTWs. However, these tighter quality conditions for each of the WwTWs can be achieved with current conventional treatment technology (within the limits of conventional treatment), ensuring the current quality is maintained.

Revised Permit Conditions – Phosphate

Revised (tighter) phosphate quality condition would be required to maintain the current quality of the discharge at Overton and Barton Stacey WwTWs. However, these tighter phosphate quality conditions for these WwTWs can also be achieved with current conventional treatment technology (within the limits of conventional treatment).

Revised Permit Conditions – TIN

The results show that a revised (tighter) TIN quality condition would be required to maintain the current quality of the discharge at Whitchurch, Oakley and North Waltham WwTWs. Southern Water provided the following information in January 2022 in respect of the revised permit conditions for TIN:

"Oakley WwTW is a filter works mainly and is marginal against the current TIN permit. North Waltham WwTW has more headroom on TIN as it is converted from a filter works to Submerged Aerated Filters in AMP5. Whitchurch WwTW is still a filter works but can comfortably meet the current permit of TIN.

The ability of a site to meet its TIN permit is both affected by the magnitude of the permit and by the strength of sewage (Nitrogen to Chemical Oxygen Demand ratio). Making small modifications each time just to meet the new TIN permit based on a load standstill may not be possible, or not as cost effective as a more permanent solution, i.e. to install a purpose built oxidation ditch, like Shipton Bellenger. This will guarantee TIN less than 9 mg/l or lower.

The three WwTW sites are not big, all discharge to underground strata, and an oxidation ditch will also improve other determinands such as BOD, COD and TSS which would protect the underground water resources better. A future business case by Southern Water to OFWAT would be needed to secure this as a longer term investment".

The Environment Agency determine the permit required to meet regulatory compliance and inform the scope of Southern Water upgrades.

5.6 Ecological Appraisal

The Habitats Regulations can, by the requirement to ensure no detrimental impact on designated sites, require site specific water quality targets which in turn require restrictions on discharges to (or abstractions from) water dependent habitats that could be impacted by anthropogenic manipulation of the water environment. Given this requirement, a Habitats Regulations Assessment (HRA) screening exercise has been undertaken in this WCS to ensure that Habitats Directive and Birds 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 sites designated at a non-European level, including Sites of Special Scientific Interest (SSSI) and Local Nature Reserves (LNRs). This assessment is reported in the following paragraphs.

The scope of this WCS does not include a full HRA covering all likely significant effects on Habitats or Birds Directive sites; however, the findings of this ecological appraisal and the supporting water quality modelling can feed into the HRA and Strategic Environmental Appraisal (SEA) of the Local Plan. 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.

5.6.1 Impact on Designated Sites

The receiving watercourses for those WwTWs assessed in Sections 5.3 – 5.5 were traced downstream from the WwTWs discharge locations. Where a receiving watercourse enters, or passes adjacent to, a statutory designated wildlife site that has potential to be vulnerable to changes in hydrology and water quality (based on its interest features, hydrological dependency and underlying geology), these are identified and discussed in the following section. Where available, reasons for designation of the wildlife sites have been gathered primarily from the following sources:

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

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 precautionary measure. This approach also allows for those sites that may be hydrologically linked via groundwater.

Following this process, 16 statutory designated wildlife sites have been identified within a distance of 20 km downstream of the WwTWs:

- River Test SSSI;
- Bere Mill Meadows SSSI;
- East Acton Common SSSI;
- Bransbury Common SSSI;
- Chilbolton Common SSSI;
- Stockbridge Fen SSSI;
- Stockbridge Common Marsh SSSI;
- Greenham and Crookham Common SSSI;
- Ashford Hill Woods and Meadows SSSI;
- Brimpton Pit SSSI;
- Aldermaston Gravel Pits SSSI;
- Ashford Hill NNR;
- Hosehill Lake LNR;
- Pamber Forest and Silchester Common SSSI;
- Pamber Forest LNR; and
- Stanford End Mill and River Loddon SSSI.

The locations of these wildlife sites are illustrated in the figures within Appendix F. All other designated sites identified within the district are remote from watercourses into which WwTWs discharge treated effluent and are not groundwater dependent where WwTWs discharge to ground. Table 5-21 lists the wildlife sites that contain linking pathways to each relevant WwTW.

Table 5-20: Wildlife sites that contain linking pathways to each relevant WwTW

WwTW	Wildlife Site	Hydrologically connected to river	Comments
In-Combination Water Bodies – SIMCAT Modelling for River Loddon			
Basingstoke	Stanford End Mill and River Loddon SSSI	✓	14.3km downstream on the River Loddon (the SSSI comprises part of the river)
Sherborne St. John (discharges into Vyne Stream a tributary of Bow Brook, ultimately flowing into the River Loddon 8.7km downstream)	Stanford End Mill and River Loddon SSSI	✓	15.2km downstream on the River Loddon (the SSSI comprises part of the river)
Sherfield on Loddon (discharges into Bow Brook, ultimately a tributary to the River Loddon 454m downstream)	Stanford End Mill and River Loddon SSSI	✓	7km downstream on the River Loddon (the SSSI comprises part of the river)
RQP Assessment			
Washwater (discharges into the River Enborne which is	Greenham and Crookham Common SSSI	x	4km downstream on the River Enborne

WwTW	Wildlife Site	Hydrologically connected to river	Comments
a tributary to the River Kennet approx. 22.5km downstream	Ashford Hill Woods and Meadows SSSI	✓	16.5km downstream on the River Enborne (approx. 500m south of the river)
	Brimpton Pit SSSI	x	19km downstream on the River Cherwell (approx. 150m north-west of the river)
Kingsclere (discharges into the River Enbourne 3.6km downstream, ultimately a tributary to the River Kennet)	Brimpton Pit SSSI	x	9.8km downstream on the River Enborne (approx 150m north-west of the river)
	Aldermaston Gravel Pits SSSI	✓	14.9km downstream on the River Kennet (approx 200m to the north of the river)
Ashford Hill (discharges into Baughurst Brook which is a tributary to the River Enborne 2.4km downstream and the River Kennet 8.9km downstream)	Ashford Hill Woods and Meadows SSSI	✓	242m downstream on Baughurst Brook (the brook runs through the SSSI)
	Ashford Hill NNR	✓	695m downstream on Baughurst Brook (the brook runs through the NNR)
	Brimpton Pit SSSI	x	4.9km downstream on the River Enborne (approx. 150m north-west of the river)
	Aldermaston Gravel Pits SSSI	✓	10km downstream on the River Kennet (approx 200m to the north of the river)
	Hosehill Lake LNR	✓	16.8km downstream on the River Kennet (approx 300m to the south-east of the river)
Silchester (discharges into Silchester Brook, ultimately a tributary to the River Kennet via Foudry Brook 18.6km downstream)	Pamber Forest and Silchester Common SSSI	x	At outfall point on Silchester Brook (approx. 150m west of the brook)
	Pamber Forest LNR	x	At outfall point on Silchester Brook (approx. 200m west of the brook)
Load Standstill Assessment			
Whitchurch (discharges to River Test Chalk)	River Test SSSI	N/A	426m to the north-west of the WwTW
Overton (discharges to River Test Chalk, but lies within close proximity of the River Test <100m; it is therefore treated as if discharging to the river)	River Test SSSI	✓	At outfall location (approx. 100m to the south of the WwTW)
	Bere Mill Meadows SSSI	✓	4.4km downstream on the River Test (directly adjacent to the river)
	East Acton Common SSSI	✓	9.7km downstream on the River Test (directly adjacent to the river)
	Bransbury Common SSSI	✓	15.1km downstream on the River Test (directly adjacent to the river)
	Chilbolton Common SSSI	✓	19.2km downstream on the River Test (directly adjacent to the river)

WwTW	Wildlife Site	Hydrologically connected to river	Comments
Oakley (discharges to River Test Chalk)	No wildlife sites within a reasonable distance for connectivity through ground infiltration and / or groundwater flow; River Test SSSI is the closest site at 3.4km distance	N/A	No further assessment in relation to wildlife sites needed
North Waltham (discharges to River Test Chalk)	No wildlife sites within a reasonable distance for connectivity through ground infiltration and / or groundwater flow; Beggarwood Park LNR is the closest site at 4km distance	N/A	No further assessment in relation to wildlife sites needed
Barton Stacey (discharges into the River Dever)	River Test SSSI	✓	At outfall location (approx. 147m to the south of the WwTW)
	Bransbury Common SSSI	✓	2.2km downstream on the River Test (directly adjacent to the river)
	Chilbolton Common SSSI	✓	7km downstream on the River Test (directly adjacent to the river)
	Stockbridge Fen SSSI	✓	14.4km downstream on the River Test (approx. 200m east of the river)
	Stockbridge Common Marsh SSSI	✓	15.3km downstream on the River Test (approx. 100m east of the river)

There are several internationally important wildlife sites (European sites) that are linked to the watercourses affected by development in Basingstoke and Deane. These sites are not primarily sensitive to phosphate, but rather nitrogen (as ammonia). The following European sites in the Solent require consideration:

- Solent Maritime SAC is designated for a variety of habitats, including estuaries, sandbanks, mudflats, coastal lagoons and shifting dunes. Furthermore, the SAC supports Spartina swards (*Spartinion maritimae*) and Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*).

- Solent and Southampton Water SPA / Ramsar and Solent and Dorset Coast SPA is located in one of the only sheltered major channels in Europe between the Isle of Wight and the mainland. The area supports extensive intertidal sandflats and mudflats, with invertebrate populations that sustain over 90,000 waders annually. Additionally, the site supports breeding tern populations.

- Solent and Isle of Wight Lagoons SPA is designated for a variety of habitats, including estuaries, sandflats, mudflats, coastal lagoons and salt marshes. The site includes a number of lagoons in the marshes in the Keyhaven – Pennington area, at Farlington Marshes in Chichester Harbour, behind the sea-wall at Bembridge Harbour and at Gilkicker, near Gosport. The lagoons show a range of salinities and substrates, ranging from soft mud to muddy sand with a high proportion of shingle, which support a diverse fauna including large populations of three notable species: the nationally rare foxtail stonewort *Lamprothamnium papulosum*, the nationally scarce lagoon sand shrimp *Gammarus insensibilis*, and the nationally scarce starlet sea anemone *Nematostella vectensis*.

5.6.2 Effects of Nutrient Inputs Upon Ecological Receptors

The designated wildlife sites identified are mainly aquatic freshwater habitats or terrestrial habitats that are supported by inundation from rivers. Furthermore, the European sites described above are all maritime sites that receive hydrological input from the rivers identified as discharge locations for the assessed WwTW. This section discusses the potential impacts of key water quality parameters (BOD, ammonia and phosphate) on these habitats, and most importantly on their respective interest features.

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 mortality 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 lead to eutrophication which fundamentally alters the structure of aquatic habitats, reducing species diversity and leading to the loss of sensitive species.

Each relevant WwTW is discussed in detail below, supported by the relevant evidence base from the water quality assessments.

5.6.3 WwTWs supported by SIMCAT Modelling

Basingstoke WwTW, Sherborne St. John WwTW and Sherfield-on-Loddon WwTW

Basingstoke WwTW, Sherborne St. John WwTW and Sherfield-on-Loddon WwTW are discussed as a unit because they all discharge to the River Loddon and SIMCAT catchment based water quality modelling was undertaken for these three WwTWs to consider in combination effects. Only one wildlife site within 20km of the WwTWs was identified as being hydrologically connected to the River Loddon, the Stanford End Mill and River Loddon SSSI. The SSSI is located at distances of 14.3km, 15.2km and 7km downstream on the River Loddon from the Basingstoke WwTW, Sherborne St. John WwTW and Sherfield-on-Loddon WwTW respectively.

Stanford End Mill and River Loddon SSSI comprises a series of waterlogged hay meadows and a 4km stretch of the River Loddon. The SSSI forms a national stronghold for two rare plant species, including the fritillary *Fritillary meleagris* and the Loddon pondweed *Potamogeton nodosus*. Many flowering plants thrive in the damper parts of the meadows, including brown sedge *Carex disticha*, carnation sedge *Carex disticha*, cuckooflower *Cardamine pratensis*, ragged-robin *Lychnis flos-cuculi* and tubular water-dropwort *Oenanthe fistulosa*. This section of the River Loddon supports a variety of fish species, two rare pea-mussels *Pisidium moitessierianum* and *P. tenuilineatum*, and several uncommon species of mollusc. Overall, the Stanford End Mill and River Loddon SSSI is highly sensitive to changes in water quality.

While the tributaries of the River Loddon that these WwTWs discharge to differ, the current WFD status for these waterbodies is similar for ammonia but differs for phosphate. For example, the Sherborne St.

John WwTW discharges into the Vyne Stream, a tributary of the Bow Brook and ultimately the River Loddon. A review of the Environment Agency's WFD classification for the discharge location shows that the Vyne Stream catchment has 'Moderate' status with 'High' quality for ammonia and dissolved oxygen, but 'Poor' quality for phosphate. The Sherfield-on-Loddon WwTW discharges directly into Bow Brook, a tributary of the River Loddon. The WFD status of the brook at the discharge location is 'Moderate', with assessment qualities of 'High' for ammonia, 'Good' for dissolved oxygen and 'Poor' for phosphate. Where the WFD status is not 'Good', point-source pollution from the discharge of treated sewage effluent is given as a primary reason for this.

Existing baseline data and SIMCAT modelling of the baseline for the River Loddon catchment highlights that the influence of the three WwTWs on the overall waterbody status of discharge locations is significant. Both Sherborne St. John and Sherfield-on-Loddon WwTWs are shown to result in an increase of phosphate concentrations in Vyne Stream and Bow Brook under the modelled 2022 baseline scenario. This is partly because the dilution factor in these streams is lower than in the River Loddon itself. Notably, the treated sewage discharge from Sherfield on Loddon reduces the WFD status for phosphate from 'Moderate' to 'Poor', although the modelling simulations suggest that a new phosphate discharge permit would counteract this. Modelling showed no significant effect of the WwTWs on ammonia and BOD concentrations in the River Loddon.

SIMCAT modelling for the two different growth scenarios in comparison to the 2022 baseline scenario showed that there are small increases in phosphate concentrations downstream Sherfield-on-Loddon WwTW, but that this would not lead to a change in the WFD status of the receiving waterbody. The SIMCAT model was also run to determine the required phosphate concentration in sewage effluent to achieve the WFD target status in the recipient waterbodies. The model determined that target WFD water quality status in the Vyne Stream could be met by imposing a limit of 0.35mg/l on phosphate discharges at Sherborne St John WwTW (including with growth under both scenarios) which demonstrates that a technically feasible solution is available. Achieving the target status of moderate in Bow Brook could be met by imposing a limit of 0.41mg/l on phosphate discharges at Sherfield on Loddon (under growth scenario 2) which demonstrates that a technically feasible solution is available. The current status of moderate in the River Loddon is already being met downstream of Basingstoke WwTW and will continue to be met under both future development scenarios. Good status for the River Loddon can be achieved using current best treatment technology at Basingstoke WwTW and limiting phosphate discharges to 0.28mg/l.

Overall, the permitted headroom in the WwTWs is sufficient to process the expected additional volume of wastewater resulting from growth within the catchments of Basingstoke, Sherborne St. John and Sherfield-on-Loddon WwTWs. However, there are no current phosphate limits in place at Sherfield on Loddon WwTW, which is 7km upstream from the Stanford End Mill and River Loddon SSSI. Using the permitted headroom to its full extent would further increase the phosphate loading in the River Loddon, unless a permit limit was enforced. Overall, it is considered that the increased discharge at the WwTWs, would not have material effects on the ecological interest features of the identified wildlife sites with the introduction of a phosphate permit condition at Sherfield-on-Loddon WwTW which is within the limits of conventional treatment.

5.6.4 WwTWs supported by RQP modelling

Washwater WwTW

Washwater WwTW discharges into Pound Street Brook, a small tributary of the River Enborne and ultimately to the River Kennet (at approximately 22.5 km distance downstream). There are three wildlife sites within a 20 km flowpath distance from the Washwater WwTW. Approximately 4 km downstream the River Enborne flows past Greenham and Crookham Common SSSI. At approximately 16.5 km downstream, the Ashford Hill Woods and Meadows SSSI lies 500 m to the south of the River Enborne. 19 km downstream from the Washwater WwTW the Brimpton Pit SSSI lies only 150 m to the north-west of the River Enborne. However, despite their relatively close proximity to the Enborne, any hydrological connectivity to these SSSIs is likely to be very limited.

For example, Greenham and Crockham Common SSSI (approximately 4.4 km downstream) lies on a long narrow ridge between the Rivers Enborne and Kennet. The ridge comprises Eocene deposits that lie on heavy impermeable clays. Due to the presence of these impermeable materials, any hydrological exchange with the River Enborne is likely to be relatively limited. The component most likely to be affected by treated sewage effluent are the waterlogged valleys of the alder woodland.

Ashford Hill Woods and Meadows SSSI lies approximately 16.5 km downstream from Washwater WwTW roughly 500 m from the River Enborne. The SSSI comprises a complex of woodlands and agriculturally unimproved meadows, including flushed areas drained by a small unpolluted river. The wet areas support diverse ecological communities including early marsh orchid *Dactylorhiza incarnata*, southern marsh orchid *D. praetermissa*, flea sedge *Carex pulicaris*, lousewort *Pedicularis sylvatica* and marsh lousewort *P. palustris*. Overall, while the site is likely to be dependent on some hydrological input (likely from the River Enborne), it is considered that any residual effect of treated sewage effluent is likely to be largely diluted due to the long distance (16.5 km) to the Washwater WwTW.

Approximately 19.5 km downstream from the WwTW lies Brimpton Pit SSSI, roughly 150 m north-west of the River Enborne. However, this SSSI is primarily of interest for its geological features (fossil molluscs and pollen). The site is not considered to be sensitive to the impact of treated sewage effluent.

The Washwater WwTW ultimately contributes to a section of the River Enborne between the A34 and Burghclere Brook, which had a WFD classification of 'moderate' in 2016. A more detailed review of the Environment Agency website highlights that this was largely due to a 'moderate' score for dissolved oxygen and a 'poor' score for phosphate. One of the main reasons for not achieving good status is due to the high phosphate levels in continuous sewage discharges.

RQP modelling for the Washwater WwTW showed that phosphate concentrations would have to be kept at 4.03 mg/l to maintain the current quality for the River Enborne. The WwTW does not have a current permit condition for phosphate, however, the phosphate permit condition required to remain could be achieved within the Limit of Conventional Treatment (0.25 mg/l). No change to the permit condition for ammonia would be required. Overall, it is considered that the increased discharge at Washwater WwTW would not have material effects on the ecological interest features of the identified wildlife sites with the introduction of a phosphate permit condition which is within the limits of conventional treatment.

Kingsclere WwTW

Kingsclere WwTW discharges into Kingsclere Brook, which is a tributary to the River Enborne 3.6 km downstream and, ultimately, the River Kennet. The closest wildlife site lies 9.8 km downstream on the River Enborne, the Brimpton Pit SSSI approximately 150 m north-west of the river. However, as discussed in relation to Washwater WwTW, this SSSI's interest features are of geological nature and not considered to be hydrologically sensitive. No further assessment regarding the Brimpton Pit SSSI is required.

14.9 km downstream from the Kingsclere WwTW lies the Aldermaston Gravel Pits SSSI, approximately 200 m to the north of the River Kennet. Due to the distance of 14.9 km from the WwTW and there being no obvious hydrological linkage with the River Kennet, it is considered that any effects of additional treated sewage effluent are likely to be very limited. The SSSI consists of flooded gravel workings surrounded by dense vegetation and scrub. The plant community primarily comprises willow species *Salix* spp., reedmace, reed sedge and pond sedge. Many waterbirds overwinter or breed within the SSSI, including teal, shoveler, warbler species, water rail, kingfisher and nightingale.

The Kingsclere WwTW discharges to the Kingsclere Brook which is a tributary to the River Enbourne. A review on the Environment Agency database highlights that this is part of the Kingsclere Brook (source to Enborne) catchment. This waterbody had a WFD classification of 'moderate' in 2016, with 'high' status for ammonia and dissolved oxygen, but 'poor' status for phosphate. One of the main reasons for not achieving good phosphate quality status is the point-source discharge of treated sewage effluent.

RQP modelling was undertaken for the Kingsclere WwTW. The modelling highlighted that ammonia concentrations would have to be kept at 3.45mg/l and phosphate concentrations would have to be kept at 3.96 mg/l in order to maintain the current quality for Kingsclere Brook. The WwTW does not have a current permit condition for phosphate, however, the phosphate permit condition required to maintain current quality could be achieved within the Limit of Conventional Treatment (0.25 mg/l). The current permit condition for ammonia would need to be tightened. It is concluded that the additional sewage effluent discharged from Kingsclere WwTW would not result in negative impacts on wildlife sites with the introduction of a phosphate permit condition and permit tightening for ammonia which are both within the limits of conventional treatment.

Ashford Hill WwTW

Ashford Hill WwTW discharges into Baughurst Brook a tributary to the River Enborne 2.4km downstream. The River Enborne joins the River Kennet approximately 8.9km downstream from Ashford Hill. The WwTW has a unique setting in that it is situated directly adjacent to the Ashford Hill Woods and Meadows SSSI (242 m downstream on Baughurst Brook) and the Ashford Hill NNR (695 m downstream on Baughurst Brook). Both of these wildlife sites depend to varying degrees on hydrological connectivity with the brook.

Its features that are most likely to be impacted by an increase in treated sewage effluent are its peaty flushed areas drained by the brook. The brook is situated adjacent to a variety of other habitats, which sustains the site's biological diversity. The wet grazed pasture in the SSSI supports several orchid species, marsh valerian *Valeriana dioica* and a variety of sedges *Carex* spp. The peaty flushes comprise early and southern marsh orchid *Dactylorhiza incarnata* and *D. praetermissa*, flea sedge *Carex pulicaris*, lousewort *Pedicularis sylvatica* and marsh lousewort *P. palustris*. In turn this habitat and plant diversity supports great invertebrate diversity, including 31 butterfly species and over 400 species of moths. A section of the SSSI is also designated as a NNR – the Ashford Hill NNR. This is of similar importance to a large number of plant and animal species.

Approximately 4.9 km downstream from the Ashford Hill WwTW the River Enborne runs past the Brimpton Pit SSSI (not hydrologically sensitive as previously discussed) and 10 km downstream the River Kennet (past the confluence with the Enborne) runs past the Aldermaston Gravel Pits SSSI (hydrologically connected to the River Enborne; please see earlier section on the sensitivity of this site).

The River Kennet then runs past the Hosehill Lake LNR approximately 16.8 km downstream of the WwTW. Despite a distance of 300 m between the river and the LNR, some hydrological connectivity (mainly as baseflow) cannot be excluded. The LNR mainly comprises a lake surrounded by a variety of habitats, which support up to 168 different bird species including lapwing, little ringed plover, goldeneye, tufted duck, pochard, gadwall, teal wigeon, great-crested grebe, bittern and sand martin. However, given the relatively long distance of 16.8 km to the WwTW, it is considered that negative impacts of sewage effluent are extremely unlikely.

The current overall WFD status for Baughurst Brook at the discharge point is 'Moderate', comprising of 'High' for ammonia, 'Good' for phosphate, but only 'Moderate' for dissolved oxygen. Pojnt-source sewage discharge is one of the reasons for dissolved oxygen not attaining 'Good' status.

The Ashford Hill WwTW does not currently hold a permit condition for ammonia and phosphate. RQP modelling for the WwTW has identified that permit conditions required to maintain the current quality for Baughurst Brook for ammonia and phosphate would be 7.47 mg/l and 5.14 mg/l, respectively. Both of these values lie within the concentrations attainable through conventional treatment of 1 mg/l (ammonia) and 0.25 mg/l (phosphate). Therefore, given that these permit conditions are imposed, the additional treated sewage effluent discharged at Ashford Hill WwTW would not negatively impact any wildlife sites.

Silchester WwTW

The Silchester WwTW discharges into Silchester Brook, which is a tributary of the River Kennet via Foudry Brook approximately 18.6 km downstream from the WwTW. Only two wildlife sites were identified in relation to the WwTW near its discharge point, namely the Pamber Forest and Silchester Common SSSI (150m from Silchester Brook) and the Pamber Forest LNR (200 m from Silchester Brook). However, neither of these sites is considered to be hydrologically closely linked to the Brook. In particular, the sites' interest features are not closely dependent on hydrology.

Furthermore, RQP modelling for the WwTW has identified that permit conditions required to maintain the current quality for Silchester Brook for ammonia and phosphate would be 2.06 mg/l and 1.31 mg/l, respectively. Both of these values lie within the concentrations attainable through conventional treatment of 1 mg/l (ammonia) and 0.25 mg/l (phosphate). Given this, and the fact that the above discussed wildlife sites are not particularly hydrologically sensitive, it is considered that the additional treated sewage effluent would not negatively affect wildlife sites.

5.6.5 WwTWs supported by Load Standstill Calculations

Whitchurch WwTW

Whitchurch WwTW discharges into the River Test Chalk groundwater body. The closest statutory site is the River Test SSSI, approximately 426m to the north-west of the WwTW. The River Test SSSI is a very species-rich river, which is considered to be particularly sensitive to phosphate pollution. While the WwTW discharges to the ground it is considered that there may be a potential for sewage effluent to reach the SSSI via groundwater baseflow.

The River Test exhibits a flora that is characteristic of chalk streams, supporting particular high diversities of invertebrates and mollusc. The water is base-rich but shows evidence of nutrient enrichment. Over centuries the river has been modified for water mills and navigation, resulting in a multiplicity of water channels. The Upper Test comprises lesser water-parsnip, brook water-crowfoot and *Ranunculus*. Other species include mare's-tail, opposite-leaved pondweed, river water-dropwort and horned pondweed. The SSSI and its adjoining vegetation provide important habitat for many birds, including kingfisher, grey wagtail, little grebe, sedge warbler, reed warbler and Cetti's warbler. Grey heron and kingfisher are the most common fish-eating species and, therefore, ultimately dependent on oxygen-rich water. The SSSI also harbours nationally rare Red Data Book invertebrate species, including a dung fly, Empidid flies, craneflies, the southern damselfly and the Desmoulin's whorl snail.

Generally, it is to be noted that the River Test's most recent overall WFD assessment is in 'good' condition. Its assessments for ammonia, phosphate and dissolved oxygen concentrations are all 'high', meaning that the river is in good physio-chemical condition.

To ensure that the modelled additional pollution load would not lead to a deterioration in water quality, load standstill calculations were undertaken. It was determined that the future Biological Oxygen Demand (BOD) (from 40 to 21.5mg/l), ammonia (from 5 to 2.7mg/l) and TIN (from 32 to 17.2mg/l) would have to be reduced to maintain the water quality in the River Test and consequently to protect the SSSI from deterioration. However, this could be achieved within the conventional technologies at the WwTW. Therefore, it is concluded that the additional sewage effluent would not materially affect the interest features of the River Test SSSI through ammonia, nitrogen or BOD with the introduction of tighter permit conditions which are within the limits of conventional treatment.

Since there is no phosphate permit for this WwTW no assessment of phosphate contribution can be undertaken. However, given the proximity of the River Test SSSI to this WwTW it is recommended that the potential impact of this WwTW on phosphate load in the nearby River Test SSSI is investigated further by the Water Company before significant new growth is permitted in the catchment. There has traditionally been a view that adsorption and metal complex formation retain the majority of potentially mobile phosphorus and thus reduce mobilisation from groundwater into surface waters. However, soils have a limited capacity to store phosphorus, and once the capacity of soil to adsorb phosphorus is exceeded, the excess will dissolve and move more freely with water either directly to a stream or downward to an aquifer. The groundwater body is extensive and establishing if the soils have reached the 'saturation level' for stored phosphorus would require extensive surveys and interpretation. Linking impact directly/solely to the increased WwTW flows would likely be inconclusive though given the extent of the waterbody & therefore other influencing factors.

Overton WwTW

Overton WwTW discharges into the River Test Chalk, but its outfall point lies approximately only 100 m from the River Test SSSI. Given this short distance and the high likelihood of treated sewage effluent moving into the SSSI laterally via baseflow, this WwTW is assessed as if discharging directly into the river. As discussed in relation to the Whitchurch WwTW, the interest features of the SSSI are highly sensitive to phosphorus pollution. For more details on the River Test SSSI, please see the previous section.

Approximately 4.4km downstream from the WwTW the River Test flows past the Bere Mill Meadows SSSI, which comprises several damp, unimproved neutral grasslands on the floodplain of the River Test. The meadows have an extensive area of extensive hydrological interactions with the river, providing linear habitat that is important for invertebrates and birds. Importantly, the SSSI comprises locally distributed wet meadow herbs, including bogbean *Menyanthes trifoliata*, ragged robin *Lychnis flos-cuculi*, water avens *Geum rivale* and marsh valerian *Valeriana dioica*. The ditches support floating sweet-grass *Glyceria fluitans*, reed sweet-grass *G. maxima*, yellow flag *Iris pseudacorus* and lesser water-parsnip *Berula erecta*.

Approximately 9.7km downstream the River Test passes the East Aston Common SSSI, which also lies on the floodplain of the River Test. It is of particular interest due to its extensive tall sedge-rich fen communities and important riparian habitats. The fen communities comprise common reed *Phragmites australis*, reed canary-grass *Phalaris arundinacea* and reed sweet-grass *Glyceria maxima* as well as various sedge species (*Carex acutiformis*, *C. riparia* and *C. paniculate*). The site's plant species and habitats support a variety of wetland birds, including reed, sedge, and grasshopper warbler, reed bunting, grey wagtail, water rail and redshank. The SSSI also supports important mayfly and caddisfly larvae.

Bransbury Common SSSI lies approximately 15.1km downstream from Overton WwTW on the floodplain of the River Test. The feature of the SSSI that is likely to be most sensitive to sewage effluent is its disused water meadow, which is dominated by perennial rye-grass *Lolium perenne*, meadow fescue *Festuca pratensis* and rough meadow-grass *Poa trivialis*. Also present are yellow flag *Iris pseudacorus*, lady's smock *Cardamine pratensis*, early marsh-orchid *Dactylorhiza incarnata* and marsh marigold *Caltha palustris*.

Approximately 19.2km downstream the Chilbolton Common SSSI covers a section of the River Test's floodplain. The SSSI, river, and adjacent fen and carr communities form a mosaic of species-rich habitats. Over 265 species of flowering plant have been recorded on the Common, including large populations of marsh arrowgrass *Triglochin palustris*, bog pimpernel *Anagallis tenella*, adder's-tongue fern *Ophioglossum vulgatum*, both southern and early marsh orchids *Dactylorhiza praetermissa* and *D. incarnata*, and abundant flat sedge *Blysmus compressus*. The SSSI supports a number of breeding wetland birds, including snipe, redshank and lapwing on Chilbolton Common, and grasshopper, reed and sedge warblers in the surrounding fen / riparian habitats.

As indicated in the previous section, the River Test is in 'good' overall condition, with ammonia, phosphate and dissolved oxygen all classified as being of 'high' quality. Notwithstanding this, it needs to be considered whether additional sewage effluent from Overton WwTW has the potential to affect the ecological integrity of any hydrologically connected SSSIs, particularly the floodplain components of these designated sites.

To ensure that the modelled additional pollution load would not lead to a deterioration in water quality, load standstill calculations were undertaken. It was determined that the future Biological Oxygen Demand (BOD) (from 40 to 32.1mg/l), ammonia (from 5 to 4mg/l) and phosphate (from 1 to 0.8mg/l) permit quality levels would all have to be reduced to maintain the water quality in the River Test, and consequently to protect the SSSI from deterioration. It was also determined that this could be achieved within the conventional technologies currently in place at the WwTW. Therefore, it is concluded that development planned to be served by this WwTW can be accommodated without any adverse effect on the interest features of the above SSSIs.

Oakley WwTW

Oakley WwTW discharges into the River Test Chalk and a review of designated sites on MAGIC highlighted that there are no wildlife sites within reasonable distances for groundwater connectivity. At approximately 3.4km distance, the River Test SSSI is the closest site, which is considered to be too far for there to be significant hydrological connectivity. Therefore, it was determined that no further assessment of wildlife sites is needed in relation to Oakley WwTW. Notwithstanding this, it is noted that the load standstill calculation for the WwTW highlights that an adjustment towards lower BOD (from 40 to 24.4mg/l), ammonia (from 5 to 3.1mg/l) and TIN (from 35 to 21.4mg/l) loads is necessary to maintain similar total pollutant loads to be emitted from the WwTW under the predicted growth scenario. However, this reduction could be achieved within the capacity of current conventional treatment technologies. This implies that even if there was a hydrological connection to wildlife sites around Oakley WwTW, the predicted growth could not negatively affect such sites.

North Waltham WwTW

North Waltham WwTW discharges into the River Test Chalk and a review of designated sites on MAGIC highlighted that there are no wildlife sites within a reasonable distance for a hydrological connection. Beggarwood Park LNR is the closest wildlife site, approximately 4km from the WwTW. Therefore, it was concluded that no further assessment of wildlife sites is needed in relation to the North Waltham WwTW. The load standstill calculation for the WwTW highlights that an adjustment towards lower BOD (from 40 to 16.2mg/l), ammonia (from 5 to 2mg/l) and TIN (from 20 to 8.1mg/l) loads would become necessary to ensure that a similar total pollutant load is emitted from the WwTW under the predicted growth scenario. However, this reduction could be achieved within the capacity of current conventional treatment technologies. This implies that even if there was a hydrological connection to wildlife sites around North Waltham WwTW, the predicted growth could not negatively affect such sites.

Barton Stacey WwTW

Barton Stacey WwTW discharges into the River Dever, which forms part of the designated River Test SSSI. There are several wildlife sites downstream from the Barton Stacey WwTW. Approximately 2.2 km downstream the River Test flows past the Bransbury Common SSSI and approximately 7km downstream it runs alongside the Chilbolton Common SSSI. Both these SSSIs comprise part of the floodplain of the River Test and are likely to be impacted by treated sewage effluent from the WwTW. However, these sites were already discussed in relation to Overton WwTW and therefore will not be discussed here (please refer to the earlier section).

Approximately 14.4 km downstream from the Barton Stacey WwTW the River Test runs through the Stockbridge Fen SSSI. The SSSI is situated within the floodplain of the Test and lies over alluvium and river gravels (both highly permeable deposits). The site supports high-quality fen communities including several rare / uncommon species. The sward comprises bottle sedge *Carex rostrata*, blunt-flowered rush *Juncus subnodulosus*, lesser tussock-sedge *C. diandra* and marsh helleborine *Epipactis palustris*. Further species of interest include the early marsh-orchid *Dactylorhiza incarnata*, southern marsh-orchid *D. praetermissa*, fragrant orchid *Gymnadenia conopsea*, greater spearwort *Ranunculus lingua*. Many of the SSSI's rarer species and plant communities critically depend on water quality, specifically the absence of nutrient enrichment.

Stockbridge Common Marsh SSSI straddles the River Test 15.3 km downstream from Barton Stacey WwTW. The SSSI comprises a mosaic of wetland habitats that extend along the River Test floodplain for approximately 2 km. Habitats include fen, carr, unimproved alluvial meadows and an extensive shallow lake. The SSSI's wetland and riparian communities sustain breeding and wintering wildfowl, as well as rare invertebrate species. Most importantly, the SSSI includes two main channels of the River Test and its water crowfoot *Ranunculus penicillatus* and water starwort *Callitriche* spp. plant communities. These SSSIs main river channels support pochard, tufted duck, mute swan, kingfisher, snipe, redshank and Cetti's warbler. Rare invertebrate species occurring in the SSSI include the weevil *Apion vicinum*, leaf beetle *Chrysolina menthastri*, marshland beetle *Anthocomus rufus* and slender grasshopper *Tetrix subulata*.

Similar to the River Test, the River Dever (close to the discharge point of the Barton Stacey WwTW) has a WFD classification of 'good' overall status. Specifically, individual status classification for ammonia, phosphate and dissolved oxygen are all 'high', indicating that the Dever is in good physico-chemical condition. Overall, it attains the same WFD conditions as the River Test, which it is a tributary of.

Further evidence that the anticipated growth relevant to the Barton Stacey WwTW will not have impacts on wildlife sites is provided by the load standstill calculations. It is anticipated that a small reduction in the permit level of BOD (15 to 14.4mg/l), ammonia (3 to 2.9mg/l) and phosphate (0.5 to 0.48mg/l) will be required to maintain pollutant discharge concentrations under the modelled growth scenario. It was also determined that this could be achieved within the conventional technologies currently in place at the WwTW. Therefore, it is concluded that development planned to be served by this WwTW can be accommodated without any adverse effect on the interest features of the above SSSIs as long as any permit changes required are instigated.

5.6.6 Nutrient neutrality and protected habitats sites in the Solent and River Itchen SAC

In addition to assessing the potential effects of treated sewage effluent on wildlife sites, the impact of nitrogen (the primary growth-limiting nutrient in the marine environment) on European sites in the Solent must also be assessed under the Conservation of Habitats and Species Regulations (2017, as amended). This is usually achieved through the Habitats Regulations Assessment (HRA) process, which ensures that there are no adverse effects on the integrity of European sites. In relation to the Borough of Basingstoke and Deane this particularly applies to the River Test Chalk and fluvial catchment, which encompasses the Whitchurch WwTW, Overton WwTW, Oakley WwTW, North Waltham WwTW and Barton Stacey WwTW. Consequently, the growth accommodated in these WwTWs will have to be assessed for potential impacts on relevant European sites, including the Solent Maritime SAC, the Solent and Southampton Water SPA / Ramsar and Solent and Dorset Coast Potential SPA. The SSSIs underpinning these European sites are also protected through this process. Recent guidance by Natural England (March 2022) also requires nutrient neutrality (phosphorus) for developments that discharge to the River Itchen catchment. None of the WwTW's within the borough discharge to this catchment, however, potentially a small number of developments that use package treatment plants or are served by WwTWs outside of the borough that discharge to the River Itchen catchment, will be affected.

The concept of nutrient neutrality has recently emerged due to the significant problems with water quality in the Solent and River Itchen SAC. To undertake this assessment, a nutrient budget should be calculated for all development sites that are shown to be in the hydrological catchment of Solent's European sites and the River Itchen catchment. The methodology for calculating the nutrient budget has most recently been set out in Natural England's advice on achieving nutrient neutrality for new development (March 2022). The calculation accounts for the anticipated magnitude of development and the nitrogen/phosphorus balance (difference between loss / gain of existing / future nitrogen/phosphorus load) in each allocation. Overall, Natural England's current position is that there cannot be any net additional nutrient input into these protected Habitats sites. BDBC are currently undertaking their own nutrient budget calculations. Water quality assessment at all WwTW's has shown that Ammonia and TIN inputs from growth across the borough can be managed by imposing new permit limits (within limits of current technology) to manage ammonia and TIN which is the key conclusion of the WCS. However, the new permit levels required to manage ammonia and TIN regarding wastewater discharges are not sufficient to meet Natural England's requirement of no net additional nitrogen input from future development. If the Ammonia and TIN permits could be tightened further this would reduce the nitrogen balance that will need to be addressed by developers and better protect the Solent wildlife sites. The nutrient balance will be addressed through the development of a Habitats Regulations Assessment for the Local Plan.

5.7 WwTW Infrastructure Requirements

Table 5-22 provides a summary of the WwTWs within the study area which have been assessed and the results of the water quality assessments.

The water quality assessment results demonstrate that, subject to the revision of discharge permits and if required, the necessary treatment process upgrades (using conventional treatment technologies) being implemented, there is environmental capacity for the proposed options for growth to ensure the no deterioration WFD water quality objectives can be met.

For the WwTWs that have been identified as potentially requiring a new flow condition permit, the following process would be undertaken by the respective Water Company:

- The Water Company must identify works where DWF is exceeded, or where there is a high risk of exceeding DWF[22,23].
- If permitted DWF is exceeded, the Environmental Permit requires the Water Company to carry out an investigation into the exceedance, and provide an Action Plan for agreement with the Environment Agency.
- In 2026 the following criteria will apply to all WwTWs with a dry weather flow limit;

    From the 1st January 2026 the limit has been complied with in an assessment calendar year unless;

[22] Southern Water baseline risk and vulnerability assessment (BRAVA) methodology is outlined at brava-methodology_wtw-dwf-compliance.pdf (southernwater.co.uk).
[23] Further information on the risk analysis process undertaken by Thames Water is illustrated at Drainage and Wastewater Management Plan (arcgis.com).

    - The limit has been exceeded in the compliance assessment calendar year, and;
    - Two or more exceedances have occurred in the preceding 4 calendar years.

- If a WwTW exceeds its DWF in 2026 and has also exceeding in 2 or more of 2025, 2024, 2023 and 2022 then it will be classed as a failed site; this currently incurs a financial penalty of £3.3million.
- In cases where flow exceedance is due to growth, then the Water Company would need to include a scheme in the AMP Business Plan.
- Permit variations for higher DWF would be secured from the Environment Agency where growth schemes are required. These can take several months to secure. It is worth noting that where DWF increases, numeric discharge quality limits are usually tightened.

In 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, current water quality as a result of additional discharge can be maintained within the receiving watercourses.

Table 5-21: WwTW Assessment Summary

WwTW and receiving watercourse		Assessment undertaken	Discussion	Further Steps
Basingstoke	River Loddon	SIMCAT Modelling	• Adequate flow headroom for proposed growth. • Although no new flow condition is required on the permit, significant growth is proposed in the catchment - modelling has assessed the implication of using this headroom. • Compliance with WFD objectives would be possible with no changes to the BOD or ammonia condition but may require a change in phosphate condition to be applied (which is close to, but within the limits of conventional treatment).	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades
Sherborne St John	Vyne Stream (Tributary of Bow Brook)	SIMCAT Modelling	• Adequate flow headroom for proposed growth. • Although no new flow condition is required on the permit, significant growth is proposed in the catchment - modelling has assessed the implication of using this headroom. • Compliance with WFD objectives would be possible with no changes to the BOD or ammonia condition but may require a phosphate condition to be applied (which is within the limits of conventional treatment).	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades – this may require additional monitoring on the Vyne Stream.
Sherfield on Loddon	Bow Brook (Tributary of River Loddon)	SIMCAT Modelling	• Adequate flow headroom for proposed growth. • Although no new flow condition is required on the permit, significant growth is proposed in the catchment - modelling has assessed the implication of using this headroom. • Compliance with WFD objectives would be possible with no changes to the BOD or ammonia condition but would require a phosphate condition to be applied (which is within the limits of conventional treatment).	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades
Washwater	Pound Street Brook	RQP (Ammonia & Phosphate)	• Adequate flow headroom for proposed growth. • Deterioration can be limited to 10% or less, without any change to the ammonia condition and potential introduction of a phosphate condition achievable within the limits of conventional treatment. • WFD compliance (maintain current quality) for ammonia would be possible without any permit changes. • WFD compliance for phosphate would be possible with potential introduction of a condition achievable within the limits of conventional treatment.	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades
		Load Standstill (BOD)	• Minor changes to the discharge permit would be required to ensure no increase in overall BOD pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	

WwTW and receiving watercourse		Assessment undertaken	Discussion	Further Steps
Kingsclere	Kingsclere Brook	RQP (Ammonia & Phosphate)	• Adequate flow headroom for proposed growth. • Deterioration can be limited to 10% or less, without any change to the ammonia condition and potential introduction of a phosphate condition achievable within the limits of conventional treatment. • WFD compliance for ammonia would be possible with changes to the permit achievable within the limits of conventional treatment. • WFD compliance for phosphate would be possible with potential introduction of a condition achievable within the limits of conventional treatment.	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades
		Load Standstill (BOD)	• Minor changes to the discharge permit would be required to ensure no increase in overall BOD pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	
Ashford Hill	Baughurst Brook	RQP (Ammonia & Phosphate)	• A new permit would be required – flow condition would be exceeded. • Deterioration can be limited to 10% or less for ammonia and phosphate with the potential introduction of conditions achievable within the limits of conventional treatment. • WFD compliance for ammonia and phosphate would be possible with potential introduction of a condition achievable within the limits of conventional treatment.	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades
		Load Standstill (BOD)	• Minor changes to the discharge permit would be required to ensure no increase in overall pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	
Silchester	Silchester Brook	RQP (Ammonia & Phosphate)	• Adequate flow headroom for proposed growth. • Deterioration can be limited to 10% or less, without any change to the ammonia condition and potential introduction of a phosphate condition achievable within the limits of conventional treatment. • WFD compliance for ammonia would be possible with changes to the permit achievable within the limits of conventional treatment. • WFD compliance for phosphate would be possible with potential introduction of a condition achievable within the limits of conventional treatment.	• EA to determine permit required to meet regulatory compliance and inform scope of Thames Water upgrades
		Load Standstill (BOD)	• Minor changes to the discharge permit would be required to ensure no increase in overall BOD pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	

WwTW and receiving watercourse		Assessment undertaken	Discussion	Further Steps
• Whitchurch • Oakley	River Test Chalk	Load Standstill (Ammonia, BOD & TIN)	• A new permit would be required – flow condition would be exceeded. • Minor changes to the discharge permit would be required to ensure no increase in overall pollutant load as a result of additional growth; however, these would be achievable with current technology. • The tighter TIN quality condition required to maintain the current quality is achievable with current technology	• EA to determine permit required to meet regulatory compliance and inform scope of Southern Water upgrades
• Overton	River Test Chalk	Load Standstill (Ammonia, BOD & Phosphate)	• A new permit would be required – flow condition would be exceeded under Growth Scenario 2 only. • Minor changes to the discharge permit would be required to ensure no increase in overall pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment.	• EA to determine permit required to meet regulatory compliance and inform scope of Southern Water upgrades
• North Waltham	River Test Chalk	Load Standstill (Ammonia, BOD & TIN)	• Adequate flow headroom for proposed growth. • Minor changes to the discharge permit for ammonia and BOD would be required to ensure no increase in overall pollutant load as a result of additional growth; however, these would be achievable within the limits of conventional treatment. • The tighter TIN quality condition required to maintain the current quality is achievable with current technology.	• EA to determine permit required to meet regulatory compliance and inform scope of Southern Water upgrades

6. Flood Risk

This section provides a summary of the potential impact of the increased wastewater flow from the proposed growth on fluvial flooding within the study area.

6.1 Increasing flows

In order to determine whether the increase in wastewater discharged from the WwTWs as a result of growth is likely to impact on flood risk downstream, estimates were made of the percentage increase in flood flows that would occur for a variety of return period events.

The Flood Estimation Handbook revitalised flood hydrograph method (ReFH2) was used to derive flow estimates for the receiving watercourses for the 1 % Annual Exceedance Probability (AEP) (1 in 100 year) flood return period (full results are provided in Appendix H. The additional flow (generated from the worst-case scenario growth) from each WwTW was calculated as a percentage of the flood flow as shown in Table 6-1 below.

Table 6-1: Additional flow from WwTWs as a percentage of estimated flood flows in the receiving watercourse

WwTW	Receiving watercourse	1 % AEP (1 in 100 year) flow (m^3/d)	Additional flow as a result of proposed growth (m^3/d)	% additional flow from WwTW as a result of growth
Basingstoke	River Loddon	668,736	5,856	0.88%
Sherborne St John	Wey Brook	105,408	170	0.16%
Sherfield on Loddon	Bow Brook	1,505,952	432	0.03%
Washwater	A tributary of River Enborne	133,920	36	0.03%
Kingsclere	Kingsclere Brook	276,480	240	0.09%
Ashford Hill	Baughurst Brook	123,552	8	0.01%
Silchester	Silchester Brook	251,424	598	0.24%

Based on these estimates the potential additional discharges from the various WwTWs into the receiving watercourses are not significant (all less than 1%). It is considered unlikely that these additional flows would result in a significant increase in flood levels.

7. Water Supply Strategy

This section provides a review of the planned water supply strategies to identify any constraints to the proposed growth.

In addition, a water neutrality assessment was undertaken for the study area to identify the required policy requirements needed to achieve 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.

7.1 Abstraction Licencing Strategies

The Environment Agency manages water resources at the local level through the use of abstraction licensing strategies (ALS). Within the ALS, 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 7-1. 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 7-1: Water resource availability status categories

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

The 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:

- Q95 (lowest);
- Q70;
- Q50; and

- Q30 (highest).

Q95 is the flow exceeded for 95% of the time and is used as a low flow indicator. Q30 is the flow exceeded for 30% of the time; and is considered to be a high flow.

7.1.1 Thames Catchment[24]

The classification for each of the Water Resource Management Units (WRMU) in the borough within the Thames catchment has been summarised for surface waterbodies in Table 7-2.

Table 7-2: Resource availability classification within the borough (Thames catchment)

River – WRMU	Surface Water (flow exceedance scenarios)			
	Q30	Q50	Q70	Q95
AP3 – Upper Loddon				
AP4 – Bow Brook				
AP3 – Upper Loddon (Thames bespoke licencing strategy applied)				
AP4 – Bow Brook (Thames bespoke licencing strategy applied)				

The Thames area has a bespoke licensing strategy that applies to all tributary systems of the Thame including the Loddon which modifies water resource availability. The Lower River Thames is classed as ‘water not available for licensing’ and any consumptive abstraction from the Thames tributaries will reduce flow in the lower River Thames. The Loddon catchment is a tributary of the Thames and as such the licensing strategy needs to take into account the river flow requirements of the River Thames. The Hands-off Flow (HoF) required to protect river flow in the Lower Thames is highly restrictive and has a significant impact on resource availability where consumptive abstraction is available less than 30% of the time. Since the Thames is important for water resources a bespoke strategy has been devised which results in consumptive abstraction being available at least 30% of the time.

7.1.2 Test and Itchen Catchment[25]

The classification for each of the Water Resource Management Units (WRMU) in the borough within the Test catchment has been summarised for surface waterbodies in Table 7-3. Consumptive abstraction within the Test is available at least 50% of the time.

Table 7-3: Resource availability classification within the borough (Test catchment)

River – WRMU	Surface Water (flow exceedance scenarios)			
	Q30	Q50	Q70	Q95
AP8 - Test				

Water resource availability for groundwater in the Test (GB40701G501200 Test Chalk) is identified as having restricted water available. Analysis shows that there is very little scope for any additional abstraction that would not cause additional impacts on sensitive water features. Consequently, there is a presumption against new consumptive groundwater abstractions from the Chalk. There is a high

[24] Loddon Abstraction Licensing Strategy (Environment Agency, 2019). Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/796162/Loddon-Abstraction-Licensing-Strategy.pdf

[25] Test and Itchen Abstraction Licensing Strategy (Environment Agency, 2019), Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/793438/Test_and_Itchen_Abstraction_Licence_Strategy.pdf

reliance on groundwater in the south east for water supply. Due to the geology, the interaction between ground and surface waters in the Test catchment are also key.

7.2 Water Resource Planning

Water companies 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 a statutory Water Resource Management Plan (WRMP) produced every five years to coincide with each of the water companies' five-yearly asset management (or business) plans.

WRMPs are a key document for a WCS as they set out how demand for water from growth within a water company's supply area can be met, taking into account the potential impacts of climate change and the need for the environment to be protected. As part of the statutory 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 there is more available water than demand; but also share the same risk of supply when demand for water is greater than the available supply (i.e. deficit of supply). Water companies undertake resource modelling to calculate if there is likely to be a surplus of available water or a deficit in each WRZ by the end of their WRMP plan period, once additional demand from growth and other factors such as climate change are taken into account.

7.2.1 Water Resource Planning in the Study Area

The latest Southern Water WRMP and South East Water WRMP were published in 2019 and 2020 respectively and the information within these WRMP's has been used to inform the WCS. In reviewing both WRMP's and through liaison with Southern Water and South East Water it has been established that the growth figures assessed for this WCS study are catered for in the prediction of supply and demand deficits in the relevant WRZs under average conditions. Therefore, conclusions on available water supply from both WRMP's can be used directly in this study to inform and support the Local Plan.

7.3 Planned Water Availability Summary

7.3.1 Supply-Demand Strategy in South East Water

It is identified within the South East Water WRMP (2020) that water supply within WRZ4 (Bracknell) is supplied from a number of sources, including:

- 21% of water is supplied by one surface water source;
- 63% of water is supplied from 12 groundwater sources from the Chalk, Greensand and Hythe aquifers; and
- 17% of water is supplied by inter-company transfer from Affinity Water.

South East Water's assessment of available water in their baseline predictions (without any measures) identifies that the Western WRZs, which includes WRZ4 (Bracknell), is in surplus from 2020/21 (+53.2 Ml/d) through to 2039/40 (+14.1 Ml/d) under average conditions. However, at a company level there is anticipated to be a deficit of water in the future with sustainability reductions being the significant driver of the deficits between 2025 and 2045.

South East Water have identified a number of schemes that will benefit the WRZ4 (Bracknell). The measures which are proposed to maintain the supply-demand balance show that the available supplies will be sufficient to meet expected demand to provide a reliable and environmentally resilient water supply. The measures for WRZ4 (Bracknell) are summarised in Table 7-4.

Table 7-4: South East Water WRMP Preferred Plan Schemes for WRZ4 (Bracknell)

Period	Preferred Plan Schemes
2020-2025	• Leakage reductions • Water efficiency
2025-2045	• Leakage reductions • Water efficiency • Catchment management at Woodgarston • Export from WRZ4 to Affinity Water – Egham to Surrey Hills (Temporary reduction)

7.3.2 Supply-Demand Strategy in Southern Water

It is identified within the Southern Water WRMP (2019) that water supply within the Hampshire Kingsclere WRZ is supplied fully from groundwater sources.

Southern Water's assessment of available water in their baseline predictions (without any measures) identifies that the western area, which includes the Kingsclere WRZ, does not have sufficient water for the whole of the planning period to meet its customers' need.

Southern Water has therefore identified a number of schemes that will benefit the WRZ. This strategy ensures that Southern Water maintains a headroom surplus throughout the planning period. The key measures identified within the Southern Water WRMP for the western area, which includes the Hampshire Kingsclere WRZ, are outlined in Table 7-5 below.

Table 7-5: Southern Water WRMP Preferred Schemes for the western area which includes the Hampshire Kingsclere WRZ

Period	Preferred Schemes
2020 onwards (all WRZs in the western area)	**Demand management** • Target 100 water efficiency activity[26] • Leakage reduction (15% reduction by 2025; 50% by 2050) • Extension of Universal Metering Programme Period • Temporary Use Ban and Non-Essential Use Ban
2027	**Resource development and bulk supplies** • Asset enhancement at a source south of Newbury

Due to abstraction licence changes, there are requirements to develop new sources of supply within the Western Area of Hampshire which Southern Water are considering and addressing via the Regulators Alliance for Progressing Infrastructure Development (RAPID) process.

7.3.3 Water efficiency in the study area

In order to ensure water efficiency in the future, South East Water and Southern Water have both 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.

Since development within the study area is not proposed to exceed that for which both South East Water and Southern Water are planning, it is not necessary to evaluate the impacts of water supply in the study area independently of the WRMPs and their assessments.

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

[26] This is an initiative to target a usage of 100 litres per person per day in properties within the Southern Water supply area

7.4 Water Neutrality

In order to ensure surplus raw water supply for growth in the study area, Southern Water WRMP is reliant on 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 and geographical setting which is at the headwaters of the rivers. Therefore looking beyond the current planning period, further new resources would potentially need to be transferred into the area to cater for further increases in population and hence water demand. This creates a very strong driver for all new homes in the borough to be made as efficient as economically possible to safeguard the future resources to be made available by South East Water and Southern Water in the study area.

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. If this can be achieved, the overall balance for water demand is 'neutral', and there is considered to be no net increase in demand as a result of development. In order to achieve this, new development needs to be subject to planning policy which aims to ensure that where possible, houses and businesses are built to high standards of water efficiency through the use of water efficient fixtures and fittings, and in some cases rainwater harvesting and greywater recycling.

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

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

Achieving 'total' water neutrality within a development remains an aspirational concept 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 blackwater 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 study area as a whole.

7.4.1 Methodology

Metering Assumptions

Installing water meters within existing residential properties is an important element of the Southern Water WRMP to manage their customers' demand for water. The existing level of metering within the Kingsclere WRZ is 76%. Southern Water's future target for meter penetration on domestic water supplies is 80% by 2039.

The existing level of metering within the whole area supplied by South East Water is 90%. However, this has been assumed to be 100% since the remaining housing stock cannot be metered and therefore there will be no increase on the current meter penetration on the existing domestic water supplies.

The Southern Water metering programme has been applied to the three water neutrality scenarios (detailed below).

Demand in new homes

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:

- **Projection 1** – Average metered consumption – New homes in the borough would use 174l/h/d, which reflects a pro-rata of the planning consumption used by South East Water and Southern Water to maintain security of supply;
- **Projection 2** – 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 3** – 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. Where it applies, new homes would conform to (and not use more than) Part G of the Building Regulations optional requirement of 110 l/h/d (which is a requirement within the current Local Plan);
- **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.

Using these projections, the increase in demand for water has been calculated for both housing growth scenarios. The projections are shown in Figure 7-1 and Figure 7-2.

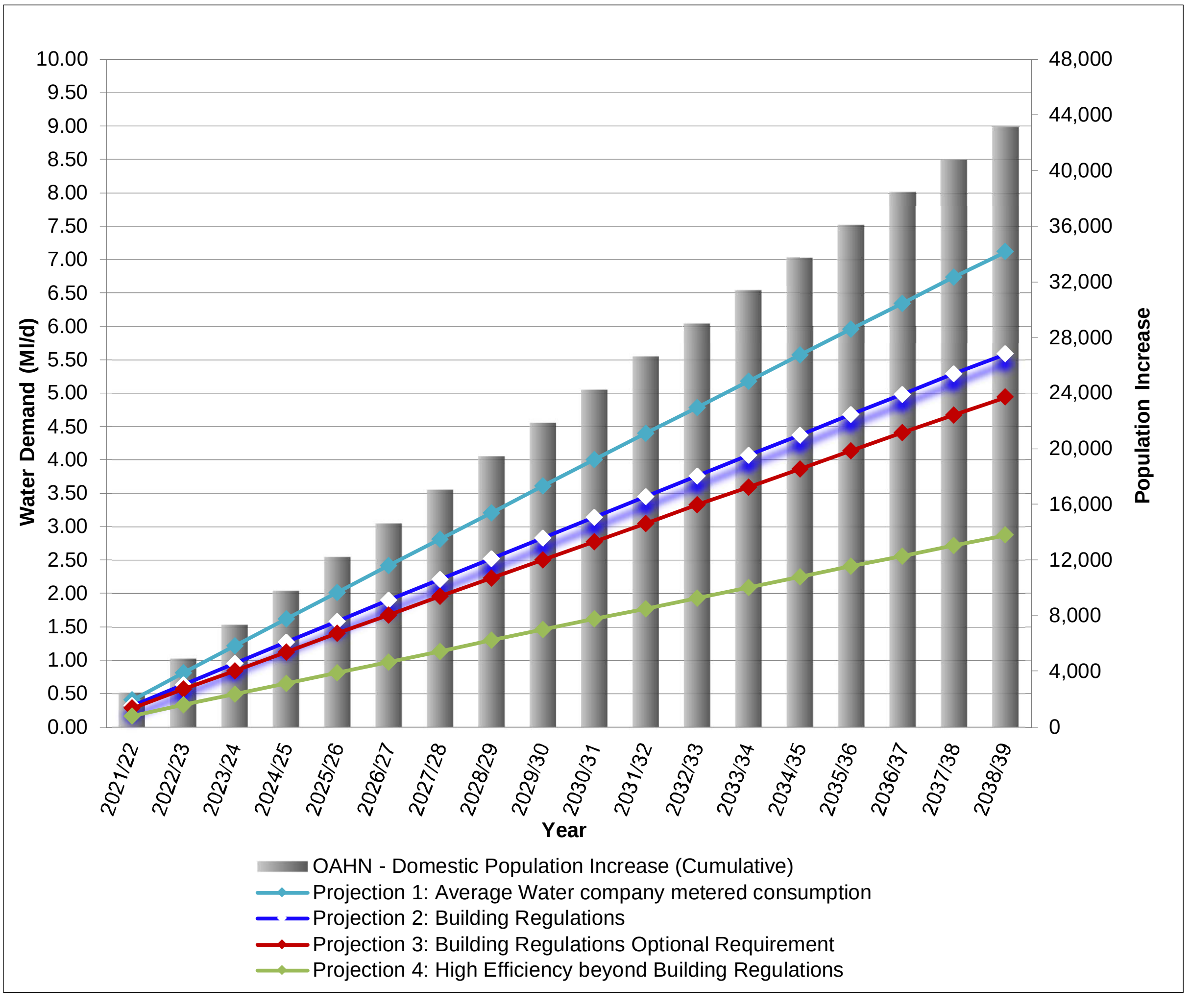


Figure 7-1: Range of water demands for Growth Scenario 1 across plan period in the study area depending on efficiency levels of new homes

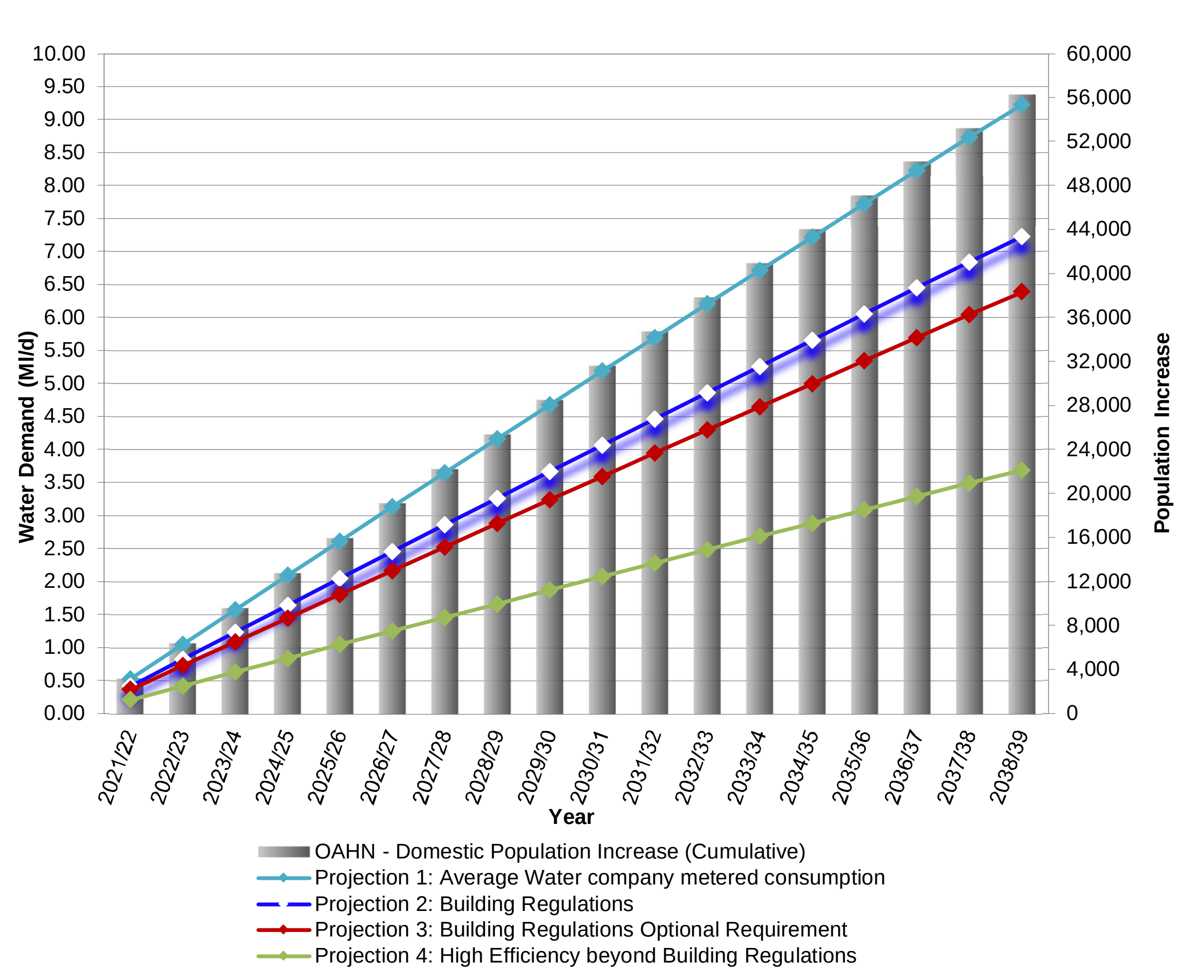


Figure 7-2: Range of water demands for Growth Scenario 2 across plan period in the study area depending on efficiency levels of new homes

Water Neutrality Scenarios

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[27]. Generally, these measures fall into two categories due to cost and space constraints, as those that should be installed in new developments and those which could be retrofitted. Appendix G provides more detail on the different types of device or system along with the range of efficiency savings they could lead to and examples of partnership approaches and funding sources that would need to be developed to achieve any level of neutrality.

Waterwise in conjunction with the Environment Agency, DEFRA, OFWAT and the Department of Communities and Local Government published a best practice guide to water efficiency and retrofitting in 2009. This guide provides case studies and advice on how water companies, local authorities and housing providers can manage retrofitting strategies under different scenarios[28]. These have been used to develop a number of 'scenarios' which have been used to demonstrate the different levels of water neutrality that could be achieved with the implementation of different measures.

1. High Scenario (Theoretical neutrality)

This 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 study area 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.

[27] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.
[28] Water Efficiency Retrofitting: A Best Practice Guide. Waterwise 2009. Available at: http://www.waterwise.org.uk/resources.php/30/water-efficiency-retrofitting-a-best-practice-guide

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 (up to 50% depending on the growth scenario) in the study area.

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 Plans 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 study area which is currently limited to small scale development in the UK.

2. Medium Scenario

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

It would require:

- Meter installation as per Southern Water's WRMP by 2039 (80% meter penetration within their supply area);
- Uptake of retrofitting water efficiency measures to be reasonably high (15%) in the study area; 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.

3. Low Scenario

The key assumptions for this scenario are that the water neutrality percentage 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 as per Southern Water's WRMP by 2039 (80% meter penetration within their supply area);
- Uptake of retrofitting water efficiency measures to be fairly low (5%); 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.

7.4.2 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 Borough was calculated to be 28.39 Ml/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 of existing housing stock for the differing levels of water efficiency in new homes;
- Stage 2 – total demand post growth with effect of metering applied to the existing housing stock for the differing levels of water efficiency in new homes; and,
- Stage 3 – total demand post growth (additional household and non-household use) 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 7-6 (for Growth Scenario 1) and Table 7-7 (for Growth Scenario 2). 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.

Table 7-6: Results of the Neutrality Scenario Assessments (Growth Scenario 1)

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 AWS metered consumption	125	0	7.12	35.51	35.51	35.51	0%
Low	Projection 1a: Building Regulations	125	0	5.59	33.98	33.98	33.98	21%
	Projection 1b: Building Regulations + retrofit	125	5	5.59	33.98	33.98	33.61	27%
Medium	Projection 2a: Building Regulations optional requirement	110	0	4.94	33.33	33.33	33.33	31%
	Projection 2b: Building Regulations optional requirement + retrofit	110	15	4.94	33.33	33.33	32.23	46%
High	Projection 3: High efficiency + retrofit	62	38.5	2.87	31.26	31.26	28.42	100%

* prior to demand management for existing housing stock

Table 7-7: Results of the Neutrality Scenario Assessments (Growth Scenario 2)

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 AWS metered consumption	125	0	9.23	37.62	37.62	37.62	0%
Low	Projection 1a: Building Regulations	125	0	7.23	35.62	35.62	35.62	22%
	Projection 1b: Building Regulations + retrofit	125	5	7.23	35.62	35.62	35.25	26%
Medium	Projection 2a: Building Regulations optional requirement	110	0	6.39	34.78	34.78	34.78	31%
	Projection 2b: Building Regulations optional requirement + retrofit	110	15	6.39	34.78	34.78	33.67	43%
High	Projection 3: High efficiency + retrofit	62	50	3.69	32.08	32.08	28.39	100%

* prior to demand management for existing housing stock

The results show that total neutrality is only achieved by applying the High water neutrality scenario, requiring new homes to use water at a rate of 62 l/h/d with retrofitting a minimum of 38.5% of the existing housing stock with water efficiency fittings for Growth Scenario 1 and a minimum of 50% for Growth Scenario 2. The Medium water neutrality scenario would give a minimum of 31% neutrality which would require only new homes to be designed to use water at a rate of 110 l/h/d (Projection 2a).

7.4.3 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 Borough, reaching neutrality should not be at the expense of increasing energy use and potentially increasing the carbon footprint of development.

Using the information compiled, the financial costs per neutrality scenario has been calculated and are included in Table 7-8 for Growth Scenario 1 and Table 7-9 for Growth Scenario 2. It should be noted that these are only estimated costs based on strategic level research into water efficiency implementation and cost.

Table 7-8: Estimated Cost of Neutrality Scenarios (Growth Scenario 1)

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	18,632	£-	3,728	£1,864,150	5%	3,728.30	£708,377	£-	£2,572,527	£2,572,527
Medium	18,632	£167,688	3,728	£1,864,150	15%	11,184.90	£2,125,131	£167,688	£3,989,281	£4,156,969
High (Theoretical Neutrality)	18,632	£76,335,304	3,728	£1,864,150	38.50%	28,707.91	£5,454,503	£76,335,304	£7,318,653	£83,653,957

Table 7-9: Estimated Cost of Neutrality Scenarios (Growth Scenario 2)

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	24,303	£-	3,728	£1,864,150	5.00%	3,728.30	£708,377	£-	£2,572,527	£2,572,527
Medium	24,303	£218,727	3,728	£1,864,150	15.00%	11,184.90	£2,125,131	£218,727	£3,989,281	£4,208,008
High (Theoretical Neutrality)	24,303	£99,569,391	3,728	£1,864,150	50.00%	37,283.00	£7,083,770	£99,569,391	£8,947,920	£108,517,311

7.4.4 Delivery Requirements

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

To achieve any level of neutrality, a series of policies, partnership approaches and funding sources would need to be developed. This WCS has assumed a 'medium' scenario would be favoured and sets out what would be required to support this strategy. This 'medium' scenario would allow a water neutrality target of between 31% and 46% for Growth Scenario 1 or 43% for Growth Scenario 2 to be reached. 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 continued implementation of the current Local Plan restriction of water use in new homes. It would require:

- New housing development to adhere to the requirements of Basingstoke and Deane Local Plan Policy EM9, being designed 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 Borough; 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 of neutrality 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.

Policy

BDBC has already included a requirement in the Basingstoke and Deane Local Plan (2011 – 2029) (Policy EM9) 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) or less; therefore, this policy element of the delivery requirements is already 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.

Partnership Approaches

Housing association partners should be targeted with a programme of retrofitting water efficient devices, to showcase the policy and promote the benefits. This should be a collaborative scheme between BDBC, South East Water, Southern Water and Waterwise. In addition, rainwater harvesting and/or greywater recycling schemes could be implemented into larger council owned and maintained buildings, such as schools or community centres. Rainwater harvesting could be introduced to public toilets.

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

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

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

- working with South East Water and Southern Water 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 Borough, but rather should be used to support a targeted scheme aimed at a specific residential group.

Relationships

The recommendations above are targeted at BDBC, South East Water and Southern Water 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 7-10.

Table 7-10: Responsibility for implementing water efficiency

Responsibility	Responsible stakeholder
Ensure planning applications are compliant with the recommended policies	BDBC
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	BDBC
Ensure continuing increases in the level of water meter penetration	Southern Water
Retrofit devices within council owned housing stock	BDBC
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 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.	BDBC
Educate and raise awareness of water efficiency	BDBC, South East Water and Southern Water

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

Retrofitting funding options

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.

Part 11 of the Planning Act 2008 (c. 29) ("the Act") provides a mechanism for the imposition of a charge on new developments to be known as the Community Infrastructure Levy (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 allows a 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.

BDBC could consider developer contributions through CIL, S106 agreements or even through development of an offset policy. However, there are considerable existing demands on developer contributions and it is unlikely that all of the retrofitting required in the Borough 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). BDBC should consider a similar scheme, although this would require the agreement of South East Water and Southern Water.

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. 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.

8. Water Cycle Study Recommendations

Based on the assessments and appraisals undertaken in the WCS, recommendations are made for water management policies and approaches that should be taken forward in the updated Local Plan to deliver the planned growth whilst supporting the sustainability of the water environment.

8.1 Wastewater

Development in the Ashford Hill, Whitchurch, Overton, Oakley and Barton Stacey catchments *(due to potential for flow condition to be exceeded)*
It is recommended that the Council consider embedding a development control policy within their Local Plan that requires developers to provide evidence to them that they have both consulted with Thames Water/Southern Water regarding wastewater treatment capacity, and the outcome of this consultation, prior to development approval. The Council should consider the response from Thames Water/Southern Water when deciding if the expected timeframe for the development site in question is appropriate, and should also be taken into consideration for development of the Local Plan.

Where there is uncertainty from Thames Water/Southern Water 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.

Treatment Capacity Review
In addition to the Council publishing its Annual Monitoring Report (AMR) on the Council's website, it is recommended that BDBC continues to consult with Thames Water, Southern Water and the Environment Agency on Local Plan proposals to ensure that plans for WwTW upgrades in response to discharge permit change requirements or flow capacity constraints take account of the most up to date planning position. In addition, it is recommended that BDBC provide regular updates about the timing and delivery of strategic sites to Thames Water and Southern Water, which would assist in planning where further investment in water recycling infrastructure is required to accommodate further growth.

Further to this, all Major Development at sites which are located within the catchments of the WwTWs that were assessed within this WCS as requiring a new flow permit or discharge permit to facilitate growth should be subject to a pre-development enquiry 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. Prior to development, it should be satisfied that the development can be accommodated either within the limits of capacity at the WwTW or by sufficient additional capacity being made available, and that the water quality requirements of the WFD will not be compromised.

Development and the Sewerage Network
It is recommended that Major Development sites should be subject to a pre-development enquiry 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.

8.2 Water Supply

Water Efficiency
In order to move towards a more 'water neutral position' throughout the Borough, 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 the Local Plan. 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 Council continues to update South East Water and Southern Water 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.

8.3 Water Quality

Water Quality Improvements

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

8.4 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 BDBC when future development plans evolve via the Council's Annual Monitoring Reports, to enable continued assessment on water supply and wastewater treatment. Where changes in growth patterns, numbers or distributions are 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, including:

- Five yearly reviews of South East Water and Southern Water's WRMP;
- Next periodic review in 2024 to develop the Thames Water and Southern Water business plan for AMP8 – 2025 to 2030; and
- Five yearly reviews of the Thames and South East River Basin Management Plan.

Appendix A Policy and Legislative Drivers Shaping the WCS

Legislation

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.
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: 1. 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. 2. 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. 3. 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. 4. To enable water and sewerage companies to operate concessionary schemes for community groups on surface water drainage charges. 5. 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 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)	This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. Its aim is to protect the environment from any adverse effects caused by the discharge of such waters.
Water Act 2003	Implements changes to the water abstraction management system and to regulatory arrangements to make water use more sustainable.
Water Framework Directive (WFD) 2000/60/EC	The WFD, combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level has been adopted. The overall requirement of the directive is that all river basins must achieve 'Good ecological status' by 2015 or by 2027 if there are no 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[29], an advisory body which has proposed water quality, ecology, water abstraction and river flow standards to be adopted in order to ensure that the water bodies in the UK (including groundwater) meet the required status[30]. Standards and waterbody 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.

Planning Documents

Category	Author	Document Name	Publication Date
Water Resources	South East Water	Water Resources Management Plan	2020
Water Resources	Southern Water	Water Resources Management Plan	2019
Local Plan	Basingstoke and Deane Borough Council	Basingstoke and Deane Local Plan 2011 to 2029	2016
Flood Risk	Hampshire County Council	Hampshire Local Flood Risk Management Strategy 2013	2013
Flood Risk	Basingstoke and Deane Borough Council	Basingstoke and Deane Level 1 Strategic Flood Risk Assessment	2020

[29] 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.
[30] UK Environmental Standards and Conditions (Phase I) Final Report, April 2008, UK Technical Advisory Group on the Water Framework Directive.

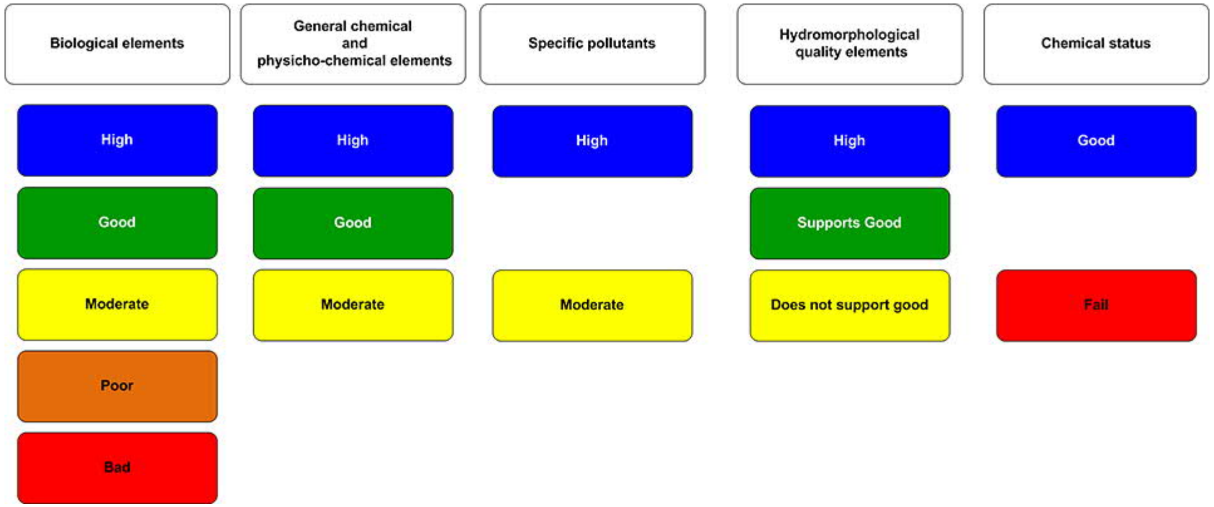
Appendix B WFD classifications for water bodies in the study area

Surface water bodies

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. Under the WFD, the worst-case classification is assigned as the overall surface water body status, that is, a 'one-out-all-out' system. The following is an example of the classification hierarchy and the diagram 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)



WFD classifications of surface water bodies in Basingstoke borough (Status in 2019)

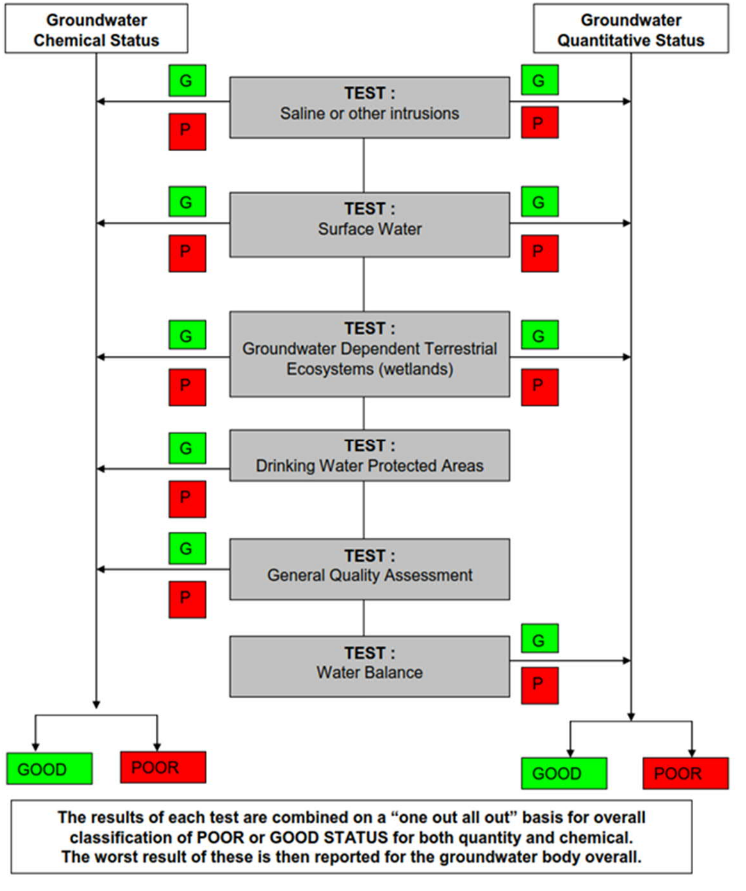
Waterbody ID	Waterbody name	Catchment	Current 2019 status	Target status/ potential	Physico-chemical 2019 status				Reasons for Not Achieving Good (2019)	Change to target status in draft RBMP (2021) compared to current RBMP (2015)
					Overall Phys-chem status	Ammonia	Dissolved Oxygen	Phosphate		
GB107042022620	Candover Brook	Itchen	Moderate	Good (2027)	High	High	High	High	Groundwater abstraction Drought	No change
GB106039017200	Baughurst Brook	Kennet	Moderate	Good (2027)	Good	High	Good	Good	Groundwater abstraction	No change
GB106039017230	Earlstone Stream and Burghclere Brook (source to Enborne)	Kennet	Poor	Good (2027)	Moderate	High	Moderate	Good	Drought Physical modifications	No change
GB106039017250	Ecchinswell Brook (source to Enborne)	Kennet	Moderate	Good (2027)	Moderate	High	High	Moderate	Poor livestock management Poor nutrient management	No change
GB106039017261	Enborne (Burghclere Brook to Kingsclere Brook)	Kennet	Moderate	Moderate (2015)	Moderate	High	Moderate	Poor	Sewage discharge Poor livestock management Groundwater abstraction	No change
GB106039017310	Enborne (downstream A34 to Burghclere Brook)	Kennet	Moderate	Moderate (2015)	Moderate	High	Moderate	Poor	Sewage discharge Poor livestock management	No change
GB106039017280	Enborne (Source to downstream A34)	Kennet	Good	Good (2027)	Good	High	Good	High		Target status of Good (2021)
GB106039017220	Kingsclere Brook (Source to Enborne)	Kennet	Moderate	Moderate (2015)	Moderate	High	High	Poor	Sewage discharge Groundwater abstraction	No change
GB106039017340	Lower Enborne	Kennet	Moderate	Good (2027)	Moderate	High	Good	Moderate	Sewage discharge Physical modifications Poor livestock management Poor nutrient management	No change

Waterbody ID	Waterbody name	Catchment	Current 2019 status	Target status/ potential	Physico-chemical 2019 status				Reasons for Not Achieving Good (2019)	Change to target status in draft RBMP (2021) compared to current RBMP (2015)
					Overall Phys-chem status	Ammonia	Dissolved Oxygen	Phosphate		
GB106039017210	Penwood Stream	Kennet	Moderate	Good (2027)	Moderate	High	Moderate	Good	Drought Physical modifications	No change
GB106039017190	Silchester Brook	Kennet	Moderate	Moderate (2015)	Moderate	Good	Moderate	Poor	Sewage discharge	No change
GB106039017300	West End Brook (tributary of Foudry Brook)	Kennet	Poor	Good (2027)	Good	High	High	Good	Physical modifications Invasive non-native species	No change
GB106039017140	Bow Brook (Bramley to Sherfield Green)	Loddon	Moderate	Moderate (2015)	Moderate	High	Good	Poor	Sewage discharge Poor nutrient management	No change
GB106039017160	Bow Brook (Pamber End to Bramley)	Loddon	Poor	Good (2027)	Good	High	High	Good	Physical modifications	No change
GB106039017080	Loddon (Basingstoke to River Lyde confluence at Hartley Wespall)	Loddon	Poor	Moderate (2027)	Good	High	Good	High	Sewage discharge Barriers – ecological discontinuity Land drainage	Target status of Good (2027) with low confidence
GB106039017150	Loddon (Hartley Wespall to Sherfield on Loddon)	Loddon	Moderate	Moderate (2015)	Moderate	High	Good	Moderate	Sewage discharge	Target status of Good (2027) with low confidence
GB106039017330	Loddon (Sherfield on Loddon to Swallowfield)	Loddon	Moderate	Moderate (2015)	Moderate	High	Good	Moderate	Sewage discharge Poor nutrient management Physical modifications	Target status of Good (2027) with low confidence
GB106039017100	Lyde	Loddon	Poor	Poor (2015)	High	High	High	High	Physical modifications	Target status of Good (2027) with low confidence
GB106039017110	Vyne Stream	Loddon	Moderate	Moderate (2015)	Moderate	High	High	Poor	Sewage discharge Poor nutrient management Physical modifications	Target status of Good (2027) with low confidence

Waterbody ID	Waterbody name	Catchment	Current 2019 status	Target status/ potential	Physico-chemical 2019 status				Reasons for Not Achieving Good (2019)	Change to target status in draft RBMP (2021) compared to current RBMP (2015)
					Overall Phys-chem status	Ammonia	Dissolved Oxygen	Phosphate		
GB106039017240	Whitewater	Loddon	Poor	Poor (2015)	Moderate	High	Moderate	Good	Sewage discharge Poor nutrient management Physical modifications	Target status of Good (2027) with low confidence
GB107042022810	Anton - Upper	Test (Upper and Middle)	Good	Good (2015)	High	High	High	High		No change
GB107042022720	Bourne Rivulet	Test (Upper and Middle)	Moderate	Good (2027)	Good	High	High	Good	Physical modifications	No change
GB107042022770	Dever	Test (Upper and Middle)	Good	Good (2015)	High	High	High	High		No change
GB107042022700	Test - Bourne Rivulet to conf Dever	Test (Upper and Middle)	Good	Good (2015)	High	High	High	High		No change
GB107042022710	Test (Upper)	Test (Upper and Middle)	Good	Good (2015)	High	High	High	High		No change
GB106039017800	North Wey at Alton	Wey	Moderate	Good (2027)	Moderate	High	Moderate	Good	Physical modification Groundwater abstraction Sewage discharge	No change

Groundwater bodies

Under the WFD, groundwater body status is classified on the basis of quantitative and chemical status. Groundwater bodies are separated into Groundwater Management Units (GWMUs) and Water Resource Units (WRMUs). Groundwater Management Units are sub-divisions of the groundwater to aid the resource assessment process. Water Resource Management Units are sub-divisions according to the water resource availability and the management of water. Status is assessed primarily using data collected from the Environment Agency monitoring network; therefore the scale of assessment means that groundwater status is mainly influenced by larger scale effects such as significant abstraction or widespread diffuse pollution. The worst-case classification is assigned as the overall groundwater body status, in a 'one-out all-out' system, similar to that of surface water body status.



WFD classifications of groundwater bodies in Basingstoke borough (Status in 2019)

Waterbody ID	Waterbody Name	Current Status (2019)	Target Status Objective	Quantitative Status	Chemical Status	Reasons for Not Achieving Good	Changes to target status in draft RBMP (2021) compared to current RBMP (2015)
GB40601G600900	Berkshire Downs Chalk	Poor	Poor (2015)	Poor	Poor	Poor nutrient management Groundwater abstraction Private Sewage Treatment	Target status of Good (2027) with low confidence
GB40602G601500	Aldermaston Bagshot Beds	Good	Good (2015)	Good	Good		No change
GB40601G501300	Basingstoke Chalk	Poor	Poor (2015)	Poor	Poor	Poor nutrient management Groundwater abstraction	Target status of Good (2027) with low confidence
GB40701G501200	River Test Chalk	Poor	Good (2027)	Good	Poor	Poor nutrient management	Target status of Good (2060)
GB40701G505000	River Itchen Chalk	Poor	Poor (2015)	Poor	Poor	Poor nutrient management Groundwater abstraction	Target status of Good (2060)

Appendix C Groundwater Inputs

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Project ref:
60616914 Basingstoke & Deane Water Cycle Study

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Date:
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Memo

Subject: Groundwater inputs to Water Cycle Study

Background

AECOM Limited are working to produce a Water Cycle Study (WCS) for Basingstoke and Deane Borough Council and were subsequently instructed to undertake technical work on the nitrate neutrality requirement in the River Test and River Itchen catchments. The Water Environment team were asked to complete two specific tasks, as follows:

- To estimate the travel time between the point of discharge for seven wastewater treatment works (WwTWs) and emergence at the nearest connected watercourse; and
- To delineate the groundwater catchment that feeds into the River Test and River Itchen catchments within the Borough Council's area.

The seven WwTWs of concern (hereafter collectively referred to as the "Sites") are located within the boundary line of the Basingstoke and Deane Borough Council as shown in Figure 1, with the exception of Barton Stacey WwTW. This site is located at approximately 2.8 km outside of the Borough Council boundary but has been included as some developments within the Borough Council boundary are served by this WwTW. The site names, including the Dry Weather Flow (DWF) volumes from each WwTW, are given in Table 1 below.

Table 1. Site names and DWF volumes

Site name	Operated by	Discharging to	DWF (m^3/day)
Barns Close Ashmansworth WwTW		Discharge to ground via infiltration system	5
Hannington WwTW		Assumed discharge to ground via infiltration system	10.2
Ivy down Lane Oakley WwTW			722
North Waltham WwTW	Southern Water	Discharge to ground via infiltration system	167
Overton WwTW			1,160
Whitchurch WwTW			2,336
Barton Stacey WwTW		Assumed discharge to ground via infiltration system	1,746

Source: Environment Agency consultation/ response to data request, dated 17/12/19

Task 1: Groundwater travel time calculations

1.A. Desk study

A desk study was carried out to review the geological and hydrogeological setting and the aquifer properties of the groundwater bodies which receive discharges from the WwTWs, in order to build up a conceptual model of groundwater flow. The British Geological Survey (BGS) online map viewer was examined for the area of interest and details of the findings are given below.

Geological and hydrogeological setting of the Sites

The geological and hydrogeological setting across the Sites is similar with slight local variations which is primarily to do with the presence and absence of superficial geological units. Additionally, the topography of the land within the vicinity of each WwTW varies, which in turn may influence the local groundwater flow direction, hydraulic gradient and flow velocity.

Superficial geology

The main superficial deposits in the area of the Sites consist of sparsely deposited Alluvium, River Terrace Deposits, Clay-with-Flints and Head Deposits, as shown in Figure 2. More detail is provided below:

- The Alluvium is generally up to 25m thick and consists of sands, silts and clays with some bands of gravel. It is found in the buried valleys and forms sinuous tracts along the valley floors and tidal reaches of the River Test and its tributary in the area.
- The River Terrace Deposits are generally up to 10m thick and consist of gravels and loams of various ages bordering the Alluvium in the river valleys.
- The Clay-with-Flint Deposits are more extensive in the area and are generally up to 10m thick, comprising of poorly bedded silty loams, which sometimes includes seams of flint and chalk pebbles.
- The Head Deposits comprise of clay, silt, sand and gravel, are of variable thickness and occur on the upper or middle slopes of catchments.

The superficial deposits are not laterally present across the entire area, and therefore they are absent underneath some of the Sites, as shown in Figure 2 and Table 2.

Bedrock geology

The White Chalk Subgroup comprises the main bedrock formation which underlies the entire area and is present underneath all seven WwTWs. The White Chalk Subgroup is over 50m thick in the area and consists of soft white Chalk with conspicuous semi-continuous nodular and tabular flint seams. The Chalk is the principal aquifer (water-bearing unit) in the area and includes Source Protection Zones (SPZs) for potable water supply. It is also the principal target receptor of all treated water discharged from each of the seven WwTW under the current assessment.

Groundwater occurrence, flow direction and hydraulic characteristics

Groundwater occurs in the Chalk across the entire region under an unconfined groundwater condition, i.e. the water table is open to receiving potentially polluting discharges from the surface, rather than being protected by an overlying impermeable unit.

Selected BGS borehole records were reviewed across the region and indicate that groundwater level varies between 60 – 90 m AOD (i.e. 0 - 30m below ground level) depending on land elevation. Fissure flow predominates groundwater flow in the Chalk.

Published Hydrogeology Map Sheet 9[1] indicates a regional groundwater flow direction of NNE – SSW with a regional hydraulic gradient of about 0.0016. However, it is worth noting that the groundwater flow direction and

[1] Institute of Geological Sciences, 1977. Hydrogeological Map of Hampshire and the Isle of Wight. Map sheet 9.

hydraulic gradient at the location of each Site may vary slightly due to land elevation and local groundwater condition resulting from seasonal fluctuations or local abstractions.

Groundwater - surface water interaction

The Sites are located within the River Test surface water catchment; therefore, the River Test and its tributaries are the main surface water bodies in the area. The unconfined nature of the Chalk and the high proportion of river flow being contributed by groundwater, or baseflow [2] (see Table 2 below), indicate the River Test and its tributaries are in hydraulic continuity with the underlying Chalk in the area. These surface water bodies are therefore considered to be secondary receptors. Accordingly, for the current assessment, the groundwater flow calculations as summarised in Table 4 have been calculated only for the Chalk.

Table 2. Baseflow indices

River name	Station No.	BFI (%)
Dever	42015	0.94
Dever	42027	0.96
Test	42024	0.97

Source: National River Flow Archive, https://nrfa.ceh.ac.uk/data/station/info/42015

Hydraulic properties of the Chalk

The Chalk is a dual-porosity rock (i.e. water is stored both in the intergranular matrix and the fissures). The porosity of the intergranular matrix is generally high (25– 45%) but with low intergranular hydraulic conductivity because of the small pore-neck sizes. The Chalk is, however, usually fractured, and the fracture component has low porosity (0.1–1%) but can increase the hydraulic conductivity by up to three orders of magnitude[3]. Groundwater movement is, therefore, slower through the matrix and much more rapid via the fractures. Implicitly, this amongst other factors can affect the movement and travel time of a contaminant through Chalk. The estimation of groundwater travel times has focused on the hydraulic properties of the Chalk appropriate to this more rapid fracture flow, to make a conservative estimate.

A literature review for this area suggests the following range of values for fracture hydraulic conductivity, effective porosity and lateral groundwater flow rates in the Chalk saturated zone[4] [5].

Table 3. Range of hydraulic properties

Parameter	Unit	Lower end of the range	Upper end of the range
Fracture hydraulic conductivity	m/d	1*	10**
Effective porosity	%	0.1 (0.001)**	1 (0.01)**
Hydraulic gradient	-	0.0016**	0.016***
Lateral flow rates (saturated zone)	m/d	1**	3**

*Source: * Hiscock, 2005 , ** Chilton et al., 2002, *** Estimated as an order of magnitude higher than calculated hydraulic gradient*

[2] Baseflow Index, or BFI, is a measure of the ratio of long-term baseflow to total stream flow and it represents the slow continuous contribution of groundwater to river flow. For streams and rivers on permeable aquifers, such as the Chalk, baseflow may provide the majority of flow in the river and in the summer months it's the entire flow.
[3] Price, M., Bird, M. and Foster, S., 1976. Chalk pore-size measurements and their significance. Water Services, Vol.80, 596–600.
[4] Chilton, P.J., Stuart, M.E., Goody, D.C., Williams, R.J., Johnson, A.C., Haria, A.H., 2002. Transport and fate of pesticides in the Chalk aquifer of southern England. British Geological Survey Research Report 2002. RR/02/04.
[5] Hiscock, K, 2005. Hydrogeology, Principles and Practice.

1.B Groundwater travel time calculations

The groundwater travel time from each WwTW location to the nearest connected watercourse has been calculated using a combination of the Darcy's Flux (v) where v = -k(dh/dl) and the Average Linear Groundwater Velocity (V= v/ne) where (v) is the Darcy's flux and (ne) is the effective porosity of the Chalk.

Applying the hydraulic properties from the lower end of the range – a hydraulic conductivity of 1m/d, a hydraulic gradient of 0.0016 (as calculated from two BGS borehole records (SU55 NE22 and SU44NW38) and an effective porosity of 0.1% (0.001), a groundwater velocity of 1.6m/d has been calculated for the area. This is in line with lateral groundwater flow rates in the Chalk saturated zone from the literature review.

Applying the hydraulic properties from the higher end of the range – a hydraulic conductivity of 10m/d, a hydraulic gradient of 0.016 (estimated as an order of magnitude above calculated hydraulic gradient) and an effective porosity of 1% (0.01), a groundwater velocity of 16m/d has been calculated for the area.

A summary of the calculated groundwater travel time from each WwTW to the identified potential receptors are presented in Table 4 below.

Assumptions and limitations:

The following assumptions and limitations apply to the estimation of the travel time between the WwTWs and emergence at the nearest connected watercourses of interest:

- The approach taken provides a simplistic time of travel between two points in the subsurface based on reported aquifer properties and an estimated hydraulic gradient. It does not account for subsurface or hyporheic zone processes which may degrade/ attenuate contaminants of concern, or of the dilution capacity of the receiving aquifer (primary target) and the receiving watercourse (secondary target), nor does it account for preferential flow paths such as highly permeable superficial deposits overlying the Chalk or karstic flow within the Chalk itself.

Figure 1 Location of the Sites

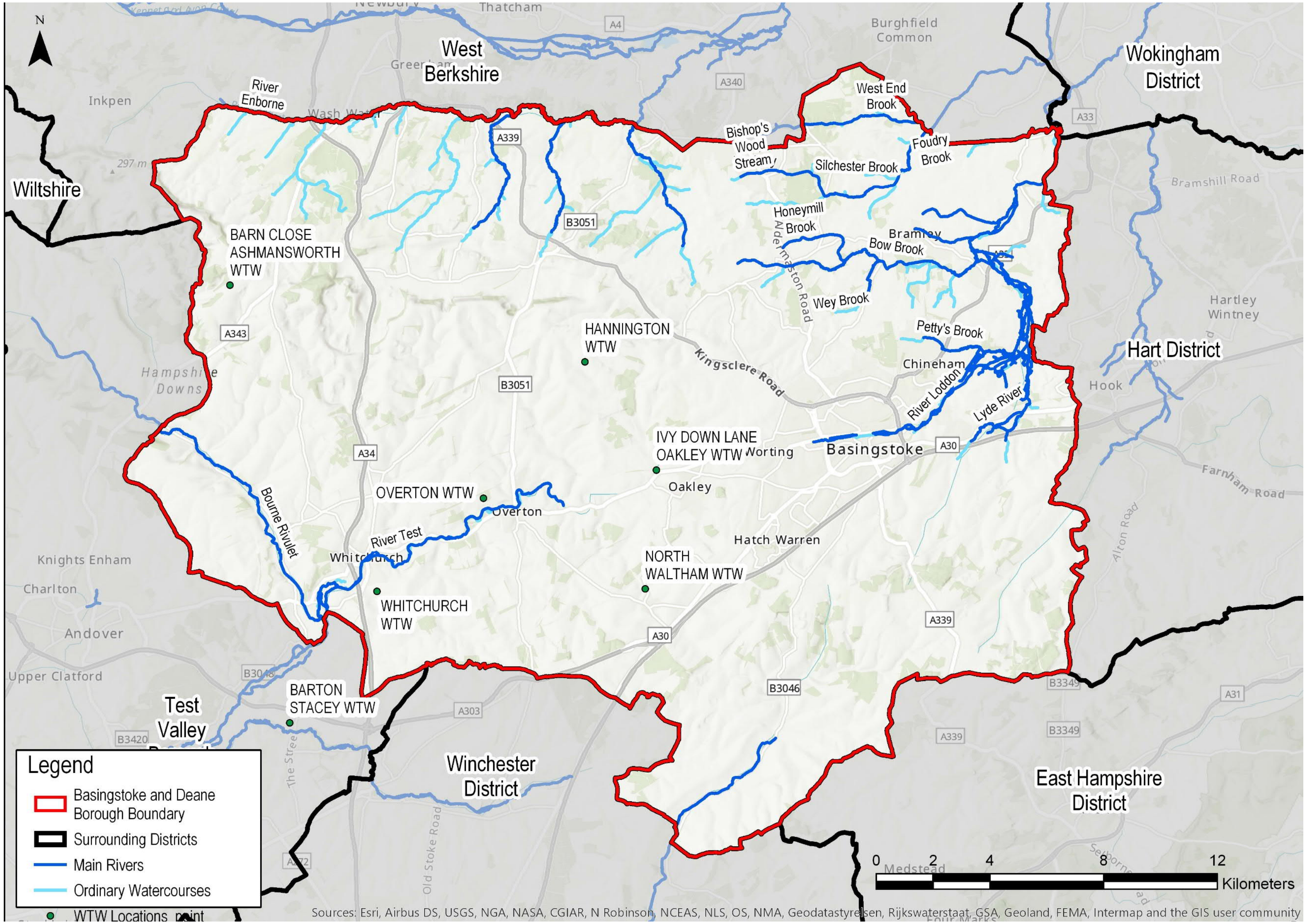

Figure 2 Geological setting of the Sites

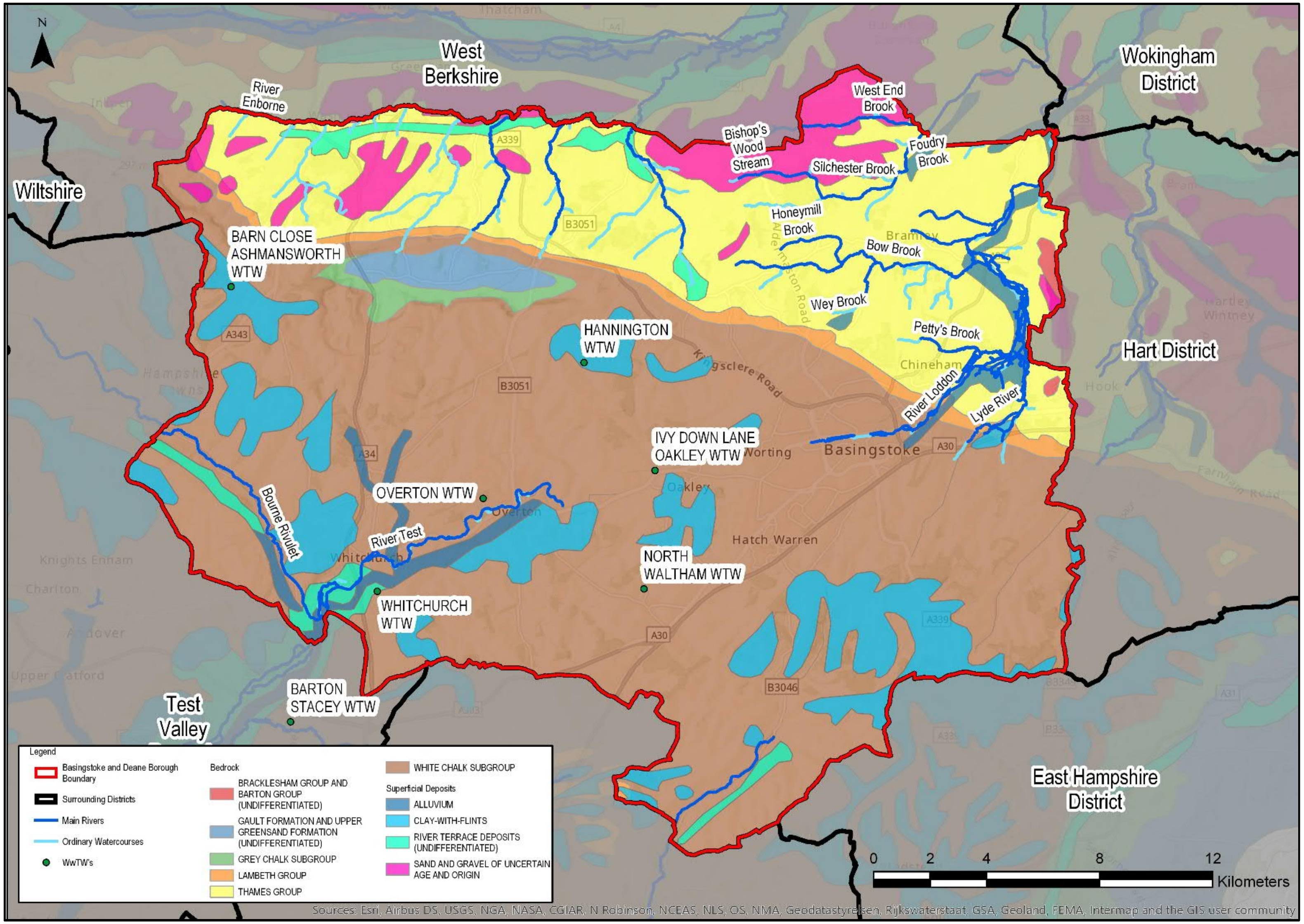

Table 4. Summary of groundwater travel time calculations

Site name	Geology		Principal receptor	Approx. distance to receptor (km)	Travel time to receptor (days)		Secondary receptor	Distance to receptor (km)	Travel time to receptor (days)	
	Superficial deposits	Bedrock geology			Lower end of range	Upper end of range			Lower end of range	Upper end of range
Whitchurch	None	Chalk	River Test	1.88	1,175	118	Unnamed Tributary to River Test	0.71	444	45
Overton	Head Deposits	Chalk	River Test	0.25	156	16	-	-	-	-
North Waltham	River Terrace Deposits	Chalk	River Dever	9	5,625	563	River Test	11	6,875	688
Ivy Down land Oakley	Chalk-with-flint	Chalk	River Test	3.75	2,344	234	-	-	-	-
Hannington	Chalk-with-flint	Chalk	River Test	4.5	2,812	281	-	-	-	-
Barn Close Ashmansworth	Chalk-with-flint	Chalk	Boyne Rivulet	5.5	3,437	344	-	-	-	-
Barton Stacey	None	Chalk	River Dever	0.27	169	17	-	-	-	-

Task 2: Delineation of groundwater catchment

2.A. Desk study

A review was undertaken of the Institute of Geological Sciences (IGS) Hydrogeology Map Sheet 9 [6], the Environment Agency-delineated Water Framework Directive (WFD) groundwater bodies [7] and source protection zones [8], and BGS bedrock geology mapping [9] to build a conceptual model of groundwater sub-catchment boundaries for the area.

The boundaries of the groundwater sub-catchment for the River Test and River Itchen surface water catchments within the Basingstoke and Deane Borough Council area have been delineated as follows:

- The eastern boundary of the groundwater sub-catchment has been delineated using a groundwater divide identified on the published (IGS) Hydrogeology Map Sheet 9 and corresponding mapped boundary of the Basingstoke Chalk groundwater body;
- The northern boundary of the groundwater sub-catchment has been delineated using the outlines of source protection zones delineated by the Environment Agency to protect groundwater sources used for public drinking supply; and
- The north-western, southern, south-western and south-eastern boundary of Chalk groundwater sub-catchment has been delineated following the jurisdictional boundary limit of the borough, even though the Chalk groundwater catchment in these directions extends several kilometres beyond the borough district boundary as indicated in Figure 3.

The Whitchurch and Overton WwTW are the closest WwTW to the River Test and both discharge over 70% (see Table 1) of the total treated wastewater discharged within the local catchment. Accordingly, across the catchment area, the magnitude of potential impact and effect significant from total nitrogen (TN) loading resulting from discharge from the WwTW is therefore likely to be confined to the areas around this two WwTW.

Assumptions and Limitations

The following assumptions and limitations apply to the delineation of the groundwater sub-catchment within which these WwTWs operate and within the Borough Council's area:

- Changes in the groundwater flow direction and or increase or decrease in the delineated catchment as a result of seasonal variations/ fluctuations, i.e. from rainfall, snow, recharge or resulting from local abstractions, have not been considered in the delineation of the local groundwater sub-catchment.

- The groundwater flow direction used in the travel time calculation and catchment delineation is based on the natural hydraulic gradient. No consideration of any potential changes to the hydraulic gradient as a result of local abstractions, seasonal fluctuation or discharge from each WwTW resulting in localised groundwater mound has also not been considered.

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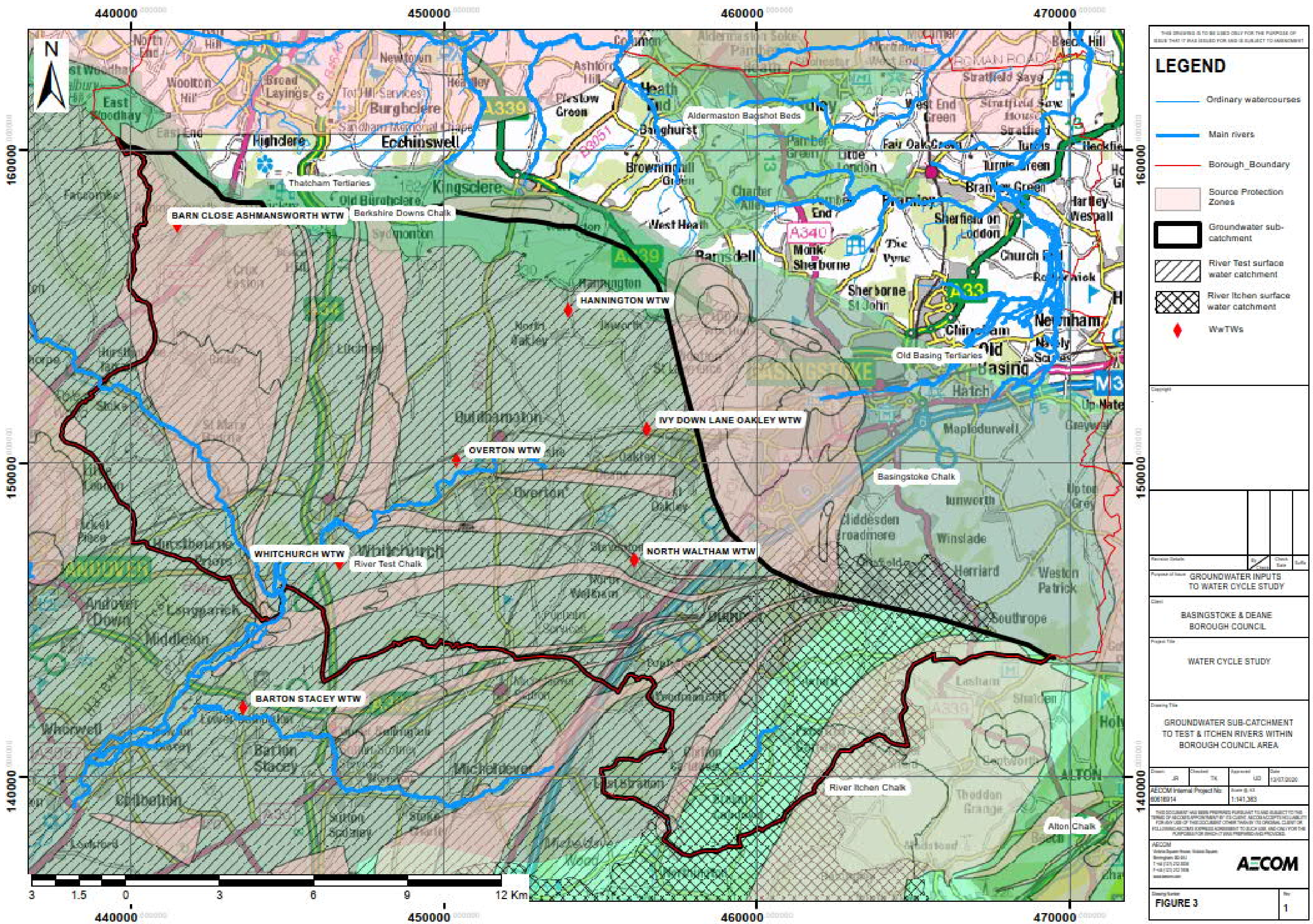
[6] Institute of Geological Sciences, 1977. Hydrogeological Map of Hampshire and the Isle of Wight. Map sheet 9. http://www.largeimages.bgs.ac.uk/iip/mapsportal.html?id=1003979
[7] https://data.gov.uk/dataset/2a74cf2e-560a-4408-a762-cad0e06c9d3f/wfd-groundwater-bodies-cycle-2
[8] https://data.gov.uk/dataset/09889a48-0439-4bbe-8f2a-87bba26fbbf5/source-protection-zones-merged
[9] http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSHydroMap

Figure 3 Groundwater sub-catchment within Basingstoke & Deane Borough Council area



Conclusion

As part of wider work being undertaken by AECOM Limited for Basingstoke and Deane Borough Council, the Water Environment team were asked (1) to estimate the groundwater travel time between the point of discharge from seven WwTWs and emergence at the nearest connected watercourses, and (2) to delineate the groundwater catchment that feeds into the River Test and River Itchen within the Borough Council's area.

In order to estimate groundwater travel times, it has been assumed that all seven WwTWs discharge to ground via an infiltration system, rather than direct to a watercourse. The flow path and travel time from the point of discharge to the nearest connected watercourse will be dictated by the geological and hydrogeological setting. The unconfined Chalk which underlies all of the WwTWs is a highly productive aquifer or groundwater unit, is characterised by rapid fracture flow and is known to contribute a high proportion of river flow to overlying watercourses. A range of groundwater travel flow rates have been estimated, using known hydraulic properties of the Chalk in this area. Then, using the approximate distance between the WwTW and the nearest connected watercourse, an estimate of groundwater travel time has been provided.

In order to delineate the groundwater sub-catchment that feeds into the River Test and River Itchen within the Borough Council boundary, a detailed look at published hydrogeological mapping was undertaken. The boundaries have been delineated using groundwater divides identified on published IGS Hydrogeology Maps, the boundaries of WFD delineated groundwater bodies and groundwater source protection zones as delineated by the Environment Agency, and the jurisdictional boundary limits of the borough.

Appendix D SIMCAT Catchment Modelling

To understand the impacts on and required mitigation of the proposed growth on the river environment in the River Loddon, water quality modelling has been undertaken using an existing SIMCAT model provided by the Environment Agency. River water quality modelling using the Environment Agency's SIMCAT modelling software is recognised as the best current approach to support decision making for water quality management, planning to achieve water quality standards and understanding and planning to limit the impacts of proposed development on the water environment. SIMCAT is used to help understand the current situation and, more significantly, predict the impacts of future changes.

D.1 Received SIMCAT Model

The 2009 River Loddon Catchment SIMCAT model received from the Environment Agency covers the entire River Loddon to the River Thames catchment, including the tributary catchments of the Rivers Whitewater and Blackwater. The model also includes the River Wey and Chertsey Bourne catchments, but results from these sections were not relevant to the River Loddon and they have not been included in the assessment.

The received model was run in Mode 0 (Basic Run) and then in Mode 6 (autocalibration) to check the model representation of river flow and quality and to check for any inconsistencies arising from the autocalibration process. The initial review of the model results showed that the model did not properly reference the observed flow data in its calibration process, so a third model run was carried out to correct this error.

The model results for flow are shown in Figure D1. The original model closely reproduces the gauged flow data in the Loddon catchment (black and yellow squares) when run in Modes 0 and 6 – the light blue mean flow line exactly overlies in the green mean flow line and the dark blue Q_{95} line exactly overlies the amber Q_{95} line. Correcting the model use of gauged flow data only affects the modelled flows at the downstream end of the River Loddon – the broken red mean flow line in Figure D1 exactly overlies the light blue and green mean flow lines except in one location, and the broken purple Q_{95} line overlies the amber and dark blue Q_{95} lines. Review of the flow data used in the received model shows incorrect flow data at the downstream gauging station on the River Loddon. This was replaced with correct data from the National River Flow Archive when updating the model in Section D.2.

Figures D-2, D-3 and D-4 show the impact of the autocalibration and model correction on modelled mean water quality. In some locations the autocalibration slightly changes the concentrations (solid blue lines vs solid green line) to better match the observed data in the received model (black points). In general, the autocalibration process slightly reduces the modelled contaminant concentrations in comparison to the uncalibrated model, although in a few locations the predicted concentrations increased. The corrected model, using all river flow data in the received model, predicts the same water quality to the received model when run in autocalibration Mode 6 (the broken red line matches the blue line).

The corrected received model was updated using all available river water quality, flow and effluent monitoring observations to create a “baseline” model. This was run and then revised further to enable modelling of growth scenarios and to determine the need for discharge permit changes for some WwTW within Basingstoke and Deane in order to meet current water quality targets.

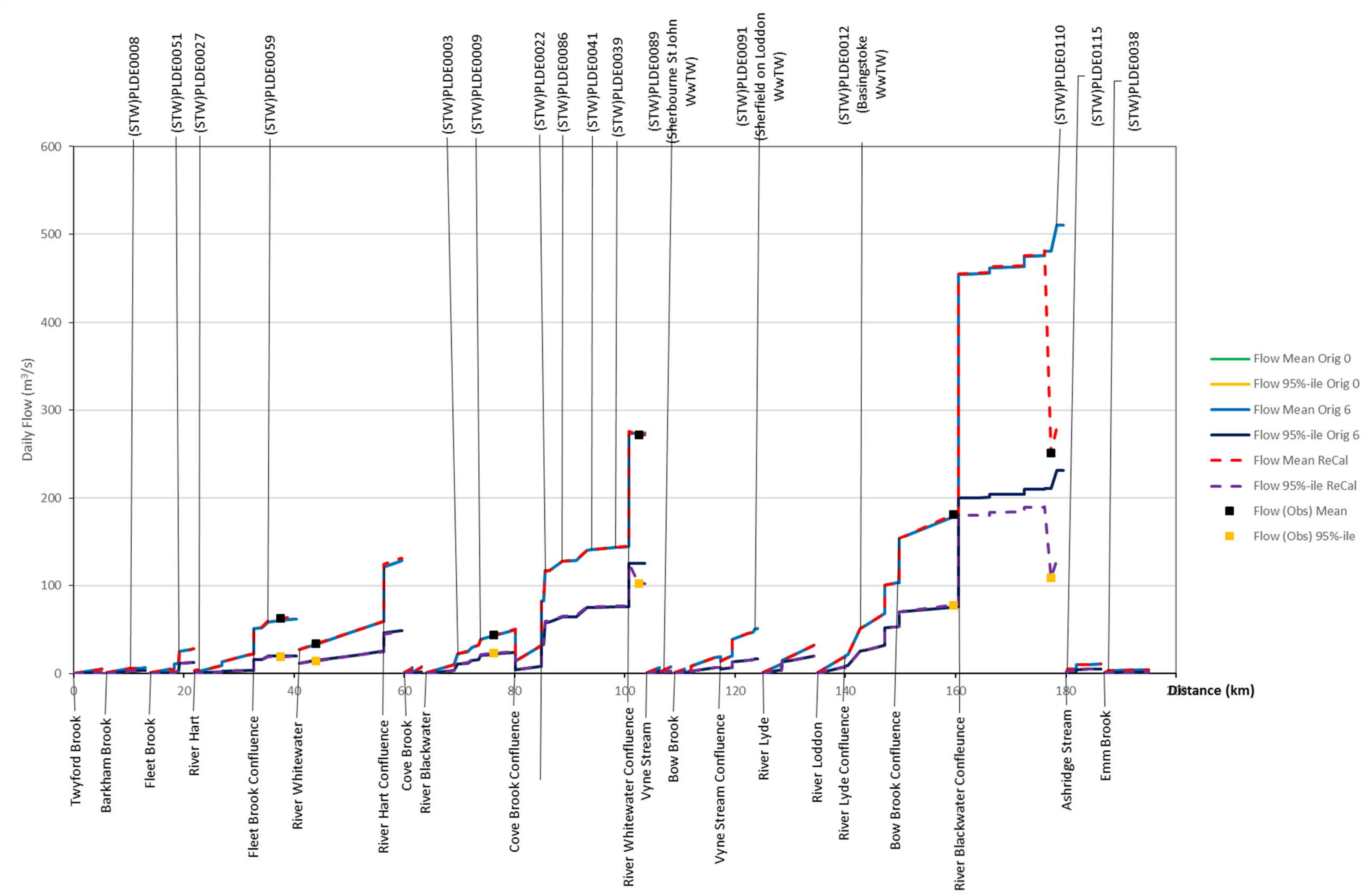


Figure D-1: Modelled Flows in the River Loddon Catchment: Received Model in Modes 0 and 6, Corrected Model in Mode 6

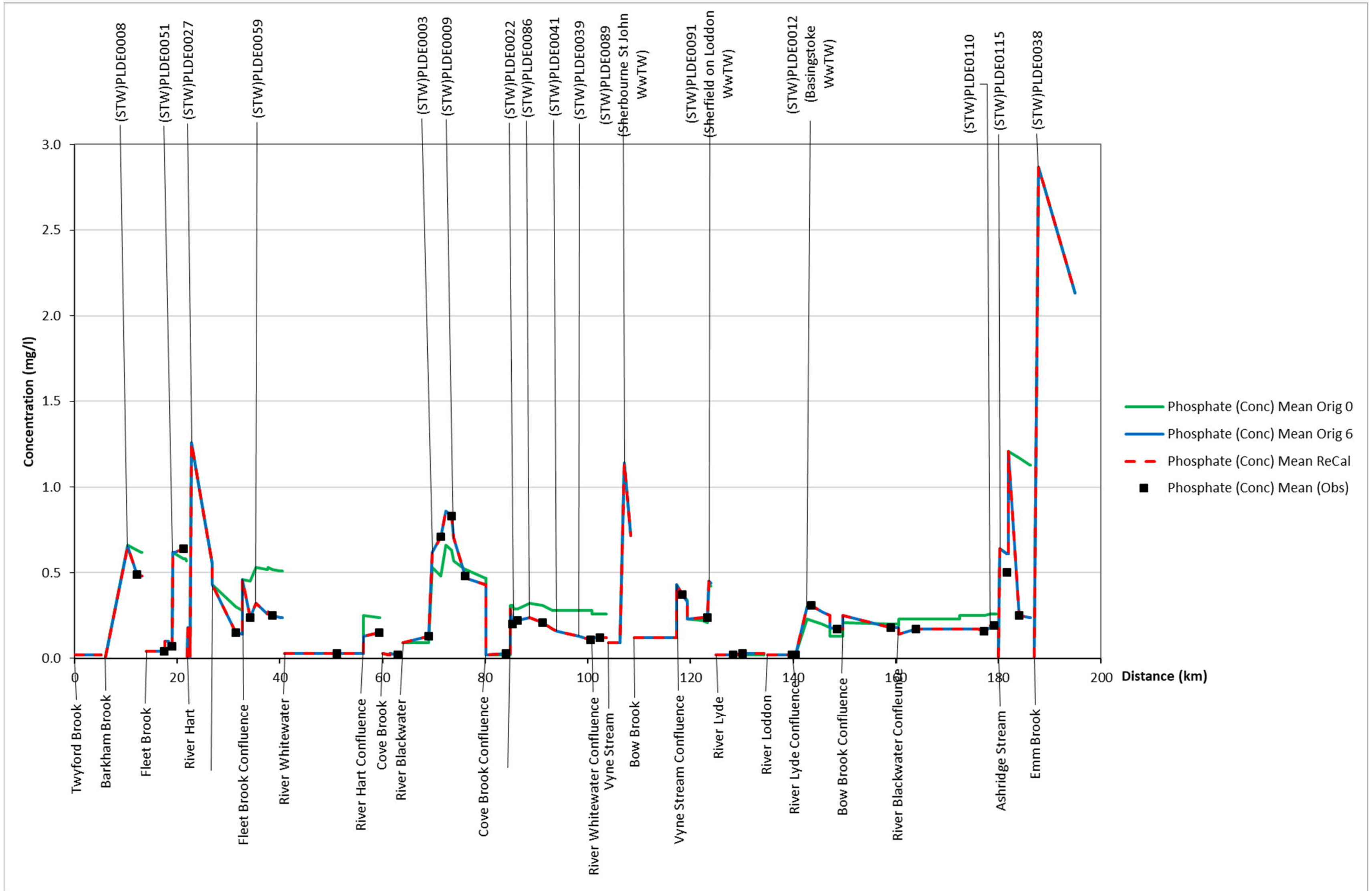


Figure D-2: Modelled Mean Phosphate Concentrations in the River Loddon Catchment: Received Model in Modes 0 and 6, Corrected Model in Mode 6

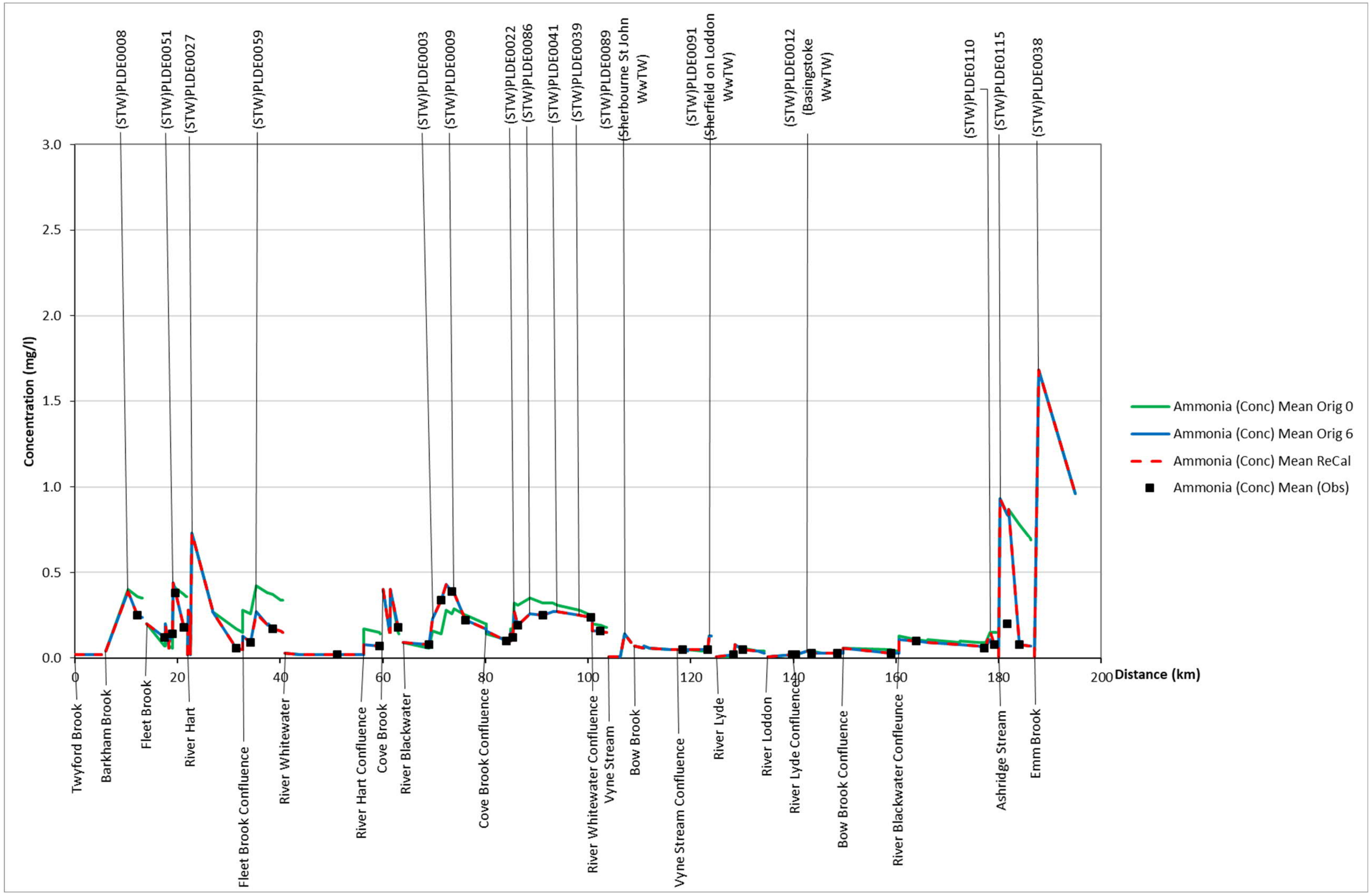


Figure D-3: Modelled Mean Ammonia Concentrations in the River Loddon Catchment: Received Model in Modes 0 and 6, Corrected Model in Mode 6

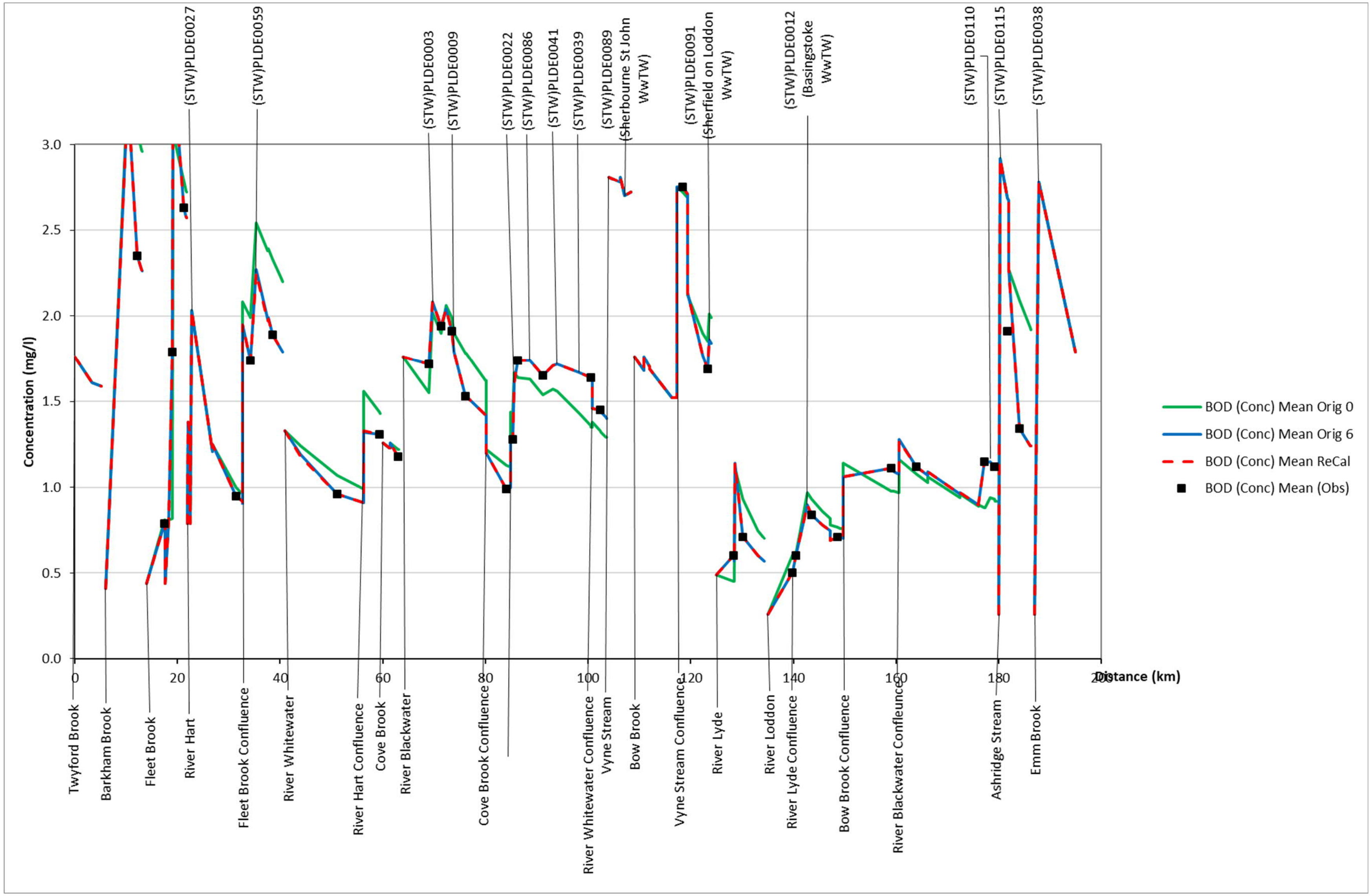


Figure D-4: Modelled Mean BOD Concentrations in the River Loddon Catchment: Received Model in Modes 0 and 6, Corrected Model in Mode 6

D.2 SIMCAT Model Updates

The received SIMCAT model has been updated to reflect current WwTW flows and effluent quality, current river flow data and the most up-to-date water quality monitoring data (up to 2021).

WwTW discharge flow

Current WwTW mean effluent flows were taken from 2017-2022 flow data provided by Thames Water. These data were used to update the original SIMCAT model, as provided by the Environment Agency, to create the "baseline" model which aims to be representative of conditions in 2022. The values used in the original and baseline model are shown in Table D-1.

Table D-8-1: Mean and Standard Deviation Values for WwTW Effluent Flow (Ml/d): Original and Baseline SIMCAT Model

Wastewater Treatment Works	Original 2009 SIMCAT Model		Updated 2022 Baseline Model Value	
	Mean flow	Standard Deviation	Mean Flow	Standard Deviation
Basingstoke	20.91	6.81	26.29	6.12
Sherborne St John	1.19	0.78	1.15	0.74
Sherfield on Loddon	1.89	0.84	1.66	0.67

For SIMCAT modelling of future discharges, development increases in the catchment areas of the three WwTW needed to be included in the model. The future discharges from the WwTW have been calculated and are set out in Table D-8-2.

Table D-8-2: Current and Future WwTW Discharges Used in SIMCAT Modelling (Ml/d)

WwTW	Baseline Model		Scenario 1		Scenario 2		Scenario 3	
	Mean Flow	Standard Deviation	Mean Flow	Standard Deviation	Mean Flow	Standard Deviation	Mean Flow	Standard Deviation
Basingstoke	26.29	6.12	32.67	7.61	33.66	7.84	33.77	7.87
Sherborne St John	1.15	0.74	1.50	0.96	1.50	0.96	1.23	0.79
Sherfield on Loddon	1.66	0.67	1.77	0.71	2.30	0.93	2.30	0.93

Note that the consented dry weather flow at Sherborne St John WwTW reduced in 2020 from 1470m^3/d to 1000m^3/d (1.47Ml/d to 1.0Ml/d). However, dry weather flows under both the current and predicted scenarios would remain below this new limit and since SIMCAT uses mean flow and not dry weather flow, the values in Table D-2 do not need to be changed to reflect this new permit condition.

WwTW discharge quality

The current discharge quality for each determinand (Ammonia, BOD and Phosphate) was calculated from the available WwTW discharge quality monitoring data provided for the period 2010-2021 by the Environment Agency (Table D-3). The most recent monitoring data takes account of changes in the effluent quality at Sherborne St John WwTW, with the imposition of a new phosphate limit of 0.6mg/l from 2020 onwards, and at Basingstoke WwTW where the phosphate pollutants limit was revised to 0.5mg/l. Note that no data have been provided for phosphate concentrations in the final effluent from Sherfield on Loddon WwTW, so the values used in the original model are assumed to be correct.

The future discharge quality for phosphate, ammonia and BOD were assumed to be the same as current (2022) values, given that no further changes are proposed to discharge limits.

Table D-8-3: Original and Updated Phosphate, Ammonia and BOD Concentrations used in SIMCAT modelling (mg/l)

	WwTW	Basingstoke	Sherfield on Loddon	Sherborne St John
Original Model	Mean Phosphate Concentration (mg/l)	0.53	4.88	4.02
	Standard Deviation Phosphate Concentration (mg/l)	0.57	1.38	1.21
	Mean Ammonia Concentration (mg/l)	0.07	1.98	0.43
	Standard Deviation Ammonia Concentration (mg/l)	0.10	1.64	0.64
	Mean BOD Concentration (mg/l)	1.45	5.74	2.14
	Standard Deviation BOD Concentration (mg/l)	0.36	2.65	2.26
2022 Baseline Model	Mean Phosphate Concentration (mg/l)	0.25	4.88	0.37
	Standard Deviation Phosphate Concentration (mg/l)	0.11	1.38	0.13
	Mean Ammonia Concentration (mg/l)	0.07	0.52	0.37
	Standard Deviation Ammonia Concentration (mg/l)	0.09	0.60	0.66
	Mean BOD Concentration (mg/l)	1.67	4.19	0.75
	Standard Deviation BOD Concentration (mg/l)	0.85	1.57	1.05

River water flow and quality

River flow gauge data for the period of record (up to September 2021) have been obtained from the NRFA database for six flow gauges in the catchment. The flow data in the model has been updated to reflect the data in the current record (Table D-4) and these values have been maintained in the 2039 model (updated baseline model plus growth). Data were also provided by the Environment Agency for the new flow gauging station on the River Loddon at Pyotts Bridge for up to December 2019. This was not present in the original SIMCAT model as provided by the Environment Agency and was added into the baseline model.

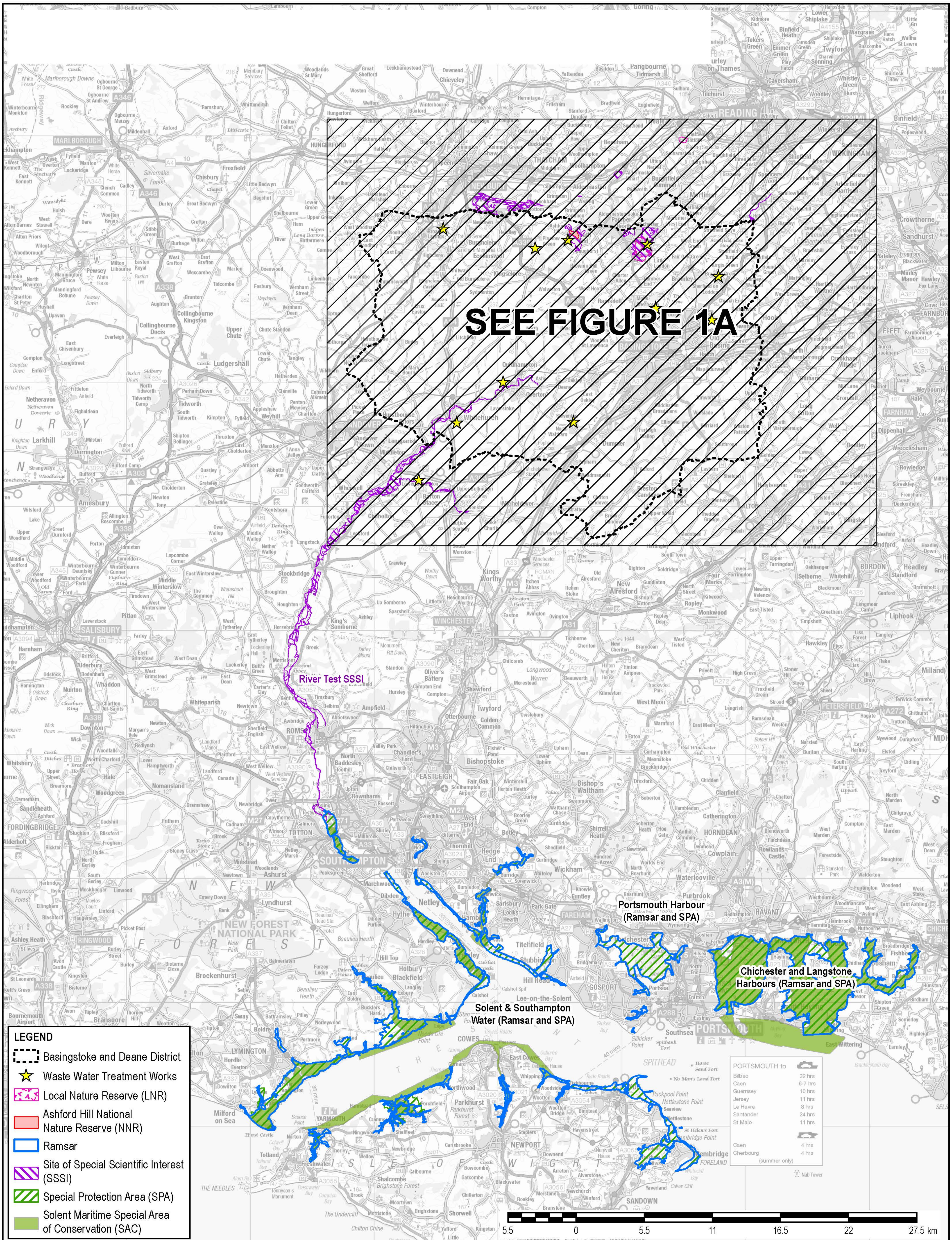
River water quality monitoring data were obtained from the Defra open data website for the period 2009 to date. These data were used to update the original SIMCAT model, as set out in Table D-5, to create and calibrate the "baseline" model. By preference, data from 2015 onwards was used, however the entire record was used where more recent data were not present, where there was insufficient recent data or where there was no significant change in mean values over the period of record. Two sample points on Bow Brook, PLDR0051 and PLDR0055, were removed from the baseline model as these sample points have no data following 2017 and are therefore unrepresentative of current water quality following changes to wastewater treatment processed at Sherborne St John WwTW in 2020. Similarly, water quality statistics from the first sample point on the River Loddon downstream of the Bow Brook confluence, PLDR0028, have been limited to data from 2019 onwards. The updated water quality data also included five sample points which were not included in the original SIMCAT model and were added into the baseline model (Table D-5). These new data points did not include data for BOD.

Table D-4: River Flow Values (Ml/d) used in the Original and Updated SIMCAT model

Watercourse	Location	Original mean flow	Original Q95	Mean (Ml/d)	Q95 (Ml/d)
River Loddon	Sheepbridge	181.1	77.7	195.4	84.7
River Blackwater	Farnborough	43.5	23.00	42.8	16.9
River Blackwater	Swallowfield	271.7	102.4	273.7	91.6
River Whitewater	Lodge Farm	33.6	14.1	33.3	14.7
River Hart	Bramshill House	62.6	19.9	69.3	19.9
River Loddon	Twyford	251.1	108.9	549.9	203.6
River Loddon	Pyotts Bridge	Not included in Model		101.2	65.8

Table D-5: River Water Quality Sample Point Data: Original and Baseline SIMCAT Model

	Ammonia Sample Data						Phosphate Sample Data						BOD Sample Data					
	Original Model			Baseline Model			Original Model			Baseline Model			Original Model			Baseline Model		
Sample Point	No. Samples	Mean	Std Dev	No. Samples	Mean	Std Dev	No. Samples	Mean	Std Dev	No. Samples	Mean	Std Dev	No. Samples	Mean	Std Dev	No. Samples	Mean	Std Dev
PLDR0007	35	0.24	0.30	13	0.04	0.01	35	0.11	0.04	22	0.13	0.07	31	1.636	0.9795	85	2.06	1.44
PLDR0010	36	0.16	0.17	33	0.012	0.13	36	0.12	0.03	40	0.12	0.04	32	1.447	0.6384	70	2.11	1.26
PLDR0056	Not included in Model			20	0.13	0.11	Not included in Model			77	0.06	0.04	Not included in Model			No data		
PLDR0055	13	0.04	0.01	Not included in Model			13	0.20	0.10	Not included in Model			33	1.691	1.025	Not included in Model		
PLDR0054	Not included in Model			102	0.06	0.13	Not included in Model			26	0.06	0.03	Not included in Model			No data		
PLDR0017	25	0.18	0.19	26	0.35	0.54	25	0.64	0.47	26	0.33	0.51	24	2.63	1.024	24	2.63	1.024
PLDR0018	37	0.060	0.03	72	0.10	0.27	35	0.15	0.06	160	0.13	0.07	33	0.9545	0.6018	16	1.9	1.43
PLDR0019	36	0.093	0.09	9	6.38	2.59	36	0.24	0.20	136	0.30	0.45	33	0.174	0.9282	9	0.34	0.6
PLDR0020	36	0.17	0.20	183	4.53	4.39	36	0.25	0.11	130	0.21	0.39	33	1.893	1.224	159	1.04	1.11
PLDR0028	36	0.03	0.04	12	0.06	0.07	34	0.18	0.06	12	0.11	0.03	25	1.106	0.7119	21	0.14	0.06
PLDR0096	Not included in Model			35	0.05	0.14	Not included in Model			34	0.02	0.01	Not included in Model			No data		
PLDR0073	24	0.03	0.03	62	0.04	0.10	35	0.31	0.33	62	0.12	0.10	32	0.8384	0.5559	62	0.12	0.10
PLDR0033	36	0.03	0.06	19	0.04	0.02	36	0.17	0.14	19	0.10	0.09	33	0.71	0.3974	19	0.10	0.09
PLDR0034	36	0.02	0.01	21	0.03	0.01	35	0.02	0.01	129	0.03	0.02	35	0.598	0.314	19	0.02	0.004
PLDR0039	36	0.05	0.03	119	0.05	0.02	36	0.03	0.01	79	0.03	0.01	31	0.7061	0.3611	34	1.54	1.83
PLDR0051	14	0.09	0.19	Not included in Model			14	0.27	0.12	Not included in Model			33	2.748	2.033	Not included in Model		
PLDR0045	36	0.07	0.08	15	0.15	0.22	36	0.15	0.06	15	0.08	0.03	32	1.306	0.7279	94	1.55	0.75
PLDR0046	Not included in Model			36	0.01	0.01	Not included in Model			36	0.02	0.01	Not included in Model			No data		
PLDR0047	35	0.02	0.01	15	0.04	0.03	36	0.34	0.04	15	0.04	0.03	31	0.9603	0.5742	96	1.38	0.65
PLDR0048	Not included in Model			33	0.02	0.03	Not included in Model			33	0.04	0.03	Not included in Model			No data		



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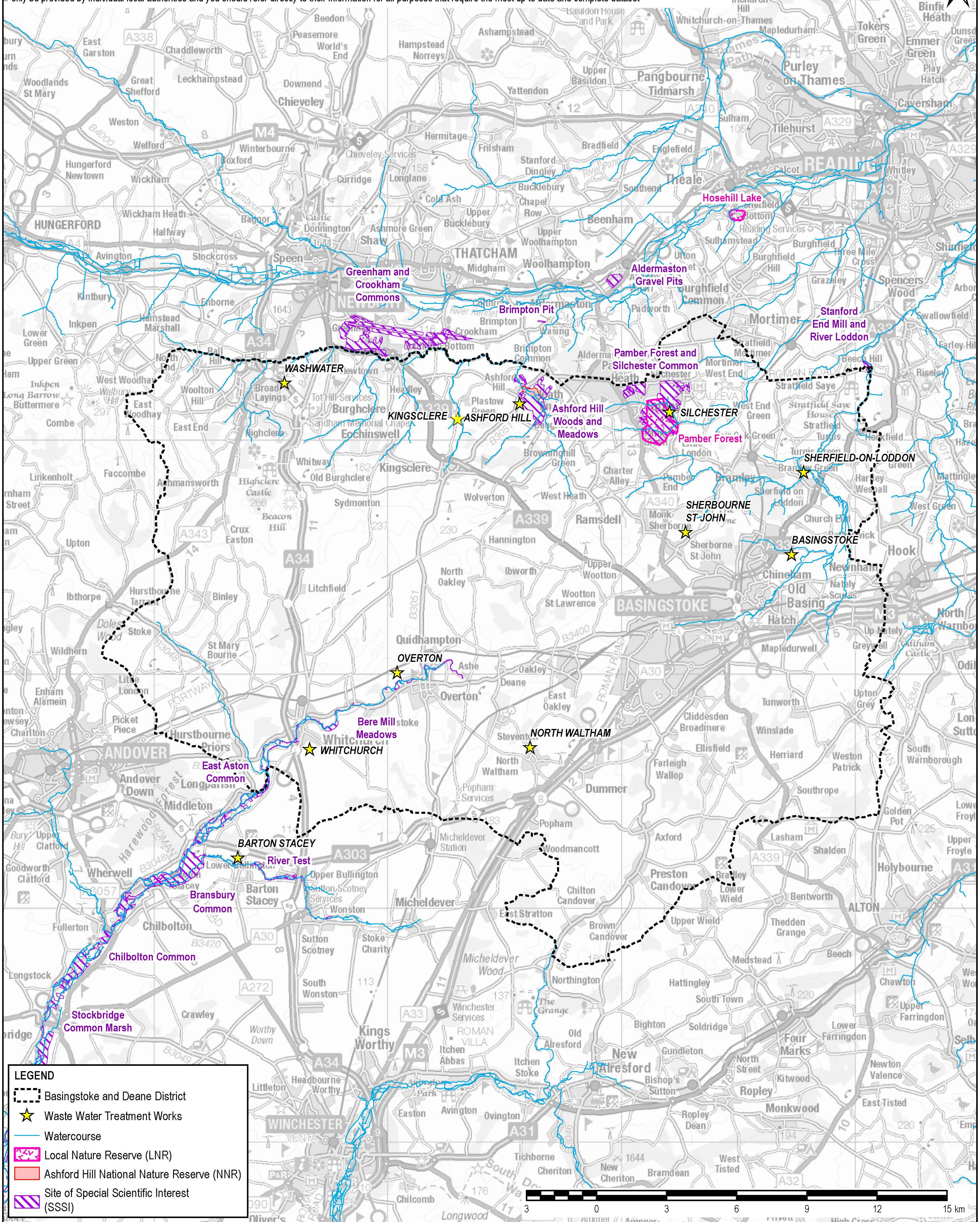

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D.3 SIMCAT Model Runs

The SIMCAT model was run as follows:

1) The Baseline Model was developed by updating the corrected original model using observed river flows and water quality and updated WwTW effluent quality and flows up to 2022. This model was also run initially in mode 0.

2) A Calibrated Baseline Model was created by re-running the Baseline Model in mode 6 to calibrate it using the updated datasets. The Calibrated Model shows the impacts of the existing inputs on water quality in the River Loddon.

3) Scenario 1: The Baseline model was run with additional flows at Basingstoke WwTW, Sherfield on Loddon WwTW and Sherborne St John WwTW to account for future development in Basingstoke and Deane Borough under scenario 1. This model was run in mode 4.

4) Scenario 2: The Baseline model was run with additional flows at Basingstoke WwTW, Sherfield on Loddon WwTW and Sherborne St John WwTW to account for future development in Basingstoke and Deane Borough under scenario 2. This model was run in mode 4.

5) Scenario 3: The Baseline model was run with additional flows at Basingstoke WwTW, Sherfield on Loddon WwTW and Sherborne St John WwTW to account for future development in Basingstoke and Deane Borough under scenario 3. This model was run in mode 4.

D.4 SIMCAT Model Results – Model Update

The SIMCAT model results are presented in Figures D-5 to D-8 for the recalibrated and corrected original received model as well as the new baseline model prior to and following calibration with the new observed data. This shows the effects of updating the model with more recent data.

The three models produce extremely similar modelled flows for the tributaries of the River Loddon, where the additional flow data in the updated model has not greatly changed the river flow values used in the updated models. The most significant changes are in the River Loddon, where the new gauge at Pyotts Bridge results in a significant correction to the modelled river flows in the most upstream section of the River Loddon (the red and purple broken lines diverge significantly from the solid lines. The models then predict more similar flows in the middle reach of the Loddon, based on measured flows at the Sheepbridge gauge. The updated model then predicts higher flows in the most downstream section of the River Loddon due to correction of the flow data at the Twyford gauge (Table D-4).

The updates have also resulted in generally modest changes to the modelled water quality in the River Loddon and its tributaries. The updated, calibrated model shows good agreement with the original calibrated model in terms of phosphate concentrations in the tributary watercourses, with the autocalibration of both models generally reducing modelled phosphate concentrations to reflect the observed data. There is a small reduction in modelled phosphate concentration in the River Loddon in the updated model, in the section where Basingstoke WwTW is located. The baseline model also shows removal of the phosphate spike in Vyne Stream following imposition of limits on phosphate discharges from Sherfield St John WwTW, which also reduces phosphate concentrations in Bow Brook downstream and in a short section of the River Loddon. The updated and calibrated original model also show good agreement in terms of ammonia concentrations, although the updated model shows a significant ammonia spike in Fleet Brook which is carried down into the River Whitewater. This spike is not present in the original model but is based on the observed data. There is more variation in terms of predicted BOD concentrations, however the variations reflect changes in the observed water quality data sets and are generally short-lived.

Because it uses the most recent observed data (river flow, WwTW discharge and in river concentrations), the updated model is considered to be more representative of current conditions and an appropriate baseline for scenario testing.

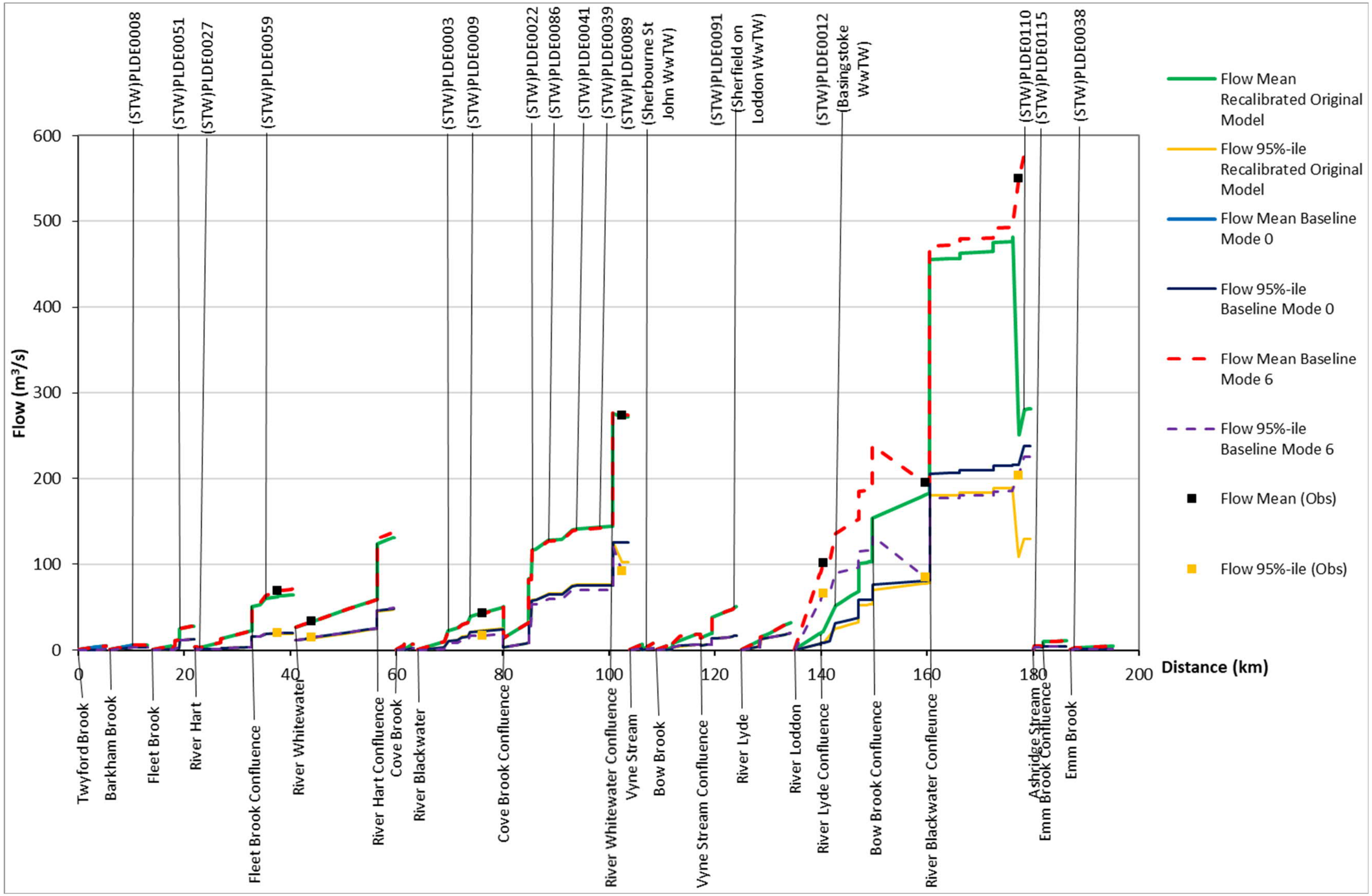


Figure D-5: Modelled Mean and Q95 Flows in the River Loddon Catchment: Corrected Model in Mode 6 and Updated Baseline Model in Modes 0 and 6

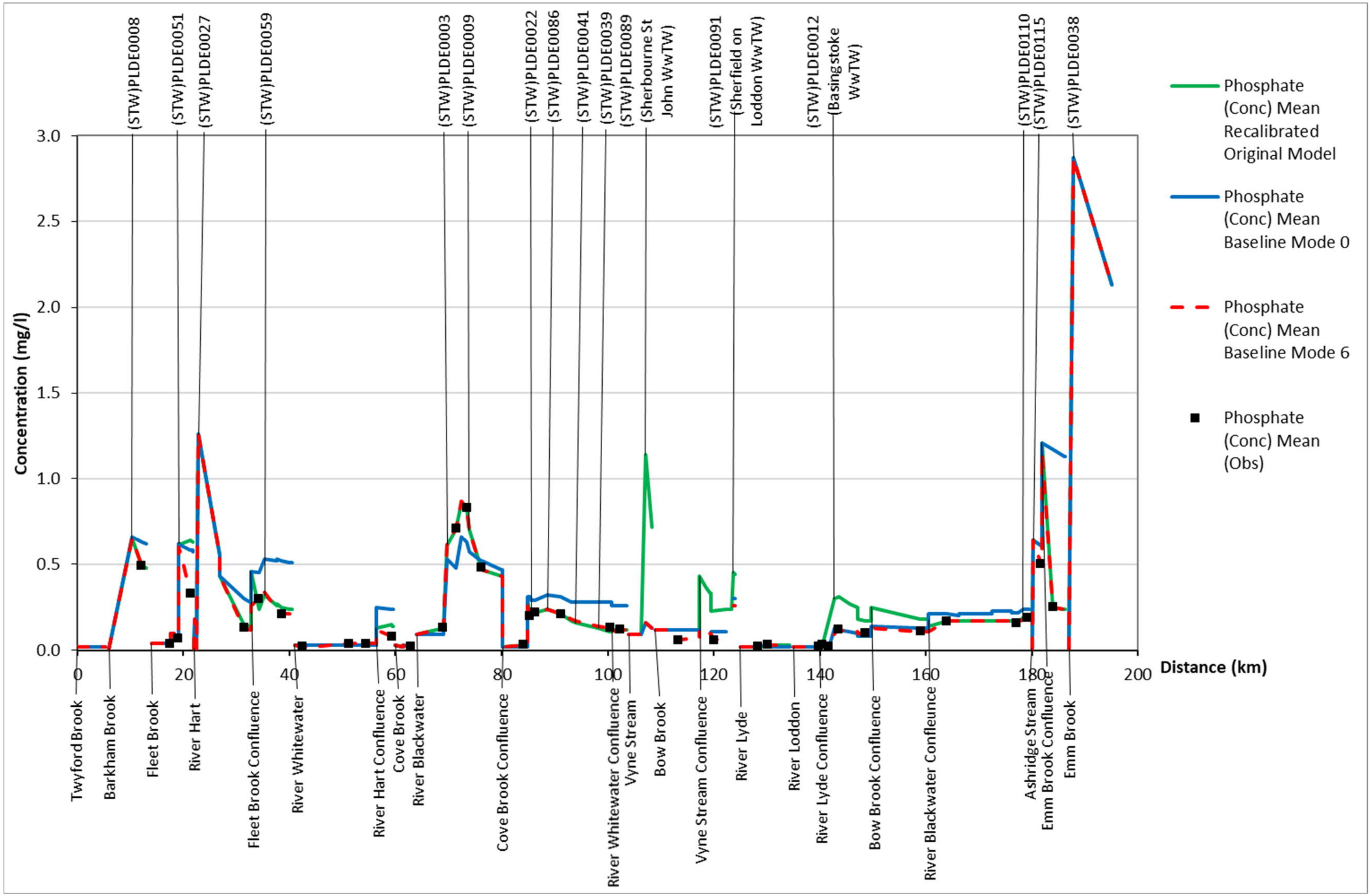


Figure D-6: Modelled Mean Phosphate Concentrations the River Loddon Catchment: Corrected Model in Mode 6 and Updated Baseline Model in Modes 0 and 6

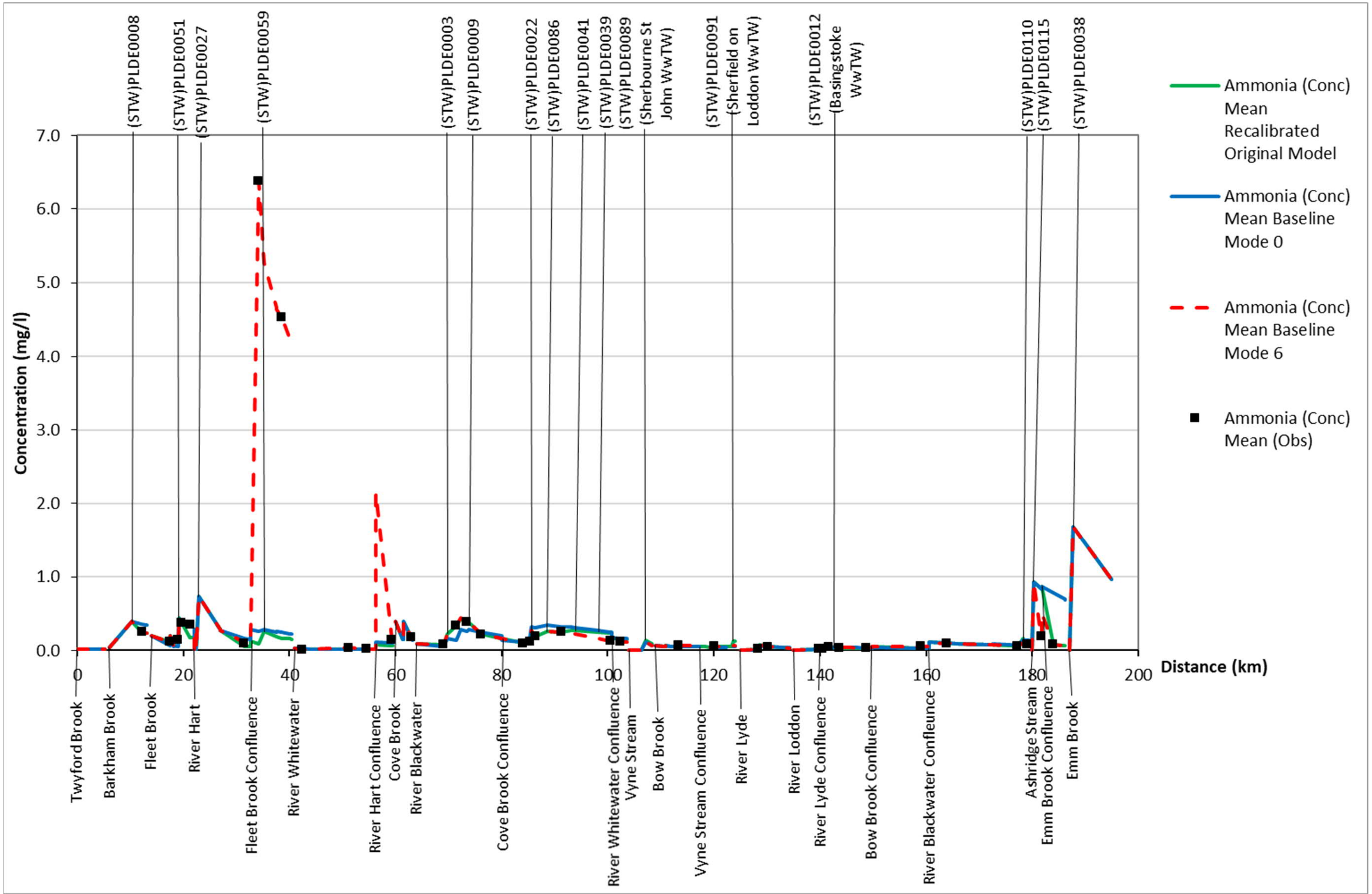


Figure D-7: Modelled Mean Ammonia Concentrations the River Loddon Catchment: Corrected Model in Mode 6 and Updated Baseline Model in Modes 0 and 6

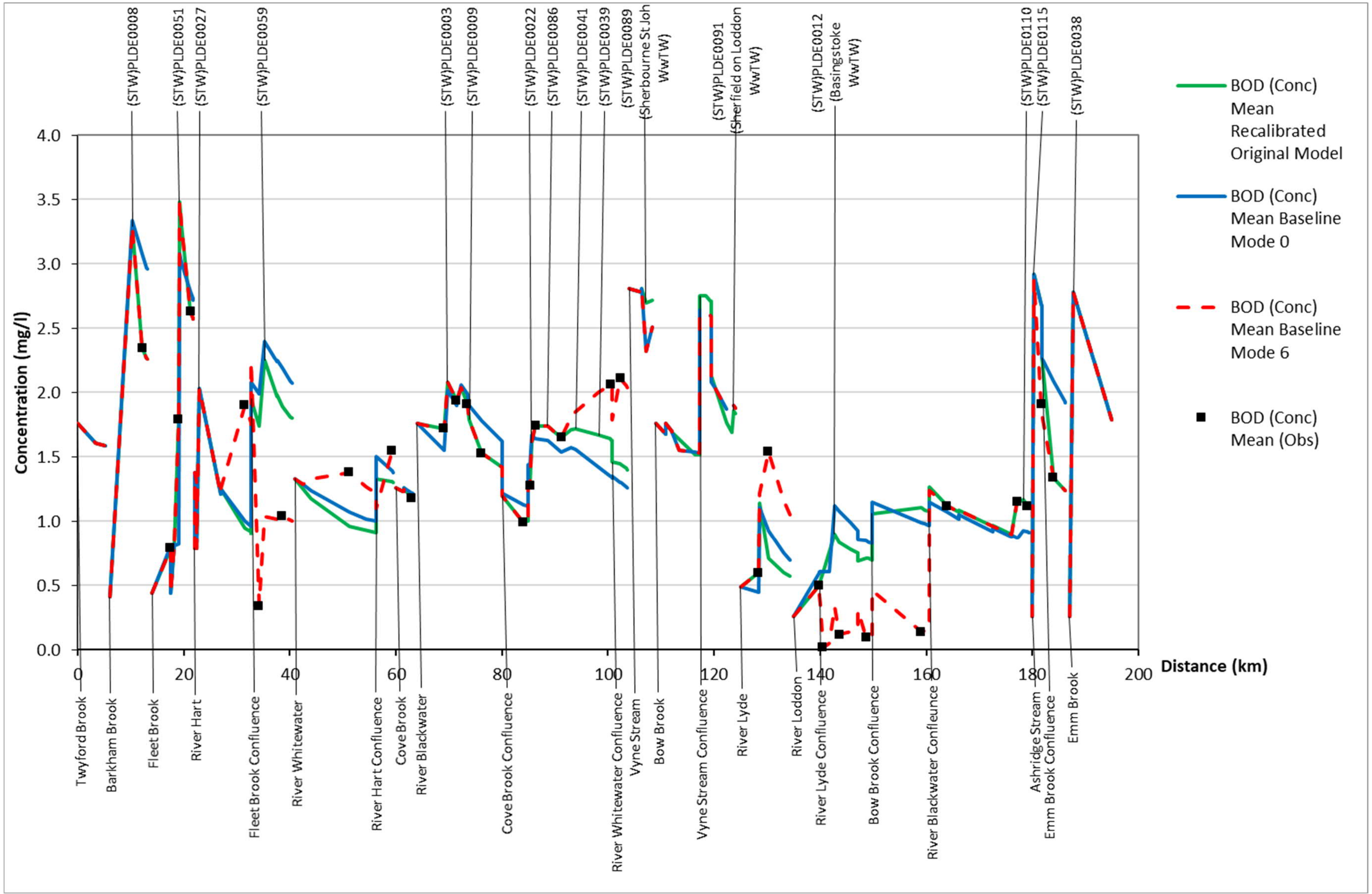


Figure D-8: Modelled Mean BOD Concentrations the River Loddon Catchment: Corrected Model in Mode 6 and Updated Baseline Model in Modes 0 and 6

D.5 SIMCAT Model Results – Development Scenarios

Figure D-10 to D-13 show the results of the scenario testing for river flow and water quality in Vyne Stream, Bow Brook and the River Loddon under development Scenarios 1 to 3. The change in flow only becomes significant downstream of Basingstoke WwTW, which is the largest WwTW and provides a significant point inflow to the River Loddon, and is the same under all three Scenarios. The increase in flow from the smaller WwTW at Sherborne St John and Sherfield on Loddon is not sufficient to result in an observable increase in flow downstream of the WwTW under either development scenario (Figure D-10).

The increase in flow under development scenarios 1 to 3 is sufficient to result in a change in phosphate concentrations in all three watercourses (Figure D-11). The impact at Sherborne St John STW is sufficient to increase modelled phosphate concentrations to just above the Moderate Status limit, i.e. to result in Poor Status, in Vyne Stream, but this only occurs immediately downstream of the discharge and Moderate Status is achieved downstream. However, this is based on assumed upstream concentrations and the lack of actual observed phosphate data upstream of the WwTW discharge makes the actual status impact impossible to determine with confidence.

The current discharges from Sherfield on Loddon WwTW are sufficient to reduce the water quality from Moderate to Poor status with respect to phosphate, and development under Scenarios 1 to 3 would increase this impact. However, the affected reach would be short and there would be minimal change in the quality of the River Loddon downstream. Phosphate pollutants from Basingstoke WwTW currently reduce the status of the River Loddon from High to Moderate, and although development under Scenarios 1 to 3 would increase this impact, the modelling shows a small additional impact and no change in status.

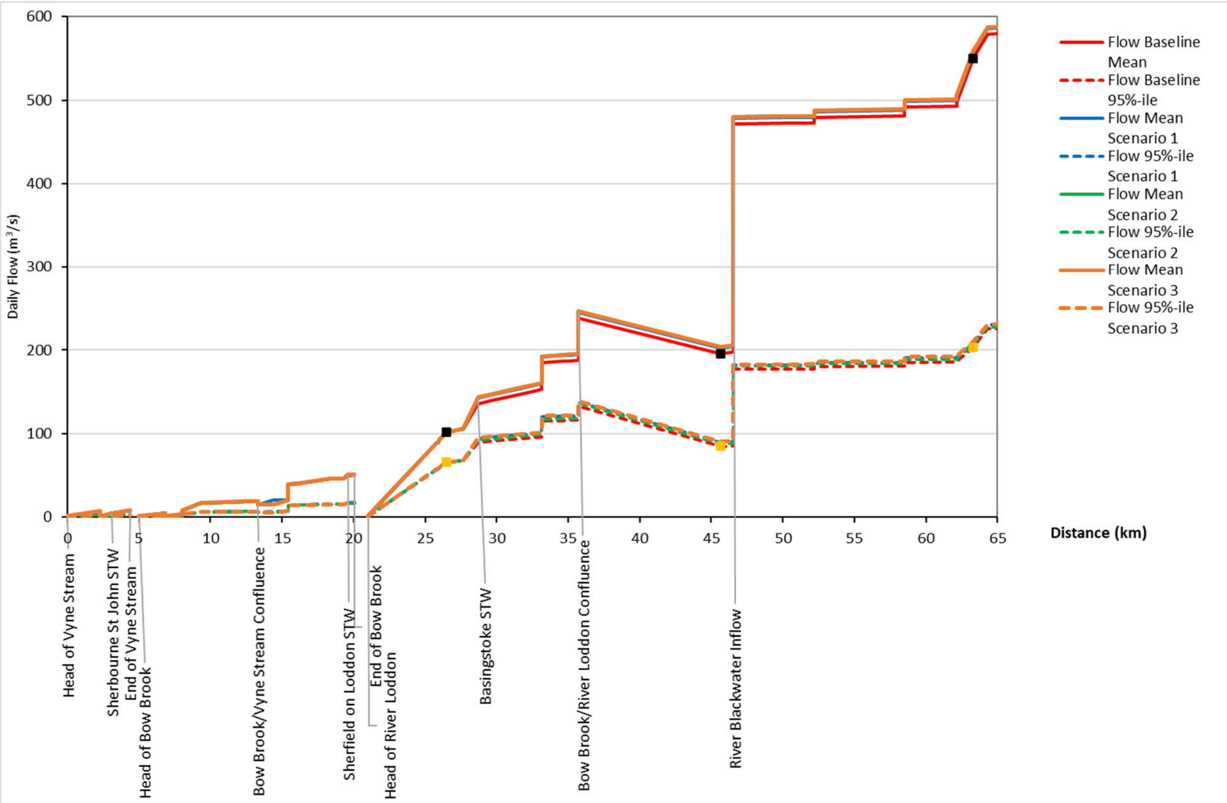


Figure D-10: Results of SIMCAT Scenario Testing for Flow in the River Loddon, Bow Brook and Vyne Stream

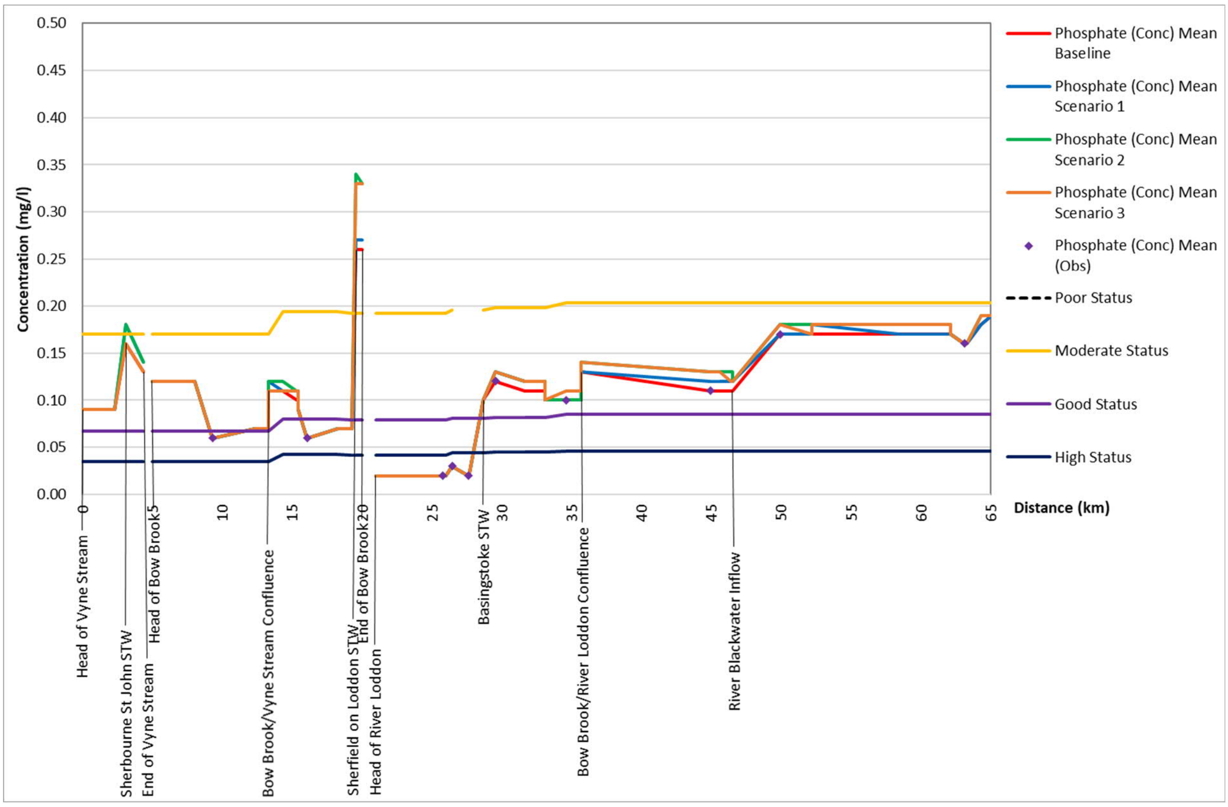


Figure D-11: Results of SIMCAT Scenario Testing for Phosphate in the River Loddon, Bow Brook and Vyne Stream

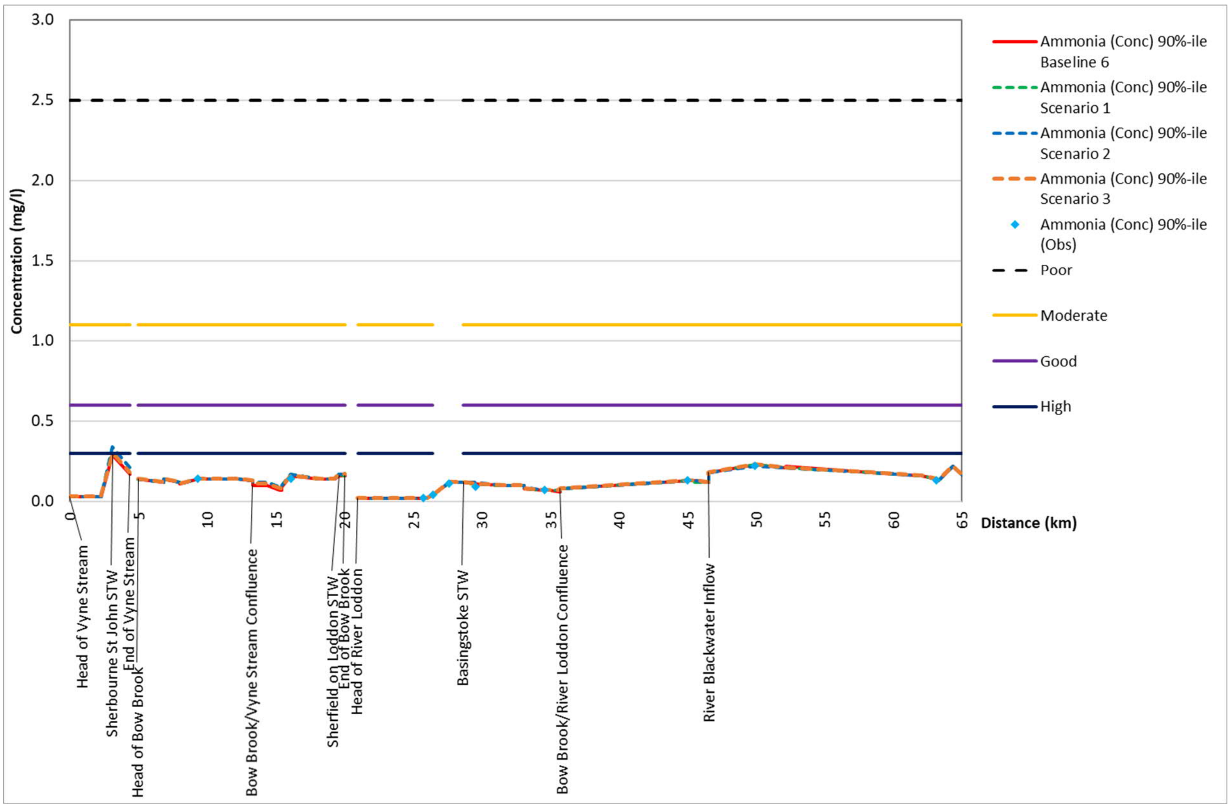


Figure D-12: Results of SIMCAT Scenario Testing for Ammonia in the River Loddon, Bow Brook and Vyne Stream

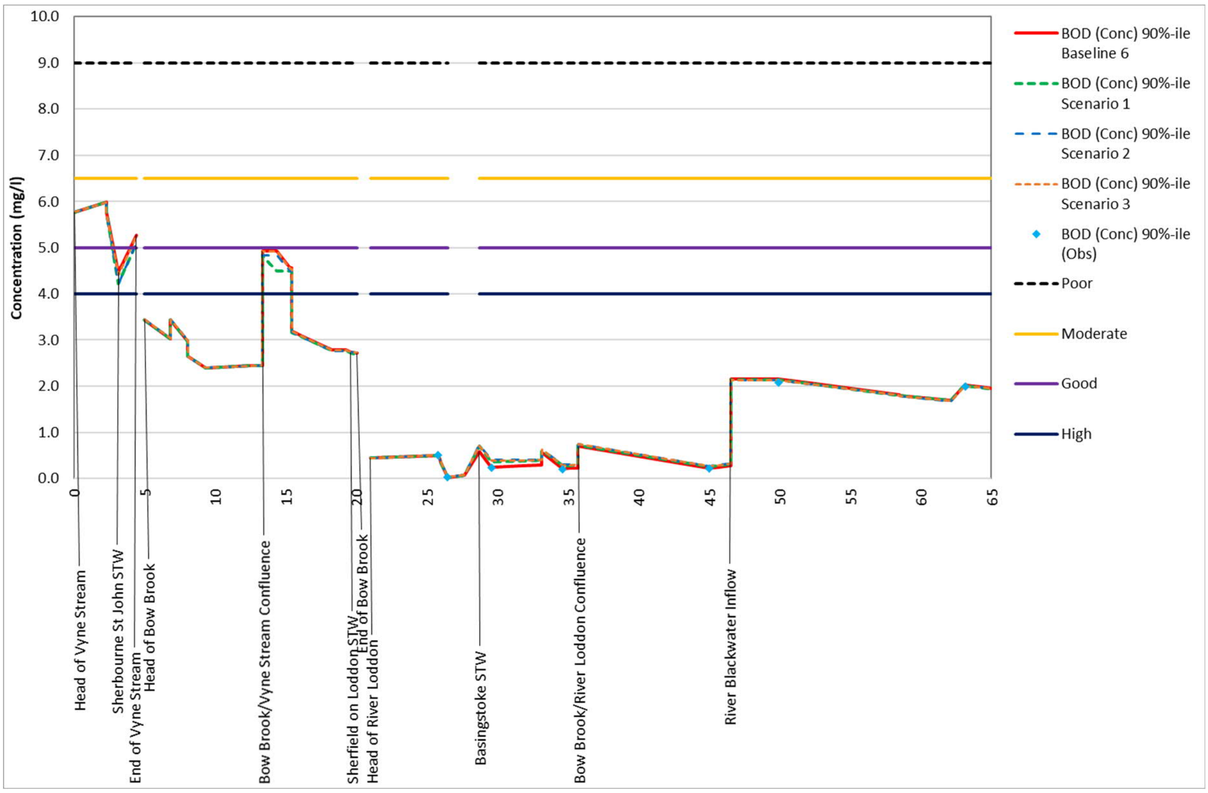


Figure D-13: Results of SIMCAT Scenario Testing for BOD in the River Loddon, Bow Brook and Vyne Stream

Figure D-12 shows that high status is achieved for ammonia in Bow Brook and the River Loddon. Inputs to Vyne Stream from Sherborne St John WwTW locally increase ammonia concentrations in this watercourse, however impacts on Bow Brook downstream are minimal. The model suggests that the future discharges would reduce the WFD status of Vyne Stream from High to Good under Scenarios 1 and 2 at the discharge point, although High Status would be achieved further downstream and there is no significant impact under Scenario 3. There is some uncertainty associated with these predictions as there is a lack of water quality data to accurately determine the current ammonia concentrations in Vyne Stream or the concentrations upstream of the WwTW outfall.

Figure D-13 shows that there is no significant impact in terms of BOD under any development scenario, with High status achieved along the entire River Loddon. BOD concentrations in Vyne Stream and Bow Brook are shown to be slightly reduced by increased flow from Sherborne St John WwTW. This is because the SIMCAT model assumes a mean concentration of 3mg/l and a 90%ile concentration of more than 7mg/l BOD in Vyne Stream upstream of the WwTW, while the mean discharge concentration from the WwTP is 0.75mg/l (Table D-3). There are no sampling data available for Vyne Stream to check this assumed upstream concentration, so although the model therefore shows no impact from the proposed development in terms of BOD, this conclusion is based on modelled information only.

D.6 SIMCAT Model Results – Achieving Target Status

The Scenario 1, 2 and 3 models have been re-run in mode 7 to determine the required discharge limit at the three WwTW to deliver the following targets for phosphate in the receiving watercourses:

- Vyne Stream = Moderate; the 2021 Draft RBMP target for this watercourse is Good, but the SIMCAT model assumes Moderate water quality upstream of the discharge point so Good status cannot be achieved by the model equations and a no-deterioration target of Moderate has been used instead.
- Bow Brook = Good; the current Environment Agency target for this watercourse is Moderate, but this is based on 2015 values which assumed ongoing high phosphate concentrations in effluent from Sherborne St John WwTW. The modelling has shown that the imposition of the new 0.6mg/l limit on phosphate from this WwTW has already achieved Good Status for this watercourse upstream of Sherfield on Loddon WwTW
- River Loddon = Good

The results are summarised in Table D-5.

Table D-5: Results of SIMCAT Modelling of Required WwTW Phosphate Discharge Limits for Achieving Target Status

WwTW	Target Status	Target Mean Concentration (mg/l)	Required Discharge Limit – 2022 Baseline (mg/l)	Required Discharge Limit – Scenario 1 (mg/l)	Required Discharge Limit – Scenario 2 (mg/l)	Required Discharge Limit – Scenario 3 (mg/l)
Sherborne St John	Moderate	0.17	Current limit is sufficient	0.35	0.35	Current limit is sufficient
Sherfield on Loddon	Good	0.079	0.55	0.52	0.41	0.41
Basingstoke	Good	0.081	0.34	0.29	0.28	0.28

These model runs have shown that the target status for phosphate in Bow Brook and Vyne Stream could be achieved by limiting phosphate pollutants from Sherfield on Loddon WwTW to 0.52mg/l under Scenario 1 and 0.41mg/l under Scenarios 2 and 3, and by limiting phosphate pollutants from Sherborne St John WwTW to 0.35mg/l (as before, note this conclusion for Vyne Stream is subject to uncertainty due to lack of available sampling data). The target status for the River Loddon can be achieved using current best treatment technology at Basingstoke WwTW and limiting phosphate concentrations in the final treated effluent to 0.28mg/l.

Discharges from the three WwTW do not significantly impact on watercourse BOD concentrations based on the currently available watercourse sampling data. Basingstoke WwTW and Sherfield on Loddon WwTW also do not impact significantly on ammonia concentrations. Discharges from Sherborne St John WwTW do impact on ammonia concentrations in Vyne Stream but the implications for achieving target status cannot be determined with confidence due to the lack of sampling data for this watercourse. Assuming upstream model concentrations are correct, the water quality status is reduced from High to Good at the outfall under the development Scenarios, reverting to High downstream. The target status for ammonia is Good but achieving this at the point of discharge under the future development scenarios requires an ammonia limit in the effluent which is unachievable using current available technology with a treatment limit of 1mg/l. Sherborne St John WwTW is currently achieving ammonia concentrations of less than 0.4mg/l in the final effluent but this may be because the WwTW is not operating at full design capacity so effluent ammonia concentrations are expected to increase following development. Exactly how future effluent ammonia discharges affect Vyne Stream water quality is therefore uncertain and a full assessment would need to be supported by water quality monitoring and a more detailed understanding of potential changes in treatment effectiveness over time. This is outside the scope of this study.

Appendix E Discharge Modelling

Section D1 – D3 provides an overview of the RQP modelling software, assumptions and assessment methodology. A detailed overview of the assessment results for the proposed growth within Basingstoke and Deane up to 3028 are summarised in D4.

E.1 Modelling Software

Modelling of the discharge 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 discharges from WwTW upstream.

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.

E.2 Modelling assumptions

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

WwTW discharge flow

- WwTW current measured flows were taken as the dry weather flows (DWF) provided by Thames Water. It should be noted that the DWF used for the WwTWs assessed using the SIMCAT modelling was taken from the measured data provided by the Environment Agency;
- The wastewater generation per new household is based on an assumed Occupancy Rate (OR) of 2.257 people per house and an average consumption of 125 l/h/d with additional flow as a percentage to account for an increase in infiltration (Washwater WwTW 40%; Kingsclere WwTW 30%; Ashford Hill WwTW 33%; and Silchester WwTW 68%) 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 available WwTW discharge quality monitoring data (January 2000 – November 2021) retrieved from the Environment Agency's Water Quality Archive[31] and current measured flow data provided by Thames Water;
- It was assumed that the statistical distribution of the quality elements of the discharge will remain the same in the future;
- 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:
  - 1mg/l 95%ile for Ammoniacal-N;
  - 5mg/l 95%ile for BOD; and
  - 0.25mg/l annual average for Phosphate.

[31] https://environment.data.gov.uk/water-quality/view/explore?search=&area=10-37&samplingPointType.group=&samplingPointStatus%5B%5D=open&loc=469205%2C156908&_limit=500

River water quality

- River water quality monitoring data was provided by the Environment Agency;
- The Environment Agency provided the published 2019 WFD status for the downstream sampling point;
- BOD and Ammonia river water qualities have been reported as 90 percentiles; and
- Phosphate river water qualities have been reported as means.

Water Quality Modelling Methodology

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.

Test 2- Status Deterioration Target

2a. Current permit required to ensure no deterioration in status at the **mixing point** Modelling of the current WwTW discharge flow (pre-growth) and current status, is the permit required to achieve quality at mixing point technically feasible with conventional technology? No: The WFD status deterioration test cannot be applied at the mixing point using RQP; Test 4.- Maintain current quality test needs to be carried out (no need for step 2b) Yes: go to Step 2b.	
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 to achieve quality at mixing point technically feasible with conventional technology?	
Yes: Ensuring no deterioration in status is possible. A tighter permit and treatment upgrades using conventional technology may 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 – depending on the length of waterbody affected. Modelling with a catchment based model to determine how much of the waterbody is affected may be required.

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 WRC discharge flow and permitted discharge quality, and assuming the upstream water quality is the midpoint of the future target status. Can the river achieve the target status at the mixing point now (pre-growth), with a technically feasible future permit and conventional technology? No - It is not possible to achieve the Future Target Status based on current discharge flow (pre-growth) – therefore, growth is not a factor in future objective status but limitations of current treatment technology. Yes – go to test 3b.	
3b. Required discharge quality (Future) to achieve Future Target Status Modelling the future WRC discharge flow and permitted discharge quality, and assuming the upstream water quality is the midpoint of the future target status. Can the river 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: Growth would prevent Future Target Status being achieved.

Test 4-Maintain Current Quality Target

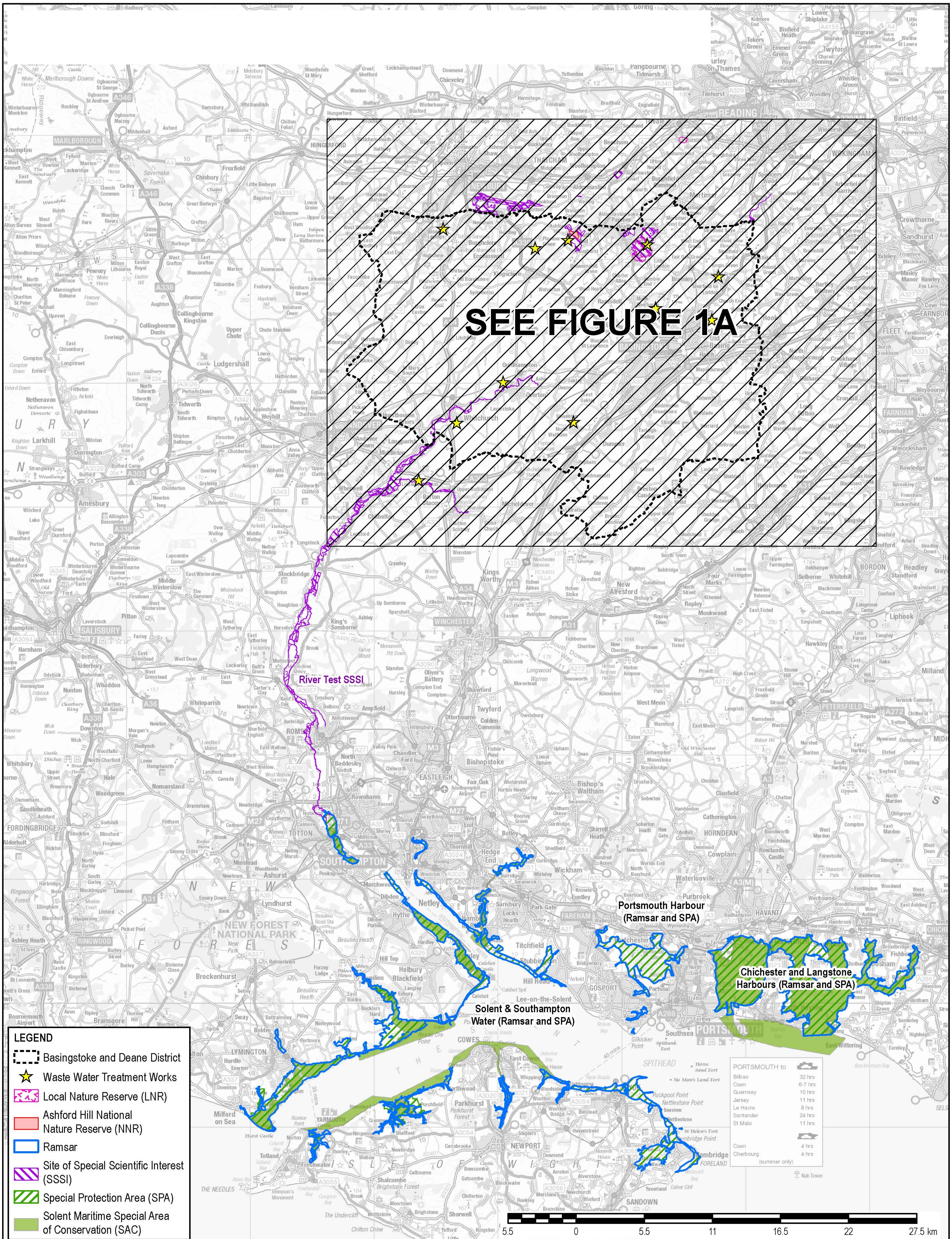
4. Revised future permit required to maintain current quality Modelling of the future WwTW discharge flow (post-growth) and current discharge quality against a river quality target of current mixing point quality; is the permit technically feasible with conventional technology to maintain current quality?	
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.

E.4 Assessment Table

WwTW	WwTW			WwTW		
Is there flow headroom in the Permit?	Washwater WwTW			Kingsclere WwTW		
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	16	-	4	12	-
Limit of Conventional Treatment (LCT)	1	5	0.25	1	5	0.25
WFD receiving waterbody and ID	**Enborne (downstream A34 to Burghclere) GB106039017310**			**Kingsclere Brook (Source to Enborne) GB106039017220**		
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 3 - 2019)	**High**	**Not recorded**	**Poor**	**High**	**Not recorded**	**Poor**
Upstream sample point	**No US Sampling Point**			**No US Sampling Point**		
Measured quality upstream of discharge	No measured data available		No measured data available	No measured data available		No measured data available
Quality Element Status based on measured data						
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)	3.07		2.95	0.44		1.06
Modelled status at mixing point with current flow	**Poor**		**Bad**	**Good**		**Bad**
10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	3.38		3.25	0.484		1.17
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate)	**5.99**		**4.46**	**3.86**		**4.76**
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)	0.20		0.993	0.30		1.044
Permit condition required at mixing point - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	**0.32**		**1.18**	**2.59**		**4.8**
Permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**0.31**		**1.18**	**2.04**		**3.84**
Maintain current quality	**5.44**		**4.03**	**3.45**		**3.96**
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		Yes	No - test not required		Yes
Target future status (2021 Cycle 3 published status target)	N/A		**Poor**	N/A		**Poor**
Permit condition required - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)			1.18			4.80
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)			1.18			3.84
Will Growth prevent future target status	N/A		No	N/A		No
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	WwTW			WwTW		
Is there flow headroom in the Permit?	Ashford Hill WwTW			Silchester WwTW		
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	-	30	-	5	7	2
Limit of Conventional Treatment (LCT)	1	5	0.25	1	5	0.25
WFD receiving waterbody and ID	**Baughurst Brook GB106039017200**			**Silchester Brook GB106039017190**		
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 3 - 2019)	**High**	**Not recorded**	**Good**	**Good**	**Not recorded**	**Poor**
Upstream sample point	**No US Sampling Point**			**Silchester Brook Above Silchester Stw (TH-PKER0081)**		
Measured quality upstream of discharge	No measured data available		No measured data available	0.209		0.135
Quality Element Status based on measured data				**High**		**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)	0.58		0.4	0.99		0.75
Modelled status at mixing point with current flow	**Good**		**Poor**	**Moderate**		**Poor**
10% deterioration limit (90 percentile Ammonia & BOD, annual average Phosphate)	0.64		0.44	1.09		0.83
Permit condition required to be within 10% deterioration target (95 percentile Ammonia & BOD, annual average Phosphate)	**8.48**		**5.73**	**2.29**		**1.45**
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		0.067	0.60		0.987
Permit condition required at mixing point - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)	**5.50**		**0.48**	**1.07**		**1.87**
Permit condition required at mixing point - after growth (95 percentile Ammonia & BOD, annual average Phosphate)	**3.10**		**0.28**	**1.07**		**1.76**
Maintain current quality	**7.47**		**5.14**	**2.06**		**1.31**
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		Yes
Target future status (2021 Cycle 3 published status target)	N/A		N/A	N/A		**Poor**
Permit condition required - current WwTW flow (95 percentile Ammonia & BOD, annual average Phosphate)						1.87
Permit condition required - after growth (95 percentile Ammonia & BOD, annual average Phosphate)						1.76
Will Growth prevent future target status	N/A		N/A	N/A		No
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**	

Appendix F Ecology Appraisal Figures



Project Title/Drawing Title	Client			AECOM
BASINGSTOKE & DEANE WATER CYLE STUDY	BASINGSTOKE & DEANE BOROUGH COUNCIL			MidPoint Alençon Link, Basingstoke Hampshire, RG21 7PP Telephone (01256) 310200 Fax (01256) 310201 www.aecom.com
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ECOLOGY, DESIGNATED SITES DISCUSSED IN REPORT	Date 28/08/2020	Scale @ A3 1:275,000	Purpose of Issue DRAFT	
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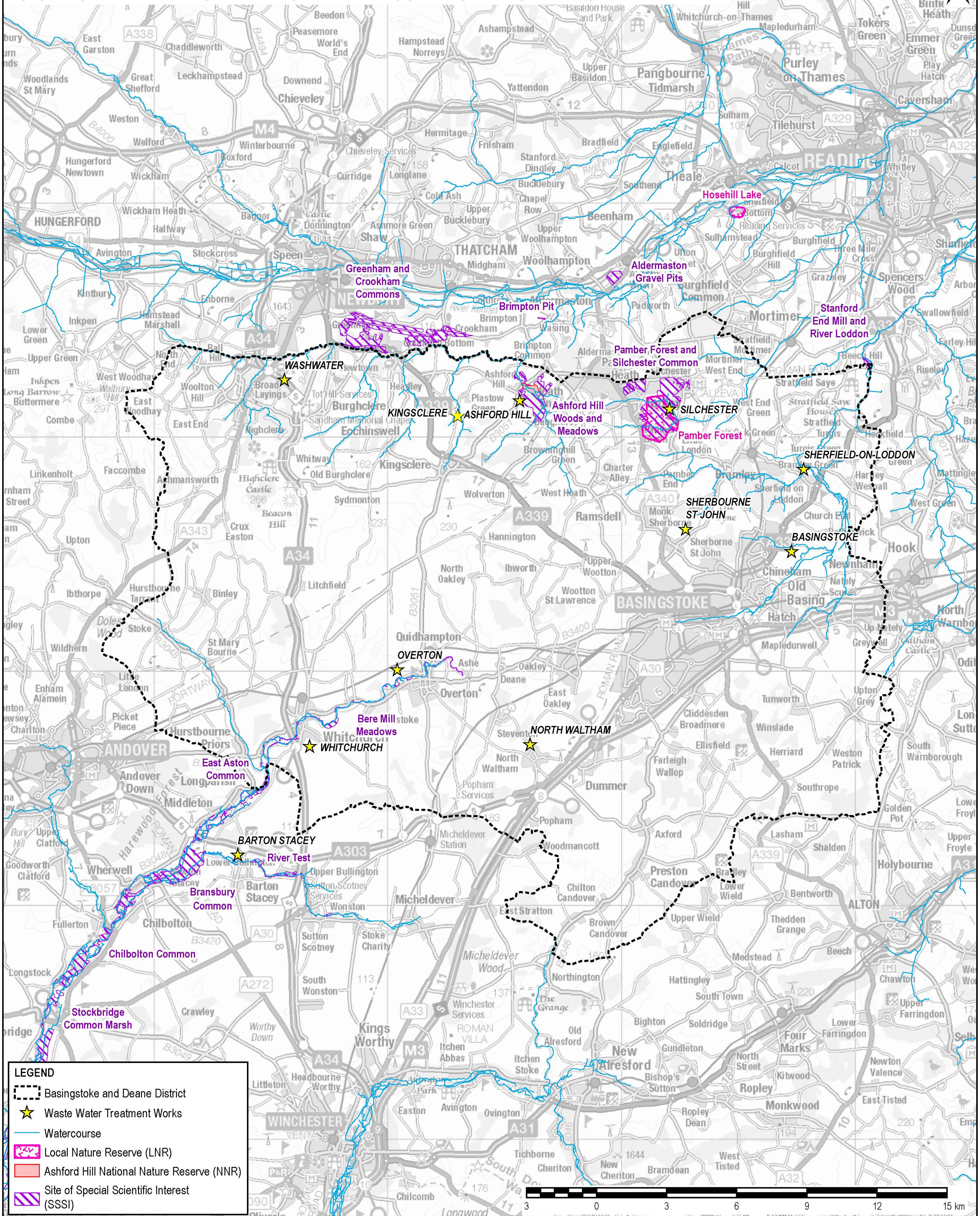

Project Title/Drawing Title	Client			AECOM
BASINGSTOKE & DEANE WATER CYLE STUDY ECOLOGY, DESIGNATED SITES DISCUSSED IN REPORT	BASINGSTOKE & DEANE BOROUGH COUNCIL			MidPoint Alençon Link, Basingstoke Hampshire, RG21 7PP Telephone (01256) 310200 Fax (01256) 310201 www.aecom.com
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	Date 28/08/2020	Scale @ A3 1:150,000	Purpose of Issue DRAFT	
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Appendix G Water Neutrality

This appendix provides supplementary information and guidance behind the processes followed in the water neutrality assessments.

G.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[32], 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[33].

G.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;

[32] Water Efficiency in the South East of England, Environment Agency, April 2007.
[33] 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.

The adopted Local Plan contains a policy relating to sustainable water use (Policy EM9). The policy requires new homes to meet a water efficiency standard of 110 litres or less per person per day and non-residential development of 1000sqm or more to meet BREEAM excellent standards for water consumption. In addition to the steps required in 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 appendix 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.

G.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 16l per person per day, assuming an occupancy rate of 2.43[34] 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)[35]. 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 F-1).

Table F-1: Change in typical metered and unmetered household bills

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

Low or Variable Flush Toilets

Toilets use about 30 per cent of the total water used in a household[36]. 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[37]per flush. A study carried out in 2000 by Southern Water and the Environment Agency[38] 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

[34] Calculated by dividing the projected 2017 population number by the projected 2017 existing housing numbers for Milton Keynes.
[35] Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009, http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/
[36] http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/toilet_flushing.html
[37] http://www.lecico.co.uk/
[38] The Water Efficiency of Retrofit Dual Flush Toilets, Southern Water/Environment Agency, December 2000

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[39].

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:

1. rising block tariff;
2. a declining block tariff;
3. a seasonal tariff; and,
4. time of day tariff.

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

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

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

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

[39] http://www.thameswater.co.uk/cps/rde/xchg/corp/hs.xsl/9047.htm

estimated[40] 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 F-2.

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

Component	126 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	25.4	18.7 b	12.3 d	12.3 d	12.3 d
Taps	21.7 a	22.7 a	20.5 a	15.3 a	15.3 a
Shower	39.42	39.8	31.8	23.9	23.9
Bath	16.7f	18.5 c	17.0 f	14.5 h	14.5 h
Washing Machine	14.07	15.6	15.6	15.6	15.6
Dishwasher	3.7	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	125.98	124.4	106.3	77.3	63.9
Total per household	304.3	300.6	256.8	186.8	154.4

- 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

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

- h 145 litre bath

Table F-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[41], 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.

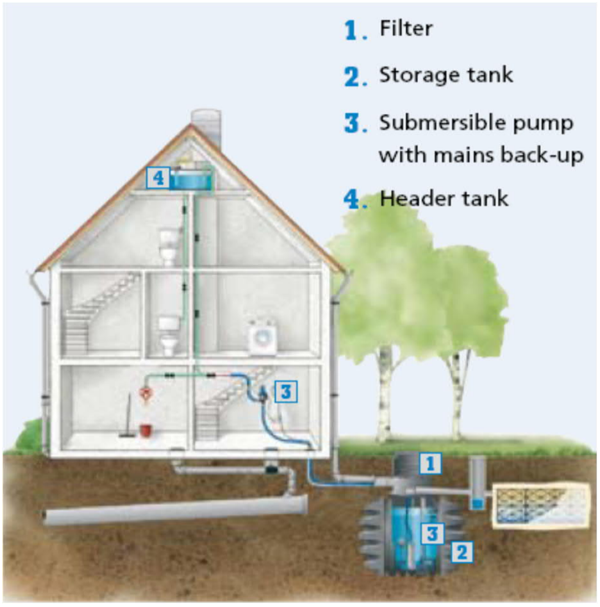
Rainwater Harvesting

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

RWH systems typically consist of a collection area (usually a rooftop), a method of conveying the water to the storage tank (gutters, down spouts and pipes), a filtration and treatment system, a storage tank and a method of conveying the water from the storage container to the taps (pipes with pumped or gravity flow). A treatment system may be included, depending on the rainwater quality desired and the source. Figure F-1 below gives a diagrammatic representation of a typical domestic system[42].

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[43].

Figure F-1: A typical domestic rainwater harvesting system



A sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[44], 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 F-3.

[41] http://www.thewatercalculator.org.uk/faq.asp
[42] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[43] Aquality Rainwater Harvesting brochure, 2008
[44] Sustainable water management strategy for Northstowe, WSP, December 2007

Table F-3: Rainwater Harvesting Systems Sizing

Number of occupants	Total water consumption	Roof area (m2)	Required storage tank (m3)	Potable water saving per head (l/d)	Water consumption with RWH (l/h/d)
1	110	13	0.44	15.4	94.6
1	110	10	0.44	12.1	97.9
1	110	25	0.88	30.8	79.2
1	110	50	1.32	57.2	52.8
2	220	25	0.88	15.4	94.6
2	220	50	1.76	30.8	79.2
3	330	25	1.32	9.9	100.1
3	330	50	1.32	19.8	90.2
4	440	25	1.76	7.7	102.3
4	440	50	1.76	15.4	94.6

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

Greywater Recycling

Greywater recycling (GWR) is the treatment and re-use of wastewater from shower, bath and sinks for use again within a property where potable quality water is not essential e.g. toilet flushing, outdoor landscaping irrigation and in some cases, washing machines. 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 F-2 below gives a diagrammatic representation of a typical domestic system[45].

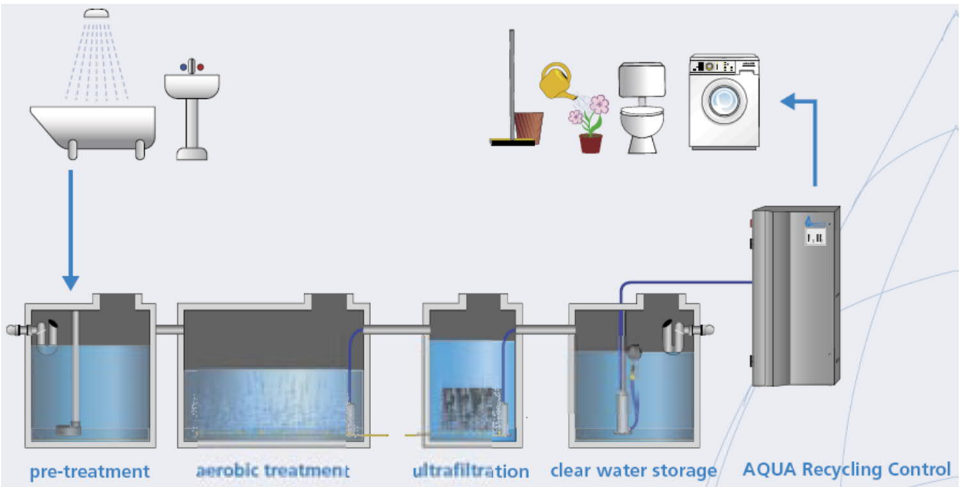


Figure F-2: A typical domestic greywater recycling system

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[46].

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

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

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

The treatment requirements of the GWR system will vary, as water which is to be used for flushing the toilet does not need to be treated to the same standard as that which is to be used for the washing machine. The source of the greywater also greatly affects the type of treatment required. Greywater from a washing machine may contain suspended solids, organic matter, oils and grease, detergents (including nitrates and Phosphates) and bleach. Greywater from a dishwasher could have a similar composition, although the proportion of fats, oils and grease is likely to be higher; similarly for wastewater from a kitchen sink. Wastewater from a bath or shower will contain suspended solids, organic matter (hair and skin), soap and detergents. All wastewater will contain bacteria, although the risk of infection from this is considered to be low[47].

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 F-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.

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

Table F-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	82% (80% within Southern Water supply area covering one third of borough; 100% within South East Water supply area covering two thirds of borough)	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	82% (80% within Southern Water supply area covering one third of borough; 100% within South East Water supply area covering two thirds of borough)	5% 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	82% (80% within Southern Water supply area covering one third of borough; 100% within South East Water supply area covering two thirds of borough)	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	82% (80% within Southern Water supply area covering one third of borough; 100% within South East Water supply area covering two thirds of borough)	15% take up across study area: - WC 4/2.6 litres dual flush - Shower 8 l/min - Basin taps 5 l/min - Sink taps 6 l/min

WN Scenario	New development requirement			Retrofitting existing development	
	New development Water use target (l/h/d)	Water Efficient Fixtures and Fittings	Water Recycling technology	Metering Penetration assumption	Water Efficient Fixtures and Fittings
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%	38.5% (Growth Scenario 1) & 50% (Growth Scenario 2) 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

G.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[48] 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 F-6.

Table F-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 F-7.

48 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/353387/021c_Cost_Report_11th_Sept_2014_FINAL.pdf

Table F-7: Costs of greywater recycling systems

Cost	Cost	Comments
Installation cost	£1,750 £2,000 £800 £2,650	Cost of reaching Code Level 5/6 for water consumption in a 2-bed flat[49] For a single dwelling[50] Cost per house for a communal system[51] Cost of reaching Code Level 3/4 for water consumption in a 3-bed semi-detached house[52]
Operation of GWR	£30 per annum[53]	
Replacement costs	£3,000 to replace	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 F-8 below.

Table F-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.

49 Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
50 http://www.water-efficient-buildings.org.uk/?page_id=1056
51 http://www.water-efficient-buildings.org.uk/?page_id=1056
52 Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008
53 Environment Agency Publication - Science Report – SC070010, Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008

Appendix H ReFH2 Summary Calculations